

REPUBLIC OF KENYA

MINISTRY OF WATER DEVELOPMENT

THE STUDY

ON

WATER DEVELOPMENT

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MINISTRY OF WATER DEVELOPMENT

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THE STUDY

ON

THE NATIONAL WATER MASTER PLAN

MAIN REPORT

VOLUME II

MASTER ACTION PLAN TOWARDS 2000

PART 1

NATIONAL WATER MASTER ACTION PLAN

JULY 1992

JAPAN INTERNATIONAL COOPERATION AGENCY

LIST OF REPORTS

EXECUTIVE SUMMARY

MAIN REPORT

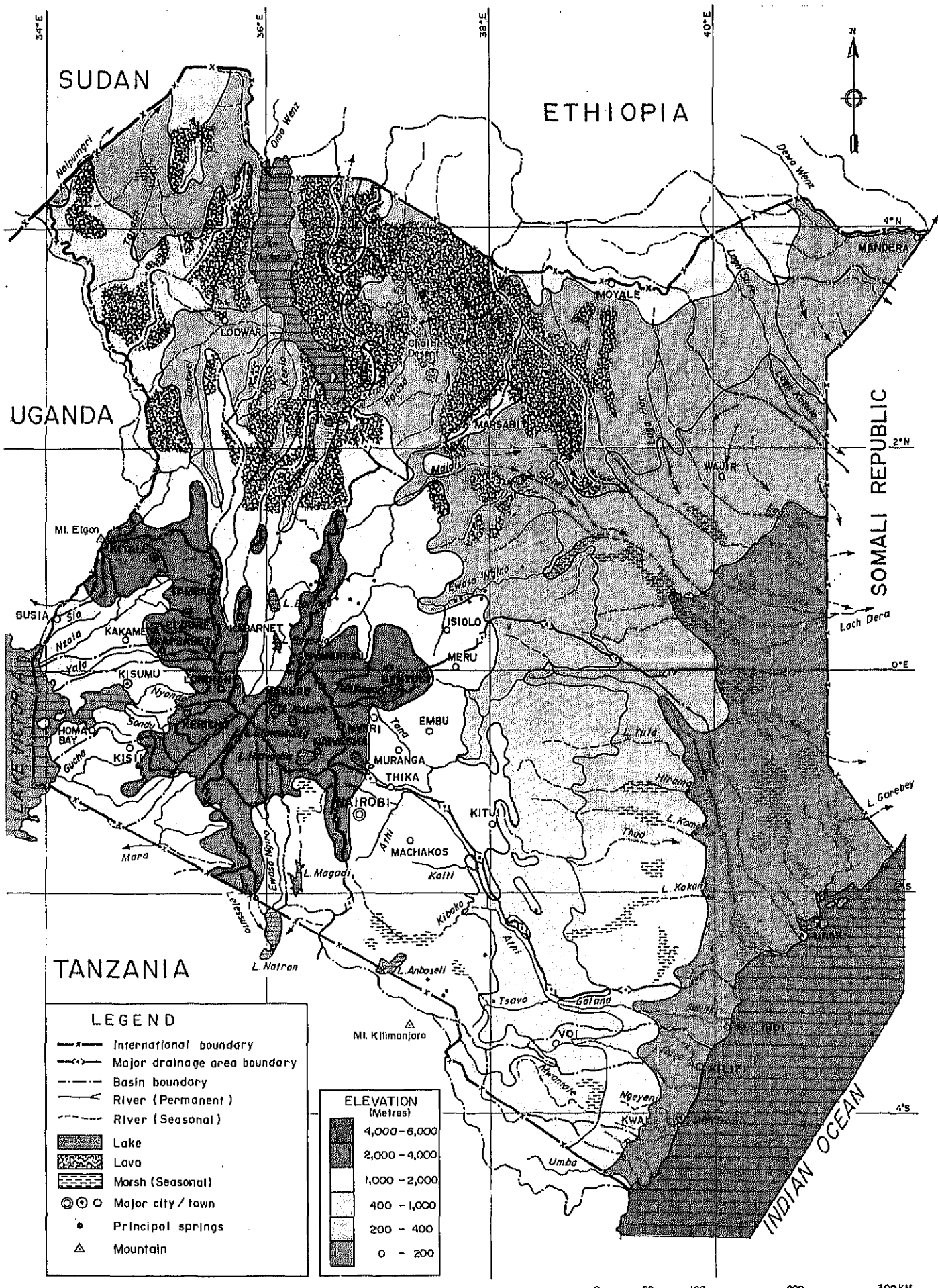
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2. Vol.2 Master Action Plan towards 2000
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LOCATION MAP

0 50 100 200 300 KM

PREFACE

Interpretation of Report

The original objective of this NWMP Study is to propose a nationwide framework for orderly planning and development of water resources in the country. The Study also deals with the formulation of individual development schemes. However, it should be noted that the plans formulated in this Study remain at a national level and do not provide complete details at local level. Further details should be examined in subsequent studies on each river basin, district, and project basis which are separately recommended in this Study.

Administrative Division of Districts

In this Study, the original 41 districts were considered and various statistical data, particularly socio-economic information, were collected for these districts. During the progress of the Study, six districts were detached from the original ones and established as new districts. In the report, the data on these new districts are grouped together with the corresponding original districts as shown below.

	<u>Original Districts</u>	<u>New Districts</u>	<u>Data included in:</u>
1.	Machakos	Makueni	Machakos/Makueni
2.	Kisii	Nyamira	Kisii/Nyamira
3.	Kakamega	Vihiga	Kakamega/Vihiga
4.	Meru	Tharaka-Nithi	Meru/Tharaka-Nithi
5.	Kericho	Bomet	Kericho/Bomet
6.	South Nyanza	Migori	South Nyanza/Migori

(Note: The last three Districts were established very recently.
The report refers only to the names of the original 41 districts.)

The administrative boundary map used in this Study is the latest complete map set covering the whole country (41 Districts, 233 Divisions and 976 Locations), prepared in 1986 by the Survey of Kenya, Ministry of Land, Housing and Physical Planning.

Data and Information

The data and information contained in the report represent those collected in the 1990-1991 period from various documents and reports made available mostly from central government offices in Nairobi and/or those analyzed in this Study based on the collected data. Some of them may be different from those kept in files at some agencies and regional offices. Such discrepancies if any should be collated and adjusted as required in further detailed studies of the relevant development projects.

Development Cost

The cost and benefit estimate was based on the 1991 price level, and expressed in US\$ equivalent according to the exchange rate of US\$1 = KShs25.2 prevailing at that time. The same exchange rate was used in calculating the development cost in K£/KShs currency.

MAIN REPORT Vol. II
NATIONAL MASTER ACTION PLAN
TOWARD YEAR 2000

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ABBREVIATION

CBK	Coffee Board of Kenya	MOMDE	Ministry of Manpower Development and Employment
CBS	Central Bureau of Statistics	MOPND	Ministry of Planning and National Development
CRF	Coffee Research Foundation	MOPW	Ministry of Public Works
CSS	Computer Service Section of MOWD	MORD	Ministry of Region Development
DAO	District Agricultural Officer	MORDASAW	Ministry of Reclamation and Development of Arid, Semi-arid and Wasteland
DC	District Commissioner	MORST	Ministry of Research, Science and Technology
DDC	District Development Committee	MOSM	Ministry of Supplies and Marketing
DO	District Officer	MOTC	Ministry of Transport and Communication
DRSRS	Department of Resource Surveys & Remote Sensing	MOTW	Ministry of Tourism and Wildlife
EAMD	East Africa Meteorological Department	MOWD	Ministry of Water Development
FAO	Food and Agriculture Organization of the United Nations	NCC	Nairobi City Commission
GDP	Gross Domestic Product	NCPB	National Cereals and Produce Board
GIS	Geographical Information System	NES	National Environment Secretariat
GRDP	Gross Regional Domestic Product	NIB	National Irrigation Board
GTZ	German Agency for Technical Cooperation	NMWP-I	National Master Water Plan (Stage I)
HCDA	Horticultural Crops Development Authority	NWCPC	National Water Conservation and Pipeline Corporation
IBRD	International Bank for Reconstruction and Development	NWMP	National Water Master Plan
ICDC	Industrial and Commercial Development Corporation	OECD	Organization for Economic Cooperation and Development
IDA	International Development Association	OECD	Organization for Economic Cooperation and Development
ILUS	Integrated Land Use Survey	OECD	Organization for Economic Cooperation and Development
IPC	Investment Promotion Center	OECD	Organization for Economic Cooperation and Development
IRS	Integrated Rural Survey	OECD	Organization for Economic Cooperation and Development
JICA	Japan International Cooperation Agency	OECD	Organization for Economic Cooperation and Development
KBS	Kenya Bureau of Standard	OECD	Organization for Economic Cooperation and Development
KIRDI	Kenya Industrial Research & Development Institute	OECD	Organization for Economic Cooperation and Development
KIU	Kenya Industrial Estates Limited	OECD	Organization for Economic Cooperation and Development
KMD	Kenya Meteorological Department	OECD	Organization for Economic Cooperation and Development
KPCU	Kenya Planters' Cooperative Union	OECD	Organization for Economic Cooperation and Development
KPLC	Kenya Power and Lighting Co.	OECD	Organization for Economic Cooperation and Development
KS	Kenya Standard	OECD	Organization for Economic Cooperation and Development
KSA	Kenya Sugar Authority	OECD	Organization for Economic Cooperation and Development
KSB	Kenya Sisal Board	OECD	Organization for Economic Cooperation and Development
KSS	Kenya Soil Survey	OECD	Organization for Economic Cooperation and Development
KTDA	Kenya Tea Development Authority	OECD	Organization for Economic Cooperation and Development
KVDA	Kerio Valley Development Authority	OECD	Organization for Economic Cooperation and Development
KWAHO	Kenya Water and Health Organization	OECD	Organization for Economic Cooperation and Development
LBDA	Lake Basin Development Authority	OECD	Organization for Economic Cooperation and Development
LU	Livestock Unit	OECD	Organization for Economic Cooperation and Development
MOA	Ministry of Agriculture	OECD	Organization for Economic Cooperation and Development
MOE	Ministry of Energy	OECD	Organization for Economic Cooperation and Development
MOED	Ministry of Education	OECD	Organization for Economic Cooperation and Development
MOENR	Ministry of Environment and Natural Resources	OECD	Organization for Economic Cooperation and Development
MOF	Ministry of Finance	OECD	Organization for Economic Cooperation and Development
MOH	Ministry of Health	OECD	Organization for Economic Cooperation and Development
MOHANH	Ministry of Home Affairs and National Heritage	OECD	Organization for Economic Cooperation and Development
MOI	Ministry of Industry	OECD	Organization for Economic Cooperation and Development
MOL	Ministry of Labour	OECD	Organization for Economic Cooperation and Development
MOLD	Ministry of Livestock Development	OECD	Organization for Economic Cooperation and Development
MOLG	Ministry of Local Government	OECD	Organization for Economic Cooperation and Development
MOLH	Ministry of Lands and Housing	OECD	Organization for Economic Cooperation and Development
		OP	Office of the President
		PC	Provincial Commissioner
		PPCSCA	Presidential Permanent Commission on Soil Conservation and Afforestation
		ROK	Republic of Kenya
		RTPC	Rural Trade and Production Center
		RWSDP	Rural Water Supply Development Project
		SEFC	Small Enterprise Financial Corporation
		SOK	Survey of Kenya
		SPI	Sessional Paper No.1 of 1986 on Economic Management for Renewed Growth
		SWAP	Surface Water Extraction Permit
		TARDA	Tana and Athi River Development Authority
		UNDP	United Nations Development Programme
		UNEP	United Nation Environment Programme
		UNESCO	United Nations Educational, Scientific, and Cultural Organization
		UNICEF	United Nations International Children's Emergency Fund
		UNIDO	United Nations Industrial Development Organization
		UNPEP	United Nation Population Fund Programme
		UON	University of Nairobi
		USAID	United States Agency for International Development
		WHO	World Health Organization

ABBREVIATION OF MEASURES

Length

mm	=	millimetre
cm	=	centimetre
m	=	metre
km	=	kilometre

Energy

Kcal	=	Kilocalorie
KW	=	kilowatt
MW	=	megawatt
KWh	=	kilowatt-hour
GWh	=	gigawatt-hour

Area

ha	=	hectare
m ²	=	square metre
km ²	=	square kilometre

Others

%	=	percent
°	=	degree
'	=	minute
"	=	second
°C	=	degree Celsius
cap.	=	capital
LU	=	livestock unit
md	=	man-day
mil.	=	million
no.	=	number
pers.	=	person
mmho	=	micromho
ppm	=	parts per million
ppb	=	parts per billion

Volume

l, lit	=	litre
m ³	=	cubic metre
m ³ /s, cms	=	cubic metre per second
MCM	=	million cubic metre
m ³ /d, cmd	=	cubic metre per day

Weight

mg	=	milligram
g	=	gram
kg	=	kilogram
t	=	ton
MT	=	metric ton

Time

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

Money

Kshs.	=	Kenya Shilling
K£	=	Kenya Pound (20 Kenya Shilling)
US\$	=	U.S. dollar
USc	=	U.S. cent

1. INTRODUCTION

1.1 Study Objective

Kenya's rapid development has begun to strain her water resources. Increasingly water stress has been occurring almost everywhere in the country even at the places where previously water was found in abundance. The responsibility for water resources development and management in Kenya has been shared among various departments and agencies in accordance with their respective functions and activities related to water. In the absence of a comprehensive system to coordinate the multifarious activities in water resources development and management, these activities tend to take place in isolation. This may lead to competition in water use and even duplication of activities and functions. An integrated approach to water resources development and management is therefore necessary to ensure future efficient use of water and other resources, and a study in this regard has become necessary

This National Water Master Plan Study has been carried out by the Study Team of the Japan International Cooperation Agency (JICA) in collaboration with officials of the Government of Kenya for about 2.5 years since January 1990 in order to establish a basic framework for the orderly planning and implementation of water resources development programs consistent with the overall national socio-economic development objectives. This was the second nation-wide study of water resources and was preceded by the National Master Water Plan (Ref. 1) prepared in 1980.

1.2 Scope of Master Action Plan

This volume is one of three volumes of the Main Report and deals with the Master Action Plan relevant to the implementation of the nation's water resources development and use in the future.

The Master Action Plan contains recommendations on actions to be taken by the Government to ensure efficient and effective execution of water resources development and management, including the projects envisaged, further studies proposed, their implementation program, financial requirement, water administration, and legal and institutional frameworks.

In preparing the Plan, emphasis was made to present the plans on a scheme basis as much as possible so that the proposed plans are implementable by the agencies concerned (this has been requested by the Steering Committee). Nevertheless, the original intent of this National Water Master Plan Study has been placed to show general direction of water resources development in Kenya through the review of future problems and needs and availability of water and other resources, based on analysis and interpretation of readily available data and information, rather than dealing with specific projects. Individual projects indicated are therefore only notional and no intention has been made to define any of their details.

The Action Plan was proposed basically for a plan period towards the year 2000, but at the same time the report also shows the follow-up actions to be taken for the subsequent 10-year period towards year 2010.

1.3 Significance of Master Action Plan

Water is not only required to meet basic human needs but is also required as an essential input for the production of services, goods, and energy. Water resources development occupies a significant position in the overall socioeconomic development plan of the country, and water resources development projects are undertaken in support of the development of several major socio-economic sectors.

The essential water demand in year 1990 (1,148 MCM/year) represents about 6% of the country's available water resources (surface water: 19,590 MCM + groundwater: 619 MCM). The water demand in the year 2010 will increase significantly (3,096 MCM/year), accounting for about 15% of the available water resources. It is foreseen that the exploitation of 15% of the water resources will be a hard task needing great care and efficiency in both the planning and the implementation.

Shortage of water has already occurred in many places of the country at the 1990 level of demand in spite of available water resources exceeding the demand as a whole. This is because the occurrence of rainfall in the country varies from region to region, and in a region, it also varies from season to season, and from year to year. As a result of this uneven distribution both in time and in space, river flows fluctuate over a wide range. In areas of growing demand, low flows during the dry seasons are insufficient to meet all demands, while during wet seasons floods occur and a large quantity of water is wasted. Because of this uneven distribution, the portion of water which is readily available the year round without having to regulate river flows by the construction of storage dams, is relatively low. This portion (in terms of 10-year probable low flow discharge) is estimated to be only 12.6% of the gross runoff in the river. To increase the portion of water for year round use, it is necessary to construct storage dams so that flood flows can be retained during the wet months and released during the dry months to augment low flows.

As the readily available portion of water resources has already been developed for use in practically all regions of major water demand, future water resources development will be characterized by the requisite of storage dams construction.

Furthermore, for regions where the demand is rapidly growing and the practicable limit of water resources development has been reached, it will be necessary to transfer water from another river basin. Inter-basin transfer of water and storage dams construction have been undertaken in the past, but the scale of undertaking will be considerably increased in the future. Needless to say, these are more costly forms of water resources development.

A specific aspect is that Kenya has a large area of semi-arid and arid lands where no perennial rivers exist and groundwater is the main source of water supply. In these areas,

there will physically be a limit of water exploitation and hence the limit of development activities if they are dependent on water availability.

Development of water resources by major user sectors has until now taken place independent of one another. In the past, this was possible insofar as the combined demand of existing water users did not exceed the readily available portion of water resources in a region or the storage development by one water user sector would not conflict with the present and future requirements of other users. As the readily available portion of water resources in regions of major water demand appears to have already been committed, an integrated approach to the development of water resources will be necessary to meet the requirement of all water user sectors, to avoid competition and conflict in water use, and to optimize the use of resources.

1.4 Report Contents

Since water resources are being depleted because of increasing water use, development and use of water in an orderly manner will require forward planning based on an assessment of long term needs, problems and constraints, and available resources. The needs for water resources development and the future program of development must necessarily be derived from a well defined national water development policy and quantified targets for development in the water resources sector within the framework of overall national socioeconomic development.

The essential elements of development policy/target assumed in this Study are discussed in Chapter 2. Chapter 3 describes water development programs and projects which would be taken up in the Master Action Plan towards the year 2000, together with information of subsequent development programmes foreseen towards the year 2010. Chapter 4 describes alternative development programmes in case of deficiency of available budgetary resources. In Chapter 5 are described legal and institutional arrangements to enable these undertakings to take place in an effective and efficient manner. Finally, Chapter 6 describes some further study programmes necessary to support the proposed development programmes.

2. NATIONAL WATER DEVELOPMENT POLICY

2.1 Rationale of the National Water Development Policy

Water resources are some of the basic resources essential for sustaining human life and for the production of goods and services. The significant role of water resources can be seen from the fact that water resources development programmes and projects now form an integral part of the overall national socioeconomic development plan that is formulated and implemented under the successive Kenya Five Year Development Plans.

The formulation of a National Water Development Policy is necessary to provide a framework whereby the desired targets are set and necessary measures are prescribed to guide the entire range of public actions in the development and management of water resources consistent with national development goals. The objectives and targets of the National Water Development Policy bind all activities related to water resources. It is to be noted that these objectives and targets should be revised in accordance with changes in national development goals or in response to changing socioeconomic conditions and requirements.

National Water Master Plan and Action Plan presented herein aims at constituting an integral part of the National Water Development Policy for the subsequent 10 to 20 years period.

2.2 Relationship with Other Public Policies

The water resources of the nation should be developed in support of the development of all socio-economic sectors related to water resources. Water demand and supply balance, or in other words the process of allocating and developing water resources to match water demand by all sectors in a region, is virtually the adjustment of seasonal availability of water resources by engineering or other means to meet demands in the region, where such demand is a function of national and regional development policies which determine specific public water supply, agricultural, and other water-related infrastructural development programmes and projects to be implemented.

The development of public water supply contributes towards public health and regional development objectives. Irrigation development is an integral part of the total development program guided by a national agricultural development policy. Increasing importance has been attached to hydropower development in the national energy development policy. Preservation of river water quality and maintenance of the requisite quantity of flow in rivers play a major role in attaining the environmental quality objective. In flood-prone areas flood mitigation contributes towards the social well-being of the people and provides a better physical environment to permit socioeconomic activities to continue to take place.

Conversely, policies for the development of specific socioeconomic sectors related to water may need adjustment in the light of limitation in water resources or the need to conserve

these resources for a better alternative use. For example, in locating new industrial estates within the framework of regional development, consideration should be given to the availability of water resources at the location and to the cost of developing public water supply to support the industrial development which should be balanced against the socioeconomic benefits that can be derived. If necessary, the proposed estates should be resited. Thus a judicious balance between water resources development and the development of water-related socioeconomic sectors would be necessary to achieve national socioeconomic goals in the most efficient way. These considerations should be given special emphasis in Nairobi, Mombasa, Nakuru, and Machakos, where water demand can by no means be met if the number of water intensive industries continues to rise.

2.3 Objectives of the National Water Development Policy

2.3.1 General objective

The general objective of the National Water Development Policy is to free the nation from water resources constraints, that is to promote national economic development, to enhance regional development, to upgrade environmental quality, and to improve social well-being by meeting water resources needs and by alleviating water resources problems.

2.3.2 Specific objectives

(1) Maintenance of requisite quantity of flow (low flow)

The requisite quantity of flow (low flow) will be maintained in main rivers at all times except during extraordinarily dry periods in order to sustain navigation, fish catch, operation and maintenance of intakes for water supply, and irrigation, maintenance of facilities in the rivers, checking sea water intrusion, watering livestock and wildlife, prevention of estuary clogging, conservation of groundwater, preservation of riparian lands and peoples' amenities.

(2) Development of public water supply

Public water supply will be developed to provide domestic water to urban and rural areas to improve social well-being and to supply water to support industrial development.

(3) Development of irrigation

Irrigation development will be undertaken to attain and maintain the desired level of self-sufficiency in food and to increase farmers' real income.

(4) Livestock development and wildlife conservation

Livestock production will be enhanced to meet the increasing food demand (meat and milk) and also to support the nomadic pastoralism.

Conservation of wildlife is quite important not only from a natural environmental conservation aspect but also from further promotion of tourism industries.

(5) Hydropower development

Hydropower potential will be developed to contribute self-reliance in energy to the maximum extent consistent with the national energy policy.

(6) Preservation of water quality

Pollution of water in rivers will be abated and water quality in rivers will be brought to meet an appropriate standard which is set from the standpoint of public health and from the standpoint of conservation of environmental quality.

(7) River and flood control works

Flood will be mitigated to protect peoples' life and to reduce flood damage. Step-wise approach will be taken towards the final goal which aims at the protection of whole population from major floods. Rivers should be conserved so as to function properly. Urban centers should have proper drainage systems to avoid the developments of unhealthful environments.

2.4 Preliminary Quantified Targets

The targets of the National Water Development Policy should be set according to the overall national development objectives, the development goals of the related socioeconomic sectors, and available financial and manpower resources. To the extent possible the Study has reviewed relevant documents and data made available by the Government departments and agencies and made assumptions as to the following preliminarily quantified targets for the various water resources development and management sectors.

Needless to say, each target set and the prescribed rate of attaining the target for water resources development have implication on the financial, manpower and other resources to be allocated to that particular water resources sector; where competing use of manpower and financial resources exists, adjustment of the targets must necessarily be made based on social and economic development needs which are most imminent at the time.

2.4.1 Maintenance of low flow

In Kenya over 95% of the water resources occur in the form of surface water resources. Consequently, surface water has been and will continue to be the main source of supply, except in semi-arid to arid areas where groundwater is the main source of water. Rivers perform the role of collecting surface water and conveying it across the land to the sea. In many cases it is from the rivers that water is abstracted or diverted for purposes of public

water supply and irrigation as well as other users. At the same time, rivers also provide for watering of livestock and wildlife, support fish life and form part of the eco-system.

For practical management purposes, it is necessary to introduce the concept of river maintenance flow. The river maintenance flow is the minimum river discharge to ensure such water depth, flow velocity, water quality, channel stability and aquatic eco-system as required for sustaining normal water uses and environmental quality. Such a minimum river discharge should obviously be determined for each river according to its natural conditions and water resources use and management requirements. A reasonable target will be to establish river maintenance flow for all major rivers in water-stressed regions toward the year 2000. In this Study, the recorded minimum daily discharge was tentatively assumed to be the minimum flow to be conserved in the river.

2.4.2 Domestic and industrial water supply

(1) Development target

The latest statement on the water supply policy is shown in the current Five-Year National Development Plan for the period from 1989 to 1993 (Ref. 2) as "during 1974, the Government promulgated the National Water Plan with the express aim of ensuring the availability of potable water within 4 kilometers of every household by the year 2000". This is regarded to be the long-term target.

Under this policy, the target during the current five-year development plan period is to increase the proportion of the population having access to water in the rural areas from 26% (4.91 million people in 1987) to 50% (11 million people) by 1993 and in the urban areas from 75% to 95% by 1993. Notwithstanding the Government effort, however, possibility to achieve the target for the period from 1989 to 1993 is not clear due chiefly to budgetary constraint. If the target can not be achieved, achievement of the year 2000 target will become difficult.

Reliable supply of safe water for health is one of the basic human needs, and hence the long-term target stated above should be retained as a target to be assumed in this Study. Instead, the Study sets out a conservative assumption that the target would be achieved over a prolonged period; say towards the year 2010, or a longer period dependent on the availability of financial resources.

(2) Concept of development sequence

This Study assumed that the development of water supplies will be undertaken in the following two (2) stages:

Stage 1: Provision of safe and sustainable water sources within walking distance, i.e. within 1 km in high potential area and within 4 km in semi-arid/arid areas, wherein the water available is not always a grade of "potable water".

Stage 2: Provision of piped water supply systems with water treatment, wherein the water would be "potable".

For each of the water sources, the development sequence would be;

	<u>Stage 1</u>	<u>Stage 2</u>
<u>Urban Water Supply</u>		
Surface water	Piped water supply, with treatment	-
Groundwater	Piped water supply, basically without water treatment	Piped water supply, with treatment where necessary from water quality aspect
<u>Rural Water Supply</u>		
Surface water	Water as available on the site (abstraction of water by people themselves)	Piped water supply, with treatment (except for spring water)
Groundwater	Spot supply at the borehole/well sites	Piped water supply, with treatment where necessary from water quality aspect
Roof catchment	Rainwater as stored	As Stage 1. No water treatment is deemed necessary.
Small dam	Water as impounded, with protection from contamination sources (e.g. livestock)	Piped water supply, with treatment
Subsurface dam	Water as stored and supplied at pipe outlet (sand dam) or well (subsurface dam)	Piped water supply, with treatment
Rock catchment	Water as stored, with protection of catchment	As Stage 1. No water treatment is deemed necessary.
Pipeline (built for urban supply and passing in rural areas)	Supply of water at water stands provided on the pipeline route. Water is treated.	Extension of branch pipeline system. Water is treated.

Of the above programmes, the Study envisages to recommend the implementation of Stage 1 work towards year 2000 as much as possible within the framework of available financial resources, leaving the rest of development towards year 2010.

2.4.3 Irrigation development

The Study envisages that self-sufficiency in major food production will be achievable by rainfed agricultures through (i) improvement of unit crop production per area and (ii) increase of cropping area (see Main Report Vol. 1 for details). Nevertheless, the role of irrigation development remains to be still important in respect of contribution to the enhancement of national economic development through production of crops in a more economical way, increase in farmer's real income, security for drought and ascertainment of flood self-sufficiency. It is assumed that known irrigation potential which can be economically developed will be fully developed by year 2010.

2.4.4 Livestock development and wildlife conservation

Water to support livestock industries should be conserved (surface water) or exploited (groundwater) everywhere as required. The estimated water demand is 326,000 m³/day in 1990, 389,000 m³/day in 2000 and 465,000 m³/day in 2010 . Another target may be the expansion of nomadic pasturage activities in semi-arid and arid areas in the wet period when the pastures grow there. Such areas cover approximately 349,000 km² in total.

Water for wildlife should also be conserved or exploited in the areas where the ecology of wildlife is to be protected. The estimated water use is very roughly 21,000 m³/day, though it is subject to further refinement in subsequent studies.

2.4.5 Hydropower development

Consistent with the Government policy for self-reliance in energy, it is assumed that the known hydropower potential that can be economically developed will be fully developed in line with the national power development plan to meet future power demand required by 2010.

2.4.6 River water quality

Water pollution adversely affects the environment and renders water resources unfit for use. The main sources of pollution are domestic and industrial sewage, effluent from factories (e.g., paper, sugar, coffee processing) and animal husbandry, and effluent from mines. Organic pollution of water is represented by the biochemical oxygen demand (BOD). The self-purification mechanism of a river is greatly reduced and the aquatic ecosystem is affected when the BOD concentration exceeds a certain limit (say, 5 mg/lit.). Odour occurs when the BOD concentration is more than say, 10 mg/lit.. Determination of the allowable limits for river water pollution control appropriate to rivers in Kenya is subject to further research.

In overall terms, waters in Kenya have not been polluted as much as experienced in some other industrialized countries. Nevertheless, local and intermittent pollution incidents have been arising and doubtless will become more frequent in the future as the population and economic growth continue. A principal target set forth here is to contain the present level

of pollution and prevent further problems arising, which would be attained through (i) a well established water quality monitoring programme and (ii) the enforcement of water pollution control measures.

Other than natural soil erosions, logging and clearing of forests, housing and road development and mining operation are major causes of high concentration of suspended solid in some rivers. The presence of heavy sediment load creates problems for the operation and maintenance of water supply systems and irrigation facilities.

2.4.7 River and flood control works

Flooding is not a very acute problem in Kenya compared with some other tropical countries. Nevertheless, flood damage has been experienced in some parts of the country. Flood events in the past were associated with disruption of economic activities, human misery and loss of life and property. Consequently, floods and the effects of floods should be mitigated by both structural and non-structural measures. The former includes channel improvement, bypass floodway, flood control dam and the like, while the latter includes restriction of development in flood-prone areas and resettlement. This Study proposed to set out the following targets and/or strategy:

- (a) Implementation of only economically viable projects for the period up to 2000 and further up to 2010.
- (b) No immediate proposal of measures for presently "damage tolerable" areas, placing a preference of using the beneficial effects which the flood brings about (e.g. transport of nourishments).

Separately from major flood protection projects, the Study foresees that need for river improvement works will arise in many rivers, especially in urban rivers. Further, proper drainage work should be provided for principal urban centres.

3. IMPLEMENTATION PROGRAMME

This chapter describes the implementation programme proposed for the period up to year 2000, and simultaneously preliminary programmes foreseen for the subsequent period (up to year 2010) are also shown.

3.1 Domestic and Industrial Water Supply

3.1.1 Urban water supply

The Study examined urban water supplies for 158 cities/towns which are nominated as urban centres and have populations of more than 5,000 in the year 2000. They are listed in Table 3.1

In preparing the implementation programme, the priority of development will be given in the following order:

(a) On-going schemes

There are many water supply projects currently under construction for completion within this Five Year Plan period (towards 1993). They are listed in Table 3.2. In case some of them have to postpone their completion owing to financial constraints, continuation of their implementation should be accorded top priority.

(b) Urban centres in tourism areas

Tourism is one of the most important industries in Kenya. Further promotion of the tourism industry demands the reliable supply of high quality potable water, and in this context a priority of the development is placed on cities which are closely related to the tourism. The cities falling in this category include Nairobi, Mombasa, Malindi, Lamu, Nakuru, Kericho, and Kisumu.

(c) District centres

Rapid urbanization is on-going. Infrastructures of major regional centres should be improved to promote regional development. The major regional centres are defined here as towns having populations of more than 10,000 and/or the District headquarters. Within this group, the priority of development will be given in the order of seriousness of water shortage expressed as the ratio of existing supply capacity to water demand in year 2000.

(d) Other urban centres

The implementation will then continue for the rest of the small urban centres (population less than 10,000). The priority will be given in the order of lesser cost requirement per m³ of water exploitation.

The Study assumes that the water demand in the years 2000 and 2010 will be met at all urban centres. The proposed implementation programme is shown in Table 3.3.

3.1.2 Rural water supply

As described in Sub-section 2.4.2, rural water supply is proposed to be undertaken in two stages:

<u>Stage</u>	<u>Description</u>	<u>Proposed Implementation Period</u>
1	Provision of access to safe and sustainable water sources – Principally, supply of water at source points – Water available at sources is not necessarily potable	1993 onward, so as to meet the demands in 2000 and 2010
2	Provision of piped water supply system – Water is supplied by combination of individual connection and communal points – Water is treated as required and hence potable	2001 onwards, up to 2010

The implementation was programmed with the following concepts:

(a) Prioritization among Districts

No specific priority criteria are placed in view of the importance of attaining equitable development over the country. However, priority of the Stage 2 work will be given to several Districts where a relatively high percentage of contraction of water-borne diseases is reported. They include Kirinyaga District in Central Province, Kilifi, Kwale, Lamu, Taita Taveta and Tana River Districts in Coast Province, Isiolo District in Eastern Province, Kisumu and Siaya Districts in Nyanza Province, and Trans Nzoia, Samburu, Turkana and West Pokot Districts in Rift Valley Province (Ref. Table C4.1 of Sectoral Report C). The high rate of contraction in Coast area is noteworthy.

(b) Prioritization within a District

It is suggested that the implementation may proceed with placing priorities on the locations where the implementation cost per m³ of water exploitation is lesser. See

Sectoral Reports M for preliminary estimates of source development (Stage 1) cost and water supply facility (Stage 2) cost for each location.

The proposed implementation programmes are shown in Table 3.4 (Stage 1 : Source Development) and Table 3.5 (State 2 : Provision of piped water supply system).

3.2 Sewerage Development

A basic principle assumed is that sewerage facilities would be developed in conjunction with the provision of water supply facilities. Accordingly, the implementation of sewerage development will be done along with the principles and priority order set forth for the urban water supply schemes in preceding Subsection 3.1.1. The proposed implementation programme is shown in Table 3.6.

3.3 Irrigation Development

3.3.1 Major irrigation projects

The Study examined 18 major irrigation schemes (over 500 ha in area) which have been identified in previous studies and their overall priorities evaluated through comparison of water availability, maturity of project studies, number of beneficiaries, environmental aspects and economic viability (see Sectoral Report E for details). Implementation programme shown in Table 3.7 was prepared following the findings in that overall priority ranking study.

Major Irrigation Projects to be Implemented by 2010

Project	Irrigation Area (ha)	River Basin	Source of Water	Main Crop
Arror	1,340	Kerio	Arror River	M, V, F
Bunyala Extension (Lower Nzoia)	10,480	Nzoia	Nzoia River	Ct, M, B, R
Kano Plain	25,640	Nyando	Sondu/Miriu dam Magwagwa dam	M, R, Ct, B
Kanzalu	4,055	Athi	Munyu dam or Ndarugu dam	M, B, Cf, R
Kibwezi	13,200	Athi	Yatta dam	M, B, Ct, V
Kimira	2,000	Awach Kabuan	Awach Kabuan	R, M, Ct, B
Kunati	1,050	Tana	Thanantu River	Ct, M, V, T
Lower Ewaso Ngiro	10,000	Ewaso Ngiro South	Oldorko dam	M, B
Lower Kuja	1,900	Kuja	Kuja River	M, B, Ct, V
Lower Rupingazi	1,800	Tana	Rupingazi River	Ct, T, M, V
Mwea Extension	2,900	Tana	Thiba dam	R, Hc
Sabaki Extension	3,000	Athi	Sabaki River	M, B, Ct
Taita Taveta	3,780	Lumi	Lumi River	M, B
Tana Delta	12,000	Tana	Tana River	R
Thanantu	2,520	Tana	Thanantu River	Ct, M, T, F
Turkwel	600	Turkwel	Turkwel River	Ct, M, B, F
Upper Nzoia	7,550	Nzoia	Nzoia River	F, M, V
Yala Swamp	7,540	Yala	Yala River	R

Remarks: M: Maize, B: Beans, V: Vegetables, F: Fruits, R: Rice, Ct: Cotton, Cf: Coffee, T: Tobacco, Hc: Horticulture

The Study had assumed that a leading factor for proposing the implementation of irrigation projects would be the economic viability accorded to the project. It is noted that, of the 18 schemes, eight schemes were evaluated to have relatively low IRR values less than 10% (Kimira, Thanantu, Kibwezi Extension, Turkwel, Sabaki Extension, Arror, Upper Nzoia and Yala Swamp schemes). These schemes, though retained in Table 3.7, will be subject to further detailed evaluation of their economic viabilities in subsequent studies.

3.3.2 Small scale irrigation schemes

Table 3.8 shows the implementation programme of some 140 small scale irrigation schemes under contemplation by the MOA and other agencies. The Study presumes that the necessary financial resources will be allocated to each District equitably for implementation towards year 2010. Since the relative attractiveness of each scheme is not known, it was assumed that the priority for implementation of schemes within a District would be given in the order of smaller scheme in view of financial constraints foreseen for the initial period.

3.4 Livestock and Wildlife Water Plan

3.4.1 Livestock water supply

(1) Urban area

Livestock water needed in urban areas, though not great in quantity, will be supplied by piped water supply system in conjunction with domestic and industrial water supply. The proposed implementation programme is therefore identical to that presented in Section 3.1 above for urban water supply.

(2) Rural area

The Study assumes that livestock will be supplied water basically at water source points (rivers, small dams, boreholes, etc.). Source development for livestock watering was evaluated by District as shown in Table 3.9. The implementation of source development is scheduled to follow the increase in water demand and so the budgetary requirement. Table 3.9 shows the rate of implementation in % divided into two periods; (i) period towards 2000 and (ii) period from 2001 onwards.

3.4.2 Provision of watering points in nomadic pasturage area

The Study proposes to provide watering points in nomadic pasturage areas in the arid lands. The objective is to promote nomadic production activities in such areas where pastures grow in the wet season but no watering points are available. The proposed plan envisages to provide a watering point every 25 km. For cost estimate purpose, the Study assumes tentatively the provision of boreholes on shallow wells with windmill pump.

However, the watering facility would preferably be small dam or water pan as far as the potential site is found.

This attempt requires a careful step-wise approach; (i) firstly the survey of wet season pasture availability, (ii) secondly the evaluation of appropriateness of provision of watering points which may in some cases cause over-grazing, devastation of the dry land ecology, and then (iii) provision of watering points. In view of an experimental type of attempt, it is assumed that only 30% of the contemplated work will be implemented by year 2000. If the attempt proves successful, the remaining work will be undertaken in the subsequent period. A very preliminary programme is shown in Table 3.10.

3.4.3 Wildlife water plan

Owing mainly to scarcity of data made available, the Study did not go into much detail on this issue and no structural plans are proposed. The recommendations are;

- (a) Conservation of dry season flow of the rivers in National Parks and Game Reserves. In principle, water transfer which may cause the reduction of dry season flow of the rivers in the National Parks and Game Reserves should not be planned unless it is proved to be not harmful to wildlife ecology.
- (b) Rehabilitation of existing watering facilities.

Of the 31 National Parks and Game Reserves for which information is available, 13 places have some manmade watering facilities (waterhole, borehole, dam). According to questionnaire survey, 12 places are contemplating the necessity of further provision of watering points by either borehole, dam or subsurface dam. Water source development will be similar to that proposed for livestock water development in preceding sub-section 3.3.1. Types of water sources would vary district by district as shown in Table 3.9.

3.5 Hydropower Development

Hydropower development will be undertaken as a part of the national power development plan formulated by the Ministry of Energy (MOE)/Kenya Power Company (KPC). This Study took up six hydropower projects (consisting of seven schemes) which are revealed to be prospective in the latest MOE/KPC's studies. All six schemes have been evaluated and found to be competitive with thermal alternative plant and also to function effectively in terms of sharing the power and energy production requirements in the power system.

Hydropower Projects Scheduled towards 2010

Project	River	Capacity(MW)	Commissioning Year	Remark
Sondu/Miriu	Sondu (No. 1)	60	1997	Multi purpose (Irrigation)
	Sondu (No. 2)	20.6	1998	Single purpose
Low Grand Falls	Tana	120	2000	Single purpose
Oldorko	Ewaso Ngiro	72	2002	Multi purpose (Irrigation, Water Supply)
Magwagwa	Sondu	120	2003	Multi purpose (Irrigation)
Gitaru #3 (Extension)	Tana	72.5	2004	Single purpose
Mutonga	Tana	60	2005	Single purpose
Total		525.1		

Out of seven schemes, five schemes (Sondu/Miriu No.1, Low Grand Falls, Oldorko, Gitaru #3 Extension and Mutonga) were proposed in the Updated Review of National Power Development Plan (Ref. 3 and 4), and the remaining two schemes (Sondu/Miriu No.2 and Magwagwa) were prioritized in the feasibility studies recently completed (Refs. 5 and 23). Implementation schedule of these schemes is shown in Table 3.11, following the recommendations given in respective studies.

It is noted that the final plan formulation of Low Grand Falls and Mutonga schemes should be subject to further comparison of relative merits with High Grand Falls scheme (an alternative plan). The inclusion of irrigation component in the Oldorko scheme should be subject to further study of socio-environmental impacts in the downstream areas.

3.6 River and Flood Control Works

3.6.1 Flood control projects

Out of nine major flood control schemes examined, this Study proposes to implement two schemes (Kano plain and Nairobi) towards year 2000 and further three schemes (Yala, Kuja and Lumi) towards year 2010. All of these five schemes were assessed to have an acceptable economic viability under the condition of damage potential in year 2010. Social requirements for the implementation of flood control projects is also high.

Proposed Flood Control Projects

Project	River	Design Flood (*)	Protected Area	Proposed Works
Kano Plain	Nyando	25-year	Agricultural land	River improvement with dykes
Nairobi City	Nairobi, etc.	25-year	Urban area	Widening of river channels
Yala Swamp	Yala/Nzoia	25-year	Agricultural land	River improvement with dykes
Kuja Rivermouth	Kuja	25-year	Agricultural land	River improvement with dykes
Lumi Rivermouth	Lumi	25-year	Agricultural land	River improvement with dykes

(*) For 1st stage development

The proposed implementation programme is shown in Table 3.12.

3.6.2 Other river related projects

Other than major flood control projects proposed above, there are other river related works needing the appropriation of budgetary resources, which are described below.

(1) Urban drainage projects

Issues relating to urban drainage are occurring in many cities and urban centers, causing standing waters sometimes in insanitary condition and inundation in local areas. The Study presumes that the priorities of urban drainage work would be given to major cities listed in Table 3.13. The implementation is proposed in order of size of population. Specific priority is given to Nairobi and Mombasa at which the problem appears to be getting worse.

(2) Minor ad-hoc river improvement projects

Other than specific flood control projects, there will also be many needs for improvement of river channels on ad-hoc basis, such as the improvement associated with urban drainage works, local bank protection work, removal of excessively accumulated siltation, channel clearing work, and canalization, particularly in urban areas.

The identification of these works on an individual scheme basis is beyond the capability of this Study, and hence a rule-of-thumb estimate of US\$ 90 million or K£ 113 million was appropriated to cover the budget for these works. District-wise distribution of the budget is assumed to be proportionate to 1990 population.

(3) Long-term improvement of Lower Tana River

This work is proposed as experimental work aimed at the achievement of long-term improvement of the Lower Tana River. The Study assumes that a budget of the order of US\$ 5 million or K£6.3 million per year will be appropriated for the coming 8-year period towards year 2000. Based on the findings therefrom, the long-term plan will be formulated for proceeding with further implementations thenceforward.

3.7 Financial Requirements

In order to meet the water demand and achieve the development frameworks described in Chapter 2, schemes proposed in the foregoing Sections 3.1 to 3.5 should be implemented towards year 2000 and further towards year 2010. For attaining this, the total development cost required towards year 2010 is estimated to be US\$12,110 million or K£15,258 million as summarized below, of which US\$5,509 million or K£6,940 million is foreseen to be required for the period up to year 2000.

Development Sector	Estimated Development Cost					
	1993 - 2000		Development Cost (Million) 2001 - 2010		Total	
	US\$ Equiv.	K£ Equiv.	US\$ Equiv.	Kf Equiv.	US\$ Equiv.	Kf Equiv.
1. Domestic/Industrial Water Supply	3,470	4,372	4,106	5,174	7,576	9,546
2. Sewerage Development	420	529	285	359	705	888
3. Irrigation Development	201	253	772	973	973	1,226
4. Livestock Water	252	318	503	633	755	951
5. Hydropower Development	542	683	492	621	1,034	1,304
6. River and Flood Control Works	624	785	443	558	1,067	1,343
Total	5,509	6,940	6,601	8,318	12,110	15,258

More details are given in Table 3.14 and annual budgetary schedule in Table 3.15. Further breakdowns by development sector are contained in Appendix 1.

4. IMPLEMENTATION PROGRAMMES FOR ALTERNATIVE BUDGETARY SCENARIOS

4.1 Budgetary Constraint

Table 4.1 shows a very rough estimate of budgetary resources (development expenditure) which are foreseen to be available towards the year 2010. The projection was made based on the assumption that the budgetary resources presently available will increase in proportion to the growth of GDP. The accumulated gross budget available for the period up to year 2010 was compared with the total development cost required for the same period.

Comparison between the Projected Available Budget and the Required Development Cost

Development Sector	Project Available Budget		Development Cost		Ratio
	US\$ Equiv.	K£ Equiv.	US\$ Equiv.	K£ Equiv.	%
	(1)		(2)		(1)/(2)
1. Domestic/Industrial Water Supply	2,596	3,271	7,576	9,546	34.3
2. Sewerage Development	220	278	705	888	31.3
3. Irrigation Development	604	761	973	1,226	62.1
4. Livestock Water Development	-	-	755	951	-
5. Hydropower Development	2,875	3,623	1,034	1,304	278.0
6. River and Flood Control Works	14	18	1,067	1,343	1.3
Total	6,309	7,951	12,110	15,258	52.1

The above two sets of figures, (1) and (2), cannot be compared with each other as they are, since the development cost (2) covers only the projects of specific categories taken up in the foregoing Sections 3.1 to 3.5, while the projected available budget (1) covers various works within respective sectors, not limited to the categories in (1). Nevertheless, the comparison of the two figures is indicative of the insufficiency of budgetary resources available towards year 2010.

The budget insufficiency is predominant among others in the sectors of (i) domestic/industrial water supply, (ii) sewerage development, (iii) livestock water development and (iv) river and flood control works; all of them are the sectors relevant to MOWD's undertakings. Budget resources available for the irrigation sector are also not sufficient, while those for hydropower sector appear to be not so critical.

Successful achievement of the proposed water development plans will depend on the availability of financial resources. The Government should reinforce the development

budget available for the relevant ministries/agencies, particularly for MOWD who would have the most prominent budgetary deficit.

4.2 Development Plan under Reduced Budgetary Scenarios

4.2.1 Achievement of development under reduced budgetary scenarios

In case the financial constraint is foreseen as a major factor hampering the proposed development scenario, the phasing of implementation will have to slow down. The Study examined two alternative cases of reduced development scenarios for the five sectors (excluding hydropower sector) for which the available budget may be foreseen to be insufficient (see Section 4.1 above).

Alternative Scenario A : Available budget to be about 50% of the total requirement (which represents a case that the availability of budget for whole water sectors would be similar to the present level; 52% in the above table)

Alternative Scenario B : Available budget to be about 75% of the total requirement (which represents a case that the availability of budget would be in between those of the Full Development Scenario (Section 3.7 and Alternative Scenario A)

In preparing the implementation plans, it was assumed that budgetary constraint would be spread equally in all the relevant sectors. The implementation programmes for Alternative Scenarios A and B are shown in Appendixes 2 and 3, respectively, together with the breakdowns of cost and annual budgetary schedule.

The achievements of development foreseen towards the years 2000 and 2010 in the cases of Alternative Scenarios A and B are summarized below.

Description	Full Development Scenario (Chapter 3)		Alternative Scenario A		Alternative Scenario B	
	2000	2010	2000	2010	2000	2010
Development Cost (Cumulative)						
Domestic/Industrial Water Supply:						
- US\$ million equiv.	3,470	7,576	2,081	4,330	2,606	5,685
- K£ million equiv.	4,372	9,546	2,622	5,456	3,284	7,163
Sewerage Development:						
- US\$ million equiv.	420	705	353	588	371	620
- K£ million equiv.	529	888	445	741	467	781
Irrigation Development:						
- US\$ million equiv.	201	973	201	486	200	598
- K£ million equiv.	253	1,226	253	613	252	754

Livestock Water Development:						
– US\$ million equiv.	252	775	128	371	192	566
– K£ million equiv.	318	951	161	475	242	713
Hydropower Development						
– US\$ million equiv.	542	1,034	542	1,034	542	1,034
– K£ million equiv.	683	1,304	683	1,304	683	1,304
River/Flood Control Works:						
– US\$ million equiv.	624	1,067	235	504	462	798
– K£ million equiv.	785	1,343	296	635	582	1,005
Total						
– US\$ million equiv.	5,509	12,110	3,540	7,319	4,373	9,301
– K£ million equiv.	6,940	15,258	4,460	9,224	5,510	11,720

Achievement of Development

Domestic/Industrial Water Supply:

(a) Urban water supply						
– No. of cities/towns	151	158	41	42	65	66
– No. of beneficiaries (million)	8	13	6	10	8	13
(%)	100	100	77	77	100	100

(b) Rural water supply						
– No. of beneficiaries (million)	14	28	9	18	14	28
(%)	100	100	39	64	61	100

Sewerage Development:

– No. of cities/towns	151	158	41	42	66	66
– No. of beneficiaries (million)	8	13	6	10	8	13
(%)	100	100	77	77	100	100

Irrigation Development:

(a) Large scale irrigation						
– Irrigation area (thousand ha)	15	111	15	58	15	83
(%)	100	100	100	52	100	75

(a) Small scale irrigation						
– Irrigation area (ha)	3,506	7,012	3,506	7,012	3,506	7,012
(%)	100	100	100	100	100	100

Livestock Water Development:

(a) Livestock water supply						
– Livestock served (mill. Lu)	3.8	11.2	1.9	5.6	2.9	8.4
(%)	100	100	50	50	75	75

(b) Water points in nomadic area						
– No. of water points (No)	171	559	0	0	0	0
(%)	100	100	0	0	0	0

Hydropower Development:

– No. of schemes (No)	2	6	2	6	2	6
(%)	100	100	100	100	100	100

River/Flood Control Works:

(a) Major flood control projects						
- No. of schemes (No)	2	5	1	2	1	3
(%)	100	100	50	40	50	60
(b) Urban drainage work						
- No. of cities/towns (No)	5	46	0	2	1	13
(%)	100	100	0	4	20	28
(c) Minor river improvement works (%)	100	100	50	50	75	75
(d) Improvement of Lower Tana river (%)	100	100	50	50	75	75

Note, % : % to the Full Development Scenario

As a natural result, the rates of achievement fall to approximately 50% and 75%, respectively. This will be hardly acceptable particularly in the domestic/industrial water supply sector in view of the fact that the majority of population could not have safe water supply even by the year 2010. Appropriation of enough financial resources to this sector is hence important and should be given priority.

4.2.2 Prioritization of development schemes

Under the reduced budgetary scenarios, the number of implementation schemes would have to be reduced. Within each sector, the prioritization of schemes was made basically following the priority order described in respective Sections of Chapter 3. The individual projects selected for implementation are as listed in tables contained in Appendices 2 and 3 for Alternative Budgetary Scenarios A and B, respectively.

The following are some noteworthy aspects taken into account in the selection of priority projects and revealed as the consequences of the selection.

(1) Domestic/industrial water supply

Urban water supply

- (a) Schemes for major cities in tourism active areas (7 cities nominated) were accorded the top priority. The development cost of these schemes amounts to US\$1,946 million in total or 38 % of the whole urban water supply cost, which is less than the budget ceiling of both the Alternative Scenarios A and B. This means that these 7 major schemes can be implemented under any budgetary scenarios. The Alternative Scenario A can also cover the schemes of other 35 district headquarters. In total, 42 schemes are included in Alternative Scenario A.
- (b) Then, for Alternative Scenario B, service centres to be selected are all the major cities for tourism, District headquarters and other major regional

centres. In total, 66 schemes are proposed for inclusion in Alternative Scenario B.

- (c) Consequently, most of the schemes for minor urban centres (116 under Alternative Scenario A and 92 under Alternative Scenario B) are to be excluded from the implementation programme towards the year 2010.

Rural water supply

Rural water supply schemes will be implemented up to the ceiling of available budget appropriated for each District under the Alternative Budgetary Scenarios A and B, respectively. The budget is allotted for the implementation of Stage-1 work (source development) which requires US\$1,414 million in total or 54% of the total requirement and therefore the Stage-2 work (piped water supply system) could not be implemented under the case of Alternative Scenario A, but some could be implemented under Alternative Scenario B.

(2) Sewerage development

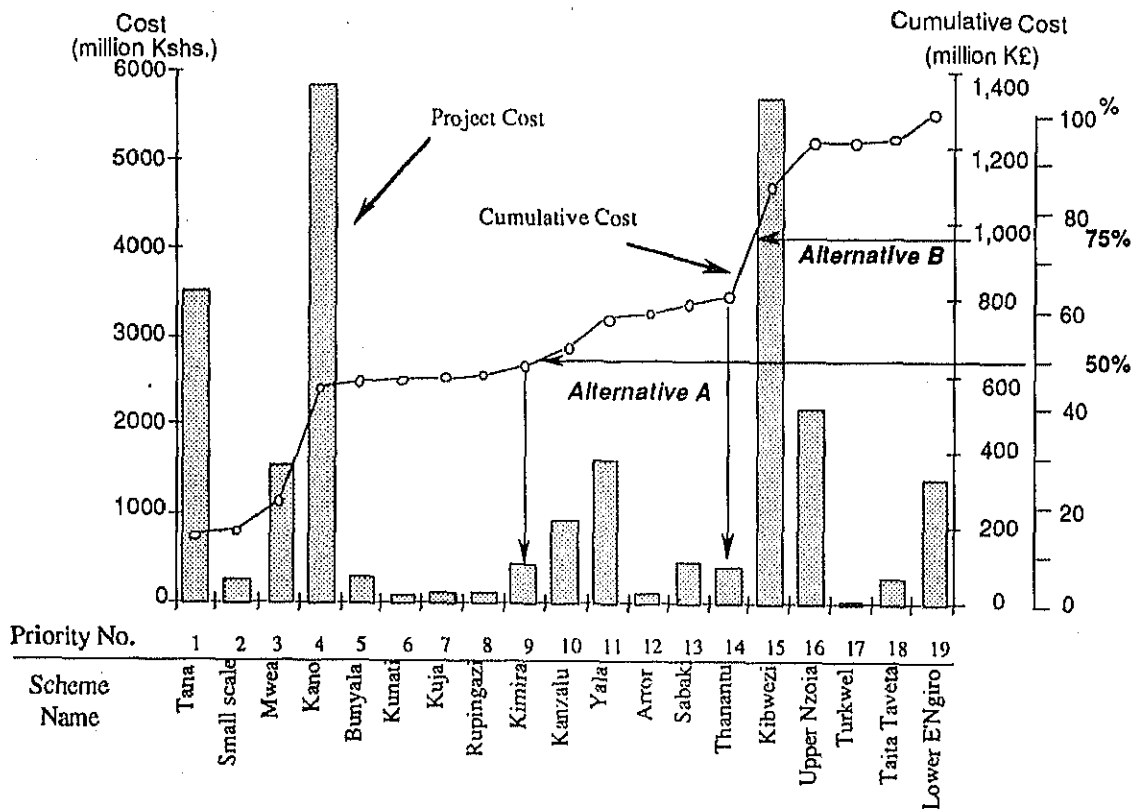
The sewerage development should be executed in pace with the urban water supply development. Thus, the alternative scenarios are the same as those for urban water supply development.

(3) Irrigation development

Based on the recommended priority development order and current irrigation development conditions, the following budget requirement graph was prepared for selecting irrigation schemes so as not to exceed anticipated cumulated public expenditure for alternative irrigation development plans A and B.

Alternative A : US\$480 million or K£ 610 million (about 50% of total requirement) would be available

Alternative B : US\$720 million or K£ 900 million (about 75% of total requirement) would be available



As can be seen in the above illustration, the following irrigation schemes would be implemented under Alternatives A and B.

Alternative A : Tana Delta , Mwea Ext., Kano Plain, Bunyala Ext., Kunati, Lower Kuja, Lower Rupingazi, Kimira and Small Scale

Alternative B : Alternative A plus Kanzalu, Yala Swamp, Aror, Sabaki Extension and Thanantu

(4) Livestock development

The implementation will be made up to the extent of available budget. The schemes for provision of watering points in nomadic area would have to be given up.

(5) Hydropower

No reduced budgetary scenario is considered for this sector on a basis that required budget would be allotted as was given in the past.

(6) River and flood control works

The proposed implementation will be within the ceiling of available budget appropriated for respective work categories.

4.2.3 Reduced development scenario of domestic/industrial water supply

A great disadvantage noted in the domestic/industrial water supply development programme proposed in Subsection 4.2.2 above is that the development be restricted to a limited number of schemes and also maldistributed geographically. This will not be fair and equitable to the districts and/or people who would not benefit.

An alternative solution may be to select a reduced development scenario where each scheme is proposed at a reduced development scale, while the development would cover as many schemes as possible. On this basis, the Study examined an alternative case that the development just meeting the demand for year 2000 level would be effected towards 2010. This implies that the water demand exceeding year 2000 level will be restricted by saving of water and rationing of water supply. This criterion was applied to all schemes including the schemes for Nairobi and Mombasa.

Achievement of development by this programme is summarized below.

Achievement of Domestic/Industrial Water Supply Development - Reduced Development Scenario

Description	Alternative Budgetary Scenarios			
	2000	A 2010	B 2000	2010
Development Cost:				
Domestic/Industrial Water Supply				
- US\$ million	1,904	3,837	3,032	5,788
- K£ million	2,399	4,835	3,821	7,293
Sewerage Development				
- US\$ million	203	407	310	563
- K£ million	256	513	390	709
Achievement of Development:				
Domestic/Industrial Water Supply				
(a) Urban water supply				
- No. of cities/towns	81	87	143	151
- No. of beneficiaries (million)	7	11	8	13
(%)	88	88	100	100
(b) Rural water supply				
- No. of beneficiaries (million)	14	28	14	28
(%)	88	88	61	100
Sewerage Development				
- No. of cities/towns	88	88	152	158
- No. of beneficiaries (million)	7	11	8	13
(%)	88	88	100	100

Notes: Water supply only meets the demand at year 2000 level

Implementation programme under this development scenario is given in Appendix 4.

5. LEGAL AND INSTITUTIONAL SET-UP

The general framework of laws and administrations related to water development in Kenya contains no significant problems on the whole, as mentioned in some references (Ref. 6 and 7 - WHO research 1973 and others). The problems are not on the framework of laws but on implementation of laws and on management of water resources and use. Therefore, the current study recommends the improvement of implementation and management in consideration of the above situation. In particular, the study mainly proposes the legal and institutional aspects regarding formulation and implementation of projects proposed in this National Water Master Plan.

5.1 Laws related to Water

5.1.1 Issues of Existing Laws

(1) Water Act

The Water Act, the supreme law on water, is now being revised by MOWD (Ref. 8). The draft version of the Act was reviewed through discussion with the Attorney General Chamber and is now at the Cabinet level (as of May 1992). This revision would improve the implementation and management of water issues.

The most important and implementing institutions appearing in the Act were Water Resources Authority (WRA) and Regional Water Committees, which do not exist any more. Instead, MOWD and newly proposed District Water Boards (DWD) will be responsible for the function practically. This point is one of the main issues for revision.

(2) Tana and Athi Rivers Development Authority (TARDA) Act

It is stipulated in the Act that TARDA is the agency of "advice and coordination" regarding the regional development in both Tana and Athi river basins. It should be revised so that TARDA functions as the implementing agency just as LBDA and KVDA.

(3) Water (Water Undertakers) Rules

These rules should be applied to non-gazetted water undertakers as well. Some articles of the rules are also not applied to local authority water undertakers, but the entire article should be applied to all the undertakers equally.

(4) Lakes and Rivers Act

The Act mainly provides regulations for dredging and use of steam vessels on certain lakes and rivers. In view of the increasing need for the protection and

management of river courses, the regulations regarding management issues on rivers and lakes should be added to the Act. In this case, MOWD will be closely related to the Act, although the Act is administered by the Ministry of Transport and Communication.

(5) Local Government Act

The Act gives power to undertake sewerage, drainage and water supply works to local authorities such as city commission, and municipal, town, urban and county councils. At the same time, the authorities should take up the duties appointed for under the Water Act as water undertakers. From this point of view, the two Acts should keep consistency in legal power and obligation.

(6) Establishment of environmental assessment and management guidelines

There are no comprehensive environmental guidelines in Kenya, other than a guideline included in the Environmental Management Report (NES, 1978). The preparation of comprehensive guidelines will be prerequisite. The guidelines should be legislated in the future.

5.1.2 Implementation of Laws

Active and strict implementation and enforcement of the laws are essential to manage water development and use pertinently. As mentioned before, a study in 1973 (Ref. 6 and 7) reported that the problems encountered arise from a low level of implementation and enforcement of the laws in the agencies concerned, so the active and strict prosecution of their duties is recommended as the most essential issue.

The reasons for the low level of enforcement are: (i) the division of responsibilities among many agencies, with little coordination, (ii) lack of funds necessary to enforce the laws (shortage of staff and equipment such as vehicles and maintenance equipment), and (iii) lack of qualified personnel. Regarding point (i) the MOWD should take the initiative in enforcement of the laws as the leading ministry in water management in the country. Regarding the other two points (ii) and (iii) the agencies concerned should be reinforced individually to fulfill their duties. To prosecute efficiently, the following three improvements are required: (i) decentralization of implementation responsibilities, to the district offices in particular; (ii) training of the officials in charge of implementation and enforcement; and (iii) wider use of existing powers (without making new regulations in vain).

5.2 Issues related to Planning and Implementation of Undertakings

5.2.1 Domestic/Industrial Water Supply

(1) Implementing agencies

The various implementation agencies related to water schemes are listed below. Active utilization of the present existing institutions and laws would basically be sufficient to promote the future projects. In the long run, it would be better to apportion responsibilities between them as follows:

MOWD: It must function as a comprehensive policy formulating agency with regard to water resources development, water use and river management of the country, covering mainly water supply, sewerage, drainage and water quality control.

NWCPC: It must take over major implementing functions of the MOWD as a practical implementing agency covering the whole country. It also keeps the important function as a bulk water supplier to water undertakers.

Other Ministries and Agencies related to water schemes are;

- **MOLG :** urban water supply schemes
- **MOTC :** water supply around railway stations
- **MOTW :** preservation of wildlife
- **MOLD :** water development for livestock
- **MOCSS :** Rural water supply in local communities
- **MOLH :** Water supply in settlement areas
- **MORDASAW :** Water supply in ASAL areas

The above respective ministries and agencies should carry on development of their water schemes, because they are familiar with the needs of development and the regional conditions. However, engineering aspects (planning and designing) of water schemes should actively rely on MOWD and NWCPC.

River Basin Development Authorities:

They should facilitate a multi-purpose development, including water supply sector which should be collaborated by MOWD/NWCPC.

Local Authorities: Operation and maintenance of water supply systems is a major duty for them, and should expand the service areas and proceed to develop water resources in their territories. It would be efficient for them to rely on NWCPC regarding large-scale water resources development.

NGOs: Their efforts contribute a lot to the development of water supply sector in the country, particularly in rural areas. They should rely on MOWD for further technical and administrative co-operation.

(2) Operation and maintenance (O&M) of water supply works

Water supply systems are operated and maintained by various organizations such as MOWD, NWCPC, local authorities, local communities, and NGOs, as mentioned above. In the long run, however, O&M should preferably be handled by an organization representing the beneficiaries, which is the county council in the case of rural water supply schemes. Bulk water supply should be operated and maintained by NWCPC continuously.

(3) Water saving measures

The following three measures are recommended for effective management and cost recovery.

- (i) Extension of individual connections and metering measurement
- (ii) Reduction of water leakage from the piping networks by assigning a leakage inspection team.
- (iii) Introduction of ascending water tariff system (Ref. 9 and 10)

(4) Diversification of water demands

The current study has revealed that the balance between water demand and potential available water will be more and more critical in many areas. The following are particular areas which would need specific attention:

- Large City with active industrial development : Nairobi and Mombasa
- Town encountering a specific environmental issue : Nakuru
- Area where water resources are critically limited : 22 urban centres in dry area (see Table 6.3)

Note: There are other areas where demand-supply balance is foreseen to be critically severe. The above shows the representative areas.

For these areas, positive measures to reduce and/or diversify the growth of water demands should be exercised. The measures will include, but not limited to;
(i) regulation of regional development as a principal policy in the area,
(ii) diversification of development activities particularly industrial development and
(iii) higher water tariff to encourage the saving of water use.

5.2.2 Sewerage System

Sewerage facilities are in almost all cases confined in the areas of respective municipalities and urban centres. The beneficiaries are also in these areas. In this context, it is appropriate that the implementing agency responsible for sewerage development will remain with the local authorities. MOWD will act as the administrator responsible for policy formulation and technical advice for sewerage development.

5.2.3 Agriculture/Irrigation Development

(1) Implementing agencies

The MOA is the administrator and also main implementing agency for the country's overall agriculture and irrigation development. Other leading agencies are NIB and six river basin authorities (LBDA, TARDA, etc.) who are developing major irrigation schemes. This present administrative structure appears to function well in general.

The MOWD is also involved in the irrigation sector for a few projects. The Study is of the opinion that the MOWD's main task in this sector will be to act as the overseer of water source allocation and use, but not as an implementing body of irrigation schemes.

(2) Overall administration of irrigation development and water use

All the information (planning, implementation and management) of irrigation schemes and their water use should be inventoried and recorded at a central administration. The MOA is an appropriate ministry to carry out this task under the present Government structure. The inventory and water use, which must be periodically updated, should be reported to WAB. Since the irrigation sector is the largest user of water, the monitoring and control of irrigation water use will be quite important to achieve overall water management in the country.

5.2.4 Livestock and Wildlife Sectors

(1) Implementing agencies

Water development and conservation programmes for livestock and wildlife are currently managed by MOLD and MOTW respectively, with technical support from MOWD. For the livestock sector, the river basin authorities and MORDASW are also involved in formulating their projects, receiving coordination from MOLD. The present implementation system seems to function well, so the effort of inter-ministerial coordination should continue.

(2) Water facilities inventory list

The Study could not obtain information on existing water facilities in form of inventory list for both the livestock and wildlife. It will be necessary for MOLD and MOTW to list all the major watering points for basic information of water management in the country.

5.2.5 Hydropower Development

(1) Organization of the power sector

The MOE is responsible for formulating the national policy of the energy sector including electric power, oil and other fossil fuels, wind, biogas, solar, geothermal and woodfuel development. The electricity industry is composed of the following six entities in the country.

- (a) The Kenya Power Company Ltd. (KPC):
 - purchases bulk power from Uganda Electricity Board (UEB)
 - owns two hydropower stations and Olkaria geothermal power plant
 - develops geothermal and hydropower resources
- (b) The Kenya Power and Lighting Company Ltd. (KPLC):
 - owns and operates all conventional thermal generating facilities and most of the power transmission facilities
 - purchases electric power in bulk from other companies and authorities
- (c) The Tana River Development Company (TRDC):
 - owns the Kamburu, Gitaru and Kindaruma hydropower stations
- (d) The Tana and Athi River Development Authority (TARDA):
 - owns the Masinga and Kiambere hydropower stations
- (e) The Kerio Valley Development Authority (KVDA):
 - develops the Turkwel multi-purpose project with hydropower installation
- (f) The Lake Basin Development Authority (LBDA):
 - no facilities related to power generation as yet

(2) Implementation of hydropower development

KPC plays the leading role in planning, design, and also implementation of the hydropower projects in collaboration with the river basin development authorities. There seems to be no major difficulties nor constraints in proceeding with the

implementation with the present institutional set-up. Hence, KPC will continue to play the leading role in future development in the hydropower sector.

Major dams are owned by the river basin development authorities. This is favourable since the water impounded in the reservoir is open to multi-sectoral uses when such need arises in future. (NB: But, this does not deny the beneficial use of water for power generation)

5.2.6 River and Flood Control Works

(1) Establishment of responsible agency

The management of water resources is undertaken by various agencies, and the responsibilities shared among the agencies are generally clear in the existing legal and institutional set-up. However, the organization responsible for the management of rivers is not clearly defined. Thus, it would be important to establish a main agency in charge of this assignment, since the use of rivers and their facilities will increase in the future. This Study proposes that MOWD should function as the responsible agency for river management.

The Water Act designates MOWD to implement the works for disposal and control of flood water.

(2) Implementing agency of river works

In (1) above, the MOWD is assigned as the responsible agency for river management works. On one hand, some of the six river basin development authorities have been implementing flood control projects such as levee construction and canalization so far. Local authorities are authorized to undertake urban drainage works by the Local Government Act. In this regard, a practical approach under the present institutional establishment may be;

- (i) Overall management of the rivers will be the responsibility of MOWD, while however MOWD can entrust some of river works (eg. river improvement work, flood control projects) to the river basin development authorities or local authorities on each project basis.
- (ii) Other river related works (eg. dam, intake, bridge, etc.) can be implemented by any agencies as is practiced at present, but subject to prior reporting to and consent of WAB (as the agency responsible for water permit) and MOWD (as river administrator).

These are under practice at present, but more clear understanding of the above principles should be established among the related agencies.

(3) Inventory of present river conditions

The MOWD should exercise effort to accumulate inventory with regard to present river conditions. The inventory should include hydrological information such as (a) rainfall in the catchment area, (b) river discharges at key gauging stations, (c) river water use, (d) flood record, (e) river water quality, and structural information such as (a) plan, longitudinal profile and cross sections of the river channel, (b) land use condition along the river course and in flood-prone area, (c) engineering features of major river facilities. The preparation of a complete inventory will require many years. Nevertheless, the information should be collected and accumulated one by one henceforward.

(4) River conservation/improvement work

River conservation work is required in order to provide, maintain, and regain the stable regime of rivers. The work includes, but not limited to, the following physical works:

- (a) Conservation of river course, including the protection of bank erosion and stabilization of river bed
- (b) Removal of excessively accumulated siltation
- (c) Cleaning of interfering vegetations in the channel
- (d) Arresting of sediment yield
- (e) Canalization and/or levee construction for augmenting the channel capacity

Not many works of the above nature have been undertaken, though some works of (c) and (e) have been carried out in some areas in the country. These works should be promoted in succession in important rivers including urban rivers. To identify the required conservation works, the overseers in charge of river maintenance should inspect river conditions periodically.

According to the Water Act, builders are responsible for operating and maintaining the river structures and are under an obligation to report failure or damage of the dams constructed by them. WAB has a right to instruct them to repair the failure or damage in pursuance of the inspection. This WAB's power is restricted to the structures relating to water permit. In the near future, however, WAB having the right of approval of water permit or MOWD, the main overseer of rivers, should have the same right to all river structures as well as the structure relating to water permit. In addition, they should give instruction to the operators of river structures to report the state of structures preserved safely and the records of operation (water use in particular) and maintenance.

There are virtually no comprehensive guidelines and/or criteria with regard to protection, conservation, and operation of river-related facilities. In the future, they should be established to keep a steady level of operation and maintenance.

(5) Flood area management

As is known widely, flood disasters cannot be abated economically only by structural measures. The following non-structural measures should also be exercised with the structural measures at the same time.

- (a) Land use control in habitual flood prone areas
- (b) Installation of flood forecasting and warning system
- (c) Establishment of flood fighting team
- (d) Formulation of an evacuation system for wide spread inundation

Since these non-structural systems cannot be established in a short time, there is nothing for them but to formulate the systems for a particular area over a long time gradually. For establishing the above (b) system, MOWD should launch the installation of observatory stations and in the formulation of a correlation model for the habitual flood prone rivers at present.

5.2.7 Multipurpose Development Approach

In general, water resources in Kenya are not abundant. Although this current Study found that the water resources could meet the demands for the next 20 years towards the year 2010, the demands will continue to increase and ultimately all available water resources should be in use most effectively.

(1) Concept of integrated river basin development

This concept covers both surface water and groundwater resources. To manage these resources well, it is recommended that a comprehensive river basin development study covering all water-related sectors be prepared and updated when the revision of this plan is deemed necessary, say, once every 10 years.

(2) Multipurpose development projects

A multipurpose development project is often more economic than a single purpose development project because of the merit of scale and the joint use of the facilities. In this case, it is necessary to introduce a system of cost allocation. A basis of calculating the cost sharing is generally embraced in the "separable cost-remaining benefit method".

(3) Storage reservoir/dam schemes

Storage dam scheme is one of the effective measures for augmenting the water exploitation, which is particularly important in a dry weather country like Kenya. Since the potential of the damsite can only be utilized by a dam initially constructed there, it is quite important to select the optimum size of the dam development taking into account the long-term viewpoint. Although it may not always be a correct

solution, the development agencies should consider exploiting the dam scheme at its maximum development potential. This is particularly emphasized for the Athi, Tana, and Lake Victoria basins where the demands for water uses would continuously be increasing in future.

(4) Benefit to local people

In case of the formulation of a multipurpose project in particular, an important consideration is that the project should benefit the population of the immediate vicinity; for example, in the form of having their own water supply of acceptable quality, fishing rights without having to get tedious licences and possibly access to water for limited irrigation. In this way the local community will see it as their project and it will improve the local environment. (Opinion from MOWD Embu).

(5) Coordination between ministries/agencies

Under the present institutional set-up, most of the multi-objective development projects will come out from the studies of the river basin development authorities. This is an ideal approach and therefore should be strengthened. In some cases, the proposal may be raised from studies of other agencies such as KPC, NIB, and NWCPC. In both cases, proper coordination will be required among the agencies concerned. A tentative proposal herein is that the proposed multipurpose project will be discussed and coordinated for decision of joint implementation at a special committee organized on ad-hoc basis. MOWD should act as the leading agency for the coordination at the committee since MOWD is, in coordination with WAB, the overseer of the country's water resources. However, in this case, it is important that MOWD/WAB should carry out this assignment in close collaboration with the river basin development authority concerned with the proposed project.

5.3 Water Resources and Use Management

5.3.1 Surface Water Management

(1) Hydrological data management

(a) Hydrological observatory work

The MOWD is currently operating some 900 water level gauging stations, but many stations have deteriorated or are not working properly because of the limited availability of financial resources. Under this situation, a practical approach at the present moment would be to reduce the number of stations. On the other hand, unique aspects prevail in Kenya that water abstraction is made mainly in tributaries and springs in upper watershed areas. These factors require hydrological observations at as many as possible places. This means that the number of observatory stations should be increased in the future. Thus, the MOWD has to increase the budgetary resources for it.

(b) Processing and storage of data

The processing of data and interpretation of the results are carried out centrally by the Surface Water Section of MOWD headquarters. This system is appropriate for application for some time span, but de-centralization of part of the work (e.g., digitization and/or input of the field records) will be considered in the future.

(c) Training of field hydrologists

The accuracy of collected hydrological data depends much on the skill and motivation of hydrologists posted to provincial/district offices. For field hydrologists, therefore, it is important to organize training courses such as annual seminars.

(d) Dissemination of hydrological information

The Surface Water Section/Data Units of MOWD would be responsible for dissemination of hydrological data to other Divisions/Sections within the Ministry and also to other government agencies and private firms. It is recommended that a publication programme be established so that hydrological information can be more readily available to users. Some charges may be imposed for publication of data to cover expenditures of data retrieval, printing and other costs.

(2) Water abstraction permit

Up to the present, WAB has stored more than 25,000 proposal documents relating to abstraction permits. However, the accurate number of water permits currently effective cannot be known. According to the review by the Study, the currently effective permits may number around 15,000. In actual water uses, there seems to be many cases that water users approved to obtain a permit abstract as much water as they require beyond the approved quantity and that some users abstract water without a permit. In some basins in high potential areas, it is reported that the abstraction volume permitted by WAB appears to have already exceeded the available natural flow.

In this context, the following actions are deemed to be required urgently:

- (a) Renovation of filing system of water abstraction permit
- (b) Water use survey for several critical river basins and ultimately for all basins
- (c) Working out naturalized river flow and the maximum permissible amount for abstraction

The works for (b) and (c) above will require a lot of expertise inputs. It is worth proposing the above studies as one of the donor assistance programmes.

The above data management has been conducted by WAB so far, but WAB has no sufficient technical staff at its head office. Therefore, MOWD should be more involved in the aspect of water permit data management.

(3) Water use monitoring and control

As mentioned in the previous section, improper uses of water exist at many places, including over-abstraction, misuse and other illegal abstractions. Hence, monitoring and control thereto are important tasks assigned to WAB and MOWD.

(a) Encouragement of water bailiffs' activities

Successful achievement of water use monitoring and control will depend largely on the capability and volition of water bailiff posted to provincial and district offices. For encouraging their activities as well as training of water bailiffs, providing an adequate transportation facility and increasing the number of highly qualified water bailiffs should be given priority. It is stressed that "proper water use" is linked up with "reduction of water development costs".

(b) Measurement and reporting of water uses

The Water Act allows WAB to require a water permit holder to install controlling/measuring devices and to keep a record of water abstractions. MOWD and WAB should clamp this application over major water permit holders.

(c) Strengthening the imposition of penalties

Present laws allow the imposition of penalties (fines and imprisonment) to offenses in water use. It would be important to exercise the strict enforcement of the penalties when the water bailiff identifies any illegal water uses. The cancellation of water permit may be the severest way of penalizing the users.

(4) River maintenance discharge

Water (General) Rules provide for compensation water. This should be revised such that all surface water abstraction schemes are to consider the compensation water to be released for the downstream water uses and to keep the minimum flow required for preserving the river for various water uses. The assessment of river maintenance discharge shall be made under river basin studies and/or each project studies carried out henceforward.