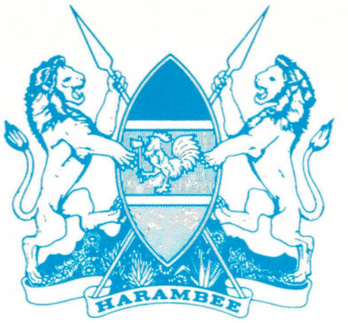
REPUBLIC OF KENYA



MINISTRY OF WATER DEVELOPMENT

MERU

title is probably wrong.
this report is on the WDev study in Isiolo

EXECUTIVE SUMMARY

OF

WATER RESOURCES ASSESSMENT STUDY AND DISTRICT WATER DEVELOPMENT STUDY

June 1991

WATER RESOURCES
ASSESSMENT SECTION
NAIROBI, KENYA

WRAP
WATER RESOURCES
ASSESSMENT & PLANNING

TNO – INSTITUTE
OF APPLIED GEOSCIENCE
DELFT, THE NETHERLANDS

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

TABLE OF CONTENTS

PREFACE i

TABLE OF CONTENTS ii

KENYAN AND NETHERLANDS TEAMS INVOLVED IN THE WRAP PROJECT IN ISIOLO DISTRICT v

1 OVERVIEW AND CONTEXT OF THE STUDY 1

1.1 Purpose and Scope of the Study 1
1.2 International Co-operation 2

2 DESCRIPTION OF ISIOLO DISTRICT 4

2.1 Physical Features and Land Use 4
2.2 Infrastructure and Economy 5
2.3 Population 5
2.4 Livestock 5
2.5 Water Supply 6
2.6 Health, Education and Social Services 6

3 WATER RESOURCES DEVELOPMENT POTENTIAL 8

3.1 Introduction 8
3.2 Surface Water Development Potential 8
3.3 Groundwater Development Potential 11
3.4 Rainwater Development Potential 13
3.5 Conclusion 13

4 DISTRICT WATER DEVELOPMENT STUDY 16

4.1 Introduction 16
4.2 Water Demand and Water Resources 16
4.3 Existing Supply, Technology Options and Costs 17
4.4 Guidelines and Recommendations for Investment Packages 18

5 DEVELOPMENT OF DOMESTIC WATER SUPPLIES 20

5.1 Pre-Feasibility Studies of Domestic Water Supplies 20
5.2 Examples of Investment Packages 23

6 OPERATION AND MAINTENANCE PROCEDURES 27

7 INSTITUTIONAL REQUIREMENTS 28

LIST OF TABLES

1	Population Estimates of Centres	5
2	Livestock Population	6
3	Proposed Water Supplies for Domestic Use in Rural Centres in Isiolo District	21
4A	Investment Packages Based on the Required Feasibility Studies	24
4B	Investment Packages Based on Technology Choice	25
4C	Investment Packages Based on Location of the Centres / Projects	25

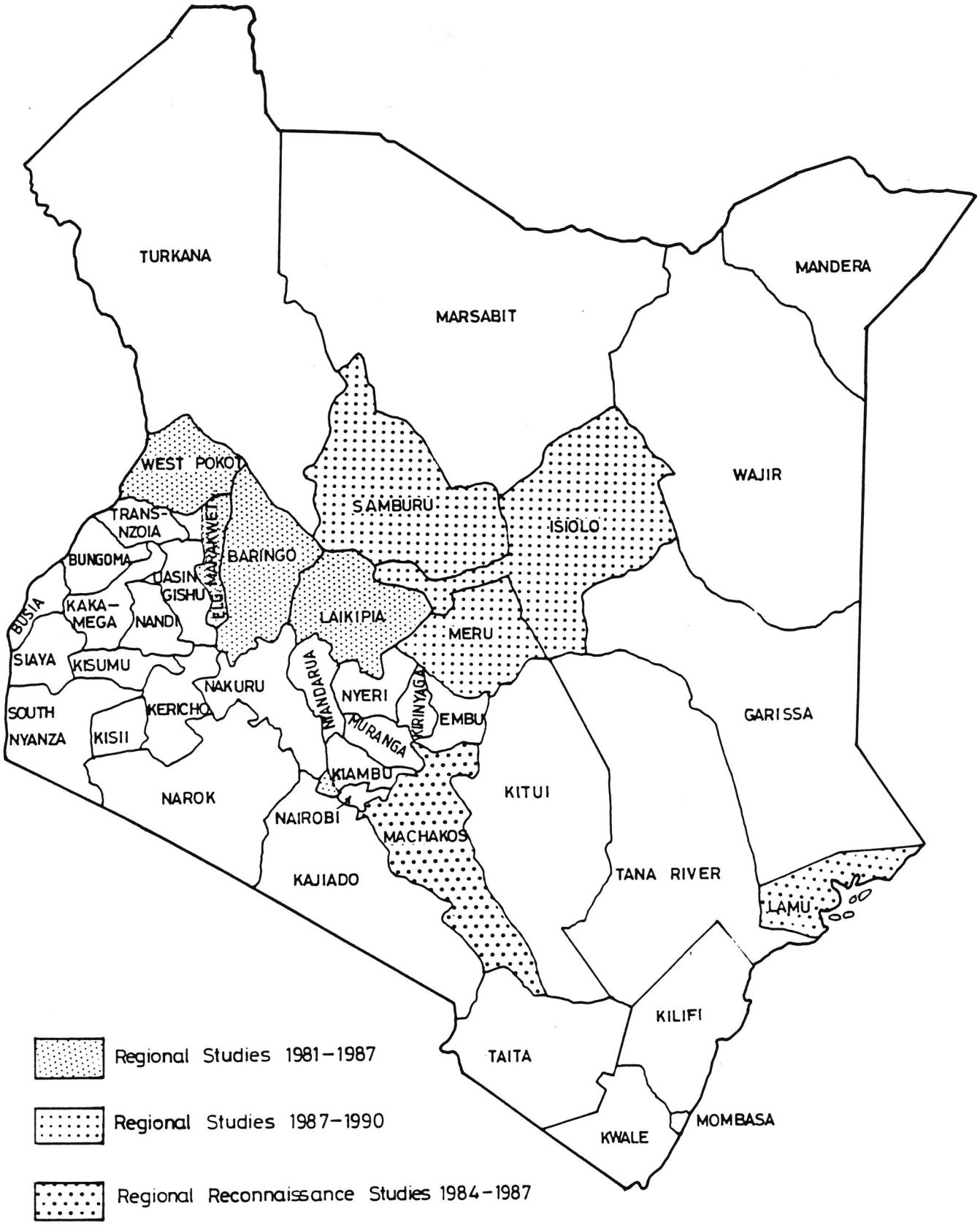
LIST OF FIGURES

1	Location Map Isiolo District	3
2	Surface Water Development Potential	10
3	Groundwater Development Potential	15
4	Development Potential for Domestic Water Supply	22

APPENDIX

Description of Water Supply to Rural Centres in Isiolo District

WATER RESOURCES ASSESSMENT & PLANNING PROJECT



Regional Assessment Studies under the WRAP Programme 1981-1990

KENYAN AND NETHERLANDS TEAMS

INVOLVED IN THE WRAP PROJECT IN ISIOLO DISTRICT

KENYAN TEAM

Project Management	Dr D.A. Arunga (Jan.1987 - Feb.1990)	Project Manager
	Mr A.M. Nzioki (as from March 1990)	Project Manager
Geology and Hydrogeology	A.M. Nzioki	Geologist I / Unit Head Assessment
Geophysics	F.K. Karanga	Geologist I /Unit Head Survey
	J.P. Oyieko	Geologist II/Acting Unit Head
	J.M. Gitari	Geologist II
	A.N. Mocha	Geologist II
	P.K. Mengich	Geophysical Assistant
	E.G. Githiora	Geophysical Assistant
	G. Ikunda	Geophysical Assistant
Hydrology	J.M. Wagura	Hydrologist II
	D.M. Muikia	Hydrologist II/ Unit Head Documentation
	M.N. Musyoka	Assistant Hydrologist
	D.K. Warutere	Assistant Hydrologist
Planning	K. Kimani	Planning Engineer
	W.K. Mureithi	Engineering Assistant
	P.M. Muriuki	Engineering Assistant
	J.K. Mbogori	Engineering Assistant
	P. Kimweya	Engineering Assistant
	A. Mohamed	Engineering Assistant
	P. Mbuvi	Engineering Assistant
Drilling	F.G. Maina	Drilling Inspector/ Head Drilling Team
	B.C. Muhang'u	Geologist II
	G.M. Kiarie	Drilling Inspector
	E. Abdi	Drilling Inspector
	S. Njue	Driller
	J.N. Nthiga	Motor Vehicle Mechanic
	A.O. Ohanya	Driver
	P. Kamau	Driver

Test Pumping	S.M. Onyango	Electronic Inspector
	E.G. Githiora	Senior Inspector
	D.W. Mwangi	Senior Inspector
	G. Ikunda	Groundwater Inspector
	S.G. Wainaina	Drilling Inspector
	A.O. Ouma	Driver
Draughting Office	J. Keza	Assistant Draughtsman
	P.P. Lumumba	Assistant Draughtsman
Secretariat	M.W. Mwaniki	Typist I
	N. Ndunda	Secretary
	L. Nyasimora	Messenger
	J. Sumba	Messenger
Transport	P. Wangai	Transport Officer
	L.M. Adaka	Driver
	J.K. Kirubi	Driver
	P. Ndegwa	Driver
	L. Gacheru	Driver
	J.M. Maina	Driver
	A.N. Muchiri	Driver

NETHERLANDS TEAM

Chief Technical Advisors	Dr J.L.J. de Sonneville (February 1986 - August 1990)	
	G. Jousma (September 1990 - August 1991)	
Geophysics	J. Csonka	Senior Geophysicist
Planning	W. van der Linden	Civil Engineer
Documentation	Ph.S. Nota	Computer Specialist

1. OVERVIEW AND CONTEXT OF THE STUDY

1.1 Purpose and Scope of the Study

The Water Resources Assessment Study and 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 studies were 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 District and a planning that is well tuned with the socio-economic and technical development of the District as laid down in the District Development Plan. In this respect it should be understood that the water resources are not necessarily the key limiting factor in the economic development of a district.

The water resources assessment study covers both groundwater and surface water and is intended to give an overview of the available water resources and their development potential in the District. Drilling of boreholes forms part of the activities and even though it is mainly undertaken for exploration purposes, drilling sites are selected in such a way, that the boreholes in most cases can be used as production wells after the study.

The methodology for planning of water resources development, embarked upon 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 for Rural Development. The DWDS can be considered the first stage of this process. The study provides insight into sustainable water supply options and the investments required to realize them. It also supports the district authorities in their search for donor contributions.

In general terms Isiolo District can be described as a rural district, with only one urban centre (Isiolo Town), about 20 small rural centres and a considerable nomadic population. District water development planning in such conditions tends to be a somewhat theoretical exercise. To avoid this, it was decided to limit the efforts on the overall DWDS to a concise description of the district water demand versus the available resources, the recommendable technology options and the investments concerned, and to expand the study with pre-feasibility studies for domestic water supplies of the 20 rural centres that can be used immediately.

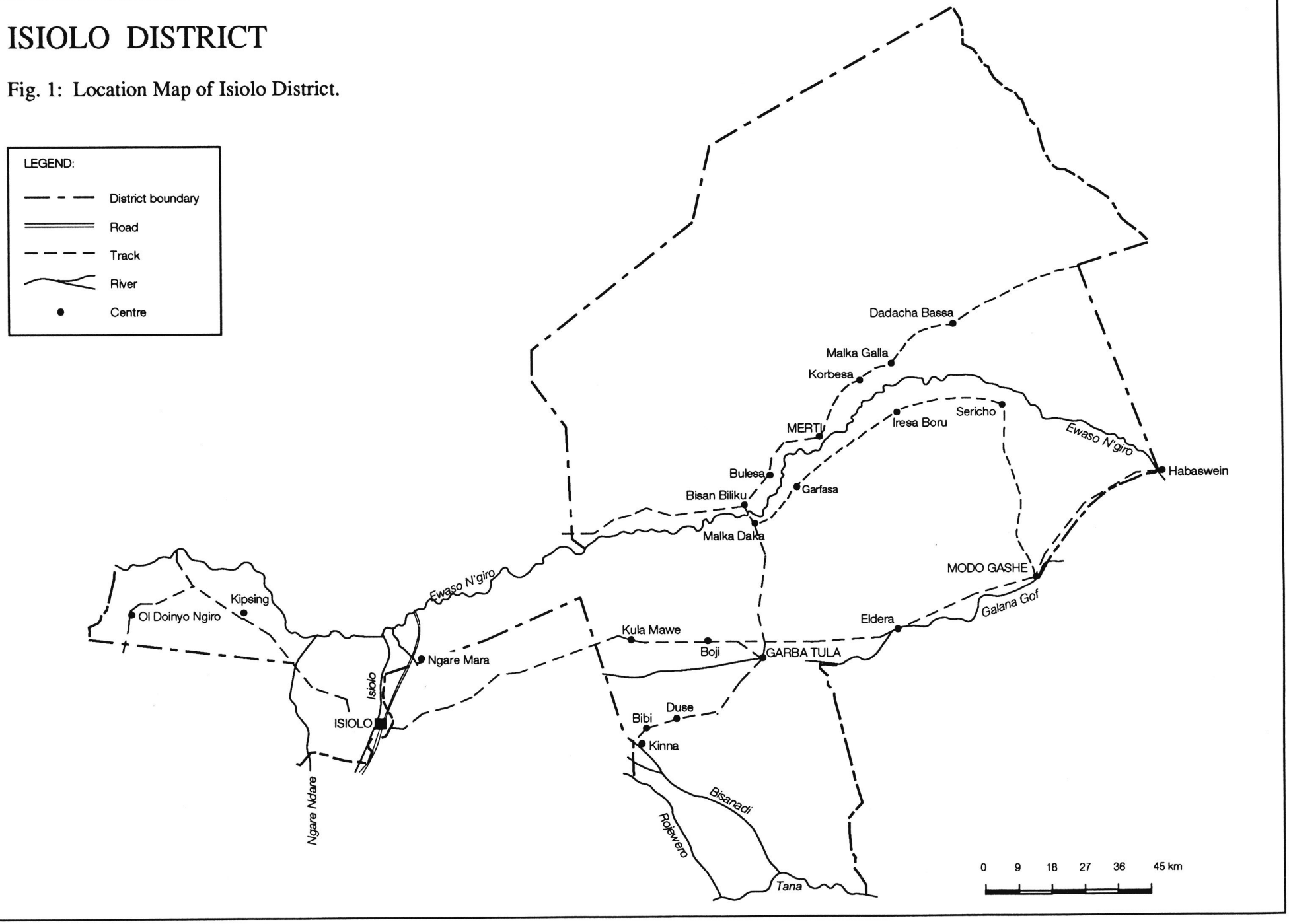
1.2 International Co-operation

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

The studies were 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 Project (WRAP)**.

ISIOLO DISTRICT

Fig. 1: Location Map of Isiolo District.



2. DESCRIPTION OF ISIOLO DISTRICT

2.1 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, 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 which roughly corresponds with the end-tertiary erosion bevel. This plain lying at about 1,000 m has levelled extensive tracts of quite diverse metamorphic rocks. The pleistocene basalt flows originating 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 the Ewaso Nyiro, Isiolo, Bisanadi and Kinna Rivers. 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.

The major 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. 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%), arid (30%) and very arid (65%).

Livestock rearing is the mainstay 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.

Four main seasons can be 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 measured in Isiolo Town is 26.6°C. In most

parts of the District sunshine is abundant.

2.2 Infrastructure and Economy

Isiolo District is administratively divided into 4 Divisions, viz. Central, Garba Tula, Merti and Sericho. These Divisions 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 can be described as a rural district. The only urban centre is Isiolo Town, the District Headquarters, with an estimated population of 15,000 people for 1988. Rural centres, also serving as Divisional Headquarters are: Garba Tula (5,600), Merti (2,600), Modogashe (6,500) and Sericho (1,300).

The centres offer to 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 one that connects Isiolo Town with the Meru - Nanyuki road covering 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.

2.3 Population

The total population of Isiolo District in 1979 was 43,478. It is estimated that this increased to about 64,000 in 1988. The estimated growth of the population of Isiolo Town and some market and local centres is shown in table 1.

Table 1: 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

2.4 Livestock

Livestock plays a major role in the economic activity of the District. Livestock production is undertaken 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 2: 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).

2.5 Water Supply

Due to the semi-arid conditions, water supply is a major constraint in the development of Isiolo District. In 1978, in the entire District only 3 minor water supplies and 4 boreholes with no distribution network could be counted. This changed dramatically in the following 5 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 is a conventional water supply that serves Isiolo Township.

The existing dams and pans have problems of siltation which reduces their capacity greatly.

2.6 Health, Education and Social Services

The new District Hospital at Isiolo with a capacity of 160 beds offers modern medical services. The old hospital building with a capacity of 36 beds will be used for infectious diseases.

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 makes their administration rather difficult.

There are 38 primary schools and 3 secondary schools in Isiolo District. 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 to be 40% and that for boys slightly lower.

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

3 WATER RESOURCES DEVELOPMENT POTENTIAL

3.1 Introduction

This chapter provides a concise description of the development potential of the water resources in Isiolo District. Three alternatives have been examined, viz. surface water, groundwater and rainwater.

A rough analysis of the data existing at the beginning of the project already revealed that the potential of these resources in Isiolo District is very limited. The major part of the District has an arid to very arid climate, with low rainfall, very high evaporation and relatively little surface water discharge. The major stream, the Ewaso Ngiro, is shared with neighbouring districts where the water seems to be fully consumed in drought periods. The geological formations in the District have relatively poor water bearing properties, with exception of the Volcanic Areas which cover a relatively small part of the District. Rainfall storage via roof catchment, dams or pans may provide some relief but rainfall is extremely low.

Hence the WRAP assessment study was focused on further analysis of the relatively poor resources, in particular the groundwater resources. In continuation WRAP has also undertaken local pre-feasibility studies to provide a basis for removing some of the most urgent water supply problems of rural centres in the District.

3.2 Surface Water Development Potential

The surface water availability in the District is highly variable in time and space.

Surface water from the main rivers in Isiolo District (Figure 2) 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. The discharge estimates on the basis of the few discharge measurements taken 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 about 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 5.2).

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 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).

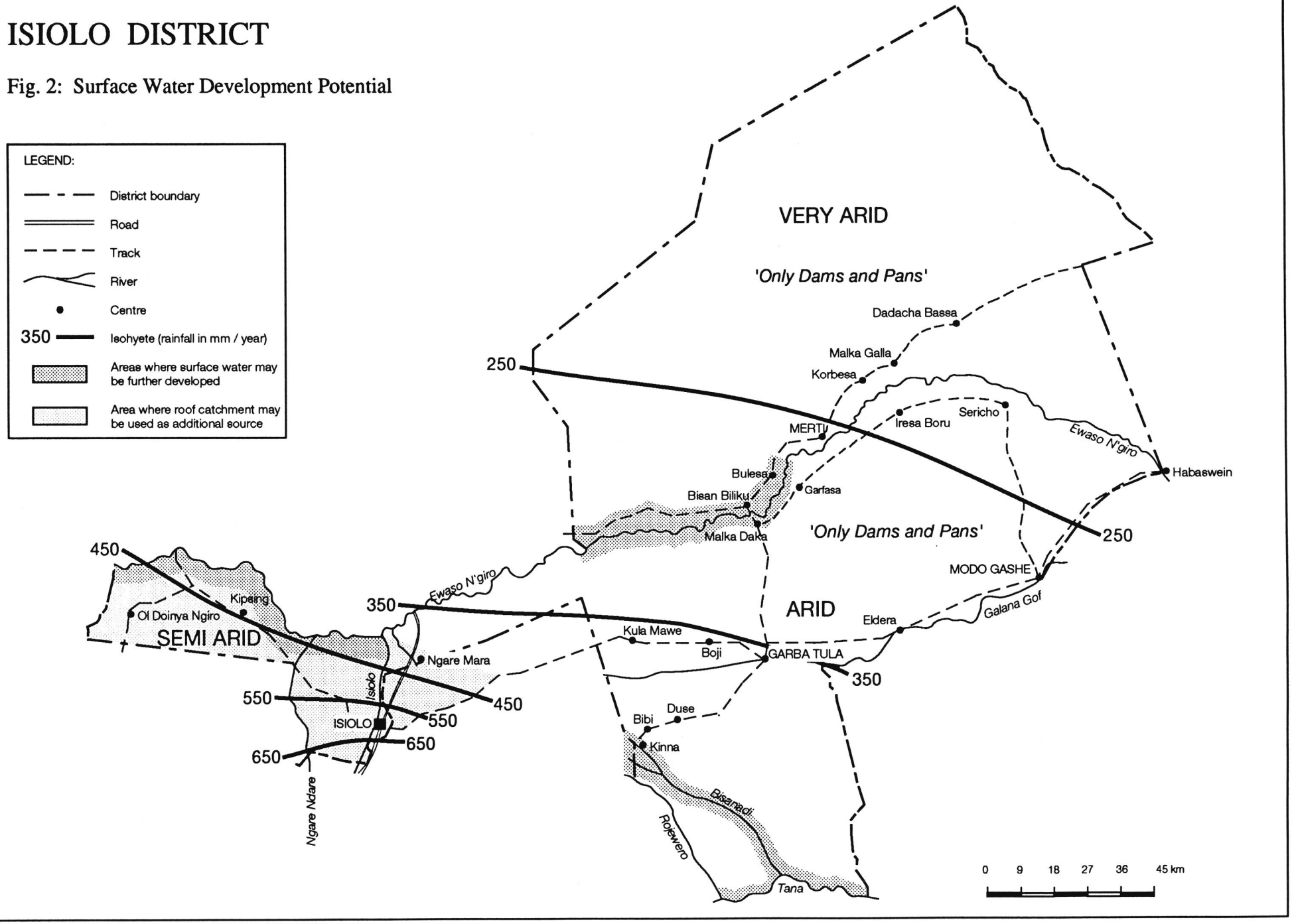
The water use along this river is not known and therefore more detailed information is needed to determine it's development potential.

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.

ISIOLO DISTRICT

Fig. 2: Surface Water Development Potential



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.

3.3 Groundwater Development Potential

The description of the groundwater development potential in Isiolo District follows the classification of the different aquifer system. The distribution of these systems coincides with the geological formations occurring in the District (see Figure 5.2 and Plates 1A en 1B).

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. The volcanic areas covering roughly 10% of the District form a positive exception.

Based on the analysis of the available hydrogeological information, two differend aquifer systems can be distinguished, viz. *regional aquifer systems (systems IA and IB)*, allowing continuous groundwater flow over large areas, and *local aquifer systems (systems IIA and IIB)* with isolated groundwater pockets and no flow across their boundaries. For the location of these aquifer systems see Figure 3.

System IA - Area of Tertiary Marine Sediments

Tertiary/Jurassic marine clays, sands and conglomerates, the so-called Merti Beds occupy about half the District and cover the whole eastern area, extending also to Marsabit, Wajir and Garissa. These deposits reach a thickness of hundreds of metres. The sand and conglomerate layers form extensive aquifers. These aquifers are confined as indicated by the difference between the water struck and water rest levels. Their hydraulic characteristics may vary from moderate to very good.

Most of the water in the aquifers is fossil with a high salinity but local recharge conditions have improved the water quality in some areas. On the basis of water quality the system can be sub-divided into two zones (Figure 5.2).

Zone 1 occupies the south western part of the system. The lithological composition is predominantly clayey, limiting the recharge capacity. This zone offers no good chances for groundwater development as the groundwater is highly mineralized. The WHO-recommended maximum permissible limit of 1,500 mg/l of TDS for drinking water is exceeded in all cases analyzed.

Zone 2 covers a fairly extensive area north of the first zone. Groundwater recharge is more pronounced due to the sandy nature of the formations here. 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.

The zone offers a considerable groundwater development potential for domestic use. Groundwater aquifers are expected at depths between 100 and 120 m on average and groundwater levels may vary from 30 to 100 m below surface. WRAP experience shows that borehole yields may range from 3 to 20 m^3 per hour.

If 30% of the estimated annual recharge is taken as a safe yield for a first phase of development then about 2,000 m^3 can be withdrawn daily. This means that 100 wells with a production of 20 m^3/day could be installed in this zone.

System IB - Volcanic Rock Area

The system comprises fissured and weathered volcanic rocks with interbedded sediments between lava flows. These rocks overly the Basement Rocks in the central western part of Isiolo District (see Figure 5.1 and Plate 1).

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. WRAP experience shows that the well yield ranges from 2 m^3/h to 30 m^3/h. The groundwater quality is generally good. If 30% of the recharge is taken as a safe yield for the first phase of development, then 60,000 m^3/day can be gradually developed. This means that a large number of wells can be drilled in this area.

System IIA - Weathered and Fissured Basement Zones

Isiolo District is wholly underlain by the Basement System rocks. The Basement surfaces (or is very close to the surface) in the utmost western part of the District (Oldo Ngiro, Kipsing) and in the central northern and eastern part (see Figure 5.2).

The aquifer systems consist of local weathered and/or fissured pockets in the Basement System Rocks containing isolated groundwater bodies. These pockets are found scattered over the Basement Areas. They occur at the surface and also at the interface between the Basement and overlying sedimentary or volcanic rocks.

The Basement System area offers 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 area.

System IIB - Local Sedimentary Deposits

To these local aquifer systems belong fluviatile (river) deposits, lacustrine (lake) deposits and deposits of other origin. These deposits can be found scattered over the District. The aquifers comprise coarse alluvial deposits (sands, grids and gravels) and limestone deposits. They form perched aquifers isolated from their surroundings by silt and clay layers. The size of the aquifers may be from very small (some metres) to rather large (some kilometres).

Important fluviatile aquifers are those along the Ewaso Ngiro. Many of them have a limited extent and depth. However, despite their limited sizes the aquifers may offer substantial amounts of water for the dry seasons. Groundwater is encountered between 30 and 45 metres below ground surface (Merti area) and between 18 and 20 metres (Sericho - Habaswein area); water rest levels are at about 11 metres below ground level. Yields of up to 20 m3/h are possible. The water quality is good.

The limestone deposits encountered in Garba Tula yield very high amounts of water against low drawdowns. Sustainability of the yields is not yet known. The water quality in the area is still acceptable for human consumption, but the absence of protecting covers makes these aquifers vulnerable for contamination.

3.4 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 to be 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.

3.5 Conclusion

The development potential of water resources in Isiolo District is rather marginal.

The perennial surface water resources have already been exploited to a considerable extent. Floodflow of the rivers could be used more optimally by constructing dams or intakes. But the feasibility of such solutions requires more detailed studies taking into account that the costs of the required structures will be very high.

The groundwater development potential is equally limited and does not support extensive development programmes with some exception of the groundwater

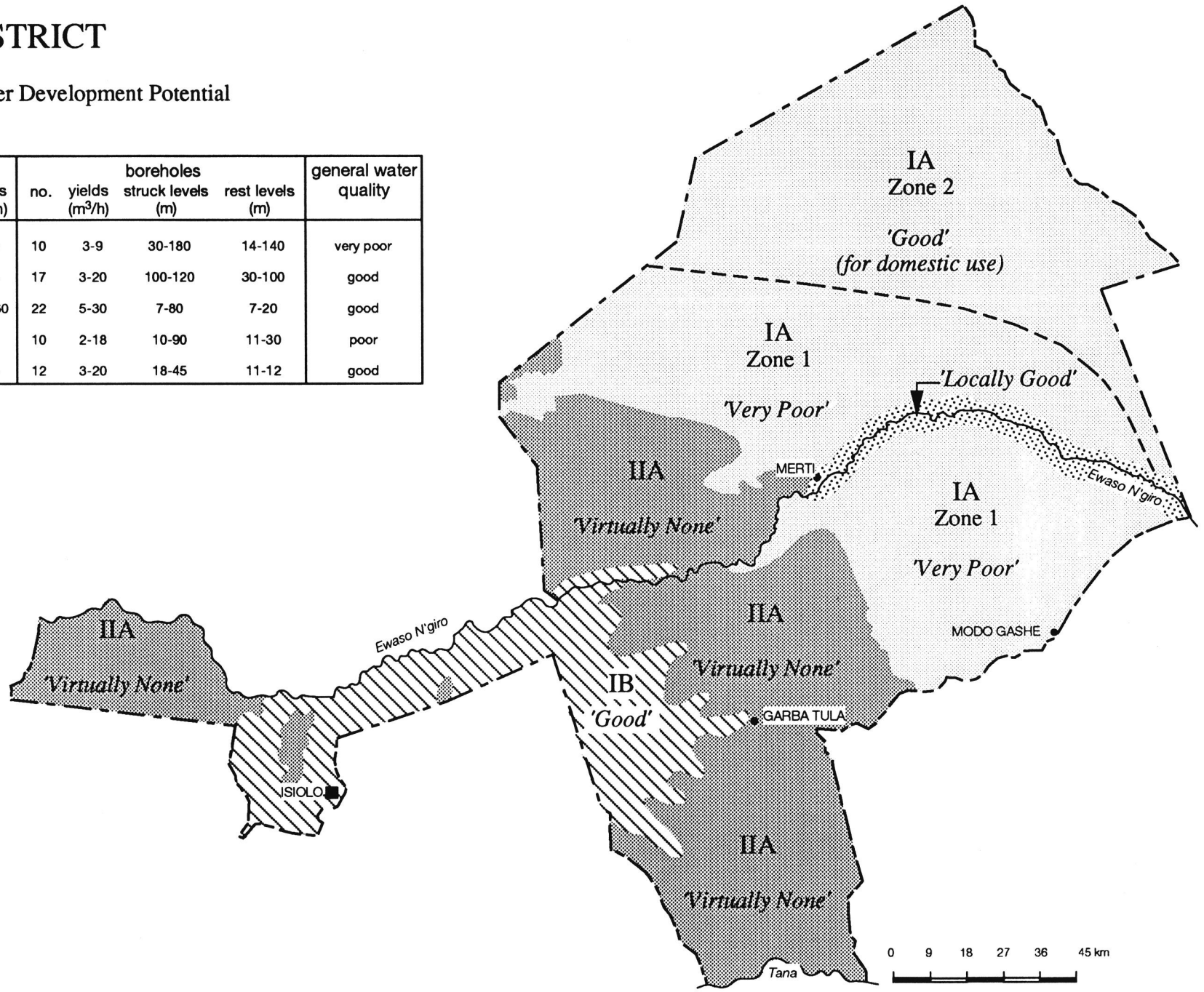
resources in the Volcanic Areas that might be exploited more intensively. However, these areas only cover an estimated 10% of the District.

The collection of rainwater in dams and pans provides an important source of water for livestock, but rainwater serves only as an additional source for domestic use.

ISIOLO DISTRICT

Fig. 3: Groundwater Development Potential

aquifer system	springs		boreholes				general water quality
	no.	yields (m^3/h)	no.	yields (m^3/h)	struck levels (m)	rest levels (m)	
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



4 DISTRICT WATER DEVELOPMENT

4.1 Introduction

The District Water Development Study (DWDS) provides the basis for the District Water Development Plan (DWDP). The Study consists of three parts describing the key elements of the Plan and the options available. The formulation of the final Plan and the selection of scenarios and priorities is left to the District Authorities concerned. A concise description of the different parts of the study and the results is given below.

The study of the water supply situation in Isiolo District mainly covered the supplies for domestic purposes and livestock watering. The use of water for irrigation has not been studied. The study of the water supplies for domestic and livestock use was done by the Ministry of Water Development (WRAP), in close collaboration with the Ministry of Livestock Development through the Isiolo Livestock Development Project (ILDP).

The population in the rural areas of Isiolo District is nomadic and water supply plays a vital role in the rearing of their livestock. To ensure sustainable conditions, the supply of water should be in balance with the other requirements of the livestock and especially with the range potential. Often the provision of water leads to concentration of livestock during long (dry) periods and results in overgrazing and damages to the pastures around the water point.

The ILDP is preparing a plan for the livestock development in Isiolo District, which will include the required water supply points for livestock. WRAP provided the information on the water resources for this plan, but the planning of the actual locations of the supplies was left to ILDP. The plan will be presented in the Final Report of ILDP which is in preparation.

4.2 Water Demand and Water Resources

Part 1 of the DWDS 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 this part is to study the feasibility of water supply development in the context of the desired economic development and the available water resources in the District.

The water demand is calculated on the basis of the unit water consumption rates as specified by the MoWD. The water demand for 1990 is 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 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 calculated for each sub-location or deda. The domestic demand (population, schools, health facilities and others) 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 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 analysis of the water demand versus the water resources was carried out for the domestic demand in each centre. The demand of population living in the rural areas of the District is covered by the Isiolo Livestock Development Project and is therefore not dealt with in detail.

In most centres the water resources are sufficient to cover the demand. In some centres the demand is not 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.

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.

4.3 Existing Supply, Technology Options and Costs

Part 2 of the DWDS presents an inventory of existing water supply, the analysis of and recommendations on water supply options and technologies, an inventory of costs of the selected technologies, and a cost effectiveness analysis. The objective of the report is to recommend affordable and sustainable water supply options and technologies for the District.

The situation in 1990 was that 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). Operational and technical data, only available from the 4 MoWD schemes, shows that the operation cost for the supplies ranges from 13 Shs to 56 Shs per beneficiary and from 1.5 to 7 Shs per m^3 of water 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 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 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, 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 solar-diesel 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. Participation of the community can only be expected, if water supply for the livestock is included.

4.4 Guidelines and Recommendations for Investment Packages

Part 3 provides the background and methodology for the implementation by the District of investments in the water sector. Indicative investment packages were developed, intended to provide cost estimates of investment projects.

Four items were identified as central to the design of successful investment projects. These are:

- the appropriate technology choice with respect to production capacity and impact on the environment,
- the socio-economic base which determines the attitude to participation in the project;
- the institutional base for design, construction and operation,
- the financial base of the project, including the policy framework.

These items 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.

For each individual rural centre an analysis was made of the available resources and their potential for development of the domestic and livestock supplies. The results of these pre-feasibility studies for the centres are presented in a separate volume accompanying the DWDS. The cost estimates of the studies 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 unavailability of data, feasibility studies must confirm the viability of specific systems/projects.
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 are for most centres between 1.8 million and 4.0 million Shs. The capital costs per household are between 5,000 and 10,000 Shs.

The O & M costs of the systems in the small rural centres range from 200 to 400 Shs per household per year, which should be affordable for most of the people.

The proposals have been based on the assumption that the community will organise the O & M and take responsibility for the financial administration. The MoWD is expected to assist mainly in the maintenance part of the operation.

5 DEVELOPMENT OF DOMESTIC WATER SUPPLIES

5.1 Pre-Feasibility Studies of Domestic Water Supplies

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 studies consist of background information, a water resources assessment, a demand calculation, a description of the existing water supply and recommendations for a proposed water supply with a tentative estimate of capital costs and Operation & Maintenance costs involved.

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. As it is practically almost impossible to isolate domestic and livestock drinking water, the water supplies may have to be used by a part of the livestock. However, provisions should then be made to avoid that the water source is contaminated.

The results of the studies are summarised in the Appendix and in Table 3. For each rural centre a short description is provided, while the more technical data and the estimates of capital costs and O&M costs are presented in the Tables 4A, 4B and 4C.

A water supply has been proposed for each of the rural centres. At many locations the only good source of water is found in the sandy sediments of the nearby dry river bed. Currently the water is obtained by digging shallow wells in the sand of the river bed and transporting it to the centre by donkey.

It is proposed to abstract the water by horizontal drains or infiltration galleries (pipes) connected to a collector well at a safe site of the river bank. This technology has been applied in the past at Modogashe only. With an improved design and construction method (especially larger depths of the drains), it should provide the required quantities of water. For pumping preference is given to solar systems with a stand-by diesel generator. The capital costs of such a system are higher, but the O & M costs are considerably lower.

The capital costs of the proposed systems that deliver the water through water points in the centre are between 1.8 and 4.0 million Shs. The capital costs per household are between 5,000 and 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 from 200 to 400 Shs, which should be affordable for most of the people. The proposals for the water supplies assume that the community will organise the O & M and be responsible for the financial administration. The MoWD is expected to assist mainly in the maintenance part of the operation.

Table 3 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

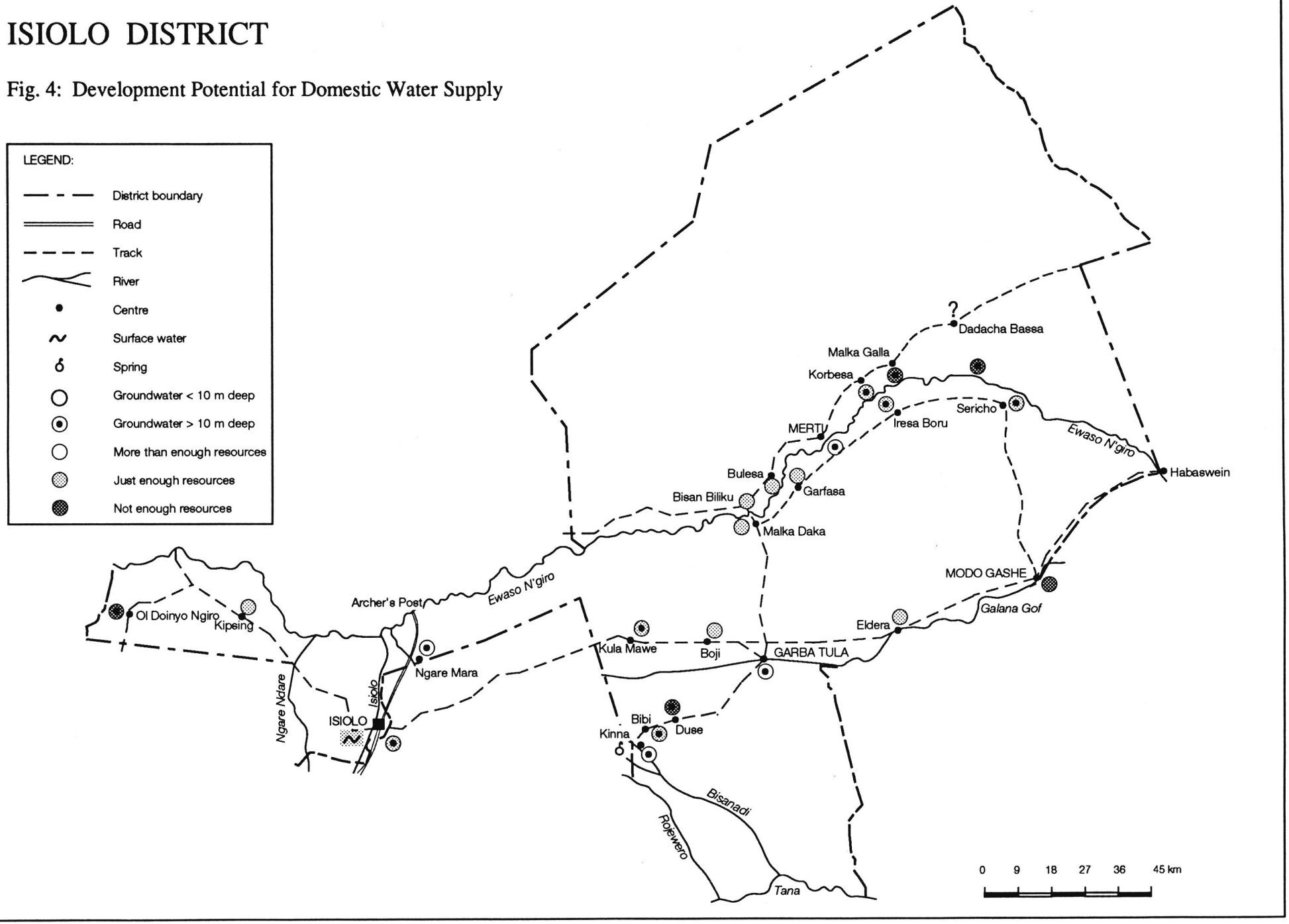
Notes: Future yr. = year 2005, Ultim. yr. = year 2015 ( ) = estimated figure

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

ISIOLO DISTRICT

Fig. 4: Development Potential for Domestic Water Supply



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 have been 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, located at large distances from the existing water sources.

5.2 Examples of Investment Packages

In the context of the above chapters and using the information from other parts of this study, examples were prepared of district investment packages for the water supply to the rural centres in the District. The investment packages are based on the results of the pre-feasibility studies. Three types of investment packages were prepared:

1. Investment packages based on the required feasibility studies;
2. Investment packages based on technology choice;
3. Investment packages based on location of the centres/projects.

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 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. 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.

In some centres feasibility studies are not required, because only the distribution system is lacking. Among these are the two larger centres Garba Tula and Merti. Projects at these centres may be started with the survey work.

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.

The investment packages based on technology choice 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 applied 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.

Table 4A 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.

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.

The combination in an investment package 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.

Table 4B Investment Packages Based on Technology Choice

	Design Population Estimate 1990	Capital Costs (Ksh)	O & M Costs per Month (Ksh)	Costs per Household	
				Capital (Ksh)	Annual O&M (Ksh)
Technology: Boreholes					
Centres: Oldo Nyiro, Bibi / Duse, Kinna, Dadacha Bassa, Malka Galla, Korbesa, Iresa Boru					
Total	12,100	19,935,000	62,500	8,238	310
Technology: Infiltration Galleries					
Centres: Kipsing, Gafarsa, Malka Daka, Bisan Biliku, Bulesa, Eldera, Modogashe					
Total	15,670	21,575,000	65,000	6,884	249
Technology: Distribution System (Source already available)					
Centres: Ngare Mara, Garba Tula, Boji, Kulamawe, Merti, Sericho					
Total	13,410	8,007,000	74,400	2,985	333

Table 4C Investment Packages Based on Location of the Centres / Projects

	Design Population Estimate 1990	Capital Costs (Ksh)	O & M Costs per Month (Ksh)	Costs per Household	
				Capital (Ksh)	Annual O&M (Ksh)
Central Division					
Centres: Ngare Mara, Kipsing, Oldo Nyiro					
Total	4,620	5,650,000	25,000	6,115	325
Garba Tula Division					
Centres: Garba Tula, Bibi / Duse, Kinna, Boji, Gafarsa, Kulamawe, Malka Daka					
Total	15,300	13,210,000	71,500	4,317	280
Merti Division					
Bisan Biliku, Dadacha Bassa, Malka Galla, Bulesa, Korbesa, Merti					
Total	11,000	18,290,000	62,000	8,314	338
Sericho Division					
Eldera, Modogashe, Iresa Boru, Sericho					
Total	10,260	12,367,000	43,400	6,027	254

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.

6 OPERATION AND MAINTENANCE PROCEDURES

It is important that the future users of rural water supply schemes be involved in their development from the beginning, not just as unpaid labourers but as full co-operating partners. Involvement and participation of the potential beneficiaries should not be regarded as a means to reduce costs only. Full involvement will allow them to actively participate in the project meant to solve their genuine needs and as such create a sense of responsibility and 'ownership'.

For the proper operation of a water supply system a number of conditions have to be met:

Participation of the Community:

In addition to the remarks above, it must be noted that the organisation of the community participation is a specialist task, which must be carried out by qualified and experienced personnel. These may come from the Ministry of Culture and Social Services or from NGO's of which several are active in this field.

Training:

The water supply attendants must be properly trained. Experience shows that attendants should be selected from the community and trained during the implementation of the project. This would ensure the success of village level operation and maintenance.

Maintenance of Machinery:

Preventive maintenance of pumps and other machinery requires that spare parts be available at the right time. This means that robust pumping sets should be recommended and standby units in good working condition be present especially in view of the accessability of Isiolo District. Pipes and fittings should be stocked for the repair of bursts.

Fuel Availability:

Fuel storage facilities of suitable size should be constructed because some roads are unaccessible during the rains. However, strict rules should be applied to avoid the fuel being "lost" or "evaporated".

O & M Expenses:

Due to the limitation of funds the Government is encouraging the running of projects by the beneficiaries. This establishes a greater sense of responsibility and ownership within the community. The community with the guidance of the District Water Board should decide on an appropriate tariff to cover the expenses of the water supply attendants, the spare parts and the other costs of maintenance. Depreciation of capital costs may not be included initially, but it should be part of the water tariff in the future.

7 INSTITUTIONAL REQUIREMENTS

In order to implement the DWDP in the context of the District Focus policy several institutional strengthening measures are required. These measures will reinforce the actions already undertaken by the MoWD. The two objectives of these measures are:

A. To provide the District Water Office with the means and resources for its co-ordinating tasks in the provision of water to communities.

The most important measures required to achieve this objective are:

- Strengthening the assessment and planning capacity at district level which in turn requires provision of equipment and of training.

- Strengthening administrative and financial systems along lines already under discussion within the MoWD. Specifically the following measures are suggested.
  - District Water Offices should be enabled to retain revenues collected, as an incentive for better collection and to ease cash flow problems. In the interim, the "appropriations in aid" policy with respect to funding of recurrent expenditure should be reassessed so as to ensure that it will not disadvantage high cost schemes and that it will provide a real incentive to efficient management.
  - Financial systems should be revised to enable effective management and implementation of District Focus and Cost Sharing policies, in particular, full costs and revenues should be brought together in one set of accounts.
  - Flexibility in pricing policy, reflecting the different operating costs of water schemes, should be introduced to effectively implement the national cost sharing policy.

- Training and support of district office staff in O&M activity and in catalysing community participation.

B. To strengthen the Central MoWD in its supporting role towards the districts and in its role of formulating and implementing the national policies and guidelines regarding water distribution, provision and conservation.

The most important measures required to achieve the second objective are:

- Training of Central Office staff to equipe them for their role of supporting the Districts. This should be training at a higher level in a great number of subjects, viz. water resources planning, O&M, financial systems, community mobilisation, technical design, environmental management, project appraisal, etc.

- MoWD in general, should put more effort in strengthening the links to other agencies and organisations, both public and private, involved in provision of water supplies.

APPENDIX

DESCRIPTION OF WATER SUPPLY TO RURAL CENTRES

IN ISIOLO DISTRICT

Description of Water Supply to Rural Centres **Appendix**

Ngare Mara

The existing borehole with windmill is operated by the mission but it also supplies the centre through a storage tank and several water supply taps. The new borehole drilled by WRAP is expected to relieve this supply and construction of a pumphouse, pipeline and storage tank is already underway. The funding of the new supply is from RDF funds. The community has not yet been contacted about their expected role in the O & M.

Kipsing

The centre is located in the Livestock Holding Ground area of LMD and is not gazetted. Water supply development depends on the future status of the centre. The most suitable water source is the groundwater in the shallow sediments of the Kipsing River.

Oldo Nyiro

The centre is located above a deep valley where already three sand dams have been constructed. The lagga in this valley provides the only nearby source of water. Extension of the water supply is needed, because currently it only serves the mission, the school and the dispensary. More studies are necessary to determine the most viable solution. Preliminary recommendation is to construct more and / or higher sand dams or to try a (shallow) borehole in or next to the lagga.

Kulamawe

The existing borehole is equipped with a diesel pump. The capacity of the pump and borehole is sufficient to supply both the centre and the livestock however the present way of operation benefits the livestock, because diesel is bought to supply the animals and only rarely to supply the centre. The operation of the pump is organised by the community and maintained by the MoWD. It is proposed to separate human and livestock supply and a new borehole was drilled on the other side of the centre. It is recommended to equip this borehole and to use it for the domestic supply.

Malka Daka

The only good source of water is the shallow groundwater in the bed of the Ewaso Nyiro. The water is currently taken from shallow open handdug wells in the sand and transported in jerry cans by donkey to the centre. It is recommended to abstract this water with infiltration galleries buried across the river and connected to a well on the bank of the river. The water may be pumped by a solar system and transported to the centre through a pipeline of 4 km. The capital costs of such a system are high, but the O & M costs are low.

It is proposed to move the centre to a site further away from the river because of flooding. This would make the supply of water more expensive, as no other sources of water are available in the vicinity of Malka Daka.

Garba Tula

The town is supplied from a borehole, which is located at about 3 km. New boreholes were drilled much closer to the town and the operation and also security of these should be better. The boreholes provide enough water to cover the domestic demand at Garba Tula. A combination of diesel and solar powered pumps may be used on the boreholes to reduce the operation costs.

Bibi/Duse

This centre is proposed to be reopened and it was therefore included in the pre-feasibility studies. At the old site of Duse centre field investigations indicated that there is no possibility to have a supply from either groundwater or surfacewater. A centre at this site thus seems not feasible. The investigations at Bibi, about 4 km from Kinna indicated better possibilities for groundwater and a borehole was drilled. The yield of this borehole is sufficient to supply a new centre at this site.

Kinna

The spring at Kinna has always been the source of supply to the centre. The quantity of water is more than enough, but it is infected with Bilharzia. The spring area needs protection before it can be used again to supply the population. Boreholes drilled at the centre may also be used for water supply. It is recommended to use a combination of both sources to provide Kinna with a reliable supply system.

Boji

The three wells at Boji provide population and livestock with water. To safeguard the quality of water for human consumption, it is recommended to separate both supplies. A new borehole may be used for supply of the population using a solar pump. The wells can continue to be used for the livestock.

Gafarsa

The only good source of water is the shallow groundwater in the bed of the Ewaso Nyiro. The water is currently taken from shallow open handdug wells in the sand and transported in jerry cans by donkey to the centre. It is recommended to abstract this water with infiltration galleries buried across the river and connected to a well on the

bank of the river. The water may be pumped by a solar system and transported to the centre through a pipeline of 4 km. The capital costs of such a system are high, but the O & M costs are low.

Bisan Biliku

The only good source of water is the shallow groundwater in the bed of the Ewaso Nyiro. The water is currently taken from shallow open handdug wells in the sand and transported in jerry cans by donkey to the centre. It is recommended to abstract this water with infiltration galleries buried across the river and connected to a well on the bank of the river. The water may be pumped by a solar system and transported to the centre through a pipeline of 4 km. The capital costs of such a system are high, but the O & M costs are low.

The costs of the supply may be reduced if the supply is combined with the supply of Malka Daka, which is located on the other side of the river.

Dadacha Bassa

This centre was moved in 1989 because of flooding. The present site offers no possibility nearby of using groundwater or surface water for it's water supply. The follow-up studies on the water supply to this centre should therefore also consider moving the centre once again, to a site closer to a reliable water source.

Malka Galla

This centre was moved in 1989 because of flooding. The nearest reliable water source is probably the groundwater at the Ewaso Nyiro at about 5 km. More studies are recommended to establish the best source of water for this centre. The studies should also consider to move the centre to a site closer to a reliable water source.

Bulesa

The only good source of water is the shallow groundwater in the bed of the Ewaso Nyiro. The water is currently taken from shallow open handdug wells in the sand and transported in jerry cans by donkey to the centre. It is recommended to abstract this water with infiltration galleries buried across the river and connected to a well on the bank of the river. The water may be pumped by a solar system and transported to the centre through a pipeline of 4 km. The capital costs of such a system are high, but the O & M costs are low. The distance of the centre to the river is about 4 km, which makes the supply of the centre very expensive. The costs of the supply may however be reduced somewhat, if the supply is combined with the supply of Gafarsa, which is located on the other side of the river.

Description of Water Supply to Rural Centres **Appendix**

Korbesa

The only reliable source of water is the groundwater in the flood plain of the Ewaso Nyiro. A borehole or dug well should be constructed to tap this water. The borehole or well should be safe from flooding. It is recommended to install a submersible pump powered by a solar system. Dug wells with hand pumps are suggested as an additional supply of safe drinking water. These may not be accessible during the wet season due to flooding.

Merti

The existing borehole and supply system is insufficient to cover the whole demand at the town. The distribution system and storage facilities need rehabilitation, because much water is currently lost through leakages. An additional borehole was drilled recently, which will assist to provide the required quantity of water. It is recommended to install a solar system on one of the boreholes to reduce the fuel consumption.

Modogashe

The supply of water to this town has been a problem for a long time. It appears that the shallow groundwater below the Galana Gof is the only source of fresh water nearby. But even this source may be depleted at times of drought. More studies are recommended to determine the reliability of this source. If this turns out not to be sufficient, than an alternative supply must be identified for drought periods. This may well be a source (borehole) at a distance too large to be economically connected to the town. In that case it should be considered to rely on emergency measures for supply during drought, such as transport of water by tankers to the town. It is recommended to construct a regular supply from infiltration galleries buried across the lagga. These are to be connected by a collector pipe to a central well from where the water is pumped to an elevated storage tank. Solar pumps and stand-by diesel are recommended.

Eldera

The only reliable source of water is the groundwater in the riverbed of the Galana Gof. The water is currently taken from shallow open handdug wells in the river bed. It is recommended to abstract this water with infiltration galleries buried across the river and connected to wells on both banks of the river. The water may be pumped by a solar system to an elevated tank and distributed to the centre. The capital costs of such a system are high, but the O & M costs are low.

Description of Water Supply to Rural Centres **Appendix**

Iresa Boru

The only reliable source of water is the groundwater in the floodplain of the Ewaso Nyiro. A borehole or dug well should be constructed to tap this water. The borehole or well should be safe from flooding. It is recommended to install a submersible pump powered by a solar system. Dug wells with hand pumps are suggested as an additional supply of safe drinking water. These may not be accessible during the wet season due to flooding. The existing borehole should be tested to check whether it can be used.

Sericho

The existing system uses a solar pump and the water is distributed through water kiosks in the centre. The supply covers the existing demand. The water supply is usually closed during the afternoon to ensure that there is water in storage for supply in the early morning. The community has proposed to add a diesel pumping set to the system to enable the supply of cattle troughs. It is recommended that this will be financed by the community as they should be able to pay for supplying their cattle. It must be investigated whether one borehole with a diesel pump can replace the thirty or so dug wells which are currently used for watering the livestock.