REPUBLIC OF KENYA



MINISTRY OF WATER DEVELOPMENT

ISIOLO

DISTRICT WATER DEVELOPMENT STUDY

1993 - 2013

PART 1

WATER DEMAND AND WATER RESOURCES

PART 2

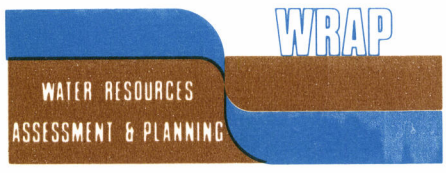
EXISTING SUPPLY, TECHNOLOGY OPTIONS AND COSTS

PART 3

GUIDELINES AND RECOMMENDATIONS FOR INVESTMENT PACKAGES

June 1991

WATER RESOURCES
ASSESSMENT SECTION
NAIROBI, KENYA



TNO – INSTITUTE
OF APPLIED GEOSCIENCE
DELFT, THE NETHERLANDS

ISIOLO

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PREFACE

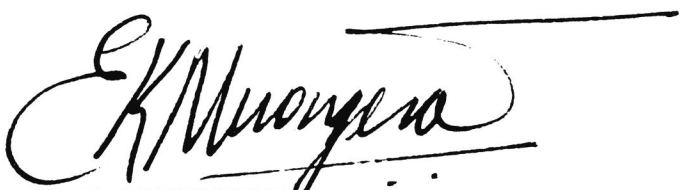
It gives me great pleasure to introduce the District Water Development Study for Isiolo District.

The Ministry of Water Development has the task of planning for water resources development, both at national and district levels. Districts have been assigned a major role in the development of the country as illustrated by the District Focus Strategy for Rural Development Policy. Consistent with this policy the Ministry of Water Development has put great emphasis on the studies for District Water Development Planning.

Water resources development can only be successfully undertaken if the long-term planning reflects the balance between availability and exploitation of water. Extensive investigations and monitoring are needed to determine the potential of the water resources and the effects of development on long-term basis. Presently, the Districts do not have the research capacity to carry out the necessary studies independently. To overcome this situation, the Ministry of Water Development has established a Water Resources Assessment Section that supports the Districts in carrying out these studies. The Section is being strengthened by the Water Resources Assessment and Planning Project.

The present study provides extensive information on the availability of water resources, the existing supply, the future water demand and the investments involved in developing the water resources in Isiolo District. Equipped with this information the District will be in a better position to plan its supply facilities. It is only after the District succeeds in explaining to the people the limitations of the natural system and the vulnerability of the environment involving them as much as possible in the planning and construction of their water supplies, that the difficult task of providing water to the people will see a good end.

I express the wish that this important study will be optimally used to achieve this common goal.



(E. K. MWONGERA)
Director of Water Development

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ABBREVIATIONS

ASAL	=	Arid and Semi-Arid Lands Development Program
CBWDP	=	Central Baringo Water Development Plan
CC	=	County Council
DANIDA	=	Danish International Development Agency
DDC	=	District Development Committee
DDO	=	District Development Officer
DDP	=	Isiolo District Development Plan 1989-1993
DvDC	=	Divisional Development Committee
DWDP	=	District Water Development Plan
DWDS	=	District Water Development Study
EC	=	Electrical Conductivity
EEC	=	European Economic Commission
EMI-ASAL	=	Embu - Meru - Isiolo Arid and Semi - Arid Lands Programm
FINNIDA	=	Finnish International Development Agency
GOK	=	Government of Kenya
GSK	=	Groundwater Survey Kenya
GTZ	=	Deutsche Gesellschaft fur Technische Zusammenarbeit
IFAD	=	International Fund for Agricultural Development
ILDP	=	Isiolo Livestock Development Project
KFRWSDP	=	Kenya Finland Rural Water Supply Development Project in Western Province
KIDP	=	Kitui Development Program
Ksh	=	Kenya shilling
KWAHO	=	Kenya Water for Health Organization
KWDP	=	Kwale District Community Water Supply and Sanitation Project
L.U.	=	Livestock Unit
LBDA	=	Lake Basin Development Authority
lpcd	=	litres per capita per day
LMD	=	Livestock Management division
MoA	=	Ministry of Agriculture
MOH	=	Ministry of Health
MoLD	=	Ministry of Livestock Development
MoWD	=	Ministry of Water Development
MPND	=	Ministry of Planning and National Development
msl	=	Meters above mean sea level
NGO	=	Non-Government Organization
NORAD	=	Norwegian Agency for Development
ODA	=	Overseas Development Agency
O&M	=	Operation and Maintenance
RDF	=	Rural Development Fund
Shs	=	Kenya shilling
SIDA	=	Swedish International Development Agency
TLU	=	Tropical Livestock Officer
UNDP	=	United Nations Development Program
UNICEF	=	United Nations International Children Emergency Fund
USAID	=	United States Agency for International Development
WECO	=	Western College of Arts
WRAP	=	Water Resources Assessment and Planning Project
WRAS	=	Water Resources Assessment Section

SUMMARY

The present report on Water Demand and Water Resources is Part 1 of three reports, composing the Isiolo District Water Development Study. Part 1 contains the assessment of the district water demand and the results of the water resources study and the analysis of the compatibility of both. The objective of Part 1 is to enable an opinion on the feasibility of water supply development, in the context of the desired economic development and the available water resources in Isiolo District.

Isiolo District is located in Eastern Province of Kenya. The District covers a total area of 25,605 square kilometres. Most of the land is flat low-lying land, especially in the lower Ewaso Nyiro Basin, a featureless plain resulting from the weathering of the friable tertiary sediments which compose it. The plains rise gently from the east, around Habaswein at an altitude of about 200 m above sea level, to the Merti area at an altitude of 300 m above sea level. To the north of the Ewaso Nyiro River, plateau lavas form low but clear escarpments above the surrounding plains.

All the land of Isiolo District is classified as low potential. It is trustee land belonging to the Government and administered by the Isiolo Local Authority. Land adjudication has not been undertaken in the District. The land area of the District is classified as semi-arid (5%), as arid (30%) and as very arid (65%).

Livestock rearing is the main stay in the District. The nomadic population continuously move their livestock around the District in search of good pastures and water. Livestock from North Eastern Province often come to use the better grazing areas in Isiolo.

Land use for farming activities is very limited. Some irrigation projects exist along the Ewaso Nyiro and in Kinna. The District also has put land aside as Animal Game Reserves.

Isiolo District is administratively divided into 4 Divisions, viz. Central, Garba Tula, Merti and Sericho. These Divisions are further sub-divided into 11 Locations. In total there are 27 sub-locations.

The total population of Isiolo District in 1979 was 43,478. It is estimated that the population increased to about 64,000 for 1988. In general terms Isiolo District could be described as a rural district. The only urban centre is Isiolo Town, the District Headquarters, with an estimated population of 15,000 people in 1988. Rural centres, also serving as Divisional Heeadquarters are: Garba Tula (5,600), Merti (2,600), Modogashe (6,500) and Sericho (1,300). In addition there are about 16 small rural centres.

The water demand was calculated using the unit water consumption rates as specified by the MoWD. The best possible estimate of the 1990 water demand was taken as the basis for the projection of the water demand during the 20-year plan period. The initial year of the DWDP, when planned water supplies are expected to be operational, is 1995.

As much as possible data and growth rates are in accordance with the Isiolo District Development Plan 1989-1993. However projections were not available beyond 1995.

The population growth rates applied for the period 1995 - 2015 are 5 % for the large centres and 4 % for the small centres and rural areas respectively. The resulting District population for 2015 amounts to about 190,000 people.

The total demand is divided into domestic and non-domestic demand. The domestic demand comprises all demand from population, schools, health - facilities and others. The non-domestic demand comprises livestock and industrial demand.

The total demand is calculated for each sub-location or deda. The domestic demand in most sub-locations is in the range of 50-200 m^3/day for the year 2005, ten years after expected completion of the schemes. The urban water demand at Isiolo Town comprises more than 50% of the total domestic demand.

The information on the water resources in the district is based on the reports of the Water Resources Assessment Study in Isiolo District, made by WRAP.

The surface water availability in the district depends mainly on rainfall which is highly variable in time and space. Average annual rainfall varies from 150 mm in the eastern and northern parts of the District to 650 mm around Isiolo Town. In Isiolo District rainfall occurs in two distinct seasons with peaks in April and November.

Laggas flow intermittently during the year, usually only for very short periods. The lagga flow can reach large volumes, due to high rainfall intensities and small storage capacities of the catchments. The laggas are said to contribute about 50% of the total flood flow.

The main perennial river in the District is the Ewaso Nyiro. Perennial tributaries of the Ewaso Nyiro are the Isiolo, Ngare Ndare, Ngare Nything and Ngare Mara. Apart from the data on the Ewaso Nyiro River, no other data of sufficient length and continuity exist. The mean annual flow of the Ewaso Nyiro at Archer's Post amounts to about 630 million m^3. The low flows of the river have gradually decreased due to an increase of water use in Laikipia District. In 1985 and 1986 the Ewaso Nyiro dried up in a reach of about 50 km upstream of Archer's Post.

Geologically, Isiolo District comprises three major rock units, namely: Basement System, sedimentary and volcanic rocks. The northern area of tertiary sedimentary rocks (System IA, Zone 2), the volcanics area (System IB) and the coarse alluvial deposits along the Ewaso Nyiro (System IIB) have good groundwater potentials. Owing to the fact that their groundwater is of good quality, these systems offer good opportunities for groundwater development. The Basement rocks offer very poor chances for groundwater development since in most cases EC values are above 4,000 μS/cm. The remaining central and southern part of the tertiary sediments offers no chances for groundwater development due to the occurance of highly mineralised water.

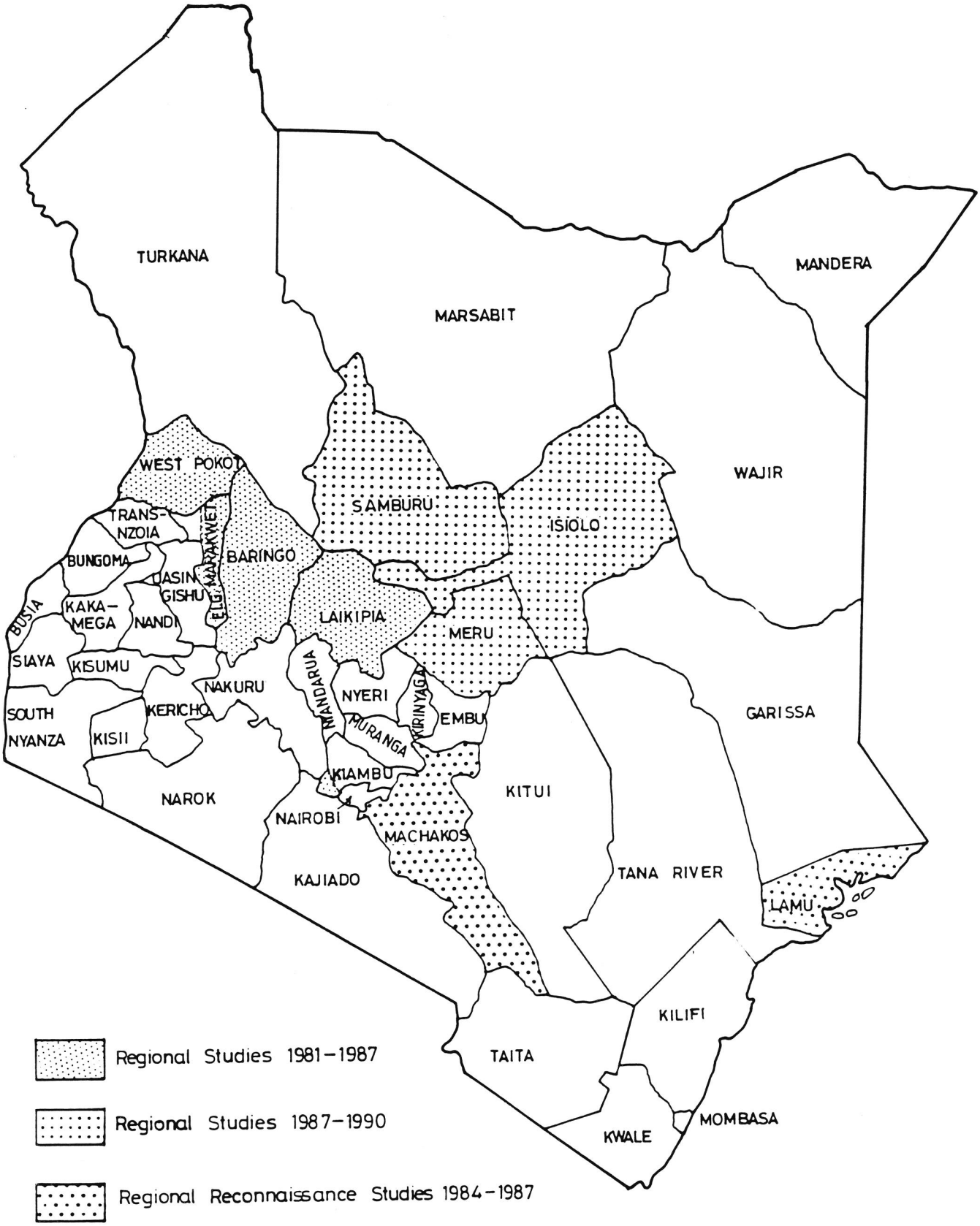
The analysis of the water demand versus the water resources is carried out for the domestic demand in each centre. The planning of the livestock supplies is undertaken by the Isiolo Livestock Development Project and is therefore not dealt with in detail.

The type of water resources available at the rural centres is generally groundwater. Permanent surface water is available only at Isiolo Town and at Kinna. Groundwater is available at different depths, but the salinity increases strongly with the depth.

In most centres the water resources are sufficient to cover the demand. However in some centres the demand may not be covered, because the distance to the source is too large (Malka Galla, Dadacha Bassa), or because the water source is insufficient during drought periods (Modogashe). Only at Duse water resources are not available at all.

The demand from livestock in the rural areas of Isiolo District may be covered from groundwater or from pans. Groundwater, however, is not an option everywhere because of high salinities. In such areas pans may be the only alternative to provide the required water.

WATER RESOURCES ASSESSMENT & PLANNING PROJECT



Regional Assessment Studies under the WRAP Programme 1981-1990

1. INTRODUCTION

1.1 Purpose and Scope of the Study

The District Water Development Study (DWDS) of Isiolo District is aimed at providing the basis for the District Water Development Plan (DWDP), which in turn will be the sector input to the District Development Plan (DDP).

The study was undertaken by the Ministry of Water Development in its role of supporting the districts in their task to develop the available water resources in a safe and sustainable way. Two conditions will have to be fulfilled to achieve this goal.

- The development of water resources must be in balance both with the capacity of these resources and with the conditions set by the environment.

- Supply of water to the community must be sustainable, meaning that the proposed schemes be designed in agreement with the technical and financial support capability of the people for whom they will be constructed.

These conditions require a thorough assessment of the situation in the districts and a planning that is in tune with the socio-economic, institutional and technical developments.

The DWDS can be considered the first stage in the process of formulating a DWDP. The study, based on extensive assessments, describes the water resources development potential in comparison to the projected water demand, discusses the viability of different water supply options in terms of sustainability and safety, and provides estimates of the investment levels involved.

The DWDP based on the study will be more specific in that it also comprises the decisions of the district authorities regarding selection and prioritization of the water development schemes. The plan is to cover a period of 20 years, according to MoWD guidelines, starting from 1995 when operation of the first new schemes will supposedly begin. The DWDP will be an important component of the DDP which includes the entire socio-economical planning of the district in perspective to all the available resources. From the above it may be clear that both plans are closely linked and can only be successfully developed in good co-ordination.

The methodology for planning of water resources development, adopted by the Ministry facilitates full participation of the district authorities, community groups and individuals concerned in all stages of the planning process, which is in line with the District Focus Policy. An outline of the general approach is given in chapter 2 of this report. A summary of the main aspects of the District Focus Policy related to water development planning is presented in Appendix 1.

In order to provide optimal conditions for district involvement, the DWDS is carried out in three phases. District engineers and institutions concerned with water use and water supply are extensively consulted during the periods of data collection and analysis. The final report includes three volumes, corresponding with the three phases of the study.

The present report is Part 1 of the DWDS carried out for Isiolo District within the framework of WRAP. The report contains the basic data used to calculate the water demand for 1990 as well as the projected demands for the years 1995 and 2015. It includes the analysis of these demands and the comparison with the available resources of groundwater and surface water.

1.2 International Co-operation

The District Water Development Study was undertaken under Co-operative Agreement between the Governments of Kenya and The Netherlands.

The studies are carried out by the Water Resources Assessment Section of the Ministry of Water Development, Nairobi, Kenya in co-operation with the TNO Institute of Applied Geoscience, Delft, The Netherlands, within the framework of the **Water Resources Assessment and Planning (WRAP)** project.

Consultancy services were provided by the Netherlands Economic Institute, Rotterdam, The Netherlands and the International Institute for Hydraulic and Environmental Engineering, Delft, The Netherlands.

2. GENERAL APPROACH

The District Water Development Study (DWDS) is a base study for preparation of the District Water Development Plan (DWDP). All components that constitute the DWDP are also covered by the DWDS.

The model introduced by the WRAP project for preparation of a DWDP is shown in figure 2.1. The DWDS follows this model in analysing the various components that finally will lead to the formulation of the DWDP. The study includes three phases focusing on different aspects of the planning, namely:

- the compatibility of available water resources with water demand in the present situation and for projected demand scenarios
- the viability of the technical options for water supply development based on environmental and sustainability criteria
- the investments involved in the district water development and the technical, institutional, social and financial factors determining the sustainability of selected solutions

The results obtained in the subsequent phases of the DWDS are presented in Part 1, Part 2 and Part 3 of the DWDS report, which should provide the district authorities with sufficient base information for initiating further development of the water resources in the District. An outline of the Study is given below.

Water Demand Study (Part 1)

The water demand study comprises of analyses and projections of the water consumption by all water users in the district. The baseline data available from various sources are often incomplete and/or inaccurate. Therefore, thorough scrutiny of the data is needed to ensure sufficient reliability of further analysis. The data is processed using a Database Management System that handles both the calculation of the water demand and the projection of the baseline data.

The water demand is calculated using the procedure laid down in the Design Manual of the Ministry of Water Development. The procedure compels to projecting the water demand in 5, 15 and 25 years time. This, in turn, requires analysis of the growth trends of population, livestock, agriculture, industries, tourism, etc.

It may be clear that the DWDS depends on the input from other sectors, such as livestock and agriculture, to complete the projections in the most realistic way.

Water Resources Assessment Study (Part 1)

Water resources assessment studies are an essential component of the DWDS. The assessment studies undertaken within the framework of the WRAP project comprise the following:

- An inventory of available data and studies on the water resources in the District

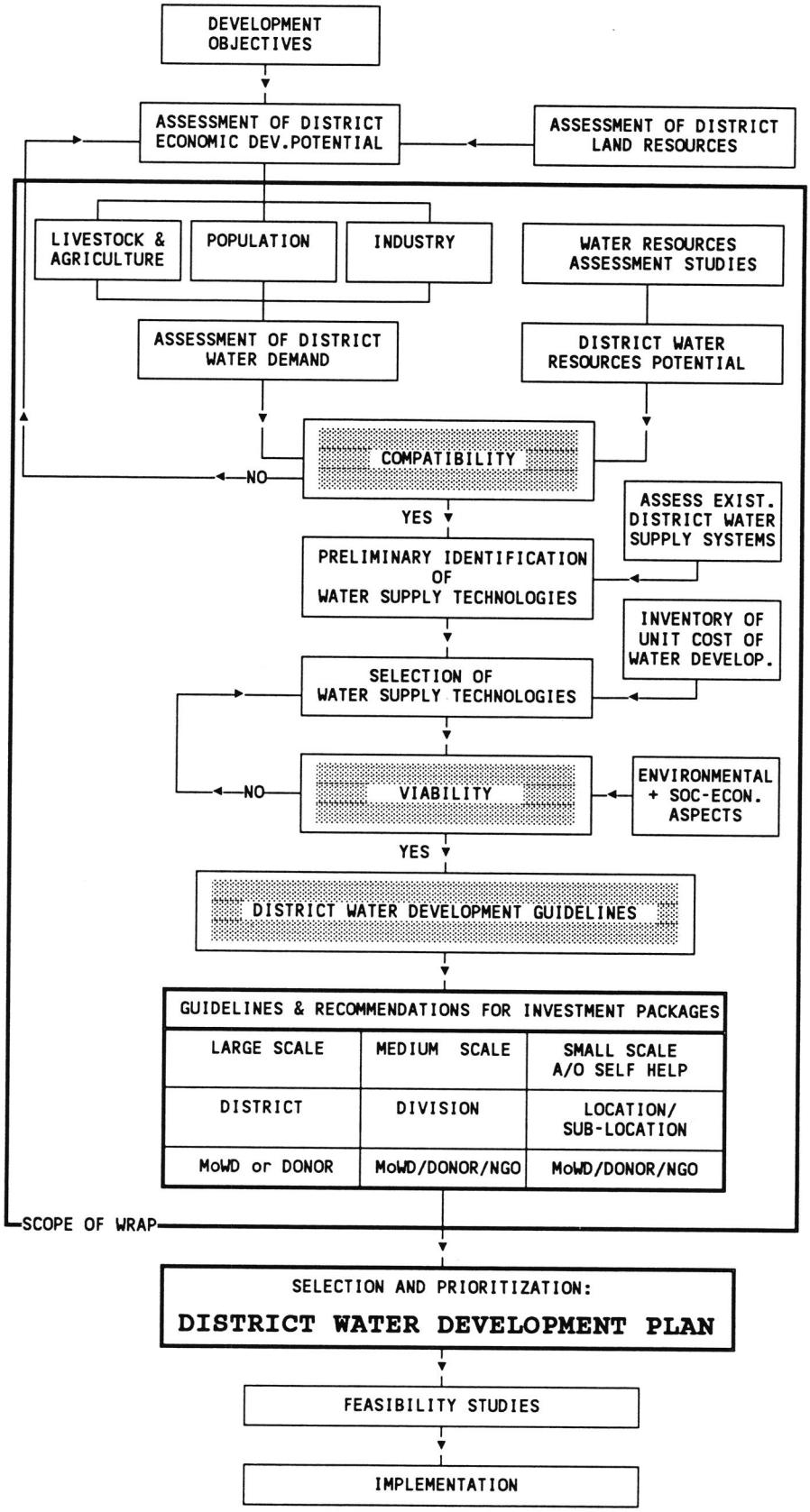


Figure 2.1 Model for Preparation of District Water Development Plan

- A field survey including collection of data on surface water and groundwater, rehabilitation of part of the existing measuring stations and installation of temporary measuring stations. Measurements are made of the quantity and quality of water in rivers, springs, wells and boreholes.

- A geophysical reconnaissance survey using vertical electrical or electromagnetic soundings and profiling, aimed at providing more insight into the hydrogeological conditions. The results of the survey are checked and calibrated by drilling of exploratory boreholes and test pumping.

- An analysis of the geological, geophysical, hydrological and hydrogeological maps and data, both from the inventory and from field investigations.

From all this information and after careful and systematic analysis, water availability maps are prepared which show the water development potential of the area. The water resources assessment investigations are described in a separate report and a summary of the main conclusions on the water development potential is given in Part 1 of the DWDS report.

Comparison of Water Demand and Available Resources (Part 1)

Having estimated the water demand over the next 25 years and the water resources available in the district, a close analysis is made of the water development potential to decide whether the projected water demand can be met.

When comparing the demand with the resources, priorities need to be set whether a district can best support human, livestock, agricultural or industrial development. In this respect both quantity and quality of the water must be considered.

What emerges from this process of comparing the demand with the resources, is a description of the development potential of the District, based on water availability.

Study of Water Supply Development Options (Part 2)

From the actual and projected water demand and the capacity of existing water supply schemes, the need for further development of the water supplies can be determined.

Limited water resources, contrasting interest or expected negative environmental impact may hamper further development. However, in situations with sufficient water available, often more than one supply option can be considered. A selection of the best alternative must then be based on considerations of financial, technical and environmental viability.

Phase 2 of the DWDS includes:

- Assessment of existing district water supply systems
- Assessment of technical options for water supply improvement
- Inventory of unit costs for water development based on existing supplies
- Preliminary identification of water supply options and cost
- Study of cost-effectiveness of water supply options

The results and conclusions are presented in Part 2 of the DWDS report. Together with Part 1 this forms the basis for the 'District Water Development Guidelines'.

Formulation of Guidelines and Recommendations for Investment Packages (Part 3)

The guidelines and recommendations for the development of the district water resources result in proposals for improvement of the existing water supply situation in the District. The proposed improvements may range from very small local supplies to comprehensive water supply schemes. The investments required to improve the water supply situation have been termed investment packages.

The purpose of the investment packages is to present to the Government of Kenya and interested donors a preliminary estimate of the funds and other inputs needed for water supply development. Each investment package or a combination of them can thus form the core of a water supply project.

WRAP has concentrated on investment packages for development of domestic supplies, because livestock supplies are currently planned for by the Isiolo Livestock Development Project of the Ministry of Livestock Development. The investment packages are based on pre-feasibility studies of water supply development in each rural centre of Isiolo District.

Phase 3 of the DWDS includes the following issues:

- Land use, environmental, social, institutional and economic/financial factors to be considered
- Guidelines for assessment of water sector investment proposals
- Pre-feasibility studies of water supply to rural centres
- Recommendations on required institutional strengthening for implementation of the DWDP
- A framework for a proposal based on the investment packages.

The analyses, results, conclusions and recommendations arrived at are presented in Part 3 of the DWDS report. The pre-feasibility studies are presented in a separate volume accompanying the DWDS report.

3. DESCRIPTION OF ISIOLO DISTRICT

3.1 Physical Features and Land Use

Isiolo District is located in Eastern Province of Kenya. The District covers a total area of 25,605 square kilometres. Most of the land is flat low-lying especially in the lower Ewaso Nyiro Basin, which is mainly a featureless plain resulting from the weathering of the friable tertiary sediments which compose it. The plains rise gently from the east, around Habaswein at an altitude of about 200 m above sea level, to the Merti area at an altitude of 300 m above sea level. To the north of the Ewaso Nyiro river, plateau lavas form low but clear escarpments above the surrounding plains.

The western part of the District is an extensive poorly developed plainland, associated particularly with the basin of the Ewaso Nyiro river, broadly corresponding with the end-tertiary erosion bevel. This plain is lying at about 1,000 m and has levelled extensive tracts of quite diverse metamorphic rocks. The pleistocene basalt flows derived from the northern slopes of Mount Kenya and the Nyambeni Hills have covered large areas of this surface, surrounding isolated inselbergs, such as Shaba Dogo.

There are only four perennial rivers in the District, these are Ewaso Nyiro, Isiolo, Bisanadi and Kinna. The Isiolo River originating from Mount Kenya is the source of water supply for Isiolo Town. There are also many seasonal laggas in the District.

Most part of Isiolo District is composed of sandy soil, but along the perennial rivers and swampy areas on the slopes of Mount Kenya and Nyambeni Hills, black cotton and red soils are found. The sandy soils hardly support any vegetation and erosion is rampant in this kind of soil.

All the land in Isiolo District is classified as low potential and is all trustee land belonging to the Government and administered by the Isiolo Local Authority. Land adjudication has not been undertaken in the District. The land area of the District is classified as semi-arid (5%), as arid (30%) and as very arid (65%).

Livestock rearing is the main stay in the District. The nomadic population continuously move their livestock around the District in search of good pastures and water. Livestock from North Eastern Province often come to use the better grazing in Isiolo.

Land use for farming activities is very limited. Some irrigation projects exist along the Ewaso Nyiro and in Kinna. The District also has put land aside as Animal Game Reserves.

Four main seasons are identified in the district. These are the hot and dry season from mid-December to mid-March; the long rains from the end of March to the end of May; the cool and dry season from June to September and the short rains from mid October to mid December.
Monsoon winds are present throughout the year and they attain their peak during the months of June, July and August.

The temperatures recorded in the District are generally high throughout the year with slight variation due to altitude. The mean annual temperature for Isiolo Town station is 26.6°C. In most parts of the District sunshine is abundant.

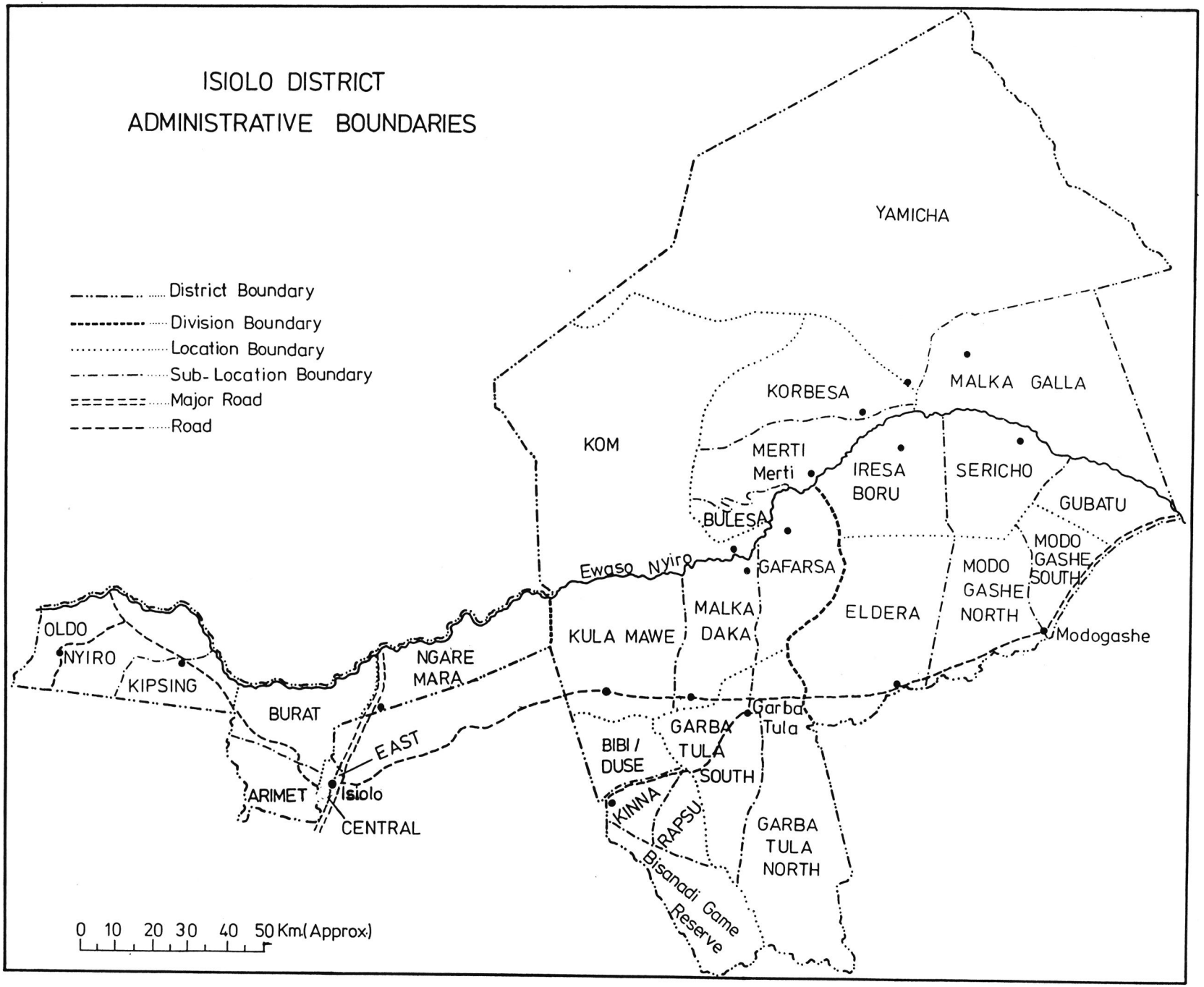


Figure 3.1 Administrative Boundaries Isiolo District

3.2 Infrastructure and Economy

Isiolo District is administratively divided into 4 Divisions viz:- Central, Garba Tula, Merti and Sericho. These are further sub-divided into 11 locations viz:- Central, Ol Donyo Nyiro, West, Garba Tula, Kinna, Kulamawe, Sericho, Modogashe, Merti, Malka Galla and Bisan Biliku. In total there are 27 sub-locations.

In general terms Isiolo District could be described as a rural district, there existing only one urban centre: Isiolo Town, which is the District Headquarters with a 1988 estimated population of 15,000 people. Other centres which are also Divisional Headquarters are: Garba Tula (5,600), Merti (2,600), Modogashe (6,500) and Sericho (1,300).

The centres offer the rural population commercial, administrative and institutional services. Hardly any industrial activity takes place here.

The infrastructure is poorly developed in the District, the only tarmac road is the road link from the Meru - Nanyuki junction which covers only a small section of the District. The total length of classified roads in 1983 was 11,406 km, 64% are dry weather roads, while the remaining 36% are all weather roads. The road network is poorly distributed.

Electricity is available from the national grid in Isiolo Town only.

The DDP (1989-1993) estimates the 1988 labour force at 21,791. The majority of this labour force is engaged in the livestock sub-sector, commercial sector and informal sector. The labour force is expected to rise to 26,973 in 1993.

The number of wage earners in the major town i.e. Isiolo Town and in the whole district is summarized in the table below.

Table 3.1 Wage Employment and Average Earnings

	Estimated Wage Employment (No)		Average Earnings Ksh/Month	
Year	1986	1987	1986	1987
Isiolo Town	2443	2307	1749	2580
Isiolo District	3688	3708	1956	2343

Source: Statistical Abstract 1988

Whereas there is a slight decrease in wage employment in Isiolo town between the years, there is a general increase in average earnings. The average earnings for the District are higher than those of Isiolo town in 1986, this state of affairs is reversed in 1987.

3.3 Population

The total population of Isiolo District in 1979 was 43,478. The District is estimated to have a population of 63,931 in 1988.

Table 3.2 Population Isiolo District

Division	1979	1988
Central	17,403	25,572
Garba Tula	12,522	18,412
Merti	7,388	10,868
Sericho	6,165	9,078
Total	43,478	63,931

Source: DDP 1989-1993

The population of the urban centre and some market and local centres is shown in the table below.

Table 3.3 Population Estimates of Centres

Division	Centre	1979	1988
Central	Isiolo	11,331	15,000
Central	Oldo Nyiro	1,300	2,000
Garba Tula	Garba Tula	3,400	5,600
Garba Tula	Kinna	1,200	2,500
Garba Tula	Kulamawe	800	1,500
Sericho	Modogashe	4,600	6,500
Sericho	Sericho	720	1,300
Merti	Merti	1,383	2,600
Merti	Bulesa	860	1,400

Source: DDP 1989-1993

In 1979 the population under 14 years of age comprised 42.6 % of the total population. In 1990 this is estimated at 44.4% of the total population. This group constitutes a large proportion of the population and it indicates that many education facilities are required.

3.4 Livestock

Livestock plays a major role in the economic activity of the District. Livestock production is carried by pastoralists on individual basis as there are no group ranches in the District.

There has been a gradual increase in livestock figures during the period 1984-1987 as shown in the table below. The gradual rise in livestock numbers since 1985 is

attributed to the improvement of pasture throughout the District after the 1984 drought, also more watering points for livestock have been constructed.

Table 3.4 Livestock Population

	1984	1985	1986	1987
Cattle	121,150	127,210	135,570	149,127
Sheep	153,427	161,622	164,702	181,172
Goats	102,922	108,068	113,468	124,814
Camels	20,978	22,082	23,182	25,500
Dairy Cattle	-	35	78	85
Donkeys	-	7,728	81,113	89,224

Source: DDP

On the whole the district has a good potential for livestock production. The planning for using this potential is being developed by ILDP (Ministry of Livestock Development).

ILDP carried out three aerial surveys in 1989 of the livestock population in Isiolo. The numbers vary according to the season, the maximum being counted in September-October: cattle 150,000, smallstock 434,000 and camels 50,000. The numbers from this survey were used for the demand calculation (chapter 5).

The livestock sub-sector forms the bulk of income in the District. The table below shows income from livestock sales: 1984-1987.

Table 3.5 Income from Sales of Livestock (1984-1987)

Year	Cattle		Goats		Camels	
	No	Value	No	Value	No	Value
1984	17,444	39,074,560	30,554	6,599,664	49	823,200
1985	16,294	43,993,800	18,932	1,116,900	524	1,100,400
1986	10,440	31,320,000	25,825	6,817,800	611	1,368,640
1987	11,125	40,050,090	27,579	7,942,752	656	1,836,800

Source: DDP 1989-1993 (only sales through LMD and Isiolo Town slaughter house)

In both cases of cattle and goats, there is a drop in sales between 1984 and 1985, this could probably be attributed to the 1984 severe drought which might have prompted cattle owners to sell many of their stock, thereby causing the decline in 1985 because already most of the mature stock had either been sold or had died. Since camels are not affected by drought so much, there has been a gradual increase in sales.

Wildlife is a very important resource for the district, as it forms a major source of income for the County Council and it provides employment. The District has 3 gazetted Game Reserves viz.: Buffalo Springs, Shaba and Bisanadi. Buffalo Springs in particular is a major tourist attraction.

3.5 Agriculture

Agriculture farming is not a very important form of activity in the District. The amount of food crop produced in the District is so low that the District is actually a net importer of foodstuffs from the neighbouring Meru and Laikipia Districts.

The only important cash crops grown (albeit on a very small scale) is cotton, but due to irregularity of payments cotton farming has not taken root in the District.

There are small irrigation schemes in Malka Daka, Rapsu, Bulesa, Gafarsa and Kinna. These have a high potential for cultivation but only a small area is cultivated.
The important food crops are maize, green grams, beans and bananas. Crop production in the District is mainly for subsistence.

Table 3.6 Agricultural Production 1984 - 1987

Crops	1984		1985		1986		1987	
	Hectare	Tonnes	Hectare	Tonnes	Hectare	Tonnes	Hectare	Tonnes
Cotton	33.7	32.4	124.5	99.6	85	45.15	28.4	16.33
Maize	412.6	590	689	861.25	749.3	674.37	524.9	524.9
Beans	33.5	23.45	83.1	57.88	84.4	40.09	64.5	58.09
Cow peas	2.68	1.5	5.65	4.52	8.8	3.96	10.8	6.45
Pigeon Peas	1.5	1.07	3.5	2.8	4.1	6.0	0.9	0.5
Green Peas	0.5	0.15	1.4	0.7	2.8	0.84	2.46	0.5
Cassava	2.2	4.00	4.1	11.0	7.5	37.5	4.1	16.4
Sweet Potatoes	4.03	12.09	6.7	30.15	7.2	27.72	6.0	48
Tomatoes	4.5	36.00	10.0	80.0	10.19	101.9	3.25	24
Citrus Fruits	5.28	31.65	24.75	136.12	8.25	49.5	9.0	56.9
Papaws	3.0	27.0	7.5	67.5	NA	-	-	-
Bananas	47.5	380	67.1	119.6	59.23	829.5	68.9	826.8

Source: DDP 1989-1993

3.6 Water Supply

Due to its semi-arid potential, water supply is a major constraint in the development of Isiolo District. In 1978, there were only 3 minor water supplies and 4 boreholes with no distribution network in the entire District. This changed dramatically in the following five years. In 1983 there already existed 1 major urban water supply, 6 minor water supplies, 9 boreholes, 9 large pans and 3 small pans.

The six minor water supplies basically serve the divisional headquarters and other centres with a relatively high concentration of population. The major urban water supply, which is a conventional urban water supply serves Isiolo Township.

The existing dams and pans have a major problem of siltation which reduces their capacity greatly.

3.7 Health, Education and Social Services

The new District Hospital which was inaugurated recently at Isiolo offers modern medical services and has a 160 bed capacity. The old hospital building will be used for infectious diseases with a 36 bed capacity.

Two health centres are located at Garba Tula and Merti respectively. In addition there are 17 dispensaries. Access to some of these dispensaries is poor and lack of water make their administration rather difficult.

There are 38 primary schools in Isiolo District and 3 secondary schools. The school attendance in Isiolo is generally low compared with other districts. This is mainly due to the nomadic lifestyle of the people. The average dropout rate for girls is estimated at 40% and slightly lower than this for boys.

The Ministry of Culture and Social Services assists the local communities to become self reliant, by involving them in the planning of rural development activities. Progress is being made and the number of registered women groups rose from 42 in 1984 to 71 in 1988.

3.8 District Development Plans

The district development objectives form an important input to the preparation of the DWDP, as the projections for future use of water need to be based on the expected or planned economical growth (Figure 1.1).

The District Development Plan is the major source of information on the district economical development potential. It consists of three parts. The first part contains mainly background information on the District's resource base and the state of development. The second part describes the development of the District, regarding strategy, potential, constraints, and proposed solutions and actions. The third part provides for each sector the district policy orientations and a list in order of priority of the major projects and programmes. A summary of the second part follows to present the assessment by the District of its potential economic development.

The DDP 1989-1993 for Samburu District does not provide the detailed basis required for accurate projection of the economic growth (or development in each of the sectors). Therefore estimates had to be made in this study in order to project future water demand. This is described in chapter 4.

3.8.1 Major Development Potential and Needs

Isiolo District is an arid District and hence as has been described earlier, it has a high potential for livestock rearing. From the previous trends of livestock numbers in the District, there has been a general gradual increase in livestock numbers and this could be an indication of the potential for livestock rearing. It has been mentioned that the potential is so large that the existing numbers could be increased without serious degradation in the environment. Despite this vast potential, there are needs which have to be undertaken to improve the livestock in quantity and quality. Apart from provision

of adequate watering points for the animals there is need for improved livestock services. An idea was mooted which had aimed at establishment of Block Grazing Zones, such that livestock rearing is only concentrated in these zones. This would ensure a easier way of livestock management because they will be concentrated in particular zones. Stock routes need to be improved such that stock movement is undertaken efficiently. Provision of water points along stock route could be one of these improvements.

The current stock holding ground in Isiolo which is in a run down condition need to be improved. Although the district is provided with services of three veterinary officers, those ones based at the Division offices lack transport and this hampers their efficiency in discharging their duties. There is also a need for a modern abattoir, with its associated benefits.

Finally there is a need for improved animal health.

Although the District is an arid region a potential exists for the development of agriculture. This can only come about if irrigation is undertaken at a large scale in order to make the District self sufficient in food production. The already existing minor irrigation schemes have a cultivable potential of an area equal to 810 hectares. This full potential has never bee achieved because of various factors one of them being lack of funds and the other a general apathy by the local community towards crop production. Although the majority of people depend on livestock for their livelihood, there is a need for gradual education such that they could also turn to crop production. Coupled to this there is a need to intensify soil conservation measures.

All in all, food production in this district can only be increased by irrigation.

Due to its climatic condition, there is plenty of sunshine and therefore a high potential for solar energy production is high, this could be used in boreholes. Wind is also another resource which could be utilized.

With the three gazetted game Reserves, the potential exists for tourism, and measures are already being undertaken to curb poaching.

The District is not well endowed with surface water resources. As mentioned earlier, there are only 4 surface waters. Not enough groundwater investigation has been undertaken, but from the existing borehole records, it appears that the district is endowed with groundwater potential which could be utilized for irrigation purposes, livestock use and for human use.

Potential exists for better utilisation of the existing secondary schools and primary schools, due to the high percentage of school drop outs, the existing schools are underutilized. There is a need for increased mass education so that more children could attend schools. With this, the human potential in District could be tapped and labour force increased.

The existing market centres and local centres lack essential infrastructure like adequate water market stalls and public toilets. Although their potential is not fully defined, they could become bigger market centres with improvement in livestock in the adjoining areas.

3.8.2 Problems Constraining Development

The major development areas in Isiolo District have been divided into seven categories.

These categories are:

(a) Livestock
(b) Human Resource
(c) Crop production
(d) Water
(e) Rural Urban Balance
(f) Wind, Solar and Bio-gas
(g) Afforestation

The major problems constraining development in these areas are described.

Apart from the problem in marketing of livestock due to the poor road network, there is a problem of overstocking particularly during droughts when a lot of livestock from neighbouring District scramble for fodder. Hence lack of fodder and adequate water has been a problem. No established ranches exist in Isiolo and so it is very difficult to improve the quality of livestock. Finally no breeding facilities exist.

Nomadism is the major constraint in human resources development. Due to this kind of lifestyle as parents move from place to place with their livestock the school going children also accompany them and in the process they abandon school leading to the previously mentioned high drop-out rate in schools. Inadequate boarding facilities and poor road network also exacerbate this problem. Finally the social cultural altitudes in which young school age girls are pulled out of school to be married off has contributed to the problem of human resources development.

Due to its arid nature, and hence unreliable rainfall, this has been the major problem in crop production. Seasonal Ewaso-Nyiro River floods caused by heavy rains in highland districts sweep away any meagre crops grown on its flood plain. Finally the sandy soil which exists in parts of the District is not conducive to crop production.

As mentioned the groundwater resource development could be undertaken but due to lack of groundwater assessment, this resource can not be utilized efficiently. Apart from the four perennial rivers, most of the rivers are seasonal.

The rural centres that exist have not been developed because of lack of water, electricity and road network. Isiolo town has not yet been gazetted as an urban centre which could attract investment.

The wind, solar and Bio-gas have not been developed in Isiolo. The problems constraining these developments have not been fully investigated as these are relatively new technologies which could be effectively utilized in the District.

Due to lack of water and aridity of the District, afforestation has not been undertaken seriously. Tree destruction by wild and domestic animals has also been a problem.

3.8.3 DDC Decision on Development Priorities

To exploit the identified livestock potential in the District the DDC has decided on improved livestock production and marketing facilities which will in turn lead to increased income to livestock owners to improve their standard of living.

In order to maintain the nomadic children in schools, more boarding facilities will be constructed together with enforced completion of 8-4-4 classes. Increased number of secondary schools also need to be undertaken. In this way the goal of human resources development will be achieved.

Food production in Garfasa irrigation scheme which is already complete need to be undertaken. More irrigation schemes along the Ewaso Nyiro River valley should be established at Malka Daka, Merti and Matarba. Increased production of citrus fruits, should also be encouraged.

It is intended to get as much water as possible to livestock and human. Digging of more boreholes will be encouraged as well as construction of dams and pans and harnessing of River Ewaso Nyiro. Water Resources Assessment needs to be undertaken.

The establishment of Jua-kali sheds in rural centres will ensure growth of these centres. Electricity will need to be installed at least in Divisional centres. If towns are accorded urban status, quick provision of infrastructure will be ensured and more systematic physical planing will be undertaken.

Windmills and solar energy as well as bio-gas use will be encouraged for provision of power.

Tree planting and tree nurseries will be encouraged especially the drought resistant types to curb deforestation and soil erosion.

(From: Isiolo DDP. 1989-1993, Ministry of Planning and National Development).

4. GROWTH SCENARIOS AND DATA PROJECTIONS

4.1 General

The activities necessary for the preparation of Part 1 were coordinated through the District Water Engineer and the District Development Officer. They included the following:

- meeting with the District Executive Committee (DEC) to explain the objectives and intentions of the project;
- meeting with all government departments present in the district to obtain information about their short term development priorities and the influence on water needs;
- follow-up visits to the same government departments to obtain data necessary for water demand calculation;
- visits to government departments in Nairobi;
- field visits by the Planning Unit of WRAP to collect data directly;
- analysis of relevant publications.

The data presented in this report was partly collected by WRAP and partly obtained from other sources. An important source of information is the District Development Plan (DDP), which contains basic data provided by each governmental district office.

WRAP has tried to achieve the best possible accuracy of data, but this could not always be fulfilled satisfactorily, because of insufficient quality or incompleteness of the source data. WRAP considers the presented data as the best possible estimate at this stage of the study.

The quality of the DWDP depends on the data on which the Plan is based. Accurate and realistic planning is only possible if reliable baseline data is available. In this respect the assistance from other ministries, local authorities, projects etc. is very valuable, but also necessary, because the DWDP cannot be prepared without it. WRAP therefore recommends that much attention is given by all government ministries to the collection and dissemination of up-to-date baseline data.

4.2 Water Demand Study

The objective of the water demand study is twofold:

- to enable a comparison of the available water resources with the existing and future water demand
- to provide the basis for the planning of the required development of water sources.

The execution of the water demand study can be summarized in 4 phases:

- determine water consumption rates
- determine present water demand
- determine methods for projection of future water demand

- determine future water demand

The adopted model for the implementation of the water demand study is presented in figure 4.1.

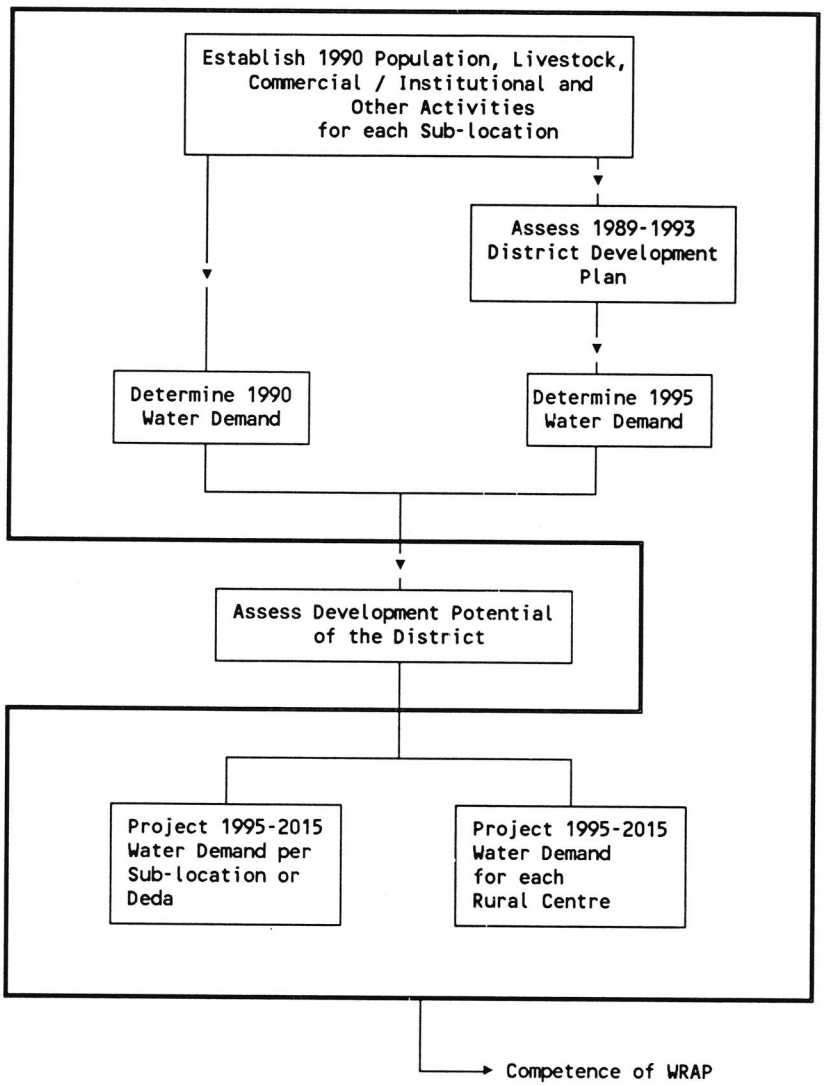


Figure 4.1 Model for Implementation of the Water Demand Study

The model indicates that the water demand needs to be determined per Sub-location or per Deda and also for each rural centre for the years 1990, 1995 and 1995-2015:

- The Deda is the traditional Boran neighbourhood and the basic unit of resource management in Boran society.[1] In most cases the Deda correspond well with the Sub-location areas. However the Deda cover only part of the District (figure 4.2). The analysis of demand versus resources is therefore carried out per Deda in the Deda-areas and per Sub-location in the other areas of Isiolo District. The calculated demand represents the total demand of each area.

[1] The Deda is used by the ILDP as the basic planning unit.

- The water demand is also determined for each rural centre separately as input to the pre-feasibility studies (chapter 2). The results of the calculation are included in the volume on the pre-feasibility studies.

- According to the Design Manual the water demand study should yield quantities of water required in the 'initial', in the 'future' and in the 'ultimate' year at the end of the design period. The initial year is defined as the year when the supply is expected to be taken into operation, the future year is 10 years later and the ultimate year is to be taken as 20 years from the initial year. Considering an earliest commissioning in 1995 of projects initiated by the presently prepared DWDP, then water demands are to be established for 1995, 2005 and 2015.

The water demand of livestock is included to provide an indication of the supply capacity required. The present DWDP does not include proposals for livestock water supplies. Such proposals are being prepared by ILDP as part of their Livestock Development Plan for Isiolo District.

4.3 Water Consumption Rates

The calculation of water demand for the DWDP is made using the unit rates and related guidelines as specified by the 'Design Manual for Water Supply in Kenya', a publication by the MoWD (Appendix 2). The consumption rates include the water demand for population, livestock and commercial/institutional facilities. Unit rates for other users (e.g. wildlife or agriculture) are not specified, therefore these are dealt with separately in this study (see paragraph 5.2.4).

The rates:

- include about 20 % allowance for water losses through leakage and wastage
- represent consumption for which systems have to be designed, without applying peak factors
- are proposed as a guide and may be adjusted if different rates are found appropriate
- represent the consumption of the average consumer category; within a category there may be considerable variations.

Specific consumption rates are not available for Isiolo District. In general the impression exists that actual consumption is somewhat lower than the "Design Manual" consumption rates. WRAP has not tried to obtain specific rates for Isiolo District because for planning purposes, it was considered that the rates from the Design Manual are adequate. The resulting water demand is possibly higher than the currently existing demand, but this has been used in planning because:

- The comparison of the water demand with the existing water resources need to be done for the future expected water consumption which must be based on the generally accepted consumption rates.
- The development of the water resources will be planned in phases in which the total demand will gradually be met and only the last phase will attain the optimum and total supply coverage.

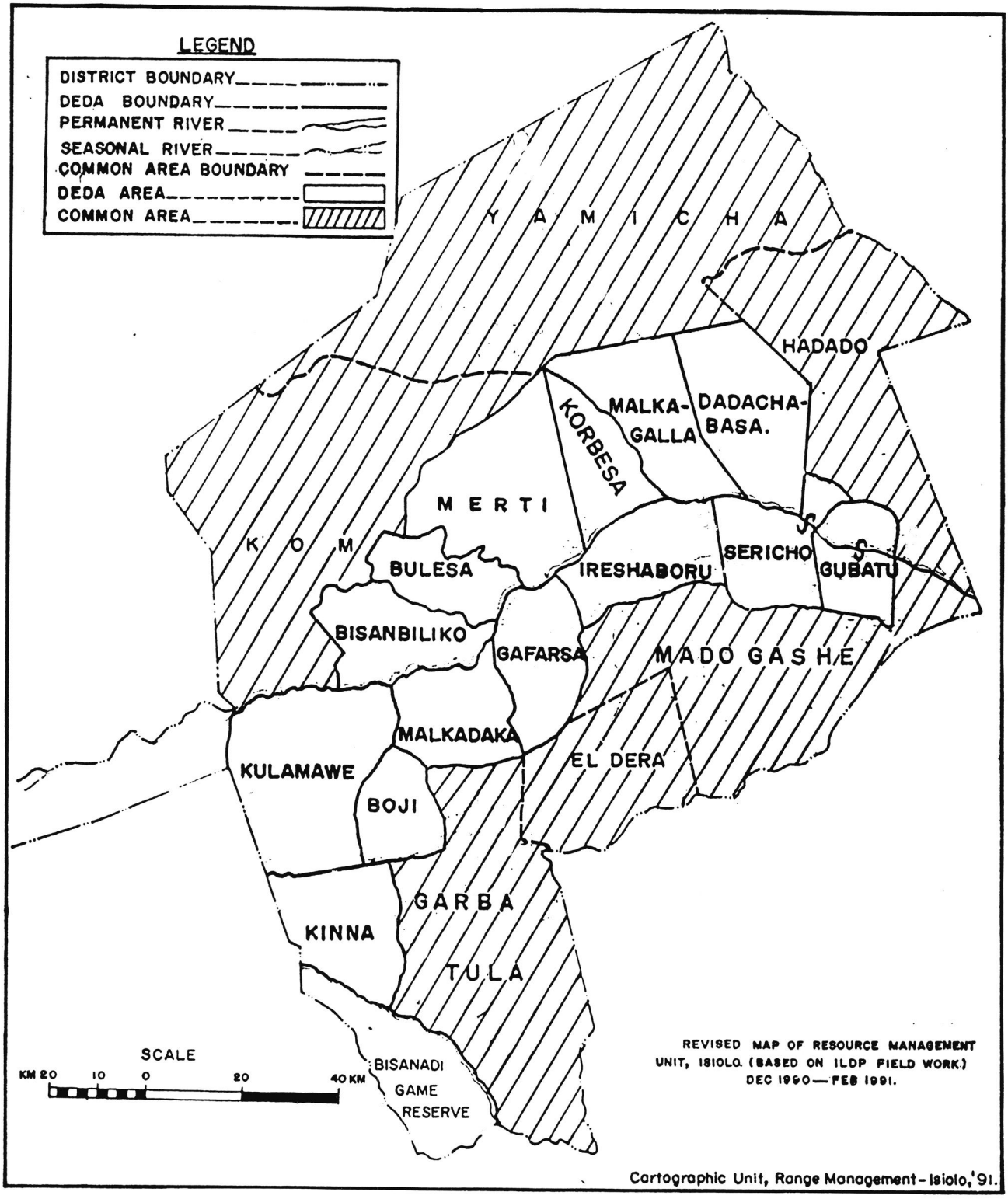


Figure 4.2 Location of Deda and Common Grazing Areas
(from ILDP)

The water consumption rate for livestock is specified in the Design Manual at 50 l/LU/day. A LU (Livestock Unit) is equal to 3 indigenous cows or 15 sheep or goats, and corresponds to 450 kg animal body weight. The MoLD uses a different unit (TLU = Tropical Livestock Unit) which corresponds to 250 kg animal body weight. The water consumption rate for the 250 kg TLU should be about 30 l/TLU/day, because the water requirement is lower for this smaller livestock unit.

The above rates are nominal figures, which do not take into account seasonal variations or local conditions. The water intake by animals during dry, hot periods, for instance, will be higher than during the wet, cool periods. Also influencing the water intake by animals is the forage water content. A different water consumption rate, therefore, must, ideally, be applied for the different seasons. This, however, has not been done for simplicity reasons.

4.4 Baseline Data

The main baseline data needed for the calculation of the water demand is on population, land potential (high/medium/low) of the rural areas, percentage distribution of high/medium/low class housing for the urban area of Isiolo Town, type and number of livestock units, and commercial/institutional facilities.

The main source of up-to-date information is the DDP 1989-1993. Other reports dealing with planning in the District e.g from departments or projects, may also provide suitable information.

Publications providing specific data were:

- for population: Census 1979, CBS
- for land potential: Farm Management Handbook, MoA.
- for livestock: Isiolo Livestock Development Project
- others : Annual Reports of District Offices MoH, MoE, etc.
  : Infrastructural Inventory, MPND

WRAP has tried to verify all the available data both in the field and in the offices of the various departments. This has been a major task, because rarely complete summaries are available, which cover the entire District. The main data are summarized in Appendix 3.

4.5 Projection of Baseline Data

The projection of the future water demand has to be based on growth rates, which have to be applied in conjunction with the baseline data. For the short term such growth rates can be found in the DDP, which specifies the economic development until 1993. For the long term growth rates are not determined at district level, but these may be obtained from publications by the Ministry of Planning and National Development. However the information in these publications is not always directly applicable to the Isiolo situation.

The projection of the baseline data suffers from the poor availability and low accuracy of data and of growth rates:

- 1990 baseline data are in itself projections (e.g population estimate is based on 1979 census) or are of uncertain accuracy
- growth rates have to be based on too few and often unreliable data available from the district and cannot be directly derived from rates used in other areas in the country, due to specific characteristics of Isiolo District.

The growth rates to be applied were determined such that they conform with the adopted growth rates at the national or district level.

The applied annual growth rates are summarised in table 4.1. The growth rates are discussed in the remainder of this paragraph.

Table 4.1 Annual Growth Rates 1990-2015

Applied Population Growth Rates	
Urban Area: Isiolo Town	5 %
Rural Centres: Garba Tula, Merti	5 %
Others	4 %
Rural Areas : High Potential	4 %
: Medium Potential	4 %
: Low Potential	4 %
Applied Livestock Growth Rates: High pot.	0 %
Medium pot.	0 %
Low pot.	0 %
Applied School Growth Rates	6 %
Applied Health (No. of Beds) Growth Rates	4 %
Applied Commercial/Administr. Growth Rates	2-4 %

The annual growth rate foreseen for the whole District population in the current District Development Plan is declining from 3.91% in 1988 to 3.82% in 1992. The population of the centres will probably grow at a higher rate, therefore a growth rate of 4.0% is used for projection within the 20 year planning period.

For specific centres deviation from this rate is possible. Isiolo Town has shown a rapid growth in recent years and this is expected to continue. Garba Tula may grow at a higher rate if the road through Kinna to Maua is improved. Merti has also shown a high growth in recent years. For these centres a growth rate of 5% was applied.

The growth of the education facilities was assumed to be above the general population growth as it is expected that parents will appreciate more and more the value of education. A rate of 6% was used.

The growth of the health facilities was assumed to correspond with the growth rate of the population. Also hotels and administrative offices are expected to increase at the same rate as the population.

The number of shops and bars was assumed to grow at a lower rate as the population at 2% per year.

The growth of the livestock numbers depend on various factors. This is studied by ILDP, which is currently preparing a development plan for livestock, which will include

the planning of water supplies for livestock. It is therefore decided that the projection of livestock numbers will not be attempted for this DWDP. At this stage it is assumed that livestock numbers will remain constant.

4.6 Constraints of Projections

The assumptions made for the projection of the water demand simplify the actual conditions. Therefore when using the results of demand calculations, the following constraints must be acknowledged:

1. The applied growth rates cannot be related to past population growth, due to the in-exactness of the census of 1969 and 1979.

2. Growth rates for rural areas have been applied uniformly, despite the fact that land potential in each Division is different.

3. Growth rates for rural centres have been applied uniformly without taking into account that these depend on potential of the served area, quality of the infrastructure etc.

4. Growth rates have been assumed constant between 1990 and 2015, although economic development of the district will not be constant during this period.

5. The effects of natural calamities e.g. droughts and epidemics has not been considered in the assumption of growth rates.

6. It should be noted that the livestock numbers in the District, which are projected over the plan period (1990-2015) are for demand calculations only. Actual livestock numbers can be different, depending on the natural conditions prevailing during the period.

The DWDP for rangelands like Isiolo must not only consider the potential of such an area for livestock development but must also consider the liability of the same to overgrazing. Especially in periods of droughts, a continued unavailability of water may bring about rangelands damage, which may take long periods to recover. The opinion of rangelands experts from the MoLD should therefore have a large influence on the contents of the DWDP in such areas.

4.7 Calculation of Water Demand

The Design Manual for Water Supply in Kenya' specifies the unit rates (Appendix 2). The rates are applied whenever a water supply is designed by the MoWD. The same rates are used to calculate the water demand for the District Water Development Plan (Paragraph 4.3).

The data required for the calculation of the Water Demand is described in chapter 5. The processing of data was done jointly by the Documentation Unit and the Planning Unit of the WRAP at Nairobi. The data was processed using a Database Management System programmed in DBase IV on a micro-computer.

The system works with clear menus on the computer screen and data can be viewed on the screen or printed. The processing yields Districts Water Demand summaries for the start year (1990) and for the initial (1995), future (2005) and the ultimate (2015) year. The summaries show per sub-location the water demand for each category of water user.

The Database Management System was specially developed by WRAP. The features of the Database programme for development planning are:

1. Separate database for each district in Kenya
2. Data entry, with an automatic check on corrections of some of the data
3. Data editing, to change any data in the database
4. Screen display, to view the data entry and demand calculations on the screen
5. Data print, with lay-out suitable for reports
6. Upto three scenarios for water development planning can be calculated
7. Calculation of water demand using unit rates.
8. Summary of sub-location water demand in tables
9. Entry of growth rates (percentages) for each category of water user for projection during plan period.
10. Projection of water demand to respectively 5, 15 and 25 years from the start year
11. Free choice of start year when utilising a new district data base
12. Password to protect database from unauthorised users.
13. Possibility to add new sub-locations, locations or divisions to a district.
14. Possibility to add provinces/Districts.

For more information on Database Management system, reference is made to the user's guide (in preparation).

The Isiolo District data is stored in separate databases for each Development Plan period (1990, 1995, 2005 and 2015). The updating of the data is easy and recalculation of the water demand can be carried out at any time. This makes it possible to update the water demand estimates whenever new data is received.

Table 4.2 Service Type (Percentage Connections)

Class of Housing	% Individual Conn.			% Non-individual Conn.		
	Initial	Future	Ultimate	Initial	Future	Ultimate
Urban Areas:						
High and Medium	100	100	100	0	0	0
Low Class	10	30	50	90	70	50
Rural Areas:						
High Potential	20	40	80	80	60	20
Medium Potential	10	20	40	90	80	60
Low Potential	5	10	20	95	90	80

Population Demand

The domestic water demand is determined by taking into account:

1. The number of individual connections versus communal connections, which depends on;
2. for urban areas: the class of housing
3. for rural areas: the land potential

According to the Design Manual, the distribution between individual connections and communal should be assumed to be as shown in table 4.2.

As the land potential in Isiolo District is low, the percentage individual connections in the rural centres is 5, 10 and 20% respectively.

Data on class of housing for the only urban centre, Isiolo Town is not available. Estimates were used to do the demand calculation: 5% high class, 20% medium class and 75% low class housing.

Livestock Demand

The planning of water supplies for livestock should be based on the maximum number of livestock. This number depends on the carrying capacity of the land, but it may even be exceeded at times of favourable weather conditions. The estimation of the carrying capacity is done by ILDP and not yet available. However the current numbers of livestock are expected to be close to the carrying capacity and therefore these numbers may be used for calculation of the water demand.

Livestock water demand is variable during the year depending on where the animals are taken for grazing. The water demand was therefore calculated for the maximum number of animals observed during 1989 in the sub-locations or deda, to obtain an estimate of the maximum water demand which is possible during the year. This will assist in determining the required supply capacity of livestock water supplies.

5. WATER DEMAND

5.1 Introduction

The District Water Development Plan will be based on the water demand as presented in this report and covers the planning period 1995-2015. The water demand during this period is determined by projecting the estimate of the present (1990) water demand.

The water demand is calculated according the procedures as described in the 'Design Manual for Water Supply in Kenya' of the MoWD. The unit water consumption rates applied are presented in Appendix 2.

The demand of all potential water users in each sub-location or deda of the district was calculated and is summarized in Appendix 5. A summary of the calculated demand is presented in paragraph 5.3.

The demand calculated for the pre-feasibility studies of the rural centres is not presented here, but is included in the volume on the pre-feasibility studies.

The available baseline data on population, livestock, institutional and commercial facilities etc., are described in paragraph 5.2 and presented in Appendix 3. The methodology of estimating and projecting the baseline data was already described in chapter 4.

5.2 Baseline Data

5.2.1 Population

The available population data of Isiolo District are from the census of 1979 and from estimates made by socio-economists of ILDP.

According to the 1979 population census, the population of Isiolo District was 43,478 persons. The District Development Plan 1989-1993 estimates the 1990 population at 69,008, which is obtained by projecting the 1979 census population with an estimated growth rate of 3.9% per annum. The DDP suggests for the period 1988-1993 a declining growth rate from 3.91% in 1987 to 3.82% in 1992.

Table 5.1 Population Data Isiolo District

DIVISION	CENSUS 1979	DDP PROJECTION 1990	ESTIMATE USED BY WRAP 1990
Central	17,403	27,034	27,034
Garba Tula	12,522	19,874	19,874
Merti	7,388	11,731	11,731
Sericho	6,165	9,799	12,470
Total	43,478	69,008	71,109

The 1989 census results will not come in time to be incorporated in the present DWDP and therefore the population of 1990 has to be estimated by projecting the 1979 census data. WRAP has adopted for the present DWDP, the same population estimate as used in the DDP 1989/1993, mainly to stay in line with the planning by the District. Only for Sericho Division a higher population was used, which is due to the high estimate of 7,000 for the population of Modogashe.

Estimates of the population in the rural areas or of the small centres in the rural areas were available from ILDP. These were used to estimate the 1990 population in all Sub-locations and Deda (Appendix 3).

The projection of the rural and urban population over the period 1995 - 2015 was carried out with the growth rates as presented in paragraph 4.5. A summary of these population projections is presented in Appendix 3.

5.2.2 Livestock

The data on livestock numbers is obtained from the 1989 aerial sample surveys carried out by ILDP. The surveys were done in three periods: 30 May - 9 June, 23 July - 2 August and 18 September - 3 October 1989, which cover the time from the start to the end of the long dry period. The surveys covered the eastern part of the District. The maximum number in any of the three surveys was used for the demand calculation (Appendix 3).

The livestock numbers for the western part of the District are based on estimates obtained from the Ministry of Livestock Development in Isiolo. The accuracy of these estimates is not known, but they may also represent the maximum number present in the area.

The projection of livestock numbers during the 20-years planning period was not attempted. It was assumed that the livestock numbers using the water supplies will remain constant.

5.2.3 Institutional and Commercial Facilities

The information on institutional facilities (schools, hospitals, health centres, dispensaries, administrative offices) and commercial facilities (hotels, shops, bars) is mainly obtained from the relevant governmental departments. The numbers of most facilities were verified during visits of the rural centres.

The projection of the number of the institutional/commercial facilities is made assuming a constant relation with population numbers or by applying a uniform growth rate. It is described per facility in this paragraph.

The 1990 data on the institutional/commercial facilities is summarised in Appendix 3.

Schools

The water demand is calculated for 42 primary schools, 4 secondary schools and 3 polytechnics in the District, of these 4 are boarding schools and 44 are day schools. All day schools were assumed to be without WC, except those in Isiolo Town, whereas

all boarding schools were assumed to be with WC. One boarding school in Modogashe but located in Garissa District was also included.

The DDP does not provide an estimate of the future number of pupils/schools. The growth rate of the number of pupils, therefore, had to be estimated. A percentage of 6% was assumed. This percentage is higher than the population growth rate, therefore it was found necessary to introduce a limit. This was determined at 40% of the population in each sub-location, which percentage was derived from the population age structure (the percentage of population of school-going age (5-17 years) for the years 1988-1993 is about 40%). With respect to day schools and boarding schools, equal growth rate was assumed for both.

Health

The water demand is calculated for a total of 28 health centres and dispensaries including one health centre in Modogashe located in Garissa district. There is one district hospital in Isiolo town with 160 beds.

Other Facilities

Information on the number of shops, bars, tearooms, butcheries and hotels was obtained from the office of the County Council and verified in the field. The projection of these numbers into the future was done by using a lower growth rate of 2% than as applied for the population.

Industries

Industries are only included for Isiolo Town. Exact information was not available but an area of 5 ha. was assumed for water demand calculation purposes.

5.2.4 Agriculture and Wildlife

The water demand for wildlife and agriculture is normally not included in the rates as used by the MoWD. Nevertheless the use of water for both purposes needs to be included in the DWDP.

The provision of water for wildlife must be planned for in cooperation with the Ministry of Tourism and Wildlife, to ensure optimal coverage of the wildlife water demand. The provision of water for wildlife was not included in this study, but it is strongly advised to incorporate wildlife demand for water in the final DWDP. Separate feasibility studies may have to be carried out to investigate the options for water supply to wildlife. There are two Game Reserves in the District, namely Buffalo Springs and Shaba, which are actually located along the Ewaso Nyiro.

Agricultural demand for water is normally dealt with in separate agricultural studies. The water demand for irrigation will not be calculated in this DWDS. The existing and proposed irrigation projects use water from the Ewaso Nyiro River when it is in flood and therefore this water use is not very critical in terms of available water resources.

5.3 Water Demand Figures

5.3.1 Total Water Demand

The results of the water demand calculations are presented in detail in the appendices:

- Appendix 4 contains some examples of the data entry sheets and the 1990 demand sheets per sub-location in the District.

- Appendix 5 contains summaries per Division of the calculated water demand of all sub-locations for the year 1990 and for the years 1995, 2005 and 2015.

The demand figures are summarized in table 5.2, which presents the total water demand per Division, both for domestic and non-domestic use.

Table 5.2 Projected Water Demand (m^3/day) in Isiolo District

Year: 1990

Division	Total Water Demand	Total Domestic	Total Non-Domestic
Central	2,253	1,666	587
Garba Tula	1,301	355	946
Merti	4,464	204	4,260
Sericho	2,484	241	2,243
District Total	10,502	2,466	8,036

Year: 1995

Division	Total Water Demand	Total Domestic	Total Non Domestic
Central	2,617	2,010	607
Garba Tula	1,368	422	946
Merti	4,500	240	4,260
Sericho	2,535	292	2,243
District Total	11,020	2,964	8,056

Year: 2005

Division	Total Water Demand	Total Domestic	Total Non Domestic
Central	3,907	3,240	667
Garba Tula	1,606	660	946
Merti	4,634	374	4,260
Sericho	2,709	466	2,243
District Total	12,856	4,740	8,116

Year: 2015

Division	Total Water Demand	Total Domestic	Total Non Domestic
Central	5,841	5,094	747
Garba Tula	2,091	1,145	946
Merti	4,901	641	4,260
Sericho	3,014	771	2,243
District Total	15,847	7,651	8,196

5.3.2 Domestic Water Demand

The largest demand for domestic water exists at Isiolo Town, where more than 50% of the total domestic demand in the district is found.

In most other areas demands are small and may easily be covered from one source, such as a borehole or a well.

In some areas domestic demand is zero, because there exist no permanent settlements or institutions. People may be present here part of the year, depending on the availability of grazing and water. In general water demand from non-sedentary people have not been estimated. It is considered that this demand may be met by the livestock supplies. In this respect it is advisable to construct separate off-takes for human supply at livestock supplies.

5.3.3 Non-Domestic Demand

The non-domestic demand comprises demand from livestock and industries. The livestock demand is presented in table 5.4.

As explained in paragraph 4.7 livestock water demand is based on actual numbers counted in 1989. The total number of animals used for the demand calculation is about 160,000 LU or 285,000 TLU.

The largest water demand from livestock is found in Merti and Sericho Divisions. A large part of this demand seems to come from animals entering the District from North-Eastern Province, using the grazing in the common grazing areas (CGA).

Industries are found only in Isiolo Town. The demand is tentatively estimated for 1990 at 100 m^3/day.

Table 5.3 Projected Domestic Water Demand (m^3/day)

Location	Sub Location / Deda	1990	1995	2005	2015
Division: Central					
Central	Isiolo Central	1,239	1,520	2,485	3,899
	Isiolo East	44	28	44	74
	Ngara Mara	107	129	198	314
Oldo Nyiro	Kipsing	30	35	55	95
	Oldo Nyiro	59	71	119	192
West	Arimet (West)	30	35	55	96
	Birat	157	191	284	424
	Divisional Total	1,666	2,009	3,240	5,094
Division: Garba Tula					
Garba Tula	Garba Tula North	34	40	63	116
	Garba Tula South	108	132	215	395
Kinna	Bibi	29	34	53	89
	Kinna	48	57	88	146
	Rapsu	14	15	22	36
Kulamawe	Boji Deda	28	33	51	87
	Gafarsa	29	33	52	87
	Kulamawe Deda	28	33	51	84
	Malka Daka Deda	37	44	65	105
	Divisional Total	355	422	660	1,145
Division: Merti					
Bisan Biliku	Bisan Biliku Deda	26	30	46	77
	Kom CGA	7	9	15	27
Malka Galla	Dadacha Bassa Deda	23	27	41	70
	Hadado CGA	0	0	0	0
	Malka Galla Deda	27	31	48	81
	Yamicha CGA	0	0	0	0
Merti	Bulesa	30	36	56	94
	Korbesa	28	33	52	89
	Merti	63	74	116	204
	Divisional Total	204	240	374	641
Division: Sericho					
Modogashe	Eldera	24	28	42	69
	Modogashe North	147	181	296	486
	Modogashe South	0	0	0	0
Sericho	Gubatu	8	10	17	31
	Iresa Boru	26	31	47	79
	Sericho	35	42	64	106
	Divisional Total	241	292	466	771

Table 5.4 Livestock Water Demand (m^3/day)

Location	Sub Location / Deda	1990
Division: Central		
Central	Isiolo Central	-
	Isiolo East	-
	Ngara Mara	190
Oldo Nyiro	Kipsing	209
	Oldo Nyiro	88
West	Arimet (West)	-
	Birat	-
	Divisional Total	487
Division: Garba Tula		
Garba Tula	Garba Tula North	316
	Garba Tula South	150
Kinna	Bibi	62
	Kinna	120
	Rapsu	-
Kulamawe	Boji Deda	5
	Gafarsa	125
	Kulamawe Deda	149
	Malka Daka Deda	19
	Divisional Total	946

Location	Sub Location / Deda	1990
Division: Merti		
Bisan Biliku	Bisan Biliku Deda	125
	Kom CGA	462
Malka Galla	Dadacha Bassa Deda	557
	Hadado CGA	1,188
	Malka Galla Deda	323
	Yamicha CGA	1,113
Merti	Bulesa	25
	Korbesa	287
	Merti	180
	Divisional Total	4,260
Division: Sericho		
Modogashe	Eldera	413
	Modogashe North	519
	Modogashe South	140
Sericho	Gubatu	206
	Iresa Boru	652
	Sericho	313
	Divisional Total	2,243

6. WATER RESOURCES DEVELOPMENT POTENTIAL

6.1 Surface Water Development Potential

The surface water availability in the District depends on rainfall and is highly variable in time and space. Average annual rainfall varies from 400 - 640 mm around Isiolo Town, to 300 - 350 mm in the areas around Barsalinga, Archer's Post and Garba Tula, and to 150 - 250 mm in the eastern and northern parts of the District (Figure 4.3).

In Isiolo District rainfall occurs in two distinct seasons with two peaks in April and November. The two seasons contribute about 80 - 95% of the total annual rainfall.

Surface water from the main rivers in Isiolo District is already extensively used for domestic water supply and irrigation. Further development possibilities are limited but could be improved through regional water management supported by monitoring. Lack of data, especially of the intermittent streams, makes it difficult to assess their development potential in more detail. The discharges estimated on the basis of the few discharge measurements indicate that the streamflow of some big streams could be used more optimally, but more exact data would be needed to prove that this is true. Considering the high evaporation rates storage of water in river banks should be preferred above open storage behind dams or in pans, but the short flow durations usually do not allow this.

A more definite answer on the possibilities and the feasibility of alternative solutions requires further detailed studies. Also minimum discharges required to avoid pollution of the river beds should then be considered. Such detailed studies were beyond the scope of WRAP. Conclusions as regards the surface water development potential of the rivers should, therefore, be considered preliminary.

Ewaso Ngiro River

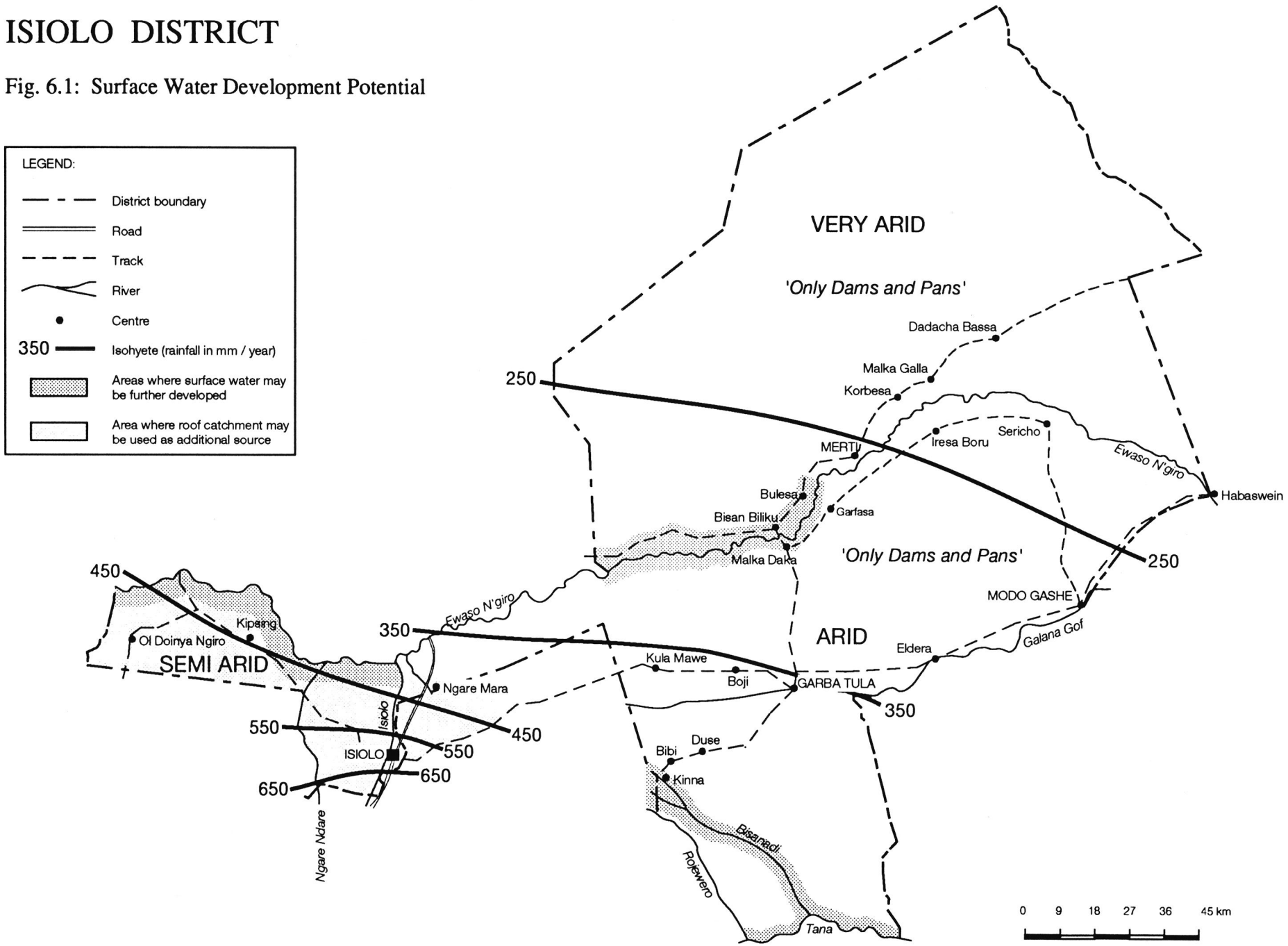
The main perennial river in the District is the Ewaso Ngiro. The river originates in the Aberdare Mountains and the north-western slopes of Mount Kenya and is perennial until Bulesa, except in drought years (see Figure 6.1 and Plate 2).

The mean annual flow of the Ewaso Ngiro at Archer's Post amounts to about 630 million m^3 with a minimum of 163 million m^3 recorded in 1952 and a maximum of 2,780 million m^3 recorded in 1961. The low flows of the river have gradually decreased due to an increase of water use in Laikipia District. In 1985 and 1986 the Ewaso Ngiro dried up in a reach of about 50 km upstream of Archer's Post, clearly showing the limitations for further development potential.

The use of the Ewaso Ngiro upstream in Laikipia District affects the development possibilities of this river for Isiolo District. For domestic supply purposes the river is not a reliable source. For irrigation further development is possible by using the flood water. However, due to the high flood levels and changes in the course of the river, siting of surface water intakes is very critical and very expensive structures are required.

ISIOLO DISTRICT

Fig. 6.1: Surface Water Development Potential



Isiolo River

Isiolo River originating from Mount Kenya is the source of water for Isiolo Town. The mean annual flow of the Isiolo river at R.G.S. 5D8 amounts to 6 million m^3 (16,400 m^3/day) with a recorded minimum of 950,000 m^3 in 1987 and a recorded maximum of 110 million m^3 in 1971.

The Isiolo River provides domestic water for Isiolo Town at approximately 2,000 m^3/day. Irrigation at present uses about 8,000 m^3/day and because the flows during the dry season are already very much reduced, the possibilities for more irrigation are limited.

Ngara Ndara River

For the short period of the study (March 1989 - September 1990) the Ngara Ndare river was observed to have a lowest flow of 8,000 m^3/day, a highest flow of 50,000 m^3/day and an annual average flow of 5 million m^3 (14,000 m^3/day).

The water use along this river is not known and therefore more detailed information is needed to determine it's development potential.

Ngara Mara River

For Ngare Mara only miscellaneous current meter gaugings are available. The lowest and highest discharge measured was 2,300 and 24,000 m^3/day respectively. The average flow is about is 12,000 m^3/day of which around 80% is used for irrigation. Further development is not recommended, also because the river is dry nowadays during part of the year.

Bisanadi and Kinna Rivers

The Bisanadi and Kinna Rivers originate from the Nyambeni Range and drain to Tana River in the south of the District. These rivers are used for irrigation in the Kinna and Rapsu irrigation schemes. Their development potential has not been assessed due to lack of data.

Laggas

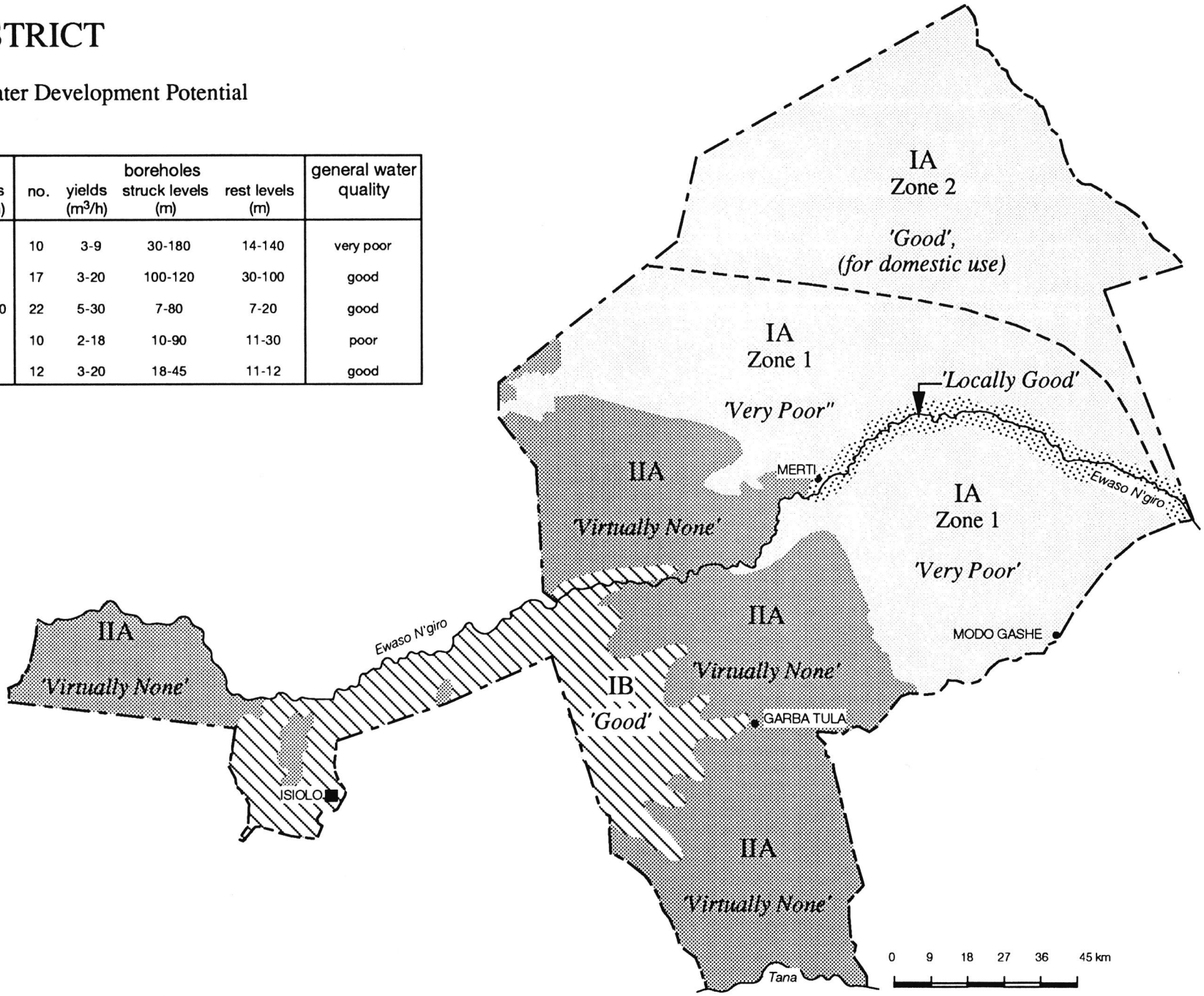
Laggas flow intermittently during the rainy seasons, usually only for very short periods. The lagga flow can reach large volumes, due to high rainfall intensities and small storage capacities of the catchments. It is estimated that they contribute about 50% of the total flood flow in the area.

The laggas can be developed for temporary storage by construction of earth dams and pans. The feasibility of subsurface dams should be investigated.

ISIOLO DISTRICT

Fig. 6.2: Groundwater Development Potential

aquifer system	springs no.	springs yields (m^3/h)	boreholes no.	boreholes yields (m^3/h)	boreholes struck levels (m)	boreholes rest levels (m)	general water quality
IA-zone 1	---	---	10	3-9	30-180	14-140	very poor
IA-zone 2	---	---	17	3-20	100-120	30-100	good
IB	23	3-360	22	5-30	7-80	7-20	good
IIA	1	2	10	2-18	10-90	11-30	poor
IIB	---	---	12	3-20	18-45	11-12	good



6.2 Groundwater Development Potential

The description of the groundwater development potential in Isiolo District follows the classification of the aquifer types as described in Chapter 5.4. The distribution of the different aquifer systems coincides with the geological formations surfacing in the District as shown in Figure 5.2 and Plates 1A and 1B. The regional aquifer systems occupy large areas of the District and as such can be shown on the maps (Plates 2A and 2B).

The local aquifer systems occupy areas too small to be shown individually on the maps. The weathered and/or fissured pockets of Basement Rocks (system IIA) can be found within the Basement Area boundaries. The fluviatile and lacustrine deposits (system IIB) are scattered all over the District, except for the sediments along the Ewaso Ngiro River.

The overall picture is that the groundwater development potential in the District is limited because of lack of good aquifers, and the presence of saline water in large parts of the District (Figure 6.2). The volcanic areas covering roughly 10% of the District form a positive exception.

Recharge conditions are especially critical for the potential of isolated local aquifers. The sustainability of the often considerable yields should be the subject of more detailed studies.

System IA - Area of Tertiary Marine Sediments

The northern zone of this area (Zone 2) offers a good groundwater development potential for domestic use.

The groundwater in the area is generally of a good quality (less than 150 mg/l TDS) except for the area around Boji - Hadado - Diri where the salinity of the water is higher.

Groundwater aquifers are expected at depths ranging from 100 to 120 m on average and groundwater levels may vary from 30 to 100 m. For more detailed information the maps should be seen. WRAP experience shows that borehole yields may range from 3 to 20 m^3 per hour.

The total groundwater flow in the area is in the order of 2.4×10^6 m^3/year (6640 m^3/day). If 30% of this amount is taken as a safe yield for a first phase of development then about 2,000 m^3/day can be withdrawn. This means that 100 wells with a daily production of 20 m^3 could be installed in this zone.

The southern zone of this area (Zone 1) offers no good chances for groundwater development as the groundwater is highly mineralized.

System IB - Volcanic Rock Area

The volcanic rock area offers a good groundwater development potential. The groundwater may be found at the surface (near springs) to depths less than 70 m below the surface. In most cases groundwater levels are less than 20 m deep.

The groundwater quality is generally good.

The yield of the inventoried wells varies from 2 m^3/h to over 30 m^3/h with an average of about 10 m^3/h.

The total groundwater flow in the area amounts to an estimated 60 x 10^6 m^3/year (roughly 166,000 m^3/day). Assuming that the average recharge is of the same magnitude and taking 30% of the recharge as a safe yield for withdrawal, then 50,000 m^3/day can be gradually developed. This means that a large number of wells can be drilled at suitable, well distributed, locations.

System IIA - Weathered and Fissured Basement Zones

The Basement areas in Isiolo District offer limited possibilities for groundwater development. The weathered and fissured zones are usually small and thin and the groundwater in these zones is mainly saline. Borehole yields are seldom higher than 3 m^3/h but usually even lower.

As a result the groundwater potential in these areas may be sufficient to permit a minimum level of living but does not support any substantial development of the areas.

System IIB - Local Sedimentary Deposits

Important alluvial aquifers are those along the Ewaso Ngiro. Many of these aquifers have a limited extent and depth. Despite their limited sizes these aquifers may offer substantial amounts of water for the dry seasons. Borehole yields of up to 15 m^3/h are possible. The water quality is acceptable for human consumption.

The limestone deposits at Garba Tula hydrogeologically have been classified as local aquifers. Such aquifers may yield significant amounts of water at very low drawdowns. The sustainability of the yields depends on the recharge of the aquifers which can be determined only through local studies. The water quality is usually very good. These systems are rather vulnerable to contamination due to lack of a protecting toplayer.

6.3 Rainwater Development Potential

Rainwater may be used as additional source for domestic water by using roof catchments. However, due to low frequency and quantity, rainwater can not be relied upon as the only source for domestic water supply in Isiolo District. The situation is a little better for the area around Isiolo Town where annual rainfall exceeds 400 mm/year.

Rock catchments have limited potential in Isiolo District due to the small number of rock outcrops with suitable surfaces.

The storage of rainwater in dams and pans has already proved a feasible solution especially for the supply of livestock. The development potential of these structures has not been studied in detail by WRAP as this is already covered by other projects in the District.

7. WATER RESOURCES VERSUS WATER DEMAND

7.1 General

The objective of the comparison between water resources and water demand is to determine whether the resources are sufficient to supply the future demand for domestic and non-domestic use.

The domestic demand is concentrated in the rural centres and Isiolo Town, and the comparison with the resources is executed for this demand only. An overview is presented here, the detailed analysis of demand and resources for each centre is included in the pre-feasibility studies.

The demand from population living in the rural areas of the District was considered to be covered by the livestock supplies. Separate domestic supplies for this population are not (yet) feasible, because this group of people is constantly moving with their animals.

The demand from livestock is indicated in chapter 5, but it is not known accurately enough to carry out a comparison with the available resources. As explained in chapter 4 planning of livestock supplies is done by ILDP, therefore only some general remarks are made here. For detailed analysis of demand and resources reference is made to the ILDP reports.

7.2 Domestic Demand

The domestic demand in the rural centres is compared with the available resources at each centre to determine whether the demand can be supplied. The comparison is done qualitatively, because at most centres it is not possible to make an accurate quantification of the water resources. An overview of the available resources is given in table 7.1.

Figure 7.1 shows the type of resources available at each centre. This is generally groundwater. Permanent surface water is available only at Isiolo Town and at Kinna. The groundwater is available at different depths, but generally groundwater has too high salinity levels when going deeper.

Figure 7.2 presents for each rural centre whether the resources are covering the domestic demand. In most centres the water resources are sufficient to cover the demand. But in some centres the demand may not be covered, because the distance to the source is too large (Malka Galla, Dadacha Bassa), or because the water source is insufficient during drought periods (Modogashe). Only at the proposed site of Duse centre, water resources are not available at all.

ISIOLO DISTRICT

Fig. 7.1: Development Potential for Domestic Water Supply

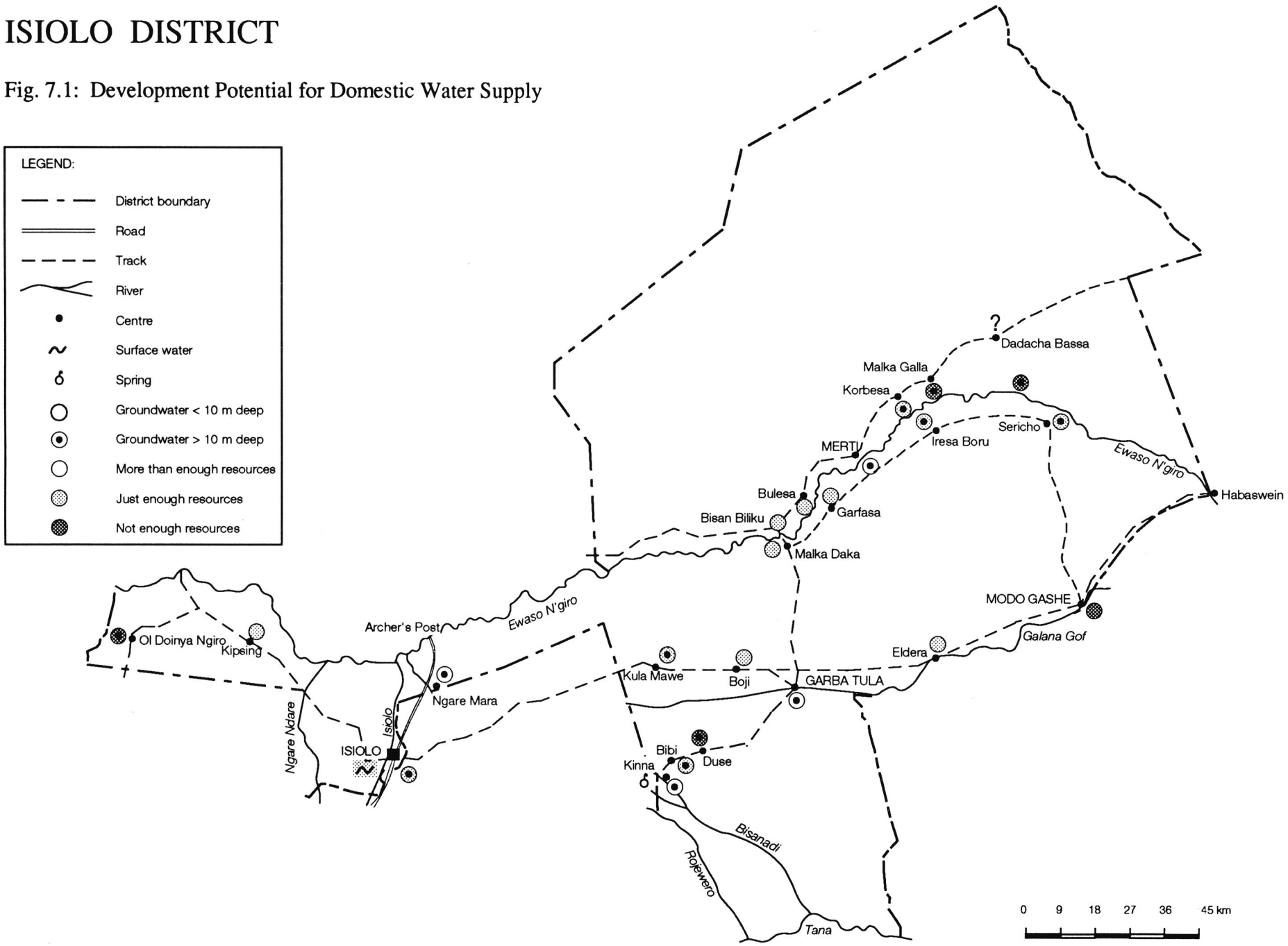


Table 7.1 Overview of Available Resources at Population Centres

Population Centre	Population Estimate 1990	Type of Available Resource	Depth of Water (m)	Quality of Water	Quantity Compared to Demand
Isiolo Town	15,000	Surfacewater / Groundwater	n.a. 25 - 100	Treatment req. Good	Enough, but additional supply from groundwater is required
Ngare Mara	1,200	Groundwater	> 20	Good	High borehole yield
Kipsing	1,420	Groundwater	> 2	Good	Limited but enough
Oldo Nyiro	2,000	Groundwater	?	?	Investigations not complete
Garba Tula	5,600	Groundwater	> 8	Good	Boreholes have a high yield
Bibi / Duse	1,800	Groundwater	> 30	Good	Adequate; at Duse no resources
Kinna	2,500	Groundwater / Spring	> 10	Good Contaminated	More than enough; spring needs to be cleaned and protected
Boji	1,100	Groundwater	3 - 10	Good	Limited, esp. in long dry periods
Gafarsa	1,700	Groundwater	1 - 10[1]	Good	Limited, esp. in long dry periods
Kulamawe	1,500	Groundwater	> 40	Good	Enough but low borehole yields
Malka Daka	1,100	Groundwater	1 - 10[1]	Good	Limited, esp. in long dry periods
Bisan Biliku	1,500	Groundwater	1 - 10[1]	Good	Limited, esp. in long dry periods
Dadacha Bassa	1,400	Groundwater	10 - 40	Good	Borehole yields are small and far from from the centre
Malka Galla	1,600	Groundwater	10 - 40	Good	Borehole yields are small and far from from the centre
Bulesa	1,700	Groundwater	1 - 10[1]	Good	Limited, esp. in long dry periods
Korbesa	1,800	Groundwater	15 - 40	Good	Borehole yields vary, but may be small
Merti	3,000	Groundwater	15 - 40	Good	Boreholes have a good yield
Eldera	1,250	Groundwater	1 - 10[1]	Good	Limited, esp. in long dry periods
Modogashe	7,000	Groundwater	1 - 10[1]	Good	Limited, esp. in long dry periods
Iresa Boru	1,000	Groundwater	10 - 40	Good	Borehole yields vary, but may be small
Sericho	1,010	Groundwater	10 - 40	Good	Borehole yields vary, but may be small

Note: 1. Actual depth not known exactly

7.3 Livestock Demand

The demand from livestock in the rural areas of Isiolo District may be covered from groundwater or from pans. Groundwater however is not an option everywhere because of high salinities. In these areas pans should be able to provide the required water.

The main difference between boreholes and pans is that boreholes provide a permanent source of supply and that pans provide water only during part of the year. Livestock range managers prefer pans in general, because they cause less damage to the range around the source. Boreholes are however required during long dry periods to provide water to the livestock.

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APPENDIX 1

DISTRICT FOCUS POLICY

APPENDIX 1

DISTRICT FOCUS POLICY

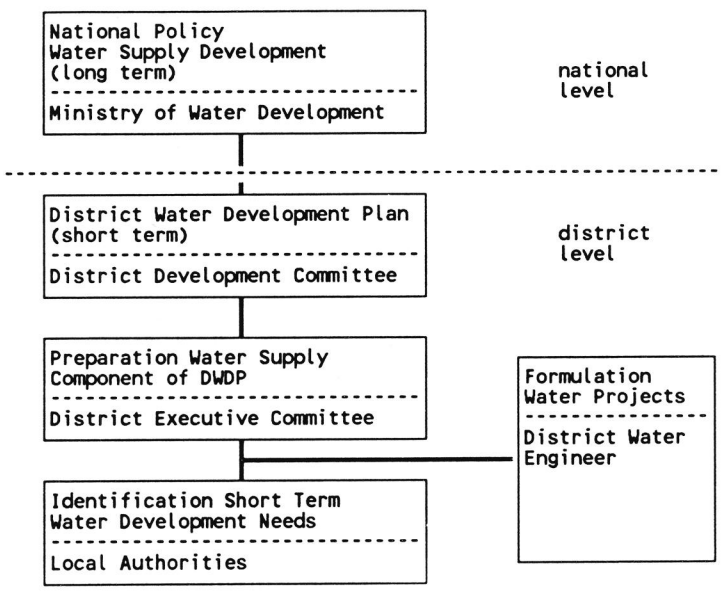
Main Aspects Related to Preparation of
a District Water Development Plan

APPENDIX 1 DISTRICT FOCUS POLICY

The Water Resources Assessment and Planning Project (WRAP) complies with the policy on District Focus for Rural Development. The water resources assessment presents the District authorities with an overall view of the water availability within their District. The study of the water development potential and options enables the District to select it's priorities and to plan for the development of the district water resources.

The district focus policy forms the background for the preparation of the District Water Development Plan and therefore the main aspects are summarized here (District Focus for Rural Development, Office of the President, 1987). The summary also contains information on the institutional set-up for planning in the District, which will be referred to in Part 3.

A schematic reproduction of the District Focus structure for the Water Sector is given below.



The responsibility for planning and implementing rural developments has been shifted from the headquarters of ministries to the districts. This strategy, known as the 'District Focus for Rural Development', is based on the principle of a complementary relationship between the ministries with their sectoral approach to development and the districts with their integrated approach to addressing local needs. Responsibility for the operational aspects of district-specific rural development projects has been delegated to the districts. Responsibility for general policy and the planning of multi-district and national programmes remains with the ministries.

The ministries and districts are co-operating on rural development through local projects and through multi-district and national programmes. Projects (or local components of larger programmes) that are primarily intended to serve one district or part of a district are referred to as 'district-specific' and are to be identified, selected, planned, and implemented at the district level.

Ministries also guide the districts in the implementation of the Budget Rationalization Programme. Districts must recognize that due to limited resources it is not possible for ministries to incorporate into their budgets and to implement all the projects being proposed at the same time. There is need, therefore, to concentrate the available resources on fewer projects so as to complete them sooner and bring them into productive service faster.

Operational consequences are, e.g.:
- limitation of proposals for GoK funding to two per sector per division;
- no drastic changes in the annual GoK budget for the District (10% plus or minus);
- identification of private resources to be put to use in support of an organised development programme.

District planning and co-ordination are carried out through a process which includes regular meetings of the development committees at each level of the district administrative structure and through the preparation of two basic planning documents: the 5 year District Development Plan and the annual Annex to that Plan. As has been mentioned before, the district responsibility for planning and co-ordination covers district-specific projects sponsored by the Government (ministries will provide policy guidelines), including those supported by foreign donors and those supported through the local authorities and through Harambee efforts. The district also reviews and endorses projects in the district sponsored by parastatal organizations, and by non-governmental organizations (NGOs), including local self-help organizations. Large national projects, which might have a great impact on the district's economic development, are meant to be included in the DDP, although they are planned on national level.

The District Development Committee is the foundation of the decentralised rural development strategy. The functions of the DDC are to:

1. review ongoing progress to ensure that current projects are rapidly implemented and that completed projects and existing infrastructure are effectively operated and maintained;
2. consider new proposals submitted by the Divisional Development Committees;
3. establish priorities for future projects in the five year District Development Plan;
4. endorse the district's annual submission of project proposals to the ministries in the annual Annex to the District Development Plan; and
5. review and endorse all project proposals of local authorities, parastatals, regional development authorities, and NGOs operating in the district.

In undertaking its planning responsibilities the DDC must take a broad perspective on ensuring the full and productive utilization of the resources available within the district, including manpower, natural resources and financial resources. In this respect the DDC should view the district as an economic unit, identifying economic potentials and the infrastructure and other conditions required for realizing these potentials. This will require also that the DDC develop and maintain a comprehensive Infrastructure Inventory of the existing and newly completed facilities in each sector of the economy (roads, schools, water systems, health facilities, etc.). A major planning function of the DDC will be to ensure that adequate resources are available for operation and maintenance of the existing infrastructure and facilities.

The District Executive Committee provides technical support for the DDC activities, including preparation of plans and management and implementation of projects. The DEC also serves to promote the inter-ministerial coordination of development activities in the district.

The principal functions of the DEC are to:

1. make operational decisions within the guiding directives of the DDC,
2. co-ordinate and monitor implementation of all projects and activities in the district,
3. prepare the draft District Development Plans and the annual Annexes for submission to the DDC, and
4. prepare briefing notes on all proposals and reports to be submitted to the DDC.

The office of the District Development Officer, who is the secretary of the DDC and the DEC, is being strengthened by the establishment of a District Planning Unit. The unit's objectives are to serve as a secretariat to the District Executive Committee for day-to-day coordination of planning and implementation work. However the DPU's are currently not yet fully operational.

The identification of projects is a continuous process. The initial idea for a project usually comes from the area that will benefit from its implementation (the location or sub-location). After being discussed and agreed upon locally, the project suggestion is forwarded to the Divisional Development Committee. Divisional Development Committees expand these suggestions into project proposals which are properly formulated and ranked according to the priorities of the division. These proposals are then submitted to the DDC.

Project proposals submitted by the DvDC to the DDC are first screened by the District Executive Committee on technical grounds and then prioritised by the DDC for inclusion in the five year District Development Plan and subsequently into the annual Annexes to that Plan.

The District Officer, District Development Officer and divisional technical officers in the DvDCs are charged with the responsibility of preparing the required documentation to support the DvDC project proposals. Local involvement in project identification and formulation is an essential element in the planning process, since it is this process which ensures that the feelings and wishes of the beneficiaries are included in the design and selection of all development projects and programmes.

The Locational Development Committees (LDCs) and Sub-locational Development Committees (SLDCs) represent the grass-roots level community and are responsible for discussion of community needs and the initial identification of projects and activities to address those needs. They are to forward initial project ideas to the Divisional Development Committee for review and appraisal and play an important role in the co-ordination and monitoring of project implementation.

These community level development committees are an essential element in promoting increased local level participation in the development process. However, while DvDCs have been active in all districts, LDCs and SLDCs have not been sufficiently active in all districts. Locational and sub-locational personnel have also not been equipped with basic skills in project planning and monitoring. It is necessary that these personnel be given training in handling these functions and in preparing detailed minutes of meetings

in order to ensure effective communication with the DvDCs and DDCs. All DDCs must take steps to ensure that these committees meet regularly to carry out the above functions and that they receive the training required to improve their capabilities for carrying out these functions.

The planning and siting of all projects should be fully discussed and approved by the local development committees so that the projects are seen as community projects. All communications with the communities and the local development committees on technical issues should also be phrased in a language that can be fully understood by them. This will promote full community participation in project implementation.

(From: District Focus for Rural Development, Office of the President, March 1987).

APPENDIX 2

UNIT WATER CONSUMPTION RATES

Appendix 2

UNIT WATER CONSUMPTION RATES

CONSUMER	UNIT	RURAL AREAS			URBAN AREAS		
		HIGH POTENTIAL	MEDIUM POTENTIAL	LOW POTENTIAL	HIGH CLASS HOUSING	MEDIUM CLASS HOUSING	LOW CLASS HOUSING
People with Individual Connections	l/head/day	60	50	40	250	150	75
People without Individual Connections	l/head/day	20	15	10	-		20
Livestock Unit	l/head/day	50			-		
Boarding Schools	l/head/day	50					
Day Schools: with WC without WC	l/head/day	25 5					
Hospitals: Regional District Other	l/bed/day	400} 200} +20 l per outpatient per day 100} (total minimum 5000 l/day)					
Dispensary and Health Centre	l/day	5000					
Hotels: High Class Medium Class Low Class	l/bed/day	600 300 50					
Administrative Offices	l/head/day	25					
Bars	l/day	500					
Shops	l/day	100					
Unspecified Industry	l/ha/day				20,000		
Coffee Pulping Factories	l/kg coffee	25 (when recirculation of water is used)					

(Source: Design Manual for Water Supply in Kenya, MoWD, 1986)

Remark: Many health centres have beds, therefore it is better to estimate the demand similar as for hospitals at 100 l/bed/day.

APPENDIX 3

BASIC DATA FOR WATER DEMAND CALCULATIONS

APPENDIX 3

BASIC DATA FOR WATER DEMAND CALCULATIONS

- POPULATION PROJECTIONS
- LIVESTOCK POPULATION IN LU
- OTHER INPUT DATA

POPULATION PROJECTIONS - ISIOLO DISTRICT

Location	Sub-Location / Deda	1979	1990	1995	2005	2015
Division: Central						
Central	Isiolo Central	11,331	16,000	19,466	28,815	42,654
	Isiolo East	838	1,074	1,307	1,935	2,864
	Ngara Mara	605	2,960	3,601	5,330	7,890
Oldo Nyiro	Kipsing	-	2,000	2,433	3,601	5,330
	Oldo Nyiro	2,701	2,500	3,042	4,503	6,666
West	Arimet (West)	1,928	2,000	2,433	3,601	5,330
	Birat	-	500	608	900	1,332
	Divisional Total	17,403	27,034	32,890	48,685	72,066
Division: Garba Tula						
Garba Tula	Garba Tula North	1,796	2,473	3,009	4,454	6,593
	Garba Tula South	3,454	5,600	6,813	10,085	16,427
Kinna	Bibi	705	1,800	2,190	3,242	4,799
	Kinna	2,524	2,500	3,042	4,503	6,666
	Rapsu	-	700	852	1,261	1,867
Kulamawe	Boji Deda	-	1,800	2,190	3,242	4,799
	Gafarsa	2,732	1,700	2,068	3,061	4,531
	Kulamawe Deda	1,311	1,500	1,825	2,701	3,998
	Malka Daka Deda	-	1,800	2,190	3,242	4,799
	Divisional Total	12,522	19,873	24,179	35,791	54,479
Division: Merti						
Bisan Biliku	Bisan Biliku Deda	-	1,500	1,825	2,701	3,998
	Kom CGA	-	628	764	1,131	1,674
Malka Galla	Dadacha Bassa Deda	-	1,400	1,703	2,521	3,732
	Hadado CGA	-	-	-	-	-
	Malka Galla Deda	1,914	1,600	1,947	2,882	4,266
	Yamicha CGA	-	-	-	-	-
Merti	Bulesa	1,736	1,800	2,190	3,242	4,799
	Korbesa	1,765	1,800	2,190	3,242	4,799
	Merti	1,973	3,000	3,650	5,403	8,801
	Divisional Total	7,388	11,728	14,269	21,122	32,069
Division: Sericho						
Modogashe	Eldera	-	1,250	1,521	2,251	3,332
	Modogashe North	1,446	7,000	8,517	12,607	18,661
	Modogashe South	-	-	-	-	-
Sericho	Gubatu	719	700	852	1,261	1,867
	Iresa Boru	2,261	1,500	1,825	2,701	3,998
	Sericho	1,739	2,020	2,458	3,638	5,385
	Divisional Total	6,165	12,470	15,173	22,458	33,243

LIVESTOCK POPULATION IN LU - ISIOLO DISTRICT

Location	Sub Location / Deda	1st Survey	2nd Survey	3rd Survey	Maximum Number
Division: Central					
Central	Ngara Mara	1,150	3,806	0	3,806
Division: Garba Tula					
Garba Tula	Garba Tula North	1,039	6,322	5,844	6,322
	Garba Tula South	0	0	2,994	2,994
Kinna	Bibi	1,233	506	222	1,233
	Kinna	161	328	2,400	2,400
	Rapsu	0	0	0	0
Kulamawe	Boji Deda	0	94	0	94
	Gafarsa	0	633	2,506	2,506
	Kulamawe Deda	2,983	728	2,283	2,983
	Malka Daka Deda	0	311	383	383
	Divisional Total	5,416	8,922	16,632	18,915
Division: Merti					
Bisan Biliku	Bisan Biliku Deda	0	606	2,500	2,500
	Kom CGA	0	2,817	9,239	9,239
Malka Galla	Dadacha Bassa Deda	2,217	4,933	11,133	11,133
	Hadado CGA	23,761	2,339	5,267	23,761
	Malka Galla Deda	6,467	3,056	4,650	6,467
	Yamicha CGA	21,267	22,267	12,072	22,267
Merti	Bulesa	417	506	222	506
	Korbesa	2,622	5,733	1,072	5,733
	Merti	3,594	2,472	3,078	3,594
	Divisional Total	60,345	44,729	49,233	85,200
Division: Sericho					
Modogashe	Eldera	1,206	6,056	8,250	8,250
	Modogashe North	1,178	10,383	7,094	10,383
	Modogashe South	978	2,150	2,806	2,806
Sericho	Gubatu	0	2,611	4,122	4,122
	Iresa Boru	6,572	3,072	13,033	13,033
	Sericho	3,272	1,361	6,261	6,261
	Divisional Total	13,206	25,633	41,566	44,855

Note: The livestock numbers were obtained from ILDP (ILCA Survey) in TLU and converted to LU.
LU = Livestock Unit used for demand calculation (450 kg animal weight).

LIVESTOCK POPULATION IN LU - ISIOLO DISTRICT

Location	Sub Location / Deda	Number
Division: Central		
Central	Isiolo Central	-
	Isiolo East	-
Oldo Nyiro	Kipsing	7,516
	Oldo Nyiro	1,750
West	Arimet (West)	-
	Birat	-
	Divisional Total	9,266

Note: The livestock numbers in Central Division were obtained from MoLD Isiolo.
LU = Livestock Unit used for demand calculation (450 kg animal weight).

Appendix 3

OTHER INPUT DATA - ISIOLO DISTRICT

Location	Sub-Location / Deda	Schools		Health Centre / Disp.	Hospitals		Out-patients per day	Hotels		Bars	Shops	Admin. Staff
		No.	Pupils		No.	Beds		No.	Beds			
Division: Central												
Central	Isiolo Central	11	4,908	3	2	205	100	15	250	10	300	500
	Isiolo East	3	1,263	-	-	-	-	-	-	-	-	-
	Ngara Mara	4	822	1	-	-	15	1	100	3	4	55
Oldo Nyiro	Kipsing	2	126	1	-	-	15	-	-	1	3	10
	Oldo Nyiro	2	365	2	-	-	20	-	-	4	5	50
West	Arimet (West)	-	-	1	-	-	40	-	-	-	-	50
	Birat	1	345	-	-	-	-	2	250	-	-	-
	Divisional Total	22	7,829	8	2	205	190	18	600	18	312	665
Division: Garba Tula												
Garba Tula	Garba Tula North	-	-	1	-	-	10	-	-	-	-	-
	Garba Tula South	6	1,659	1	1	12	40	1	12	15	30	150
Kinna	Bibi	1	200	1	-	-	10	-	-	4	2	5
	Kinna	3	953	1	-	-	25	-	-	6	20	10
	Rapsu	-	-	1	-	-	15	-	-	-	2	5
Kulamawe	Boji Deda	1	115	1	-	-	20	-	-	2	3	5
	Gafarsa	1	236	1	-	-	12	-	-	3	9	10
	Kulamawe Deda	1	300	1	-	-	30	1	5	6	6	10
	Malka Daka Deda	1	300	1	-	-	15	-	-	16	16	10
	Divisional Total	14	3,763	9	1	12	177	2	17	52	88	205
Division: Merti												
Bisan Biliku	Bisan Biliku Deda	1	150	1	-	-	15	-	-	3	6	10
	Kom CGA	-	-	-	-	-	-	-	-	-	-	-
Malka Galla	Dadacha Bassa Deda	1	142	1	-	-	15	-	-	-	8	5
	Hadado CGA	-	-	-	-	-	-	-	-	-	-	-
	Malka Galla Deda	1	202	1	-	-	20	-	-	2	8	5
	Yamicha CGA	-	-	-	-	-	-	-	-	-	-	-
Merti	Bulesa	1	500	1	-	-	20	-	-	1	10	10
	Korbesa	1	230	1	-	-	40	-	-	-	5	5
	Merti	5	1,200	2	1	12	100	4	20	6	35	60
	Divisional Total	10	2,424	7	1	12	210	4	20	12	72	95
Division: Sericho												
Modogashe	Eldera	1	137	1	-	-	15	-	-	5	6	30
	Modogashe North	3	980	1	1	4	100	2	25	13	100	60
	Modogashe South	-	-	-	-	-	-	-	-	-	-	-
Sericho	Gubatu	1	61	-	-	-	-	-	-	-	1	-
	Iresa Boru	1	303	1	-	-	15	-	-	3	5	5
	Sericho	2	337	1	-	-	11	-	-	8	11	5
	Divisional Total	8	1,818	4	1	4	141	2	25	29	123	100

APPENDIX 4

DATA ENTRY SHEETS

DEMAND SHEETS

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Isiolo Central

LOCATION : Central
DIVISION : Central

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 39999 mN Long. = 342000 mE

TYPE = 4
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	38 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	0 % population
	Urban Area :	High Class Housing	=	5 % population
		Medium Class Housing	=	20 % population
		Low Class Housing	=	75 % population
POPULATION	:	1979 (census)	=	11331 No.
		1990 (estimated)	=	16000 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	0 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		11 Day Schools with WC ->		4908 Pupils
		0 Day Schools no WC ->		0 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	3 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		1 District Hospitals ->		160 Beds
		1 Other Hospitals ->		45 Beds
		Outpatients/day =		100 No.
HOTELS		0 High Class Hotels ->		0 Beds
		1 Medium Class Hotels ->		50 Beds
		14 Low Class Hotels ->		200 Beds
ADMINISTRATION OFFICES	:	Staff =		500 No.
BARS	:	=		10 No.
SHOPS	:	=		300 No.
INDUSTRIES		->		5 ha.

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Isiolo Central DIVISION : Central
LOCATION : Central DISTRICT : Isiolo

POPULATION : 16000 Rural Pop. = 0 % Urban Pop. = 100 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 0 % population
High Class Housing = 5 % population
Medium Class Housing = 20 % population
Low Class Housing = 75 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 0 % Urban Area = 33 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	0 % =	0	No.		40	0
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	0 % =	0	No.		10	0
	Total Demand for RURAL population							0
URBAN POPULATION	with IC,	High :	5 % =	800	No.		250	200000
		Medium :	20 % =	3200	No.		150	480000
		Low :	8 % =	1280	No.		75	96000
	with NC,	Low :	67 % =	10720	No.		20	214400
	Total Demand for URBAN population							990400
LIVESTOCK			(L.U.) =	0	No.		50	0
SCHOOLS	Day Schools with WC ->		Pupils =	4908	No.		25	122700
	Day Schools no WC ->		Pupils =	0	No.		5	0
	Boarding Schools ->		Pupils =	0	No.		50	0
HEALTH	Health Centres\Dispensaries		=	3	No.		5000	15000
	Regional Hospitals ->		Beds =	0	No.		400	0
	District Hospitals ->		Beds =	160	No.		200	32000
	Other Hospitals ->		Beds =	45	No.		100	4500
	All Hospitals Outpatients		=	100	No.		20	2000
HOTELS	High Class Hotels ->		Beds =	0	No.		600	0
	Medium Class Hotels ->		Beds =	50	No.		300	15000
	Low Class Hotels ->		Beds =	200	No.		50	10000
ADMINISTRATIVE OFFICES			Staff =	500	No.		25	12500
BARS			=	10	No.		500	5000
SHOPS			=	300	No.		100	30000
INDUSTRIES			=	5	ha.		20000	100000
TOTAL DEMAND (l/day)								1339100

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Isiolo East

LOCATION : Central
DIVISION : Central

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 39999 mN Long. = 342500 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	19 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	838 No.
		1990 (estimated)	=	1074 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	0 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		3 Day Schools with WC ->		1263 Pupils
		0 Day Schools no WC ->		0 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	0 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	0 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	0 No.
BARS	:		=	0 No.
SHOPS	:		=	0 No.
INDUSTRIES	No			

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Isiolo East DIVISION : Central
LOCATION : Central DISTRICT : Isiolo

POPULATION : 1074 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION :
High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	53	No.		40	2120
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	1020	No.		10	10200
	Total Demand for RURAL population							12320
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	0	No.		50	0
SCHOOLS	Day Schools with WC -> Pupils =			1263	No.		25	31575
	Day Schools no WC -> Pupils =			0	No.		5	0
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			0	No.		5000	0
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			0	No.		20	0
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.		25	0
BARS			=	0	No.		500	0
SHOPS			=	0	No.		100	0
TOTAL DEMAND (l/day)								43895

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Ngara Mara

LOCATION : Central
DIVISION : Central

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 59000 mN Long. = 351500 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 580 (km²)			
CLASSIFICATION	Rural Area :	High Potential =	0	% population
		Medium Potential =	0	% population
		Low Potential =	100	% population
	Urban Area :	High Class Housing =	0	% population
		Medium Class Housing =	0	% population
		Low Class Housing =	0	% population
POPULATION	: 1979 (census) =		605	No.
	1990 (estimated) =		2960	No.
LIVESTOCK	: Grade cow =		0	No.
	Indigenous cow =		11417	No.
	Sheep/goats =		0	No.
	Donkey =		0	No.
	Camel =		0	No.
SCHOOLS	0 Day Schools with WC ->		0	Pupils
	4 Day Schools no WC ->		822	Pupils
	0 Boarding Schools ->		0	Pupils
HEALTH CENTRES/DISPENSARIES	=		1	No.
HOSPITALS	0 Regional Hospitals ->		0	Beds
	0 District Hospitals ->		0	Beds
	0 Other Hospitals ->		0	Beds
	Outpatients/day =		15	No.
HOTELS	1 High Class Hotels ->		100	Beds
	0 Medium Class Hotels ->		0	Beds
	0 Low Class Hotels ->		0	Beds
ADMINISTRATION OFFICES	: Staff =		55	No.
BARS	: =		3	No.
SHOPS	: =		4	No.
INDUSTRIES	No			

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Ngara Mara DIVISION : Central
LOCATION : Central DISTRICT : Isiolo

POPULATION : 2960 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	148	No.		40	5920
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	2812	No.		10	28120
	Total Demand for RURAL population							34040
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	3805	No.		50	190250
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			822	No.		5	4110
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			15	No.		20	300
HOTELS	High Class Hotels -> Beds =			100	No.		600	60000
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	55	No.		25	1375
BARS			=	3	No.		500	1500
SHOPS			=	4	No.		100	400
TOTAL DEMAND (l/day)								296975

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Kipsing

LOCATION : Oldo Nyiro
DIVISION : Central

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 68000 mN Long. = 305000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 250 (km²)			
CLASSIFICATION	Rural Area :	High Potential	= 0	% population
		Medium Potential	= 0	% population
		Low Potential	= 100	% population
	Urban Area :	High Class Housing	= 0	% population
		Medium Class Housing	= 0	% population
		Low Class Housing	= 0	% population
POPULATION	:	1979 (census)	= 1	No.
		1990 (estimated)	= 2000	No.
LIVESTOCK	:	Grade cow	= 0	No.
		Indigenous cow	= 5600	No.
		Sheep/goats	= 25000	No.
		Donkey	= 1000	No.
		Camel	= 500	No.
SCHOOLS		0 Day Schools with WC ->	0	Pupils
		1 Day Schools no WC ->	126	Pupils
		0 Boarding Schools ->	0	Pupils
HEALTH CENTRES/DISPENSARIES			= 1	No.
HOSPITALS		0 Regional Hospitals ->	0	Beds
		0 District Hospitals ->	0	Beds
		0 Other Hospitals ->	0	Beds
		Outpatients/day =	15	No.
HOTELS		0 High Class Hotels ->	0	Beds
		0 Medium Class Hotels ->	0	Beds
		0 Low Class Hotels ->	0	Beds
ADMINISTRATION OFFICES	:	Staff =	10	No.
BARS	:	=	1	No.
SHOPS	:	=	3	No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Kipsing DIVISION : Central
LOCATION : Oldo Nyiro DISTRICT : Isiolo

POPULATION : 2000 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	100	No.		40	4000
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	1900	No.		10	19000
	Total Demand for RURAL population							23000
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	4183	No.		50	209150
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			126	No.		5	630
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			15	No.		20	300
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	10	No.		25	250
BARS			=	1	No.		500	500
SHOPS			=	3	No.		100	300
TOTAL DEMAND (l/day)								239130

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Oldo Nyiro

LOCATION : Oldo Nyiro
DIVISION : Central

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 70000 mN Long. = 275000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA Total = 960 (km²)

CLASSIFICATION	Rural Area	: High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area	: High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION		: 1979 (census)	=	2701 No.
		1990 (estimated)	=	2500 No.
LIVESTOCK		: Grade cow	=	0 No.
		Indigenous cow	=	2400 No.
		Sheep/goats	=	6000 No.
		Donkey	=	500 No.
		Camel	=	700 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		1 Day Schools no WC ->		45 Pupils
		1 Boarding Schools ->		320 Pupils
HEALTH CENTRES/DISPENSARIES			=	2 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day =		20 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES		: Staff	=	50 No.
BARS		:	=	4 No.
SHOPS		:	=	5 No.
INDUSTRIES		No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Oldo Nyiro DIVISION : Central
LOCATION : Oldo Nyiro DISTRICT : Isiolo

POPULATION : 2500 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	125	No.		40	5000
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	2375	No.		10	23750
	Total Demand for RURAL population							28750
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	1750	No.		50	87500
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			45	No.		5	225
	Boarding Schools -> Pupils =			320	No.		50	16000
HEALTH	Health Centres\Dispensaries =			2	No.		5000	10000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			20	No.		20	400
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	50	No.		25	1250
BARS			=	4	No.		500	2000
SHOPS			=	5	No.		100	500
TOTAL DEMAND (l/day)								146625

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Arimet (West)

LOCATION : West
DIVISION : Central

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 40000 mN Long. = 330000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 250 (km²)		
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1928 No.
	1990 (estimated)	=	2000 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	0 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	0 Day Schools no WC ->		0 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	1 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	40 No.
HOTELS	0 High Class Hotels ->		0 Beds
	0 Medium Class Hotels ->		0 Beds
	0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	: Staff	=	50 No.
BARS	:	=	0 No.
SHOPS	:	=	0 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Arimet (West) DIVISION : Central
LOCATION : West DISTRICT : Isiolo

POPULATION : 2000 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	100	No.	40	4000
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	1900	No.	10	19000
	Total Demand for RURAL population						23000
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	0	No.	50	0
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			0	No.	5	0
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			1	No.	5000	5000
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			40	No.	20	800
HOTELS	High Class Hotels -> Beds =			0	No.	600	0
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	50	No.	25	1250
BARS			=	0	No.	500	0
SHOPS			=	0	No.	100	0
TOTAL DEMAND (l/day)							30050

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Birat

LOCATION : West
DIVISION : Central

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 50000 mN Long. = 330000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 525 (km²)		
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1 No.
	1990 (estimated)	=	500 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	0 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	1 Day Schools no WC ->		345 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	0 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	0 No.
HOTELS	2 High Class Hotels ->		250 Beds
	0 Medium Class Hotels ->		0 Beds
	0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	: Staff	=	0 No.
BARS	:	=	0 No.
SHOPS	:	=	0 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Birat DIVISION : Central
LOCATION : West DISTRICT : Isiolo

POPULATION : 500 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	25	No.	40	1000
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	475	No.	10	4750
	Total Demand for RURAL population						5750
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	0	No.	50	0
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			345	No.	5	1725
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			0	No.	5000	0
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			0	No.	20	0
HOTELS	High Class Hotels -> Beds =			250	No.	600	150000
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.	25	0
BARS			=	0	No.	500	0
SHOPS			=	0	No.	100	0
TOTAL DEMAND (l/day)							157475

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Garba Tula North

LOCATION : Garba Tula
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 30000 mN Long. = 460000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	1796 No.
		1990 (estimated)	=	2473 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	18967 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		0 Day Schools no WC ->		0 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	10 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	0 No.
BARS	:		=	0 No.
SHOPS	:		=	0 No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Garba Tula North DIVISION : Garba Tula
LOCATION : Garba Tula DISTRICT : Isiolo

POPULATION : 2473 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	123	No.		40	4920
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	2349	No.		10	23490
	Total Demand for RURAL population							28410
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	6322	No.		50	316100
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			0	No.		5	0
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			10	No.		20	200
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.		25	0
BARS			=	0	No.		500	0
SHOPS			=	0	No.		100	0
			TOTAL DEMAND (l/day)					349710

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Garba Tula South

LOCATION : Garba Tula
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES UTM-grid = 37N
(main Centre) Lat. = 59000 mN Long. = 446000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	3454 No.
		1990 (estimated)	=	5600 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	8983 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS	0	Day Schools with WC ->		0 Pupils
	5	Day Schools no WC ->		1354 Pupils
	1	Boarding Schools ->		305 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS	0	Regional Hospitals ->		0 Beds
	0	District Hospitals ->		0 Beds
	1	Other Hospitals ->		12 Beds
		Outpatients/day	=	40 No.
HOTELS	0	High Class Hotels ->		0 Beds
	0	Medium Class Hotels ->		0 Beds
	1	Low Class Hotels ->		12 Beds
ADMINISTRATION OFFICES	:	Staff	=	150 No.
BARS	:		=	15 No.
SHOPS	:		=	30 No.
INDUSTRIES	No			

Printed : 11-06-1991

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Garba Tula South DIVISION : Garba Tula
LOCATION : Garba Tula DISTRICT : Isiolo

POPULATION : 5600 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	280	No.		40	11200
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	5320	No.		10	53200
	Total Demand for RURAL population							64400
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	2994	No.		50	149700
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			1354	No.		5	6770
	Boarding Schools -> Pupils =			305	No.		50	15250
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			12	No.		100	1200
	All Hospitals Outpatients =			40	No.		20	800
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			12	No.		50	600
ADMINISTRATIVE OFFICES			Staff =	150	No.		25	3750
BARS			=	15	No.		500	7500
SHOPS			=	30	No.		100	3000
TOTAL DEMAND (l/day)								257970

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Bibi

LOCATION : Kinna
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 45000 mN Long. = 415000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	705 No.
		1990 (estimated)	=	1800 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	3700 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		1 Day Schools no WC ->		200 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	10 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	5 No.
BARS	:		=	4 No.
SHOPS	:		=	2 No.
INDUSTRIES	No			

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Bibi DIVISION : Garba Tula
LOCATION : Kinna DISTRICT : Isiolo

POPULATION : 1800 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	90	No.		40	3600
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	1710	No.		10	17100
	Total Demand for RURAL population							20700
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	1233	No.		50	61650
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			200	No.		5	1000
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			10	No.		20	200
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	5	No.		25	125
BARS			=	4	No.		500	2000
SHOPS			=	2	No.		100	200
TOTAL DEMAND (l/day)								90875

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Kinna

LOCATION : Kinna
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 35000 mN Long. = 412000 mE

TYPE = 1

1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)		
CLASSIFICATION	Rural Area	: High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area	: High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION		: 1979 (census)	=	2524 No.
		1990 (estimated)	=	2500 No.
LIVESTOCK		: Grade cow	=	0 No.
		Indigenous cow	=	7200 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		2 Day Schools no WC ->		873 Pupils
		1 Boarding Schools ->		80 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	25 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES		: Staff	=	10 No.
BARS		:	=	6 No.
SHOPS		:	=	20 No.
INDUSTRIES		No		

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Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Kinna DIVISION : Garba Tula
LOCATION : Kinna DISTRICT : Isiolo

POPULATION : 2500 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	125	No.		40	5000
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	2375	No.		10	23750
	Total Demand for RURAL population							28750
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	2400	No.		50	120000
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			873	No.		5	4365
	Boarding Schools -> Pupils =			80	No.		50	4000
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			25	No.		20	500
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	10	No.		25	250
BARS			=	6	No.		500	3000
SHOPS			=	20	No.		100	2000
TOTAL DEMAND (l/day)								167865

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Rapsu

LOCATION : Kinna
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 33000 mN Long. = 428000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)	
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1 No.
	1990 (estimated)	=	700 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	0 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	0 Day Schools no WC ->		0 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	1 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	15 No.
HOTELS	0 High Class Hotels ->		0 Beds
	0 Medium Class Hotels ->		0 Beds
	0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	: Staff	=	5 No.
BARS	:	=	0 No.
SHOPS	:	=	2 No.
INDUSTRIES	No		

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Rapsu DIVISION : Garba Tula
LOCATION : Kinna DISTRICT : Isiolo

POPULATION : 700 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC, High :	0 % =	0	No.		60	0
	Medium :	0 % =	0	No.		50	0
	Low :	5 % =	35	No.		40	1400
	with NC, High :	0 % =	0	No.		20	0
	Medium :	0 % =	0	No.		15	0
	Low :	95 % =	665	No.		10	6650
	Total Demand for RURAL population						8050
URBAN POPULATION	with IC, High :	0 % =	0	No.		250	0
	Medium :	0 % =	0	No.		150	0
	Low :	0 % =	0	No.		75	0
	with NC, Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population						0
LIVESTOCK	(L.U.) =		0	No.		50	0
SCHOOLS	Day Schools with WC -> Pupils =		0	No.		25	0
	Day Schools no WC -> Pupils =		0	No.		5	0
	Boarding Schools -> Pupils =		0	No.		50	0
HEALTH	Health Centres\Dispensaries =		1	No.		5000	5000
	Regional Hospitals -> Beds =		0	No.		400	0
	District Hospitals -> Beds =		0	No.		200	0
	Other Hospitals -> Beds =		0	No.		100	0
	All Hospitals Outpatients =		15	No.		20	300
HOTELS	High Class Hotels -> Beds =		0	No.		600	0
	Medium Class Hotels -> Beds =		0	No.		300	0
	Low Class Hotels -> Beds =		0	No.		50	0
ADMINISTRATIVE OFFICES	Staff =		5	No.		25	125
BARS	=		0	No.		500	0
SHOPS	=		2	No.		100	200
	TOTAL DEMAND (l/day)						13675

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Boji Deda

LOCATION : Kulamawe
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 63000 mN Long. = 426000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 713 (km²)			
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	1 No.
		1990 (estimated)	=	1800 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	283 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		1 Day Schools no WC ->		115 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	20 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	5 No.
BARS	:		=	2 No.
SHOPS	:		=	3 No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Boji Deda DIVISION : Garba Tula
LOCATION : Kulamawe DISTRICT : Isiolo

POPULATION : 1800 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	90	No.	40	3600
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	1710	No.	10	17100
	Total Demand for RURAL population						20700
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	94	No.	50	4700
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			115	No.	5	575
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			1	No.	5000	5000
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			20	No.	20	400
HOTELS	High Class Hotels -> Beds =			0	No.	600	0
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	5	No.	25	125
BARS			=	2	No.	500	1000
SHOPS			=	3	No.	100	300
TOTAL DEMAND (l/day)							32800

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Gafarsa

LOCATION : Kulamawe
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 100000 mN Long. = 460000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	49 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	2732 No.
		1990 (estimated)	=	1700 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	7517 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		1 Day Schools no WC ->		236 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	12 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	10 No.
BARS	:		=	3 No.
SHOPS	:		=	9 No.
INDUSTRIES	No			

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Gafarsa DIVISION : Garba Tula
LOCATION : Kulamawe DISTRICT : Isiolo

POPULATION : 1700 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	85	No.		40	3400
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	1615	No.		10	16150
	Total Demand for RURAL population							19550
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	2505	No.		50	125250
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			236	No.		5	1180
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			12	No.		20	240
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	10	No.		25	250
BARS			=	3	No.		500	1500
SHOPS			=	9	No.		100	900
			TOTAL DEMAND (l/day)					153870

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Kulamawe Deda

LOCATION : Kulamawe
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 63000 mN Long. = 411000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 130 (km²)		
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1311 No.
	1990 (estimated)	=	1500 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	8950 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	1 Day Schools no WC ->		300 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	1 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	30 No.
HOTELS	0 High Class Hotels ->		0 Beds
	0 Medium Class Hotels ->		0 Beds
	1 Low Class Hotels ->		5 Beds
ADMINISTRATION OFFICES	: Staff	=	10 No.
BARS	:	=	6 No.
SHOPS	:	=	6 No.
INDUSTRIES	No		

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Kulamawe Deda DIVISION : Garba Tula
LOCATION : Kulamawe DISTRICT : Isiolo

POPULATION : 1500 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC, High :	0 % =	0	No.		60	0
	Medium :	0 % =	0	No.		50	0
	Low :	5 % =	75	No.		40	3000
	with NC, High :	0 % =	0	No.		20	0
	Medium :	0 % =	0	No.		15	0
	Low :	95 % =	1425	No.		10	14250
	Total Demand for RURAL population						17250
URBAN POPULATION	with IC, High :	0 % =	0	No.		250	0
	Medium :	0 % =	0	No.		150	0
	Low :	0 % =	0	No.		75	0
	with NC, Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population						0
LIVESTOCK	(L.U.) =		2983	No.		50	149150
SCHOOLS	Day Schools with WC -> Pupils =		0	No.		25	0
	Day Schools no WC -> Pupils =		300	No.		5	1500
	Boarding Schools -> Pupils =		0	No.		50	0
HEALTH	Health Centres\Dispensaries =		1	No.		5000	5000
	Regional Hospitals -> Beds =		0	No.		400	0
	District Hospitals -> Beds =		0	No.		200	0
	Other Hospitals -> Beds =		0	No.		100	0
	All Hospitals Outpatients =		30	No.		20	600
HOTELS	High Class Hotels -> Beds =		0	No.		600	0
	Medium Class Hotels -> Beds =		0	No.		300	0
	Low Class Hotels -> Beds =		5	No.		50	250
ADMINISTRATIVE OFFICES	Staff =		10	No.		25	250
BARS	=		6	No.		500	3000
SHOPS	=		6	No.		100	600
	TOTAL DEMAND (l/day)						177600

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Malka Daka Deda

LOCATION : Kulamawe
DIVISION : Garba Tula

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 90000 mN Long. = 440000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 36 (km²)		
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1 No.
	1990 (estimated)	=	1800 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	1150 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	1 Day Schools no WC ->		300 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	1 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	15 No.
HOTELS	0 High Class Hotels ->		0 Beds
	0 Medium Class Hotels ->		0 Beds
	0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	: Staff	=	10 No.
BARS	:	=	16 No.
SHOPS	:	=	16 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Malka Daka Deda DIVISION : Garba Tula
LOCATION : Kulamawe DISTRICT : Isiolo

POPULATION : 1800 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC, High :	0 % =	0	No.		60	0
	Medium :	0 % =	0	No.		50	0
	Low :	5 % =	90	No.		40	3600
	with NC, High :	0 % =	0	No.		20	0
	Medium :	0 % =	0	No.		15	0
	Low :	95 % =	1710	No.		10	17100
	Total Demand for RURAL population						20700
URBAN POPULATION	with IC, High :	0 % =	0	No.		250	0
	Medium :	0 % =	0	No.		150	0
	Low :	0 % =	0	No.		75	0
	with NC, Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population						0
LIVESTOCK		(L.U.) =	383	No.		50	19150
SCHOOLS	Day Schools with WC -> Pupils =		0	No.		25	0
	Day Schools no WC -> Pupils =		300	No.		5	1500
	Boarding Schools -> Pupils =		0	No.		50	0
HEALTH	Health Centres\Dispensaries =		1	No.		5000	5000
	Regional Hospitals -> Beds =		0	No.		400	0
	District Hospitals -> Beds =		0	No.		200	0
	Other Hospitals -> Beds =		0	No.		100	0
	All Hospitals Outpatients =		15	No.		20	300
HOTELS	High Class Hotels -> Beds =		0	No.		600	0
	Medium Class Hotels -> Beds =		0	No.		300	0
	Low Class Hotels -> Beds =		0	No.		50	0
ADMINISTRATIVE OFFICES	Staff =		10	No.		25	250
BARS	=		16	No.		500	8000
SHOPS	=		16	No.		100	1600
	TOTAL DEMAND (l/day)						56500

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Bisan Biliku Deda

LOCATION : Bisan Biliku
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 98000 mN Long. = 440000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)	
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1 No.
	1990 (estimated)	=	1500 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	7500 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	1 Day Schools no WC ->		150 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	1 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	15 No.
HOTELS	0 High Class Hotels ->		0 Beds
	0 Medium Class Hotels ->		0 Beds
	0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	: Staff	=	10 No.
BARS	:	=	3 No.
SHOPS	:	=	6 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Bisan Biliku Deda DIVISION : Merti
LOCATION : Bisan Biliku DISTRICT : Isiolo

POPULATION : 1500 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC, High :	0 % =	0	No.		60	0
	Medium :	0 % =	0	No.		50	0
	Low :	5 % =	75	No.		40	3000
	with NC, High :	0 % =	0	No.		20	0
	Medium :	0 % =	0	No.		15	0
	Low :	95 % =	1425	No.		10	14250
	Total Demand for RURAL population						17250
URBAN POPULATION	with IC, High :	0 % =	0	No.		250	0
	Medium :	0 % =	0	No.		150	0
	Low :	0 % =	0	No.		75	0
	with NC, Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population						0
LIVESTOCK		(L.U.) =	2500	No.		50	125000
SCHOOLS	Day Schools with WC -> Pupils =		0	No.		25	0
	Day Schools no WC -> Pupils =		150	No.		5	750
	Boarding Schools -> Pupils =		0	No.		50	0
HEALTH	Health Centres\Dispensaries =		1	No.		5000	5000
	Regional Hospitals -> Beds =		0	No.		400	0
	District Hospitals -> Beds =		0	No.		200	0
	Other Hospitals -> Beds =		0	No.		100	0
	All Hospitals Outpatients =		15	No.		20	300
HOTELS	High Class Hotels -> Beds =		0	No.		600	0
	Medium Class Hotels -> Beds =		0	No.		300	0
	Low Class Hotels -> Beds =		0	No.		50	0
ADMINISTRATIVE OFFICES	Staff =		10	No.		25	250
BARS	=		3	No.		500	1500
SHOPS	=		6	No.		100	600
TOTAL DEMAND (l/day)							150650

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Kom CGA

LOCATION : Bisan Biliku
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 130000 mN Long. = 410000 mE

TYPE = 1

1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	1 No.
		1990 (estimated)	=	628 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	27717 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		0 Day Schools no WC ->		0 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	0 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	0 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	0 No.
BARS	:		=	0 No.
SHOPS	:		=	0 No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Kom CGA DIVISION : Merti
LOCATION : Bisan Biliku DISTRICT : Isiolo

POPULATION : 628 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION :
- High Potential = 0 % population
- Medium Potential = 0 % population
- Low Potential = 100 % population
- High Class Housing = 0 % population
- Medium Class Housing = 0 % population
- Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	31	No.		40	1240
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	596	No.		10	5960
	Total Demand for RURAL population							7200
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	9239	No.		50	461950
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			0	No.		5	0
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			0	No.		5000	0
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			0	No.		20	0
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.		25	0
BARS			=	0	No.		500	0
SHOPS			=	0	No.		100	0
			TOTAL DEMAND (l/day)					469150

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Dadacha Bassa Deda

LOCATION : Malka Galla
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 150000 mN Long. = 510000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 118 (km²)		
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1 No.
	1990 (estimated)	=	1400 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	33400 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	1 Day Schools no WC ->		142 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	1 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	15 No.
HOTELS	0 High Class Hotels ->		0 Beds
	0 Medium Class Hotels ->		0 Beds
	0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	: Staff	=	5 No.
BARS	:	=	0 No.
SHOPS	:	=	8 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Dadacha Bassa Deda DIVISION : Merti
LOCATION : Malka Galla DISTRICT : Isiolo

POPULATION : 1400 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC, High :	0 % =	0	No.		60	0
	Medium :	0 % =	0	No.		50	0
	Low :	5 % =	70	No.		40	2800
	with NC, High :	0 % =	0	No.		20	0
	Medium :	0 % =	0	No.		15	0
	Low :	95 % =	1330	No.		10	13300
	Total Demand for RURAL population						16100
URBAN POPULATION	with IC, High :	0 % =	0	No.		250	0
	Medium :	0 % =	0	No.		150	0
	Low :	0 % =	0	No.		75	0
	with NC, Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population						0
LIVESTOCK		(L.U.) =	11133	No.		50	556650
SCHOOLS	Day Schools with WC -> Pupils =		0	No.		25	0
	Day Schools no WC -> Pupils =		142	No.		5	710
	Boarding Schools -> Pupils =		0	No.		50	0
HEALTH	Health Centres\Dispensaries =		1	No.		5000	5000
	Regional Hospitals -> Beds =		0	No.		400	0
	District Hospitals -> Beds =		0	No.		200	0
	Other Hospitals -> Beds =		0	No.		100	0
	All Hospitals Outpatients =		15	No.		20	300
HOTELS	High Class Hotels -> Beds =		0	No.		600	0
	Medium Class Hotels -> Beds =		0	No.		300	0
	Low Class Hotels -> Beds =		0	No.		50	0
ADMINISTRATIVE OFFICES	Staff =		5	No.		25	125
BARS	=		0	No.		500	0
SHOPS	=		8	No.		100	800
	TOTAL DEMAND (l/day)						579685

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Hadado CGA

LOCATION : Malka Galla
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 163000 mN Long. = 530000 mE

TYPE = 1

1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)		
CLASSIFICATION	Rural Area :	High Potential	= 0 %	population
		Medium Potential	= 0 %	population
		Low Potential	= 100 %	population
	Urban Area :	High Class Housing	= 0 %	population
		Medium Class Housing	= 0 %	population
		Low Class Housing	= 0 %	population
POPULATION	:	1979 (census)	= 1	No.
		1990 (estimated)	= 1	No.
LIVESTOCK	:	Grade cow	= 0	No.
		Indigenous cow	= 71283	No.
		Sheep/goats	= 0	No.
		Donkey	= 0	No.
		Camel	= 0	No.
SCHOOLS	0	Day Schools with WC ->	0	Pupils
	0	Day Schools no WC ->	0	Pupils
	0	Boarding Schools ->	0	Pupils
HEALTH CENTRES/DISPENSARIES		=	0	No.
HOSPITALS	0	Regional Hospitals ->	0	Beds
	0	District Hospitals ->	0	Beds
	0	Other Hospitals ->	0	Beds
		Outpatients/day =	0	No.
HOTELS	0	High Class Hotels ->	0	Beds
	0	Medium Class Hotels ->	0	Beds
	0	Low Class Hotels ->	0	Beds
ADMINISTRATION OFFICES	:	Staff =	0	No.
BARS	:	=	0	No.
SHOPS	:	=	0	No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Hadado CGA DIVISION : Merti
LOCATION : Malka Galla DISTRICT : Isiolo

POPULATION : 1 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION :
High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	0	No.	40	0
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	0	No.	10	0
	Total Demand for RURAL population						0
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	23761	No.	50	1188050
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			0	No.	5	0
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			0	No.	5000	0
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			0	No.	20	0
HOTELS	High Class Hotels -> Beds =			0	No.	600	0
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.	25	0
BARS			=	0	No.	500	0
SHOPS			=	0	No.	100	0
			TOTAL DEMAND (l/day)				1188050

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Malka Galla Deda

LOCATION : Malka Galla
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 150000 mN Long. = 490000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 626 (km²)			
CLASSIFICATION	Rural Area :	High Potential	= 0	% population
		Medium Potential	= 0	% population
		Low Potential	= 100	% population
	Urban Area :	High Class Housing	= 0	% population
		Medium Class Housing	= 0	% population
		Low Class Housing	= 0	% population
POPULATION	:	1979 (census)	= 1914	No.
		1990 (estimated)	= 1600	No.
LIVESTOCK	:	Grade cow	= 0	No.
		Indigenous cow	= 19400	No.
		Sheep/goats	= 0	No.
		Donkey	= 0	No.
		Camel	= 0	No.
SCHOOLS		0 Day Schools with WC ->	0	Pupils
		1 Day Schools no WC ->	202	Pupils
		0 Boarding Schools ->	0	Pupils
HEALTH CENTRES/DISPENSARIES			= 1	No.
HOSPITALS		0 Regional Hospitals ->	0	Beds
		0 District Hospitals ->	0	Beds
		0 Other Hospitals ->	0	Beds
		Outpatients/day =	20	No.
HOTELS		0 High Class Hotels ->	0	Beds
		0 Medium Class Hotels ->	0	Beds
		0 Low Class Hotels ->	0	Beds
ADMINISTRATION OFFICES	:	Staff =	5	No.
BARS	:	=	2	No.
SHOPS	:	=	8	No.
INDUSTRIES	No			

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Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Malka Galla Deda DIVISION : Merti
LOCATION : Malka Galla DISTRICT : Isiolo

POPULATION : 1600 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	80	No.	40	3200
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	1520	No.	10	15200
	Total Demand for RURAL population						18400
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	6466	No.	50	323300
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			202	No.	5	1010
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			1	No.	5000	5000
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			20	No.	20	400
HOTELS	High Class Hotels -> Beds =			0	No.	600	0
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	5	No.	25	125
BARS			=	2	No.	500	1000
SHOPS			=	8	No.	100	800
			TOTAL DEMAND (l/day)				350035

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Yamicha CGA

LOCATION : Malka Galla
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 193000 mN Long. = 475000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)	
CLASSIFICATION	Rural Area :	High Potential =	0 % population
		Medium Potential =	0 % population
		Low Potential =	100 % population
	Urban Area :	High Class Housing =	0 % population
		Medium Class Housing =	0 % population
		Low Class Housing =	0 % population
POPULATION	:	1979 (census) =	1 No.
		1990 (estimated) =	1 No.
LIVESTOCK	:	Grade cow =	0 No.
		Indigenous cow =	66800 No.
		Sheep/goats =	0 No.
		Donkey =	0 No.
		Camel =	0 No.
SCHOOLS		0 Day Schools with WC ->	0 Pupils
		0 Day Schools no WC ->	0 Pupils
		0 Boarding Schools ->	0 Pupils
HEALTH CENTRES/DISPENSARIES		=	0 No.
HOSPITALS		0 Regional Hospitals ->	0 Beds
		0 District Hospitals ->	0 Beds
		0 Other Hospitals ->	0 Beds
		Outpatients/day =	0 No.
HOTELS		0 High Class Hotels ->	0 Beds
		0 Medium Class Hotels ->	0 Beds
		0 Low Class Hotels ->	0 Beds
ADMINISTRATION OFFICES	:	Staff =	0 No.
BARS	:	=	0 No.
SHOPS	:	=	0 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Yamicha CGA DIVISION : Merti
LOCATION : Malka Galla DISTRICT : Isiolo

POPULATION : 1 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	0	No.	40	0
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	0	No.	10	0
	Total Demand for RURAL population						0
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	22266	No.	50	1113300
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			0	No.	5	0
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			0	No.	5000	0
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			0	No.	20	0
HOTELS	High Class Hotels -> Beds =			0	No.	600	0
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.	25	0
BARS			=	0	No.	500	0
SHOPS			=	0	No.	100	0
			TOTAL DEMAND (l/day)				1113300

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Bulesa

LOCATION : Merti
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 107000 mN Long. = 448000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 36 (km²)			
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	1736 No.
		1990 (estimated)	=	1800 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	1517 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		1 Day Schools no WC ->		500 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	20 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	10 No.
BARS	:		=	1 No.
SHOPS	:		=	10 No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Bulesa DIVISION : Merti
LOCATION : Merti DISTRICT : Isiolo

POPULATION : 1800 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION :
High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	90	No.		40	3600
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	1710	No.		10	17100
	Total Demand for RURAL population							20700
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	505	No.		50	25250
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			500	No.		5	2500
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			20	No.		20	400
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	10	No.		25	250
BARS			=	1	No.		500	500
SHOPS			=	10	No.		100	1000
TOTAL DEMAND (l/day)								55600

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Korbesa

LOCATION : Merti
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 142000 mN Long. = 482000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	75 (km²)	
CLASSIFICATION	Rural Area : High Potential	=	0 % population
	Medium Potential	=	0 % population
	Low Potential	=	100 % population
	Urban Area : High Class Housing	=	0 % population
	Medium Class Housing	=	0 % population
	Low Class Housing	=	0 % population
POPULATION	: 1979 (census)	=	1765 No.
	1990 (estimated)	=	1800 No.
LIVESTOCK	: Grade cow	=	0 No.
	Indigenous cow	=	17200 No.
	Sheep/goats	=	0 No.
	Donkey	=	0 No.
	Camel	=	0 No.
SCHOOLS	0 Day Schools with WC ->		0 Pupils
	1 Day Schools no WC ->		230 Pupils
	0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES		=	1 No.
HOSPITALS	0 Regional Hospitals ->		0 Beds
	0 District Hospitals ->		0 Beds
	0 Other Hospitals ->		0 Beds
	Outpatients/day	=	40 No.
HOTELS	0 High Class Hotels ->		0 Beds
	0 Medium Class Hotels ->		0 Beds
	0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	: Staff	=	5 No.
BARS	:	=	0 No.
SHOPS	:	=	5 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Korbesa DIVISION : Merti
LOCATION : Merti DISTRICT : Isiolo

POPULATION : 1800 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC, High :	0 % =	0	No.		60	0
	Medium :	0 % =	0	No.		50	0
	Low :	5 % =	90	No.		40	3600
	with NC, High :	0 % =	0	No.		20	0
	Medium :	0 % =	0	No.		15	0
	Low :	95 % =	1710	No.		10	17100
	Total Demand for RURAL population						20700
URBAN POPULATION	with IC, High :	0 % =	0	No.		250	0
	Medium :	0 % =	0	No.		150	0
	Low :	0 % =	0	No.		75	0
	with NC, Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population						0
LIVESTOCK	(L.U.) =		5733	No.		50	286650
SCHOOLS	Day Schools with WC -> Pupils =		0	No.		25	0
	Day Schools no WC -> Pupils =		230	No.		5	1150
	Boarding Schools -> Pupils =		0	No.		50	0
HEALTH	Health Centres\Dispensaries =		1	No.		5000	5000
	Regional Hospitals -> Beds =		0	No.		400	0
	District Hospitals -> Beds =		0	No.		200	0
	Other Hospitals -> Beds =		0	No.		100	0
	All Hospitals Outpatients =		40	No.		20	800
HOTELS	High Class Hotels -> Beds =		0	No.		600	0
	Medium Class Hotels -> Beds =		0	No.		300	0
	Low Class Hotels -> Beds =		0	No.		50	0
ADMINISTRATIVE OFFICES	Staff =		5	No.		25	125
BARS	=		0	No.		500	0
SHOPS	=		5	No.		100	500
TOTAL DEMAND (l/day)							314925

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Merti

LOCATION : Merti
DIVISION : Merti

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 118000 mN Long. = 463000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 527 (km²)			
CLASSIFICATION	Rural Area	: High Potential	= 0 %	population
		Medium Potential	= 0 %	population
		Low Potential	= 100 %	population
	Urban Area	: High Class Housing	= 0 %	population
		Medium Class Housing	= 0 %	population
		Low Class Housing	= 0 %	population
POPULATION		: 1979 (census)	= 1973	No.
		1990 (estimated)	= 3000	No.
LIVESTOCK		: Grade cow	= 0	No.
		Indigenous cow	= 10783	No.
		Sheep/goats	= 0	No.
		Donkey	= 0	No.
		Camel	= 0	No.
SCHOOLS		0 Day Schools with WC ->	0	Pupils
		5 Day Schools no WC ->	1200	Pupils
		0 Boarding Schools ->	0	Pupils
HEALTH CENTRES/DISPENSARIES			= 2	No.
HOSPITALS		0 Regional Hospitals ->	0	Beds
		0 District Hospitals ->	0	Beds
		1 Other Hospitals ->	12	Beds
		Outpatients/day =	100	No.
HOTELS		0 High Class Hotels ->	0	Beds
		0 Medium Class Hotels ->	0	Beds
		4 Low Class Hotels ->	20	Beds
ADMINISTRATION OFFICES		: Staff	= 60	No.
BARS		:	= 6	No.
SHOPS		:	= 35	No.
INDUSTRIES		No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Merti DIVISION : Merti
LOCATION : Merti DISTRICT : Isiolo

POPULATION : 3000 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION :
High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	150	No.		40	6000
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	2850	No.		10	28500
	Total Demand for RURAL population							34500
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	3594	No.		50	179700
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			1200	No.		5	6000
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			2	No.		5000	10000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			12	No.		100	1200
	All Hospitals Outpatients =			100	No.		20	2000
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			20	No.		50	1000
ADMINISTRATIVE OFFICES			Staff =	60	No.		25	1500
BARS			=	6	No.		500	3000
SHOPS			=	35	No.		100	3500
			TOTAL DEMAND (l/day)					242400

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Eldera

LOCATION : Modogashe
DIVISION : Sericho

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 66000 mN Long. = 483000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 1165 (km²)			
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	1 No.
		1990 (estimated)	=	1250 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	24750 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		1 Day Schools no WC ->		137 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	15 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	30 No.
BARS	:		=	5 No.
SHOPS	:		=	6 No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Eldera DIVISION : Sericho
LOCATION : Modogashe DISTRICT : Isiolo

POPULATION : 1250 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	62	No.		40	2480
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	1187	No.		10	11870
	Total Demand for RURAL population							14350
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	8250	No.		50	412500
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			137	No.		5	685
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			15	No.		20	300
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	30	No.		25	750
BARS			=	5	No.		500	2500
SHOPS			=	6	No.		100	600
TOTAL DEMAND (l/day)								436685

MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Modogashe North

LOCATION : Modogashe
DIVISION : Sericho

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 100000 mN Long. = 505000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 1242 (km²)			
CLASSIFICATION	Rural Area :	High Potential	= 0	% population
		Medium Potential	= 0	% population
		Low Potential	= 100	% population
	Urban Area :	High Class Housing	= 0	% population
		Medium Class Housing	= 0	% population
		Low Class Housing	= 0	% population
POPULATION	: 1979 (census)		= 1446	No.
	1990 (estimated)		= 7000	No.
LIVESTOCK	: Grade cow		= 0	No.
	Indigenous cow		= 31150	No.
	Sheep/goats		= 0	No.
	Donkey		= 0	No.
	Camel		= 0	No.
SCHOOLS	0 Day Schools with WC ->		0	Pupils
	1 Day Schools no WC ->		200	Pupils
	2 Boarding Schools ->		780	Pupils
HEALTH CENTRES/DISPENSARIES			= 1	No.
HOSPITALS	0 Regional Hospitals ->		0	Beds
	0 District Hospitals ->		0	Beds
	1 Other Hospitals ->		4	Beds
	Outpatients/day =		100	No.
HOTELS	0 High Class Hotels ->		0	Beds
	0 Medium Class Hotels ->		0	Beds
	2 Low Class Hotels ->		25	Beds
ADMINISTRATION OFFICES	:	Staff =	60	No.
BARS	:	=	13	No.
SHOPS	:	=	100	No.
INDUSTRIES	No			

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MINISTRY OF WATER DEVELOPMENT

Water Resources Assessment & Planning Project - Documentation Section

WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Modogashe North DIVISION : Sericho
LOCATION : Modogashe DISTRICT : Isiolo

POPULATION : 7000 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	350	No.		40	14000
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	6650	No.		10	66500
	Total Demand for RURAL population							80500
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	10383	No.		50	519150
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			200	No.		5	1000
	Boarding Schools -> Pupils =			780	No.		50	39000
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			4	No.		100	400
	All Hospitals Outpatients =			100	No.		20	2000
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			25	No.		50	1250
ADMINISTRATIVE OFFICES			Staff =	60	No.		25	1500
BARS			=	13	No.		500	6500
SHOPS			=	100	No.		100	10000
			TOTAL DEMAND (l/day)					666300

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Modogashe South

LOCATION : Modogashe
DIVISION : Sericho

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 100000 mN Long. = 523000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	1 (km²)	
CLASSIFICATION	Rural Area :	High Potential =	0 % population
		Medium Potential =	0 % population
		Low Potential =	100 % population
	Urban Area :	High Class Housing =	0 % population
		Medium Class Housing =	0 % population
		Low Class Housing =	0 % population
POPULATION	:	1979 (census) =	1 No.
		1990 (estimated) =	1 No.
LIVESTOCK	:	Grade cow =	0 No.
		Indigenous cow =	8417 No.
		Sheep/goats =	0 No.
		Donkey =	0 No.
		Camel =	0 No.
SCHOOLS		0 Day Schools with WC ->	0 Pupils
		0 Day Schools no WC ->	0 Pupils
		0 Boarding Schools ->	0 Pupils
HEALTH CENTRES/DISPENSARIES		=	0 No.
HOSPITALS		0 Regional Hospitals ->	0 Beds
		0 District Hospitals ->	0 Beds
		0 Other Hospitals ->	0 Beds
		Outpatients/day =	0 No.
HOTELS		0 High Class Hotels ->	0 Beds
		0 Medium Class Hotels ->	0 Beds
		0 Low Class Hotels ->	0 Beds
ADMINISTRATION OFFICES	:	Staff =	0 No.
BARS	:	=	0 No.
SHOPS	:	=	0 No.
INDUSTRIES	No		

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Modogashe South DIVISION : Sericho
LOCATION : Modogashe DISTRICT : Isiolo

POPULATION : 1 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION :
High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	0	No.	40	0
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	0	No.	10	0
	Total Demand for RURAL population						0
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	2805	No.	50	140250
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			0	No.	5	0
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			0	No.	5000	0
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			0	No.	20	0
HOTELS	High Class Hotels -> Beds =			0	No.	600	0
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.	25	0
BARS			=	0	No.	500	0
SHOPS			=	0	No.	100	0
TOTAL DEMAND (l/day)							140250

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Gubatu

LOCATION : Sericho
DIVISION : Sericho

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 110000 mN Long. = 540000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 504 (km²)			
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	719 No.
		1990 (estimated)	=	700 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	12367 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS		0 Day Schools with WC ->		0 Pupils
		1 Day Schools no WC ->		61 Pupils
		0 Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	0 No.
HOSPITALS		0 Regional Hospitals ->		0 Beds
		0 District Hospitals ->		0 Beds
		0 Other Hospitals ->		0 Beds
		Outpatients/day	=	0 No.
HOTELS		0 High Class Hotels ->		0 Beds
		0 Medium Class Hotels ->		0 Beds
		0 Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	0 No.
BARS	:		=	0 No.
SHOPS	:		=	1 No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Gubatu DIVISION : Sericho
LOCATION : Sericho DISTRICT : Isiolo

POPULATION : 700 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	35	No.		40	1400
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	665	No.		10	6650
	Total Demand for RURAL population							8050
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	4122	No.		50	206100
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			61	No.		5	305
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			0	No.		5000	0
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			0	No.		20	0
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	0	No.		25	0
BARS			=	0	No.		500	0
SHOPS			=	1	No.		100	100
			TOTAL DEMAND (l/day)					214555

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Iresa Boru

LOCATION : Sericho
DIVISION : Sericho

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 124000 mN Long. = 487000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total =	82 (km²)		
CLASSIFICATION	Rural Area :	High Potential	=	0 % population
		Medium Potential	=	0 % population
		Low Potential	=	100 % population
	Urban Area :	High Class Housing	=	0 % population
		Medium Class Housing	=	0 % population
		Low Class Housing	=	0 % population
POPULATION	:	1979 (census)	=	2261 No.
		1990 (estimated)	=	1500 No.
LIVESTOCK	:	Grade cow	=	0 No.
		Indigenous cow	=	39100 No.
		Sheep/goats	=	0 No.
		Donkey	=	0 No.
		Camel	=	0 No.
SCHOOLS	0	Day Schools with WC ->		0 Pupils
	1	Day Schools no WC ->		303 Pupils
	0	Boarding Schools ->		0 Pupils
HEALTH CENTRES/DISPENSARIES			=	1 No.
HOSPITALS	0	Regional Hospitals ->		0 Beds
	0	District Hospitals ->		0 Beds
	0	Other Hospitals ->		0 Beds
		Outpatients/day	=	15 No.
HOTELS	0	High Class Hotels ->		0 Beds
	0	Medium Class Hotels ->		0 Beds
	0	Low Class Hotels ->		0 Beds
ADMINISTRATION OFFICES	:	Staff	=	5 No.
BARS	:		=	3 No.
SHOPS	:		=	5 No.
INDUSTRIES	No			

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Iresa Boru DIVISION : Sericho
LOCATION : Sericho DISTRICT : Isiolo

POPULATION : 1500 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION							RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.		60	0
		Medium :	0 % =	0	No.		50	0
		Low :	5 % =	75	No.		40	3000
	with NC,	High :	0 % =	0	No.		20	0
		Medium :	0 % =	0	No.		15	0
		Low :	95 % =	1425	No.		10	14250
	Total Demand for RURAL population							17250
URBAN POPULATION	with IC,	High :	0 % =	0	No.		250	0
		Medium :	0 % =	0	No.		150	0
		Low :	0 % =	0	No.		75	0
	with NC,	Low :	0 % =	0	No.		20	0
	Total Demand for URBAN population							0
LIVESTOCK			(L.U.) =	13033	No.		50	651650
SCHOOLS	Day Schools with WC -> Pupils =			0	No.		25	0
	Day Schools no WC -> Pupils =			303	No.		5	1515
	Boarding Schools -> Pupils =			0	No.		50	0
HEALTH	Health Centres\Dispensaries =			1	No.		5000	5000
	Regional Hospitals -> Beds =			0	No.		400	0
	District Hospitals -> Beds =			0	No.		200	0
	Other Hospitals -> Beds =			0	No.		100	0
	All Hospitals Outpatients =			15	No.		20	300
HOTELS	High Class Hotels -> Beds =			0	No.		600	0
	Medium Class Hotels -> Beds =			0	No.		300	0
	Low Class Hotels -> Beds =			0	No.		50	0
ADMINISTRATIVE OFFICES			Staff =	5	No.		25	125
BARS			=	3	No.		500	1500
SHOPS			=	5	No.		100	500
			TOTAL DEMAND (l/day)					677840

MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DATA (1990)

SUB-LOCATION : Sericho

LOCATION : Sericho
DIVISION : Sericho

DISTRICT : Isiolo PROVINCE : Eastern

COORDINATES (main Centre) UTM-grid = 37N
Lat. = 126000 mN Long. = 512000 mE

TYPE = 1
1 = Rural
2 = Market or Local Centre < 2000 population
3 = Rural Centre > 2000 population
4 = Urban Centre > 5000 population

AREA	Total = 678 (km²)			
CLASSIFICATION	Rural Area	: High Potential	= 0	% population
		Medium Potential	= 0	% population
		Low Potential	= 100	% population
	Urban Area	: High Class Housing	= 0	% population
		Medium Class Housing	= 0	% population
		Low Class Housing	= 0	% population
POPULATION		: 1979 (census)	= 1739	No.
		1990 (estimated)	= 2020	No.
LIVESTOCK		: Grade cow	= 0	No.
		Indigenous cow	= 18783	No.
		Sheep/goats	= 0	No.
		Donkey	= 0	No.
		Camel	= 0	No.
SCHOOLS		0 Day Schools with WC ->	0	Pupils
		2 Day Schools no WC ->	337	Pupils
		0 Boarding Schools ->	0	Pupils
HEALTH CENTRES/DISPENSARIES			= 1	No.
HOSPITALS		0 Regional Hospitals ->	0	Beds
		0 District Hospitals ->	0	Beds
		0 Other Hospitals ->	0	Beds
		Outpatients/day =	11	No.
HOTELS		0 High Class Hotels ->	0	Beds
		0 Medium Class Hotels ->	0	Beds
		0 Low Class Hotels ->	0	Beds
ADMINISTRATION OFFICES		: Staff =	5	No.
BARS		: =	8	No.
SHOPS		: =	11	No.
INDUSTRIES		No		

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MINISTRY OF WATER DEVELOPMENT

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WATER DEVELOPMENT PLANNING - BASE YEAR DEMAND (1990)

SUB-LOCATION : Sericho DIVISION : Sericho
LOCATION : Sericho DISTRICT : Isiolo

POPULATION : 2020 Rural Pop. = 100 % Urban Pop. = 0 %

CLASSIFICATION : High Potential = 0 % population
Medium Potential = 0 % population
Low Potential = 100 % population
High Class Housing = 0 % population
Medium Class Housing = 0 % population
Low Class Housing = 0 % population

ASSESSMENT OF IC-POTENTIAL : Rural Area = 5 % Urban Area = 0 %

DEMAND CALCULATION						RATE	DEMAND
RURAL POPULATION	with IC,	High :	0 % =	0	No.	60	0
		Medium :	0 % =	0	No.	50	0
		Low :	5 % =	101	No.	40	4040
	with NC,	High :	0 % =	0	No.	20	0
		Medium :	0 % =	0	No.	15	0
		Low :	95 % =	1919	No.	10	19190
	Total Demand for RURAL population						23230
URBAN POPULATION	with IC,	High :	0 % =	0	No.	250	0
		Medium :	0 % =	0	No.	150	0
		Low :	0 % =	0	No.	75	0
	with NC,	Low :	0 % =	0	No.	20	0
	Total Demand for URBAN population						0
LIVESTOCK			(L.U.) =	6261	No.	50	313050
SCHOOLS	Day Schools with WC -> Pupils =			0	No.	25	0
	Day Schools no WC -> Pupils =			337	No.	5	1685
	Boarding Schools -> Pupils =			0	No.	50	0
HEALTH	Health Centres\Dispensaries =			1	No.	5000	5000
	Regional Hospitals -> Beds =			0	No.	400	0
	District Hospitals -> Beds =			0	No.	200	0
	Other Hospitals -> Beds =			0	No.	100	0
	All Hospitals Outpatients =			11	No.	20	220
HOTELS	High Class Hotels -> Beds =			0	No.	600	0
	Medium Class Hotels -> Beds =			0	No.	300	0
	Low Class Hotels -> Beds =			0	No.	50	0
ADMINISTRATIVE OFFICES			Staff =	5	No.	25	125
BARS			=	8	No.	500	4000
SHOPS			=	11	No.	100	1100
			TOTAL DEMAND (l/day)				348410

APPENDIX 5

DEMAND SUMMARIES

DISTRICT WATER DEMAND SUMMARY (1990) - Scenario 0

DIVISION: CENTRAL **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Central	Isiolo Central	1339100	1239100	100000	0	990400	0	122700	53500	100000	72500
	Isiolo East	43895	43895	0	12320	0	0	31575	0	0	0
	Ngara Mara	296975	106725	190250	34040	0	190250	4110	5300	0	63275
	Total (l/day):	1679970	1389720	290250	46360	990400	190250	158385	58800	100000	135775
Oldo Nyiro	Kipsing	239130	29980	209150	23000	0	209150	630	5300	0	1050
	Oldo Nyiro	146625	59125	87500	28750	0	87500	16225	10400	0	3750
	Total (l/day):	385755	89105	296650	51750	0	296650	16855	15700	0	4800
West	Arimet (West)	30050	30050	0	23000	0	0	0	5800	0	1250
	Birat	157475	157475	0	5750	0	0	1725	0	0	150000
	Total (l/day):	187525	187525	0	28750	0	0	1725	5800	0	151250
	Division Total (l/day):	2253250	1666350	586900	126860	990400	486900	176965	80300	100000	291825

MINISTRY OF WATER DEVELOPMENT

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DISTRICT WATER DEMAND SUMMARY (1990) - Scenario 0

DIVISION: GARBA TULA **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Garba Tula	Garba Tula North	349710	33610	316100	28410	0	316100	0	5200	0	0
	Garba Tula South	257970	108270	149700	64400	0	149700	22020	7000	0	14850
	Total (l/day):	607680	141880	465800	92810	0	465800	22020	12200	0	14850
Kinna	Bibi	90875	29225	61650	20700	0	61650	1000	5200	0	2325
	Kinna	167865	47865	120000	28750	0	120000	8365	5500	0	5250
	Rapsu	13675	13675	0	8050	0	0	0	5300	0	325
	Total (l/day):	272415	90765	181650	57500	0	181650	9365	16000	0	7900
Kulamawe	Boji Deda	32800	28100	4700	20700	0	4700	575	5400	0	1425
	Gafarsa	153870	28620	125250	19550	0	125250	1180	5240	0	2650
	Kulamawe Deda	177600	28450	149150	17250	0	149150	1500	5600	0	4100
	Malka Daka Deda	56500	37350	19150	20700	0	19150	1500	5300	0	9850
	Total (l/day):	420770	122520	298250	78200	0	298250	4755	21540	0	18025
	Division Total (l/day):	1300865	355165	945700	228510	0	945700	36140	49740	0	40775

DISTRICT WATER DEMAND SUMMARY (1990) - Scenario 0

DIVISION: MERTI **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Bisan Biliku	Bisan Biliku Deda	150650	25650	125000	17250	0	125000	750	5300	0	2350
	Kom CGA	469150	7200	461950	7200	0	461950	0	0	0	0
	Total (l/day):	619800	32850	586950	24450	0	586950	750	5300	0	2350
Malka Galla	Dadacha Bassa Deda	579685	23035	556650	16100	0	556650	710	5300	0	925
	Hadado CGA	1188050	0	1188050	0	0	1188050	0	0	0	0
	Malka Galla Deda	350035	26735	323300	18400	0	323300	1010	5400	0	1925
	Yamicha CGA	1113300	0	1113300	0	0	1113300	0	0	0	0
	Total (l/day):	3231070	49770	3181300	34500	0	3181300	1720	10700	0	2850
Merti	Bulesa	55600	30350	25250	20700	0	25250	2500	5400	0	1750
	Korbesa	314925	28275	286650	20700	0	286650	1150	5800	0	625
	Merti	242400	62700	179700	34500	0	179700	6000	13200	0	9000
	Total (l/day):	612925	121325	491600	75900	0	491600	9650	24400	0	11375
	Division Total (l/day):	4463795	203945	4259850	134850	0	4259850	12120	40400	0	16575

DISTRICT WATER DEMAND SUMMARY (1990) - Scenario 0

DIVISION: SERICHO **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Modogashe	Eldera	436685	24185	412500	14350	0	412500	685	5300	0	3850
	Modogashe North	666300	147150	519150	80500	0	519150	40000	7400	0	19250
	Modogashe South	140250	0	140250	0	0	140250	0	0	0	0
	Total (l/day):	1243235	171335	1071900	94850	0	1071900	40685	12700	0	23100
Sericho	Gubatu	214555	8455	206100	8050	0	206100	305	0	0	100
	Iresa Boru	677840	26190	651650	17250	0	651650	1515	5300	0	2125
	Sericho	348410	35360	313050	23230	0	313050	1685	5220	0	5225
	Total (l/day):	1240805	70005	1170800	48530	0	1170800	3505	10520	0	7450
	Division Total (l/day):	2484040	241340	2242700	143380	0	2242700	44190	23220	0	30550

DISTRICT WATER DEMAND SUMMARY (1995) - Scenario 1

DIVISION: CENTRAL **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Central	Isiolo Central	1640205	1520205	120000	0	1204815	0	164200	66940	120000	84250
	Isiolo East	28085	28085	0	15010	0	0	13075	0	0	0
	Ngara Mara	319285	129035	190250	41400	0	190250	5500	5360	0	76775
	Total (l/day):	1987575	1677325	310250	56410	1204815	190250	182775	72300	120000	161025
Oldo Nyiro	Kipsing	244405	35255	209150	27950	0	209150	845	5360	0	1100
	Oldo Nyiro	158775	71275	87500	34970	0	87500	21700	10480	0	4125
	Total (l/day):	403180	106530	296650	62920	0	296650	22545	15840	0	5225
West	Arimet (West)	35455	35455	0	27950	0	0	0	5980	0	1525
	Birat	190585	190585	0	6970	0	0	1215	0	0	182400
	Total (l/day):	226040	226040	0	34920	0	0	1215	5980	0	183925
	Division Total (l/day):	2616795	2009895	606900	154250	1204815	486900	206535	94120	120000	350175

DISTRICT WATER DEMAND SUMMARY (1995) - Scenario 1

DIVISION: GARBA TULA **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Garba Tula	Garba Tula North	355920	39820	316100	34580	0	316100	0	5240	0	0
	Garba Tula South	282060	132360	149700	78320	0	149700	29460	7480	0	17100
	Total (l/day):	637980	172180	465800	112900	0	465800	29460	12720	0	17100
Kinna	Bibi	95740	34090	61650	25160	0	61650	1340	5240	0	2350
	Kinna	177245	57245	120000	34970	0	120000	10675	5600	0	6000
	Rapsu	15480	15480	0	9770	0	0	0	5360	0	350
	Total (l/day):	288465	106815	181650	69900	0	181650	12015	16200	0	8700
Kulamawe	Boji Deda	37560	32860	4700	25160	0	4700	770	5480	0	1450
	Gafarsa	158690	33440	125250	23760	0	125250	1580	5300	0	2800
	Kulamawe Deda	182645	33495	149150	20970	0	149150	2005	5720	0	4800
	Malka Daka Deda	62775	43625	19150	25160	0	19150	2005	5360	0	11100
	Total (l/day):	441670	143420	298250	95050	0	298250	6360	21860	0	20150
	Division Total (l/day):	1368115	422415	945700	277850	0	945700	47835	50780	0	45950

DISTRICT WATER DEMAND SUMMARY (1995) - Scenario 1

DIVISION: MERTI **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Bisan Biliku	Bisan Biliku Deda	154835	29835	125000	20970	0	125000	1005	5360	0	2500
	Kom CGA	470720	8770	461950	8770	0	461950	0	0	0	0
	Total (l/day):	625555	38605	586950	29740	0	586950	1005	5360	0	2500
Malka Galla	Dadacha Bassa Deda	583580	26930	556650	19570	0	556650	950	5360	0	1050
	Hadado CGA	1188050	0	1188050	0	0	1188050	0	0	0	0
	Malka Galla Deda	354550	31250	323300	22370	0	323300	1350	5480	0	2050
	Yamicha CGA	1113300	0	1113300	0	0	1113300	0	0	0	0
	Total (l/day):	3239480	58180	3181300	41940	0	3181300	2300	10840	0	3100
Merti	Bulesa	61135	35885	25250	25160	0	25250	3345	5480	0	1900
	Korbesa	320080	33430	286650	25160	0	286650	1540	5980	0	750
	Merti	253315	73615	179700	41950	0	179700	7300	13940	0	10425
	Total (l/day):	634530	142930	491600	92270	0	491600	12185	25400	0	13075
	Division Total (l/day):	4499565	239715	4259850	163950	0	4259850	15490	41600	0	18675

DISTRICT WATER DEMAND SUMMARY (1995) - Scenario 1

DIVISION: SERICHO **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Modogashe	Eldera	440855	28355	412500	17480	0	412500	915	5360	0	4600
	Modogashe North	699865	180715	519150	97910	0	519150	53540	7940	0	21325
	Modogashe South	140250	0	140250	0	0	140250	0	0	0	0
	Total (l/day):	1280970	209070	1071900	115390	0	1071900	54455	13300	0	25925
Sericho	Gubatu	216380	10280	206100	9770	0	206100	410	0	0	100
	Iresa Boru	682255	30605	651650	20970	0	651650	2025	5360	0	2250
	Sericho	354645	41595	313050	28230	0	313050	2255	5260	0	5850
	Total (l/day):	1253280	82480	1170800	58970	0	1170800	4690	10620	0	8200
	Division Total (l/day):	2534250	291550	2242700	174360	0	2242700	59145	23920	0	34125

DISTRICT WATER DEMAND SUMMARY (2005) - Scenario 1

DIVISION: CENTRAL **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Central	Isiolo Central	2664930	2484930	180000	0	2021135	0	249975	99520	180000	114300
	Isiolo East	44480	44480	0	25130	0	0	19350	0	0	0
	Ngara Mara	388505	198255	190250	69290	0	190250	9850	5540	0	113575
	Total (l/day):	3097915	2727665	370250	94420	2021135	190250	279175	105060	180000	227875
Oldo Nyiro	Kipsing	264355	55205	209150	46800	0	209150	1515	5540	0	1350
	Oldo Nyiro	206025	118525	87500	58520	0	87500	38835	15720	0	5450
	Total (l/day):	470380	173730	296650	105320	0	296650	40350	21260	0	6800
West	Arimet (West)	55510	55510	0	46800	0	0	0	6460	0	2250
	Birat	283500	283500	0	11700	0	0	1800	0	0	270000
	Total (l/day):	339010	339010	0	58500	0	0	1800	6460	0	272250
	Division Total (l/day):	3907305	3240405	666900	258240	2021135	486900	321325	132780	180000	506925

DISTRICT WATER DEMAND SUMMARY (2005) - Scenario 1

DIVISION: GARBA TULA **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Garba Tula	Garba Tula North	379340	63240	316100	57880	0	316100	0	5360	0	0
	Garba Tula South	364540	214840	149700	131080	0	149700	52775	8660	0	22325
	Total (l/day):	743880	278080	465800	188960	0	465800	52775	14020	0	22325
Kinna	Bibi	114465	52815	61650	42130	0	61650	2400	5360	0	2925
	Kinna	207850	87850	120000	58520	0	120000	15800	5880	0	7650
	Rapsu	22345	22345	0	16380	0	0	0	5540	0	425
	Total (l/day):	344660	163010	181650	117030	0	181650	18200	16780	0	11000
Kulamawe	Boji Deda	55555	50855	4700	42130	0	4700	1380	5720	0	1625
	Gafarsa	176950	51700	125250	39780	0	125250	2830	5440	0	3650
	Kulamawe Deda	200200	51050	149150	35100	0	149150	3590	6060	0	6300
	Malka Daka Deda	84060	64910	19150	42130	0	19150	3590	5540	0	13650
	Total (l/day):	516765	218515	298250	159140	0	298250	11390	22760	0	25225
	Division Total (l/day):	1605305	659605	945700	465130	0	945700	82365	53560	0	58550

DISTRICT WATER DEMAND SUMMARY (2005) - Scenario 1

DIVISION: MERTI **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Bisan Biliku	Bisan Biliku Deda	170790	45790	125000	35100	0	125000	1800	5540	0	3350
	Kom CGA	476640	14690	461950	14690	0	461950	0	0	0	0
	Total (l/day):	647430	60480	586950	49790	0	586950	1800	5540	0	3350
Malka Galla	Dadacha Bassa Deda	597975	41325	556650	32760	0	556650	1700	5540	0	1325
	Hadado CGA	1188050	0	1188050	0	0	1188050	0	0	0	0
	Malka Galla Deda	371215	47915	323300	37450	0	323300	2420	5720	0	2325
	Yamicha CGA	1113300	0	1113300	0	0	1113300	0	0	0	0
	Total (l/day):	3270540	89240	3181300	70210	0	3181300	4120	11260	0	3650
Merti	Bulesa	81340	56090	25250	42130	0	25250	5990	5720	0	2250
	Korbesa	338925	52275	286650	42130	0	286650	2760	6460	0	925
	Merti	295345	115645	179700	70220	0	179700	10805	20820	0	13800
	Total (l/day):	715610	224010	491600	154480	0	491600	19555	33000	0	16975
	Division Total (l/day):	4633580	373730	4259850	274480	0	4259850	25475	49800	0	23975

DISTRICT WATER DEMAND SUMMARY (2005) - Scenario 1

DIVISION: SERICHO **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Modogashe	Eldera	454655	42155	412500	29250	0	412500	1640	5540	0	5725
	Modogashe North	815030	295880	519150	163860	0	519150	95900	9320	0	26800
	Modogashe South	140250	0	140250	0	0	140250	0	0	0	0
	Total (l/day):	1409935	338035	1071900	193110	0	1071900	97540	14860	0	32525
Sericho	Gubatu	223315	17215	206100	16380	0	206100	735	0	0	100
	Iresa Boru	698840	47190	651650	35100	0	651650	3625	5540	0	2925
	Sericho	376955	63905	313050	47260	0	313050	4040	5380	0	7225
	Total (l/day):	1299110	128310	1170800	98740	0	1170800	8400	10920	0	10250
	Division Total (l/day):	2709045	466345	2242700	291850	0	2242700	105940	25780	0	42775

DISTRICT WATER DEMAND SUMMARY (2015) - Scenario 1

DIVISION: CENTRAL **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Central	Isiolo Central	4158605	3898605	260000	0	3343720	0	249975	147960	260000	156950
	Isiolo East	74440	74440	0	45790	0	0	28650	0	0	0
	Ngara Mara	504445	314195	190250	126240	0	190250	14580	5800	0	167575
	Total (l/day):	4737490	4287240	450250	172030	3343720	190250	293205	153760	260000	324525
Oldo Nyiro	Kipsing	304150	95000	209150	85280	0	209150	2245	5800	0	1675
	Oldo Nyiro	279915	192415	87500	106640	0	87500	57490	21060	0	7225
	Total (l/day):	584065	287415	296650	191920	0	296650	59735	26860	0	8900
West	Arimet (West)	95765	95765	0	85280	0	0	0	7160	0	3325
	Birat	423555	423555	0	21290	0	0	2665	0	0	399600
	Total (l/day):	519320	519320	0	106570	0	0	2665	7160	0	402925
	Division Total (l/day):	5840875	5093975	746900	470520	3343720	486900	355605	187780	260000	736350

MINISTRY OF WATER DEVELOPMENT

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DISTRICT WATER DEMAND SUMMARY (2015) - Scenario 1

DIVISION: GARBA TULA

DISTRICT: ISIOLO

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Garba Tula	Garba Tula North	432140	116040	316100	105460	0	316100	0	10580	0	0
	Garba Tula South	545120	395420	149700	262810	0	149700	85980	15980	0	30650
	Total (l/day):	977260	511460	465800	368270	0	465800	85980	26560	0	30650
Kinna	Bibi	151020	89370	61650	76750	0	61650	3555	5540	0	3525
	Kinna	265825	145825	120000	106640	0	120000	23410	6300	0	9475
	Rapsu	36175	36175	0	29850	0	0	0	5800	0	525
	Total (l/day):	453020	271370	181650	213240	0	181650	26965	17640	0	13525
Kulamawe	Boji Deda	91380	86680	4700	76750	0	4700	2045	6060	0	1825
	Gafarsa	212255	87005	125250	72480	0	125250	4190	5660	0	4675
	Kulamawe Deda	232890	83740	149150	63940	0	149150	5315	6560	0	7925
	Malka Daka Deda	123890	104740	19150	76750	0	19150	5315	5800	0	16875
	Total (l/day):	660415	362165	298250	289920	0	298250	16865	24080	0	31300
	Division Total (l/day):	2090695	1144995	945700	871430	0	945700	129810	68280	0	75475

DISTRICT WATER DEMAND SUMMARY (2015) - Scenario 1

DIVISION: MERTI **DISTRICT: ISIOLO**

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Bisan Biliku	Bisan Biliku Deda	201680	76680	125000	63940	0	125000	2665	5800	0	4275
	Kom CGA	488700	26750	461950	26750	0	461950	0	0	0	0
	Total (l/day):	690380	103430	586950	90690	0	586950	2665	5800	0	4275
Malka Galla	Dadacha Bassa Deda	626280	69630	556650	59690	0	556650	2515	5800	0	1625
	Hadado CGA	1188050	0	1188050	0	0	1188050	0	0	0	0
	Malka Galla Deda	403805	80505	323300	68240	0	323300	3580	6060	0	2625
	Yamicha CGA	1113300	0	1113300	0	0	1113300	0	0	0	0
	Total (l/day):	3331435	150135	3181300	127930	0	3181300	6095	11860	0	4250
Merti	Bulesa	119700	94450	25250	76750	0	25250	8865	6060	0	2775
	Korbesa	375870	89220	286650	76750	0	286650	4085	7160	0	1225
	Merti	383205	203505	179700	140800	0	179700	15995	28660	0	18050
	Total (l/day):	878775	387175	491600	294300	0	491600	28945	41880	0	22050
	Division Total (l/day):	4900590	640740	4259850	512920	0	4259850	37705	59540	0	30575

MINISTRY OF WATER DEVELOPMENT

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DISTRICT WATER DEMAND SUMMARY (2015) - Scenario 1

DIVISION: SERICHO

DISTRICT: ISIOLO

Location	Sub-Location	Total Demand	Total Domestic	Total Non Domestic	Population Rural	Population Urban	Livestock	Schools	Health	Industry	Others
Modogashe	Eldera	481570	69070	412500	53290	0	412500	2430	5800	0	7550
	Modogashe North	1005075	485925	519150	298560	0	519150	141955	11360	0	34050
	Modogashe South	140250	0	140250	0	0	140250	0	0	0	0
	Total (l/day):	1626895	554995	1071900	351850	0	1071900	144385	17160	0	41600
Sericho	Gubatu	237140	31040	206100	29850	0	206100	1090	0	0	100
	Iresa Boru	730480	78830	651650	63940	0	651650	5365	5800	0	3725
	Sericho	419375	106325	313050	86160	0	313050	5980	5560	0	8625
	Total (l/day):	1386995	216195	1170800	179950	0	1170800	12435	11360	0	12450
	Division Total (l/day):	3013890	771190	2242700	531800	0	2242700	156820	28520	0	54050

ISIOLO

DISTRICT WATER DEVELOPMENT STUDY

1993 - 2013

PART 2

EXISTING SUPPLY, TECHNOLOGY OPTIONS AND COSTS

June 1991

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ABBREVIATIONS

ASAL	=	Arid and Semi-Arid Lands Development Program
CBWDP	=	Central Baringo Water Development Plan
CC	=	County Council
DANIDA	=	Danish International Development Agency
DDC	=	District Development Committee
DDP	=	Meru District Development Plan 1989-1993
DvDC	=	Divisional Development Committee
DWDP	=	District Water Development Plan
DWDS	=	District Water Development Study
EEC	=	European Economic Commission
FINNIDA	=	Finnish International Development Agency
GOK	=	Government of Kenya
GSK	=	Groundwater Survey Kenya
GTZ	=	Deutsche Gesellschaft fur Technische Zusammenarbeit
KFRWSDP	=	Kenya Finland Rural Water Supply Development Project in Western Province
KIDP	=	Kitui Development Program
Ksh	=	Kenya shilling
KWAHO	=	Kenya Water for Health Organization
KWDP	=	Kwale District Community Water Supply and Sanitation Project
L.U.	=	Livestock Unit
LBDA	=	Lake Basin Development Authority
lpcd	=	liters per capita per day
MoA	=	Ministry of Agriculture
MOH	=	Ministry of Health
MoLD	=	Ministry of Livestock Development
MoWD	=	Ministry of Water Development
MCSS	=	Ministry of Culture and Social Services
MPND	=	Ministry of Planning and National Development
msl	=	Meters above mean sea level
NGO	=	Non-Government Organization
NORAD	=	Norwegian Agency for Development
ODA	=	Overseas Development Agency
Shs	=	Kenya shilling
SIDA	=	Swedish International Development Agency
UNDP	=	United Nations Development Project
UNICEF	=	United Nations International Childrens Emergency Fund
USAID	=	United States Agency for International Development
WECO	=	Western College of Arts
WRAP	=	Water Resources Assessment and Planning Project

SUMMARY

The present report is Part 2, of three reports, composing the Isiolo District Water Development Study. Part 2 presents an inventory of existing water supply in Isiolo District, the analysis of and recommendation on water supply options and technologies for Isiolo District, an inventory of costs of the selected technologies, and compares these costs using a cost effectiveness analysis. The objective of the report is to recommend affordable and sustainable water supply options and technologies for Isiolo District.

The inventory of existing water supply was carried out by collecting data from the files of the MoWD (Operational Charts of MoWD supplies) and by field visits. The analysis of feasible water supply options was based on this inventory.

The availability of improved water supply is mainly restricted to rural trading centres which are in the dry grazing areas of the nomadic pastoralists of Isiolo District. Some livestock water supplies e.g Yamicha have been developed in the drought grazing areas although no trading centre has been established. During the rainy seasons the livestock are moved far from the rural centres and the herders use the water available in natural depressions and the numerous seasonal rivers.

All improved water supply systems in Isiolo draw water from boreholes except Isiolo and Kinna which have surface water sources. Modogashe rural centre has an infiltration gallery source. All the schemes are pumped and treatment is only done at Isiolo water supply.

The organisations involved in operation and maintenance of the water supplies are the MoWD with 5 water supplies, the LMD, the County Council, self help (Sericho Water Supply) and religious organisations (Oldo Nyiro and Ngare Mara). It is only in 4 of the MoWD ran water supplies that operational and technical data was available. In these supplies the operation cost ranges from 13 Shs to 56 Shs per beneficiary and between 1.5 and 7 Shs per m^3 produced. The maintenance costs are not available.

The selection of the feasible water supply technologies was done by considering the different type of water users, the distribution and user related character of the water demand and the type of water sources in the district. Other considerations were the limited source options, the poorly developed infrastructure, the limited availability of local staff, the low density of the population and the limited chances of effective cost recovery.

The recommended technologies from which a choice may be made for the different supply areas are:

- boreholes in areas where groundwater is suitable, with either a diesel pump, a solar pump, a combined solar - diesel system or a windmill,
- infiltration galleries with a collector well in areas where good groundwater is available only in the sandy sediments of seasonal rivers, from which the water may be pumped by diesel, solar or a combination of pumps,
- pans for livestock water supply, with an outlet for domestic water use.

Other technologies may be applicable sometimes in individual cases.

WRAP determined the typical properties and components of the water supply technologies selected for Isiolo District and cost estimates were made for each component. The capital costs include costs of materials, labour, transport and depreciation of construction equipment. Overhead costs, such as depreciation of vehicles, offices and supervision, are not included. Added on are 10% costs for contingencies.

The O & M costs were determined also, as these have to be raised by the community. The operation costs include energy, salaries, chemicals, transport and offices. The maintenance costs include spare parts, tools and costs of repairs.

The selected technologies were analyzed using the cost effectiveness approach, which measures the cost per cubic meter capacity of each supply system over its lifetime. The lowest cost technology applicable in a given circumstance will be the most "cost effective". The analysis was conducted for different types of domestic supply systems, representing supplies to rural centres. The analysis was carried out over a 20 years period, and the systems were rated according to the 10% discount rate. Conclusions from this analysis must be taken as indicative due to the nature of the used estimates.

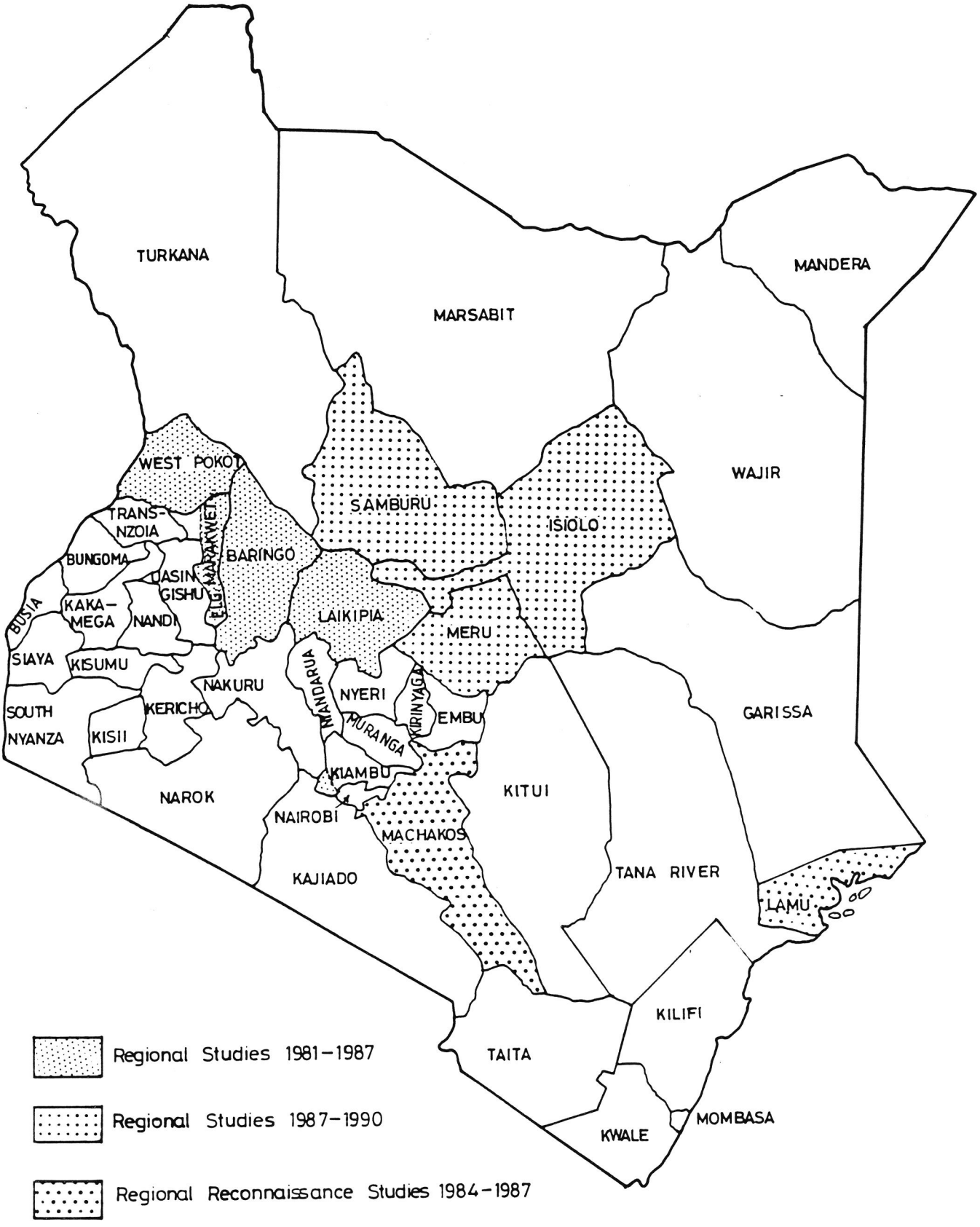
The outcome of the comparison of boreholes or wells equipped with solar pumps, windmills or diesel pumps shows that diesel pumps are the most cost effective. Solar pumps alone are less cost effective than combined systems. It appears that the lower O & M costs of solar systems do not compensate for the higher capital costs.

The windmill is more cost effective than solar systems. However the windmill is not applicable in most parts of Isiolo District, because of insufficient wind potential. A combined system of windmill and submersible pump is not possible in one borehole.

The analysis shows that systems are more cost effective for larger yields. This is due to the lower capital and O & M costs per m^3 produced.

Options where domestic and non-domestic supply can be combined should be preferred, especially in the rural areas where the number of users per facility is small, due to the dispersion of the population. It may even be so that participation of the community can only be expected, if water supply for the livestock is included, e.g. as at Kulamawe.

WATER RESOURCES ASSESSMENT & PLANNING PROJECT



Regional Assessment Studies under the WRAP Programme 1981-1990

1. INTRODUCTION

1.1 Purpose and Scope of the Study

The District Water Development Study (DWDS) of Isiolo District is aimed at providing the basis for the District Water Development Plan (DWDP), which in turn will be the sector input to the District Development Plan (DDP).

The study was undertaken by the Ministry of Water Development in its role of supporting the districts in their task to develop the available water resources in a safe and sustainable way. Two conditions will have to be fulfilled to achieve this goal.

- The development of water resources must be in balance both with the capacity of these resources and with the conditions set by the environment.

- Supply of water to the community must be sustainable, meaning that the proposed schemes be designed in agreement with the technical and financial support capability of the people for whom they will be constructed.

These conditions require a thorough assessment of the situation in the districts and a planning that is in tune with the socio-economic, institutional, and technical developments.

The DWDS can be considered the first stage in the process of formulating a DWDP. The study, based on extensive assessments, describes the water resources development potential in comparison to the projected water demand, discusses the viability of different water supply options in terms of sustainability and safety, and provides estimates of the investment levels involved.

The DWDP based on the study will be more specific in that it also comprises the decisions of the district authorities regarding selection and prioritization of the water development schemes. The plan is to cover a period of 20 years, according to MoWD guidelines, starting from 1993 when operation of the first new schemes will supposedly begin. The DWDP will be an important component of the DDP which includes the entire socio-economical planning of the district in perspective to all the available resources. From the above it may be clear that both plans are closely linked and can only be successfully developed in good co-ordination.

The methodology for planning of water resources development, adopted by the Ministry facilitates full participation of the district authorities, community groups and individuals concerned in all stages of the planning process, which is in line with the District Focus Policy. An outline of the general approach is given in Chapter 2 of this report. A summary of the main aspects of the District Focus Policy related to water development planning is presented in Part 1.

In order to provide optimal conditions for district involvement, the DWDS is carried out in three phases. District engineers and institutions concerned with water use and water supply are extensively consulted during the periods of data collection and analysis. The final report includes three volumes, corresponding with the three phases of the study.

The present report is Part 2 of the DWDS carried out for Isiolo District within the framework of WRAP. The report studies the functioning of the existing water supplies in Isiolo District in the broad sense (quantity, quality, reliability, cost, cost recovery, operational staff, management), inventories the cost of various water supply technologies, and compares these costs using a cost effectiveness analysis approach. The objective of the report is to recommend affordable water supply options for the variety of situations encountered in Isiolo District.

1.2 International Co-operation

The District Water Development Study was undertaken under Co-operative Agreement between the Governments of Kenya and The Netherlands.

The studies are carried out by the Water Resources Assessment Section of the Ministry of Water Development, Nairobi, Kenya in co-operation with the TNO Institute of Applied Geoscience, Delft, The Netherlands, within the framework of the **Water Resources Assessment and Planning (WRAP)** project.

Consultancy services were provided by the Netherlands Economic Institute, Rotterdam, The Netherlands and the International Institute for Hydraulic and Environmental Engineering, Delft, The Netherlands.

2. GENERAL APPROACH

The District Water Development Study (DWDS) is a base study for preparation of the District Water Development Plan (DWDP). All components that constitute the DWDP are also covered by the DWDS.

The model introduced by the WRAP project for preparation of a DWDP is shown in figure 2.1. The DWDS follows this model in analysing the various components that finally will lead to the formulation of the DWDP. The study includes three phases focusing on different aspects of the planning, namely:

- the compatibility of available water resources with water demand in the present situation and for projected demand scenarios
- the viability of the technical options for water supply development based on environmental and sustainability criteria
- the investments involved in the district water development and the technical, institutional, social and financial factors determining the sustainability of selected solutions

The results obtained in the subsequent phases of the DWDS are presented in Part 1, Part 2 and Part 3 of the DWDS report, which should provide the district authorities with sufficient base information for initiating further development of the water resources in the District. An outline of the Study is given below.

Water Demand Study (Part 1)

The water demand study comprises of analyses and projections of the water consumption by all water users in the district. The baseline data available from various sources are often incomplete and/or inaccurate. Therefore, thorough scrutiny of the data is needed to ensure sufficient reliability of further analysis. The data is processed using a Database Management System that handles both the calculation of the water demand and the projection of the baseline data.

The water demand is calculated using the procedure laid down in the Design Manual of the Ministry of Water Development. The procedure compels to projecting the water demand in 5, 15 and 25 years time. This, in turn, requires analysis of the growth trends of population, livestock, agriculture, industries, tourism, etc.

It may be clear that the DWDS depends on the input from other sectors, such as livestock and agriculture, to complete the projections in the most realistic way.

Water Resources Assessment Study (Part 1)

Water resources assessment studies are an essential component of the DWDS. The assessment studies undertaken within the framework of the WRAP project comprise the following:

- An inventory of available data and studies on the water resources in the District

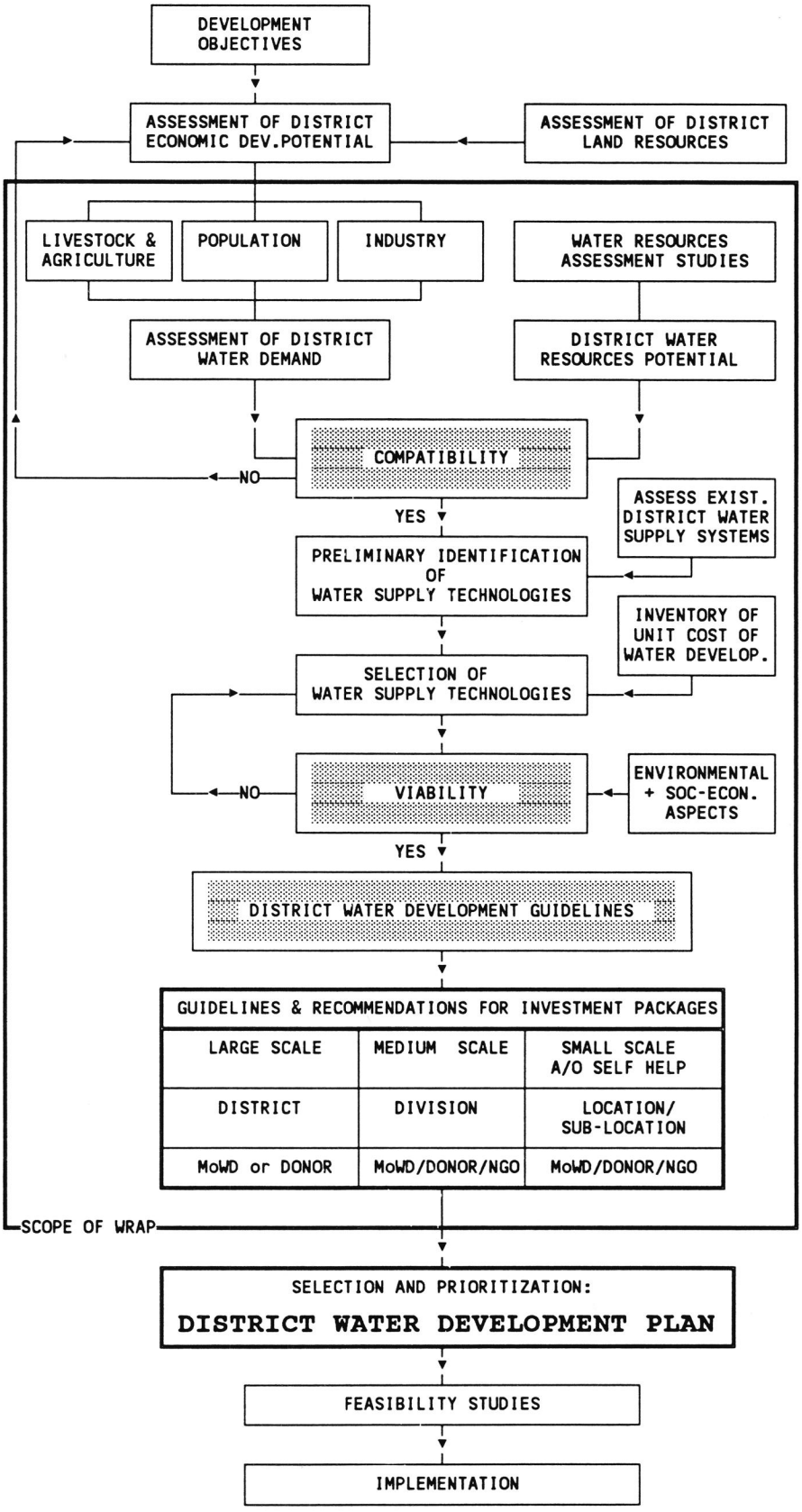


Figure 2.1 Model for Preparation of District Water Development Plan

- A field survey including collection of data on surface water and groundwater, rehabilitation of part of the existing measuring stations and installation of temporary measuring stations. Measurements are made of the quantity and quality of water in rivers, springs, wells and boreholes.

- A geophysical reconnaissance survey using vertical electrical or electromagnetic soundings and profiling, aimed at providing more insight into the hydrogeological conditions. The results of the survey are checked and calibrated by drilling of exploratory boreholes and test pumping.

- An analysis of the geological, geophysical, hydrological and hydrogeological maps and data, both from the inventory and from field investigations.

From all this information and after careful and systematic analysis, water availability maps are prepared which show the water development potential of the area. The water resources assessment investigations are described in a separate report and a summary of the main conclusions on the water development potential is given in Part 1 of the DWDS report.

Comparison of Water Demand and Available Resources (Part 1)

Having estimated the water demand over the next 25 years and the water resources available in the district, a close analysis is made of the water development potential to decide whether the projected water demand can be met.

When comparing the demand with the resources, priorities need to be set whether a district can best support human, livestock, agricultural or industrial development. In this respect both quantity and quality of the water must be considered.

What emerges from this process of comparing the demand with the resources, is a description of the development potential of the District, based on water availability.

Study of Water Supply Development Options (Part 2)

From the actual and projected water demand and the capacity of existing water supply schemes, the need for further development of the water supplies can be determined.

Limited water resources, contrasting interest or expected negative environmental impact may hamper further development. However, in situations with sufficient water available, often more than one supply option can be considered. A selection of the best alternative must then be based on considerations of financial, technical and environmental viability.

Phase 2 of the DWDS includes:

- Assessment of existing district water supply systems
- Assessment of technical options for water supply improvement
- Inventory of unit costs for water development based on existing supplies
- Preliminary identification of water supply options and cost
- Study of cost-effectiveness of water supply options

The results and conclusions are presented in Part 2 of the DWDS report. Together with Part 1 this forms the basis for the 'District Water Development Guidelines'.

Formulation of Guidelines and Recommendations for Investment Packages (Part 3)

The guidelines and recommendations for the development of the district water resources result in proposals for improvement of the existing water supply situation in the District. The proposed improvements may range from very small local supplies to comprehensive water supply schemes. The investments required to improve the water supply situation have been termed investment packages.

The purpose of the investment packages is to present to the Government of Kenya and interested donors a preliminary estimate of the funds and other inputs needed for water supply development. Each investment package or a combination of them can thus form the core of a water supply project.

WRAP has concentrated on investment packages for development of domestic supplies, because livestock supplies are currently planned for by the Isiolo Livestock Development Project of the Ministry of Livestock Development. The investment packages are based on pre-feasibility studies of water supply development in each rural centre of Isiolo District.

Phase 3 of the DWDS includes the following issues:

- Land use, environmental, social, institutional and economic/financial factors to be considered
- Guidelines for assessment of water sector investment proposals
- Pre-feasibility studies of water supply to rural centres
- Recommendations on required institutional strengthening for implementation of the DWDP
- A framework for a proposal based on the investment packages.

The analyses, results, conclusions and recommendations arrived at are presented in Part 3 of the DWDS report. The pre-feasibility studies are presented in a separate volume accompanying the DWDS report.

3. METHODOLOGY

3.1 Introduction

The objective of Part 2 is to recommend affordable and sustainable water supply options for the variety of situations encountered in Isiolo District. The study distinguishes water supply for urban population in large and small trading centres, water supplies for isolated rural institutions and dispersed rural population, and water supplies for livestock.

WRAP has tried to achieve the best possible accuracy of data, but this could not always be fulfilled satisfactorily, because of insufficient quality or incompleteness of the source data. At this stage of the study WRAP considers the presented data as the best possible estimate.

The quality of the DWDP depends on the data on which the Plan is based. Accurate and realistic planning is only possible if reliable baseline data is available. In this respect the assistance from other ministries, local authorities, projects etc. is not only valuable, but also necessary, because the DWDP cannot be prepared without it. WRAP therefore recommends that much attention is given by all government ministries to the collection and dissemination of up-to-date baseline data.

The descriptions of the supply technologies remain only superficial in the present study, because already sufficient publications exist where detailed information on these can be found. However it would be useful to have a publication accompanying the DWDP which provides descriptions and designs of the technology options. Such a publication may be an update of McPherson et al (1984), which contains a very useful description of the low cost water supply technologies in Kenya. This publication contains also evaluations of implemented projects and gives proposals for new water supply projects.

3.2 Study of Existing Water Supplies

The objective of the study of existing water supplies is to analyse the condition and effectiveness of the supplies, in order to recommend the appropriate technologies for water supply development in Isiolo District.

The study of the existing water supplies in the District comprises:

1. A technical description of the water supplies
2. An analysis of the service level and functioning of the water supplies
3. A financial analysis of the water supplies
4. An analysis of the institutional arrangements

The information necessary for the study was collected at the District Water Office and at the water supplies. The main source of information at the District Water Office were the monthly Operational Charts of the MoWD water supplies. The charts consist of four sections.

Section 1: Provides quantities of chemicals used and water quality data
Section 2: Provides the number of pumping hours and fuel consumption
Section 3: Provides the number of connections and total quantities of water produced and water sold.
Section 4: Provides the operational costs, consisting of chemicals, fuel, salaries/wages, overheads, etc.

Examples of the charts are included in Appendix 1. Although the charts are the official record of a water supply, still care must be exercised in using the information. Operators or pump attendants usually fill the charts, but their data may be incomplete or inaccurate, because the usefulness of reliable information is not perceived by them.

3.3 Selection of Water Supply Technologies

The objective of the analysis of the supply options is to select the appropriate water supply technologies which suit the conditions prevailing in Isiolo District.

The analysis of feasible water supply options for Isiolo District depends on the conclusions which can be drawn from the source options and the functioning of the existing water supplies, taking into consideration that the selected water supply system should give the community the highest service level that it is willing to pay for, will benefit from and has the institutional capacity to sustain.

The main considerations in the selection of water supply technologies are:

- the different water users in the district, which can be distinguished in:
  - urban areas >10,000 population
  - rural centres <10,000 population
  - rural institutions (schools, health centres, etc.)
  - dispersed rural population mainly herders
  - industries
  - tourist lodges
  - livestock
  - wildlife
  - agriculture
- the distribution and user related character of the water demand:
  - urban areas: supply mainly through individual connections
  - rural centres: supply by combination of individual connections and communal water points
  - rural institutions: supply specifically for institution and possibly also for nearby rural population
  - dispersed rural population: supply to market centres and rural homes
  - industries and tourist lodges: large point supply of high required reliability
  - livestock: supply for sedentary and for moving animals
  - wildlife: supply for free moving animals
  - agriculture: supply for irrigation

- the type of water sources in the district

  . few perennial rivers and springs
  . generally low rainfall areas
  . poor groundwater potential in many areas, due to unsuitable water quality.
  . good groundwater potential in volcanic areas

- the poorly developed physical infrastructure, resulting in poor accessibility and serviceability of water supply systems

- the limited availability of local staff with adequate training in operation and maintenance of water supplies

- the problems related to the effective recovery of investment costs and costs of operation and maintenance.

The present study does not cover all water users as yet:

. irrigation is using flood waters, which availability is not a restriction,

. industries are expected to be supplied through existing supplies or organize their own supply, therefore no separate industrial water supplies are planned for,

. tourist lodges usually organise their water supply independently, therefore these are not included,

. wildlife uses natural water resources, which are abundant in the Game Reserves.

3.4 Cost of Water Supply

The objective of the cost study is:

- to provide estimates of capital costs and operation and maintenance costs for each selected water supply technology
- to enable a cost effectiveness analysis to determine the lowest cost technology
- to provide unit costs of supplies per m^3 produced and per beneficiary for the determination of costs of investment packages.

The cost study on capital costs included:

- The collection of construction costs of complete water supplies or supply components, which can be obtained from contracts, quotations, design reports, project documents, annual project reports, etc.
- The collection of data on design capacities and number of beneficiaries
- The determination of cost per head of population or per m^3 supplied for completed water supply systems

The collected costs were updated to the 1991 price level by using price index figures obtained from the Central Bureau of Statistics.

The costs of O & M were estimated on the basis of information from the Design Manual of the MoWD or from publications. The aspects of O & M are described in paragraph 6.4 for each technology.

The type of water supplies for which costs were obtained are:

1. Domestic water supply (incl. water for livestock kept at the homes):

    a) Conventional surface water supply (intake, treatment, storage, distribution)
    b) Conventional groundwater supply (wells or boreholes, treatment, storage, distribution)
    c) Drilled and dug wells with electrical or diesel pumps, hand pumps, windmills and solar pumps
    d) Infiltration galleries with a collector well.

2. Livestock water supply:

    a) Dams
    b) Pans
    c) Boreholes

The system components for which costs were obtained are:

1. Water treatment plants (type, capacity)
2. Pipelines (for various diameters)
3. Reservoirs (elevated, ground level)
4. Spring captations
5. Drilled and dug wells
6. Hand pumps, windmills, solar pumps

Cost estimates for irrigation systems were not included. It is considered that the planning of irrigation systems must be done primarily from the Ministry of Agriculture and cannot be done by the Ministry of Water Development alone. As the time did not allow to coordinate this issue with the Ministry of Agriculture, the planning of irrigation systems was not included in this study.

The cost study comprises a cost effectiveness analysis in which the different costs and benefit patterns are compared using the technique of discounting. This refers to the process of transferring future values into present values. The objective of the cost effectiveness analysis is to compare the economics of the different supply technologies to determine the lowest cost technology. Only direct costs are taken into account, which are incurred in establishing, operating and maintaining the water supply. Derived costs, such as costs of land degradation due to a water supply, are not considered. On the benefit side only the water produced is included. Benefits such as improved health of the population are not considered.

4 STUDY OF EXISTING WATER SUPPLY

The assessment of the existing water supplies in Isiolo District includes a technical description, and an analysis of the supplies in terms of the service level, the functioning of the systems, the financial performance and the institutional aspects. The description here concentrates on the supplies to the urban and rural centres in the District. Table 4.5 gives a summary of the existing supplies. Detailed information on each of the twenty rural centres is available also separately in the pre-feasibility studies.

4.1 Technical Description

The improved water supplies in Isiolo District are mainly piped systems, drawing water from boreholes. Isiolo and Kinna are the only water supplies that have surface water sources, while Modogashe has an infiltration gallery source. It is only at Isiolo (electric pumping), Sericho (solar) and Ngare Mara (windmill) where diesel pumping is not used. Numerous unprotected seasonal handdug wells exist in the seasonal rivers and they are an important source of water for both the nomadic pastoralists and their livestock.

4.2 Service Level

Drinking water is supplied through communal water points, kiosks, and house connections (metered or un-metered). The number and type of service connections is known for 4 supplies, however the number of beneficiaries per unit can only be estimated. The number of beneficiaries per connection ranges from 10 (Isiolo Water Supply) to 43 (for Garba Tula Water Supply) for the four water supplies with complete data.

Water production is on record for 1 urban scheme and 3 rural schemes. The average water production is per beneficiary is 21 lpcd. The figures are low, but this may be due to an overestimation of the number of beneficiaries, who being mostly nomadic are not always present at the centre. The availability of fuel and the poor working condition of the systems also contribute to the low per capita water production.

Table 4.1 Estimated Supply and Service Level

Name of Water Supply	Production (m^3/yr)	No. of Beneficiaries	Average Water Production per Beneficiary (lpcd)	No. of Connections		Number of Beneficiaries per Connection
				Metered	Non-Metered	
Isiolo	110,000	15,000	20	1,510	-	10
Garba Tula	45,000	5,600	22	73	58	43
Merti	26,000	3,000	24	96	-	32
Kulamawe	13,000	1,500	24	39	-	39
Total	194,000	25,100	21	1,718	58	14

4.3 Functioning of the Systems

Isiolo Water Supply was in good working condition throughout 1989 and was only stopped once due to interruption of electricity supply. Although it is on record that Garba Tula had 40 days without pumping, Merti 5 and Kulamawe 5 the number of pumping hours in a day are normally below what would be required to satisfy the water demand. This was understood to be due to lack of diesel. The long distances between the rural centres and the poor accessability has at times contributed to the delay in provision of spares.

4.4 Financial Performance

The financial records are only available for the four MoWD water supplies. The financial records include operation costs, and revenue billed and collected. Costs of maintenance and repairs could not be obtained.

Table 4.2 Cost Recovery in Existing Water Supplies

Name of Water Supply	Annual Operation Cost (Shs)	Annual Revenue (Shs)		Ratio of Revenue Collected to Operation Costs
		Billed	Collected	
Isiolo	674,000	1,300,000	807,000	1.20
Garba Tula	74,000	90,000	28,000	0.38
Merti	40,000	52,000	10,000	0.25
Kulamawe	84,000	24,000	16,000	0.67

Table 4.3 Unit Cost of Operation

Name of Water Supply	Population	Water Produced (m^3/year)	Operation Cost (Shs/year)	Annual Operation Cost per Beneficiary
Isiolo	15,000	110,000	674,000	45
Garba Tula	5,600	45,000	74,000	13
Merti	3,000	26,000	40,000	13
Kulamawe	1,500	12,000	84,000	56
Total	25,100	193,000	872,000	Average 35

Revenue billed and collected in Isiolo Water Supply covers the operation costs. At Garba Tula and Merti only the revenue billed covers the operation cost but the revenue

collected is less than half the amount required for operation. At Kulamawe both the revenue billed and the revenue collected are lower than the operation cost.

The average operation cost per beneficiary is calculated to be 35 Kshs per year while the average cost per m^3 produced is 4.5 Ksh.

4.5 Institutional Aspects

Water committees have been set up in most of the rural centres where the MoWD does not own or operate a water supply. The water committees manage their water for livestock and domestic use by applying the Borana customary law (see chapter 5). Modern supplies (e.g. at Sericho and Kulamawe) are run successfully by the water committees. Sericho has one water attendant employed by the community while the attendants at Kulamawe are Government employees. The community at Kulamawe supplies the diesel.

For the MoWD Water Supplies the number of water supply attendants are 24 deployed as shown in table 4.4. The district and divisional personnel supervises and supplies spares for these water supplies. It would appear that the water supplies are under staffed, but except for Isiolo Water Supply the annual water production in the schemes is low, either due to the limited source capacity or problems in diesel supply.

Table 4.4 Staffing of MoWD Operated Water Supplies

Name of Water Supply	Number of Beneficiaries	Number of Site Staff	Number of Site Staff Per 1000 Beneficiaries
Isiolo	15,000	10	0.7
Garba Tula	5,600	5	0.9
Merti	3,000	4	1.3
Kulamawe	1,500	4	2.7
Modogashe	7,000	1	0.1

Table 4.5 Existing Domestic Water Supplies in Isiolo District

Population Centre	Population Estimate 1990	Type of Existing Water Supplies	Existing Supply Capacity (m^3/day)	Storage (m^3)	Approximate Length of Pipe work (m)	Working Condition
Isiolo Town	15,000	Intake with electr. pumps	300	200	10,000	Fair
Ngare Mara	1,200	Borehole w. diesel pump	(10)	50	1,000	Fair
Kipsing	1,420	Well with diesel pump	(10)	1.5	500	Poor
Oldo Nyiro	2,000	Sand dam, diesel pump	(15)	250	1,000	Poor
Garba Tula	5,600	Borehole w. diesel pump	60	100	8,000	Fair
Bibi / Duse	1,800	Dug wells	-	-	-	Poor
Kinna	2,500	Spring		5	2,000	Poor
Boji	700	Dug wells	-	50	200	Poor
Gafarsa	1,000	Seasonal dug wells	-	15	-	Fair
Kulamawe	1,500	Borehole w. diesel pump	72	50	200	Poor
Malka Daka	1,100	Seasonal dug wells	-	-	1,000	Poor
Bisan Biliku	1,500	Seasonal dug wells	-	-	-	Poor
Dadacha Bassa	1,400	Seasonal dug wells	-	-	-	Poor
Malka Galla	1,600	Seasonal dug wells	-	-	-	Poor
Bulesa	1,700	Seasonal dug wells	-	-	-	Poor
Korbesa	1,800	Seasonal dug wells	-	-	-	Poor
Merti	3,000	Borehole with Diesel pump	60	50	7,000	Poor
Eldera	1,250	Seasonal dug wells	-	100	-	Poor
Modogashe	7,000	Well with diesel pump	120	-	1,000	Poor
Iresa Boru	1,600	Seasonal dug wells	-	-	-	Poor
Sericho	1,500	Borehole with solar pump	30	75	4,000	Good

( ) approximate capacity

5. WATER SUPPLY DEVELOPMENT TECHNOLOGIES

5.1 Need for Improved Water Supply

The infrastructure in Isiolo District is governed by the seasonal grazing movements of the pastoralists. Improved domestic water supply development is mainly in the dry grazing areas and on stock routes. Population concentrations during the dry periods have led to the establishment of rural centres where commercial activities have started. The presence of water, construction of schools, police posts, health centres and other infrastructure have enabled permanent settlement, where population varies seasonally.

Except for two water supplies (Isiolo and Kinna, which have surface water sources) all the others have either borehole sources or use unimproved traditional hand dug wells along seasonal rivers. Isiolo water supply is the only supply with treatment facilities.

A fair reticulation system exists at Isiolo, Garba Tula and Merti. All the other supplies can be considered to be point sources with insufficient communal water points.

Operation and maintenance is difficult due to the long distances between the District Headquarters, the poorly developed infrastructure and the limited Government funding. Some NGO's mostly religious organisations assist in running some of the water supplies. Likewise financial analysis indicates that the Government subsidises heavily on operation and maintenance on all the improved water supplies in Isiolo District, except Isiolo water supply.

This DWDS shall concentrate on the proposals for the provision of domestic water supply to the established and proposed rural centres of Isiolo District. It is recommended that appropriate low cost and low yielding water supplies be incorporated in all livestock water development programmes to cater for the herders. An example of such a supply is the construction of a protected hand dug well equipped with a handpump next to a water conservation pan.

5.2 Organisation and Attitude

As stated in the last section the proposals of Water Development shall concentrate on the rural centres in Isiolo District. In order to come up with suitable recommendations adequate knowledge of the people living in the project area and its surrounding is necessary. In carrying out this exercise a lot of information has been obtained from sociology studies undertaken by the Isiolo Livestock Development Project (see District Livestock Production Office, 1991).

The major ethnic group in Isiolo is the Borana, followed by Somali, Turkana and the Samburu. These nomadic pastoralists form 86% of the District population. The Borana are the majority ethnic group and with the recent expulsion of Somali herders from the District, the rural population is composed almost entirely of Boranas.

The Borana are organised into a clan leadership system composed of customary officers who govern through the use of their own customary laws and the legal statutes of Kenya. In practice the customary law tends to prevail in the lives of the pastoralists.

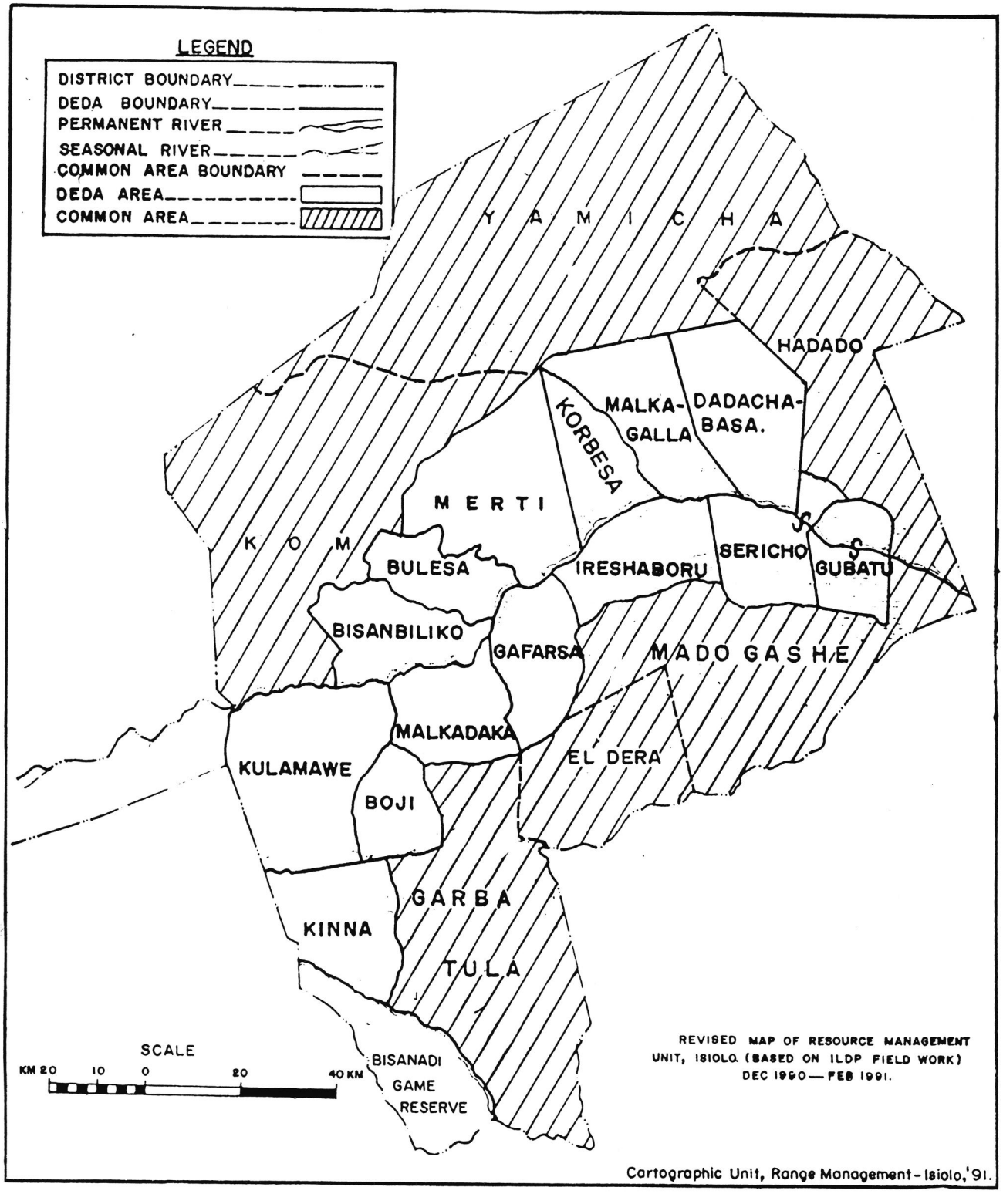


Figure 5.1 Resource Management Units
from ILDP

Customary law covers the digging, maintenance of hand dug wells and these traditional water sources are under control of an aba hirega. He allocates access time and sequence to the various herds using a water source, and maintains orderliness and cleanliness. The same management principle is evolving at boreholes, such as at Kula Mawe, where a committee organises revenue collection and watering procedure.

In principle there is controlled management of dams, including the enforcement of herdowners removing animal dung from the banks up to high water level, but in practice control is seldom possible owing to undefined ownership or responsibility.

The Ewaso Ngiro has particular access points known as malka for stock watering. No particular customary laws govern the use of a malka, but no problems over their use normally arise.
The neighbourhoods who use the same pasture or other common resources, who share the same clan leaders, whose children go to the same school, and who reserve the same grazing area for the milk herds that supply the school children, are known as dedowan (sg deda). Deda areas have wet and dry grazing areas and it is in the dry grazing areas that population centres have been established.

In contrast to the deda areas, with their stable communities, are the common grazing areas adjoining many of the district boundaries. These are areas with no permanent or habitual camps and are used opportunistically by herds from various dedowan as well as by large numbers of stock from the adjacent districts.

Several different categories of poverty emerge among the pastoral society. The poorest group is found mainly on the fringes of the towns and is the destitute population of the completely stockless. The next category is still in or on the edge of the pastoral economy but with herds well below the minimum necessary for independent pastoral production. Female headed households have been found to be disproportionately represented in the lower wealth categories. The wealthiest category had the biggest household sizes, and included all the members of prestigious social status like the camp leaders.

The minimum viable herd for a household is estimated to be 5 tropical livestock units, which is equivalent to approximately 50 sheep and goats or 7 cattle, or a combination. These figures correspond to the number of livestock in the poorest households that are considered viable. They also correspond to the 40 - 50 small stock considered necessary by the Garba Tula Catholic Mission restocking project to start a new viable household in pastoralism. The Boran view is that the betume, or the herd needed to start an economically independent household, consists of a unit of 5 cows and a bull.

Differences in livestock holdings have implications for livestock management. Large herds tend to move less often and prefer high capacity water points (e.g. dams, boreholes), whereas small herds are more mobile and satisfied by small water sources (e.g. wells, springs).

5.3 Considerations for Technology Choice

The definition of technical options for the extension of water supply coverage should be placed within the context of the Isiolo situation, as described in the previous paragraphs.

Major considerations in developing water supply are the following:

1. The limited source options: at many places the possible sources are confined to shallow groundwater; deep groundwater or surface water are available only at a few centres;

2. Poorly developed physical infrastructure, resulting in poor accessibility and serviceability of water supply systems (e.g in terms of fuel and spare parts supply and repairs);

3. Limited availability of local staff with adequate training in operation and maintenance of water supplies;

4. The small size of the rural centres, and the extremely low density of the rural population.

5. Limited chances of effective cost recovery

In view of the above characteristics the technologies to be selected should be confined to those with minimum operation and maintenance requirements.

5.4 Technology Choice

The sources for water supply development in Isiolo District have been recommended in Part 1. The proposed development of the water resources was determined according the following assumptions:

1. The development of groundwater (and springs) is preferred to the development of surfacewater for reasons of water quality and of supply reliability during drought situations.

2. Rural domestic demand is supplied from springs (if present), groundwater (boreholes or wells) or rainwater (roof catchments). The use of these sources ensures the best possible water quality, with no or little treatment required.

3. Urban domestic demand (Isiolo Town) is supplied from surface water in combination with groundwater. Water supply is required in greater quantities than for rural domestic supplies, while a combination of sources improves the reliability of supply. Treatment is required for surface water.

4. Rural non-domestic (livestock) demand is supplied from springs, surface water or groundwater. If possible surfacewater and groundwater are used in combination on a 50-50% basis. In some areas sources are naturally available from rivers, streams, springs or depressions.

The technical options recommended for the provision of water supply based on the above consideration are shown in table 5.1 and 5.2 for the various supply categories:

Table 5.1 Suitability of Technologies for Domestic Water Supply

Domestic Water Supply Development Options				Suitability 1) for Supply Category 2)		
Source Development		Water Supply Development				
Source	Technology	Water Distribution	Technology	1	2	3
Ground-water	Borehole or Dug Well or Infiltration Gallery	Single outlet 3)	Hand pump	-	+	++
			Windmill + Storage	-	++	+
			Solar pump + Storage	-	++	+
			Diesel pump + Storage	-	++	+
		Multiple outlet	Windmill + Storage + Distribution System	-	+	-
			Solar pump + Storage + Distribution System	-	+	-
			Motor pump + Storage + Distribution System	++	+	-
	Spring Protection	Single outlet	Storage	-	+	+
		Multiple outlet	Storage + Distribution System	+	-	-
Rain water	Roof Catch-ments	Single outlet	Gutters + Storage	+	++	++
	Rock Catch-ments	Single outlet	Storage	-	+	+
		Multiple outlet	Storage + gravity distrib.	-	-	-
Surface water	Sub-surface dam + dug wells	SEE ABOVE FOR DRILLED/DUG WELL				
	Direct intake	Multiple Outlet	Motorized pumps, treatment, storage, distribution	++	-	-

Notes: 1) Suitability: (-) not suitable, (+) suitable, (++) very suitable

2) Supply category: 1. Urban Centre
2. Rural Centre
3. Rural Institution

3) Single outlet may be a communal water point/kiosk, or a single line with some CWP's or kiosks

Table 5.2 Suitability of Technologies for Livestock Water Supply

Livestock Water Supply Development			
Source Development		Water Supply Development	Suitability
Source	Technology		
Groundwater	Borehole or Dug Well or Infiltr. Gallery	Hand pump	-
		Windmill + storage + trough	+
		Solarpump + storage + trough	+
		Motorpump + storage + trough	+
Rainwater	Deepening Depressions	-	++
	Dam Construction	Fencing + troughs	+

The use of solar pumps has already proven to be successful in Sericho. However the output of the solar pump may not always be sufficient to cover the demand or may be restricted at times of cloudiness. It is therefore recommended to use solar pumps in combination with electrical submersible pumps driven by a generator. One borehole may accommodate both pumps if the diameter is 6 inch or more.

For rural areas, provided suitable precautions are taken to avoid source contamination, one source could provide for domestic supply through a communal water point and for livestock watering through troughs. Joint source development may be very cost-effective.

Summarizing the above, the technologies to be considered would be as shown below.

Table 5.8 Recommended Technologies for Various Types of Users

Population of Rural Centre	Source Development	Water Supply Development 1)	Feasi-bility 2)
Urban Area	Boreholes	Motorized Pump, Storage, Distribution	++
	Surface Water Intake	Treatment, Storage, Distribution	++
Rural Centres Large size	Boreholes	Solar/Diesel Pumps, Storage, Distrib.	++
	Infiltration Galleries	Solar/Diesel Pumps, Storage, Distrib.	++
	Roof Catchment	Gutters, storage (individual)	+
	Rock Catchment	Storage	+
Rural Centres Small size Rural Centres	Borehole	Solar/Diesel Pumps, Storage, Distrib.	++
	Infiltration Galleries	Solar/Diesel Pumps, Storage, Distrib.	++
	Borehole	Windmill, Storage, Distribution	++
	Roof Catchment	Gutters, storage (individual)	++
	Spring Protection	Storage, Distribution	+
	Rock Catchment	Storage	+
Rural Institution	Dug/Drilled wells	Hand pumps (small units)	++
	Dug/Drilled well	Windmill + storage (large units)	++
	Roof Catchment	Gutters, storage (individual)	++
	Rock Catchment	Storage	+
Rural Livestock	Deepening Depressions	-	++
	Dam construction 3)	Fencing, trough	+
	Dug/Drilled well 3)	Windmill, storage, trough	+
	Dug/Drilled well 3)	Solar Pump, storage, trough	+
	Dug/Drilled well 3)	Motor Pump, storage, trough	+

1) Development shown in decreasing order of suitability for each type of supply area
2) Feasibility with regards to availability of water resources:
(-) not feasible, (+) feasible, (++) very feasible
3) May be used also for supply of rural population, provided adequate measures are taken

6. COST OF WATER SUPPLY

A cost estimate which includes the capital (construction) cost and operation and maintenance cost has been done for each of the twenty one rural centres. This has been based on the water supply technologies possible for each centre. These costs have been used for determining unit costs per m^3 of water produced per beneficiary.

Information on costs was obtained from the Planning and Design Division of the Ministry of Water Development Nairobi and various suppliers. A location factor was also included Isiolo being very far from the principal suppliers in Nairobi.

6.1 Description of Cost Estimates of Water Supply Technologies

At this stage of planning, cost estimates need only be indicative, as the objective is only to provide a rough estimate of the cost of water development in each of the rural centres. The estimates of construction cost given here were considered to include the following items:

- Cost of materials
- Cost of skilled and unskilled labour
- Cost of transport and
- Cost of depreciation of construction equipment

It is often difficult to compare he costs from different sources for a similar water supply or water supply component, because these costs are usually not compatible. This is mainly due to several factors, the most important being:

- differences in designs: apart from differences in the structural designs, also different makes of handpumps, motorpumps, etc. are being used. Sometimes materials are imported by the project (duty free).

- level of community participation: the local community is normally involved in the construction, but their required contribution, in terms of materials, labour or transport may differ. The costs of this contribution is usually not specified.

- allocation method of labour costs: labour provided by the community is sometimes paid for, but often provided free of charge. The free labour however should also be included as costs, because it must be treated as if it is a financial contribution by the community.

- allocation method of overhead costs: overhead costs differ greatly from project to project, but are often also allocated differently to the construction costs. The costs of expatriate assistance or of materials bought with overseas funds is sometimes not included in the overhead costs.

The DWDS has tried to use appropriate designs by determining the typical properties and components of the water supply technologies specific for Isiolo District, and to obtain separate cost estimates for these components.

Table 6.1 Development Costs of Domestic Water Supply

Supply	Source Development	Water Supply Development	Initial Capital Cost (Shs) 1)			Annual O&M Cost (Shs)	Capital Cost/ Capita (Shs)	Annual Cost/ Capita (Shs)	Capital Cost/ m^3/day (Shs)	Annual Cost/ m^3/day (Shs)
			Source Develop.	Supply Develop.	Total Cost					
300 m^3/day Pop. 7,000	Infiltration Galleries	Diesel pump	2,375,000	8,460,000	10,835,000	370,000	1,554	53	36,000	1,230
	Infiltration Galleries	Diesel pump, solar pump	2,375,000	9,110,000	11,485,000	340,000	1,640	49	38,280	1,130
100 m^3/day Pop. 3,000	Boreholes (2, 40 m.)	Diesel pump	300,000	5,170,000	5,470,000	208,000	1,823	70	54,700	2,080
	Boreholes (2, 40 m.)	Diesel pump, solar pump,	300,000	6,170,000	6,470,000	196,000	2,157	65	64,700	1,960
	Infiltration Galleries	Diesel pump	800,000	4,610,000	5,410,000	120,000	1,803	40	54,100	1,200
	Infiltration Galleries	Diesel pump, solar pump	800,000	5,610,000	6,410,000	108,000	2,137	36	64,100	1,080
50 m^3/day Pop. 1,500	Borehole (40 m.)	Diesel pump	150,000	2,860,000	3,010,000	96,000	2,007	64	60,200	1,920
	Borehole (40 m.)	Diesel pump, solar pump,	150,000	3,655,000	3,705,000	84,000	2,470	56	74,100	1,680
	Borehole (80 m)	Windmill	300,000	3,035,000	3,335,000	72,000	2,223	48	66,700	1,440
	Borehole (80 m)	Diesel	300,000	2,985,000	3,285,000	112,000	2,190	75	65,700	2,240
	Infiltration Galleries	Diesel pump	400,000	2,575,000	2,975,000	84,000	1,983	56	65,700	1,680
	Infiltration Galleries	Diesel pump, solar pump	400,000	3,235,000	3,635,000	74,000	2,423	50	72,700	1,480
5-10 m^3/day Pop. 250	Dug Well (10 m)	Handpump	50,000	30,000	80,000	600	320	3	10,700	400
	Borehole (40 m)	Handpump	150,000	30,000	180,000	3,000	720	12	24,000	400

Price level: 1991

Notes: 1) For detailed estimates of capital costs, see Appendix 3.
2) Indicative cost estimate, because this depends very much on local conditions.

Table 6.2 Development Costs of Livestock Water Supply

Source Development	Water Supply Development	Initial Capital Cost (Shs)			Annual O&M Cost (Shs)
		Source Develop.	Supply Develop.	Total Cost	
Borehole (150 m.)	Diesel pump, 50 m^3 storage tank, Cattle trough	562,500	588,000	1,150,500	10,000
Borehole (40 m.)	Diesel pump, Tank 50 m^3 Storage Tank Cattle Trough	150,000	588,000	738,000	6,200
Borehole (150 m.)	Windmill, Storage Tank, Cattle Trough	562,500	638,000	1,200,000	7,000
Borehole (40 m.)	Windmill, 50 m^3 Storage Tank, Cattle Trough	150,000	638,000	788,000	4,600
Pan (20000 m^3)	Fence, cattle trough	1,600,000	100,000	1,730,000	7,200

The construction costs of each component were analysed and finally cost estimates were determined of the complete water supply options, which are applicable to the conditions in Isiolo District (Appendix 3). The costs are summarized in table 6.1 and 6.2.

The capital costs do not include overhead costs, such as depreciation of vehicles, costs of office staff or expatriate staff. The costs include 10% contingencies.

The typical properties and components of the water supply options for Isiolo District are described in the next paragraphs by separating source development and water supply development. The description of the source development also includes a summary of the average properties of the water sources in Isiolo District (see also chapter 6 of Part 1).

6.2 Source Development

Surface Water Intake: This normally consists of a weir constructed across a perennial river. The cheapest abstraction is by gravity but pumping is used where the topography does not allow. In Isiolo District only few perennial rivers occur, this alternative source is not a general option and therefore its unit costs were not determined. However the cost estimate of an average weir including diversion box and including fittings can be estimated of 300,000 Shs.

Springs: The only spring with sufficient discharge that could be developed in Isiolo is at Kinna. More details are included in the pre-feasibility study reports.

Dug Wells: Shallow wells (or hand drilled tube wells) are feasible in areas, where sedimentary deposits exist near surface water channels. They can also be considered as means of water quality improvement as for example as off-takes in pans and dams. Shallow well siting for natural aquifers should be undertaken by specialists. Inner lining of wells may be done with rings of brick, stone or concrete rings precast or cast in situ, etc. The wells must be protected from pollution by a well cover. Abstraction of water

may be done by a windmill, a hand pump or by other means.

Cost estimates of dug wells fitted with hand pumps were available from LBDA, SIDA and FINNIDA. The construction cost is about 60,000-80,000 Shs, which means a unit cost of about 300-400 Shs/capita. The unit cost determined for Isiolo District is 320 Shs/capita (Appendix 3). These costs do not include survey costs to determine the location of the well, which may give additional costs of about 10,000 Shs.

Drilled Wells: Drilled deep wells or boreholes are feasible at several locations in Isiolo District. The abstraction method depends on the demand, but can be either by motor pump, windmill or hand pump. Well siting should be undertaken by specialists, if possible using geophysical techniques.

The unit cost of borehole drilling, casing, development, testing, etc. (no pump) depends on the local conditions and number of boreholes to be drilled. Appendix 2 contains some cost estimates. For the DWDS a unit cost of 3,750 Shs/m is applied.

Cost estimates of boreholes fitted with hand pumps were available from LBDA, SIDA, FINNIDA and PENCOL. The costs vary considerably, mainly due to the depth of drilling. The construction cost adopted for Isiolo District was based on boreholes with a depth of 40 m and of 80 m (Appendix 3). The cost estimate does not include survey costs to determine the location of the borehole, which may give an additional cost of about 10,000-25,000 Shs or more.

Sub-Surface Dams And Sand Dams: In seasonal flow rivers, water extraction in the dry season may be improved by building a structure across the river bed under the surface to retain the sub-surface flow. Water is generally withdrawn through infiltration drains and large diameter wells up-stream of the sub-surface dam. Suitable sites often coincide with a natural barrier in a river such as a rock outcrop or impervious material in the river bed. This type of sub-surface dam has proved successful in many parts of Kenya. This method may be useful especially in areas where groundwater outside the river sediments is saline or has a high fluoride concentration.

Sand dams are useful in semi-arid areas where flood water carries a high silt load and evaporation is high. The dam should be built in stages to ensure the deposition of sand and gravel. However, often this construction in stages is ignored.

The potential for sub-surface dams or sand dams was not investigated by WRAP. But at the twenty rural centres covered in the pre-feasibility studies suitable sites for sub-surface or sand dams exist only in the Basement area, such as at Kipsing or at Oldo Nyiro. The unit cost was not determined, but cost estimates obtained from other studies (PENCOL, GSK) indicate a unit cost of 1,500 Shs/capita. It is not clear whether costs of dug wells are included. More study of this technology is needed, to determine the feasibility in Isiolo District and the associated construction costs.

Infiltration Galleries: Infiltration galleries are made of pipes, gravel or other pervious material and buried across (seasonal) rivers, sometimes in combination with a sub-surface dam. The galleries tap the shallow groundwater in such rivers and are connected to collector wells constructed on the banks. The water is pumped from these wells to the supply point. The use of infiltration galleries in wide channels such as the Ewaso Nyiro or the Galana Gof may make a sub-surface dam unnecessary, because the groundwater will stop flowing in downstream direction due to lowering of the groundwater table.

Cost estimates for infiltration galleries were not available. An estimated unit cost of 8,000 Shs per m^3/day was used for Isiolo District.

Rock and Roof Catchments: Rock catchments are simple in nature. Siting should take into account community access and geological structure. The best sites are found on lower reaches of bare rock inselbergs which minimise runoff loss to soil, vegetation and fractures. Storage may be provided behind dams, because generally a large storage is required (see table 6.3). The required catchment area depends on rainfall quantity and variability, but often the available area is limited due to the local conditions.

Roof Catchments for schools and other institutions where extensive roof corrugation exists, and which include guttering and ground storage tanks, may offset the water supply problem considerably. The length of dry periods must be considered in the design of the tank. First water from each shower should be prevented from entering the storage to reduce pollution by dust, leaves and bird droppings on the roof.

The required surface area and storage for rainwater harvesting can be estimated roughly with formulas provided in the MoWD Design manual. The 90% - probability annual rainfall is used.

The required sizes of storage and area indicate that in many cases rainwater can only be used as an additional drinking water source (Eg. a school with 400 m^2 roof area could supply 175 people every day with only 1-2 litre drinking water). With rock catchments the required storage capacity can only be obtained behind small dams (this solution is used frequently in Kitui District).

Table 6.3 Required Area and Storage of Rainwater Catchments

Continuous Demand (m^3/day)	Storage Tank (m^3)	250 mm rainfall		600 mm rainfall	
		Roof Area (m^2)	Rock Area (m^2)	Roof Area (m^2)	Rock Area (m^2)
1	120	2,250	3,600	940	1,500
5	600	11,250	18,000	4,690	7,500
10	1,200	22,500	36,000	9,375	15,000
20	2,400	45,000	72,000	18,750	30,000

Notes:

1) Storage capacity = 0.03 x Demand x (T + 2)
T = longest dry spell = 2 months

2) Surface Area = (450 x Demand) / coef x 90% - rain
coef = 0.8 for roof catchments and
0.5 for rock catchments

It was not possible to obtain good cost estimates on rock catchments. Costs of these depend very much on the local conditions. The feasibility of rock catchments is insufficiently known in Isiolo District. Therefore more study is needed of this technology especially at Kipsing and Oldonyiro.

Small reservoirs (< 10,000 m^3) can usually be constructed with small earth-moving equipment. They are relatively cheap and not difficult to operate and maintain. Site selection must be done by qualified personnel. Earth dams need proper catchments (conservation measures are often needed as a pre-condition). Siltation is almost inevitable if no measures are taken. Evaporation in the reservoirs is usually high.

Spillways must be properly designed to prevent erosion and overtopping of the dam. The site must be properly selected to have maximum storage and should not have leakages. Care should be taken to prevent mosquito and snail breeding.

Fencing of the reservoir and dam site is necessary to prevent pollution and erosion by livestock. For domestic consumption, a shallow well at the foot of the dam where some seepage occurs, may be constructed which will draw reasonably clean water. Alternatively an off-take structure may be constructed in the lower part of the reservoir connected to a filter structure with a hand pump.

A rough estimate was made of total costs based on rates obtained from dam construction in Samburu District (DCU5). The unit cost per m^3 was taken as 80 Shs/m^3.

- Small dams/pans (5,000 m^3): 400,000 Shs
- Medium earth dams (25,000 m^3): 2,000,000 Shs

6.3 Supply Development

Hand pumps: These are easy to install and are not expensive. Hand pumps require regular, sometimes skilled maintenance, which if well organised, improves considerably the reliability of operation. Hand pumps can pump water from a maximum depth of 60 m, but generally the water level should be less to assure a reasonable yield and to reduce the wear and tear of the pump. The yield of the well or borehole should be between 0.5 and 2.0 m^3/hr (or more). An average person can draw the following quantities from a well:

Dynamic water level (m)	5	10	20	30	40	50
Yield (m^3/hr)	3.5	2.0	1.0	0.8	0.65	0.5

Source: (IHE, 1988)

The most common types of hand pumps installed in Kenya are:

Shallow depth - NIRA (Kefinco), SWN (LBDA)
Medium depth - Afridev (Kefinco, Kwale), SWN (LBDA)
Large depth - India Mk II (Kefinco)

The Afridev and India Mk II are manufactured locally (e.g by WECO in Kakamega for Kefinco). The Afridev pump costs 14,000 Shs ex works at Nairobi. The SWN pump used by LBDA costs, including installation 14,000 - 32,000 Shs, depending on the depth of the water (Appendix 2).

Windmills (Pumps): Wind is free, therefore windmills are relatively cheap in operation. But windmills are expensive to install. They may be combined with a hand pump so that water can be pumped by hand if there is no wind. Or a diesel engine may be used as standby. If only wind power is used, a three day storage of water is required as minimum.

The most common and successful Kijito windmill is produced with four different rotor sizes (3.7, 4.9, 6.0 and 7.5 m diameter). Standard height is 9 m, but an extension to 12 m is possible. The costs are summarised in Appendix 2.

Hydraulic Rams: A hydraulic ram uses a large volume of water to pump a small proportion of that volume. Rams require careful adjustment. Ram pumps are relatively expensive, but easy to maintain. The application of ram pumps is limited to locations with ample flowing water. There does not exist any possibility of using hydraulic rams in Isiolo District.

Solar Pumps: Solar pumps are suitable in areas where sunshine is abundant. They may pump as much as 6 l/s. Sophisticated technology is required and they are not easy to repair. The cost of a complete solar pump unit is about 600,000 Shs (ex. works). Not many solar units have been installed as yet but some donors currently include solar units in their projects, therefore it will be interesting to monitor the performance of these units. The solar pumpset at Sericho has been performing satisfactory since its installation in 1987.

Diesel and Electric Pumps: Diesel pumps in remote areas often lack fuel, spare parts and personnel to maintain. Electric motors need less maintenance and are more reliable and are preferred where a reliable supply of electricity is available.

The selected water supply options all deliver water by gravity to the consumers. It is assumed that motor pumps are included only to pump water from the source to the full treatment plant. The pump capacity to the treatment plant is based on 24 hours pumping. Borehole pumps are also designed to operate 24-hours.

The total cost of a diesel generator and borehole pump is estimated at 300,000 Shs. The cost of a pump plant in a surface water scheme between intake and supply area depends on the discharge and head but preliminary may be estimated at 500,000 Shs for 200 m^3/day supply.

Storage: Sufficient storage is required at a water supply to cover periods of peak demand or to supply water if the supply is temporarily out of order (emergency storage). The MoWD Design Manual states that emergency storage is not required in rural areas, including rural centres, except for supplies from windmills (3 days storage) or from a single borehole (1 day storage). This study however applies 1 day storage also for supplies from a spring or from surface water, including urban supplies (5000 people). The required storage for rainwater harvesting systems is already described in the previous paragraph.

The costs of storage was based on masonry/concrete tanks and was estimated at Shs 4,500 per m^3.

Treatment: Water schemes supplying domestic water always require some kind of treatment, to ensure a safe water quality. Supplies using as source springs or surface water either include treatment by filtration or chlorination only or include full treatment. Supplies using groundwater as source usually need treatment by chlorination only.

The cost of treatment works was estimated at between 120 and 150 Shs per m^3/day for chlorination only. A full treatment plant comprises chemical feeders, flocculation and sedimentation tanks, sand filters, pumps and storage for backwashing of filters. Since this is only applicable at Isiolo town only it's unit cost was not included.

Distribution System: A piped distribution system may be included for supplies to rural areas, rural centres or urban centres. The number of connections for a typical water supply were determined at:

	Rural Centre (50 m^3/day)	Urban Area (200 m^3/day)	Urban Area (300 m^3/day)
Individual Connections	5	10	15
Communal Water Points	20	20	100

It is difficult to establish a unit cost for distribution systems, because it is not possible to generalize diameters and lengths of pipes. Comparison of various distribution systems installed with assistance from SIDA or Norad yielded a rough estimate which will be applied in this District Water Development Study:

Costs of supply points were adopted from SIDA:

Communal water points : 20,000 Shs each
Cattle Troughs : 33,000 Shs each

The cost of an individual connection was generally estimated at 3,000 Shs per connection.

6.4 Cost of Operation and Maintenance of Water Supplies

The success of a water supply depends on various factors, of which the organisation of the operation and maintenance (O & M) is one of the most important. When planning for water supply development it is crucial that the O & M is taken into account. Implementation of water supplies should not be started, unless satisfactory conditions are created for the O & M.

The policy of the government is that O & M of water supply facilities is undertaken primarily through joint efforts between the government and the beneficiaries, which requires that communities contribute significantly towards the (construction and) maintenance of facilities. It is therefore important that the communities participate in the decision making at the earliest stage possible.

Government policy is also that cost recovery is an essential element in the water supply programmes. In urban areas water prices should cover both maintenance and capital costs. In rural areas water rates should cover at least the direct O & M costs of the water supply.

The involvement of the community in the O & M of the water supplies is actively promoted in several programmes around Kenya (e.g in LBDA, Western and Kwale). The approach may differ slightly between these programmes, but generally communities are expected to participate in all phases, in the planning, construction, operation and maintenance of the supplies. Usually the communities form water committees, which are responsible for the water supply. Part 3 elaborates further on the aspect of community participation.

The O & M costs of the various selected technologies, described in the previous chapter, were estimated using information from the above mentioned programmes and from publications. O & M costs were found for only some of the supply technologies. The costs are expressed in Shs/m^3 produced (Appendix 4). The annual maintenance costs may also be estimated as a percentage of the construction (installation) cost as presented in the MoWD Design Manual (Appendix 4).

The available examples of O & M costs can not always be compared directly, because the organisation of the O & M may differ. WRAP has adopted as much as possible O & M costs, as they have to be raised by the community, without a contribution from projects or such. The O & M costs may include:

Operation:
- fuel or electricity
- salaries of operators, attendants etc.
- chemicals
- transport and offices

Maintenance:
- spare parts
- tools
- costs of repair

The true cost of spare parts are not always available, because sometimes parts have to be imported and are provided by the projects free of charge or against the duty free price. Costs of replacement due to expiry of the lifetime of materials are not included in the O & M costs. These are dealt with separately in the costing of the water supplies in Part 3. However the lifetime is indicated of the technologies described below.

Surface Water Intakes: The main attention given to intakes is to ensure that the diversion inlet is kept free from debris. Usually intakes located in the forest have little problems. But if human activities take place upstream of the intake, then much time may have to be devoted to the proper functioning of the intake.

Operation: - cost of attendant unless intake site is trouble free
Maintenance: - 1% of capital costs
Lifetime: - 40 years

Springs: The operation of a spring supply is usually easy, because it does not involve valves. It is important that a good design is used, which ensures as little as possible disturbance of the spring flow. Contamination of the spring can be prevented by protecting the area immediately above and around the spring and by keeping the collection point at a distance. The spring can also be connected to a (gravity) piped system in which case the operation becomes similar to other piped systems.

Operation: - no costs (unless a spring attendant is needed)
Maintenance: - very low, estimate 2% of capital cost
Lifetime: - 30 years

Dug Wells: The operation of a dug well depends on the installed type of pump, which are described below. Open dug wells without a cover are not considered in this study. The maintenance of dug wells which are covered is rarely required.

Operation: - no costs
Maintenance: - no costs
Lifetime: - 20 years or more

Boreholes: Generally little maintenance is needed for boreholes, if the borehole is properly designed. But the operation can be troublesome if a wrong borehole screen

is installed, which causes sediments to enter. Separate operation costs are not included, as these depend on the type of pump.

Operation: - no costs
Maintenance: - 1% of capital cost
Lifetime: - 20 years

Handpumps: Many publications are available on the operation and maintenance of handpumps and therefore the description here can be short. Improvements to handpumps are made continuously and some types are now manufactured in Kenya. However some parts need to be imported, because the quality of locally available material is not sufficient (PVC pipes for rising main, pump cylinder, bearings).

The handpumps can be distinguished in VLOM (Village Level Operation and Maintenance) and not VLOM. In case communities are expected to be responsible for the O & M of handpumps, then it is necessary to install handpumps of the VLOM type. VLOM handpumps in Kenya are the NIRA 85 and Afridev both in use by KEFINCO and the latter also in Kwale. Not VLOM handpumps are the India Mark II and the SWN, which are used by respectively KEFINCO and LBDA. The costs of maintenance are indicated at 200 Shs/year by LBDA and Kwale. KEFINCO estimates the costs at 500-1000 Shs/year, which also includes the cost of repairman. Usually maintenance becomes more expensive, if the watertable is deeper.

Operation: - no costs (unless a pump attendant is paid)
Maintenance: - 600 Shs/year for handpump on a dug well
3,000 Shs/year for handpump on a borehole
Lifetime: - 6 years or more

Windmills: The O & M of windmills is easy and very little maintenance is required. Normally only some greasing is needed. An attendant is usually required and the operation costs therefore have to include his salary.

Operation: - 36,000 Shs/year (salary of attendant)
Maintenance: - 36,600 Shs/year
Lifetime: - 20 years

Solar Pumps: The solar pumps have only recently been introduced and not many units have been installed as yet. O & M is easy and very little maintenance is needed. The major problem may be the breakage of the panels by vandalism or wind gusts, although it appears that panels currently on the market do not break easily. Maintenance costs therefore may comprise mainly replacement of broken panels, which cost about 10,000 Shs each.

Operation: - 36,000 Shs/year
Maintenance: - 36,000 Shs/year
Lifetime - panels: - 20 years
- pump: - 5 years (15,000 hours)

Motor Pumps: The O & M of motor pumps depends on the type. Electrical pumps usually require little maintenance. Diesel engines either driving pumps directly or through a generator, require regular maintenance. This has to be done by a mechanic, who is usually in the staff which runs the pump plant. Operation costs of motor pumps also include energy costs.

Operation: - costs include salaries + energy (electricity or fuel)
Maintenance: - Regular service of engines is needed. The MoWD estimate is 5% of the capital costs of pumps and generators.

Lifetime: - 10 years for pumps and generators

Distribution Systems: The O & M depends on the size of the system and the pressures in the pipes. Simple gravity supplied distribution systems are easy to maintain. But a proper design including gate valves, wash-outs, air-valves, etc. is needed, to ensure easy operation of the system. Storage is usually included in the system to ensure supply during peak hours.

Operation: - cost of attendant
Maintenance: - 1% of capital cost
Lifetime: - 30 years

The operation of larger distribution systems which supply urban centres normally involve a number of staff, which require an office, transport etc. The costs of O & M is estimated according the rates used by the MoWD.

Operation: - depends on number of staff
Maintenance: - 2% of capital costs (1% for piping only)
Lifetime: - 30 years

Pans and Dams: The maintenance of pans and dams is often neglected, although regular attention may improve the lifetime of the facility. A major problem is the generally high rate of erosion in the semi-arid areas, which causes a reduction in storage capacity of the reservoirs. Only measures in the catchment areas can remedy this. Scooping of the pans and dams may maintain a sufficient water storage. But if this is not done on a regular bases, than often large desalting operations are needed. These may prove just as expensive as building a new pan or dam.
Larger dams usually have an attendant, who may also be able to repair the fencing or to maintain the vegetation on and around the embankment(s). An attendant will also be required, to operate an off-take for domestic use.

Operation: - 12,000 Shs/year (salary of attendant)
Maintenance: - 5% of capital cost
Lifetime: - varies from site to site, but may be only a few years in areas with high erosion.

Sub-surface Dams and Sand Dams: The maintenance may be very little if a proper design is used. The water is usually abstracted through dug wells or a piped off-take and the O & M of these do not differ from similar supplies.

Operation: - none (unless an attendant is required)
Maintenance: - 1% of capital cost
Lifetime: - 20 years or more

Rock Catchments: The maintenance may be very little if a proper design is used.

Operation: - none (unless an attendant is required)
Maintenance: - 1% of capital cost
Lifetime: - 20 years

Roof Catchments: The O & M is done on a private basis, because the supply is either for a family or an institution. The maintenance should be very little, unless poor materials are used for gutters or storage.

Operation: - none
Maintenance: - 1% of capital cost
Lifetime: - 20 years (corrugated tanks 10 years)

6.5 Cost Effectiveness Analysis

6.5.1 Introduction

A complete economic analysis of a water supply system would take into account the costs of the system over the life of the project and compare them to the benefits of the system. In practice, while costs are relatively straightforward to establish, the full benefits of water supplies are difficult to estimate. This is particularly the case in rural supplies where time savings, health and induced economic activity will be important. A methodology for assessment of some of these benefits is set out in Paragraph 5.2 of Part 3, but it is not possible to undertake this assessment for the various systems in general as the value of these benefits (and costs) is project specific. The approach adopted in this section considers only the cost and the output of the systems.

This approach is known as cost effectiveness analysis. It measures the cost per cubic meter capacity of each system over its lifetime. The lowest cost technology applicable in a given circumstance will be the most "cost effective". The present cost per cubic meter capacity is found using a technique known as discounting, where future expenditures are expressed in present values.

The methodology followed in discounting costs and benefits involved the following steps:

1. Estimation of the total costs incurred in the system during 20 years of operation, such as:
   - capital costs: source, pumps, storage;
   - recurrent costs: staff salaries, general maintenance, fuel and lubricants.
2. Estimation of the yields of water in m^3, similarly as in step 1 above, year by year.
3. Discounting of all costs figures to arrive at their present values by using different discount rates.
4. Calculation of the cost effectiveness per m^3 capacity of water supply at present value by totalling the discounted costs divided by the annual yield of the system.

The discounting was done using three different rates 5%, 10% and 15%. This range of percentages was used to indicate that the ranking of the technologies may differ according to the selected discount percentage.

The cost effectiveness analysis was intended in this study for comparison of the proposed water supplies and for comparison of the pumping systems. The analysis gives an indication of the cost effectiveness of the proposed system at a rural centre in comparison to the cost effectiveness of the proposed system at another centre. Table 6.4 sets out the results of the cost effectiveness analysis of the various proposed types of water supplies to the rural centres.

It should be noted that this analysis was carried out in order to obtain a comparison of systems according to cost effectiveness criteria. It does NOT produce an average cost of water over the lifetime of the project.

Table 6.4 Results of Cost Effectiveness Analysis

Technology	Daily Yield (m^3)	Total Capital Costs (Shs)	Total O&M Costs (Shs)	Total Cost/m^3 (Shs)		
				5% disc.	10% disc.	15% disc.
Borehole with Diesel Pump	50	3,310,000	2,016,000	247.0	222.0	208.0
Borehole with Diesel Pump	75	3,772,500	2,646,000	196.8	175.7	163.9
Two Boreholes with Diesel Pumps	100	6,070,000	4,368,000	237.7	210.9	195.9
Borehole with Diesel and Solar Pump	50	4,605,000	1,764,000	292.7	262.2	245.9
Borehole with Diesel and Solar Pump	75	5,072,500	2,394,000	227.4	202.7	189.3
Two Boreholes with Diesel and Two Solar Pumps	100	7,970,000	4,116,000	273.1	241.5	224.4
Borehole with Windmill	50	3,535,000	1,512,000	288.2	263.6	250.0
Infiltration Galleries with Diesel Pump	50	3,275,000	1,764,000	236.1	213.7	201.2
Infiltration Galleries with Diesel Pump	75	4,232,500	2,142,000	201.9	184.2	174.4
Infiltration Galleries with Two Diesel Pump	100	6,010,000	2,520,000	203.2	186.0	176.5
Infiltr. Galleries with Diesel and Solar Pumps	50	4,535,000	1,554,000	281.3	253.0	237.9
Infiltr. Galleries with Diesel and Solar Pumps	75	5,502,500	1,869,000	230.9	209.8	198.5
Inf. Galleries with Diesel and Two Solar Pumps	100	7,910,000	2,268,000	238.5	216.6	205.0
Infiltration Galleries with Solar Pump	50	4,405,000	1,512,000	337.5	308.9	293.4
Infiltration Galleries with Windmill	50	3,355,000	1,512,000	276.2	251.6	238.0
Infiltration Galleries with Windmill	75	4,695,000	1,512,000	241.4	223.9	214.4
Dug Well with Handpump	5	183,500	63,000	101.6	84.3	74.7
Borehole with Handpump	5	310,000	63,000	170.9	153.7	144.0

Note (1) - Total Cost/m^3 is the total discounted cost per cubic meter capacity per year
(2) - Total Capital Costs include investment + replacement costs.

6.5.2 Results of Analysis

The water supplies dealt with here will mainly supply water for domestic use. Table 6.1 presents an overview of the cost of water supply development for the different supply areas: rural centres and rural area (livestock). Indicated in table 6.1 are estimates of the initial capital (investment) costs, the annual 0 & M costs and the costs per capita and per m^3/day capacity.

The cost effectiveness exercise was conducted for complete water supply systems using boreholes or wells connected to infiltration galleries (Appendix 5). The systems are based on the proposals for the water supplies to the rural centres, which are generally comparable except for differences in lengths of main lines and distribution systems. This should be taken into account when comparing the cost effectiveness of these systems.

The output of the solar pumps depends on the number of solar panels, which in this analysis was 32. The yield of the solar pump for this number of panels is 35 m^3/day for boreholes (30 m. head) and 60 m^3/day for wells with infiltration galleries (15 m. head). Two submersible pumps in one borehole of at least 6 inch diameter are possible, allowing combined systems of solar and diesel. It was assumed in the analysis that solar pumps and windmills only provide water during 300 days in a year.

6.5.3 Conclusions

The cost effectiveness analysis allows to compare pumping systems with different supply capacities. Due to the nature of the estimates used, the following conclusions must be taken as indicative.

The outcome of the comparison of boreholes or wells equipped with solar pumps, windmills or diesel pumps shows that diesel pumps are the most cost effective. Solar pumps alone are less cost effective than combined systems. It appears that the lower O & M costs of solar systems do not compensate for the higher capital costs.

The windmill is more cost effective than solar systems. However the windmill is not applicable in most parts of Isiolo District, because of insufficient wind potential. A combined system of windmill and submersible pump is not possible in one borehole.

For comparison also systems with handpumps are included. The cost effectiveness of handpumps is higher than of the other pump systems, in spite of the low output of the handpumps.

The analysis shows that systems are more cost effective for larger yields. This is due to the lower capital and O & M costs per m^3 produced.

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APPENDIX 1

WRAP - INVENTORY SHEETS FOR EXISTING WATER SUPPLIES

OPERATIONAL CHARTS OF MOWD WATER SUPPLIES

APPENDIX 1

WRAP - INVENTORY SHEETS FOR EXISTING WATER SUPPLIES

Sheet 1	General Inventory
Sheet 2.1	Water Supply Inspection Form for Surface Water Source
Sheet 2.2	Water Supply Inspection Form for Groundwater Sources
Sheet 2.3	Water Supply Inspection Form for Distribution System
Sheet 3	Operational Inventory
Sheet 4	Financial Inventory

OPERATIONAL CHARTS OF MOWD WATER SUPPLIES

Section 1:	Provides Quantities of Chemicals used and Water Quality Data
Section 2:	Provides the Number of Pumping Hours and Fuel Consumption
Section 3:	Provides the Number of Connections and Total Quantities of Water Produced and Water Sold.
Section 4:	Provides the Operational Costs, Consisting of Chemicals, Fuel, Salaries/Wages, Overheads, etc.

WATER RESOURCES ASSESSMENT AND PLANNING PROJECT

-Survey of Existing Water Supplies-

GENERAL INVENTORY **SHEET 1**

Date of Field Check:

Name of Water Supply: .....

Organization: o MoWD o Council o Mission o Self Help o Other .....

District ..... Division .....

Location ..... Sub-Location .....

Map-Sheet (50 000) ..... Coordinates (UTM) X ..... Y .....

Raw Water Source: o Borehole o Shallow Well o Spring o Waterhole o Rain
o River o Lake o Dam o Pan o Rock Catchment o Other .....

Pumping Plant: o Electrical o Diesel o Handpump o Gravity o Manual
o Other .....

Discharge: Design ..... m^3/d Present ..... m^3/d

Raw Water: Storage ..... m^3 Conveyance ..... km

Clear Water: Storage ..... m^3 Distribution ..... km

Treatment: o None o Chlorination o Full o Other .....

Water Quality: o Good o High TDS o Turbid o High F o Not known
o Contamination .....

Facilities: Workshop ..... Housing ..... Laboratory ..... Office .....
Other .....

Consumer Supply Points: Individual ..... Metered no. ..... Non-metered no. .....
Kiosks ..... Cattle-troughs ..... -dips ..... Communal Waterpoints .....
Other .....

Population Served ..... Livestock ..... Irrigation .....

Commercial Establishments / Institutions Served No.: .....

.....

Operational Reliability: o Good o Medium o Bad (more on sheet 3)

.....

Project Type .....

Year of Commissioning .....

Cost at Commissioning Time .....

WATER RESOURCES ASSESSMENT AND PLANNING PROJECT
Ministry of Water Development

WATER SUPPLY INSPECTION FORM **SHEET 2.1**
for surface water sources

1. Name of Supply: . . . . . .
2. Location: . . . . . .
3. Source: dam / pan / weir / water hole / river / lake / rock catchment / roof catchment / other: . . . . . .

4. Technical Information:

Intake structure: dam / weir / pipe / other: . . . . . .
structure material: clay / rocks / concrete / bricks / metal / other: . . . . . .
structure size: width m., height m., diameter m.
Intake storage capacity: m^3

Pumping plant: electrical / diesel / petrol / hand / gravity / none / other: . . . . . .
Discharge (estimate): m^3/day or litre/sec.

Constructed by: . . . . . .
Year of construction: 19 . .

5. Condition of Works:

Intake: good / fair / poor **Required rehabilitation:**
Erosion: much/moderate/little/none . . . . . .
Spillway: silted/eroded/good/not present . . . . . .
Reeds: much/moderate/little/none . . . . . .
Dam silted: much/moderate/little/none . . . . . .
Leakage: much/moderate/little/none . . . . . .
Outlet pipe: working/not working/not pres. . . . . .
Fence: good/damaged/not present . . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .

Pumping plant:
Pump: good / fair / poor
Engine: good / fair / poor

Required rehabilitation:
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . .
. . . . . continue on other side

WATER RESOURCES ASSESSMENT AND PLANNING PROJECT
Ministry of Water Development

WATER SUPPLY INSPECTION FORM **SHEET 2.2**
for groundwater sources

1. Name of Supply: . . . . . .
2. Location: . . . . . .
3. Source: borehole / dug well / spring / other: . . . . . .

4. Technical Information: (to be copied from inventory sheets)

Width / diameter: m. Depth: m.
Water level: m.
Discharge (estimate): m^3/day or litre/sec.
Well / borehole lining: yes/no
Type of lining: concrete / bricks / steel casing / pvc casing / . . . . . .

Pump present: yes/no Type: handpump / submersible / reciprocating / centrifugal / other: . . . . . .
Pumping plant: electrical / diesel / petrol / hand / other: . . . . . .
Discharge (estimate): m^3/day or litre/sec.

Constructed by: . . . . . .
Year of construction: 19 . .

5. Condition of Works:

	Borehole	Dug well	Spring
General structure:	good/fair/poor	good/fair/poor	good/fair/poor
Lining:	good/fair/poor	good/fair/poor	
Slab:	good/fair/poor	good/fair/poor	good/fair/poor
Structure/slab undermined:	yes/no yes/no	yes/no	
Cover/cap:	good/fair/poor	good/fair/poor	good/fair/poor
Casing:	good/fair/poor		
Screen:	good/fair/poor		
Leakage sides:	yes/no yes/no	yes/no	
Leakage underneath:	yes/no yes/no	yes/no	
Proper excess water drainage:	yes/no yes/no	yes/no	
Overflow pipe present:			yes/no
Protection agst. surf. water:	good/fair/poor	good/fair/poor	good/fair/poor
Fence: yes/no	good/fair/poor	good/fair/poor	good/fair/poor

Pumping plant:
Pump: good / fair / poor
Engine: good / fair / poor
Pump-engine connection: good / fair / poor

Required rehabilitation:

. . . . . .
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WATER RESOURCES ASSESSMENT AND PLANNING PROJECT
Ministry of Water Development

WATER SUPPLY INSPECTION FORM **SHEET 2.3**
for distribution system

1 . Name of Supply: . . . . . .
2 . Location: . . . . . .

3 . Technical Information:

Distribution system: Total pipe length: km.
Pipe diameters: inches/mm.

Booster pumps: yes/no Number of pumps:
Pump Capacity: m^3/hr

Storage: yes/no Type: tank/other Number of tanks:
Storage capacity: m^3

Treatment plant: yes/no Type:

4 . Condition of Works:

Distribution system:
In operation?: yes/no, because . . . . . .
. . . . . .

General condition:
pipes: good/fair/poor
valves: good/fair/poor
taps: good/fair/poor
meters: good/fair/poor
pumps: good/fair/poor
storage: good/fair/poor
treatment: good/fair/poor

5 . Appraisal of facility: Comments

Supply:
Domestic: Adequate / Not adequate / None . . . . . .
Livestock: Adequate / Not adequate / None . . . . . .
Irrigation: Adequate / Not adequate / None . . . . . .

Water pressure: Sufficient / Not sufficient . . . . . .

Water quality:
Domestic: Acceptable / Not acceptable . . . . . .
Livestock: Acceptable / Not acceptable . . . . . .
Irrigation: Acceptable / Not acceptable . . . . . .

Rehabilitation works required?: yes/no
(Specify requirements on seperate quantities form)

. . . . . .
. . . . . .
. . . . . .
. . . . . continue on other side

WATER RESOURCES ASSESSMENT AND PLANNING PROJECT

-Survey of Existing Water Supplies-

OPERATIONAL INVENTORY **SHEET 3**

Name of Water Supply: .....

Organization responsible for operation: .....

Organization responsible for maintenance: .....

Operation staff:

Designation	Task	Training Level

Maintenance: How often ? .....

Who pays for maintenance ? .....

Operation: How many working hours per day ? .....

How many days per month is supply working on average ? .....

How is fuel supply ? .....

Operation Reliability .....

Reliability of Pumps .....

Reliability of Conveyance .....

Reliability of Distribution .....

Reliability of Treatment .....

Causes of malfunctioning .....

.....

.....

.....

.....

WATER RESOURCES ASSESSMENT AND PLANNING PROJECT

-Survey of Existing Water Supplies-

FINANCIAL INVENTORY **SHEET 4**

Date of Field Check:

Name of Water Supply: .....

	Year of Commissioning	Cost	Capacity
Intake			m3
Treatment Works			m3/d
Pipelines			km
Storage			m3
Dams/Pans			m3

Total Revenue Collected per month ..... Ksh

Flat rate per connection ..... Ksh/month No. of connections: .....

Metered Consumption Rate ..... Ksh/m^3 No. of metered connections: .....

Total Operational Costs per month ..... Ksh

Electric Power Consumption Cost per month ..... Ksh

Diesel Consumption cost per month ..... Ksh

Chemicals cost per month ..... Ksh

Staff / Labour Costs per month ..... Ksh

Maintenance Costs: Labour ..... Ksh

Spare Parts ..... Ksh

Other ..... Ksh

Other Sources of funds: state:

WATER SUPPLY OPERATION CHART - SECTION 1

EMCH WATER SUPPLY — JULY — MONTH — YEAR 1989

DAY	CHEMICAL DOSING: CHLORINE DOSAGE P.P.M.	CHLORINE WEIGHT (GRAMS)	ALUM SULPHATE DOSAGE P.P.M.	ALUM SULPHATE WEIGHT KILOGRAM	LIME AND/OR SODA-ASH PRETREATMENT DOSAGE P.P.M.	PRETREATMENT WEIGHT KILOGRAM	CONDITIONING DOSAGE P.P.M.	CONDITIONING WEIGHT KILOGRAM	RESIDUAL CHLORINE MORNING 8-0 A.M. 10 MIN.	MORNING 8-0 A.M. 60 MIN.	AFTERNOON 4-0 P.M. 10 MIN.	AFTERNOON 4-0 P.M. 60 MIN.	TURBIDITY P.P.M. RAW WATER	TURBIDITY P.P.M. TREATED WATER	P.H. VALUES RAW WATER	P.H. VALUES TREATED WATER SAMPLE POINT	CALCIUM STABILITY (WEEKLY) RAW WATER ORIGINAL PH	RAW WATER ORIGINAL TOTAL ALK	RAW WATER FINAL PH	RAW WATER FINAL TOTAL ALK	TREATED WATER ORIGINAL PH	TREATED WATER ORIGINAL TOTAL ALK	TREATED WATER FINAL PH	TREATED WATER FINAL TOTAL ALK	ALKALINITY (PPM) (WEEKLY) RAW WATER PHEN PHTH	RAW WATER TOTAL	TREATED WATER SAMPLE POINT PHEN PHTH	TREATED WATER SAMPLE POINT TOTAL
25	0.8	7.5	48	52			8	12	0.6	0.4	0.5	0.3	50	7	6.8	7.0												
26	0.8	7.5	48	52			8	12	0.5	0.3	0.4	0.2	50	7	6.8	7.0									NIL	8	NIL	10
27	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	60	7	6.8	7.0												
28	0.8	7.5	48	52			8	12	0.5	0.3	0.5	0.3	50	7	6.8	7.0	6.8	6			7.0	8						
29	0.8	7.5	48	52			8	12	0.4	0.2	0.5	0.3	40	7	6.8	7.0												
30	0.8	7.5	48	52			8	12	0.6	0.4	0.4	0.2	40	7	6.8	7.0			8.2	28			8.4	30				
31																												
1	0.8	7.5	48	52			8	12	0.6	0.4	0.5	0.3	40	7	6.8	7.0												
2	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0												
3	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0									NIL	6	NIL	8
4	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0												
5	0.8	7.5	48	52			8	12	0.5	0.3	0.4	0.2	40	7	6.8	7.0	6.8	6			7.0	8						
6	0.8	7.5	48	52			8	12	0.6	0.5	0.5	0.3	40	7	6.8	7.0												
7	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0			8.2	28			8.4	30				
8	0.8	7.5	48	52			8	12	0.4	0.2	0.5	0.2	40	7	6.8	7.0												
9	0.8	7.5	48	52			8	12	0.5	0.3	0.5	0.3	40	7	6.8	7.0												
10	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0												
11	0.8	7.5	48	52			8	12	0.4	0.2	0.5	0.3	40	7	6.8	7.0									NIL	6	NIL	8
12	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0	6.8	8			7.0	10						
13	0.8	7.5	48	52			8	12	0.5	0.3	0.4	0.2	40	7	6.8	7.0												
14	0.8	7.5	48	52			8	12	0.5	0.3	0.4	0.2	40	7	6.8	7.0			8.4	30			8.6	32				
15	0.8	7.5	48	52			8	12	0.5	0.3	0.5	0.3	40	7	6.8	7.0												
16	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0												
17	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0									NIL	8	NIL	10
18	0.8	7.5	48	52			8	12	0.5	0.3	0.4	0.2	40	7	6.8	7.0												
19	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0	6.8	6			7.0	8						
20	0.8	7.5	48	52			8	12	0.6	0.3	0.5	0.3	40	7	6.8	7.0												
21	0.8	7.5	48	52			8	12	0.5	0.3	0.5	0.2	40	7	6.8	7.0			8.4	30			8.6	32				
22	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0												
23	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0												
24	0.8	7.5	48	52			8	12	0.4	0.2	0.4	0.2	40	7	6.8	7.0									NIL	6	NIL	8
TOTAL	Kgr. 225	Gr. 000	Kgr. 1560	Gr. 000	Kgm	Gr.	Kgr. 360	Gr. 000																				

WATER SUPPLY OPERATION CHART – SECTION 2

EMBU URBAN WATER SUPPLY — JULY — MONTH — 1989 YEAR

PUMPING PLANT

DAY	PRIME MOVERS: ENGINES, ELEC. MOTORS, GENERATING SETS, TURBINES, — No. 1 DRIVING PUMP No/s — MAKE:- — SIZE:-			No. 2 DRIVING PUMP No/s — MAKE:- — SIZE:-			No. 3 DRIVING PUMP No/s — MAKE:- — SIZE:-			No. 4 DRIVING PUMP No/s — MAKE:- — SIZE:-		
	HRS RUN	FUEL LITRE OR K.W. HRS	LUB OIL LITRES	HRS RUN	FUEL LITRE OR K.W. HRS	LUB OIL LITRES	HRS RUN	FUEL LITRE OR K.W HRS	LUB. OIL LITRES	HRS RUN	FUEL LITRE OR K.W HRS	LUB OIL LITRES
5												
6												
27												
28												
29												
30												
31												
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
TOTAL												

DAY	PUMPS: SURFACE:- INCLUDING HYDRAMS, BOREHOLE:- INCLUDING AIRLIFT COMPRESSORS, AND GRAVITY SUPPLIES. — No KAPINGAZI RAW WATER/~~PURE WATER~~ (DELETE DUTY NOT APPLICABLE) — MAKE:- GRAVITY — SIZE:- 150 MM								No. NGANDORI ~~RAW WATER~~/PURE WATER (DELETE DUTY NOT APPLICABLE) — MAKE:- GRAVITY — SIZE:- 150 MM								No. RAW WATER/PURE WATER (DELETE DUTY NOT APPLICABLE) — MAKE:- — SIZE:-								No. RAW WATER/PURE WATER (DELETE DUTY NOT APPLICABLE) — MAKE:- — SIZE:-							
	HRS RUN	VOLUMETRIC TEST M³/hr	B/H WATER LEVEL B.S. FT.	AMPS	VOLTS	K.W. HRS. OR LUB OIL LITRE			HRS RUN	VOLUMETRIC TEST M³/hr	B/H WATER LEVEL B.S. FT.	AMPS	VOLTS	K.W. HRS. OR LUB OIL LITRE			HRS RUN	VOLUMETRIC TEST M³/hr	B/H WATER LEVEL B.S. METRE	AMPS	VOLTS	K.W. HRS OR LUB. OIL LITRE			HRS RUN	VOLUMETRIC TEST M³/hr	B/H WATER LEVEL B.S. LITRE	AMPS	VOLTS	K.W. HRS OR LUB. OIL LITRE	
5	24								24																					
6	24								24																					
27	24	22							24	110																				
28	24								24																					
29	24								24																					
30	24								24																					
31	–								–																					
1	24								24																					
2	24								24																					
3	24								24																					
4	24	20							24	110																				
5	24								24																					
6	24								24																					
7	24								24																					
8	24								24																					
9	24								24																					
10	24								24																					
11	24	22							24	100																				
12	24								24																					
13	24								24																					
14	24								24																					
15	24								24																					
16	24								24																					
17	24								24																					
18	24	20							24	110																				
19	24								24																					
20	24								24																					
21	24								24																					
22	24								24																					
23	24								24																					
24	24								24																					
TOTAL	720								720																					

WATER SUPPLY OPERATION CHART - SECTION 3.

EMBRO URBAN .... WATER SUPPLY ..JULY..... MONTH YEAR 1989.....

DAY	WASTE WATER. IF MASTER METER IS ON RAW WATER MAIN COLS. A.B.C. ONLY. IF MASTER METER IS ON PURIFIED WATER MAIN, COLS A.& B. ONLY. A FILTERS. (WASH WATER)	B RESERVOIR.	C COAG. BASIN.	MASTER METERS. METER NO. IV INDEX READING. 8.0. A.M.	QUANTITY PASSED M³.	METER NO. V INDEX READING. 8.0. A.M.	QUANTITY PASSED M³	METER NO. VI INDEX READING 8.0. A.M.	QUANTITY PASSED M³
				MASTER METER READING - LAST DAY PRECEEDING MONTH.					
				483614		116850		433	
25				483635	21	116850	—	433	—
26				483647	12	116850	—	433	—
27				483678	31	116850	—	433	—
28				483689	11	116850	—	433	—
29				483898	209	116850	—	433	—
30				484004	106	116850	—	433	—
31	—			—	—	—	—	—	—
1				484184	140	116850	—	433	—
2				484328	144	116850	—	433	—
3				484407	79	116850	—	433	—
4				484571	104	116850	—	433	—
5				484639	128	116850	—	433	—
6				484773	134	116850	—	433	—
7				484848	75	116850	—	433	—
8				484968	120	116850	—	433	—
9				485101	133	116850	—	433	—
10				485174	73	116850	—	433	—
11				485240	66	116850	—	433	—
12				485284	44	116850	—	433	—
13				485423	139	116850	—	433	—
14				485518	155	116850	—	433	—
15				485733	155	116850	—	433	—
16				485880	147	116850	—	433	—
17				486037	157	116850	—	433	—
18				486190	153	116850	—	433	—
19				486338	148	116850	—	433	—
20				486480	142	116850	—	433	—
21				486615	135	116850	—	433	—
22				486750	135	116850	—	433	—
23				486889	139	116850	—	433	—
24				487020	131	117538	688	433	—
TOTAL					3406		688		206

METERS ALLOCATED TO THE SUPPLY

SIZE MILLIMETRES	12	20	25	38	50	63 75	100 PLAIN	100 COMB.	150 PLAIN	150 COMB
MASTER No.										
ON WATER SUPPLY "										
ON CONNECTIONS. "										
SERVICEABLE IN STORE "										
UNSERVICEABLE. "										
SENT FOR REPAIR "										
TOTAL . "										

CONSUMERS.

CONSUMERS ON METERD CONNECTIONS No.	
" ON FLAT RATE CONNECTIONS "	
TOTAL CONSUMERS "	

WATER PRODUCED, USED, SOLD AND UNACCOUNTED FOR.

TOTAL WATER SOLD THRO' METERS M³	
" " " " FLAT RATE "	
" " " AVERAGE ASSESMENT. "	
TOTAL WATER SOLD "	
1. MASTER METERS COMBINED TOTAL. M³	
2. TOTAL WASTE WATER. M³	
3. WATER AVAILABLE FOR SALE (1-2) "	
4. TOTAL WATER SOLD. "	
5. BALANCE UNACCOUNTED FOR (3-4). "	
PERCENTAGE UN-ACCOUNTED FOR (LINE 5 × 100) / LINE 1 = × 100	%.
AVERAGE WATER PRODUCED M³ P. D.	
" " SOLD M³ P. D	

REMARKS ON LOSSES CAUSED BY BURSTS AND FROM OTHER CAUSES.

AV. ASS.

WATER SUPPLY OPERATION CHART SECTION 4.

EMBU WATER SUPPLY. MONTH JULY YEAR 1989

ITEM	COST OF OPERATION PER MONTH. QUANTITY USED. kg.	RATE. Per kg.	TOTAL. Shgs.	Cts.	BALANCE OF STORES. BALANCE B/F. kg	QUANTITY RECEIVED. kg.	BALANCE C/F. kg.
PURCHASE OF WATER..... m³ @.....							
CHEMICALS: Alum.	1560.000	4.75	7380	00	116.000	1500.000	56.000
Soda Ash.	360.000	2.12	763	20	—	400.000	40.000
Hydrated Lime							
Chlorine Gas or Trop. Chloride of Lime.	225.000	10.25	2,306	25	15.000	250.000	40.000
other chemicals.							
	Litre	Per Litre	—	—	Litre	Litre	Litre
FUEL: Diesel (Not For Transport.)							
Lub. Oil. (" " ")							
Petrol. (" " ")							
Electricity Units.	480	0.99	475	20			
MISC: Uniforms.	Lump Sum For Month						
Pointing	" " " "						
Sundry Items. (See Notes.)	" " " "						
SALARIES FUEL ETC	" " " "		3560	00			
TRANSPORT: Funding. P.O.L. (Lump Sum)	" " " "		700	00			
CREATIVE SHARE	" " " "		[illegible]	[illegible]			
OVERHEADS: Provincial Engineer .....%. (See Notes)	" " " "						
Water Supt.....%. (See Notes)	" " " "						

OPERATOR – STATE ANY PLANT MAINTENANCE REQUIRED.

for W.S.O. i/c

SIGN.

REMARKS. S.I.W.S.

STAFF: ALL WORKS PAID OPERATION STAFF (Excluding All Operators.)

NAME.	DUTY.		
1. ZAKARIA M'KEMBLNIA	C/ ATTENDANTS	1190	00
2. CHARLES KABIRU	"	770	00
3. MOSES K. MUGANE	"	966	00
4. REUBEN K. MUCHIRI	"	1190	00
5. MAINA GATERI	"	1130	00
6. WILSON MUGWE	SS	1150	00
7. ANTONY NJERU	"	1150	00
8. NELSON KARIUKI	"	1120	00
9 CHARLES KANGICHO	"	1120	00
10. SAMSON MURAGU	PIPE FITTER	1570	00
Divisional costs: (see Notes.)			
TOTAL COSTS CHARGED TO O. E. W. S. E.		36744	00

METERS – COST OF REPAIRS CHARGED TO METER REPAIR S. E. FOR MONTH.

OPERATORS – HEAD OFFICE & WORKS PAID.

NAME	GRADE	H.O. or W.P.	Salary For Month Shgs.	Cts.
GEORGE M KIUNJURI	I		2250	00
STEPHEN K MURIMI	II		1740	00
EPHANIUS K. GITHINJI	II	X10	1520	00
PETER K. NJUGUNA	II		1520	00
STEPHEN MAITHERU	II		1240	00
MERCY K. MWARANIA	II		1240	00

DISTRICT WATER OFFICER
P.O. Box 542, EMBU
SIGN 30/8/89

Provincial Water Engineer/ Officer Remarks

EXPENDITURE & REVENUE	Shgs.	Cts.	£.
TOTAL EXPENDITURE, EX-LEDGER: (Incl. Liabilities) SINCE 1st JULY.	36744	65	1361.4.25
REVENUE EARNED DURING MONTH:	1024	80	37.22.Nil
REVENUE EARNED SINCE 1st JULY:	1024	80	37.22

PROVINCIAL WATER ENGINEER
P. O. Box [illegible]
15/9/89
SIGN.

P.T.O. FOR DETAILS OF SUNDRY ITEMS PURCHASED.

NOTES: SUNDRY ITEMS: This covers any items for which specific headings have not been provided. Details of items purchased to be shown on reverse.

OVERHEADS: (a) Provincial Water Engineer. Show the percentages retained by the P.W.E. of the annual O.E.M. funds issued. The amounts to be entered in the Total column are ¼ of the actual amounts retained for the whole year.

(b) Divisional. Enter in the Total column the apportionment to the supply for the month of the salaries of all works paid Divisional clerical and break-down staff. (See also note 4 on cover sheet.)

APPENDIX 2

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

APPENDIX 2

UNIT COSTS OF WATER SUPPLIES:

SOURCE DATA

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply: Rural Supply Groundwater

Including: Boreholes, pump, storage, distribution

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Turima/Gampua	1988	720,000	1,220	590	Solar pump, 1 borehole
	Kitihori	1988	500,000	430	1,160	Solar pump, 1 borehole
	Nkururuni	1988	680,000	1,300	523	5 bh's, handpump, s/s dam
	Kagombe	1988	290,000	430	674	2 bh's, handpump, s/s dam
	Rwakinanga	1988	270,000	340	794	2 bh's, handpump,
	Muguko	1988	270,000	280	965	2 bh's, handpump, s/s dam
	Rukenya	1988	440,000	550	800	3 bh's, handpump, s/s dam

Supply: Rural Supply Surfacewater/Gravity

Including: Intake, main lines, storage, Treatment, Distribution

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
BISH	Chepalunga	1989	105,902,652	135,850	780	Large supply 10,050 m^3/d
McPherson	-	1984	972,118	5,150	190	Hypothetical supply, low costs of intake and storage (no treatment)
Norconsult	Gakauni	1990	2,338,250	1,200	1,950	Intake chamber, filtration, Ultimate population served 3,131
P.K.Njiru (Diploma design)	Kibauni	1989	32,000,000	33,466	956	Pumped supply, 900 m^3/d

Supply: Rural Supply Surfacewater/Hydram

Including: Hydram, Treatment, Storage tank, Distribution

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Karuma	1988	540,000	1,200	450	
	Muyoya-Kamatungu		660,000	1,500	440	

Supply: Protected Spring

Including: Spring Captation with one outlet

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	KWDP	1988	63,500	500	127	Excluding overhead
FINNIDA	KFRWSDP	1988	14,716	200	132	Excluding overhead

Supply: Protected Spring

Including: Spring Captation with off-take pipeline and water points

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
GSK	KIDP	1989	100,000	500	200	20 m^3/day
			250,000	1,250	200	50 m^3/day

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply: Boreholes

Including: Drilling, casing, development, superstructure, handpump, labour costs

Source of Data	Project Name	Year	Average Bh. Depth (m)	Total Costs	Popu.	Costs/ Capita	Remarks
LBDA	RDWS & SP	1986	65	107,500 127,470	200 200	538 637	Excluding overhead Including overhead
SIDA	Nkururuini	1988		120,000	260	460	
	KWDP	`85-`87	?	68,228	200	341	Excluding overhead
FINNIDA	KFRWSDP	1988	?	71,480 120,486	200 200	357 602	Excluding overhead Including overhead
PENCOL	CBWDP	1984	50	227,700	200	1138	
NORCONSULT	Gakauni	1990	?	240,000	175	1370	Based on 33% success rate

Supply Component: Borehole Construction,

Including: Drilling, casing, developing, testing

Source of Data	Project Name	Year	Total Costs	Depth	Costs/ m	Remarks
Diocese	of Marsabit	1989			2,100	
MoWD	Design Manual	1986	90,000	50	1,800	Large nr. in same area
GSK	KIDP	1989	150,000	50-200	3,500-5,000	Single or few holes
PENCOL	CBWDP	1984	360,000	125	2,880	150 mm diameter
		1984	470,000	125	3,760	200 mm diameter
Diocese	Baragoi		-		2,500	
	Lodokojek	1986	159,550		2,660	One borehole (24 m 150 mm Johnson screen)

Supply: Dug Wells

Including: Dug well, lining, superstructure, handpump, labour costs

Source of Data	Project Name	Year	Average Well Depth (m)	Total Costs	Popu.	Costs/ Capita	Remarks
LBDA	RDWS & SP	1986	15	37,000 54,440	200 200	185 272	Excluding overhead Including overhead
SIDA	KWDP	1985- 1987	-	57,000	200	285	Excluding overhead
FINNIDA	KFRWSDP	1988	6.2	51,218 79,959	200 200	256 400	Excluding overhead Including overhead
PENCOL	CBWDP	1984	?	47,438	200	237	
GSK	KIDP	1989	?	35,000	100	350	

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply Component: Dug Wells

Including: Digging Only

Source of Data	Project Name	Year	Average Well Depth (m)	Total Costs	Popu.	Costs/ meter	Remarks
LBDA	RDWS & SP	1986	15	11,000		750	
GSK	KIDP	1989	?			1000	Including Slab
MoWD	Design Manual	1986	5-15	70,000		>5000	Concrete rings, including survey

Supply: Handdrilled Well

Source of Data	Project Name	Year	Average Well Depth (m)	Total Costs	Popu.	Costs/ meter	Remarks
MoWD	Design Manual	1986	5-15	30,000		>2000	Including survey

Supply: Rain Catchment (Roof)

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Kwale	1988	50,350	50	1,007	Including overhead
CBWDP	PENCOL	1984	14,304,000	3,700	3,866	Based on consumption of 20 l/person/day. Roof + Storage costs
GSK	Oral Information	1989	25,000			25-28 m^3 ferro cement tank & gutters
SIDA	Marimanti-Health Centre		77,000			90 m^3 tank, 138 m gutters
	Primary Sch.		95,000			112 m^3 tank, 160 m
	Marimanti				525/m^3	Tank
	Marimanti				215/m^3	Gutters

Supply: Roof Catchment Tanks

Source of Data	Project Name	Year	Type	Volume (m^3)	Costs/ m^3	Remarks
McPherson		1984	Corrugated Iron	1	890	Must be transported to site
				5	384	Not very durable
				10	354	
			Brick/Cement	1-1000	600-900	Cost assumes standard design
			Ghala Basket	1-8	2500-600	2000-3000 constructed in Kenya
			Cement Jars	1-10	500-750	Large jars need reinforcement
			Ferrocement	1-200	200-400	
			Concrete ring	1-25	350	Simpler to build than ferrocement

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply: Rain Catchment (Rock)

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Kwale	1988	?			
GSK	KIDP	1989	900/m^3			Stone masonry
			41/m^3			Stone gutters
			100,000	200	500	Complete 10 m^3/day
McPherson	Mutomo	1984	150,000	1,500	100	Storage 3,500 m^3, 15m^3/day
	Mutomo	1984	250,000	1,500	175	Costs including supervision and self help labour

Supply: Sub-Surface Dams and Sand Dams

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
PENCOL	CBWDP	1984	300,000	200	1,500	11 m^3/day
GSK	KIDP	1989	900/m^3			Stone masonry wall
			150,000	100	1,500	Sand Dam 5 m^3/day
	Kyandili	1979	30,000	1,000	30	3 m high, no community involvement
	Kalama	1980	15,000	1,000	15	3 m high, community involved
	Ethiopia	1981	66,666	800	83	38 m high, no community involvement
SIDA	Nkururuini	1988	80,000			Livestock supply
McPherson	MIDP	1984	22,000			Concrete dam, 6,500 m^3 storage
EMI-ASAL	Embu District	1984	125,000	300-400	300-400	Sand weirs, donor:ODA
Norconsult	Gakauni	1990	94,000	175	540	Dam with handpump

Supply: Pans

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
PENCOL	CBWDP	1984	2,923,000	1250	2340	50 m^3/day perennial
			950,000	(1250)	760	50 m^3/day seasonal
			1,500,000	450	3333	18 m^3/day domestic
DCU5	-	1989	Rates	60	Shs/m^3	Desilting
			Only	85	Shs/m^3	Embankment (excavation, transport, compaction)
				65	Shs/m^3	Excavation
GSK	KIDP	1989	10,000	200	50	Small earth dam, 10 m^3/day
			250,000	1,200	208	Medium earth dam, 60 m^3/day

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply Component: Distribution Systems (Groundwater)

Including: Main line, storage, Distribution Network Communal Water Points, Cattle Troughs

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Sericho	1988	1,417,600	2,000	709	8 CWP 5 troughs. Solar pump set (2 bh's)
SIDA	Dabel	1988	2,570,600	4,340	592	Part of pop. may use dug wells and handpumps
SIDA	Sololo	1988	2,250,000	9,500	(237)	Part of pop. may use other Sources (no cattle troughs)
NORAD	Mwingi	1988	5,500,000	<10,000	550	Design pop. 1995
	Iten	1988	2,000,000	4,200	(476)	Only main line, no distribution

Supply Component: Distribution Systems (Surface water/gravity)

Including: Main line, Storage, Distribution Network, Communal Water, Points, Cattle Troughs

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	South Horr	1988	1,125,000	5,400	208	20 CWP. 8 troughs
NORAD	Ol Joro Orok	1988	7,500,000	12,000	625	Design population 2005
NORAD	Ishiara	1987	4,800,000	14,000	(343)	Distribution only
SIDA	Karuma	1988	540,000	1,200	450	5 CWP, Roughing Filters

Supply Component: Distribution (pipes only)

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	South Horr.	1988	200,000	5,400	37	
	Sericho	1988	127,600	2,000	61	
	Dabel	1988	1,534,600	4,340	354	large supply area
	Sololo	1988	1,600,000	9,500	168	
	Nkabune	1988	500,000	3,000	167	extension of existing net. work
Norad	Mwingi	1988	3,000,000	10,000	300	12 km
	Ol Joro Orok	1988	7,000,000	12,000	583	28 km
SIDA	Karuma	1988	180,000	1,200	150	
	Ishiara	1987	4,800,000	14,000	343	58 km
LBDA	RDWSSP	1989	230,000	-	-	Unit cost per km²

All SIDA-costs excluding labour

Supply Component: Communal Water Points

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	South Horr.	1986	15,000			
PENCOL	CBWDP	1984	27,000			Kiosk
		1984	16,000			Hydrant
NORCONSULT	Gakauni	1990	1,500	175	9	

Supply Component: Cattle Troughs

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	South Horr	1986	25,000			
GSK	KIDP	1989	1,000			

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply Component: Surfacewater Intake

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Nkabune	1988	200,000	6,000	33	? m^3/day
	South Horr	1988	120,000	5,400	22	192 m^3/day
Norad	Ol Joro Orok	1988	11,900,000	12,000	992	Concrete Dam, 2500 m^3/day
	Ena	1988	2,000,000	44,000	45	2700 m^3/day
	Sagana	1988	500,000	-	-	-
NORCONSULT	Gakauni	1990	70,000	1,200	58	Intake chamber
MoWD (Meru)	Kiamiogo/Kimuri	1990	104,000			Materials only, excluding contingencies 5900 m^3/day Trapping weir and diversion box
	Katheri Ontulili	1990	60,000			Materials and labour, excluding contingencies 2160 m^3/day
	Gatabora (ASK)	1990	52,000			Materials, labour, contingencies, 750 m^3/day

Supply Component: Treatment

Including: Chlorination only

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Costs/ m^3/day	Remarks
Norad	Mwingi	1988	100,000	10,000	10	143	Gw source, Prod. 700 m^3/day
	Meru	1988	500,000	95,000	5	50	Sw source 10000 m^3/day
	Iten	1988	100,000	4,200	24	182	Gw source 550 m^3/day

Supply Component: Treatment

Including: Filters

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Karuma	1988	220,000	1,200	185	Horizontal roughing filters incl. 50m^3 tank
Norconsult	Gakauni	1990	400,000	1,200	333	

Supply Component: Treatment

Including: Full Treatment

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Costs/ m^3/day	Remarks
Norad	Ol Joro Orok	1988	5,600,000	12,000	467	2,240	Sw source, 2500 m^3/day
	Ena	1987	6,000,000	44,000	136	2,222	Sw source, 2,700 m^3/day
MoWD	Design Manual	1986	15,000,000			1,500	Capacity 10000 m^3/day
			14,000,000			1,750	8000 m^3/day
			12,300,000			2,050	6000 m^3/day
			10,800,000			2,700	4000 m^3/day
			7,600,000			3,800	2000 m^3/day
H.Humpr.	Maralal W.S.	1976	2,700,000	11,000	250	1,561	1729 m^3/day
	Kisima W.S.						

Supply Component: Motor Pump

Including: Diesel Generator - Pump

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
ODA	Kijito Wind-pump	1989	123,255			Excluding installation
	Evaluation		150,975			Including installation
GSK	Kitui/Danida	1989	150,000			50 m^3/day
Diocese of Marsabit	Baragoi	1988	82,450			
	Nanyuki	19?	67,475			excluding generator
	Lodokojek	1987	128,750			excluding generator (including 1500m cable)
	Wamba	1987	181,015			including generator
Wiggles-worth	Quotation	1989	176,650			1 m^3/hr, 75 m head
			209,850			3 m^3/hr, 75 m head
			273,600			5 m^3/hr, 75 m head
			325,600			8 m^3/hr, 75 m head
			383,600			12 m^3/hr, 75 m head

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply Component: Storage Tanks

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ m^3	Remarks
MoWD	Design Manual (Concrete Tanks)	1986	280,000		2,800	100 m^3 (excluding contingencies
			440,000		2,200	200 m^3 (")
			720,000		1,800	400 m^3 (")
			1,040,000		1,300	800 m^3 (")
			1,260,000		1,050	1200 m^3 (")
ODA	Kijito Wind-Pump Evaluation				480	
Warren	Quotation	1986	72,068			32 m^3 tank (Pressed steel)
			62,800			Tower 4 m
SIDA	South Horr	1988	75,000		3,000	25 m^3 tank
			300,000			100 m^3 tank
	Dabel	1988	675,000		3,000	225 m^3 (3 tanks)
Pencol	CBWDP	1984	70,000		7,000	10 m^3
			104,000		4,160	25 m^3
			150,000		3,000	50 m^3
			257,000		2,570	100 m^3
			463,000		2,315	200 m^3
			670,000		2,233	300 m^3
			1,087,000		2,174	500 m^3
			1,704,000		2,130	800 m^3
			1,826,000		1,521	1200 m^3
Norad	Mwingi	1988	2,500,000		5,000	500 m^3
	Garissa	1989	3,000,000		7,500	400 m^3
Norconsult	Gakauni	1990	50,000		1,000	50 m^3
SIDA	Marimanti	1988			525	Roof tank

Supply Component: Hydram

Including: Hydram, pumphouse

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
SIDA	Karuma	1988	100,000	1200		

Supply Component: Solar Pump

Source of Data	Year	Total Costs	Remarks
Davis & Shirtliff	1989	325,000	complete, 2 m^3/hr, 30 m head, 21 modules (excl. installation)
	1989	90,000	submersible pump, inverter, connectors
	1989	9,500	solar module (ARCO)
	1989	8,000	support structure for 7 modules
McPherson	1984	210,000	complete, 35 panels, 65-105 m^3/day (excluding installation)
Norconsult	1990	300,000	solar pump, panels, etc.
Norconsult	1990	1,427,000	borehole with solar pump, storage, distribution

UNIT COSTS OF WATER SUPPLIES: SOURCE DATA

Supply Component: Windmill

Including: Kijito Windmill, Pump and Stuffing Box, Installation

Source of Data	Project Name	Year	Total Costs	Popu.	Costs/ Capita	Remarks
ODA	Kijito Windpump Evaluation	1989	133,155 172,260 234,135 269,940			3.7 m rotor 4.9 m rotor 6.0 m rotor 7.5 m rotor
Diocese	Marsabit		226,492			6.0 m rotor

Supply Component: Handpump

Source of Data	Project Name	Year	Total Costs	Remarks
SIDA	KWDP	1988	14,000	Afridev pump
Warren	Quotation	1988	23,670	Mono pump, depth 5.2 m
GSK	KIDP	1989	10,000	
MoWD	Design Manual	1986	20,000	Depth up to 20 m
LBDA	Siaya District	1988	14,218	SWN-handpump duty free imported, well 10 m deep
			16,293	SWN-handpump duty free imported, well 15 m deep
			18,368	SWN-handpump duty free imported, well 20 m deep
			23,520	SWN-handpump duty free imported, borehole 50 m deep
			27,670	SWN-handpump duty free imported, borehole 60 m deep
			31,820	SWN-handpump duty free imported, borehole 70 m deep

Supply Component: Handpump

Including: Handpump + Superstructure on Dug well + Installation

Source of Data	Project Name	Year	Total Costs	Remarks
LBDA	Siaya District	1988	34,218	SWN-handpump duty free imported, well 10 m deep
			36,293	SWN-handpump duty free imported, well 15 m deep
			38,368	SWN-handpump duty free imported, well 20 m deep

Supply Component: Handpump

Including: Handpump + Superstructure on Borehole + Installation

Source of Data	Project Name	Year	Total Costs	Remarks
LBDA	Siaya District	1988	43,520	SWN-handpump duty free imported, borehole 50 m deep
			47,670	SWN-handpump duty free imported, borehole 60 m deep
			51,820	SWN-handpump duty free imported, borehole 70 m deep
MoWD	Design Manual	1986	20,000	

APPENDIX 3

DETAILS AND COSTS OF A TYPICAL WATER SUPPLY

APPENDIX 3

DETAILS AND COSTS OF A TYPICAL WATER SUPPLY

Using:
- Boreholes
- Infiltration Galleries

Details and Costs of a Typical Water Supply in Isiolo District using a Borehole

Yield of Supply	100 m^3/day	100 m^3/day	50 m^3/day	50 m^3/day	50 m^3/day	50 m^3/day	5-10 m^3/day
Location	Merti	Merti	Rural Centres, eg. Korbesa, Sericho	Rural Centres, eg. Iresa Boru	Ngare Mara, Kulamawe	Ngare Mara	Rural Centres
Boreholes	2 nr.	2 nr.	1 nr.	1 nr.	1 nr.	1 nr.	1 nr.
Borehole Depth	40 m.	40 m.	40 m.	40 m.	80 m.	80 m.	40 m.
Borehole Yield	10 m^3/hr	10 m^3/hr	5 m^3/hr	5 m^3/hr	5-30 m^3/hr	30 m^3/hr	> 2 m^3/hr
Pump Head	30 m.	30 m.	30 m.	30 m.	50 m.	30 m.	20 m.
Pump Plant	2 Diesel	2 Solar / 1 Diesel	1 Diesel	1 Solar / 1 Diesel	1 Diesel	Windmill	Handpump
Main Lines	3 km, 100 mm PVC	3 km, 100 mm PVC	4 km, 100 mm PVC	4 km, 100 mm PVC	1 km, 100 mm PVC	1 km, 100 mm PVC	-
Treatment	-	-	-	-	-	-	-
Storage	100 m^3	100 m^3	50 m^3	50 m^3	50 m^3	50 m^3	-
Distribution	4 km, PVC and GI	4 km, PVC and GI	1 km, PVC and GI	1 km, PVC and GI	3 km, PVC and GI	3 km, PVC and GI	-
Communal Water Points	10 nr.	10 nr.	5 nr.	5 nr.	5 nr.	5 nr.	-
Individual Connections	20 nr.	20 nr.	10 nr.	10 nr.	10 nr.	10 nr.	-
Capital Costs							
Boreholes	300,000 Shs	300,000 Shs	150,000 Shs	150,000 Shs	300,000 Shs	300,000 Shs	150,000 Shs
Pump Plant: Solar	- Shs	1,200,000 Shs	- Shs	600,000 Shs	- Shs	- Shs	-
Diesel	600,000 Shs	300,000 Shs	300,000 Shs	300,000 Shs	300,000 Shs	- Shs	-
Windmill/Handpump	-	-	-	-	-	350,000 Shs	30,000 Shs
Superstructure	60,000 Shs	60,000 Shs	30,000 Shs	60,000 Shs	30,000 Shs	30,000 Shs	20,000 Shs
Main Lines	900,000 Shs	900,000 Shs	1,200,000 Shs	1,200,000 Shs	300,000 Shs	300,000 Shs	-
Treatment	-	-	-	-	-	-	-
Storage	450,000 Shs	450,000 Shs	225,000 Shs	225,000 Shs	225,000 Shs	225,000 Shs	-
Distribution	2,000,000 Shs	2,000,000 Shs	500,000 Shs	500,000 Shs	1,500,000 Shs	1,500,000 Shs	-
Communal Water Points	200,000 Shs	200,000 Shs	100,000 Shs	100,000 Shs	100,000 Shs	100,000 Shs	-
Individual Connections	60,000 Shs	60,000 Shs	30,000 shs	30,000 shs	30,000 Shs	30,000 Shs	-
Cattle Troughs	-	-	-	-	-	-	-
Buildings	400,000 Shs	400,000 Shs	200,000 Shs	200,000 Shs	200,000 Shs	200,000 Shs	-
Contingencies (10%)	500,000 Shs	600,000 Shs	275,000 Shs	340,000 Shs	300,000 Shs	300,000 Shs	20,000 Shs
Total Construction Costs	5,470,000 Shs	6,470,000 Shs	3,010,000 Shs	3,705,000 Shs	3,285,000 Shs	3,335,000 Shs	220,000 Shs
Costs per m^3/day	54,700 Shs	64,700 Shs	60,200 Shs	74,100 Shs	65,700 Shs	66,700 Shs	44,000 Shs
Operational Costs							
Salaries	72,000 Shs/yr	72,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	-
Energy	36,000 Shs/yr	24,000 Shs/yr	24,000 Shs/yr	12,000 Shs/yr	40,000 Shs/yr	-	-
Chemicals	-	-	- Shs/yr	- Shs/yr	-	-	-
Maintenance	100,000 Shs/yr	100,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	3,000 Shs/yr
Total O&M Costs	208,000 Shs/yr	196,000 Shs/yr	96,000 Shs/yr	84,000 Shs/yr	112,000 Shs/yr	72,000 Shs/yr	3,000 Shs/yr

Cost level: 1991

Details and Costs of a Typical Water Supply in Isiolo District using Infiltration Galleries

Yield of Supply	300 m^3 /day	300 m^3 /day	100 m^3 /day	100 m^3 /day	50 m^3 /day	50 m^3 /day
Location	Modogashe	Modogashe	Rural Centres, e.g. Malka Daka	Rural Centres, e.g. Gafarsa	Rural Centres, e.g. Malka Daka, Eldera	Rural Centres, eg. Gafarsa
Infiltration Galleries	1,500 m.	1,500 m.	500 m.	500 m.	250 m.	250 m.
Collector Well	5 nr.	5 nr.	2 nr.	2 nr.	1 nr.	1 nr.
Total Yield	20 m^3 /hr	20 m^3 /hr	13 m^3 /hr	13 m^3 /hr	7 m^3 /hr	7 m^3 /hr
Pump Head	15 m.	15 m.	15 m.	15 m.	15 m.	15 m.
Pump Plant	2 Solar / 3 Diesel	5 Diesel	2 Solar / 1 Diesel	2 Diesel	1 Solar / 1 Diesel	1 Diesel
Main Lines	1.5 km, 100 mm PVC	1.5 km, 100 mm PVC	3 km, 100 mm PVC	3 km, 100 mm PVC	3 km, 100 mm PVC	3 km, 100 mm PVC
Treatment	Chlorination only	Chlorination only	-	-	-	-
Storage	300 m^3	300 m^3	100 m^3	100 m^3	50 m^3	50 m^3
Distribution	6 km, PVC and GI	6 km, PVC and GI	3 km, PVC and GI	3 km, PVC and GI	1 km, PVC and GI	1 km, PVC and GI
Communal Water points	15 nr.	15 nr.	10 nr.	10 nr.	5 nr.	5 nr.
Individual Connections	100 nr.	100 nr.	20 nr.	20 nr.	10 nr.	10 nr.
Capital Costs						
Infiltration Galleries	2,250,000 Shs	2,250,000 Shs	750,000 Shs	750,000 Shs	375,000 Shs	375,000 Shs
Wells	125,000 Shs	125,000 Shs	50,000 Shs	50,000 Shs	25,000 Shs	25,000 Shs
Pump Plant: Solar	1,000,000 Shs	- Shs	1,200,000 Shs	- Shs	600,000 Shs	- Shs
Diesel	600,000 Shs	1,000,000 Shs	300,000 Shs	600,000 Shs	300,000 Shs	300,000 Shs
Main Lines	450,000 Shs	450,000 Shs	900,000 Shs	900,000 Shs	900,000 Shs	900,000 Shs
Treatment	60,000 Shs	60,000 Shs	- Shs	- Shs	- Shs	- Shs
Storage	1,350,000 Shs	1,350,000 Shs	450,000 Shs	450,000 Shs	225,000 Shs	225,000 Shs
Distribution	3,000,000 Shs	3,000,000 Shs	1,500,000 Shs	1,500,000 Shs	500,000 Shs	500,000 Shs
Communal Water Points	300,000 Shs	300,000 Shs	200,000 Shs	200,000 Shs	100,000 Shs	100,000 Shs
Individual Connections	300,000 Shs	300,000 Shs	60,000 Shs	60,000 Shs	30,000 shs	30,000 shs
Cattle Troughs	-	-	-	-	-	-
Buildings	1,000,000 Shs	1,000,000 Shs	400,000 Shs	400,000 Shs	250,000 Shs	250,000 Shs
Contingencies (10%)	1,050,000 Shs	1,000,000 Shs	600,000 Shs	500,000 Shs	330,000 Shs	270,000 Shs
Total construction Costs	11,485,000 Shs	10,835,000 Shs	6,410,000 Shs	5,410,000 Shs	3,635,000 Shs	2,975,000 Shs
Costs per m^3 /day	38,300 Shs	36,000 Shs	64,100 Shs	54,100 Shs	72,700 Shs	59,500 Shs
Operational Costs						
Salaries	90,000 Shs/yr	90,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr
Energy	60,000 Shs/yr	90,000 Shs/yr	12,000 Shs/yr	24,000 Shs/yr	2,000 Shs/yr	12,000 Shs/yr
Chemicals	40,000 Shs/yr	40,000 Shs/yr	- Shs/yr	- Shs/yr	-	-
Maintenance	150,000 Shs/yr	150,000 Shs/yr	60,000 Shs/yr	60,000 Shs/yr	36,000 Shs/yr	36,000 Shs/yr
Total O&M Costs	340,000 Shs/yr	370,000 Shs/yr	108,000 Shs/yr	120,000 Shs/yr	74,000 Shs/yr	84,000 Shs/yr

Cost level: 1991

APPENDIX 4

OPERATION AND MAINTENANCE COSTS

APPENDIX 4

OPERATION AND MAINTENANCE COSTS

- Annual Maintenance Costs as Percentage of Construction Costs
- References of Operation and Maintenance Costs

Annual Maintenance Costs as Percentage of Construction Costs

Water Supply Component	Economic Lifetime Years	Annual Maintenance Costs in %
- Dams	40	0.5
- Intake works, including boreholes: Mass concrete structures, such as intakes, underground pits, culverts, etc.	40	1
- Earthworks generally	40	1
- Boreholes and wells	20	1
- Pumps:		
Hydrams and Hydrostats	15	5
Other pumps	10	5
- Power		
Diesel Engines	10	5
Engine and pump sets petrol paraffin	5	5
Electric motors, cables and switch gears	10	5
- Piping:		
All types	30	1
- Treatment Works:		
Treatment works in masonry or reinforced concrete	30	1
- Reservoirs:		
Storage tanks in masonry or reinforced concrete	30	1
Storage tanks, sectional steel including towers	20	2
Storage tanks, corrugated galvanized steel (C.G.S.) on timber stands	10	2
- Building:		
Building C.G.S. on timber	20	1
Building, masonry	30	1
- Miscellaneous structures and items: Communal water points (CWP)	10	5
Water kiosks, latrines, licensed retailer points etc.	20	2
Gantries, steelwork etc	20	2
Permanent tools and plant not mentioned elsewhere	10	2
Water meters	10	5
- Chemical Apparatus:		
Chemical dosing gear	10	5
Instruments and testing apparatus	5	5
- Roads, fences etc.		
Roads of access, general	30	1
Fences, G.S. wire or mesh on timber	10	1
Fences, G.S. wire or mesh on concrete posts	20	1

Source: MoWD, Design Manual, 1986

Operation and Maintenance Costs: Source Data

Project/Source Information	Short Description	Population	O & M Costs (Shs/m^3)
	Surface Water Source:		
SIDA - South-Horr	Gravity, 20 cwp, 8 troughs	5,400	4 *
Chepalunga	Gravity (7% pumping), 4330 km^2	135,850	1.6 *
P.K. Njiru (Diploma design)	Pumped scheme, operation costs: pumps	33,466	5.6
	treatment	33,466	1.4
	salaries	33,466	.5
	total	33,466	7.5
	maintenance costs: 2% of capital costs	33,466	2.0
	total O&M		9.5
Norconsult-Gakauni	Gravity, intake chamber, filtration, storage, piped distribution	1,863	15.5 Shs/pop.
	Groundwater Source:		
SIDA - Sericho	6 boreholes, solar pump, 8 cwp, 5 troughs	2,000	11.8 *
- Dabel	5 boreholes, handpumps, motorpumps	4,340	11.8 *
- Sololo	boreholes, dug wells, solar/motor pump	9,500	10 *
LBDA - RDWS & SP	Dug wells, handpump	200	17
FINNIDA - KFRWSDP	Dug well, handpump		500-1000 Shs/well
SIDA - KWDP	Handpump		200 Shs/pump
Norconsult-Gakauni	Handpump on borehole	1,200	9.4 Shs/pop.
	Solar pump on borehole	1,200	9.5 Shs/pop.

* O & M costs include depreciation

APPENDIX 5

COST EFFECTIVENESS ANALYSIS

APPENDIX 5

COST EFFECTIVENESS ANALYSIS

Borehole with Diesel Pump, 50 m^3 Storage
Borehole with Diesel Pump, 75 m^3 Storage
Boreholes with Diesel Pumps, 100 m^3 Storage
Borehole with Diesel and Solar Pump, 50 m^3 Storage
Borehole with Diesel and Solar Pump, 75 m^3 Storage
Boreholes with Diesel and Solar Pumps, 100 m^3 Storage
Borehole with Windmill

Infiltration Gallery with Diesel Pump, 50 m^3 Storage
Infiltration Gallery with Diesel Pump, 75 m^3 Storage
Infiltration Galleries with Diesel Pumps, 100 m^3 Storage
Infiltration Gallery with Diesel and Solar Pump, 50 m^3 Storage
Infiltration Gallery with Diesel and Solar Pump, 75 m^3 Storage
Infiltration Galleries with Diesel and Solar Pumps, 100 m^3 Storage
Infiltration Gallery with Solar Pump, 150 m^3 Storage
Infiltration Gallery with Windmill, 50 m^3 Storage
Infiltration Gallery with Windmill, 100 m^3 Storage

Borehole with Handpump
Dug Well with Handpump

Borehole with Diesel Pump, 50 m³ Storage

Appendix 5

Technology: 1 Borehole (40 m. deep) with Diesel Pump, 50 m3 Storage

Capital Cost:

Borehole	150,000 Shs
Pump	300,000 Shs
Storage	225,000 Shs
Pipelines	1,830,000 Shs
Other + Cont.	505,000 Shs
Total	3,010,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	24,000 Shs
General Maint.	36,000 Shs
Total	96,000 Shs

Replacement Costs: 300,000 for pump every 15 years

Annual Yield: 50 m3/day * 360 = 18000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	18000	3,010,000	96,000	3,106,000	172.6	3,106,000	172.6	3,106,000	172.6
1	18000		96,000	91,429	5.1	87,273	4.8	83,478	4.6
2	18000		96,000	87,075	4.8	79,339	4.4	72,590	4.0
3	18000		96,000	82,928	4.6	72,126	4.0	63,122	3.5
4	18000		96,000	78,979	4.4	65,569	3.6	54,888	3.0
5	18000		96,000	75,219	4.2	59,608	3.3	47,729	2.7
6	18000		96,000	71,637	4.0	54,189	3.0	41,503	2.3
7	18000		96,000	68,225	3.8	49,263	2.7	36,090	2.0
8	18000		96,000	64,977	3.6	44,785	2.5	31,383	1.7
9	18000		96,000	61,882	3.4	40,713	2.3	27,289	1.5
10	18000		96,000	58,936	3.3	37,012	2.1	23,730	1.3
11	18000		96,000	56,129	3.1	33,647	1.9	20,635	1.1
12	18000		96,000	53,456	3.0	30,589	1.7	17,943	1.0
13	18000		96,000	50,911	2.8	27,808	1.5	15,603	0.9
14	18000		96,000	48,487	2.7	25,280	1.4	13,568	0.8
15	18000	300,000	96,000	190,483	10.6	94,799	5.3	48,666	2.7
16	18000		96,000	43,979	2.4	20,892	1.2	10,259	0.6
17	18000		96,000	41,884	2.3	18,993	1.1	8,921	0.5
18	18000		96,000	39,890	2.2	17,266	1.0	7,757	0.4
19	18000		96,000	37,990	2.1	15,697	0.9	6,745	0.4
20	18000		96,000	36,181	2.0	14,270	0.8	5,866	0.3
Total	378,000	3,310,000	2,016,000	4,446,677	247.0	3,995,120	222.0	3,743,764	208.0

	DISCOUNT RATE		
	5 %	10 %	15 %
Total Cost (Shs/m3)	247.0	222.0	208.0

Borehole with Diesel Pump, 75 m³ Storage

Appendix 5

Technology: 1 Borehole (40 m. deep) with Diesel Pump, 75 m3 Storage

Capital Cost:

Borehole	150,000 Shs
Pump	300,000 Shs
Storage	337,500 Shs
Pipelines	2,145,000 Shs
Other + Cont.	540,000 Shs
Total	3,472,500 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	30,000 Shs
General Maint.	60,000 Shs
Total	126,000 Shs

Replacement Costs: 300,000 for pump every 15 years

Annual Yield: 75 m3/day * 360 = 27000 m3/year

				Discount Rate 5 %		Discount Rate 10 %		Discount Rate 15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	27000	3,472,500	126,000	3,598,500	133.3	3,598,500	133.3	3,598,500	133.3
1	27000		126,000	120,000	4.4	114,545	4.2	109,565	4.1
2	27000		126,000	114,286	4.2	104,132	3.9	95,274	3.5
3	27000		126,000	108,844	4.0	94,666	3.5	82,847	3.1
4	27000		126,000	103,661	3.8	86,060	3.2	72,041	2.7
5	27000		126,000	98,724	3.7	78,236	2.9	62,644	2.3
6	27000		126,000	94,023	3.5	71,124	2.6	54,473	2.0
7	27000		126,000	89,546	3.3	64,658	2.4	47,368	1.8
8	27000		126,000	85,282	3.2	58,780	2.2	41,190	1.5
9	27000		126,000	81,221	3.0	53,436	2.0	35,817	1.3
10	27000		126,000	77,353	2.9	48,578	1.8	31,145	1.2
11	27000		126,000	73,670	2.7	44,162	1.6	27,083	1.0
12	27000		126,000	70,162	2.6	40,147	1.5	23,550	0.9
13	27000		126,000	66,820	2.5	36,498	1.4	20,479	0.8
14	27000		126,000	63,639	2.4	33,180	1.2	17,807	0.7
15	27000	300,000	126,000	204,913	7.6	101,981	3.8	52,353	1.9
16	27000		126,000	57,722	2.1	27,421	1.0	13,465	0.5
17	27000		126,000	54,973	2.0	24,928	0.9	11,709	0.4
18	27000		126,000	52,356	1.9	22,662	0.8	10,181	0.4
19	27000		126,000	49,862	1.8	20,602	0.8	8,853	0.3
20	27000		126,000	47,488	1.8	18,729	0.7	7,699	0.3
Total	567,000	3,772,500	2,646,000	5,313,044	196.8	4,743,027	175.7	4,424,044	163.9

	Discount Rate 5 %	Discount Rate 10 %	Discount Rate 15 %
Total Cost (Shs/m3)	196.8	175.7	163.9

Boreholes with Diesel Pumps, 100 m³ Storage

Appendix 5

Technology: 2 Boreholes (40 m. deep) with Diesel Pumps, 100 m3 Storage

Capital Cost:

Borehole	300,000 Shs
Pumps	600,000 Shs
Storage	450,000 Shs
Pipelines	3,160,000 Shs
Other + Cont.	960,000 Shs
Total	5,470,000 Shs

Annual Costs:

Staff	72,000 Shs
Fuel	36,000 Shs
General Maint.	100,000 Shs
Total	208,000 Shs

Replacement Costs: 300,000 for each pump every 15 years

Annual Yield: 100 m3/day * 360 = 36000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	36000	5,470,000	208,000	5,678,000	157.7	5,678,000	157.7	5,678,000	157.7
1	36000		208,000	198,095	5.5	189,091	5.3	180,870	5.0
2	36000		208,000	188,662	5.2	171,901	4.8	157,278	4.4
3	36000		208,000	179,678	5.0	156,273	4.3	136,763	3.8
4	36000		208,000	171,122	4.8	142,067	3.9	118,925	3.3
5	36000		208,000	162,973	4.5	129,152	3.6	103,413	2.9
6	36000		208,000	155,213	4.3	117,411	3.3	89,924	2.5
7	36000		208,000	147,822	4.1	106,737	3.0	78,195	2.2
8	36000		208,000	140,783	3.9	97,034	2.7	67,996	1.9
9	36000		208,000	134,079	3.7	88,212	2.5	59,127	1.6
10	36000		208,000	127,694	3.5	80,193	2.2	51,414	1.4
11	36000		208,000	121,613	3.4	72,903	2.0	44,708	1.2
12	36000		208,000	115,822	3.2	66,275	1.8	38,877	1.1
13	36000		208,000	110,307	3.1	60,250	1.7	33,806	0.9
14	36000		208,000	105,054	2.9	54,773	1.5	29,396	0.8
15	36000	600,000	208,000	388,662	10.8	193,429	5.4	99,299	2.8
16	36000		208,000	95,287	2.6	45,267	1.3	22,228	0.6
17	36000		208,000	90,750	2.5	41,152	1.1	19,329	0.5
18	36000		208,000	86,428	2.4	37,411	1.0	16,807	0.5
19	36000		208,000	82,313	2.3	34,010	0.9	14,615	0.4
20	36000		208,000	78,393	2.2	30,918	0.9	12,709	0.4
Total	756,000	6,070,000	4,368,000	8,558,750	237.7	7,592,456	210.9	7,053,678	195.9

	DISCOUNT RATE		
	5 %	10 %	15 %
Total Cost (Shs/m3)	237.7	210.9	195.9

Borehole with Diesel and Solar Pump, 50 m³ Storage

Appendix 5

Technology: 1 Borehole (40 m. deep) with Diesel and Solar Pump, 50 m3 Storage

Capital Cost:

Borehole	150,000 Shs
Pumps	900,000 Shs
Storage	225,000 Shs
Pipelines	1,830,000 Shs
Other + Cont.	600,000 Shs
Total	3,705,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	12,000 Shs
General Maint.	36,000 Shs
Total	84,000 Shs

Replacement Costs: 900,000 for pumps every 15 years

Yields: Solar Pump 35 m3/day; Diesel Pump 15 m3/day
Annual Yield: 50 m3/day * 360 = 18000 m3/year

				Discount Rate 5 %		Discount Rate 10 %		Discount Rate 15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	18000	3,705,000	84,000	3,789,000	210.5	3,789,000	210.5	3,789,000	210.5
1	18000		84,000	80,000	4.4	76,364	4.2	73,043	4.1
2	18000		84,000	76,190	4.2	69,421	3.9	63,516	3.5
3	18000		84,000	72,562	4.0	63,110	3.5	55,231	3.1
4	18000		84,000	69,107	3.8	57,373	3.2	48,027	2.7
5	18000		84,000	65,816	3.7	52,157	2.9	41,763	2.3
6	18000		84,000	62,682	3.5	47,416	2.6	36,316	2.0
7	18000		84,000	59,697	3.3	43,105	2.4	31,579	1.8
8	18000		84,000	56,855	3.2	39,187	2.2	27,460	1.5
9	18000		84,000	54,147	3.0	35,624	2.0	23,878	1.3
10	18000		84,000	51,569	2.9	32,386	1.8	20,764	1.2
11	18000		84,000	49,113	2.7	29,441	1.6	18,055	1.0
12	18000		84,000	46,774	2.6	26,765	1.5	15,700	0.9
13	18000		84,000	44,547	2.5	24,332	1.4	13,652	0.8
14	18000		84,000	42,426	2.4	22,120	1.2	11,872	0.7
15	18000	900,000	84,000	473,321	26.3	235,562	13.1	120,928	6.7
16	18000		84,000	38,481	2.1	18,281	1.0	8,977	0.5
17	18000		84,000	36,649	2.0	16,619	0.9	7,806	0.4
18	18000		84,000	34,904	1.9	15,108	0.8	6,788	0.4
19	18000		84,000	33,242	1.8	13,735	0.8	5,902	0.3
20	18000		84,000	31,659	1.8	12,486	0.7	5,132	0.3
Total	378,000	4,605,000	1,764,000	5,268,741	292.7	4,719,592	262.2	4,425,389	245.9

	Discount Rate 5 %	Discount Rate 10 %	Discount Rate 15 %
Total Cost (Shs/m3)	292.7	262.2	245.9

Borehole with Diesel and Solar Pump, 75 m³ Storage

Appendix 5

Technology: 1 Borehole (40 m. deep) with Diesel and Solar Pump, 75 m3 Storage

Capital Cost:

Borehole	150,000 Shs
Pumps	900,000 Shs
Storage	337,500 Shs
Pipelines	2,145,000 Shs
Other + Cont.	640,000 Shs
Total	4,172,500 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	18,000 Shs
General Maint.	60,000 Shs
Total	114,000 Shs

Replacement Costs: 900,000 for pumps every 15 years

Yields: Solar Pump 35 m3/day; Diesel Pump 40 m3/day
Annual Yield: 75 m3/day * 360 = 27000 m3/year

				Discount Rate 5 %		Discount Rate 10 %		Discount Rate 15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	27000	4,172,500	114,000	4,286,500	158.8	4,286,500	158.8	4,286,500	158.8
1	27000		114,000	108,571	4.0	103,636	3.8	99,130	3.7
2	27000		114,000	103,401	3.8	94,215	3.5	86,200	3.2
3	27000		114,000	98,477	3.6	85,650	3.2	74,957	2.8
4	27000		114,000	93,788	3.5	77,864	2.9	65,180	2.4
5	27000		114,000	89,322	3.3	70,785	2.6	56,678	2.1
6	27000		114,000	85,069	3.2	64,350	2.4	49,285	1.8
7	27000		114,000	81,018	3.0	58,500	2.2	42,857	1.6
8	27000		114,000	77,160	2.9	53,182	2.0	37,267	1.4
9	27000		114,000	73,485	2.7	48,347	1.8	32,406	1.2
10	27000		114,000	69,986	2.6	43,952	1.6	28,179	1.0
11	27000		114,000	66,653	2.5	39,956	1.5	24,504	0.9
12	27000		114,000	63,479	2.4	36,324	1.3	21,307	0.8
13	27000		114,000	60,457	2.2	33,022	1.2	18,528	0.7
14	27000		114,000	57,578	2.1	30,020	1.1	16,111	0.6
15	27000	900,000	114,000	487,751	18.1	242,744	9.0	124,615	4.6
16	27000		114,000	52,225	1.9	24,810	0.9	12,183	0.5
17	27000		114,000	49,738	1.8	22,554	0.8	10,594	0.4
18	27000		114,000	47,369	1.8	20,504	0.8	9,212	0.3
19	27000		114,000	45,114	1.7	18,640	0.7	8,010	0.3
20	27000		114,000	42,965	1.6	16,945	0.6	6,965	0.3
Total	567,000	5,072,500	2,394,000	6,140,107	227.4	5,472,499	202.7	5,110,669	189.3

	Discount Rate 5 %	Discount Rate 10 %	Discount Rate 15 %
Total Cost (Shs/m3)	227.4	202.7	189.3

Boreholes with Diesel and Solar Pumps, 100 m³ Storage

Appendix 5

Technology: 2 Boreholes (40 m. deep) with 1 Diesel and 2 Solar Pumps, 100 m3 Storage

Capital Cost:

Borehole	300,000 Shs
Pumps	1,500,000 Shs
Storage	450,000 Shs
Pipelines	3,160,000 Shs
Other + Cont.	1,060,000 Shs
Total	6,470,000 Shs

Annual Costs:

Staff	72,000 Shs
Fuel	24,000 Shs
General Maint.	100,000 Shs
Total	196,000 Shs

Replacement Costs: 1,500,000 for pumps every 15 years

Yields: Solar Pump 35 m3/day; Diesel Pump 65 m3/day
Annual Yield: 100 m3/day * 360 = 36000 m3/year

				Discount Rate 5 %		Discount Rate 10 %		Discount Rate 15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	36000	6,470,000	196,000	6,666,000	185.2	6,666,000	185.2	6,666,000	185.2
1	36000		196,000	186,667	5.2	178,182	4.9	170,435	4.7
2	36000		196,000	177,778	4.9	161,983	4.5	148,204	4.1
3	36000		196,000	169,312	4.7	147,258	4.1	128,873	3.6
4	36000		196,000	161,250	4.5	133,871	3.7	112,064	3.1
5	36000		196,000	153,571	4.3	121,701	3.4	97,447	2.7
6	36000		196,000	146,258	4.1	110,637	3.1	84,736	2.4
7	36000		196,000	139,294	3.9	100,579	2.8	73,684	2.0
8	36000		196,000	132,661	3.7	91,435	2.5	64,073	1.8
9	36000		196,000	126,343	3.5	83,123	2.3	55,715	1.5
10	36000		196,000	120,327	3.3	75,566	2.1	48,448	1.3
11	36000		196,000	114,597	3.2	68,697	1.9	42,129	1.2
12	36000		196,000	109,140	3.0	62,452	1.7	36,634	1.0
13	36000		196,000	103,943	2.9	56,774	1.6	31,855	0.9
14	36000		196,000	98,993	2.7	51,613	1.4	27,700	0.8
15	36000	1,500,000	196,000	815,805	22.7	406,009	11.3	208,429	5.8
16	36000		196,000	89,790	2.5	42,655	1.2	20,945	0.6
17	36000		196,000	85,514	2.4	38,778	1.1	18,213	0.5
18	36000		196,000	81,442	2.3	35,252	1.0	15,838	0.4
19	36000		196,000	77,564	2.2	32,048	0.9	13,772	0.4
20	36000		196,000	73,870	2.1	29,134	0.8	11,976	0.3
Total	756,000	7,970,000	4,116,000	9,830,119	273.1	8,693,747	241.5	8,077,171	224.4

	Discount Rate 5 %	Discount Rate 10 %	Discount Rate 15 %
Total Cost (Shs/m3)	273.1	241.5	224.4

Borehole with Windmill

Appendix 5

Technology: 1 Borehole (40 m. deep) with Windmill, 50 m3 Storage

Capital Cost:

Borehole	150,000 Shs
Pump	350,000 Shs
Storage	225,000 Shs
Pipelines	1,930,000 Shs
Other + Cont.	530,000 Shs
Total	3,185,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	0 Shs
General Maint.	36,000 Shs
Total	72,000 Shs

Replacement Costs: 350,000 for pump every 15 years

Annual Yield: 50 m3/day * 300 = 15000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	15000	3,185,000	72,000	3,257,000	217.1	3,257,000	217.1	3,257,000	217.1
1	15000		72,000	68,571	4.6	65,455	4.4	62,609	4.2
2	15000		72,000	65,306	4.4	59,504	4.0	54,442	3.6
3	15000		72,000	62,196	4.1	54,095	3.6	47,341	3.2
4	15000		72,000	59,235	3.9	49,177	3.3	41,166	2.7
5	15000		72,000	56,414	3.8	44,706	3.0	35,797	2.4
6	15000		72,000	53,728	3.6	40,642	2.7	31,128	2.1
7	15000		72,000	51,169	3.4	36,947	2.5	27,067	1.8
8	15000		72,000	48,732	3.2	33,589	2.2	23,537	1.6
9	15000		72,000	46,412	3.1	30,535	2.0	20,467	1.4
10	15000		72,000	44,202	2.9	27,759	1.9	17,797	1.2
11	15000		72,000	42,097	2.8	25,236	1.7	15,476	1.0
12	15000		72,000	40,092	2.7	22,941	1.5	13,457	0.9
13	15000		72,000	38,183	2.5	20,856	1.4	11,702	0.8
14	15000		72,000	36,365	2.4	18,960	1.3	10,176	0.7
15	15000	350,000	72,000	202,989	13.5	101,023	6.7	51,861	3.5
16	15000		72,000	32,984	2.2	15,669	1.0	7,694	0.5
17	15000		72,000	31,413	2.1	14,245	0.9	6,691	0.4
18	15000		72,000	29,917	2.0	12,950	0.9	5,818	0.4
19	15000		72,000	28,493	1.9	11,773	0.8	5,059	0.3
20	15000		72,000	27,136	1.8	10,702	0.7	4,399	0.3
Total	315,000	3,535,000	1,512,000	4,322,635	288.2	3,953,764	263.6	3,750,685	250.0

	Discount Rate		
	5 %	10 %	15 %
Total Cost (Shs/m3)	288.2	263.6	250.0

Infiltration Gallery with Diesel Pump, 50 m³ Storage

Appendix 5

Technology: 1 Infiltration Gallery and Well with Diesel Pump, 50 m3 Storage

Capital Cost:

Infil. Gallery	400,000 Shs
Pump	300,000 Shs
Storage	225,000 Shs
Pipelines	1,530,000 Shs
Other + Cont.	520,000 Shs
Total	2,975,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	12,000 Shs
General Maint.	36,000 Shs
Total	84,000 Shs

Replacement Costs: 300,000 for pump every 15 years

Annual Yield: 50 m3/day * 360 = 18000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	18000	2,975,000	84,000	3,059,000	169.9	3,059,000	169.9	3,059,000	169.9
1	18000		84,000	80,000	4.4	76,364	4.2	73,043	4.1
2	18000		84,000	76,190	4.2	69,421	3.9	63,516	3.5
3	18000		84,000	72,562	4.0	63,110	3.5	55,231	3.1
4	18000		84,000	69,107	3.8	57,373	3.2	48,027	2.7
5	18000		84,000	65,816	3.7	52,157	2.9	41,763	2.3
6	18000		84,000	62,682	3.5	47,416	2.6	36,316	2.0
7	18000		84,000	59,697	3.3	43,105	2.4	31,579	1.8
8	18000		84,000	56,855	3.2	39,187	2.2	27,460	1.5
9	18000		84,000	54,147	3.0	35,624	2.0	23,878	1.3
10	18000		84,000	51,569	2.9	32,386	1.8	20,764	1.2
11	18000		84,000	49,113	2.7	29,441	1.6	18,055	1.0
12	18000		84,000	46,774	2.6	26,765	1.5	15,700	0.9
13	18000		84,000	44,547	2.5	24,332	1.4	13,652	0.8
14	18000		84,000	42,426	2.4	22,120	1.2	11,872	0.7
15	18000	300,000	84,000	184,711	10.3	91,927	5.1	47,191	2.6
16	18000		84,000	38,481	2.1	18,281	1.0	8,977	0.5
17	18000		84,000	36,649	2.0	16,619	0.9	7,806	0.4
18	18000		84,000	34,904	1.9	15,108	0.8	6,788	0.4
19	18000		84,000	33,242	1.8	13,735	0.8	5,902	0.3
20	18000		84,000	31,659	1.8	12,486	0.7	5,132	0.3
Total	378,000	3,275,000	1,764,000	4,250,131	236.1	3,845,957	213.7	3,621,652	201.2

	DISCOUNT RATE		
	5 %	10 %	15 %
Total Cost (Shs/m3)	236.1	213.7	201.2

Infiltration Gallery with Diesel Pump, 75 m³ Storage

Appendix 5

Technology: 1 Infiltration Gallery and Well with Diesel Pump, 75 m3 Storage

Capital Cost:

Infil. Gallery	600,000 Shs
Pump	300,000 Shs
Storage	337,500 Shs
Pipelines	2,095,000 Shs
Other + Cont.	600,000 Shs
Total	3,932,500 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	18,000 Shs
General Maint.	48,000 Shs
Total	102,000 Shs

Replacement Costs: 300,000 for pump every 15 years

Annual Yield: 75 m3/day * 360 = 27000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	27000	3,932,500	102,000	4,034,500	149.4	4,034,500	149.4	4,034,500	149.4
1	27000		102,000	97,143	3.6	92,727	3.4	88,696	3.3
2	27000		102,000	92,517	3.4	84,298	3.1	77,127	2.9
3	27000		102,000	88,111	3.3	76,634	2.8	67,067	2.5
4	27000		102,000	83,916	3.1	69,667	2.6	58,319	2.2
5	27000		102,000	79,920	3.0	63,334	2.3	50,712	1.9
6	27000		102,000	76,114	2.8	57,576	2.1	44,097	1.6
7	27000		102,000	72,489	2.7	52,342	1.9	38,346	1.4
8	27000		102,000	69,038	2.6	47,584	1.8	33,344	1.2
9	27000		102,000	65,750	2.4	43,258	1.6	28,995	1.1
10	27000		102,000	62,619	2.3	39,325	1.5	25,213	0.9
11	27000		102,000	59,637	2.2	35,750	1.3	21,924	0.8
12	27000		102,000	56,797	2.1	32,500	1.2	19,065	0.7
13	27000		102,000	54,093	2.0	29,546	1.1	16,578	0.6
14	27000		102,000	51,517	1.9	26,860	1.0	14,416	0.5
15	27000	300,000	102,000	193,369	7.2	96,236	3.6	49,404	1.8
16	27000		102,000	46,727	1.7	22,198	0.8	10,900	0.4
17	27000		102,000	44,502	1.6	20,180	0.7	9,478	0.4
18	27000		102,000	42,383	1.6	18,346	0.7	8,242	0.3
19	27000		102,000	40,365	1.5	16,678	0.6	7,167	0.3
20	27000		102,000	38,443	1.4	15,162	0.6	6,232	0.2
Total	567,000	4,232,500	2,142,000	5,449,951	201.9	4,974,701	184.2	4,709,820	174.4

	Discount Rate		
	5 %	10 %	15 %
Total Cost (Shs/m3)	201.9	184.2	174.4

Infiltration Galleries with Diesel Pumps, 100 m³ Storage

Appendix 5

Technology: 2 Infiltration Galleries and Wells with Diesel Pumps, 100 m3 Storage

Capital Cost:

Infil. Gallery	800,000 Shs
Pumps	600,000 Shs
Storage	450,000 Shs
Pipelines	2,660,000 Shs
Other + Cont.	900,000 Shs
Total	5,410,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	24,000 Shs
General Maint.	60,000 Shs
Total	120,000 Shs

Replacement Costs: 300,000 for each pump every 15 years

Annual Yield: 100 m3/day * 360 = 36000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	36000	5,410,000	120,000	5,530,000	153.6	5,530,000	153.6	5,530,000	153.6
1	36000		120,000	114,286	3.2	109,091	3.0	104,348	2.9
2	36000		120,000	108,844	3.0	99,174	2.8	90,737	2.5
3	36000		120,000	103,661	2.9	90,158	2.5	78,902	2.2
4	36000		120,000	98,724	2.7	81,962	2.3	68,610	1.9
5	36000		120,000	94,023	2.6	74,511	2.1	59,661	1.7
6	36000		120,000	89,546	2.5	67,737	1.9	51,879	1.4
7	36000		120,000	85,282	2.4	61,579	1.7	45,112	1.3
8	36000		120,000	81,221	2.3	55,981	1.6	39,228	1.1
9	36000		120,000	77,353	2.1	50,892	1.4	34,111	0.9
10	36000		120,000	73,670	2.0	46,265	1.3	29,662	0.8
11	36000		120,000	70,162	1.9	42,059	1.2	25,793	0.7
12	36000		120,000	66,820	1.9	38,236	1.1	22,429	0.6
13	36000		120,000	63,639	1.8	34,760	1.0	19,503	0.5
14	36000		120,000	60,608	1.7	31,600	0.9	16,959	0.5
15	36000	600,000	120,000	346,332	9.6	172,362	4.8	88,484	2.5
16	36000		120,000	54,973	1.5	26,115	0.7	12,824	0.4
17	36000		120,000	52,356	1.5	23,741	0.7	11,151	0.3
18	36000		120,000	49,862	1.4	21,583	0.6	9,697	0.3
19	36000		120,000	47,488	1.3	19,621	0.5	8,432	0.2
20	36000		120,000	45,227	1.3	17,837	0.5	7,332	0.2
Total	756,000	6,010,000	2,520,000	7,314,075	203.2	6,695,263	186.0	6,354,856	176.5

	Discount Rate		
	5 %	10 %	15 %
Total Cost (Shs/m3)	203.2	186.0	176.5

Infiltration Gallery with Diesel and Solar Pump, 50 m³ Storage

Appendix 5

Technology: 1 Infiltration Gallery and Well with Diesel and Solar Pump, 50 m3 Storage

Capital Cost:

Infil. Gallery	400,000 Shs
Pumps	900,000 Shs
Storage	225,000 Shs
Pipelines	1,530,000 Shs
Other + Cont.	580,000 Shs
Total	3,635,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	2,000 Shs
General Maint.	36,000 Shs
Total	74,000 Shs

Replacement Costs: 900,000 for pumps every 15 years

Yields: Solar Pump 50 m3/day; Diesel Pump stand-by
Annual Yield: 50 m3/day * 360 = 18000 m3/year

				Discount Rate 5 %		Discount Rate 10 %		Discount Rate 15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	18000	3,635,000	74,000	3,709,000	206.1	3,709,000	206.1	3,709,000	206.1
1	18000		74,000	70,476	3.9	67,273	3.7	64,348	3.6
2	18000		74,000	67,120	3.7	61,157	3.4	55,955	3.1
3	18000		74,000	63,924	3.6	55,597	3.1	48,656	2.7
4	18000		74,000	60,880	3.4	50,543	2.8	42,310	2.4
5	18000		74,000	57,981	3.2	45,948	2.6	36,791	2.0
6	18000		74,000	55,220	3.1	41,771	2.3	31,992	1.8
7	18000		74,000	52,590	2.9	37,974	2.1	27,819	1.5
8	18000		74,000	50,086	2.8	34,522	1.9	24,191	1.3
9	18000		74,000	47,701	2.7	31,383	1.7	21,035	1.2
10	18000		74,000	45,430	2.5	28,530	1.6	18,292	1.0
11	18000		74,000	43,266	2.4	25,937	1.4	15,906	0.9
12	18000		74,000	41,206	2.3	23,579	1.3	13,831	0.8
13	18000		74,000	39,244	2.2	21,435	1.2	12,027	0.7
14	18000		74,000	37,375	2.1	19,487	1.1	10,458	0.6
15	18000	900,000	74,000	468,511	26.0	233,168	13.0	119,699	6.6
16	18000		74,000	33,900	1.9	16,105	0.9	7,908	0.4
17	18000		74,000	32,286	1.8	14,641	0.8	6,877	0.4
18	18000		74,000	30,749	1.7	13,310	0.7	5,980	0.3
19	18000		74,000	29,284	1.6	12,100	0.7	5,200	0.3
20	18000		74,000	27,890	1.5	11,000	0.6	4,521	0.3
Total	378,000	4,535,000	1,554,000	5,064,119	281.3	4,554,457	253.0	4,282,796	237.9

	DISCOUNT RATE 5 %	10 %	15 %
Total Cost (Shs/m3)	281.3	253.0	237.9

Infiltration Gallery with Diesel and Solar Pump, 75 m³ Storage

Appendix 5

Technology: 1 Infiltration Gallery and Well with Diesel and Solar Pump, 75 m3 Storage

Capital Cost:

Inf. gallery	600,000 Shs
Pumps	900,000 Shs
Storage	337,500 Shs
Pipelines	2,095,000 Shs
Other + Cont.	670,000 Shs
Total	4,602,500 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	5,000 Shs
General Maint.	48,000 Shs
Total	89,000 Shs

Replacement Costs: 900,000 for pumps every 15 years

Yields: Solar Pump 60 m3/day; Diesel Pump 15 m3/day
Annual Yield: 75 m3/day * 360 = 27000 m3/year

				Discount Rate 5 %		Discount Rate 10 %		Discount Rate 15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	27000	4,602,500	89,000	4,691,500	173.8	4,691,500	173.8	4,691,500	173.8
1	27000		89,000	84,762	3.1	80,909	3.0	77,391	2.9
2	27000		89,000	80,726	3.0	73,554	2.7	67,297	2.5
3	27000		89,000	76,882	2.8	66,867	2.5	58,519	2.2
4	27000		89,000	73,221	2.7	60,788	2.3	50,886	1.9
5	27000		89,000	69,734	2.6	55,262	2.0	44,249	1.6
6	27000		89,000	66,413	2.5	50,238	1.9	38,477	1.4
7	27000		89,000	63,251	2.3	45,671	1.7	33,458	1.2
8	27000		89,000	60,239	2.2	41,519	1.5	29,094	1.1
9	27000		89,000	57,370	2.1	37,745	1.4	25,299	0.9
10	27000		89,000	54,638	2.0	34,313	1.3	21,999	0.8
11	27000		89,000	52,036	1.9	31,194	1.2	19,130	0.7
12	27000		89,000	49,559	1.8	28,358	1.1	16,635	0.6
13	27000		89,000	47,199	1.7	25,780	1.0	14,465	0.5
14	27000		89,000	44,951	1.7	23,436	0.9	12,578	0.5
15	27000	900,000	89,000	475,726	17.6	236,759	8.8	121,543	4.5
16	27000		89,000	40,772	1.5	19,369	0.7	9,511	0.4
17	27000		89,000	38,830	1.4	17,608	0.7	8,270	0.3
18	27000		89,000	36,981	1.4	16,007	0.6	7,192	0.3
19	27000		89,000	35,220	1.3	14,552	0.5	6,254	0.2
20	27000		89,000	33,543	1.2	13,229	0.5	5,438	0.2
Total	567,000	5,502,500	1,869,000	6,233,552	230.9	5,664,660	209.8	5,359,186	198.5

	DISCOUNT RATE 5 %	10 %	15 %
Total Cost (Shs/m3)	230.9	209.8	198.5

Infiltration Galleries with Diesel and Solar Pumps, 100 m³ Storage Appendix 5

Technology: 2 Infiltration Galleries and Wells with 1 Diesel and 2 Solar Pump, 100 m3 Storage

Capital Cost:

Infil. gallery	800,000 Shs
Pumps	1,500,000 Shs
Storage	450,000 Shs
Pipelines	2,660,000 Shs
Other + Cont.	1,000,000 Shs
Total	6,410,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	12,000 Shs
General Maint.	60,000 Shs
Total	108,000 Shs

Replacement Costs: 1,500,000 for pumps every 15 years

Yields: Solar Pump 60 m3/day; Diesel Pump 40 m3/day
Annual Yield: 100 m3/day * 360 = 36000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	36000	6,410,000	108,000	6,518,000	181.1	6,518,000	181.1	6,518,000	181.1
1	36000		108,000	102,857	2.9	98,182	2.7	93,913	2.6
2	36000		108,000	97,959	2.7	89,256	2.5	81,664	2.3
3	36000		108,000	93,294	2.6	81,142	2.3	71,012	2.0
4	36000		108,000	88,852	2.5	73,765	2.0	61,749	1.7
5	36000		108,000	84,621	2.4	67,060	1.9	53,695	1.5
6	36000		108,000	80,591	2.2	60,963	1.7	46,691	1.3
7	36000		108,000	76,754	2.1	55,421	1.5	40,601	1.1
8	36000		108,000	73,099	2.0	50,383	1.4	35,305	1.0
9	36000		108,000	69,618	1.9	45,803	1.3	30,700	0.9
10	36000		108,000	66,303	1.8	41,639	1.2	26,696	0.7
11	36000		108,000	63,145	1.8	37,853	1.1	23,214	0.6
12	36000		108,000	60,138	1.7	34,412	1.0	20,186	0.6
13	36000		108,000	57,275	1.6	31,284	0.9	17,553	0.5
14	36000		108,000	54,547	1.5	28,440	0.8	15,263	0.4
15	36000	1,500,000	108,000	773,475	21.5	384,942	10.7	197,614	5.5
16	36000		108,000	49,476	1.4	23,504	0.7	11,541	0.3
17	36000		108,000	47,120	1.3	21,367	0.6	10,036	0.3
18	36000		108,000	44,876	1.2	19,425	0.5	8,727	0.2
19	36000		108,000	42,739	1.2	17,659	0.5	7,589	0.2
20	36000		108,000	40,704	1.1	16,054	0.4	6,599	0.2
Total	756,000	7,910,000	2,268,000	8,585,444	238.5	7,796,553	216.6	7,378,350	205.0

	DISCOUNT RATE		
	5 %	10 %	15 %
Total Cost (Shs/m3)	238.5	216.6	205.0

Infiltration Gallery with Solar Pump, 150 m³ Storage

Appendix 5

Technology: 1 Infiltration Gallery and Well with Solar Pump, 150 m3 Storage

Capital Cost:

Infil. Gallery	400,000 Shs
Pump	600,000 Shs
Storage	675,000 Shs
Pipelines	1,530,000 Shs
Other + Cont.	600,000 Shs
Total	3,805,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	0 Shs
General Maint.	36,000 Shs
Total	72,000 Shs

Replacement Costs: 600,000 for pump every 15 years

Annual Yield: 50 m3/day * 300 = 15000 m3/year

Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Discount Rate 5 % Costs (Shs)	5 % Cost/yr (Shs/m3)	10 % Costs (Shs)	10 % Cost/yr (Shs/m3)	15 % Costs (Shs)	15 % Cost/yr (Shs/m3)
0	15000	3,805,000	72,000	3,877,000	258.5	3,877,000	258.5	3,877,000	258.5
1	15000		72,000	68,571	4.6	65,455	4.4	62,609	4.2
2	15000		72,000	65,306	4.4	59,504	4.0	54,442	3.6
3	15000		72,000	62,196	4.1	54,095	3.6	47,341	3.2
4	15000		72,000	59,235	3.9	49,177	3.3	41,166	2.7
5	15000		72,000	56,414	3.8	44,706	3.0	35,797	2.4
6	15000		72,000	53,728	3.6	40,642	2.7	31,128	2.1
7	15000		72,000	51,169	3.4	36,947	2.5	27,067	1.8
8	15000		72,000	48,732	3.2	33,589	2.2	23,537	1.6
9	15000		72,000	46,412	3.1	30,535	2.0	20,467	1.4
10	15000		72,000	44,202	2.9	27,759	1.9	17,797	1.2
11	15000		72,000	42,097	2.8	25,236	1.7	15,476	1.0
12	15000		72,000	40,092	2.7	22,941	1.5	13,457	0.9
13	15000		72,000	38,183	2.5	20,856	1.4	11,702	0.8
14	15000		72,000	36,365	2.4	18,960	1.3	10,176	0.7
15	15000	600,000	72,000	323,243	21.5	160,871	10.7	82,585	5.5
16	15000		72,000	32,984	2.2	15,669	1.0	7,694	0.5
17	15000		72,000	31,413	2.1	14,245	0.9	6,691	0.4
18	15000		72,000	29,917	2.0	12,950	0.9	5,818	0.4
19	15000		72,000	28,493	1.9	11,773	0.8	5,059	0.3
20	15000		72,000	27,136	1.8	10,702	0.7	4,399	0.3
Total	315,000	4,405,000	1,512,000	5,062,889	337.5	4,633,612	308.9	4,401,409	293.4

	DISCOUNT RATE 5 %	10 %	15 %
Total Cost (Shs/m3)	337.5	308.9	293.4

Infiltration Gallery with Windmill, 50 m³ Storage

Appendix 5

Technology: 1 Well and Infiltration Gallery with Windmill, 50 m3 Storage

Capital Cost:

Infil. Gallery	400,000 Shs
Pump	350,000 Shs
Storage	225,000 Shs
Pipelines	1,530,000 Shs
Other + Cont.	500,000 Shs
Total	3,005,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	0 Shs
General Maint.	36,000 Shs
Total	72,000 Shs

Replacement Costs: 350,000 for pump every 15 years

Annual Yield: 50 m3/day * 300 = 15000 m3/year

				Discount Rate					
				5 %		10 %		15 %	
Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)	Costs (Shs)	Cost/yr (Shs/m3)
0	15000	3,005,000	72,000	3,077,000	205.1	3,077,000	205.1	3,077,000	205.1
1	15000		72,000	68,571	4.6	65,455	4.4	62,609	4.2
2	15000		72,000	65,306	4.4	59,504	4.0	54,442	3.6
3	15000		72,000	62,196	4.1	54,095	3.6	47,341	3.2
4	15000		72,000	59,235	3.9	49,177	3.3	41,166	2.7
5	15000		72,000	56,414	3.8	44,706	3.0	35,797	2.4
6	15000		72,000	53,728	3.6	40,642	2.7	31,128	2.1
7	15000		72,000	51,169	3.4	36,947	2.5	27,067	1.8
8	15000		72,000	48,732	3.2	33,589	2.2	23,537	1.6
9	15000		72,000	46,412	3.1	30,535	2.0	20,467	1.4
10	15000		72,000	44,202	2.9	27,759	1.9	17,797	1.2
11	15000		72,000	42,097	2.8	25,236	1.7	15,476	1.0
12	15000		72,000	40,092	2.7	22,941	1.5	13,457	0.9
13	15000		72,000	38,183	2.5	20,856	1.4	11,702	0.8
14	15000		72,000	36,365	2.4	18,960	1.3	10,176	0.7
15	15000	350,000	72,000	202,989	13.5	101,023	6.7	51,861	3.5
16	15000		72,000	32,984	2.2	15,669	1.0	7,694	0.5
17	15000		72,000	31,413	2.1	14,245	0.9	6,691	0.4
18	15000		72,000	29,917	2.0	12,950	0.9	5,818	0.4
19	15000		72,000	28,493	1.9	11,773	0.8	5,059	0.3
20	15000		72,000	27,136	1.8	10,702	0.7	4,399	0.3
Total	315,000	3,355,000	1,512,000	4,142,635	276.2	3,773,764	251.6	3,570,685	238.0

	DISCOUNT RATE		
	5 %	10 %	15 %
Total Cost (Shs/m3)	276.2	251.6	238.0

Infiltration Gallery with Windmill, 100 m³ Storage

Appendix 5

Technology: 1 Well and Infiltration Gallery with Windmill, 100 m3 Storage

Capital Cost:

Infil. Gallery	600,000 Shs
Pump	450,000 Shs
Storage	450,000 Shs
Pipelines	2,095,000 Shs
Other + Cont.	650,000 Shs
Total	4,245,000 Shs

Annual Costs:

Staff	36,000 Shs
Fuel	0 Shs
General Maint.	36,000 Shs
Total	72,000 Shs

Replacement Costs: 450,000 for pump every 15 years

Annual Yield: 75 m3/day * 300 = 22500 m3/year

Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Discount Rate 5 % Costs (Shs)	5 % Cost/yr (Shs/m3)	10 % Costs (Shs)	10 % Cost/yr (Shs/m3)	15 % Costs (Shs)	15 % Cost/yr (Shs/m3)
0	22500	4,245,000	72,000	4,317,000	191.9	4,317,000	191.9	4,317,000	191.9
1	22500		72,000	68,571	3.0	65,455	2.9	62,609	2.8
2	22500		72,000	65,306	2.9	59,504	2.6	54,442	2.4
3	22500		72,000	62,196	2.8	54,095	2.4	47,341	2.1
4	22500		72,000	59,235	2.6	49,177	2.2	41,166	1.8
5	22500		72,000	56,414	2.5	44,706	2.0	35,797	1.6
6	22500		72,000	53,728	2.4	40,642	1.8	31,128	1.4
7	22500		72,000	51,169	2.3	36,947	1.6	27,067	1.2
8	22500		72,000	48,732	2.2	33,589	1.5	23,537	1.0
9	22500		72,000	46,412	2.1	30,535	1.4	20,467	0.9
10	22500		72,000	44,202	2.0	27,759	1.2	17,797	0.8
11	22500		72,000	42,097	1.9	25,236	1.1	15,476	0.7
12	22500		72,000	40,092	1.8	22,941	1.0	13,457	0.6
13	22500		72,000	38,183	1.7	20,856	0.9	11,702	0.5
14	22500		72,000	36,365	1.6	18,960	0.8	10,176	0.5
15	22500	450,000	72,000	251,091	11.2	124,963	5.6	64,151	2.9
16	22500		72,000	32,984	1.5	15,669	0.7	7,694	0.3
17	22500		72,000	31,413	1.4	14,245	0.6	6,691	0.3
18	22500		72,000	29,917	1.3	12,950	0.6	5,818	0.3
19	22500		72,000	28,493	1.3	11,773	0.5	5,059	0.2
20	22500		72,000	27,136	1.2	10,702	0.5	4,399	0.2
Total	472,500	4,695,000	1,512,000	5,430,737	241.4	5,037,703	223.9	4,822,974	214.4

	DISCOUNT RATE 5 %	10 %	15 %
Total Cost (Shs/m3)	241.4	223.9	214.4

Borehole with Handpump

Appendix 5

Technology: Borehole with Handpump

Capital cost: 220,000 Shs
Annual Costs: 3,000 Shs (Maintenance of Borehole and Handpump)
Replacement Costs: Handpump 30,000 Shs - every 6 years.

Annual Yield: 5 m3/day * 365 = 1825 m3/year

Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Discount Rate 5 % Costs (Shs)	5 % Cost/yr (Shs/m3)	10 % Costs (Shs)	10 % Cost/yr (Shs/m3)	15 % Costs (Shs)	15 % Cost/yr (Shs/m3)
0	1825	220,000	3,000	223,000	122.2	223,000	122.2	223,000	122.2
1	1825		3,000	2,857	1.6	2,727	1.5	2,609	1.4
2	1825		3,000	2,721	1.5	2,479	1.4	2,268	1.2
3	1825		3,000	2,592	1.4	2,254	1.2	1,973	1.1
4	1825		3,000	2,468	1.4	2,049	1.1	1,715	0.9
5	1825		3,000	2,351	1.3	1,863	1.0	1,492	0.8
6	1825	30,000	3,000	24,625	13.5	18,628	10.2	14,267	7.8
7	1825		3,000	2,132	1.2	1,539	0.8	1,128	0.6
8	1825		3,000	2,031	1.1	1,400	0.8	981	0.5
9	1825		3,000	1,934	1.1	1,272	0.7	853	0.5
10	1825		3,000	1,842	1.0	1,157	0.6	742	0.4
11	1825		3,000	1,754	1.0	1,051	0.6	645	0.4
12	1825	30,000	3,000	18,376	10.1	10,515	5.8	6,168	3.4
13	1825		3,000	1,591	0.9	869	0.5	488	0.3
14	1825		3,000	1,515	0.8	790	0.4	424	0.2
15	1825		3,000	1,443	0.8	718	0.4	369	0.2
16	1825		3,000	1,374	0.8	653	0.4	321	0.2
17	1825		3,000	1,309	0.7	594	0.3	279	0.2
18	1825	30,000	3,000	13,712	7.5	5,935	3.3	2,667	1.5
19	1825		3,000	1,187	0.7	491	0.3	211	0.1
20	1825		3,000	1,131	0.6	446	0.2	183	0.1
Total	38,325	310,000	63,000	311,944	170.9	280,430	153.7	262,779	144.0

	DISCOUNT RATE 5 %	10 %	15 %
Total Cost (Shs/m3)	170.9	153.7	144.0

Dug Well with Handpump

Technology: Dug Well with Handpump

Capital cost: 93,500 Shs
Annual Costs: 3,000 Shs (Maintenance)
Replacement Costs: Handpump 30,000 Shs - every 6 years.

Annual Yield: 5 m3/day * 365 = 1825 m3/year

Year	Annual Yield (m3)	Capital Costs (Shs)	Annual Costs (Shs)	Discount Rate 5 % Costs (Shs)	5 % Cost/yr (Shs/m3)	10 % Costs (Shs)	10 % Cost/yr (Shs/m3)	15 % Costs (Shs)	15 % Cost/yr (Shs/m3)
0	1825	93,500	3,000	96,500	52.9	96,500	52.9	96,500	52.9
1	1825		3,000	2,857	1.6	2,727	1.5	2,609	1.4
2	1825		3,000	2,721	1.5	2,479	1.4	2,268	1.2
3	1825		3,000	2,592	1.4	2,254	1.2	1,973	1.1
4	1825		3,000	2,468	1.4	2,049	1.1	1,715	0.9
5	1825		3,000	2,351	1.3	1,863	1.0	1,492	0.8
6	1825	30,000	3,000	24,625	13.5	18,628	10.2	14,267	7.8
7	1825		3,000	2,132	1.2	1,539	0.8	1,128	0.6
8	1825		3,000	2,031	1.1	1,400	0.8	981	0.5
9	1825		3,000	1,934	1.1	1,272	0.7	853	0.5
10	1825		3,000	1,842	1.0	1,157	0.6	742	0.4
11	1825		3,000	1,754	1.0	1,051	0.6	645	0.4
12	1825	30,000	3,000	18,376	10.1	10,515	5.8	6,168	3.4
13	1825		3,000	1,591	0.9	869	0.5	488	0.3
14	1825		3,000	1,515	0.8	790	0.4	424	0.2
15	1825		3,000	1,443	0.8	718	0.4	369	0.2
16	1825		3,000	1,374	0.8	653	0.4	321	0.2
17	1825		3,000	1,309	0.7	594	0.3	279	0.2
18	1825	30,000	3,000	13,712	7.5	5,935	3.3	2,667	1.5
19	1825		3,000	1,187	0.7	491	0.3	211	0.1
20	1825		3,000	1,131	0.6	446	0.2	183	0.1
Total	38,325	183,500	63,000	185,444	101.6	153,930	84.3	136,279	74.7

	DISCOUNT RATE 5 %	10 %	15 %
Total Cost (Shs/m3)	101.6	84.3	74.7

ISIOLO

DISTRICT WATER DEVELOPMENT STUDY

1993 - 2013

PART 3

GUIDELINES AND RECOMMENDATIONS FOR INVESTMENT PACKAGES

June 1991

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APPENDICES

1. Priority Water Supply Investment
2. Project Proposal - Indicative Investment Packages

ABBREVIATIONS

ASAL	=	Arid and Semi-Arid Lands Development Program
CBWDP	=	Central Baringo Water Development Plan
CC	=	County Council
DANIDA	=	Danish International Development Agency
DDC	=	District Development Committee
DDP	=	Meru District Development Plan 1989-1993
DvDC	=	Divisional Development Committee
DWDP	=	District Water Development Plan
DWDS	=	District Water Development Study
EEC	=	European Economic Commission
FINNIDA	=	Finnish International Development Agency
GOK	=	Government of Kenya
GSK	=	Groundwater Survey Kenya
GTZ	=	Deutsche Gesellschaft fur Technische Zusammenarbeit
KFRWSDP	=	Kenya Finland Rural Water Supply Development Project in Western Province
KIDP	=	Kitui Development Program
Ksh	=	Kenya shilling
KWAHO	=	Kenya Water for Health Organization
KWDP	=	Kwale District Community Water Supply and Sanitation Project
L.U.	=	Livestock Unit
LBDA	=	Lake Basin Development Authority
lpcd	=	liters per capita per day
MoA	=	Ministry of Agriculture
MOH	=	Ministry of Health
MoLD	=	Ministry of Livestock Development
MoWD	=	Ministry of Water Development
MCSS	=	Ministry of Culture and Social Services
MPND	=	Ministry of Planning and National Development
msl	=	Meters above mean sea level
NGO	=	Non-Government Organization
NORAD	=	Norwegian Agency for Development
ODA	=	Overseas Development Agency
Shs	=	Kenya shilling
SIDA	=	Swedish International Development Agency
UNDP	=	United Nations Development Project
UNICEF	=	United Nations International Childrens Emergency Fund
USAID	=	United States Agency for International Development
WECO	=	Western College of Arts
WRAP	=	Water Resources Assessment and Planning Project

SUMMARY

The present report is Part 3, Guidelines and Recommendations for Investment Packages, which is the third of three reports, composing the Isiolo District Water Development Study. Part 3 provides the background and methodology for the implementation by the District of investments in the water sector.

Indicative investment packages were developed, which were intended to provide cost estimates of investment projects. Four considerations were identified as central to the design of successful investment projects. These were:

- the appropriate technical choice in terms of ability to produce the required quantity and quality, and impact on the environment; the latter is particularly sensitive for the use of the water supplies by livestock;
- the socio-economic base which determines the attitude to participation in the project; this issue is important as nomadic communities are particularly difficult to mobilise, further, social factors add to the technical difficulties of supplying water to nomads and stock as the communities (or parts thereof) move throughout the year.
- the institutional base for design, construction and operation of the investment project, including community consultation during all of these phases, and
- the financial base of the project including the policy framework, particularly on cost sharing and on district financial autonomy, and the financial systems used.

Each of these considerations effect the economic demand of the people for water on the one hand, and the ability of the MoWD and other bodies to supply it on the other.

The major issues raised when the above factors are considered are:

- supply of water for livestock must be provided only in areas where any consequent increase in numbers will not degrade the environment.
- cost sharing policies with respect to government/donor schemes may need to be flexible depending on the community served; full cost sharing (Capital and O&M costs) may be feasible in urban schemes, but for rural schemes cost sharing may have to be limited to recovery of O & M costs.
- even with these limited objectives, the choice of technology must be appropriate to the communities ability and willingness to pay, in particular rural schemes must have minimum O & M costs if they are to be born by the community.
- in order to implement the District Focus policy which gives the District MoWD responsibility for co-ordination the provision of water to the Isiolo communities, several facets of the operation of the Central and District MoWD should change.

Based on the above considerations, specific criteria were developed for use in the appraisal of investment projects. These criteria were incorporated in a simple checklist, a version of which, as modified by the DWE, should be included in the DWDP. Such checklist will enable quick assessment of the impact and viability of proposed projects.

The checklist covers the following topics:
- water resources
- land use planning/environmental impact
- social impact
- institutional/community participation

- economics/affordability
- finance.

For each rural centre, the available resources and their potential for development of the domestic and livestock supplies was analysed. The results are described in pre-feasibility studies of each centre. These are combined in a separate volume accompanying the DWDS. The cost estimates were used to prepare indicative investment packages.

Three types of investment packages were prepared:

1. Investment packages based on technology choice
2. Investment packages based on location of the centres/projects
3. Investment packages based on the required feasibility studies.

Because of uncertainty, or simple unavailability, of data, feasibility studies must confirm the viability of specific systems/projects. The total costs of the feasibility studies are estimated at Ksh 1.5 million.

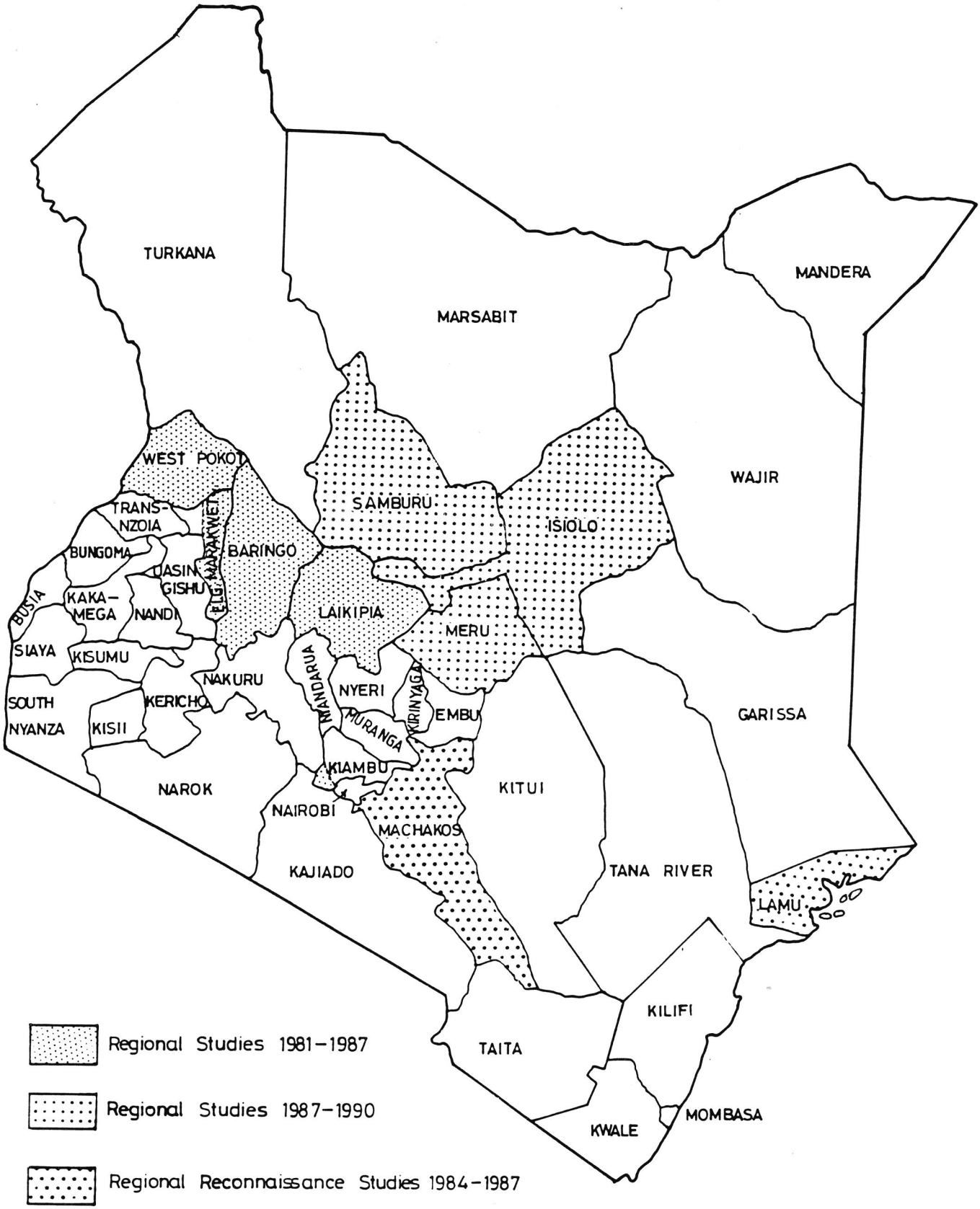
The pre-feasibility studies cover the domestic supply of the centres and include only a small part of the livestock supply associated with the centre. The capital costs of the proposed systems which deliver water through water points in the centre range for most centres between 1.8 million to 4.0 million Shs. The capital costs per household are about 5,000 to 10,000 Shs.

The O & M costs of the systems in the small rural centres range between 200 to 400 Shs per household per year, which must be affordable for most of the people. The proposals for the water supplies assumes that the community will organise the O & M and will be responsible for the financial administration. The MoWD is expected to assist mainly in the maintenance part of the operation.

In order to implement the District Focus policy which gives the District MoWD responsibility for co-ordinating the provision of water to the Isiolo communities, several facets of the operation of the Central and District MoWD should change. The most important are:

- District water offices should retain revenue collected as an incentive to better collection and to ease cash flow problems
- the "appropriations in aid" policy with respect to funding of development (capital) works should be clearly specified and revised so as not to disadvantage high cost schemes
- financial systems should be revised to enable these effective management and implementation of District Focus and Cost Sharing policies, in particular, full costs and revenues should be brought together in the one set of accounts
- flexibility in pricing policy is also required by the cost sharing policy catalysing community participation.
- Central office staff, in their role as support to the District, require better training in higher level skills in the areas of training, water resources planning, O & M, financial systems, community mobilisation, technical design, environmental management and project appraisal
- MoWD in general, requires strengthening of the links to other agencies and organisations, both public and private, involved in provision of water supplies.

WATER RESOURCES ASSESSMENT & PLANNING PROJECT



Regional Assessment Studies under the WRAP Programme 1981-1990

1. INTRODUCTION

1.1 Purpose and Scope of the Study

The District Water Development Study (DWDS) of Isiolo District is aimed at providing the basis for the District Water Development Plan (DWDP), which in turn will be the sector input to the District Development Plan (DDP).

The study was undertaken by the Ministry of Water Development in its role of supporting the districts in their task to develop the available water resources in a safe and sustainable way. Two conditions will have to be fulfilled to achieve this goal.

- The development of water resources must be in balance both with the capacity of these resources and with the conditions set by the environment.

- Supply of water to the community must be sustainable, meaning that the proposed schemes be designed in agreement with the technical and financial support capability of the people for whom they will be constructed.

These conditions require a thorough assessment of the situation in the districts and a planning that is in tune with the socio-economic, institutional and technical developments.

The DWDS can be considered the first stage in the process of formulating a DWDP. The study, based on extensive assessments, describes the water resources development potential in comparison to the projected water demand, discusses the viability of different water supply options in terms of sustainability and safety, and provides estimates of the investment levels involved.

The DWDP based on the study will be more specific in that it also comprises the decisions of the district authorities regarding selection and prioritization of the water development schemes. The plan is to cover a period of 20 years, according to MoWD guidelines, starting from 1993 when operation of the first new schemes will supposedly begin. The DWDP will be an important component of the DDP which includes the entire socio-economical planning of the district in perspective to all the available resources. From the above it may be clear that both plans are closely linked and can only be successfully developed in good co-ordination.

The methodology for planning of water resources development, adopted by the Ministry facilitates full participation of the district authorities, community groups and individuals concerned in all stages of the planning process, which is in line with the District Focus Policy. An outline of the general approach is given in Chapter 2 of this report.

In order to provide optimal conditions for district involvement, the DWDS is carried out in three phases. District engineers and institutions concerned with water use and water supply are extensively consulted during the periods of data collection and analysis. The final report includes three volumes, corresponding with the three phases of the study.

The present report on the guidelines and recommendations for investment packages is Part 3 of the DWDS carried out for Isiolo District within the framework of WRAP.

The report provides the background and methodology for the implementation by the District of investments in the water sector. The report presents cost estimates, which are based on the analysis of the water development possibilities at each rural centre. These estimates are used in the preparation of district investment packages, which may be used by the District to formulate concrete project proposals. Also recommendations for implementation of investment packages are discussed, with respect to strengthening of institutions, execution of feasibility studies and efforts to secure external funding support.

1.2 International Co-operation

The District Water Development Study was undertaken under Co-operative Agreement between the Governments of Kenya and The Netherlands.

The studies are carried out by the Water Resources Assessment Section of the Ministry of Water Development, Nairobi, Kenya in co-operation with the TNO Institute of Applied Geoscience, Delft, The Netherlands, within the framework of the **Water Resources Assessment and Planning (WRAP)** project.

Consultancy services were provided by the Netherlands Economic Institute, Rotterdam, The Netherlands and the International Institute for Hydraulic and Environmental Engineering, Delft, The Netherlands.

2. GENERAL APPROACH

The District Water Development Study (DWDS) is a base study for preparation of the District Water Development Plan (DWDP). All components that constitute the DWDP are also covered by the DWDS.

The model introduced by the WRAP project for preparation of a DWDP is shown in figure 2.1. The DWDS follows this model in analysing the various components that finally will lead to the formulation of the DWDP. The study includes three phases focusing on different aspects of the planning, namely:

- the compatibility of available water resources with water demand in the present situation and for projected demand scenarios
- the viability of the technical options for water supply development based on environmental and sustainability criteria
- the investments involved in the district water development and the technical, institutional, social and financial factors determining the sustainability of selected solutions

The results obtained in the subsequent phases of the DWDS are presented in Part 1, Part 2 and Part 3 of the DWDS report, which should provide the district authorities with sufficient base information for initiating further development of the water resources in the District. An outline of the Study is given below.

Water Demand Study (Part 1)

The water demand study comprises of analyses and projections of the water consumption by all water users in the district. The baseline data available from various sources are often incomplete and/or inaccurate. Therefore, thorough scrutiny of the data is needed to ensure sufficient reliability of further analysis. The data is processed using a Database Management System that handles both the calculation of the water demand and the projection of the baseline data.

The water demand is calculated using the procedure laid down in the Design Manual of the Ministry of Water Development. The procedure compels to projecting the water demand in 5, 15 and 25 years time. This, in turn, requires analysis of the growth trends of population, livestock, agriculture, industries, tourism, etc.

It may be clear that the DWDS depends on the input from other sectors, such as livestock and agriculture, to complete the projections in the most realistic way.

Water Resources Assessment Study (Part 1)

Water resources assessment studies are an essential component of the DWDS. The assessment studies undertaken within the framework of the WRAP project comprise the following:

- An inventory of available data and studies on the water resources in the District

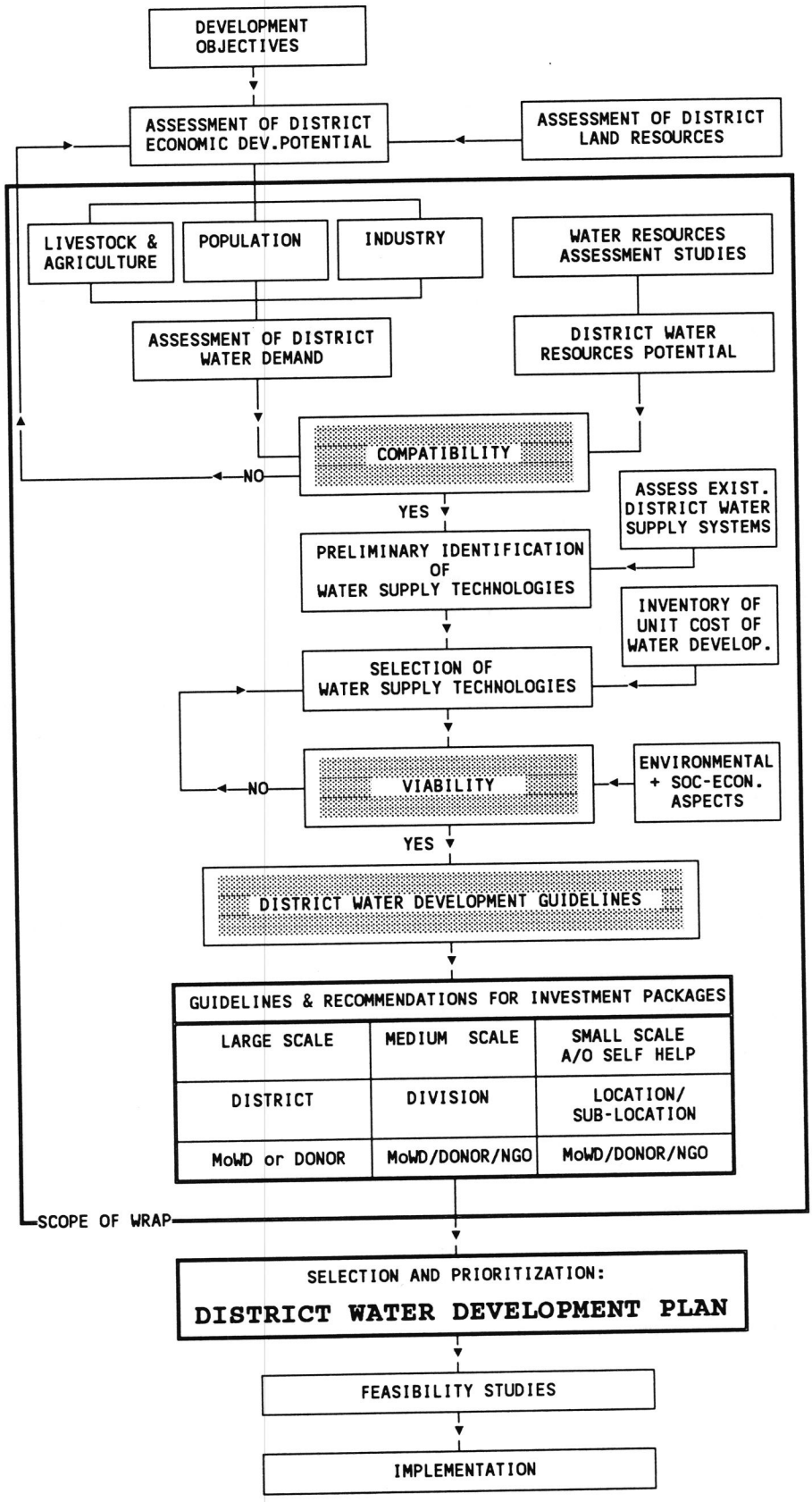


Figure 2.1 **Model for Preparation of District Water Development Plan**

- A field survey including collection of data on surface water and groundwater, rehabilitation of part of the existing measuring stations and installation of temporary measuring stations. Measurements are made of the quantity and quality of water in rivers, springs, wells and boreholes.

- A geophysical reconnaissance survey using vertical electrical or electromagnetic soundings and profiling, aimed at providing more insight into the hydrogeological conditions. The results of the survey are checked and calibrated by drilling of exploratory boreholes and test pumping.

- An analysis of the geological, geophysical, hydrological and hydrogeological maps and data, both from the inventory and from field investigations.

From all this information and after careful and systematic analysis, water availability maps are prepared which show the water development potential of the area. The water resources assessment investigations are described in a separate report and a summary of the main conclusions on the water development potential is given in Part 1 of the DWDS report.

Comparison of Water Demand and Available Resources (Part 1)

Having estimated the water demand over the next 25 years and the water resources available in the district, a close analysis is made of the water development potential to decide whether the projected water demand can be met.

When comparing the demand with the resources, priorities need to be set whether a district can best support human, livestock, agricultural or industrial development. In this respect both quantity and quality of the water must be considered.

What emerges from this process of comparing the demand with the resources, is a description of the development potential of the District, based on water availability.

Study of Water Supply Development Options (Part 2)

From the actual and projected water demand and the capacity of existing water supply schemes, the need for further development of the water supplies can be determined.

Limited water resources, contrasting interest or expected negative environmental impact may hamper further development. However, in situations with sufficient water available, often more than one supply option can be considered. A selection of the best alternative must then be based on considerations of financial, technical and environmental viability.

Phase 2 of the DWDS includes:

- Assessment of existing district water supply systems
- Assessment of technical options for water supply improvement
- Inventory of unit costs for water development based on existing supplies
- Preliminary identification of water supply options and cost
- Study of cost-effectiveness of water supply options

The results and conclusions are presented in Part 2 of the DWDS report. Together with Part 1 this forms the basis for the 'District Water Development Guidelines'.

Formulation of Guidelines and Recommendations for Investment Packages (Part 3)

The guidelines and recommendations for the development of the district water resources result in proposals for improvement of the existing water supply situation in the District. The proposed improvements may range from very small local supplies to comprehensive water supply schemes. The investments required to improve the water supply situation have been termed investment packages.

The purpose of the investment packages is to present to the Government of Kenya and interested donors a preliminary estimate of the funds and other inputs needed for water supply development. Each investment package or a combination of them can thus form the core of a water supply project.

WRAP has concentrated on investment packages for development of domestic supplies, because livestock supplies are currently planned for by the Isiolo Livestock Development Project of the Ministry of Livestock Development. The investment packages are based on pre-feasibility studies of water supply development in each rural centre of Isiolo District.

Phase 3 of the DWDS includes the following issues:

- Land use, environmental, social, institutional and economic/financial factors to be considered
- Guidelines for assessment of water sector investment proposals
- Pre-feasibility studies of water supply to rural centres
- Recommendations on required institutional strengthening for implementation of the DWDP
- A framework for a proposal based on the investment packages.

The analyses, results, conclusions and recommendations arrived at are presented in Part 3 of the DWDS report. The pre-feasibility studies are presented in a separate volume accompanying the DWDS report.

3 BASIS FOR INVESTMENT

3.1 Overview

This report, Part 3 of the District Water Development Study, is intended to provide the background and methodology for the implementation by the District of investments in the water sector. All three parts of the Study will serve as a basis of the District Water Development Plan (DWDP), to be prepared by the District Water Engineer for submission to the District Development Committee. This Report and the subsequent DWDP will give the district an additional instrument with which to strengthen the District Focus policy with Ministry of Water Development (MoWD) in a co-ordinating role.

Water supply investments must be compatible with the District Development Plan and the DWDP. This chapter will set out an overview of the technical, social, institutional and financial basis for the preparation of investment packages. These issues have been discussed in Parts 1 and 2 of the Study.

On this base, indicative investment packages, consisting of water supply schemes (or projects), for the district will be developed in three stages. The first stage (Chapter 4) will examine the major factors to be considered with respect to design of these investment packages. This chapter will examine both the factors which influence supply of water, the technical, institutional and financial factors in particular, and factors which determine the (economic) demand for water. Affordability and willingness to pay, and the institutions required for community participation are the key factors discussed with respect to the demand side. The second stage (Chapter 5) will describe the methodology and criteria for choice of investment, either individual projects or packages, consistent with the DWDP. The last stage (Chapter 6) will describe indicative investment packages using the methodology developed in the previous two stages.

The implementation of these investment packages, or any others, will require significant institutional strengthening, feasibility study and efforts to secure external funding support. These requirements will be discussed in the concluding section (Chapter 7) of the Study.

Throughout the Study, a distinction will be made between water systems which are suitable for direct government support, and those systems (usually smaller systems) for which the local community must be the focus of development activity. This distinction is necessary because of the widely differing circumstances of different parts of the District, with some parts firmly in the formal, money economy and others only partly so.

3.2 Technical Base

The various water supply technologies available and appropriate for use in Isiolo District were detailed in Part 2, Chapters 5 and 6. These technologies were selected to address the various types of water resources available in the district. They are summarised in Table 3.1 below.

Table 3.1 Results of Cost Effectiveness Analysis

Technology	Daily Yield (m^3)	Total Capital Costs (Shs)	Total O&M Costs (Shs)	Total Cost/m^3 (Shs)		
				5% disc.	10% disc.	15% disc.
Borehole with Diesel Pump	50	3,310,000	2,016,000	247.0	222.0	208.0
Borehole with Diesel Pump	75	3,772,500	2,646,000	196.8	175.7	163.9
Two Boreholes with Diesel Pumps	100	6,070,000	4,368,000	237.7	210.9	195.9
Borehole with Diesel and Solar Pump	50	4,605,000	1,764,000	292.7	262.2	245.9
Borehole with Diesel and Solar Pump	75	5,072,500	2,394,000	227.4	202.7	189.3
Two Boreholes with Diesel and Two Solar Pumps	100	7,970,000	4,116,000	273.1	241.5	224.4
Borehole with Windmill	50	3,535,000	1,512,000	288.2	263.6	250.0
Infiltration Galleries with Diesel Pump	50	3,275,000	1,764,000	236.1	213.7	201.2
Infiltration Galleries with Diesel Pump	75	4,232,500	2,142,000	201.9	184.2	174.4
Infiltration Galleries with Two Diesel Pump	100	6,010,000	2,520,000	203.2	186.0	176.5
Infiltr. Galleries with Diesel and Solar Pumps	50	4,535,000	1,554,000	281.3	253.0	237.9
Infiltr. Galleries with Diesel and Solar Pumps	75	5,502,500	1,869,000	230.9	209.8	198.5
Inf. Galleries with Diesel and Two Solar Pumps	100	7,910,000	2,268,000	238.5	216.6	205.0
Infiltration Galleries with Solar Pump	50	4,405,000	1,512,000	337.5	308.9	293.4
Infiltration Galleries with Windmill	50	3,355,000	1,512,000	276.2	251.6	238.0
Infiltration Galleries with Windmill	75	4,695,000	1,512,000	241.4	223.9	214.4
Dug Well with Handpump	5	183,500	63,000	101.6	84.3	74.7
Borehole with Handpump	5	310,000	63,000	170.9	153.7	144.0

Note (1) - Total Cost/m^3 is the total discounted cost per cubic meter capacity per year
(2) - Total Capital Costs include investment + replacement costs.

The technologies set out in the Table provide the technical options from which are chosen the systems appropriate to the social, financial and institutional structures applicable at population centres within the District.

In general, these options fall into two categories which reflect the above mentioned economic division of the district. These are:

- the small scale urban systems catering for growing urban populations, and,
- the market centres and other rural schemes which must serve a dual role of providing water to people and to animals.

In the future, as more people give up a nomadic existence or diversify from dependence on livestock, the rural schemes may have to cope with increasing demand from small scale irrigated agriculture.

3.3 Socio-economic Base

The "rural" district of Isiolo is composed of four types of settlement for which water supply is required. These are:

- Small urban areas such as Isiolo, Garba Tula, Modogashe and Merti with an estimated population greater than 2,000. They are major market centres for livestock and as service centres for government (education and health in particular), small scale repair facilities, and retail of basic consumer goods. They are surrounded by an increasingly permanent housing (olas) at very low densities.
- Market centres such as Oldo Nyiro, Kinna, Kulamawe, Sericho and Bulesa with an estimated population less than 2,000. In these settlements the permanent, formal sector structures are ranged along one or two streets (livestock purchasing agencies and shops selling basic consumer goods). This area is surrounded by an area of very low density housing (olas) as above.
- Olas (encampments) of the pastoralist Boran and Somali in rural areas. These structures are usually temporary, but may occupy the same general area over prolonged periods. Of the Isiolo people, the Boran comprise an estimated 70%.
- "Independent" facilities such as tourist lodges, missions and schools.

Nomadic peoples are not well represented in the formal urban sector.

In addition water is required for several different uses, some of which must be associated with these settlements. The most important is the demand for water for livestock. The olas of the dominant Boran surrounding the small urban and market centres have many associated herds which constitute a substantial demand. When the cattle move to better pasture, the olas sometimes also move. Water is thus required along the routes used by livestock. Tourist facilities have associated demand from wildlife. Other demand from small-scale agriculture (supplying small urban centres) is significant. This demand comes from some irrigation schemes along the Ewaso Nyiro River and at Kinna.

With the exception of government provided park facilities such as gates, airports, ranger posts, etc., wildlife (tourism) is a formal sector activity carried out by the private sector. Investments for water supply in this industry can thus be left to the private sector, given that the projected investments are in line with the DWDP. Nomadic pastoralism is the main traditional economic activity and is substantially outside the formal economy. This activity combined with urban demand, cover the majority of the population who will have difficulty in obtaining water without government intervention. They are thus the legitimate focus of government activity in the water sector. However, it should be noted that the approach adopted for these two groups will be, of necessity, quite different.

The average urban income in the district (Isiolo town) was estimated at Shs 2,580 per month in 1987 (source: Central Bureau of Statistics, Statistical Abstract 1988). The average rural income in the district could not be estimated from available data, but surveys carried out under the Isiolo Livestock Development Project (ILDP) will give useful information on rural wealth.

Apart from water, the main constraints to District economic development are limitations on livestock capacity, poor transport links/access to markets and underdeveloped

market structure.

Considering the technical options available and the settlement pattern, water will thus be delivered to people and industries in four groupings, the first three of which require support of government. These are:

- urban systems with mainly service and small scale industry demand in addition to residential demand,
- market centre systems with some service demand, a small permanent residential demand, increasing demand from semi-permanent residents, who may require water supply for cattle
- rural supplies for nomadic pastoralists, transit cattle and some agriculture provided in accordance with the recommendations of the ILDP, and
- supplies to "independent" facilities in the formal sector, usually government institutions such as schools and police stations.

Within these groupings there are social groups which have differing cultural requirements and income levels which will effect their effective demand for the various technical options. That is, these different groups can afford different amounts for their water and have different priorities with respect to availability/quality/use. ILDP studies confirm this. Different groups will thus often demand different things from water supply systems. In order to resolve these competing demands strong institutional systems are required and it is these systems which will now be examined.

3.4 Institutional Base

3.4.1 Context

The existing network of organisations involved in the water sector is complex. With the District Focus Policy, the district is expected to co-ordinate all investment, including investment in water supplies. However, there is a confusion in policy direction between what is known in other countries as "deconcentration", i.e. placing implementation activities of line Ministries at local level while retaining centralised control of staff and budgeting, and "decentralisation", i.e. giving staffing and finance control to the local institutions. The former course has been adopted in Kenya, and, as a consequence, effective district co-ordination of investment, including that in the water sector, is difficult.

Four key activities are required to implement a water supply. It must be planned, designed, constructed and operated. Overall water policy planning, and technical (design) support is the responsibility of the Ministry of Water Development (MoWD). Responsibility for construction and operation is fragmented however. Local offices of line ministries, including the District Office of the MoWD, have considerable autonomy in design and construction of water supply schemes.

Private formal sector organisations, missions and other entities may obtain permits as "water undertakers", to exploit local water resources. The appointment of a water undertaker is done by the Minister of Water Development under the powers of the Water Act (cap.372). There is little reference to District level institutions. This process is, therefore, mostly outside the district focus policy. In Isiolo, the County Council and the Catholic Church are water undertakers for schemes at Kinna and Oldo Nyiro

respectively.

Local Water Associations are legal entities which have a Water Permit. They are being formed in some districts to become responsible for existing water systems or to undertake new ones. Permission to utilise water resources under the Water Act is presently given by a committee of the MoWD meeting in Nairobi, but is usually decided on the recommendation of the District Office of the MoWD. The lowest level institutions are the informal water committees. There are no examples of such committees in the Isiolo district. In general, District MoWD implements urban/market centre supplies and smaller schemes are undertaken by communities sometimes assisted by an NGO.

3.4.2 Implementation of District Focus in the Water Sector

The existing institutional base of future water investment in the district is limited. In the context of the District Focus policy, the District Development Committee (DDC), assisted by the District Executive Committee, is expected to co-ordinate investment in the water sector. This includes expenditures by the County Council (under the Ministry of Local Government). While the structure is in place, the resources to carry out the required project appraisal, prioritisation and implementation are very limited.

The MoWD District offices are being strengthened as part of the "deconcentration" of Ministry activity. The policy of "appropriations in aid" has been instituted which will link future recurrent expenditure funds allocated to districts to their performance in meeting revenue targets established by treasury. Wages for lower levels of staff will be the responsibility of the district to pay. This may have a considerable impact on efficiency as there are indications that district level staff are underskilled, and that, compared to the resources available to work with, there may be significant over staffing.

The head office of the Ministry in Nairobi will now concentrate on providing policy, training and technical support, especially as key implementation activity has also been taken over by the National Water Conservation and Pipeline Corporation. In this role, it has begun to institutionalise the assessment and planning process developed, to a great extent, through the WRAP project. The water assessment studies and planning reports are now an important resource for the MoWD, and its staff are being trained in the techniques of assessment. The Planning Unit within the recently created Water Resources Assessment Section (see Directory MoWD, May 1989) is responsible for carrying out these studies and assessments.

However, two major issues remain. The first is the lack of effective implementation of decentralisation policy and the second is that there is no clear policy on which organisation(s) should implement projects at district level. There are several options. These include the District office of the MoWD, the County Council, and local Water Associations. The choice of institution will depend on the existing strength of these institutions, and potential for future strengthening.

Planning of water development and choice of implementing organisations may best be addressed by an approach which involves all interested parties. Such an approach is currently being developed in Baringo District with assistance from UNICEF where a district water coordination group has been formed led by an inter-ministerial team and supported by every operational NGO in the district. The inter-ministerial team has representatives of MoWD, MoH and MCSS as well as the DDO and it is to be in contact with all operating organizations in the district who have an interest in water. It has been

agreed in Baringo that this group meets every three months for information sharing, decision making, etc.

Thus in Baringo District, responsibility for the district water development strategy is shared by all concerned groups. Groups of institutions become the "lead" agency for community mobilization and implementation in their division. Such matters as overlapping and duplication are worked out. Once plans are agreed it is up to each group to implement in their own way. With this approach it will be possible to implement water programmes by different organizations within the overall district strategy.

In Isiolo District, the limited autonomy and resources of the District office of the MoWD restrict its project implementation roles. A significant shift in operational procedures would be required for it to take the initiative in this respect. Such changes would need to address the DWE's inability to determine staffing, purchasing and revenue (tariff).

The Isiolo County Council has had a role in the provision of water supplies in the District and is anxious to see an expansion of supplies, but if it is to have a role in this activity considerable strengthening will be required. The County Council sees a role for itself in supporting communities in their efforts to plan and implement water systems. A significant shift in operational procedures would be required for it to take the initiative in this respect. With an annual budget of Shs 5 million of which 45 percent comes from Game Park revenues, there is little scope for new initiatives. Increasing Game Park revenues is thus a high priority in any strengthening operation in addition to more general revenue enhancement and operational strengthening.

3.4.3 Community Involvement in the Water Sector

Water Associations or Committees, in theory ideal for the implementation and/or operation of small community schemes, also have a weak base in the Isiolo District. While various community leaders are present on the Divisional Development Councils and are represented on the DDC by the Divisional Officer, there is no formal structure of community participation, although the informal links through chiefs and sub-chiefs to the elders are said to be effective. Such participation is fundamental to the success of water supply projects in rural areas.

Water Committees are active at several centres in the District. They mainly deal with the water supply of livestock, but are also involved in organizing the domestic water supply. As yet, they have had little experience with the running of a complete water supply system with water delivery points in the centre, such as exists at Sericho. The committees continue to rely heavily on the technical assistance by the MoWD. Only at Sericho training for self-sustained operation and maintenance has been undertaken.

The institutional base will also play a key role in the type of system chosen. Systems which require complex or expensive operations and maintenance support will not be easily handled by district institutions. This is particularly important in the choice of system where local communities will have a major role in implementing the systems.

The experience with participation of local communities within the district has not been encouraging, although few attempts have been made. ILDP studies have found that the Boran community does have effective social structures which control the construction, use and finance of certain types of traditional (wells) and non-traditional

(boreholes) water sources. Where construction is involved, the communities do pay workers for labour (although mainly in food - goats). Where diesel is required for borehole pumps, each user brings his or her own. Such activities are organised through traditional decision-making processes. Some types of non-traditional sources (pans and dams) have not, however, proved suitable for traditional management systems. Current sociological investigations being carried out by ILDP are attempting to define the mechanisms for effective participation within the Boran and Somali communities. It is expected that these will probably be based on the unit of resource management, the deda.

For co-ordination of the use of water resources over a wider area (the District) an approach such as used in Baringo District could be considered. Communities are involved especially in the smaller centres, the district team concentrates more on the larger population centres using conventional piped schemes. The small schemes will be community owned and therefore communities are involved from the beginning of discussions on planning, cost sharing and implementation.

It is likely that the extent of involvement of the community and the sophistication of the organisational measures required to manage that participation will vary with the size of water supply. Examples of such schemes are few in Isiolo, although the SIDA Sericho project has some relevant lessons. In Meru, there are examples of self help schemes which point the way to viable organisational models for a variety of scheme sizes. However,of more relevance is the experience in the Samburu District.

In the Samburu District, the most effective form of community participation has been that practised under the Integrated Food Security Programme in Wamba Division. This programme was initiated after the severe droughts of the early 1980's. It has expanded into areas of small scale infrastructure, including water supplies. This programme begins by demanding that the community form a committee, including some elders, which must make a formal application to the government for the project. This committee must commit the community to pay a substantial sum to the capital works, which is used first. They must also commit to a substantial input of labour, half of which is payed for (half in food and half in money). The community thus feels it "owns" the project, and will maintain the scheme to the limits of its financial and organisational ability (these limits should be taken into account when technologies are chosen). The initial community contribution can be almost offset by labour payments.

The participation of the communities in improving their water supply is linked, in other districts (e.g. Baringo and Kisumu) with the community health programme, which has been running successfully for several years. As with other forms of technology, health education is about changing attitudes and past practices as well as importing knowledge. It is therefore an activity which extends beyond the life of a development project. An essential operational factor is to identify animators/ educators who come from within the communities in order for them to participate in training and to use that training on a long term basis during and after the project. The task for the water coordinators (or water network) will be to draw on these existing human resources in order to spread essential health/water messages.

3.5 Financial Base

3.5.1 Financial Context

Two sets of structures are central to consideration of the financial systems for water supply. These are:

- policies and systems linking national and district levels, and
- systems operating at district level.

Policy at national level is currently under review. The final form of this policy will be seen in a Cabinet Paper currently under preparation. Although this document is not yet available, certain issues to be addressed in the Paper are clear in the context of the Cost Sharing policy set out in the National Development Plan. These are:

- definition of the extent of cost sharing required from various types of schemes
- mechanisms for tariff setting,
- incentives for increased efficiency of revenue collection, particularly through the use of the system of "appropriations in aid" (AIA) such that districts will be able to retain all or most of revenue raised in the district above the set target for recurrent expenditure, and
- authorising stricter enforcement (disconnections).

At present, these policies are not defined, but the direction of policy is clear. The water sector has the following immediate goals:

- to maximise the amount of revenue collected as a proportion of billed, and
- to maximise the amount of water billed as a proportion of water produced.

Although no definite targets have been set for cost recovery, the objective of all government systems is to improve current performance in this respect. Targets for revenue collection set as part of the AIA policy have been distributed for comment, and appear to require considerable adjustment. Further, the mechanism for distribution of appropriations in relation to the estimates system (see below) is not clear. It is of little use increasing the allowed District estimates by the minimum of 80% of funds raised above the target, if the allocated funds are only 50% of District estimates.

The National Development Plan also states that water supplied should be affordable. The review of tariff policy will no doubt give due consideration to this factor.

These policies have significant implications for the structure of the organisations undertaking water supply, the financial systems they employ and the monitoring that is done, and the choice of system for a particular project (in terms of the capital and operational costs). The current systems can now be described.

3.5.2 National-District Financial Systems

National Ministries, including the MoWD, submit yearly budgets for both development (capital) and recurrent expenditures to Treasury. On final approval, the districts are informed of their allocation on a six monthly basis.

Each district has a District Cash Fund (account) from which line Ministries can make payments. For approved capital expenditures, the Authority to Incur Expenditure (AIE) is cleared from central MoWD. AIEs for approved recurrent expenditures are issued by the District MoWD. The Cash Fund is reimbursed from Treasury. Additional resources are also available through the Rural Development Fund and the EC Micro-project Fund on application, although this allocation must be approved centrally by both Treasury and MoWD.

Revenues from consumers in all MoWD schemes are not collected by the District MoWD, but by the District Treasury and thence are forwarded to national level. In theory, the District MoWD in this system cannot make use of the revenues collected directly. However, an interim arrangement, designed to overcome desperate cashflow problems, appears to be operating (as of November 1990) whereby collections of arrears and normal revenues can be converted into cash for recurrent expenditures. A cheque from the District Treasurer, made payable to the Permanent Secretary of the MoWD is given to the DWE to forward to the MoWD which, in turn, will make recurrent funds available to the DWE. The amount of the cheque as a proportion of the revenue collected varies from District to District. In the case of Isiolo the District gets about 50 percent of receipts.

3.5.3 District Financial Systems

These systems focus on control of individual systems and associated District office support. The existing situation with respect to MoWD schemes in the Isiolo District may be summarised under the following headings:

a) Monitoring

- Accurate monitoring of water production is sometimes achieved in Isiolo town through the MoWD, but monitoring of distribution is difficult. In other MoWD schemes, the monitoring of production is fair, especially for new connections, but some water meters are not serviceable, so monitoring of delivered water is again difficult. Significant levels of unaccounted are expected. Adequate staff appear available to carry out monitoring.

- The systems for monitoring of actual revenue collected are fragmented with MoWD forwarding receipts to the District Treasurer.

- Monitoring of construction by contractors appeared adequate, but, hampered by lack of funds for materials and transport for day labour construction, the MoWD's own projects appear to progress very slowly.

- Procedures for monitoring of production, operation and maintenance are simple, comprehensive and, if they were accurately completed, would provide an excellent basis for cost control.

b) Revenue Collection

- Procedures for billing are in place, although the SIDA Water Use Test Project in Embu sees possibilities to strengthen them. Better identification of consumers and better integration of billing and accounting systems are key elements of the proposed systems.

- Collection systems are inadequate, especially from the viewpoint of accessibility of customers for payment. Monitoring is made difficult by the fact that District Office revenue clerks are required to collect revenue for water which is forwarded directly to the Ministry of Finance (MoWD revenue clerks act as agents for the District Treasurer). Procedures for sanctions are in place and are increasingly being used against non-payers, both government and private.

c) Accounting and Capital Budgeting Systems

- Capital budgeting is carried out in a rolling three year period through requests for "development" funds called "estimates". Funds are allocated on a six monthly basis. Development expenditures allocated are a fraction of those requested. The capital budgeting system would be adequate, if it were operated efficiently

- The accounting and payment system for "development" funds is well designed, and would be adequate if funds were made available on time, and if forms were accurately completed.

- The accounting system for "recurrent" funds is also based on estimates. Again, the amounts allocated are often far short of the amounts required for effective operation. The systems themselves would be adequate for small water schemes if forms were accurately completed.

d) Generally

- In the absence of a system which enables the District office to hold revenue it collects, the "appropriations in aid" policy is important as an incentive for better revenue performance. As the mechanisms to implement the policy have yet to be established, there has been no direct impact on recurrent funding from the AIA policy.

- Management information systems linking these diverse activities are the major flaw in the system. Reporting on revenue collected going through one channel, and on expenditures going through another means that revenues and expenditures directly related to a scheme are not compared. No attempt to allocate overhead costs to schemes is made (such a summary should be available to the DWE). Current informal systems being developed by the DWE Meru are of great use and should be seen as the basis for such monitoring until more comprehensive systems from the SIDA project are available.

Financial systems similar to those currently operated by the MoWD, in a simplified form, would be adequate for community groups. Such systems are operated by a community based water supply schemes (e.g. Murugi - Mugumango and Tuuru Water Supply) in Meru District. These systems record meter readings, invoices, receipts, consumer accounts, and payment vouchers. These records are consolidated in a cash book. More sophisticated systems for larger schemes are being developed through the SIDA Water Use Test project and are currently under evaluation.

4 GUIDELINES FOR DESIGN OF INVESTMENT PACKAGES

4.1 Introduction

This section describes the various considerations involved in the design of investment options in the Isiolo District. The focus of the discussion will be on the appropriate choice of a given technology for a given project within the constraints of its water resource, socio-economic, institutional and financial context. Discussion of these considerations will be structured by examining, in turn, those concerning supply, (economic) demand and pricing (which brings supply and demand into equilibrium).

In the analysis, it will be assumed that the policies set out in the National Development Plan are to be implemented. In Chapter 6 the institutional and financial strengthening required to implement these policies will be examined.

4.2 Supply Considerations

4.2.1 Available Technologies

Given the physical environment of the proposed water supply, a certain range of technical options will be available. These options can be ranged on a scale according to their cost per cubic meter of water delivered over, say, 20 years, which is the period used in the DWDP.

The first set of elements to be considered in the physical environment are, of course, those related to the water resources available. These resources should be considered in relation to the potential (water) demand of the inhabitants, in that the total supply must be adequate for projected population increase (see water demand estimation methodology in Part 1 of this Study). In parts of Isiolo District, generally adequate resources are available, especially groundwater resources, but, in other parts of the District, ground water is saline and surface water scarce, setting an absolute limit to economically justifiable development.

The second set of elements of the physical environment to be considered are those related to land use and environmental issues. "Land use" covers such questions as the actual positioning of the plant, equipment, and associated civil works, in the context of land ownership, and of planned and traditional land use. Additionally, engineering aspects of water systems such as foundations and structural design will be influenced by location. It is important to note that changes in the design due to these considerations may change the order of cost set out in Table 3.1 above. In Isiolo District, the low densities of settlements and the communal nature of most land holdings make it unlikely that these considerations will be of major importance. "Environmental" issues are important, particularly as regards the impact of livestock movements and their relation to water. In Isiolo, this issue is particularly important and sets limits to the growth of livestock numbers, given traditional management techniques.

With a range of feasible technical solutions selected by considering the above mentioned elements, the next phase of the project development can commence.

4.2.2 Socio-economic aspects

While most of the important considerations related to these aspects are demand side considerations or related to the final choice of investment options, there are some issues which effect the supply side. In particular, these are the alternative or traditional sources of water and the institutional structures which are appropriate for project design and implementation.

The alternative or traditional supply source may be considered by the people as superior, even if it is demonstrably inferior with respect to technical standards. The importance of community education in this respect cannot be underemphasised. This education campaign should preferably be associated with a sanitation campaign. Instances of problems arising from these issues have already been found in Isiolo District. Despite the adverse effects on water quality, handpumps have been removed from boreholes supplying both people and cattle and replaced with a large open well. This enables the use of buckets to water stock. This method is much quicker and yields more water than with the handpump. Thus, the issues of adequate storage for animal watering, its separation from human supplies and the protection of both supplies are crucial to acceptance by the community.

The second impact on the supply side is on the structure of the organisation which will supply water. This organisation must be responsive to the structure of the communities identified above. In the Isiolo society, the elders have key roles in decision making and should be incorporated in the structures of the implementation organisation if this organisation is to receive government and community support.

Detailed studies as to acceptable and effective forms of education and organisations will be required at feasibility study stage.

4.2.3 Institutional Considerations

With the above issues in mind, the structure of the institutions which will plan, design construct and operate the water system can be considered in more detail. The scale of the projected system will often determine the institutions involved in these activities. These institutions will, in turn, have an impact on the selection of the most appropriate technical option.

The key functions which must be carried out by the selected institutions are:

- preliminary design and feasibility study (planning, siting, technology choice)
- approval of project
- detailed design
- construction supervision/construction
- staff training
- operation and maintenance, and
- financial functions (see section 4.2.4 below).

The organisations which undertake these functions, and the community liaison activities which must run in parallel to them, will differ depending on the type of system to be undertaken. The precise allocation of these functions should be a task for the feasibility studies to determine.

In Isiolo District, the MoWD has the ability to undertake surveys and limited ability in design, construction and operation (including finance) of small scale systems. Assessment studies, feasibility studies, complex design, and training are beyond its capacity, and MoWD headquarters (or other agency) support is required for these activities. The assessment of feasibility studies/proposals should be undertaken by the DDC with advice from the District MoWD, but this is not the case at present and there are insufficient skills in the District to carry out this role.

Extensive strengthening of a variety of organisations will thus be required in order to effectively implement either urban or rural/community based projects in the District.

4.2.4 Financial Aspects

The organisations chosen to implement the project must effectively undertake ALL of the major financial functions associated with any enterprise. This is essential to the sustainability of the project. The key functions and associated systems are:

- accurate monitoring of water production and distribution
- efficient billing systems for water distributed
- efficient collection systems for water billed and effective sanctions against non-payers
- accurate monitoring and cost effective control of construction costs
- ensuring adequate for, and cost effective control of, operation and maintenance expenditure
- systems of capital budgeting which relate to specific water schemes
- accurate and timely reporting of above activities, and
- financial incentives both to individuals and to schemes to implement government policies, eg cost sharing.

Even if the implementing institution consists of a village Water Association, these tasks must be carried out, and the systems required for these tasks must be present even if in a simplified form. Variations on the current documentation of the MoWD would appear to be adequate if used correctly.

Where more than one organisation is involved, for example where one authority constructs the scheme and another operates it while a third funds construction, the financial relationships between them must be clear. The extent and terms of subsidy and/or cross-subsidy must be described in the accounting systems of the various organisations. In general, the organisation which will operate the scheme should be given control of the funds and the responsibility to perform to (financial) targets.

As we have seen in Paragraph 3.5, the financial systems of the MoWD are not fully operational in Isiolo District. Where extensive financial co-ordination with other agencies or communities is required, significant strengthening of existing systems will be required. If the District is to have control of its own financial resources, staffing and expenditures, extensive strengthening, using similar concepts to those suggested in the SIDA Water Use Test Project will be required. Simplified systems along the lines of the current MoWD system will be required for small community systems.

4.3 Demand Considerations

4.3.1 General

The basis of demand for water is the population projections contained in Part 1 of the Study. However, different groups of people will have different demands according to their circumstances - which will change over time. The most important change over time will be rising real incomes. People tend to spend more on water as their incomes rise. Projections of district income growth rates are not yet available, however, and water demand estimates contained in Part 1 provide the best estimate of what might be termed "latent" demand in an economic sense. Whether this demand becomes "effective", that is becomes translated into money spent on water, depends on several factors. The most important of these are affordability and willingness to pay.

4.3.2 Affordability

Central to the choice of a system, given a pricing policy (see 4.4 below), is the affordability of that portion of the cost to be borne by the consumers. Accurate data on the incomes of the various groups of consumers can be obtained in feasibility studies. The normally accepted range of affordability is 3-5% of total household income. However, especially in the context of Isiolo District, this does not mean people are willing to pay this amount. While the value of family assets (cattle, sheep, goats and donkeys) may be high during the good years, there is little cash income, and the culture inhibits sales of animals used for payment, as a person's status depends largely on the number of animals owned.

4.3.3 Community Participation/Willingness to Pay

In community based schemes, community participation must start from the feasibility study phase. The participation of the community is vital in determining the type of scheme which they can and will operate successfully. The extent of participation should be much more than the "dig and pay".

The amount that a community is willing to pay will be influenced by these cultural issues, the availability of alternative sources (and their cost) and the extent to which they are involved in the project (whether they "own" it or not). Again, these issues must be addressed in a feasibility study of a specific system.

Appropriate mechanisms for involving the community will differ between cultures. The ILDP studies indicate that an appropriate base for such a mechanism in pastoral (Boran) Isiolo District will be based on the traditional institutions active within the dedas. Use of these institutions will require the formal sector organisations, such as the County Council and the District Office of the MoWD to be capable of liaison with such groups.

4.3.4 Institutions for Community Participation

Community participation in a project does not occur without considerable effort. It must be remembered, especially with respect to groups not fully within the modern sector, that the benefits obvious to the project promoters are not obvious to the

potential recipients. Two basic preconditions for effective community participation are:

- education and
- organisation.

The benefits of the project must be made concrete to the people. If there is no obvious advantage of the scheme, if, for example, the people have adequate clean water, free, from wells near the house, it should be asked if a water supply is, in fact, a high priority for the area. While there is a scarcity of readily available water in the Isiolo, the perception of the people of as to the priority for water supply (i.e. cattle) and of adequate water quality, must be considered in the planning of any education programme.

The structures and resources for effective participation must also be available from the time of project formulation. These structures include:

- formation and recognition of the community organisation
- establishing a formal process for consultation with the community organisation, and
- providing organisational support, for example in undertaking some administration for these organisations.

These activities are difficult in the light of the lack of resources for even routine activities, and this is an issue which will be discussed in more detail later.

These elements were present in the Integrated Food Security Programme in Wamba, Samburu District. The Programme supported the formation of the community committees, provided the administration required for the project, and employed a Samburu to act as a site supervisor (field assistant) and as liaison with a site committee of elders.

Records are kept of attendance, and of food and cash payments. Programme "topping up" of capital expenditures comes from the development budget of the Arid and Semi-Arid Lands Ministry supported by donors. The extent of topping up varies with the type of project, and may vary from 60 to 90 percent of materials cost.

4.4 Pricing and Cost Recovery Policies

4.4.1 General

The price of water is the mechanism which brings together supply and demand. Establishing the price of any commodity is a trial and error process but some guidelines can be established in the light of the cost sharing and affordability policies set out in Chapter 4. Two major objectives are to be considered. These are:

- cost recovery, and
- demand management.

Cost recovery will be the major issue of pricing policy in Isiolo.

Table 4.1 Technologies Ranked by Minimum Cost by Cost Recovery Policy

Summary of rankings

Type / Technology	Supply Capacity (m^3/day)	Overall Rankings			Type Rankings		
		Capital + O & M (Discounted) Cost/m^3	Capital Cost/m^3	O & M Cost/m^3	Capital + O & M (Discounted) Cost/m^3	Capital Cost/m^3	O & M Cost/m^3
Borehole with Diesel Pump	50	11	4	11	4	1	3
Borehole with Diesel Pump	75	3	7	16	1	3	5
Two Boreholes with Diesel Pumps	100	8	16	18	3	6	7
Borehole with Diesel and Solar Pump	50	16	11	8	6	4	2
Borehole with Diesel and Solar Pump	75	6	13	14	2	5	4
2 Bhs. with Diesel and 2 Solar Pumps	100	13	18	17	5	7	6
Borehole with Windmill	(50)	17	6	3	7	2	1
Infiltration Galleries with Diesel Pump	50	9	3	8	4	1	5
Infiltration Galleries with Diesel Pump	75	4	8	12	1	3	7
Infiltr. Galleries with 2 Diesel Pump	100	5	15	15	2	8	9
Inf. Galleries with Diesel and Solar P.	50	15	10	7	8	5	4
Inf. Galleries with Diesel and Solar P.	75	7	14	10	3	7	6
Inf. Galleries w. Diesel and 2 Solar P.	100	10	17	13	5	9	8
Infiltration Galleries with Solar Pump	(50)	18	9	3	9	4	1
Infiltration Galleries with Windmill	(50)	14	5	3	7	2	1
Infiltration Galleries with Windmill	(75)	12	12	3	6	6	1
Dug Well with Handpump	5	1	1	1	1	1	1
Borehole with Handpump	5	2	2	1	2	2	1

Note: (1) - Cost/m^3 is Cost per cubic meter capacity
(2) - Supply capacity between brackets indicates that supply is not guaranteed all year around

4.4.2 Cost Recovery

The cost recovery issue is closely linked to choice of technology (supply), and affordability/willingness to pay (demand). As stated in Paragraph 3.5 above, cost recovery policies are not yet firmly established. Thus, three approaches to cost recovery may be used. The three approaches to cost recovery are:

1. **Recovery of full capital and operation and maintenance costs** - this is the ideal situation with respect to the government's cost sharing and district focus policy, and appears feasible for urban schemes. Technologies will be selected such that the total cost will be minimised in order to maximise affordability under this cost sharing arrangement.

2. **Recovery of operation and maintenance costs only - partial capital subsidy and hand over to community** - the next best outcome in terms of the cost recovery objective. The district focus policy is also satisfied. It is likely that this

approach will be used for smaller schemes. Technologies will be selected such that operations and maintenance costs are minimised in order to maximise affordability for the recipient community.

3. **Full capital subsidy from government and hand over to community** - Technologies will be selected such that capital costs are minimised. The costs of O/M are not taken into account in selecting technologies. This policy will minimise the cost to the government.

The various technologies identified in Table 3.1 have been ranked according to the three approaches described above and are shown in Table 4.1.

The results of this ranking show considerable difference between the cost recovery approaches. The choice of cost recovery approach will therefore have a considerable bearing on the technology selection.

This DWDS suggests to follow the approach with maximum affordability to the population. Thus only the approach which minimises O & M costs will be used in the remaining sections of this document.

4.4.3 Demand Management

The other objective of pricing policy, demand management, does not apply with any real force to Isiolo District. Only where unplanned exploitation of water resources threatens efficient economic development should pricing policy be used to ration scarce resources between users. In the sparsely settled, pastoral Isiolo District this is not yet a pressing issue, as it is in other areas of Kenya, and will not be considered in this report. It should be noted however, that issues of demand management do exist in the District. The possible overgrazing of some areas and the impact of irrigation schemes may become serious issues as more information is gathered on the impact of these activities. However, in the case of overgrazing, pricing policy has limited application as the majority of the pastoralists are substantially outside the money economy.

5 GUIDELINES FOR APPRAISAL OF INVESTMENT PACKAGES

5.1 Introduction

This chapter will attempt to bring together the considerations discussed above and set out a methodology for the assessment of investment packages. This methodology is intended for use by the DDC and DEC (in conjunction with District MoWD) in assessing investments put to it for approval.

The analysis will be divided into three parts. The first part will outline a methodology to assess the economic/financial viability of the water supply systems in the most general terms. This methodology should be applied in feasibility studies when more detailed data will be available. The second part will set out a process of appraisal of investment proposals so as to help ensure that they are in conformity with the District Development Plan and the DWDP. The third part indicates how prioritisation of proposals may be achieved based on a policy of cost sharing.

The following chapter will describe indicative investment packages based on pre-feasibility studies of water supply to rural centres, which meet the criteria established in this chapter.

5.2 Economic and Financial Analysis

5.2.1 Introduction

Appraisal of investments in the water sector should include economic and financial analysis of each project/system. Any proposal to utilise water resources should include simple analysis indicating that the proposal is financially viable. For larger investments, an economic analysis should be undertaken. Depending on the data available, economic analysis will be either a cost effectiveness analysis as described in Part 2, chapter 6.3, or a cost/benefit analysis as described in this chapter. It is expected that, where feasibility analysis studies are required, cost/benefit analysis should be used.

Economic cost/benefit analysis of water supply systems can be divided into a financial and an economic part. The financial part approaches the system from an individual's (e.g. the "water undertaker", the community) point of view, whereas the economic part looks at the implications of the system for the nation as a whole. The financial approach thus typically considers revenues and expenditures in the context of cost effectiveness and cost recovery objectives. Economic analysis estimates costs and benefits to the nation, in which items like time savings, health improvement and indirect benefits/disbenefits accruing from the water supply system are considered.

Cost/benefit analysis of water supply systems in urban centres differs considerably from that of water supply in rural areas. In small urban centres (e.g. Isiolo, Garba Tula and Merti, with estimated population greater than 2,000) the analysis is done by comparing the amount of distributed water at an affordable tariff with capital and O&M costs. The methodology to be used for analysis of water supply systems in market centres (population < 2,000) and in other rural areas in Isiolo District stresses the

economic aspects of supply of water. Time savings and, to a lesser degree, health improvement and indirect economic benefits need to be considered and compared with costs and economic disbenefits.

Financial cost analysis is based on market prices, whereas economic analysis generally uses shadow prices. The economic analysis set out below uses market prices. This is because the distinction between tradables and non-tradables is difficult to make in rural water supply systems and because conversion factors could not be determined within the scope of this report (ref: The value of time spent on collecting water: some estimates for Ukunda, Kenya; Whittington et al, 1989).

The methodology used distinguishes between a) small urban areas and b) rural market centres. For each area a description of benefits and costs is given, followed by an example valuing and comparing the described benefits and costs.

Capital costs and operation and maintenance costs vary between different systems. The relation between these costs and the cost sharing policy, and the effect of both on the choice of systems is discussed in paragraph 5.2.4 on financial analysis. This paragraph also discusses these items in relation to possible sources of funding of projects.

The economic benefits of water supply systems in the District are considered for supply to urban centres and rural market centres. Estimates of benefits of supply of water to small urban areas can be based on willingness to pay. Supply to poorer rural areas in the District often must count benefits in the form of time savings, health improvement and other indirect economic benefits.

5.2.2 Economic Analysis of Water Supply in Urban Areas

a) Benefits

In urban water supply systems benefits of supply of water are reflected in the consumers willingness to pay for the service. This does not necessarily translate into collected revenue, however . Due to inefficient revenue collection, broken down meters and insufficient meter readers etc., revenue collected does not always match with revenue billed (assuming all water distributed is billed). Furthermore, people often are not disconnected after non-payment and therefore have no incentive to pay.

In estimating the benefit of a water supply system it is therefore better to look at the quantities of water produced and distributed. Differences in these figures are caused by leakages in the distribution system. The quantity of water consumed (paid for or not), valued at an affordable tariff, is the best indication of direct benefits of water supply to small urban centres. The affordable tariff is derived from the fact that people spend from 3% - 5% of their income on water.

b) Costs

Costs of water supply systems can be split into capital costs (e.g. materials, transport, wages of labourers) and operation and maintenance costs (e.g. fuel/electricity, salaries of staff, chemicals, transport, spare parts, tools, costs of repair). Costs are related to water production/distribution and are therefore expressed in Shs./m^3 per year. A

ranking according to cost effectiveness per m^3 was carried out and shown in table 3.1. This ranking was based on total discounted cost/m^3 for various systems.

c) Comparing Benefits and Costs

When discounted benefits (revenues based on total quantity produced) are large enough to cover discounted costs, the system is viable from an economic point of view.

5.2.3 Economic Analysis of Water Supply to Rural Areas

a) Benefits

Considerations such as willingness to pay, limited money economy, cultural and traditional use of water etc. make it more difficult to consider revenue as a justification for a water supply system in rural areas including market centres. Time savings, health improvement and other indirect economic benefits are therefore major benefits of these water schemes.

Time Savings

A water supply system (or an improved distribution system) enables people to get water from a supply point, which is closer/more reliable than the source they originally used. If they spend less time hauling water in the new situation, compared to the old 'without project' situation, the time they save may (and often can) be valued. Women usually collect water and therefore their time savings have to be considered. The time they save can be used for extra care for children, activities in the house, milking and processing of dairy and income generating casual work.

Valuation of time savings by women due to an improved or new water supply system will be based on rural-female income level. Total time saved will be calculated by estimating the number of households, their water needs and time saved as compared to existing sources.

Health Improvement

Health improvement resulting from improved or new water supply is extremely important, but difficult to value, and it is not expected that the situation in Isiolo offers possibilities to do so. Other masking variables (improved sanitation, electricity etc.) are present. However, the results of estimates form other areas (for example, Samburu District) may be used as a guide if they can be obtained.

Other Economic Benefits

These benefits will probably fall into two categories in the Isiolo context. These are:

- the money and time saved from not having to boil water, and
- indirect benefits from water supply; these benefits relate to the long run and are a result of possible economic development of the District due to better water usage.

Because of the more regular supply of water, other economic activities may increase. At this stage, such future developments are difficult to estimate without detailed investigation which is beyond the scope of the present study.

b) Costs

The costs of rural water supply systems can also be split in capital costs and O&M costs. These costs are however, unlike costs of urban water supply systems, not the only costs which are to be taken into account. Supply of water to rural areas brings some economic costs with it. For example, in a community-run scheme, people have to participate in operation and maintenance activities and co-ordination meetings. This requires time which they could not have spent on income producing activities in a 'without project' situation. People have to pay for water consumption and they often have to walk considerable distances in order to pay their monthly bills.

c) Comparing Benefits and Costs

Health and time savings benefits accruing from water supply justify a certain cost range of water supply systems. Additional economic benefits enlarge the range of viable systems.
Further selection of systems will include technical aspects (not discussed in this chapter) and cost recovery aspects.
As in urban water supply benefits should cover costs.

5.2.4 Financial Analysis

Financial analysis is carried out from the viewpoint of an individual entity, usually either from the viewpoint of the community or of the government. It uses projections of money expenditures and incomes over time. Inflation must be considered in these projections. The extent to which expenditures, like capital and O&M costs, are matched by incomes or revenues, such as payments by the community, is the basis of the analysis. The difference between revenues and expenditures is the net cashflow. At the most basic level, a project is viable from a financial point of view if net cashflow remains positive.

a) Community's viewpoint

In the perspective of a community, the cashflow is largely determined by:

- the governments policy on cost sharing (i.e. how much of expenditures are to be met by the community), and
- the amount the community can afford/is willing to contribute (i.e. how much revenue can be collected).

Capital expenditures of a water supply system can be met by:

- grants and/or loans sourced from one or more donors (usually channelled through the government), or from the government itself
- money contributions from the community, and
- labour and/or materials contributions from the community.

When capital contributions of the community are insufficient to meet cost sharing

requirements, additional expenditures may be paid for by a loan which will have to be paid back by the community through charges levied for use of the water (i.e. the revenue of the system).

System revenues must also cover expenditures on O&M as government policies require this level of cost sharing as a minimum. Such expenditures include operators, chemicals, fuel, electricity, and periodic replacement of parts.

Viable projects, from the point of view of a community, are projects where the system revenues can meet the required level of cost sharing. Depending on the components of that cost sharing, different strategies will be adopted. If the community must bear the cost of both capital and O&M expenditures, then systems which are most cost effective with respect to total costs should be chosen (see Table 4.1). If the community must bear the cost O&M expenditures only, then systems which are most cost effective with respect to O&M costs should be chosen (see Table 4.1).

Feasibility studies of future investments should focus on the cashflow of the community scheme. Sources and applications of funds should be identified over the life of the investment. Revenue projections should carefully consider issues of affordability/ willingness to pay.

b) Government's viewpoint

As the institutional structure of the MoWD stands at the present time, cost recovery policy cannot be made coherent. As the funds expended on schemes and the revenues from them flow through different and multi-layered channels, matching expenditures to revenues is difficult. This situation will change in the future, when the enforcement of cost sharing policies, such as set out above, will be possible as the District offices of the MoWD are strengthened.

At present, severe limits on capital works budgets requires that capital expenditures be minimised. Such investment is often not recommended as economically efficient or as financially affordable for the recipient community, but is a possible short term strategy in the present context (see Table 4.1).

Current recommendations for institutional strengthening provide the possibility that the accounts of the District will give a clear picture of the trading, profit and balance sheet position of the systems under MoWD control. Investment decisions can then be made in this context.

Feasibility studies of future investments should consider the impact of proposed schemes on the viability of the District MoWD as an entity. Investments, particularly in small urban areas, should obtain an acceptable financial rate of return. Investments which cannot meet such criteria should receive a subsidy specific to each scheme.

5.3 Appraisal Methodology

5.3.1 General

The purpose of developing a methodology for investment appraisal is to ensure that any proposed investments will be consistent with, in the first instance, the DWDP, and

secondly, with the District Development Plan. It is intended for use by the DDC or DEC, supported by the District MoWD, in order to give these institutions the central role they merit under the District Focus policy.

For this reason the criteria used in the appraisal include factors which are not strictly water resources issues. The methodology developed is intended to provide basic assessment of investment proposals which will be neither too time consuming or skill-intensive for use in the district. Nevertheless, districts will need some strengthening before this methodology can be fully applied.

It should be noted that each project or supply system should be assessed individually. These projects can be aggregated into a package, but appraisal remains primarily at the level of the individual project as conditions vary so much between locations.

Criteria will be established for appraisal of investment projects in the following categories:

- water resources
- land use planning/environmental impact
- social impact
- institutional/community participation
- economic
- affordability
- financial.

Simple checklists will be established to test a project against each of these sets of criteria. The checklists ask "plain English" questions which will trigger consideration of major issues. If there is any doubt as to the answers to the questions, technical support can be sought from the MoWD and Ministry of Planning and National Development.

The checklist, as amended by the district organisations, should be included in the DWDP. For those proposing to use water, it will provide a guide to the major factors which they must consider, and on which their proposal will be judged.

For those investments that the district proposes to initiate, a process for prioritisation of projects will also be described. Establishing priority for projects is useful in the event that insufficient funds are available at a given time to carry out all viable projects, or where some projects in a programme of implementation of a given investment package cannot proceed. Decisions can then be made as to which projects should be delayed or brought forward. The methodology used is tailored to the existing and potentially achievable levels of appraisal skills in the District.

5.3.2 Development of Criteria

a) Water Resources

The basis for these criteria is the Water Resources Assessment Study by WRAP. This study contains all the existing basic data on the availability and quality of both surfacewater and groundwater. The basic questions to be answered are:

Can the required present and future water supply be met from the indicated water

source throughout the year?

e.g if a surfacewater reservoir is proposed, how will siltation affects its capacity?
or if a groundwater source is proposed, how will groundwater levels develop in future.

Can the required water supply be maintained during drought periods?

Does the proposed technology make optimum use of the available water source?

e.g if a groundwater source is proposed, does the pump capacity match the well yield?

Is there an alternative water source and has it been considered? Maybe to serve as alternative if the first source is out of order?

i.e a system using two different sources is more reliable

Is the quality of the water suitable for its intended use?

e.g for livestock water supply quality criteria are less than for domestic water supply

b) Land Use/Environmental Impact

The basis for these criteria are the District Development Plan and documents on land resources, such as the proposed Livestock Management Plan for Isiolo District to be prepared under the EMI-ASAL/ILDP Programme. The basic questions to be answered are:

Does the project supply water to activities consistent with the District Development Plan?

e.g is water for livestock provided near settlements in order to encourage nomads to settle?

Are the facilities/plant of the project consistent with the existing land carrying capacity?

e.g. can the rangeland sustain the number of livestock which will be attracted by the new water supply?

Are the facilities/plant of the project consistent with plans for urban/rural development?

e.g the proposed siting of the reservoir will not sterilise mineral deposits, or block the most appropriate route for an upgraded access road?

Will the facilities/plant of the project, or their construction, have an adverse environmental impact?

The major forms of impact to be considered in the Isiolo District are:

- the degradation of vegetation cover and soils from overgrazing, in particular the extensive damage occurring around water points in droughts
- the impact of dams which intercept surface water causing downstream wet lands to dry up - this may have a significant impact on some wildlife
- heavy pumping of ground water may cause springs to dry up, affecting animals and sometimes people.

c) Social Impact

It is difficult to discuss appropriate criteria for social assessment in the absence of a socio-economic study of the District which is designed to develop such criteria. However, some significant issues have been raised in consultation with local people. These are:

Where traditional groups are affected by the scheme, does the proposed scheme work within the cultural context of those groups?

> This issue should be balanced against development goals in so far as sub-groups, such as women, within these groups should be given the opportunity to develop their talents

Does the proposed scheme improve the welfare of the people of the District, particularly lower income groups and/or women?

> i.e. does it provide employment, or does it provide opportunities for people to earn income from conditions created by the scheme?

d) Institutional/Community Participation Issues

- ***Institutions***

The major tasks which must be addressed with respect to institutional issues are design, construction and operation/maintenance of the systems. The organisation, or grouping of organisations must be able to carry out these tasks effectively. One organisation should be in charge of co-ordinating these tasks, and, preferably, this organisation should be that which will operate and maintain the project. The key issues are thus:

Which organisation is co-ordinating the project?

Does it have a realistic project organisational structure and implementation schedule?

Which organisations have responsibility for design, construction and operation of the schemes?

Are skills and financial resources available for each of these organisations to undertake their tasks?

If not, who is to supply training/funds to achieve the required levels of performance?

Are there written agreements with the co-ordinating organisation to support the above statements?

- ***Community Participation***

Community participation can occur in any of the above tasks. In small scale water supply projects, it is likely that it will occur in all of these tasks. The organisation of this participation is thus a key element in the successful implementation of the project. The main issues involved are:

Are the leaders of the community organisation representative of the community?

- i.e are the ones promising resource inputs capable of organising the delivery of those inputs?

Can they deliver the promised labour and money inputs to the project on time?

- i.e does the community have the resources?

Can the community organisation effectively carry out the liaison activities that are required to implement the project?

- e.g with government, contractors etc.

Is the organisation recognised by the local government agencies and will/can they provide the organisational and logistic support required?

e) Economic Issues

The methodology required to undertake an economic assessment of the project is set out in Paragraph 5.2 above. For small scale projects which are to be implemented and paid for by the community, it may be assumed that the economic benefit is proven by the level of commitment shown. Where substantial levels of government or donor funds are to be used, a feasibility study of the project should include an assessment of economic viability, and the average/indicative values used in the above analysis should be replaced with those applicable to the specific project.

f) Affordability Issues

Based on the above analysis, the issue of affordability can be addressed. Particularly with respect to water supplies for the partly nomadic peoples, the issues of affordability and willingness to pay are complex, and bound up with slowly changing traditional beliefs and priorities. If the community is to implement and pay for the water scheme, there is little need to assess willingness to pay. Only confirmation of this must be obtained in feasibility studies. Where government and/or donor involvement is envisaged, the feasibility studies must address this issue in some detail.

In the latter case, the main consideration is the level of cost sharing required by the government or donor agency. This will determine the fee or tariff set in the scheme.

General guidelines which are likely to be adopted require full cost recovery in urban schemes, and, outside urban areas, recovery of operation and maintenance costs. The basic questions are:

Does the sum involved in cost recovery constitute more than 5% of the income of, say, the poorest 20% of the population?

- if so, use another technology or review level of cost sharing

If not, what is the community attitude to paying this amount of money?

- if negative, as it often is, then additional questions are required

Is there an acceptable alternative source and what is the cost?

- if there is no alternative, or if it is more expensive than the proposed scheme, then there is a good prospect of achieving a sufficient level of willingness to pay given adequate institutional systems and political support
- if there is an alternative which is acceptable to the people, even if the water is technically inferior, another technology should be considered, or the level of cost recovery should be reviewed.

g) Financial Issues

The key financial issue is the sustainability of the project. With the above analysis complete, and concurrently with the determination of affordability, it is possible to project likely demand for (see Paragraphs 5.3 and 5.2), and the costs of, the scheme over time. The feasibility study must identify the sources of funds for design, construction and operation/maintenance. The projection of the expenditure of these funds must be realistic. A basic cash flow analysis can then be carried out to identify potential liquidity problems, and measures developed to overcome them. The financial return on the project can also be calculated.

Financial systems for revenue collection and recording financial flows (simple records of costs and receipts) have been developed, and could be applied to even the smallest schemes. For larger schemes, simple procedures for capital budgeting and funding of preventative maintenance schemes could be developed based on experience in some NGO projects. These types of procedures will take some time to establish, however.

The key criteria are thus:
Does the cash flow show that expenditures are covered by revenues through the life of the project?
Are procedures for revenue collection and monitoring of revenues and expenditures described and realistic?

5.3.3 Prioritisation

Usually there are several projects competing for available funds. Often these funds are insufficient to implement all of the projects. A method must be found to rank these projects for access to available funds. That is, they must be given a priority ranking. The prioritisation process is a difficult one because it involves judgements as to the value of performance in one criterion against performance in another. This weighting process is contentious. Unless extensive resources are available to carry out a valid Multi-Criteria Analysis, it is better to assess a project as to whether it achieves an acceptable level of performance in all criteria, and then prioritise on one. This one is often financial.

The suggested method of prioritisation focuses on the sustainability of the project. Basically, it consists of ensuring that all of the questions set out above in each of the criteria categories have a satisfactory answer. Then, priority is assessed according to how well projects meet the cost sharing policy.
Revenue from the system and its expenditures will be estimated in the financial analysis as set out in 5.3.2 g) above. The extent to which this revenue covers costs will thus determine the extent to which the cost sharing policy is being implemented.

First priority projects will recover both capital and operation and maintenance (O&M) costs. Second priority projects will recover O&M costs. Third priority projects will be economically viable and be ranked according to the extent of recovery of O&M costs. Other projects should not be implemented.

An indication of the technical priorities for the DWE and the County Council may be found in Appendix 1. The report describes the priorities as provided by these agencies and therefore does not attempt to present a definitive priority ranking.

6 EXAMPLES OF INVESTMENT PACKAGES

6.1 Introduction

In the context of the above chapters and using the information in the other parts of this study, this chapter will set out examples of district investment packages for the water supply to the rural centres in the District.

The investment packages for the supplies to the rural centres will be designed to be appropriate for various physical and settlement situations in Isiolo, and for the possible types of cost recovery policy applicable. The main situations covered will take into account:

- the potential of surface water and groundwater resources in the District at each centre, based on the findings of the Water Resources Assessment Study
- the current water supply coverage by existing supply facilities
- the different water qualities required for domestic supply and non-domestic supply
- the selection of technologies according the cost recovery approach with minimal operation and maintenance costs per m^3 produced, which will maximise the affordability to the community.

The investment packages are based on the results of the pre-feasibility studies carried out by WRAP for each centre in the District. Three types of investment packages were prepared:

1. Investment packages based on technology choice
2. Investment packages based on location of the centres/projects
3. Investment packages based on the required feasibility studies.

Because of uncertainty, or simple unavailability, of data, the resulting investment packages must be taken as indicative, and feasibility studies must confirm the viability of specific systems/projects.

The supplies in the rural areas are the subject of intensive study by the Isiolo Livestock Development Project within the EMI Programme. This programme will identify in detail the key interventions required to supply water to meet rural, in particular livestock, demand in such a way as to prevent environmental degradation. These interventions will be designed within the context of an overall Livestock Management Plan for Isiolo District.

Table 6.1 Proposed Water Supplies for Domestic Use in Rural Centres in Isiolo District

Population Centre	Existing Supply (1990)	Recommended Source for Additional Supply	Recommended Technology for Additional Supply	Alternative Technology for Add. Supply	Existing Supply Capacity (m^3/day)	Total Supply Capacity		Domestic Demand		Livestock Demand (m^3/day)
						Future yr. (m^3/day)	Ultim. yr. (m^3/day)	Future yr. (m^3/day)	Ultim. yr. (m^3/day)	
Ngare Mara	Borehole w. Windmill	Borehole	Diesel pump	Windmill	(10)	60	85	38.7	64.0	16.7
Kipsing	Well w. Diesel Pump	Infiltration pipes	Solar / Stand-by Diesel	Handpumps	(10)	80	110	41.6	70.3	37.6
Oldo Nyiro	Sand dams (Mission)	Sand dams/Borehole	Solar / Diesel	Handpumps	(15)	*	*	97.8	157.7	8.8
Garba Tula	Borehole w. Diesel P.	Boreholes	Diesel combined with Solar		60	300	500	228.0	421.8	75.8
Bibi / Duse	Seasonal dug wells	Borehole	Solar / Stand-by Diesel	Handpumps	-	75	115	52.8	89.4	22.0
Kinna	Spring	Boreholes / Spring	Solar / Spring protect.	Handpumps	(15)	90	150	88.4	146.6	-
Boji	Open dug wells	Borehole / Wells	Solar / Stand-by Diesel	Handpumps	-	60	85	34.4	56.7	26.7
Gafarsa	Seasonal dug wells	Infiltration pipes	Solar / Stand-by Diesel	Handpumps	-	85	85	51.7	87.0	30.0
Kulamawe	Borehole w. Diesel P.	Borehole	Diesel pumps	None	72	75	85	51.1	83.7	25.0
Malka Daka	Seasonal dug wells	Infiltration pipes	Solar / Stand-by Diesel	Handpumps	-	50	80	48.8	75.3	-
Bisan Biliku	Seasonal dug wells	Infiltration pipes	Solar / Stand-by Diesel	Handpumps	-	50	80	47.3	78.7	-
Dadacha Bassa	Seasonal dug wells	Boreholes	Solar / Stand-by Diesel	Handpumps	-	*	*	43.3	72.1	56.3
Malka Galla	Seasonal dug wells	Boreholes	Solar / Stand-by Diesel	Handpumps	-	*	*	48.4	81.5	11.7
Bulesa	Seasonal dug wells	Infiltration pipes	Solar / Stand-by Diesel	Handpumps	-	65	105	55.2	93.2	8.5
Korbesa	Seasonal dug wells	Boreholes	Solar / Stand-by Diesel	Handpumps	-	65	100	53.9	91.3	8.0
Merti	Borehole w. Diesel P.	Boreholes	Diesel combined with Solar		60	120	220	121.5	215.8	-
Eldera	Seasonal dug wells	Infiltration pipes	Solar / Stand-by Diesel	Handpumps	-	45	75	42.1	69.0	2.8
Modogashe	Well w. Diesel Pump	Infiltration pipes	Diesel combined with Solar		120	300	410	295.9	405.9	2.0
Iresa Boru	Seasonal dug wells	Boreholes	Solar / Stand-by Diesel	Handpumps	-	45	55	32.7	45.5	10.5
Sericho	Borehole w. Solar Set	Boreholes	Diesel pump	Handpumps	30	55	80	40.2	63.3	13.4

Notes: Future yr. = year 2005, Ultim. yr. = year 2015 ( ) = estimated figure

Existing supply capacities of diesel pumps are based on 8 hrs. pumping; at Modogashe capacity depends on water level in the wells.

* = more study is needed to determine the supply capacity of the source

Table 6.2 Preliminary Cost Estimates of Proposed Water Supplies for Rural Centres in Isiolo District

Population Centre	Design Population Estimate 1990	Capital Costs (Ksh)	O & M Costs per Month (Ksh)	Costs per Household		Required Follow-up
				Capital (Ksh)	Annual O&M (Ksh)	
Ngare Mara	1,200	1,200,000	8,000	5,000	400	3
Kipsing	1,420	2,200,000	7,000	7,750	300	1
Oldo Nyiro	2,000	2,250,000	10,000	5,600	300	1
Garba Tula	5,600	2,500,000	21,500	2,250	230	2,3
Bibi / Duse	1,800	1,760,000	8,000	5,000	270	1,2
Kinna	2,500	2,500,000	7,500	5,000	180	1,2
Boji	1,100	1,350,000	7,000	6,100	380	1,2
Gafarsa	1,700	2,100,000	8,000	6,000	280	1
Kulamawe	1,500	900,000	13,000	3,000	520	2,3
Malka Daka	1,100	2,100,000	6,500	9,500	350	1
Bisan Biliku	1,500	2,600,000	6,500	8,500	260	1
Dadacha Bassa	1,400	3,500,000	11,000	12,500	470	1
Malka Galla	1,600	3,500,000	11,000	11,000	400	1
Bulesa	1,700	4,125,000	8,000	12,000	300	1
Korbesa	1,800	3,025,000	8,000	8,500	270	1
Merti	3,000	1,540,000	17,500	2,600	350	2,3
Eldera	1,250	2,750,000	6,500	11,000	300	1
Modogashe	7,000	5,700,000	22,500	4,100	190	1
Iresa Boru	1,000	3,400,000	7,000	17,000	420	1
Sericho	1,010	517,000	7,400	2,500	440	2,3

Key: Follow-up: 1 - Feasibility study, 2 - Design, 3 - Implementation
Note: A household comprises five people

6.2 Results of Pre-feasibility Studies

The objective of the pre-feasibility studies is to summarise the existing information on each rural centre and to provide a proposal with a preliminary cost estimate for the required water supply development. The studies are intended to provide more specific proposals than the DWDS will contain and to provide a solid base for future feasibility studies. The pre-feasibility studies are combined in a separate volume accompanying the DWDS. The results of the pre-feasibility studies are summarized in table 6.1 and 6.2.

The pre-feasibility studies consist of background information, a water resources assessment, a demand calculation, a description of the existing water supply and recommendations for the proposed water supply with a tentative estimate of capital costs and Operation & Maintenance costs.

Table 6.3 Investment Packages Based on the Required Feasibility Studies.

Population Centre	Design Population Estimate 1990	Capital Costs (Ksh)	O & M Costs per Month (Ksh)	Costs per Household		Required Follow-up
				Capital (Ksh)	Annual O&M (Ksh)	
Feasibility Studies Required						
Oldo Nyiro	2,000	2,250,000	10,000	5,600	300	1
Bibi / Duse	1,800	1,760,000	8,000	5,000	270	1,2
Kinna	2,500	2,500,000	7,500	5,000	180	1,2
Boji	1,100	1,350,000	7,000	6,100	380	1,2
Dadacha Bassa	1,400	3,500,000	11,000	12,500	470	1
Malka Galla	1,600	3,500,000	11,000	11,000	400	1
Korbesa	1,800	3,025,000	8,000	8,500	270	1
Iresa Boru	1,000	3,400,000	7,000	17,000	420	1
Kipsing	1,420	2,200,000	7,000	7,750	300	1
Gafarsa	1,700	2,100,000	8,000	6,000	280	1
Malka Daka	1,100	2,100,000	6,500	9,000	350	1
Bisan Biliku	1,500	2,600,000	6,500	8,500	260	1
Bulesa	1,700	4,125,000	8,000	12,000	300	1
Eldera	1,250	2,750,000	6,500	11,000	300	1
Modogashe	7,000	5,700,000	22,500	4,100	190	1
Total	28,870	42,860,000	134,500	7,423	280	
Feasibility studies Not Required						
Ngare Mara	1,200	1,200,000	8,000	5,000	400	3
Garba Tula	5,600	2,500,000	21,500	2,250	230	2,3
Kulamawe	1,500	900,000	13,000	3,000	520	2,3
Merti	3,000	1,540,000	17,500	2,600	350	2,3
Sericho	1,010	517,000	7,400	2,500	440	2,3
Total	12,310	6,657,000	67,400	2,704	329	

Key: Follow-up: 1 - Feasibility study, 2 - Design, 3 - Implementation
Note: A household comprises five people

The pre-feasibility studies cover the domestic supply of the centres and include only a small part of the livestock supply associated with the centre. Since it is almost practically impossible to isolate domestic and livestock drinking water, provision has to be made for a certain percentage of the livestock to use the water supply, but without contaminating the water source.

The capital costs of the proposed systems which deliver water through water points in the centre range for most centres between 1.8 million to 4.0 million Shs. The capital costs per household are about 5,000 to 10,000 Shs.

The O & M costs of the systems in the small rural centres are based on the salary for 2 pump attendants and the expenses for fuel and general maintenance. The annual O & M costs per household range between 200 to 400 Shs, which must be affordable for most of the people. The proposals for the water supplies assumes that the community will organise the O & M and will be responsible for the financial administration. The MoWD is expected to assist mainly in the maintenance part of the operation.

The pre-feasibility studies should be followed by proper feasibility studies, which at several of the centres may be executed simultaneously with the surveying and design of the system. The feasibility of the infiltration pipes should be studied first in general, as these are proposed for many centres. At some centres thorough studies are still needed before a well founded proposal can be presented, in particular at Modogashe, where the available good quality water is limited, and at Malka Galla and Dadacha Bassa, which are located at large distances from the existing water sources.

6.3 Indicative Investment Packages

6.3.1 Investment Packages Based on the Required Feasibility Studies.

The first investment package presented combines all projects in the District where feasibility studies have to be carried out. These feasibility studies may be executed simultaneously, in preparation for the implementation phase. This may require a team to work for some time in the district, visiting the centres and carrying out investigations. However it is preferred that feasibility studies will not be placed in a separate project, but instead are part of a project in which also implementation is carried out. This is to avoid that the next phase will consist of more studies only.

The total costs of the feasibility studies in all centres are estimated at Ksh 1.5 million. Once these studies are completed, then combinations of projects may be decided on for implementation according to the technology or to the location. These are presented in the next paragraphs.

In some centres feasibility studies are not required, because only the distribution system is to be constructed. Among these are two of the larger centres: Garba Tula and Merti. Projects at these centres may be started with the survey work.

Table 6.4 Investment Packages Based on Technology Choice

Population Centre	Design Population Estimate 1990	Capital Costs (Ksh)	O & M Costs per Month (Ksh)	Costs per Household		Required Follow-up
				Capital (Ksh)	Annual O&M (Ksh)	
Technology: Boreholes						
Oldo Nyiro	2,000	2,250,000	10,000	5,600	300	1
Bibi / Duse	1,800	1,760,000	8,000	5,000	270	1,2
Kinna	2,500	2,500,000	7,500	5,000	180	1,2
Dadacha Bassa	1,400	3,500,000	11,000	12,500	470	1
Malka Galla	1,600	3,500,000	11,000	11,000	400	1
Korbesa	1,800	3,025,000	8,000	8,500	270	1
Iresa Boru	1,000	3,400,000	7,000	17,000	420	1
Total	12,100	19,935,000	62,500	8,238	310	
Technology: Infiltration Galleries						
Kipsing	1,420	2,200,000	7,000	7,750	300	1
Gafarsa	1,700	2,100,000	8,000	6,000	280	1
Malka Daka	1,100	2,100,000	6,500	9,000	350	1
Bisan Biliku	1,500	2,600,000	6,500	8,500	260	1
Bulesa	1,700	4,125,000	8,000	12,000	300	1
Eldera	1,250	2,750,000	6,500	11,000	300	1
Modogashe	7,000	5,700,000	22,500	4,100	190	1
Total	15,670	21,575,000	65,000	6,884	249	
Technology: Distribution System (Source already available)						
Ngare Mara	1,200	1,200,000	8,000	5,000	400	3
Garba Tula	5,600	2,500,000	21,500	2,250	230	2,3
Boji	1,100	1,350,000	7,000	6,100	380	1,2
Kulamawe	1,500	900,000	13,000	3,000	520	2,3
Merti	3,000	1,540,000	17,500	2,600	350	2,3
Sericho	1,010	517,000	7,400	2,500	440	2,3
Total	13,410	8,007,000	74,400	2,985	333	

Key: Follow-up: 1 - Feasibility study, 2 - Design, 3 - Implementation
Note: A household comprises five people

6.3.2 Investment Packages Based on Technology Choice

These investment packages represent the possibility for a combination of projects using similar construction equipment. This would facilitate an efficient use of expensive construction equipment. E.g. a drilling rig could drill all the boreholes required in the District.

One technology for which a combined approach is preferable, would be the infiltration galleries. This is a relatively unknown technology and knowledge and experience obtained during feasibility studies and construction should be useful at all centres where galleries are proposed.

Modogashe may have to be treated as a separate project, due to it's larger size and also because of the problems expected during implementation. A thorough feasibility study is still required here to determine the viability of the proposed technology.

At some centres sources are already available, e.g. a borehole drilled by WRAP. The construction works here will concentrate on the water distribution system, including pumps and storage facilities. A combination of such projects will certainly make the purchase, transport and storage of materials more efficient. Surveying and construction may be planned in stages, with work going on at a few centres simultaneously. Other projects where a source still has to be constructed may be gradually included in this programme, as distribution systems are similar.

An important advantage of combining projects is the possibility to standardize equipment and to standardize the community involvement during the planning and construction phase and during the operational phase after completion. Such standardisation may well mean the difference between success and failure of the projects.

6.3.3 Investment Packages Based on Location of the Centres / Projects

The combination of projects according their location is in line with the planning structure in the District. If all projects from one Division are combined than the Divisional Development Committee would find it easy to plan and prioritize the projects. Also supervision and assistance from MoWD may be organized practically through their Divisional Office.

The disadvantage of this combination of projects is that different construction equipment is needed, especially if sources like boreholes or infiltration galleries need to be constructed. However this may be solved if construction activities are carried out simultaneously in different Divisions.

The water supplies at Garba Tula, Modogashe and Merti are of a larger size than in the other rural centres and it may be considered to combine these in one project. Only at Modogashe a source will need to be constructed. Otherwise the distribution systems are similar, just as the organisation of the operation and maintenance.

Table 6.5 Investment Packages Based on Location of the Centres / Projects

Population Centre	Design Population Estimate 1990	Capital Costs (Ksh)	O & M Costs per Month (Ksh)	Costs per Household		Required Follow-up
				Capital (Ksh)	Annual O&M (Ksh)	
Central Division						
Ngare Mara	1,200	1,200,000	8,000	5,000	400	3
Kipsing	1,420	2,200,000	7,000	7,750	300	1
Oldo Nyiro	2,000	2,250,000	10,000	5,600	300	1
Total	4,620	5,650,000	25,000	6,115	325	
Garba Tula Division						
Garba Tula	5,600	2,500,000	21,500	2,250	230	2,3
Bibi / Duse	1,800	1,760,000	8,000	5,000	270	1,2
Kinna	2,500	2,500,000	7,500	5,000	180	1,2
Boji	1,100	1,350,000	7,000	6,100	380	1,2
Gafarsa	1,700	2,100,000	8,000	6,000	280	1
Kulamawe	1,500	900,000	13,000	3,000	520	2,3
Malka Daka	1,100	2,100,000	6,500	9,000	350	1
Total	15,300	13,210,000	71,500	4,317	280	
Merti Division						
Bisan Biliku	1,500	2,600,000	6,500	8,500	260	1
Dadacha Bassa	1,400	3,500,000	11,000	12,500	470	1
Malka Galla	1,600	3,500,000	11,000	11,000	400	1
Bulesa	1,700	4,125,000	8,000	12,000	300	1
Korbesa	1,800	3,025,000	8,000	8,500	270	1
Merti	3,000	1,540,000	17,500	2,600	350	2,3
Total	11,000	18,290,000	62,000	8,314	338	
Sericho Division						
Eldera	1,250	2,750,000	6,500	11,000	300	1
Modogashe	7,000	5,700,000	22,500	4,100	190	1
Iresa Boru	1,000	3,400,000	7,000	17,000	420	1
Sericho	1,010	517,000	7,400	2,500	440	2,3
Total	10,260	12,367,000	43,400	6,027	254	
Major Centres						
Garba Tula	5,600	2,500,000	21,500	2,250	230	2,3
Merti	3,000	1,540,000	17,500	2,600	350	2,3
Modogashe	7,000	5,700,000	22,500	4,100	190	1
Total	15,600	9,740,000	61,500	3,122	237	

Key: Follow-up: 1 - Feasibility study, 2 - Design, 3 - Implementation
Note: A household comprises five people

7 RECOMMENDATIONS FOR IMPLEMENTATION OF PACKAGES

7.1 General Institutional Aspects

7.1.1 Introduction

The packages described in Chapter 6 represent groups of physical investments. In order to implement these investments significant institutional strengthening measures will be necessary. The costings of the packages should include an indicative allowance for institution building and this institution building is described below. As set out in Paragraph 3.4, different approaches are possible with respect to the choice of roles for different organisations. These different roles imply different institutional strengthening measures.

It is necessary, then, to specify the roles each institution will play in any implementation of District Focus Policy in the Isiolo District. The roles chosen reflect the existing capacities and "orientation" of these organisations. In summary, they are:

- overall co-ordination with DDC, administration of project appraisal - DDO
- water resources planning - Central MoWD
- water project appraisal and water supply for urban centres - District MoWD
- water supply for market centres and rural areas - community, assisted by District MoWD, Isiolo County Council and NGO's.

Given these roles, the organisational strengthening required can be described.

7.1.2 Organisations

a) Central Ministry of Water Development (MoWD)

Water resources assessment and planning will remain a Central MoWD function for the immediate future. The skills and facilities required will only be available, and the activity is better co-ordinated from, Nairobi. Despite significant progress in institutionalising this process, additional steps remain to be implemented. These are:

- additional formal and on-the-job training of MoWD staff in the Resources Assessment Section in techniques required, this training must be given to officers who will remain within the section for a sufficient time to train replacements

- additional and replacement of equipment (to be determined)

- additional (given existing zero capability) capacity and systems to strengthen District MoWD Offices in their role as semi-autonomous water supply agencies, specifically the ability to execute training in resources assessment, preparation of the DWDP, O&M procedures, environmental management, financial systems management and techniques of community mobilisation; this activity should be supported by improved information linkages between Central Office and District

- improve internal co-ordination between the Resources Assessment Section and

other sections of the MoWD especially with respect to pricing policy and planning of water resource usage in catchments, and

- improve links with other ministries and NGO's with respect to usage of water resources.

b) District Ministry of Water Development

The aim of the institutional strengthening of the District MoWD is to create, as far as is practical, an autonomous water agency focused on the district's needs. The key roles of the District MoWD will be:

- with Central MoWD support, preparation of DWDP
- support to DDO in appraisal of proposals for utilisation of water resources, and in preparing proposals for investment packages in conformity with the DWDP
- efficient construction and/or operation and maintenance of "urban" water supply systems where required
- support to all other types of water supply systems through Local Government, Community groups and Water Associations in assessment, planning, design, implementation, project appraisal, community participation (through NGO's too) and financial systems
- training of trainers/training of Local Government/Community groups/Water Associations.
- co-ordination with ILDP/EMI ASAL Programme on water resource planning and implementation.

In order to fulfil these roles District MoWD will require:

- training in appraisal of proposals for utilisation of water resources
- training in methodology for the preparation of the DWDP
- training and resources to enforce the provisions of the DWDP
- training in support to all other types of water supply systems in assessment, planning, project appraisal, community participation and financial systems
- training to train members of Local Government/Community groups/Water Associations in these skills.
- legislation and/or regulations under the Water Act and possible revenue acts to enable the District Office to carry out the above roles

The efficient construction and/or operation and maintenance of "urban" water supply systems is constrained by two factors. These are:

1) Districts do have limited control of revenue collected from their systems. This provides no incentive for efficient operation of these systems at district level.

The appropriation in aid policy has not yet had significant impact on this situation.

2) As a consequence, district offices are over-staffed, under skilled, and under equipped.

The systems for giving the District such financial and administrative control are currently being developed. Support for their implementation is thus important.

c) Isiolo County Council

Support to community groups will require additional staff and training in catalysing community participation and in operation and maintenance. Given the size of the systems, full cost recovery (i.e. including capital costs) will not be possible in the short to medium term (say ten years). In the interim, recovery of O&M costs should be possible after several years (timing should be confirmed by feasibility studies).

d) District Development Office

Current staffing of the District Office is adequate for required liaison activities. In order to strengthen the co-ordination role of the DDO, increased training of DDO staff in Water Resources Planning would be an asset. Such training should be part of a programme which would result in the officers trained remaining in positions where they could utilise such training, at least until they had a chance to train replacements.

In addition, some revision of the legal and/or administrative base for the DDC's oversight of water matters may be necessary.

e) Community Groups

While community participation in design, construction, operation and maintenance is possible within the cultural context of the Isiolo people, different parts of the District are capable of undertaking different levels of responsibility. Thus, close liaison with the chiefs and sub-chiefs will be necessary to understand the situation in a particular area. Initially, especially for small groups, full cost recovery (ie including capital costs) and autonomous administration of water systems, will not be possible. However, such policies should be objectives, and progressively introduced as the community moves towards a formal, money economy. The MoWD already carries out such activities on a limited scale.

7.2 Investment Funding

Implementation of an investment programme requires the acquisition of a source of funds for feasibility studies and for capital investment. This source may be, in addition to local or GOK funds, such agencies as the World Bank, the African Development Bank, NGO's, the EC, and many different bi-lateral donors.

Each of these organisations have different criteria for assessment of funding proposals, but there are many aspects of their assessment process in common.

7.3 Feasibility Studies

7.3.1 Introduction

Once the institutional strengthening arrangements are resolved in outline, and a likely source of funding identified, a detailed feasibility study must be undertaken for projects and programmes. This may in many cases encompass the detailed design for the new water supply, enabling an efficient transition to implementation. Although detailed requirements of funding agencies will differ, the feasibility study should incorporate all the appraisal criteria set out in Paragraph 5.3 above. Each project within a package should be studied individually, and the institutional and financial impact of the whole programme on the organisations involved should be detailed separately.

7.3.2 Key Implementation Requirements

The study of alternative approaches to implementation of the project/programme should address several key issues. These are:

- technical soundness,
- social impact,
- institutional arrangements, including source of funds,
- financial/economic viability, including phasing of the project and
- recommended project priority where there is more than one project.

The basic methodologies for appraisal are set out in Chapter 5 above.

Additional institutional strengthening activities required for implementation but not covered in Paragraph 7.1 will include training counterpart staff of the MoWD to undertake their responsibilities in the feasibility study phase.

In addition to participation in the studies themselves, significant community strengthening activities in preparation for implementation are also required at feasibility phase. This entails information of and discussion with the population and assistance in the formation of (water) committees by the population. Co-ordination with ILDP/EMI ASAL Programme is also strongly recommended at all stages of design. Design of new systems should conform with the requirements of the Livestock Management Plan.

7.4 Implementation

Implementation from feasibility phase onwards includes detailed design, construction and setting up routine operations. These phases contain many activities, each of which should be detailed in a project proposal. These activities must be funded and monitored, and the structure of the organisation which is to co-ordinate the project package must be capable of:

- disbursing capital funds to recipients according to established procedures, and
- gathering and processing the required data for monitoring.

This will require training of staff, and additional equipment and resources if the MoWD is to take on this co-ordinating role.

Effective community participation in construction and operation will require a flexible approach to implementation on the part of the support organisations, principally the MoWD. Where local communities are not familiar with the requirements for management of formal sector organisations, such as a water supply, close contact over a prolonged period of time will be required to develop and refine workable systems. Adequate skills and resources for such an approach must be identified at feasibility phase and be in place for construction and operation phases.

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APPENDIX 1

PRIORITY WATER SUPPLY INVESTMENT

APPENDIX 1 PRIORITY WATER SUPPLY INVESTMENT

DWE PRIORITY

A) Urban and Market Centres

Isiolo -
1) Treatment plant capacity (117 m^3/hr) to be upgraded to capacity of intake (193 m^3/hr),
2) intake to be moved upstream
3) institutions to be moved to borehole supplies
4) groundwater exploitation by boreholes possible in future

Garba Tula - existing boreholes and storage require rehabilitation for protection of source (current amoeba infection) and pump

Modogashe
1) lagga source to be developed with sub-surface dam to clay layer (4m deep), protected wells tapping collected water
2) some pipes available to extend service areas
3) piping water from Lorian Swamp spring source at 30-40 km distance

Merti - no immediate development required, but aquifer drawdown levels to be monitored

Oldo Nyiro - existing sub-surface dam inadequate, Catholic Mission to develop pumped supply from Ewaso Nyiro

Kinna
1) existing County Council project problems with contamination of storage, intake to be extended to spring source in forest and storage protected
2) possible use of groundwater by borehole

Kulamawe - existing supply adequate for people, additional source to be developed for animals

Sericho - no immediate development required, SIDA installed solar pump is operating well, aquifer drawdown levels to be monitored

Bulessa - supply to be developed to pump water from river (nearby - 4 km, although it requires significant investment as river changes its course) or from perched aquifer at distance of 2 km

B) Other centres

Kom - subsurface dam in lagga required (deep groundwater is saline)

Ngare Mara - borehole (by WRAP) equipped by RDF

Duse - no permanent population, borehole projected but no source identified, pipes bought

Bibi - as above

Eldera - sub-surface dam to be developed in lagga

COUNTY COUNCIL PRIORITIES

Apart from the above areas

Shaba Reserve -
1) Shaba gate requires spring protection and division of supplies for livestock and people
2) Airstrip requires expansion of spring supply and source protection
3) Ngare Mara and Buffalo Springs gates require better supplies

APPENDIX 2

PROJECT PROPOSAL

INDICATIVE INVESTMENT PACKAGES

APPENDIX 2

PROJECT PROPOSAL - INDICATIVE INVESTMENT PACKAGES

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Appendix 2 PROJECT PROPOSAL - INDICATIVE INVESTMENT PACKAGES

1 INTRODUCTION

This appendix is intended to provide the basic structure of a proposal to a funding agency for funds to implement a rural water supply project. The requirements and emphasis of these agencies will differ, but many key aspects of these proposals are common to most. The major topics covered in the proposal are:

1) Summary of Project

2) Background

- policy context
- previous assistance
- pattern of settlement
- institutional setting

3) Project description

- objectives and scope
- description
- justification

4) Implementation Arrangements

- scope of work and activities
- inputs
- outputs

5) Costing and Counterpart Resources

- costing
- counterpart resources

The proposal will describe and justify funding of the programme implied by the investment packages developed in Chapter 6 of Part 3. The description will be set out in terms of the technical, social, institutional and financial/economic aspects of the programme.

The project will implement water supply systems over the Isiolo District, in accordance with the District Water Development Plan (DWDP). This plan takes into account previous and continuing activity in the water sector the District.

The overall objective of the project is to implement sustainable rural water supply systems, focusing on ASAL areas. In order to achieve this objective several lower level objectives are required. It requires extensive strengthening of institutional procedures and structures to implement such an objective. Specifically:

- development of a viable systems of designing, funding, implementing, operating and maintaining water supply systems at DISTRICT level

- such systems are to include mechanisms of COST SHARING in order to ensure the systems are viable in the long run, and

- the systems should utilise technologies which are appropriate to the physical, cultural and affordability contexts of the communities in which they are used.

It must be realised that the responsibility for submitting a project proposal to a funding agency lies with the District Development Committee. This proposal should thus be seen as an example which may have to be revised to include additional issues raised by the District. This revision could cover aspects of technology choice, project area, time schedule, etc. The investments described in the proposal could also be broken into smaller packages.

2 BACKGROUND

2.1 Policy context

Four major policies shape the development of rural water supply in Kenya. The primary policy is a general one set out in the National Development Plan 1989-1993. This sets the target of providing every household with a potable water source within 4 kilometres.

The other three objectives have a determining role in the way this policy is achieved. They are:

- the District focus policy,
- the policy of cost sharing, and
- the policy of ensuring access to lower income groups (affordability).

These policies can, in some institutional contexts, be contradictory. However, the task of the proposed project is to develop an institutional system in which such objectives can be met.

In addition, consideration should be given to the priority accorded to development of Arid and Semi-Arid Lands (ASAL). Many of the areas where water supply is a central issue are ASAL.

2.2 Previous Assistance

Previous assistance to Kenya in the water sector has been extensive. Bi-laterals, multi-laterals, NGOs and others have been active in the sector. However, no major water supply projects focusing on the Isiolo District have been implemented. The two key projects, currently being implemented, which form the basis of the proposed project are:

- the Water Resources Assessment and Planning (WRAP) Project, and
- the Isiolo Livestock Development Project (ILDP) of EMI - ASAL

The WRAP project, and the Isiolo District Water Development Study (IDWDS) produced by the project, form the basis of the proposed project. The IDWDS identifies the water resources and projected demand for these resources in the District. It also suggests, in general terms, the level of investment required to satisfy this demand. The proposed project provides a mechanism to implement this investment.

The ILDP Project is preparing a plan for the development of the livestock water supply in the District. Incorporated into the proposal is the experience and study results of this project with respect to the development of water resources for livestock.

The SIDA Water Use Test Project or Water and Finance Management Project (WAFIM) also provides a basis for the proposed project. The SIDA project focuses on the administrative and financial systems required by the District Office of the MoWD. Both the WRAP and SIDA projects make recommendations for institutional strengthening which are also incorporated in this proposal.

2.3 District Profile

The "rural" district of Isiolo is composed of four types of settlement for which water supply is required. These are:

- Small urban areas such as Isiolo, Garba Tula, Modogashe and Merti with an estimated population greater than 2,000. They are major market centres for livestock and as service centres for government (education and health in particular), small scale repair facilities, and retail of basic consumer goods. They are surrounded by an increasingly permanent housing (olas) at very low densities.
- Market centres such as Oldo Nyiro, Kinna, Kulamawe, Sericho and Bulesa with an estimated population less than 2,000. In these settlements the permanent, formal sector structures are ranged along one or two streets (livestock purchasing agencies and shops selling basic consumer goods). This area is surrounded by an area of very low density housing (olas) as above.

- Olas (encampments) of the pastoralist Boran and Somali in rural areas. These structures are usually temporary, but may occupy the same general area over prolonged periods. Of the Isiolo people, the Boran comprise an estimated 70%.
- "Independent" facilities such as tourist lodges, missions and schools.

Nomadic peoples are not well represented in the formal urban sector.

In addition water is required for several different uses, some of which must be associated with these settlements. The most important is the demand for water for livestock. The olas of the dominant Boran surrounding the small urban and market centres have many associated herds which constitute a substantial demand. When the cattle move to better pasture, the olas sometimes also move. Water is thus required along the routes used by livestock. Tourist facilities have associated demand from wildlife. Other demand from small-scale agriculture (supplying small urban centres) is significant. This demand comes from some irrigation schemes along the Ewaso Nyiro River and at Kinna.

With the exception of government provided park facilities such as gates, airports, ranger posts, etc., wildlife (tourism) is a formal sector activity carried out by the private sector. Investments for water supply in this industry can thus be left to the private sector, given that the projected investments are in line with the DWDP. Nomadic pastoralism is the main traditional economic activity and is substantially outside the formal economy. This activity combined with urban demand, cover the majority of the population who will have difficulty in obtaining water without government intervention. They are thus the legitimate focus of government activity in the water sector. However, it should be noted that the approach adopted for these two groups will be, of necessity, quite different.

The average urban income in the district (Isiolo town) was estimated at Shs 2,580 per month in 1987 (source: Central Bureau of Statistics, Statistical Abstract 1988). The average rural income in the district could not be estimated from available data, but surveys carried out under the Isiolo Livestock Development Project (ILDP) will give useful information on rural wealth.

Apart from water, the main constraints to District economic development are limitations on livestock capacity, poor transport links/access to markets and underdeveloped market structure.

Considering the technical options available and the settlement pattern, water will thus be delivered to people and industries in four groupings, the first three of which require support of government. These are:

- urban systems with mainly service and small scale industry demand in addition to residential demand,
- market centre systems with some service demand, a small permanent residential demand, increasing demand from semi-permanent residents, who may require water supply for cattle
- rural supplies for nomadic pastoralists, transit cattle and some agriculture provided in accordance with the recommendations of the ILDP, and
- supplies to "independent" facilities in the formal sector, usually government institutions such as schools and police stations.

Within these groupings there are social groups which have differing cultural requirements and income levels which will effect their effective demand for the various technical options. That is, these different groups can afford different amounts for their water and have different priorities with respect to availability/quality/use. ILDP studies confirm this. Different groups will thus often demand different things from water supply systems. In order to resolve these competing demands strong institutional systems are required and it is these systems which will now be examined.

2.4 Institutional Setting

2.4.1 Context

The existing network of organisations involved in the water sector is complex. With the District Focus Policy, the District is expected to co-ordinate all investment, including investment in water supplies. However, this policy has yet to move fully from one of "deconcentration", i.e. placing implementation activities of line Ministries at local level while retaining centralised control of staff and budgeting, to one of true "decentralisation", i.e. giving staffing and finance control to the local institutions. This process

requires extensive support, especially by providing systems and funding for effective district co-ordination and implementation of investment in the water sector. As will be seen below, providing this support is a major objective of this project.

Four key activities are required to implement a water supply. It must be planned, designed, constructed and operated. Overall water policy planning, and technical (design) support is the responsibility of the Ministry of Water Development (MoWD). Responsibility for construction and operation is fragmented however. When undertaken by the MoWD, local offices of the MoWD, have considerable autonomy in design and construction of water supply schemes. Other ministries also design and construct water supplies.

Private formal sector organisations, missions and other entities may obtain permits as "water undertakers", to exploit local water resources. The appointment of a water undertaker is done by the Minister of Water Development under the powers of the Water Act (cap.372).

Local Water Associations are legal entities which have a Water Permit. They are being formed in some districts to become responsible for existing water systems or to undertake new ones. Permission to utilise water resources under the Water Act is presently given by a committee of the MoWD meeting in Nairobi, but is usually decided on the recommendation of the District Office of the MoWD. The lowest level institutions are the informal water committees. Such committees exist at several places in Isiolo, but they are currently involved mainly with the organisation of the water supply of the livestock.

In general, the District Office of the MoWD implements urban/market centre supplies and smaller schemes are undertaken by communities sometimes assisted by an NGO. Co-ordination of these activities is to be achieved by the District Water Development Plan, based on the IDWDS.

2.4.2 Implementation of District Focus in the Water Sector

The existing institutional base of future water investment in the District is limited. In the context of the District Focus policy, the District Development Committee (DDC), assisted by the District Executive Committee, is expected to co-ordinate investment in the water sector. This includes expenditures by the Municipal Council (under the Ministry of Local Government). As stated above, the instrument used to achieve this co-ordination is the District Water Development Plan (DWDP). This plan is prepared by the DWE. While the structure for implementation of the plan is in place, the resources to carry out the required project appraisal, prioritisation and implementation are very limited. It is this situation that the project is intended to address.

The three key aspects of implementation which require strengthening are:

1) The administrative and financial systems of the District Offices of the MoWD.
The MoWD District offices are being strengthened as part of the "deconcentration" of Ministry activity. The policy of "appropriations in aid" has been instituted which will link future recurrent expenditure funds allocated to districts to their performance in meeting revenue targets established by Treasury. Wages for lower levels of staff are now the responsibility of the district to pay. This may have a considerable impact on efficiency as there are indications that district level staff are under skilled, and that, compared to the resources available to work with, there may be significant over staffing.

2) The support systems both the District Offices and to community groups provided by central MoWD.
The head office of the Ministry in Nairobi will now concentrate on providing policy, training and technical support, especially as key implementation activity has also been taken over by the National Water Conservation and Pipeline Corporation. In this role, it has begun to institutionalise the assessment and planning process developed, to a great extent, through the WRAP project. The water assessment studies and planning reports are now an important resource for the MoWD, and its staff are being trained in the techniques of assessment. The Planning Unit within the Water Resources Assessment Section is responsible for carrying out these studies and assessments.

3) Co-ordination of the organisations which will implement the plan.
Currently, there is no clear policy on which organisation(s) should implement projects at district level. There are several options. These include the District office of the MoWD, the Municipal

Council, NGO's and local Water Associations. The choice of institution will depend on the existing strength of these institutions, and potential for future strengthening.

One apparently successful method has been adopted in the Baringo District. It has been developed with assistance from UNICEF. A district water coordination group has been formed led by an inter-ministerial team and supported by every operational NGO in the district. The inter-ministerial team has representatives of MoWD, MoH and MCSS as well as the DDO and it is to be in contact with all operating organizations in the district who have an interest in water. It has been agreed in Baringo that this group meets every three months for information sharing, decision making, etc.

Thus, the responsibility for development and implementation of the district plan for water development is shared by all concerned groups. Individual groups become the "lead" agency for community mobilization and implementation in their Division. Such matters as overlapping and duplication are worked out. Once plans are agreed it is up to each group to implement in their own way. With this approach it will be possible to implement water programmes by different organizations within the overall district strategy.

2.4.3 Community Involvement in the Water Sector

It is expected that the communities involved will play a central role in planning, implementing and maintaining the water supplies identified as viable under the proposed project. This is particularly the case for the small scale rural schemes. However, these communities require significant support over a considerable period in order to take on this role. The proposed project should identify and provide such support.

Water Associations or committees, in theory ideal for the implementation and/or operation of small community schemes, also have a weak base in Isiolo District. While various community leaders are present on the Divisional Development Committees and are represented on the DDC by the Divisional Officer, there is no formal structure of community participation, although the informal links through chiefs and sub-chiefs to the elders are said to be effective. Such participation is fundamental to the success of water supply projects in rural areas. No Water Associations have been formed as yet, but community water committees have functioned effectively at some centres.

The institutional base will also play a key role in the technical option chosen. Options involving water systems which require complex or expensive operations and maintenance support can not, at present, be easily handled by district institutions. Where such systems must be used, extensive support to strengthen these institutions will be required. Such strengthening, although on a more basic level, is particularly important for local community groups where they will have a major role in implementing systems.

3 PROJECT DESCRIPTION

3.1 Project Objectives and Scope

The goal of project activity in the water sector in the District is to support environmentally sustainable development in order to provide for an equitable distribution of the nation's economic growth. Such activity is necessary in view of the increasing population, livestock and agricultural pressure on, and the sensitive nature of the environment in, this area.

The overall objective of the project is:

- to implement sustainable rural water supply systems.

In order to achieve this objective several lower level objectives are required. It requires extensive strengthening of institutional procedures and structures to implement such an objective. Specifically:

- development of a viable systems of designing, funding, implementing, operating and maintaining water supply systems at DISTRICT level
- such systems are to include mechanisms of COST SHARING in order to ensure the systems are viable in the long run, and
- the systems should utilise technologies which are appropriate to the physical, cultural and affordability contexts of the communities in which they are used.

The project will implement water supply systems at rural centres in Isiolo District, in accordance with the District Water Development Plan (DWDP). This plan takes into account previous and continuing activity in the water sector by the District. An indicative level of physical investment was estimated by the IDWDS. The total amount of required investment for the supplies was some Kshs 49 million (approximately US$ 1.65 million).

The distribution of this investment over the Divisions in the District is shown in Table 3.1.

3.2 Project Description

3.2.1 Overview

The project will be divided into three phases. The first phase will consist of feasibility studies. The second phase will carry out detailed design in consultation with the community where appropriate, and commence the institutional strengthening activities identified in the Feasibility studies. The third phase will consist of implementing the remaining institutional strengthening activities and construction of the water supply systems. These phases are described in detail below.

Briefly, the roles each institution will play in any implementation of the project in Isiolo District reflect the existing capacities and "orientation" of these organisations, government objectives, and potential of these organisations. In summary, they are:

- overall co-ordination with DDC - DDO
- water resources planning - central MoWD
- water project appraisal and water supply for urban centres - District MoWD
- water supply for market centres and rural areas- community, assisted by District MoWD, DDO, other ministries and NGOs.

3.2.2 Feasibility Studies

In the context of the DWDP, the major activities required to prepare the feasibility studies are:

- detail survey - physical and socio-economic of potential sites identified in the DWDP
- preliminary design and costing of water systems and institutional/community structures for implementation
- liaison with community groups on self help aspects

- assessment of proposed designs on the following criteria:

  . water resources
  . land use planning/environmental impact
  . social impact
  . institutional/community participation
  . economic
  . affordability
  . financial.

3.2.3 Detailed Design

Major activities involved in this phase are:

- physical survey of feasible sites
- design and documentation of water systems and implementation of first round of institutional strengthening (training in planning, design, community participation, and construction supervision; implementation of financial systems) and structures for community participation
- liaison with community groups on self help aspects

3.2.4 Implementation

The major activities are:

- land acquisition, if any
- tender of construction
- construction of systems and supervision thereof
- second round institutional strengthening (training in community participation, operation & maintenance)
- operation and maintenance systems

3.2.5 Project Duration

It is difficult to determine accurately the duration of the project, as much depends on bringing the rural communities involved along with the planning process and involving them in it. As such this process will proceed from one step to the next, and the design of the approach to the next step will depend on the experience in the proceeding step. This is so-called "process planning". Other parts of the studies, the surveys and the planning and design of the urban supplies can be implemented in a more programmed manner. This being said, it is expected that initial commitment to the project will be for three years. Projected date of commencement is July 1992.

It is estimated that the feasibility study phase will last 6 months, the detailed design phase 6 months, and the implementation phase 36 months.

The project will have a formal mid-term and final review in addition to reports will be completed at the end of each phase and bi-monthly progress reports which will be required throughout the project.

3.2.6 Project Location

The project will be based in MoWD headoffice, the office of the District Water Engineer in Isiolo, and in project sites throughout the District as identified in the feasibility study phase.

3.3 Project Justification

3.3.1 General

In the DWDS for Isiolo District, criteria for appraisal of investment options were established in the following categories:

- water resources
- land use planning/environmental impact
- social impact
- institutional/community participation
- economic
- affordability
- financial.

Simple checklists were established to test a project against each of these sets of criteria. These will be used in Section 3.3.2 below to assess the proposed project in general terms.

A prioritisation of projects will also be carried out using the methodology described in the DWDP. The methodology used is tailored to the existing and potentially achievable levels of assessment skills in the District.

3.3.2 Detailed Justification

a) Water Resources

The project will use the water resources identified in the IDWDS to meet demand in an efficient manner, rather than in a haphazard and potentially environmentally damaging way.

The yield of the proposed project water sources has been analysed and it was found that the required quantity of water can be supplied during the lifetime of the project. The variation of the yield during the year is such that at minimum flow periods the water demand can be sufficiently met.

The occurrence of droughts was studied and it may be possible that during droughts the water available is insufficient to supply the full demand. However it is expected that livestock will leave the area during drought periods, because of shortage of fodder, which will reduce the water demand. Domestic water demand can be supplied always during drought periods. The frequency of the droughts could not be determined due to insufficient data.

The traditional water sources are hand dug wells in the dry river beds. It is expected that the use of these sources will decline, because the project provides water closer to the homes of the people. The importance of a better water quality provided by the project needs to be explained to the population to be really appreciated. This will have to be done in combination with a campaign on improved sanitation measures.

b) Land Use/Environmental Impact

The project is intended to foster sustainable economic development in the District. It supplies water to activities consistent with the District Development Plan. In particular:

- water for livestock is provided near the settlements in order to encourage nomads to settle
- sufficient investment is planned to allow for increase in ranching and small scale irrigation.

The facilities/plant of the project are consistent with plans for urban/rural development.

- the systems are sized to cater for projected rural and urban growth
- no significant physical constraints appear to limit siting or sizing of systems.

Neither the facilities/plant of the project, nor their construction, are likely to have an adverse environmental impact. The major forms of impact to be considered in the Isiolo District are:

- the degradation of vegetation cover and soils from overgrazing, in particular the extensive damage occurs around water points in droughts - the project will alleviate this by dispersing watering points along grazing routes
- the impact of dams which intercept surface water causing downstream wetlands to dry up - this may have a significant impact on some wildlife, and dams are not proposed in the project
- heavy pumping of ground water may cause springs to dry up, effecting animals and sometimes people - at this stage this is not expected to be a problem for the proposed sites

c) Social Impact

The project is intended to foster inter-regional equity and to support community development in one of the poorest areas of Kenya.

Traditional groups are affected by projects, but the programme is designed to work within the cultural context of those groups. Developed within this context, the mechanisms for community participation in design, implementation, operation and maintenance will be central to the project.

The proposed project will improve the welfare of the people of the District, particularly lower income groups and women. The self-help components of the project provide employment for women in particular. Additional water provides opportunities for small scale agriculture and, possibly, additional cash income.

d) Institutional/Community Participation Issues

The project will strengthen government and community institutions in line with the District Focus policy.

Institutions

The major tasks which must be addressed with respect to institutional issues are design, construction and operation/maintenance of the systems. The organisation, or grouping of organisations must be able to carry out these tasks effectively.

As set out in the project description above, the roles each institution will play in any implementation of the project reflect the existing capacities and "orientation" of these organisations, government objectives, and potential of these organisations. In summary, they are:

- overall co-ordination - DDO
- water resources planning - central MoWD
- water project appraisal and water supply for urban centres - District MoWD
- water supply for market centres and rural areas- community, assisted by District MoWD and NGOs.

Design and construction supervision will be supported by the project which will also strengthen MoWD counterparts at head office and district levels in these roles. The MoWD has agreed to provide the required staff and facilities for the project as set out in Section 5.

This appears to be a realistic project organisational structure and the implementation schedule set out in Section 4 also appears viable.

Community Participation

Community participation will occur in many aspects of the project. In small scale water supply projects, it is likely that it will occur in design, construction and operation activities. The organisation of this participation is thus a key element in the successful implementation of the project.

Community committees are to be formed with the support of the chiefs and elders in each area. If insufficient support exists for the formation of the committee, no project will be attempted. Local DDO and MoWD staff will assess whether the leaders of the community organisation are representative of the community in order to ensure that the promised community inputs will be delivered.

Socio-economic surveys will check if the communities can deliver the promised labour and money inputs to the project on time.

Table 3.1 Preliminary Cost Estimate of Water Supply Development for Rural Centres

Population Centre	Design Population Estimate 1990	Capital Costs (Ksh)	O & M Costs per Month (Ksh)	Costs per Household		Required Follow-up
				Capital (Ksh)	Annual O&M (Ksh)	
Central Division						
Ngare Mara	1,200	1,200,000	8,000	5,000	400	3
Kipsing	1,420	2,200,000	7,000	7,750	300	1
Oldo Nyiro	2,000	2,250,000	10,000	5,600	300	1
Total	4,620	5,650,000	25,000	6,115	325	
Garba Tula Division						
Garba Tula	5,600	2,500,000	21,500	2,250	230	2,3
Bibi / Duse	1,800	1,760,000	8,000	5,000	270	1,2
Kinna	2,500	2,500,000	7,500	5,000	180	1,2
Boji	1,100	1,350,000	7,000	6,100	380	1,2
Gafarsa	1,700	2,100,000	8,000	6,000	280	1
Kulamawe	1,500	900,000	13,000	3,000	520	2,3
Malka Daka	1,100	2,100,000	6,500	9,000	350	1
Total	15,300	13,210,000	71,500	4,317	280	
Merti Division						
Bisan Biliku	1,500	2,600,000	6,500	8,500	260	1
Dadacha Bassa	1,400	3,500,000	11,000	12,500	470	1
Malka Galla	1,600	3,500,000	11,000	11,000	400	1
Bulesa	1,700	4,125,000	8,000	12,000	300	1
Korbesa	1,800	3,025,000	8,000	8,500	270	1
Merti	3,000	1,540,000	17,500	2,600	350	2,3
Total	11,000	18,290,000	62,000	8,314	338	
Sericho Division						
Eldera	1,250	2,750,000	6,500	11,000	300	1
Modogashe	7,000	5,700,000	22,500	4,100	190	1
Iresa Boru	1,000	3,400,000	7,000	17,000	420	1
Sericho	1,010	517,000	7,400	2,500	440	2,3
Total	10,260	12,367,000	43,400	6,027	254	
Major Centres						
Garba Tula	5,600	2,500,000	21,500	2,250	230	2,3
Merti	3,000	1,540,000	17,500	2,600	350	2,3
Modogashe	7,000	5,700,000	22,500	4,100	190	1
Total	15,600	9,740,000	61,500	3,122	237	

Key: Follow-up: 1 - Feasibility study, 2 - Design, 3 - Implementation
Note: A household comprises five people

This approach has been effective in ensuring community participation in Isiolo District in the past. Local government agencies were prepared, given project support, to provide the organisational and logistic support required for such activity.

e) Economic and Financial Issues

The project will assess the economic viability of each sub-project. The methodology required to undertake an economic assessment of the project is set out in the DWDP. The feasibility study phase of the project will include such an assessment for each scheme.

Affordability

Particularly with respect to water supplies for the partly nomadic peoples, the issues of affordability and willingness to pay are complex, and bound up with slowly changing traditional beliefs and priorities. Feasibility studies will address this issue in some detail.

The main consideration is the level of cost sharing required. This will determine the fee or tariff set in the scheme. In general, the guidelines which will apply in respect to urban schemes are that full recovery of capital and all operation and maintenance costs is to be achieved over a period of ten years. Outside urban areas, full recovery of operations and maintenance costs will be required, and community contribution to capital works will also be a factor in deciding the priority of the scheme - the more contribution the higher the priority.

Basic affordability criteria are:

- the sum involved in cost recovery should not constitute more than 5% of the income of the poorest 20% of the population
- if there is no alternative water source, or if it is more expensive than the proposed scheme, then there is a good prospect of achieving a sufficient level of willingness to pay given adequate institutional systems and political support
- if there is an alternative which is acceptable to the people, even if the water is technically inferior, a new technology should be considered, or the level of cost recovery should be reviewed.

Financial Issues

The key financial issue is the sustainability of the project. With the above analysis complete, and concurrently with the determination of affordability, it is possible to project likely demand, and the costs of each sub-project over time. The feasibility study must identify the sources of funds for design, construction and operation/maintenance. The projection of the expenditure of these funds must be realistic. A basic cashflow analysis can then be carried out to identify potential liquidity problems, and measures developed to overcome them. The financial return on the project can also be calculated.

Financial systems for revenue collection and recording financial flows (simple records of costs and receipts) have been developed, and could be applied to even the smallest schemes. For larger schemes, simple procedures for capital budgeting and funding of preventative maintenance schemes could be developed based on experience in some NGO projects. These types of procedures will be designed in the feasibility study phase and implemented during subsequent phases of the project.

3.3.3 Prioritisation

The project will prioritise the investments (sub-projects) identified in the feasibility studies. The suggested method of prioritisation focuses on the sustainability of the project. Basically, it consists of ensuring that all of the questions set out above in each of the criteria categories have a satisfactory answer. Then, priority is assessed according to how well projects meet the cost sharing policy.

First priority projects will recover both capital and operation and maintenance (O&M) costs. Second priority projects will recover O&M costs. Third priority projects will be economically viable and be ranked according to the extent of recovery of O&M costs. Other projects should not be implemented.

Table 3.1 sets out the total required investments for water supplies to rural centres as estimated from preliminary data. Detailed sub-project ranking will be confirmed by the feasibility phase of the project. The proposed projects for the different supply areas were based on recovery of O&M costs only.

Figure 4.1 Personnel Inputs and Outputs (Example)

ACTIVITY	MONTHS 1–6	7–12	13–18		36	TOTAL MONTHS	COST	TRAVEL COST Extern.Local
Activity 1								
DWDP Support TA								
Inputs:								
1) Foreign Personnel								
Team Leader	**********	**********				12		
Planner/Engineer	** ** *	* ***				4		
Volunteer	**********	**********				12		
2) Government Personnel								
Project Manager	**********	**********				12		
DWE	**********	**********				12		
HO Engineer	**********	**********				12		
Hydrologist	**********	**********				12		
etc								
3) Support Staff								
Secretary	**********	**********				12		
Assistant	**********	**********				12		
Outputs:	Draft DWDP, Draft Institution Rpt	Final DWDP & Institution Rpts						
Activity 2								
FS Support TA								
Inputs:								
1) Foreign Personnel								
Team Leader	******	**********	**********	****	****	33		
Planner/Engineer	******	**********	**********	****	****	33		
Sociologist	******	**********	**********	****	****	33		
Engineer (Water Supply)		**********	**********	****	****	30		
Surveyor	******					3		
Economist/Finance	**	**	**			6		
Environmental	**	**	**			6		
Institutional	**	**	**			6		
2) Local Consultants								
Deputy Team Leader	******	**********	**********	****	****	33		
Planner/Engineer	******	**********	**********	****	****	33		
Sociologist	******	**********	**********	****	****	33		
Engineer (Water Supply)		**********	**********	****	****	30		
Surveyor	******					3		
Economist/Finance	**	**	**			6		
etc								
3) Government Personnel								
Project Manager	******	**********	**********	****	****	33		
Engineer Counterp. x 4	******	**********	**********	****	****	132		
4) Support Staff								
Office Manager	******	**********	**********	****	****	33		
Secretary x 2	******	**********	**********	****	****	66		
Assistant	******	**********	**********	****	****	33		
Drivers x 4	******	**********	**********	****	****	132		
Cleaner	******	**********	**********	****	****	33		
Outputs:	Draft Physical & Social Rpts	Draft FS Rpt, Final Physical & Social Rpts	Final FS Rpt					

4 PROJECT IMPLEMENTATION

4.1 Scope of Work and Activities

4.1.1 Feasibility Study Phase

Two separate streams of Technical Assistance (TA) are required. The first is required to support the MoWD in its project preparation activity. The second is to carry out the detailed feasibility study activity. Thus the two main activities involved in this phase of the project are:

1) TA support to the MoWD in Project Preparation.

   The main tasks are:

   - liaison with various concerned agencies for input to the DWDP
   - finalise the DWDP
   - conduct on-the-job training in parallel with TA for feasibility studies.

2) TA support for Feasibility studies.

   The main tasks are:

   - detail survey, physical and socio-economic of potential sites identified in the DWDP
   - preliminary design of water systems and institutional/community structures for implementation
   - liaison with community groups on self help aspects
   - assessment of proposed designs on the following criteria.

4.1.2 Detailed Design Phase

The division of the responsibility for the various activities involved in the detailed design phase between MoWD and TA resources will be determined at the mid-term review of the project. However, the main activities involved in this phase of the project are:

- physical survey of feasible sites
- design and documentation of water systems and implementation of first round of institutional strengthening (training in planning, design, community participation, and construction supervision; implementation of financial systems) and structures for community participation
- liaison with community groups on self help aspects

4.1.3 Implementation Phase

Again, the division of the responsibility for the various activities involved in the implementation phase between MoWD and TA resources will be determined towards the end of the design phase. However, the main activities involved in this phase of the project are:

- land acquisition, if any
- tender of construction
- construction of systems and supervision thereof
- second round institutional strengthening (training in community participation, operation & maintenance)
- operation and maintenance systems

4.2 Inputs

Key personnel inputs to each key activity in the feasibility phase of the project are described in Figure 4.1. Equipment and other inputs to the project are described in Figure 4.2. These inputs are to be supplied by donor and government funding as described in section 5 below.

Figure 4.2 Non-personnel Inputs

ACTIVITY	MONTHS 1 12	13 24	25 36	ITEMS (OUTPUT)	COST
Activity 1					
DWDP Support TA					
Inputs:					
1) Foreign					
Procurement	******			Photocopier?	
Training	******	**********		Community Participation - KWAHO?	
	******	**********		Planning & Assessment - TNO?	
	******	**********		Economics/Finance - Rotterdam/IHS?	
Office	**********	**********		Consumables	
2) Local					
Office	**********	**********		Space & Equipment	
Activity 2					
FS Support TA					
Inputs:					
1) Foreign					
Procurement					
- Vehicles	******			4WD x 4	
- Major Equipment	******			photocopier & computers	
Training			**********	?	
Office	******	**********	**********		
2) Local					
Information	******	**********	**********		
Counterparts?	******	**********	**********		

4.3 Outputs

4.3.1 Outputs of Project Preparation TA

Institutional Outputs

a) Central Ministry of Water Development (MoWD)

The outputs are:

- additional formal and on-the-job training of MoWD staff in the Resources Assessment (RA) Section in techniques required, this training must be given to officers who will remain within the section for a sufficient time to train replacements
- additional equipment (to be determined)
- additional (given existing zero capability) capacity and systems to strengthen District MoWD offices in their role as semi-autonomous water supply agencies, specifically the ability to train in resources assessment, preparation of the DWDP, O&M procedures, financial systems management and techniques of community mobilisation; this activity will be supported by improved in information linkages between central office and District
- improved internal co-ordination between the RA Section and other sections of the MoWD, and
- improved links with other ministries with respect to usage of water resources.

b) District Ministry of Water Development

Outputs are:

- training in appraisal of proposals for utilisation of water resources
- training in methodology for the preparation of the DWDP
- improved construction and operation and maintenance of "urban" water supply systems through implementation of financial and administrative systems giving effective control these activities at district level
- training in support to all other types of water supply systems in assessment, planning, project appraisal, community participation and financial systems
- training to train members of Local Government/Community groups/Water Associations in these skills
- legislation and/or regulations under the Water Act and possible revenue acts to enable the District office to carry out the above roles

c) District Development Office

Outputs are:

- an assistant DDO with specific responsibility for water matters
- training in Water Resources Planning for this person
- revision of the legal and/or administrative base for the DDC's oversight of water matters.

d) Community Groups

Outputs are:

- education and community awareness campaigns initiated through the chiefs and sub-chiefs
- strengthen cost recovery and administration of water systems.

Reports

Outputs are:

- inception report (first bi-monthly report)
- bi-monthly reports
- mid-term institutional report
- final institutional report
- the DWDP for the Isiolo District.

4.3.2 Outputs of the Feasibility Study TA

Major reporting outputs are described and scheduled in Figure 4.1. The major reporting requirements are:

- inception report (first bi-monthly report)
- bi-monthly reports
- physical and social survey report
- mid-term draft feasibility report
- final feasibility report.

The feasibility report will assess each sub-project identified on the criteria established in the DWDP. In addition, the institutional and financial requirements for design and implementation of the sub-projects assess as viable will be detailed.

4.3.3 Implementation of Design, Construction and Operation

Implementation from feasibility phase onwards includes outputs of detailed design and implementation phases. These phases involve many activities, which are be detailed by the feasibility studies. These activities require:

- resources (money, staff and equipment) for design activity
- systems for disbursing capital funds to recipients according to established procedures
- systems for gathering and processing the required data for monitoring, and
- additional training for MoWD and other organisations involved in implementation.

Outputs will thus be:

- detailed designs and documentation for sub-projects
- completed water supply projects as detailed in Table 3.1
- adequate administration, resource planning and financial systems in place in order to operate these projects efficiently and on a sustainable basis, and
- trained staff in place where required.
- additional equipment and resources.

Effective community participation in construction and operation will require a flexible approach to implementation on the part of the support organisations, principally the MoWD. Where local communities are not familiar with the requirements for management of formal sector organisations, such as a water supply, close contact over a prolonged period of time will be required to develop and refine workable systems. Adequate skills and resources for such an approach must be identified at feasibility phase and be in place for construction and operation phases.

5. COSTING AND COUNTERPART RESOURCES

5.1 Costing

by inputs by activity/overheads in section 4.2

5.2 Counterpart Resources

5.2.1 Implementing Agency

Ministry of Water Development:

- Planning Unit, Resource Assessment Section
- District Water Engineer, Isiolo District

5.2.2 Counterpart Contribution

by inputs by activity/overheads in section 4.2