REPUBLIC OF KENYA

MINISTRY OF WATER DEVELOPMENT

ISIOLO

DISTRICT WATER DEVELOPMENT STUDY

PART 4

PRE-FEASIBILITY STUDIES OF WATER SUPPLY TO RURAL CENTRES

June 1991

WATER RESOURCES
ASSESSMENT SECTION
NAIROBI, KENYA

WRAP
WATER RESOURCES
ASSESSMENT & PLANNING

TNO – INSTITUTE
OF APPLIED GEOSCIENCE
DELFT, THE NETHERLANDS

ISIOLO

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ABBREVIATIONS

AP	=	Administration Police
ASAL	=	Arid and Semi-Arid Lands Development Program
CC	=	County Council
DDC	=	District Development Committee
DDO	=	District Development Officer
DDP	=	Isiolo District Development Plan 1989-1993
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
G.I.	=	Galvanised iron
GOK	=	Government of Kenya
IFAD	=	International Fund for Agricultural Development
ILDP	=	Isiolo Livestock Development Project
KWAHO	=	Kenya Water for Health Organization
L.U.	=	Livestock Unit
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
O&M	=	Operation and Maintenance
RDF	=	Rural Development Fund
SIDA	=	Swedish International Development Agency
TLU	=	Tropical Livestock Unit
UNDP	=	United Nations Development Program
WRAP	=	Water Resources Assessment and Planning Project
WRAS	=	Water Resources Assessment Section

1 INTRODUCTION

1.1 Context of the Studies

Isiolo District falls under the Arid and Semi Arid Lands (ASAL) agro-ecological zones VI and VII with an annual rainfall of between 200 - 700 mm falling in two seasons. The rainfall is erratic both within and between seasons and high intensity storms cause considerable erosion due to lack of sufficient vegetation cover. The vegetation in most of the District consists of bushland with stunted acacia trees and with perennial and annual grasses. Nomadic pastoralism is the main subsistence activity of the inhabitants of Isiolo District.

In light of the unfavourable natural environment and harsh climatic conditions and with regard to socio-economic and socio-cultural scenarios in ASAL, water supply plays a vital role in the development of the nomadic society. The highest water priority is human drinking water followed by livestock drinking water.[1] Since it is almost practically impossible to isolate domestic and livestock drinking water, combined or supplementary systems are preferred. However provisions must be made for the livestock to use the water without contaminating the water source.

The nomadic population of Isiolo District moves their livestock mainly within the District between the wet season and dry season grazing areas. The presence of water is critical especially in the dry season, because the availability of water will enable the livestock to utilize the pastures. The planning of the livestock water supplies must therefore be based on the potential of the grazing areas.

The Ministry of Livestock Development through the Isiolo Livestock Development Project (EMI-ASAL) has been studying the livestock potential of the district and is preparing a plan for the development of the livestock sector. The provision of water will be part of this plan, and because this will be based on the land potential, it will provide a planning which is economically and environmentally viable. WRAP has decided to support this planning and will use the proposals for the planning of the independent livestock water supplies.

The rural centres in Isiolo District serve the population for commercial purposes, provide facilities for education, health, etc. and give security. The centres offer an increasing quality and quantity of facilities and are growing rapidly as the nomadic community increasingly make use of these. Excluding Isiolo town, there are about 20 centres.

For each rural centre a water system has been proposed with due consideration of the water resources availability and the appropriate technological options. In all instances the traditional water sources have been included and their protection recommended.

There has been disagreement by some communities on some of the recommended systems (especially the use of handpumps) but this was attributed to the lack of awareness and poor planning of the facility. Further dialogue should continue during

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[1] Arid and Semi Arid Lands (ASAL) Development Programme: Summary of Technical Reports on Strategy, Policy and ASAL Development Programme 1989-1993. Report no. 0131-KE, IFAD/UNDP, Nairobi, 1988

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the planning stages of the proposed water supplies. In fact popular participation should be stimulated as early as possible for any system to be successful. Also crucial equipment e.g. hand pump types or diesel engine brands should be standardized in the whole District for ease of maintenance.

Finally it should be noted that development of water supplies alone cannot realise the expected benefits, unless a multi-disciplinary approach is followed in which health, education, animal health, environmental protection and the relevant infrastructures are part of the development initiative. The collaboration between the different sectors is very important to ensure that the activities take place within the scenarios laid out for the development of the ASAL areas.

1.2 Background of the Studies

The execution of the pre-feasibility studies of the water supply to the rural centres in Isiolo District is carried out as part of the District Water Development Study (DWDS) of Isiolo District.

This 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 District and a planning that is in tune with the socio-economic, institutional and technical developments. The results of this assessment are included in Part 1, Part 2 and Part 3 of the DWDS Report.

The present volume can be considered as an Appendix to the DWDS. It contains a pre-feasibility study of the water supply of each centre (20) in Isiolo District. The studies are based on the information collected by the Water Resources Assessment and Planning Project (WRAP) and were prepared in close cooperation with the Planning & Design Section of the Isiolo District Water Office. Useful information especially on livestock and on socio-economical aspects was obtained from the Isiolo Livestock Development Project (ILDP) of the Ministry of Livestock Development. The information was verified during field visits in March and April 1991.

The objective of the pre-feasibility studies is to summarise the existing information on each 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.

These feasibility studies may be combined with survey, design and costing of the supply for most of the centres. For some centres however, in particular Modogashe, a thorough feasibility study is still needed to decide what type of supply can serve the

centre most suitably.

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

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 livestock is expected to be covered by separate supply facilities either near the centre or in the rural areas. These livestock supplies are not planned within the current DWDS, because this planning forms part of the proposals by the Isiolo Livestock Development Project (ILDP).

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. Here, the land rises gently from east around Londiani swamp at an altitude of 300 m above sea level to Kula Mawe at an altitude of 700 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 contains the Northern Grazing Area and the Livestock Holding Ground along the foothills of the Nyambeni Range and the Mount Kenya Massif.

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 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 swamp areas, 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 for 5%, as arid for 30% and as very arid for 65%.

Livestock rearing is the main practise in the District. The nomadic population continuously moves their livestock around the District in search of good pastures and water. Livestock from North Eastern Province also 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 station 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 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

2.3 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.

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

Population Estimates of Centres

Division	Centre	1979	1988
Central	Isiolo	11,331	15,000
Central	Oldonyiro	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

2.4 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.

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 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 1983, when 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 thereby reducing their capacity greatly.

2.6 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.

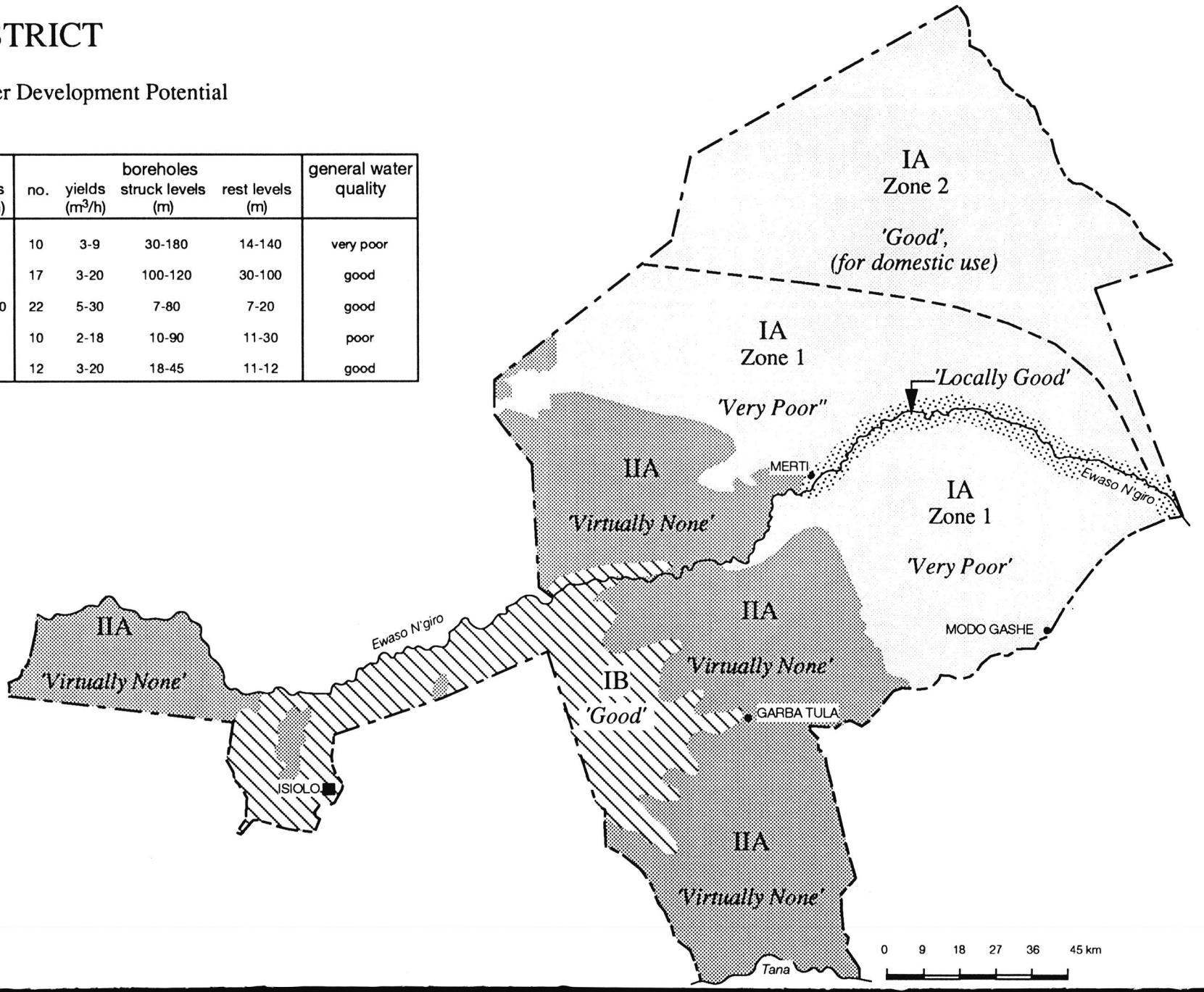
There are 38 primary schools in Isiolo District and 3 secondary schools. The school attendance in Isiolo is generally low compared with other districts. This is mainly due to the nomadic lifestyle of the people. The average dropout rate for girls is estimated at 40% and slightly lower than this for boys.

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

ISIOLO DISTRICT

Fig. 1: 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



3 WATER RESOURCES DEVELOPMENT POTENTIAL

3.1 Surface Water Development Potential

There are only four perennial rivers in the District. These are the Ewaso Ngiro, Isiolo, Bisanadi and Kinna. The Ewaso Ngiro River flows from the Aberdare Mountains and the north-western slopes of Mount Kenya, and is perennial until Bulesa (except in drought years). Bisanadi and Kinna originate from the Nyambene Range and have been used for irrigation purposes in the Kinna and Rapsu irrigation schemes. The Isiolo River originating from Mount Kenya is the source of water for Isiolo Town. There are also many seasonal laggas in the District.

Apart from the data on the Ewaso Ngiro River, no other data of sufficient length and continuity exist. The mean annual flow of the Ewaso Ngiro at Archer's Post amounts to around 660 million m^3 with a minimum of 163 million m^3 in 1952 and a maximum of 2,780 million m^3 in 1962. 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.
An inventory identified 24 springs, mainly along the right bank of the Ewaso Ngiro between Isiolo river and Malka Daka bridge. The discharges vary between about 5 and more than 200 m^3/hr. Other springs exist at Kinna (36 m^3/hr.) and at Kuru Barata (40 m^3/hr).

The river waters have already been extensively exploited so that their further development potential is very limited.

3.2 Groundwater Development Potential

The Water Resources Assessment Study distinguishes two types of aquifer systems in Isiolo District: (I) Regional Systems and (II) Local Systems. The systems can be sub-divided as follows:

System IA: Tertiary Marine Sediments

The sediments overly the Basement in the eastern part of the District. The system comprises layers of sands, sandstones and grits, interbedded with clay layers. The potential of this system is quite good except for the southern zone (Zone 1) where the salinity and fluoride levels of the water are very high.

System IB: Volcanic Rocks

Volcanics rocks (lava flows) interbedded with sediments (old land surface deposits) overlying the Basement complex. The potential of this system is high, with generally good water quality.

System IIA: Fissured and/or Weathered Basement

Fissured and weathered pockets in the metamorphic Basement rocks; the potential of this system is generally poor and water quality is often not acceptable for human consumption.

System IIB: Local Alluvial Deposits

Alluvial deposits of fluviatile, lacustrine or other nature. The most important aquifers of this kind are the coarse river deposits along the Ewaso Ngiro. The potential of these local (perched) systems is very variable, due to their limited extent.

A summary of the main data on the aquifer systems is presented below:

Major Aquifer Systems

Aquifer System	Water Rest Level (m)	Tested Yield (m^3/h)	EC ($\mu S/cm$)	F (mg/l)	Remarks
IA - Zone 1	30-100	3-20	8,000-26,000	0.5-20	Groundwater not suitable
IA - Zone 2	30-100	3-20	500- 5,000	0.5-20	Salinity variable, but acceptable
IB	10-40	5-30	500- 5,000	0 - 2	Hard water
IIA	20-60	1- 5	1,000-10,000	1 - 5	Quality often problematic
IIB	20-40	1-20	1,000-10,000	1 - 5	Borehole yields variable

More information on the water resources is contained in the Water Resources Assessment Report.

4. WATER DEMAND

4.1 Consumption Rates

The water consumption rates as issued in the MoWD Design Manual for rural centres have been used as guidelines for determining demand.

Water Consumers	Water Consumption litre/head/day
People with individual connections	40
People without individual connections	10
One livestock unit	50
Day schools without WC	5
Boarding schools	50
Dispensaries / Health centres	5000 l/day
Out-patients	20
Bars	500 l/day
Tea rooms	500 l/day
Butcheries	500 l/day
Shops	100 l/day
Hotels (low class)	50 l/bed/day
Administrative offices	25

The percentage of individual connections is assumed to be 5% of the total population rising to 10% and 20% in the future and ultimate design years.

4.2 Design Period

The scheme is to be designed for water requirements at the end of the design period i.e 20 years.

Taking into account the period required for preparation of the projects and for procurement of adequate funds, it is likely that the schemes shall only be commissioned after several years, hence the initial year has been taken as 1995, the future year as 2005 and the ultimate year as 2015.

4.3 Projected Growth

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% will be used for projection within the 20 year planning period.

For specific centres deviation from this rate is possible. Garba Tula may grow at a higher rate if the road through Kinna to Maua is improved. Merti has shown already a high growth in recent years. For both 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.

4.4 Livestock Demand

It is assumed for the purpose of the preparation of the pre-feasibility studies that the livestock numbers using the water supply shall remain constant. If the number of the livestock resident at the centre is unknown, then an estimated 10% of the livestock in the rural area surrounding the water supply (often corresponding with the deda-area) was assumed to depend continuously on the water supply.

The demand of the livestock which is only temporarily present at the centre, e.g. during the dry season, was not taken into account for the calculation of the supply capacity of the water supply facility. It was considered that this seasonal demand will be covered by separate supplies for livestock only, which supplies are planned by ILDP (Ministry of Livestock Development). This planning takes into account the range potential of the area, which potential is not regarded here.

5 WATER SUPPLY ALTERNATIVES

5.1 Alternative Sources

The sources of water available in general are groundwater, surface water and rain water. This section describes the possible technologies for using these sources.

Surface Water Intake

This normally consist of a weir or dam constructed across a perennial river. The cheapest abstraction alternative is by gravity but pumping is used where the topography does not allow. In Isiolo District only few perennial rivers do occur, therefore this alternative source is not a general option. Isiolo Town Water Supply is currently the only surface water supply; it has an intake weir on the Isiolo River.

Sub-Surface Dams/Sand Dams

These are constructed on seasonal rivers (laggas) to retain the sub-surface flow in the shallow (sandy) sediments. Suitable sites often coincide with natural barriers in a river such as a rock out-crop or impervious material in the river bed. This alternative is recommended where groundwater potential of deeper aquifers is lacking or saline. Examples of sub-surface dams in Isiolo District are found at Oldo Nyiro. The possibilities of using sub-surface dams at Modogashe, Eldera, Bulesa and Bisan Biliku should be investigated.

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.

Dug-Wells

Shallow large diameter wells are recommended near laggas where sediments or weathered rock of sufficient thickness occur. They can also be used as off-takes from infiltration galleries, sub-surface dams, pans and dams.
Hand dug wells protection includes lining the inner side with brick, stone or concrete (precast or cast in situ) and covering with a slab on which a handpump may be installed. Arrangements for drainage of excess water are also necessary. Appropriate sanitary practices should be enforced by the community to eliminate (faecal) pollution. Traditionally hand dug wells have been a source of water for both domestic and livestock use in Isiolo District. It is recommended that such traditional sources be studied and easier ways of protection and abstraction be initiated, especially with respect to protecting good water quality for domestic use.

Boreholes

The groundwater potential in Isiolo District varies according the geology and the water quality of the groundwater. In the Basement area borehole yields are low and the water is often saline, except where the Basement is covered with limestones. In the volcanic lava's borehole yields are usually good and the water quality is normally acceptable. The sediments in the Ewaso Nyiro and the Galana Gof rivers contain fresh groundwater, but only at shallow depths, below which very saline groundwater is found. Successful boreholes in this area are only found at Merti and Sericho.

Pans and Dams

Pans are water retaining structures which can be constructed by using manual labour or small earth moving equipment. In Isiolo District their capacities range from 20,000 m^3 (Bibi pan) to over 50,000 m^3 (Wamahatho & Madodubera pans). The site selection and size of the pan should be done by qualified personnel to avoid silting by erosion and ecological damage. The water is generally suitable for livestock but for human consumption a shallow well or an appropriate off-take structure is recommended.

Roof Catchments

Roof catchments are suitable from structures with sufficient roof area, such as schools or health centres. Rural dwellings are not suitable and normally also not permanent. Rainwater should be considered as an additional source and storage of sufficient size is a prerequisite to ensure water availability throughout (or a large part of) the year. The potential of rain water is limited, because rainfall quantities are low in the District.

5.2 Alternative Technologies

This section describes some of the possible technologies to be applied in the proposed water supply systems.

Borehole with Handpump

Water is normally of good bacteriological quality. The handpump can later be upgraded to a mechanically powered system when demand increases. The population served is limited to 200 people per handpump to avoid damage. Pump yields decrease with depth.

Shallow Well with Handpump

Good quality water may be abstracted from protected wells. The advantage of this technology is that the local community who have a lot of experience in the use and construction of handdug wells may easily adapt to protected hand dug wells.
However the handpump is not favoured by the Borans, because of the low output. Handpumps are only feasible at places where the water will be used for human consumption only. The experience from Boji shows that installation of handpumps on sources which are also used for watering livestock, is not advisable.

Diesel Powered Pump

From interviews during field visits this was the most favoured technology option because according to those interviewed "diesel powered pumps produce a lot of water". The communities were also ready to "purchase the fuel required to run the engine". But payment of operators and maintenance is normally expected from the government. This system is suitable for intensive livestock watering during the dry months. The sustainability of this system is however doubtful, due to the remoteness and poor accessibility of many areas. The submersible pump driven by a diesel generator is preferable to a direct driven pump. The maintenance of the submersible pump is minimal, but the maintenance of the generator is more complicated. The advantage of this system is easy operation, possibility of high pump yields and extra use of generator for lighting, etc.

Solar Powered Pump

The submersible pump is driven by energy from solar panels. This system does not require fuel, but at times of cloudiness it does not produce water. The solar radiation of Isiolo District at 5 kWh/m^2 is sufficient to run most types of solar pumps. Since they have very few moving parts this system can easily be maintained and managed for a long time. Except for its capital cost per capita the system is reliable, sustainable and environmentally sound.

Wind Powered Pump

The pump is directly coupled to a windmill. This system does not require fuel, but it needs a good wind potential with winds of sufficient speed and frequency. This is apparently found only in the western parts of the District. The initial capital costs are high, but O&M costs are low.

Animal Powered Pump

Traditionally donkeys are used for transporting water from the handdug wells in most of Isiolo District. These can as well be used to pump water. This technology is not in use in Isiolo but should be tried both for domestic and livestock watering. In fact it may be an appropriate system because except for the maintenance of the pump, the prime mover (animal power) requires little maintenance. The technology can also be adopted for use in the present handdug wells.

Desalinisation

Although distillation, reverse osmosis and demineralization can make saline water potable, such technologies have been considered to be too expensive and beyond the requirements of Isiolo District.

5.3 Materials

Building Materials

These can be divided into two sets:

(a) Ready made - such as fittings, general hardware and prefabricated material. Also included here could be pumping equipment. All these have to be bought at Isiolo or outside the District.
(b) On site fabricated material such as blocks, timber and timber products.

Both categories would be needed in varying quantity and at different times in the course of any proposed construction activity. Adequate timing of supply should be ensured to avoid complications of storage.

Pipes

Preferable piping material should be G.I. pipes. PVC pipes are cheaper ,but often give problems as it appears that installation prescriptions are not adhered to, e.g. the required burying depth. PVC pipes are also easily damaged by excessive heat and direct sun. G.I. pipes have to be used where terrain can not allow adequate depth or likelihood of exposure. Types and sizes of pipes are included in the Cost Estimate.

Storage

Following are notable features of the storage provisions:

(a) The area being very hot, needs overhead shades for most materials that can be destroyed by direct heat or sunlight such as pipes. The shade should be made using local materials.
(b) Nuisance of termites require that platforms be provided for materials such as timber and related items. Alternatively, cemented bays be provided.
(c) Security of stored materials be looked into such that there is adequate housing for caretaker staff; thus staff housing should be a priority.
(d) Handling into and out of storage sites be carefully planned with respect to proposed construction sites to reduce costs of double handling where it can be avoided.

6 WATER SUPPLY PROPOSALS

6.1 Considerations

Communities anywhere in the world always desire to have the best. They tend to overlook the excessive cost of desirable, but unreasonable, high technology options and their consequent maintenance problems. Environmental effects are also often disregarded leading to damaged ecosystems. A suitable technology option would be that which meets the basic needs of the current generation without undermining the conditions for future generations. Sustainable development is increasingly becoming a guiding principle for development. For example it would be futile to equip a high yielding borehole with disregard to overgrazing.

The possibilities of developing small yielding water supplies for domestic water supplies in the trading centres is appealing, but most of the trading centres of Isiolo District are also in the dry grazing areas. Livestock are expected to be conveniently watered during the dry months and therefore it would better to develop high yielding sources near the trading centres to be used only during dry months. The planning of such supplies as mentioned earlier, will be done by ILDP (Ministry of Livestock Development).

The choice of technology and type of system was based as much as possible on the following considerations:

- the water supply will include a small distribution system providing water to communal water points and some individual connections
- the place where the people can obtain the water from a communal water point should be nearer to their homes than the location of the traditional unprotected source,
- the quality of the water supplied must be reliable and if possible better than the quality of the water which is used now,
- the capital costs are expected to be provided from external funds and will not be retrieved from the sale of the water,
- the operation and maintenance costs are expected to be borne by the community from the sale of the water,
- preference is given to systems with low operation and maintenance costs, even if these have higher capital costs,
- the supply should be capable to provide water even during prolonged periods of drought.

6.2 Preliminary Cost Estimates

The preliminary estimate of the capital costs was based on unit costs derived from the most recent tenders received from similar works by the Planning & Design Division of the Ministry of Water Development. Current prices (1990) for pipework, pumping equipment and other plant where applicable, were obtained also from local manufacturers and supply agents. An overview of the unit costs is included in Part 2 of the DWDS.

The presented cost estimates should be considered as preliminary, because at this prefeasibility stage detailed survey and design have not been done. Also, some of the suggested technologies are relatively new to the District, such as infiltration galleries,

and detailed site investigations are still needed to confirm their applicability.

A preliminary sum and a general contingency sum were included in all instances. The preliminary sum although arbitrary, was based on the expected quantity of design and survey work needed during the feasibility study.

The operation and maintenance costs include staff costs, fuel costs and general costs. The staff costs are based on the present government rates and since a general term "water supply attendants" is used, it is expected that the community shall recruit the attendants locally and pay them a negotiated salary. Depending on the complexity of the recommended system the salary has been taken to range between Ksh 900 and Ksh 1,500. In the bigger centres like Garba Tula, Modogashe and Merti the District Water Office should provide the water supply attendants.

The cost of fuel is based on the diesel used (5.3 l/hr) by a 8 HP diesel engine. In hybrid systems (i.e. solar combined with diesel) a generous estimate has been allowed for the extra pumping required with diesel.

As general O&M costs were considered repairs of bursts, leaks, control systems like valves, etc. and any other preventive maintenance. A lump sum per month of approximately Ksh 3,000 to Ksh 5,000 was estimated for this purpose.

6.3 Results of the Pre-feasibility Studies

The proposals described here cover the domestic water supply to the centres and are presented for each centre in separate pre-feasibility reports, which are attached. A summary of the results is provided in the Appendix. 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 two tables on the next pages. The location of the centres is indicated on Plate 1.

At many centres the only good source of water is found in the sandy sediments of the nearby dry river bed. Currently that water is obtained by digging shallow wells in the sand and the water is transported by donkey to the centre. It is proposed to abstract this water using horizontal drains or infiltration galleries (pipes) which are connected to a collector well located on a safe site on the river bank. This technology has been applied in the past at Modogashe only and with an improved design and construction method (especially larger depths of the drains) should provide the required quantities of water. For pumping preference was 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 which deliver water through water points in the centre range for most centres between 1.8 million to 3.6 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.

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

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

7 IMPLEMENTATION OF PROPOSALS

7.1 Operation and Maintenance Procedures

It is clearly recognized that in any rural water supply scheme the people using the system must be involved from the beginning, not just to act as unpaid labourers but to be full co-operating partners in the scheme. It is important to note further that, participation by the potential beneficiaries should not be regarded merely as a means of reducing costs. This will give the people a chance to participate in a development project (which is meeting their genuine needs) and hence give them a sense of responsibility and 'ownership'. This would not be achieved with communities which are given services at no cost to themselves.

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 are 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 those they are supposed to benefit. This establishes a greater sense of responsibility and ownership within the community.
The community should with the guidance of the District Water Board decide on an appropriate tariff to enable them to pay the water supply attendants, to purchase spare parts and to pay for other costs of maintenance. Depreciation of capital costs may not be included initially, but in the future should also be part of the water tariff.

7.2 Follow-up to Pre-feasibility Studies

The pre-feasibility studies presented here provide summaries of the existing information on each centre and 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.
These feasibility studies may be combined with survey, design and costing of the supply for most of the centres. For some centres however, in particular Modogashe, a thorough feasibility study is still needed to decide what type of supply can serve the centre most suitably.

The type of follow-up studies required for each centre are indicated in the table on page 17. These studies cannot be carried out alone by the Planning & Design Section of the District Water Office, because sufficiently qualified personnel is not available. Assistance from the MoWD Headquarters or from engineers employed by NGO's will be necessary.

The most important task for the feasibility studies is to prove that the infiltration galleries provide a suitable solution, which is also economically viable. This technology has been proposed for many centres along the Galana Gof and the Ewaso Nyiro.

8 SUMMARY OF WATER SUPPLY STUDIES FOR RURAL CENTRES

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.

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.

Iresa Boru

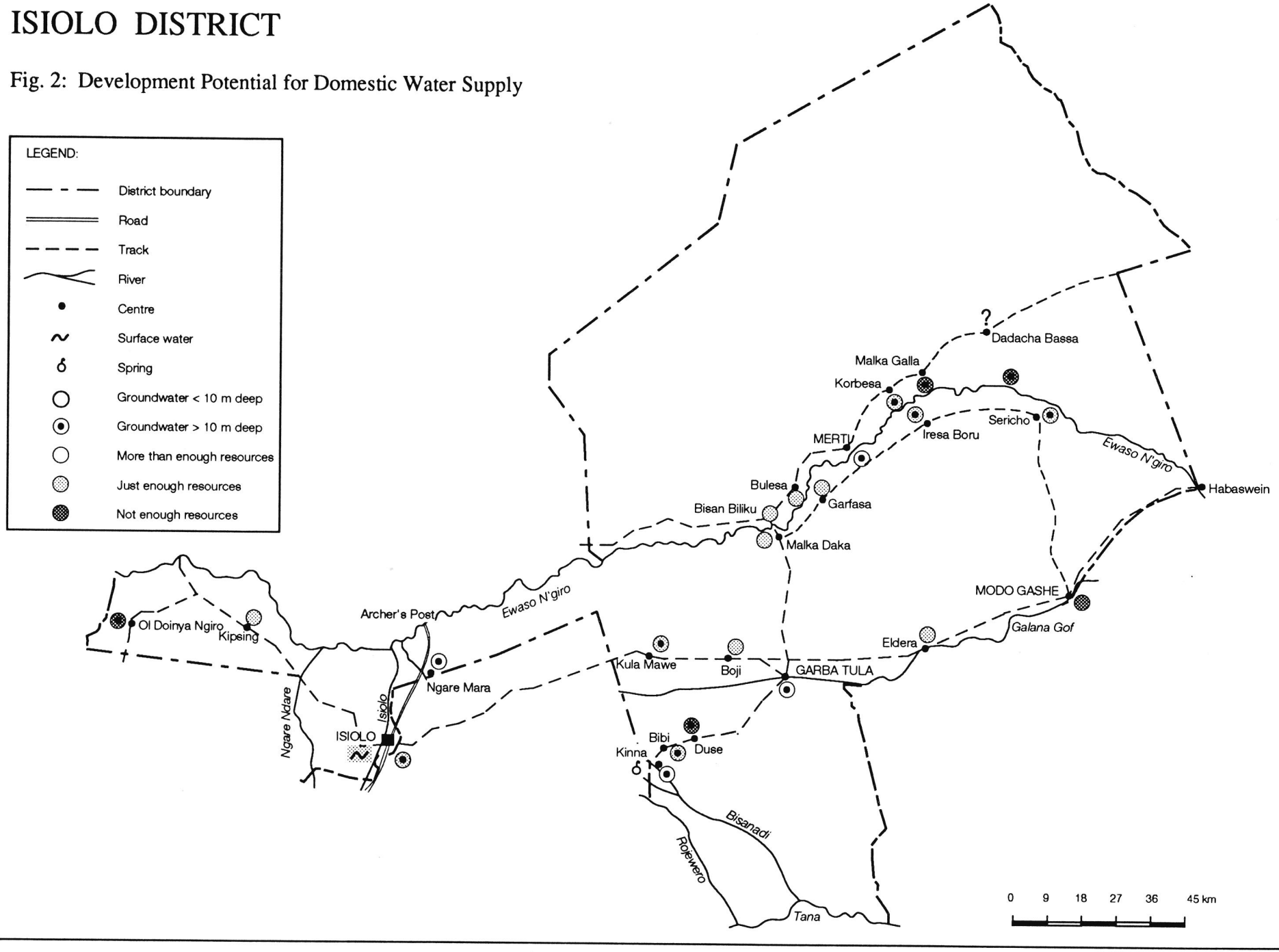
The only reliable source of water is the groundwater in the floodplain of the Ewaso Nyiro. A borehole or dug well should be constructed to tap this water. The borehole or well should be safe from flooding. It is recommended to install a submersible pump powered by a solar system. Dug wells with hand 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.

ISIOLO DISTRICT

Fig. 2: Development Potential for Domestic Water Supply



PRE-FEASIBILITY STUDIES OF WATER SUPPLY DEVELOPMENT

REPORTS OF RURAL CENTRES, ISIOLO DISTRICT:

Ngare Mara
Kipsing
Oldo Nyiro

Garba Tula
Bibi / Duse
Kinna
Boji
Gafarsa
Kulamawe
Malka Daka

Bisan Biliku
Dadacha Bassa
Malka Galla
Bulesa
Korbesa
Merti

Eldera
Modogashe
Iresa Boru
Sericho

NGARE MARA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Ngare Mara market is located 18 kilometre north of Isiolo town on the right hand side of the Isiolo - Marsabit road. It is sited close to Ngare Mara seasonal stream. The area is inhabited by Turkana and Samburu tribes with an estimated population of 2,960 people. The market is inhabited mainly by Turkana.

The Ngare Mara stream was once a permanent river. Due to development of modern agriculture in its upper reaches leading to irrigation in Meru District the quantity of water flowing downstream is very low in the dry season and this quantity only increases during the rain season.

Quite a number of livestock find pasture within the area getting water from Ngare Mara river, hand dug wells, Uaso Nyiro and others at Chumvi Yale.

1.2 Social Economic Stratification

Ngare Mara is a major local market being the administrative centre of Central Location of Central Division. Like other parts of Isiolo the area is said to have substantial livestock numbers although not actually at the centre but in the surroundings. About 80% of the people depend on livestock. There is also minimal cultivation within the area along Ngare Mara river.

The nearby game parks do not provide much income. Only nine people are employed in the tourist industry.

1.3 Scope of the Report

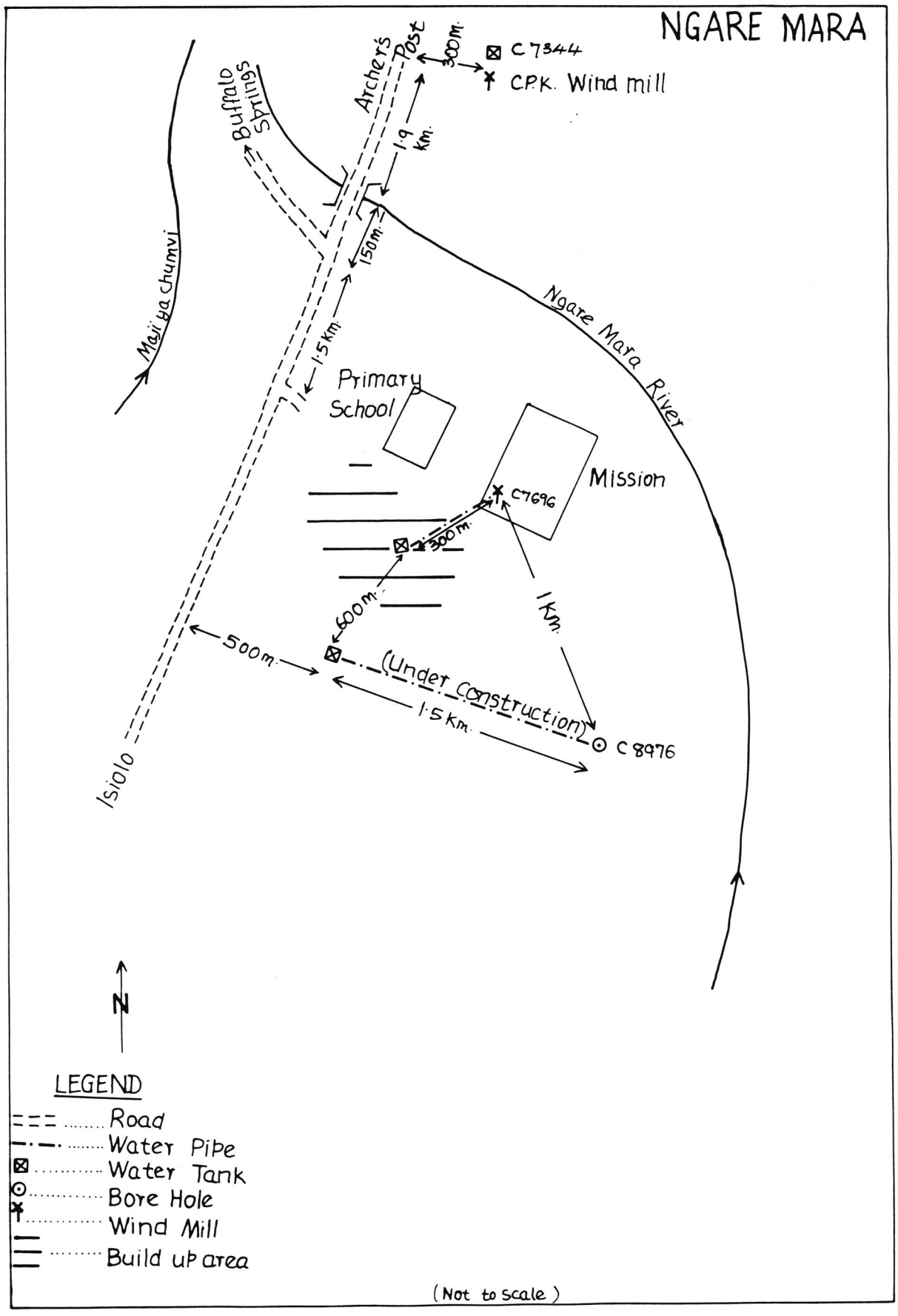
This report covers the supply of water to Ngare Mara trading centre and its surroundings. The population mainly depends on the catholic mission borehole for their domestic use. Since the area lacks enough water there is likelihood for livestock to benefit from the water project if completed.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

Ngare Mara is a fast growing centre situated about 18 km along the Isiolo-Marsabit road. The centre is located next to the game parks Buffalo Springs and Shaba. It is situated on latitude 0° 50'N and longitude 37° 38'E.

The centre is located in Central Division of Isiolo District and is the administrative headquarters of Central Location. The assistant chief resides at the centre.



Sketch of the Project Area

2.2 Topography

Ngare Mara is located in a comparatively flat plain which is tilting towards the north. The only permanent river close to the market at a distance of 20 km north is the Ewaso Nyiro river. But the area between the river and the market is game reserve. It is therefore not possible to get water from Ewaso Nyiro. The quantity of water flowing down stream in the Ngare Mara River is very low in the dry season and even flow may stop during dry years. The flow quantity increases during the rain seasons. The drainage of the area is poor.

2.3 Climate

The area has a semi-arid climate with an average annual rainfall between 300 - 400 mm and the annual potential evaporation is below 2000 mm. The average annual temperature is about 25°C.

2.4 Soils and Vegetation

The area consists of scattered acacia trees and sparse low bushes. The soils comprise of mostly black cotton soil mixed with grey stony patches with silts and gravel of kunkar limestones.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

The assistant chief of Ngare Mara resides in the centre. Currently there is no administration office opened and the public is served from the divisional offices at Isiolo. One livestock, agriculture and public health technician have been posted at Ngare Mara but they operate from Isiolo.

3.2 Education

There is only one primary school opened in early 1979 with one class of 35 pupils. Presently it is a full primary with about 160 pupils and 9 teachers. About 90% of the students are Turkana in origin, the rest are Borans and other residents (Samburu and Meru). The school is expected to expand soon. A nursery school has currently 35 children and one teacher. There are no boarding facilities.

3.3 Health

One local dispensary operated by the catholic mission from Isiolo is served by a mobile health vehicle which visits the centre once a week. The average attendance is 100 patients. The most common diseases are malaria, URTI and skin diseases.

3.4 Commerce

Ngare Mara serves as major trading centre for the local people. There is no possibility to have industries there but likelihood for the town to expand, if water is made available. Currently there are four shops, one bar, one tearoom and a butchery. Seven hawkers operate from the centre. There is no open air market.

3.5 Transport

Ngare Mara is well placed along the Isiolo-Marsabit main road. Paths within the centre can be difficult during the rain season as they are not murramed and not clearly defined.

3.6 Agriculture

There is development of modern agriculture in the upper part of Ngare Mara stream and there is likelihood of Ngare Mara people being introduced to agriculture. At least with the little rainfall which falls in the area some drought resistant crop might do well.

3.7 Livestock Husbandry

Like other parts of Isiolo district the area is depending on livestock. All the people are pastoral. The number of livestock in this area is according to the chief: 37,000 cattle, 41,141 goats, 1,121 camels and 3,000 donkeys. The herd at the centre is 860 cattle, 300 goats and 70 donkeys.

4. WATER RESOURCES

4.1 Groundwater

Ngare Mara centre falls under zone 1b of the geologic formation. This zone is composed of old land surface deposits and sediments interbedded between the lava flows or outcropping limestones overlying the metamorphic rocks. In Ngare Mare deposits of volcanic origin predominate.

Data from boreholes indicate that water struck levels range from 17 to 31 m. while water rest levels range from 9.4 to 20.7 m. below ground level. Yields from these boreholes ranges between 8.5 and 30.0 m^3/h.

Water is chemically fit, EC = 1.56 mS/cm, TDS = 936 mg/l, HC03 = 186 mg/l.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HC03 (mg/l)	F (mg/l)	Remarks
C7344	70	17	14	10	1.56	186	0.6	Equipped with windmill (CPK)
C7406	50	21	9.4	8.5	1.3	-	-	Equipped with windmill (CPK)
C7696	-	-	-	-	-	-	-	Equipped with windmill (Mission)
C8976	45.8	31	20.7	30	1.4	-	-	Drilled by WRAP

4.2 Surfacewater

The Ngare Mara river is an alternative source of surface water during the rainy season. however this river is not dependable since it dries up at this point due to too much use upstream on irrigation.

The Ewaso Nyiro River is located across the game parks and is not accessible for livestock. The distance from the centre is 20 km.

5. WATER DEMAND

5.1 Human Population

The current population of the sub-location is 2,960. The current population of the centre is 640. The population used for the demand calculation is 1,200. The growth rate is 4%.

5.2 Education

The student population including teachers is 205. It is assumed that this will increase at a growth rate of 6%.

5.3 Livestock

The number of livestock is assumed to remain constant for the purpose of this feasibility study. Only the number of livestock at the centre is assumed to benefit from the water supply.

5.4 Health

Water demand for a health centre is included, because one may be opened in the near future. The same growth rate as for population is taken.

5.5 Commerce

The number of hotels, shops and other commercial institutions will increase at a lower rate of 2% as the population.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	60	73	216	640
	using Communal Water Points	1,140	1,386	1,944	2,559
Education	Primary Schools: Students	205	274	491	727
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	860	860	860	860
	Sheep & Goats	300	300	300	300
	Camels	-	-	-	-
	Donkeys	70	70	70	70
	Total Livestock Units	334	334	334	334
Health	No. of Beds	-	-	-	-
	No. of Outpatients	15	18	27	40
Commerce	Shops	4	4	5	6
	Tea rooms	1	1	2	3
	Butcheries	1	1	1	1
	Bars	1	1	1	1
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3 /day			
	1990	1995	2005	2015
Individual Connections	2.4	2.9	8.6	25.6
People using C.W.P's	11.4	13.9	19.4	25.6
Primary School	1.0	1.4	2.5	3.6
Health Centre	5.3	5.4	5.5	5.8
Administration	0.1	0.2	0.2	0.3
Shops	0.4	0.4	0.5	0.6
Butcheries	0.5	0.5	0.5	0.5
Bars / Tea rooms	1.0	1.0	1.5	2.0
Hotels (Low Class)	-	-	-	-
Livestock	16.7	16.7	16.7	16.7
Total	38.8	42.4	55.4	80.7

6. EXISTING WATER SUPPLY

6.1 Technical Description

The centre is currently supplied from a borehole at the mission which is equipped with a 20 ft. diameter windmill. The water is supplied to a 30 m^3 ferrocement tank constructed in 1989 which is connected to several taps.

There is one hand dug well at the catholic mission of about 6 - 7.5 m. deep, equipped with a high lift hand pump. The yields are very low during dry periods.

Another borehole drilled by C.P.K church at about 2 km from the centre and fitted with a 12 ft. diameter windmill produces water of good amount. The water is pumped into a 50 m^3 tank and from there supplies two cattle troughs and a tap.

The borehole drilled by WRAP in 1989 will be equipped with a submersible pump. The construction of a 100 mm ϕ 1.5 km long rising main and a storage tank is in progress. This supply will relieve the mission from supplying the centre and will also ensure water during periods of little wind.

6.2 Potential and Actually Served Beneficiaries

The population of the centre and the surrounding manyattas and their livestock is expected to benefit from this supply.

7. PROPOSED WATER SUPPLY

7.1 Recommendations

The supply from the new borehole will adequately cover the demand of the centre. The operation of the supply should be organised in close cooperation with the population. The existing development committee therefore has to be alerted as soon as possible.

Due to the good ground water potential all future water sources should be based on boreholes. A hybrid system whereby different energy sources are combined, such as a windmill, a solar system and a diesel generating set, should be tried.

8. COST ESTIMATES

8.1 Capital Costs

The project is under construction and most of the materials are already on site. The estimates given hereunder are therefore taken from the Isiolo DWE's files. The construction of the pump house, storage tank and equipping of the borehole should be the priority. The construction of the operator's house and the reticulation system should be done later.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Stage	Amount Kshs.
Pump house	Almost complete	54,000
Pipework	Pipes delivered / trench excavated	280,000
Storage tank (100 m^3)	Site cleared	290,000
Staff house	Site cleared	170,000
Pumping unit	Not purchased	250,000
	Sub-Total	1,044,000
10 % Contingencies		104,400
	Total Say	1,200,000

With a population of 1,200, the per capita construction costs will be about Ksh. 1,000.

8.2 O & M Costs

The council of elders should be left to decide on how best to man their new water supply when the need arises. Meanwhile it is unlikely that with the current population the new water supply shall be fully utilised in the near future.

Two water supply attendants shall be required for maintaining the water supply.

MONTHLY O&M COSTS

Description	Amount Ksh.
Staff salary	3,000
Fuels for pumping 4 hours per day	3,000
General maintenance	2,000
Total	8,000

With the present population the per capita monthly O&M cost would be about Ksh. 7. An annual O&M cost per household (of five members) would be in the range of Ksh. 400, which should be affordable for most of the community members.

Much emphasis should be put on the revenue collection. The District Water Board should come up with a suitable solution to meet the cost recovery criterion.

KIPSING

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8. COST ESTIMATES

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1. INTRODUCTION

1.1 Background

Kipsing market is located about 60 km to the west of Isiolo town. It is accessible by a dry weather road, which is not passable during the rain season. The same road continues to Oldo-Nyiro centre. The centre is sited on the Kipsing river.

The centre is located inside the area of the Livestock Marketing Division and has no legal status. The LMD refuses people permission to settle, because it interferes with the operation of the holding ground. However the centre has now a primary school and there is a proposal for a health centre.

The present pre-feasibility study was made on the ground that there is a settlement existing and therefore it is useful to have an inventory of the water supply situation. However the study does not imply that a proper centre should be established.

The area is inhabited by mainly Samburu and few Turkana. The centre is very small and is inhabited mainly by LMD staff. The majority of the population lives in the surrounding manyattas. Kipsing sub-location has an estimated population of about 2,000 people.

1.2 Social Economic Stratification

Kipsing centre has quite a number of livestock. Which belong to the local people of the area. The people mostly occupy the area to the south and west of the centre, while the northern site is left open for the Kipsing Livestock Holding Ground.

Agriculture has not taken off from the ground since the locals know nothing about agriculture. However the catholic mission is considering an irrigation project at Kipsing.

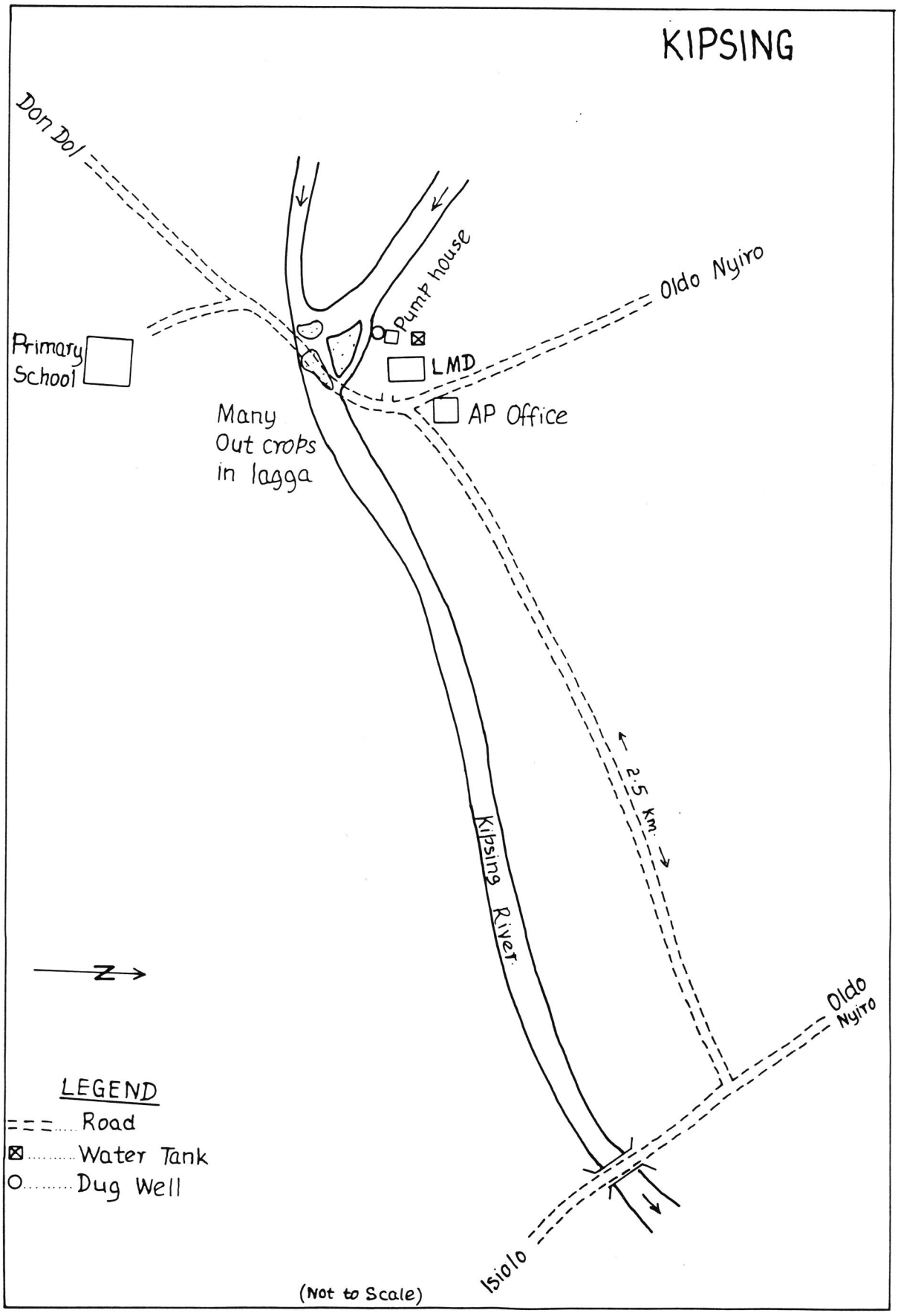
1.3 Scope of the Report

The report covers the supply of water to the Kipsing centre and to the southern part of the centre where there is a proposed catholic church and a primary school which was started a few years ago. The community gets water from wells in the Kipsing River or directly from the river. There is a well which supplies water to the centre.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The centre is situated on latitude 0° 37'N and longitude 37° 14'E in Central Division of Isiolo District.



Sketch of the Project Area

2.2 Topography

Kipsing centre is located in a relatively flat area between the foothills of Mount Kenya to the south and the Ewaso Nyiro River to the north. The Kipsing River passes the centre in a several metres deep valley which is about 50 m. wide. The river is seasonal. Another seasonal river to the north of the centre drains to the Kipsing River only during the rain season but remains dry immediately after the rains. There are many outcrops in the Kipsing River.

2.3 Climate

Data collected by the ministry of water development shows that the centre receives an average annual rainfall between 300 mm - 350 mm. The mean annual temperature is about 30°C.

The rain falls like in other parts of Isiolo District between March and May and between October and December.

2.4 Soils and Vegetation

The area comprises of scattered acacia trees, sparse low bushes and thick grasses after the rains. The soils are mostly sandy, derived from the Basement rocks.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

Presently in Kipsing centre, there is one sub-chief who resides in one of the nearby manyattas. There is also an administration police post.

3.2 Education

Kipsing primary school is the only school in the area. The school has about 80 pupils, 40 pre-primary pupils, five teachers and one none teaching staff. The school has been sponsored by catholic mission through the Oldo-Nyiro catholic church.

3.3 Health

There is no established dispensary in Kipsing centre. The people go for treatment either to Oldo-Nyiro or some come to Isiolo general hospital. There is a proposal for a health centre.

3.4 Commerce

Ngare Mara serves as major trading centre for the local people. There is no possibility to have industries there but likelihood for the town to expand, if water is made available. Currently there are four shops, one bar, one tearoom and a butchery. Seven hawkers operate from the centre. There is no open air market.

3.5 Transport

Ngare Mara is well placed along the Isiolo-Marsabit main road. Paths within the centre can be difficult during the rain season as they are not murramed and not clearly defined.

3.6 Agriculture

There is development of modern agriculture in the upper part of Ngare Mara stream and there is likelihood of Ngare Mara people being introduced to agriculture. At least with the little rainfall which falls in the area some drought resistant crop might do well.

3.7 Livestock Husbandry

Like other parts of Isiolo district the area is dependant on livestock. All the people are pastoral. The number of livestock in this area is according to the chief: 37,000 cattle, 41,141 goats, 1,121 camels and 3,000 donkeys. The herd at the centre is 860 cattle, 300 goats and 70 donkeys.

4. WATER RESOURCES

4.1 Groundwater

Kipsing centre is under zone 2 of the geologic formation. This zone is comprised of fissured and/or weathered metamorphic rocks.

Data from boreholes C1611 and C1784, drilled about 15 km upstream along the Kipsing river, indicate that they were dry. Data from other boreholes in the area also indicates that the groundwater potential is poor.

The handdug well used by LMD (total depth 5.2 m. and water rest level 1.95 m.) has a good water quality (EC = 0.75 mS/cm). The well is concrete lined and it is pumped with a diesel pump. The well is located on the bank of the river and is reported to have an infiltration pipe extending under the riverbed. A pumptest carried out by WRAP on 10/11/89 indicated a safe yield of 2.5 m^3/hour. It is not certain whether this discharge can be maintained always, because the waterlevel varies considerably during the year.

The sands in the riverbed seem the only good source of water.

4.2 Surfacewater

The Kipsing lagga has flowing water only during the rainy season (March/April and November/December).

5. WATER DEMAND

5.1 Human Population

The population used for the purpose of calculating the water demand is estimated at 50% of the total population in the area, which is 2,000. The population in the centre itself is only about 300. The growth rate of the population is taken to be 4%.

5.2 Education

As stated earlier the only primary school has about 80 pupils, 40 pre-primary pupils, five teachers and one none teaching staff. The growth rate of pupils is assumed to be higher as the population growth, at a rate of 6%.

5.3 Livestock

The number of livestock according to the Ministry of Livestock Development is shown in the table. It is assumed that 10% of this number will use the water supply.

5.4 Health

The proposed health centre is included for 1990 for the purpose of the demand calculation. The health centre attendance is assumed at 15 people per day.

5.5 Commerce

The present number of hotels, tea rooms and other commercial institutions is assumed to increase at a rate of 2% for this feasibility study.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	53	64	190	565
	using Communal Water Points	947	1,152	1,615	2,126
Education	Primary Schools: Students	126	169	303	449
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	560	560	560	560
	Sheep & Goats	7,500	7,500	7,500	7,500
	Camels	50	50	50	50
	Donkeys	100	100	100	100
	Total Livestock Units	752	752	752	752
Health	No. of Beds	-	-	-	-
	No. of Outpatients	15	18	27	40
Commerce	Shops	3	3	4	5
	Tea rooms	1	1	1	1
	Butcheries	-	-	-	-
	Bars	-	-	-	-
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	10	12	18	27

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	2.1	2.6	7.6	22.6
People using C.W.P's	9.5	11.5	16.2	21.3
Primary School	0.6	0.8	1.5	2.2
Health Centre	5.3	5.4	5.5	5.8
Administration	0.3	0.3	0.5	0.7
Shops	0.3	0.3	0.4	0.5
Butcheries	-	-	-	-
Bars / Tea rooms	0.5	0.5	0.5	0.5
Hotels (Low Class)	-	-	-	-
Livestock	37.6	37.6	37.6	37.6
Total	56.2	59.0	69.8	91.2

6. EXISTING WATER SUPPLY

6.1 Technical Description

Most consumers depend entirely on the river Kipsing mainly using donkeys to ferry water.

The small centre is supplied from a well dug by the Ministry of Livestock Development. The well is protected. Water is pumped using a diesel powered engine. There is a G.I 1 m^3 storage tank. There is no other distribution.
Water is supplied free of charge.

The school has a 50 m^3 storage tank. Water is brought by tractor from the well. The roof of the school is unfortunately made from asbestos.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

The following sources should be considered:

- Sand dams to increase the storage capacity of the sands in the river bed
- Boreholes or wells in or near the river to tap good quality groundwater below the river
- Roof / rock catchments (as additional source)

7.2 Recommended Systems

Sand dam with pumping
In the absence of a perennial surface water and the poor ground water potential near the project area, it is recommended that investigations be carried out into the feasibility of more and/or higher sub-surface dams as sources.
Infiltration pipes could be laid leading to a central collecting point for pumping to the town centre. Hand pumps should also be installed in protected hand dug wells to be constructed beside the sand dams.
A submersible solar driven pump is recommended for this water supply with a stand-by generator.

Borehole with submersible pump
The possibility of a borehole in or near the lagga should be investigated. The quality of the groundwater may be reasonable here, due to infiltration of fresh surface water form the lagga. The sub-surface dams may even improve the infiltration.
A submersible pump driven by a generator or if possible by a solar unit is recommended.

Roof / rock catchment
To supplement the other sources it is further recommended that appropriate roof catchment systems be installed in all buildings with suitable roofs.

A rock catchment system is also possible at some distance from the town centre. This would also supplement the centre's water supply.

7.3 Operation & Maintenance Procedures

It is expected that the operation of this water supply shall be community based and as such two local water supply attendants should be trained. Their salaries of approximately Ksh. 1,500 should be paid by the community. A suitable payment method should be arrived at by the community with the guidance of the District Water Board.

8. COST ESTIMATES

8.1 Capital Costs

The presented costs represent a solution using a sand dams. More investigations are necessary to decide whether this is the most viable supply system.

Since in the construction of the proposed system labour shall be required in large amounts, the local people should participate to reduce costs. Unless there is popular participation the water supply should not be developed.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	100,000
Construction of sand dam with infiltration pipes	400,000
Clear water well	25,000
Purchase of pump set solar	600,000
Purchase of stand-by generator set	250,000
Installation of dug wells with handpumps 2 no.	50,000
Construct storage (50 m^3)	225,000
Pipework	300,000
Cattle trough	20,000
Sub-Total	1,970,000
10 % Contingencies	197,000
Total Say	2,200,000

With a population of 1,420, the per capita construction costs will be Ksh. 1,550.

8.2 O & M Costs

The community should employ two local water supply attendants, to be increased to four later as the size of the project increases. Housing of the attendants should be constructed on self-help basis should the need arise. The community should come up with a suitable mode of payment to meet the required O&M costs.

The solar pump is estimated to provide 48 m^3/day, which is sufficient for the domestic supply in the future year. The remaining supply (for livestock) should be provided by the diesel pump.

MONTHLY O&M COSTS

Description	Amount Ksh.
Staff salary	3,000
Fuels for pumping	1,000
General maintenance	3,000
Total	7,000

With the present population the per capita monthly O&M cost would be about Ksh. 5. An annual O&M cost per household (of five members) would be in the range of Ksh. 300, which is higher than in most other supplies in Isiolo.

OLDO NYIRO

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1. INTRODUCTION

1.1 Background

Oldo Nyiro is situated at the extreme west end of Isiolo District. It is 70 km north of Nanyuki and 100 km north-west of Isiolo town. It is accessible by a dust road from either of the two towns.

Oldo Nyiro Location has a total population of 2,701 as per 1979 census. The population of the centre was 1,300 in 1979 and the population as of 1988 is estimated at 2,000 by the DDO.

The area is comprised of the Samburu tribe. The Samburu people are pastoral and they also get food from the trading centre. The proposal to have a water supply for Oldo Nyiro dates back as far as 1972 but little has been done. It was formerly LMD centre but now its occupied by the Samburu people. The LMD have moved to Longopito which is 20 km from Oldo Nyiro centre.

1.2 Social Economic Stratification

Livestock forms the basic wealth of the area. There is possibility for agriculture in the area but there is need to educate the people how to cultivate. The mission plays a big role in the development of the area. The people have shown willingness to organize themselves for various activities like women groups and cooperative societies etc.

1.3 Scope of the Report

This report covers a proposal for supply of water to Oldo Nyiro centre and the surrounding area. Both the inhabitants of the project area and a small part of their livestock will depend on the water supply.
The supply will cover the AP Post, chiefs camp and the centre itself.

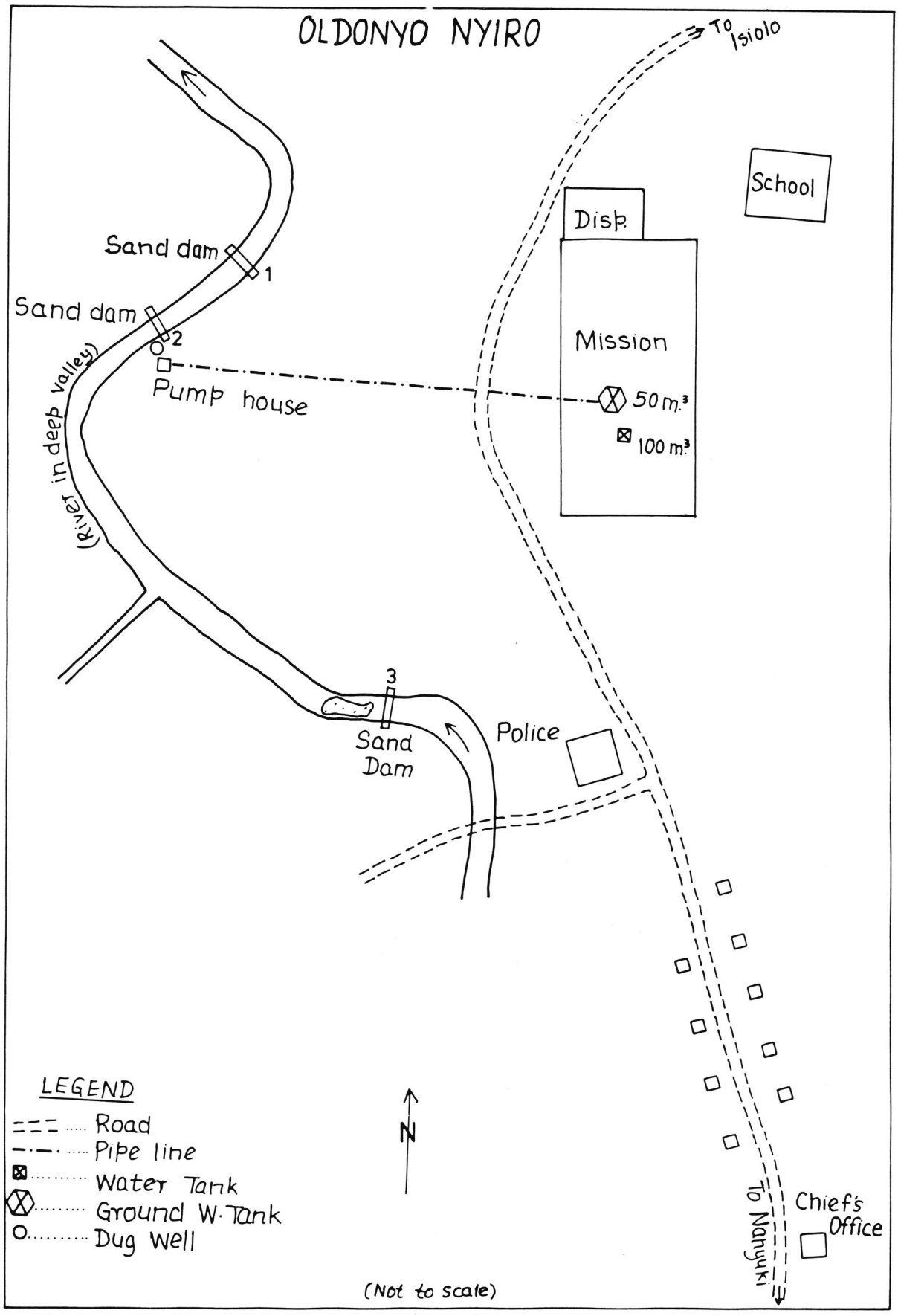
2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is in the western part of Isiolo District at latitude 37° east and longitude 1° north of the equator about 70 km north of Nanyuki and 100 km north west of Isiolo town.
It is in Oldo - Nyiro location of Central Division of Isiolo District.

2.2 Topography

The topography is dominated by rocky hills separated by shallow valleys with steep slopes. Seasonal rivers drain the hills along the valleys northwards and north-westwards and the sandy riverbeds remain dry almost immediately after the rains.



Sketch of the Project Area

2.3 Climate

The area is semi-arid with unreliable rainfall of below 600 mm per annum. The rainfall falls in April - May and October November. The average temperature is above 20°C and as a result of this evaporation is extremely high and exceeds average annual rainfall. The centre experiences cold weather during the rain season, characterised by strong winds and cold nights. It is in the leeward side of Mount Kenya.

2.4 Soils and Vegetation

The rock type found here is part of the Basement System, consisting of granite and gneisses. The soil cover is not deep and many rock out crops can be seen on the hills, on the slopes and in some of the valleys. The chance of striking potable water in a drilled hole are very slim except in the valleys which drain the area.

The vegetation is characterized by stunted thorn trees and scattered bushes as well as coarse grass grow in the sandy soils but in the valley luxuriant vegetation thrives in the deep soils and relatively moist conditions that occur there.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

This is the administration centre for Oldo Nyiro Location. The chiefs' office is within the vicinity of the main shopping centre. In addition to the chiefs camp there is also a Police Post, Administration Police Post, Health Centre, a School, Public Health and Ministry of Livestock and Agriculture. There are 39 police personnel and 6 Administration personnel who are fully deployed within the centre. The number of Government officers are six.

3.2 Education

There is a primary school with about 320 pupils and 7 teachers and the same is being expanded on harambee basis. There is no secondary school presently although there are proposals to have one in the nearby future. There is also one nursery school.

3.3 Health

The area is well served by a well constructed government dispensary which is within the vicinity. It is staffed by two clinical nurses and one attendant. The out-patients attendance is about 20 per day. There are plans by the catholic mission to build another health centre in the same shopping centre. And it is also anticipated that a maternity ward might be started within a short time.

3.4 Commerce and Industry

There is no industrial development. Oldo Nyiro being the only shopping centre has five shops, one butchery, one bar and two tearooms. The local people come to buy items from the shops as from 9 am to 4 pm. There is no open air market.

3.5 Transport

It is well connected with the surrounding area. The road to Nanyuki is a dry weather road. The road to Isiolo and Samburu districts is unreliable during rain season since some rivers are without bridges. There is no public transport. The people rely mainly on government vehicles and catholic mission vehicles which pass often. From Isiolo to Oldo Nyiro is 100 km. Donkeys are used for ferrying water and for transport when the nomadic Samburu change the grazing area.

3.6 Agriculture

The Government assisted by the Catholic mission has introduced rain fed agriculture and a number of cultivated plots can be seen around the trading centre. Maize and beans are the major crops grown in the area.

3.7 Livestock Husbandry

The area has a good potential in livestock. There is need for improvement of indigenous cattle by teaching the pastoralists modern livestock husbandry.

The centre started as Livestock Marketing Centre. When L.M.D. moved from the area the Samburu tribe started occupying the centre. Although the L.M.D. constructed cattle crushes and dips which are still in good working order they left not much development within the centre.

There is no possibility of Samburu people moving from the centre since they have started to develop the area by building modern shops, permanent houses and the centre is likely to be uplifted to divisional level status in the near future.

Since the livestock get water from Uaso Nyiro and others from the nearby lagga there are no cattle troughs. There are no developed boreholes in the area for livestock because the ground water potential is poor.

4. WATER RESOURCES

4.1 Surfacewater

The Uaso Nyiro passes near this centre at about 7.5 km. It is perennial along this part.

On both sides of the centre there is a lagga which is about 1 km from the centre. There is a substantial flow during the rain season, but otherwise the lagga is dry most of the year. The sandy river bed contains water all year around. The inhabitants dig shallow wells to retrieve water from the sand. Others use roof catchment during rain season.

4.2 Groundwater

The records available from boreholes which have been tried show very low yields and high salinities. According to the local people a borehole was drilled way back in 1971 which had a high yield but it was misused and filled back which led to it been abandoned during the Somali - Ndorobo hostilities. Its casing can be seen on the surface. No proper record of this borehole has been found.

Groundwater prospects in this area are generally poor. Drilling a deep borehole is likely to yield water of unacceptable quality. A shallow borehole of an experimental nature in the valley north of Oldo Nyiro may yield useful information.

Geophysical investigations carried out by WRAP in June 1991 revealed possibility for a borehole with a reasonable yield near the lagga on the western side of the centre. The measurements indicated the possibility of an old buried channel of the lagga. WRAP plans to drill a borehole which is expected to be only 20 metres deep.

5. WATER DEMAND

5.1 Human Population

The population of the centre is estimated at 2,000. A population growth rate of 4% is assumed for the project area.

5.2 Education

The student population including the teachers is taken to be 320 for the purpose of knowing water demand. A higher growth rate as for the population is applied: 6%. The student population also includes a nursery which is within the school compound and all the pupils are boarded.

The demand of the boarding school is significant. Considering the low yield of the sources it may be necessary to construct a separate supply to the school.

5.3 Livestock

It is assumed for the purpose of the preparation of this report that there shall be no increase in livestock and only 10% of this livestock shall depend on this water supply.

5.4 Health

The growth rate of the health centre attendance is taken to increase with the population at a growth rate of 4%. There is a likelihood that a maternity wing will be opened in future, therefore some beds have been taken into account.

5.5 Commerce

The present number of shops is likely to increase during the design period. A growth rate of 2% is applied.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	100	122	360	1,066
	using Communal Water Points	1,900	2,311	3,242	4,266
Education	Primary Schools: Students	320	428	766	1,134
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	240	240	240	240
	Sheep & Goats	600	600	600	600
	Camels	-	-	-	-
	Donkeys	50	50	50	50
	Total Livestock Units	175	175	175	175
Health	No. of Beds	-	4	10	15
	No. of Outpatients	20	24	36	53
Commerce	Shops	5	6	7	9
	Tea rooms	2	2	3	4
	Butcheries	1	1	1	1
	Bars	1	1	1	1
	Hotels (No. of beds)	-	-	10	20
Administration	Number of staff	50	61	90	133

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3 /day			
	1990	1995	2005	2015
Individual Connections	4.0	4.9	14.4	42.7
People using C.W.P's	19.0	23.1	32.4	42.7
Primary School	16.0	21.4	38.3	56.7
Health Centre	5.4	5.5	6.7	7.6
Administration	1.3	1.5	2.3	3.3
Shops	0.5	0.6	0.7	0.9
Butcheries	0.5	0.5	0.5	0.5
Bars / Tea rooms	1.5	1.5	2.0	2.5
Hotels (Low Class)	-	-	0.5	0.8
Livestock	8.8	8.8	8.8	8.8
Total	57.0	67.8	106.6	166.5

6. EXISTING WATER SUPPLY

6.1 Technical Description

Oldo Nyiro has as source three small subsurface dams which have been constructed in the lagga. The subsurface dams increase the volume of the sands held in the riverbed above the bedrock and this in turn increases the amount of water held within the porous sands which is drawn daily for domestic use. This water is clean and good to taste but can very easily be, polluted, unless precautionary measures are taken.

During the rain season livestock drink the overflow water at the foot of the dam. It is evident that water still flows in the sand long after the rains since large amounts are drawn in the dry season from the river bed, more than the sands can hold at once. This water may come from fissures in the slopes. During prolonged drought however, the water diminishes and the wells have to be made deeper and deeper as the yield declines progressively.

There is a protected well dug near one of the sand dams from where water is pumped to the mission, the school and the dispensary. The pump is driven by a generator at the mission. The inhabitants of Oldo Nyiro dig shallow wells in the sandy river bed. Rainfall harvesting is done by some and is an important supplement.

A 100 m^3 storage tank has been constructed by the Ministry of Water Development in the compound of the mission. The mission uses a 200 m^3 rectangular reinforced concrete storage tank.

6.2 Potential and Actually Served Beneficiaries

The proposal to have a water supply for Oldo Nyiro dates back as far as 1972. The project was designed to supply Oldo Nyiro centre with fresh water and to improve the standard of living of the inhabitants. The supply was proposed to supply a population of 2,500 people.

6.3 Functional Analysis

The water supply covers an area of 4 km^2. The operational charts show 8 hours pumping per day. The water is mainly supplied to the catholic mission, the primary school and the dispensary.
The rest of the population fetches water from the lagga using jerry cans.

6.4 Financial Analysis

No revenue is collected since the catholic mission uses the water for its own use and supplies outsiders freely. The mission has got its own pumping set. There is no revenue collection for the time being, but this may be done at a later stage. The community is co-operative and are willing to pay if communal stand posts are established.

6.5 Institutional Analysis

The Ministry of Water Development has not posted any personnel since the water project is not complete. The catholic mission has their own personnel paid by their church. The community still needs additional training to be self sufficient.

The community is willing to contribute in O & M and has contributed towards the construction of the sub-surface dams (labour). They have also contributed towards the building of the primary school.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

The following sources should be considered:

- More and higher (sub-surface) sand dams to increase the storage capacity of the current sand dams
- Boreholes in the river bed to tap good quality groundwater below the river
- The Ewaso Nyiro
- Roof / rock catchments (as additional source)

The mission is planning for a water supply from the Ewaso Nyiro. The distance to the river is at least 7.5 km, but due to the hilly and rocky terrain not easy to cross. The cost of the project is estimated at 20 million Shs.

7.2 Recommended Systems

Sub-surface dam with pumping
In the absence of a perennial surface water and the poor ground water potential near the project area, it is recommended that investigations be carried out into the feasibility of more and/or higher sub-surface dams as sources.
Infiltration pipes could be laid leading to a central collecting point for pumping to the town centre. Hand pumps should also be installed in protected hand dug wells to be constructed beside the sand dams.
Water for livestock may come from the most downstream sand dam in the series to prevent contamination.
A submersible solar driven pump is recommended for this water supply with a stand-by generator.

Borehole with submersible pump
Geophysical investigations indicate the possibility of a borehole in or near the lagga. The quality of the groundwater may be reasonable here, due to infiltration of fresh surface water from the lagga. The sub-surface dams may even have improved this infiltration. A submersible solar driven pump is recommended for this water supply with a stand-by generator.

Roof / rock catchment
To supplement the other sources it is further recommended that appropriate roof catchment systems be installed in all buildings with suitable roofs.
A rock catchment system is also possible at some distance from the town centre. This would also supplement the centre's water supply.

7.3 Operation & Maintenance Procedures

It is expected that the operation of this water supply shall be community based and as such two local water supply attendants should be trained. Their salaries of approximately Ksh. 1,500 should be paid by the community. A suitable payment method should be arrived at by the community with the guidance of local government officers.

8. COST ESTIMATES

8.1 Capital Costs

The presented costs represent a solution using a borehole. Drilling has not been done, therefore it is not yet sure whether this is the most viable supply system. The construction of this water supply should be phased. Since in the construction of the proposed system labour shall be required in large amounts, the local people should participate to reduce costs. Unless there is popular participation the water supply should not be developed.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	100,000
Borehole (20 m. deep)	75,000
Purchase of pump set solar	600,000
Purchase of stand-by generator set	250,000
Construction of dug wells 5 no.	300,000
Installation of handpumps 5 no.	150,000
Construct additional storage (50 m^3)	225,000
Additional Pipework	300,000
Cattle troughs	20,000
Sub-Total	2,020,000
10 % Contingencies	202,000
Total Say	2,250,000

With a population of 2,000, the per capita construction costs will be Ksh. 1,125.

8.2 O & M Costs

The community should employ two local water supply attendants, to be increased to four later as the size of the project increases. Housing of the attendants should be constructed on self-help basis should the need arise. The community should come up with a suitable mode of payment to meet the required O&M costs.

The solar pump is expected to provide 20 m^3/day. The remaining demand should come from the diesel pump.

MONTHLY O&M COSTS

Description	Amount Ksh.
Staff salary	3,000
Fuels for pumping	4,000
General maintenance	3,000
Total	10,000

With the present population the per capita monthly O&M cost would be about Ksh. 5. An annual O&M cost per household (of five members) would be in the range of Ksh. 300.

GARBA TULA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Garba Tula is situated on the Isiolo-Wajir road about 7 km off the main road and 120 km from Isiolo town. It is a divisional headquarters functioning as administrative as well as commercial centre.

About 5,600 people live within a radius of 12 km of Garba Tula centre. The population living in the centre depends on retail trade, hotels or wage employment and the rest on pastoral economy. There have been insignificant agricultural practices at Garba Tula. Most of the inhabitants are Borans.

Some 50,000 TLU find their pasture within Garba Tula Division getting water from pans and wells in the lagga, which have water in most of the times.

1.2 Social Economic Stratification

The majority of the people are solely dependent on livestock for their income. A minority depend on trade or wage labour. A small group of people, many from outside the District is employed by the government.

A recent study among the population of Manyatta Dhemo showed that large sums of money are spent by a large part of the population on miraa (information obtained from the Mission).

The wealth ranking study done by ILDP shows from a sample of the population of Manyatta Matagari that all households have less than 5 TLU. This number of livestock is considered below the minimum living standard for nomadic subsistence, which also explains why these households are living at Garba Tula centre.

1.3 Scope of the Report

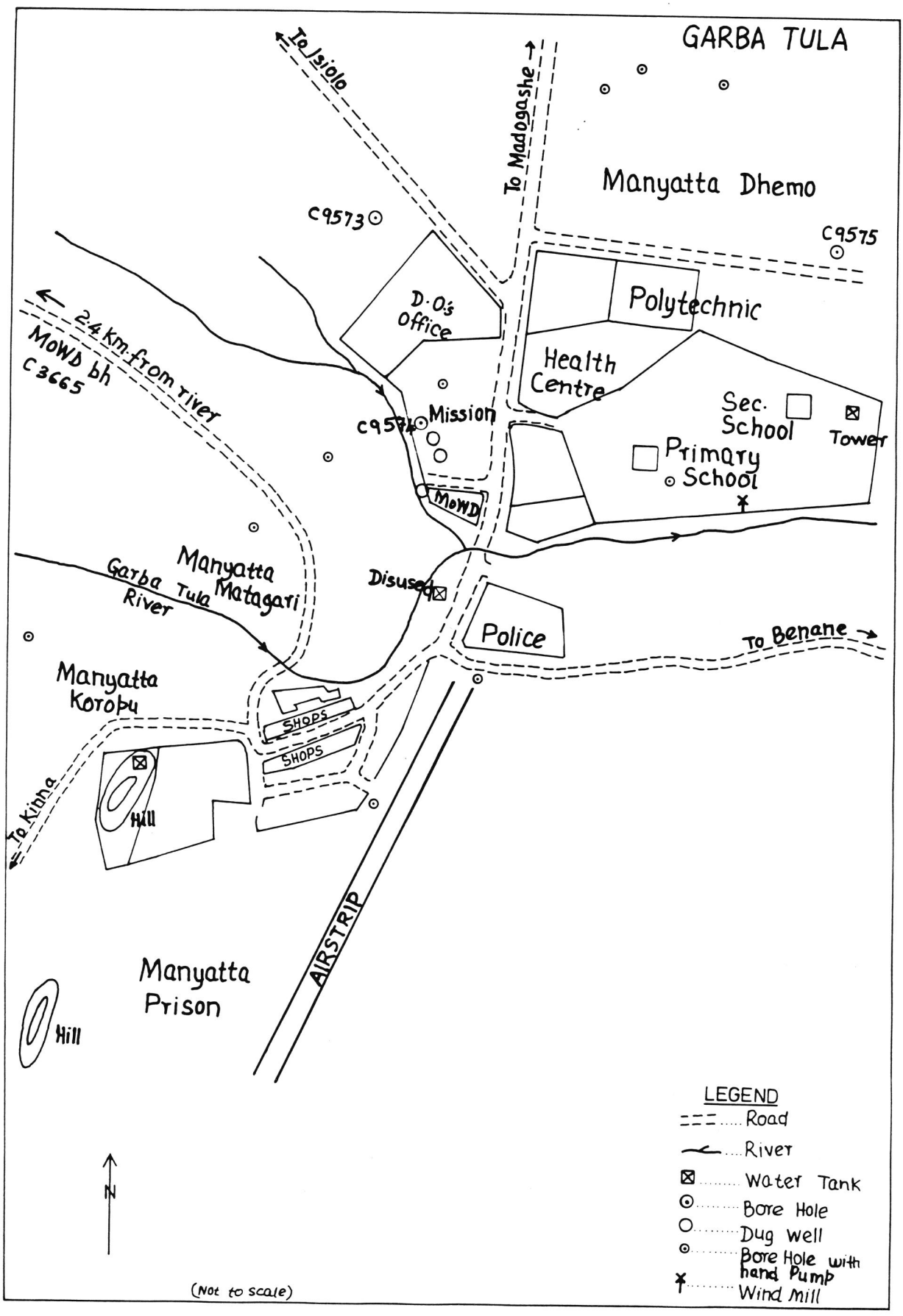
The report covers the supply of water to Garba Tula rural trading centre and institutions. The inhabitants of the project area being composed of a population which currently depends entirely on the Garba Tula borehole and the wells for their water supply needs.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located 7 km off the Isiolo-Wajir dry weather road and 120 km from Isiolo town. It is situated on grid reference 0° 32' N - 38° 31' E.

It is in Garba Tula Sub-location of Garba Tula Location of Garba Tula Division 60 km south of the Ewaso Nyiro river.



Sketch of the Project Area

2.2 Topography

The area is flat located on a plain grassland with stone outcrops south-east of the town. The Galana Gof lagga passes through the town dividing it into two. The shops and residential areas are on the south side of the lagga. The majority of the institutions and one residential area (Manyatta Dhemo) is on the north side of the lagga.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 300 - 350 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 20 - 30°C.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

Vegetation in this area is mainly dry thorn bushland dominated by acacia trees. The grass cover depends on the density of the woody vegetation but usually contains many annual species and a few perennial.

Soils are composed mainly of sandy soil but in parts of the Location along the dry river beds there are black cotton soils. The sandy soil does not support crop production because water drains easily. Soil erosion is a menace and the top fertile layer of the area is easily washed away.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

A chief and an assistant chief are stationed at Garba Tula trading centre. The other public offices include a police post, an administration police post, a health centre, MoWD, secondary school, village polytechnic and primary schools. There are also a social development officer, public health service and environmental officer stationed here. Another important establishment is the catholic mission.

3.2 Education

Garba Tula location has five primary schools with a total enrolment of 1,166, one secondary school with total enrolment of 262, a village polytechnic and a children's home.

3.3 Health

There is a well equipped health centre in the project area. The annual outpatient attendance is 14,315 people. The annual attendance is high as the town is a transit town for people going to either Kinna or Wajir.
The health centre has 12 beds and a maternity wing. The common diseases are malaria, diarrhoea, tuberculosis, S.T.D., anaemia in children, dental problems due to miraa, skin diseases due to unhygienic conditions in the manyatta areas.

3.4 Commerce

The Garba Tula trading centre is the only trading centre in the sub-location and serves the transit traffic to Wajir and Kinna apart from the people in the project area. There are 30 shops, 5 butcheries, 7 tea shops, 2 bars and 2 lodgings with 7 and 5 beds respectively. There is also a slaughterhouse, but no open air market.

3.5 Transport

There is no public transport except for occasional government vehicles.

3.6 Agriculture

Erratic rainfall and sandy soils which characterise most of the area, limit crop production and most of the inhabitants are pastoralists.

3.7 Livestock Husbandry

There is only one cattle dip in the Location but its utilization is rather low due to lack of water. There are two crushes for general cleaning of livestock. The priority should be to build more crushes rather than dips as their utilization is quite necessary.
There is a veterinary officer within the location for treating animals when need arises.

4. WATER RESOURCES

4.1 Groundwater

Garba Tula centre falls under zone 1b of the geologic formation. This zone is comprised of old land surface deposits and sediments interbedded between the lava flows or outcropping limestones overlying the metamorphic rocks. At Garba Tula lava deposits are not present.

There are many boreholes at Garba Tula, which allows a good assessment of the hydrogeological conditions. Water is found in highly cavernous limestone and in the underlying fractured Basement. The boreholes drilled by WRAP have a yield of more than 15 m^3/h (which was the maximum discharge of the test pump).

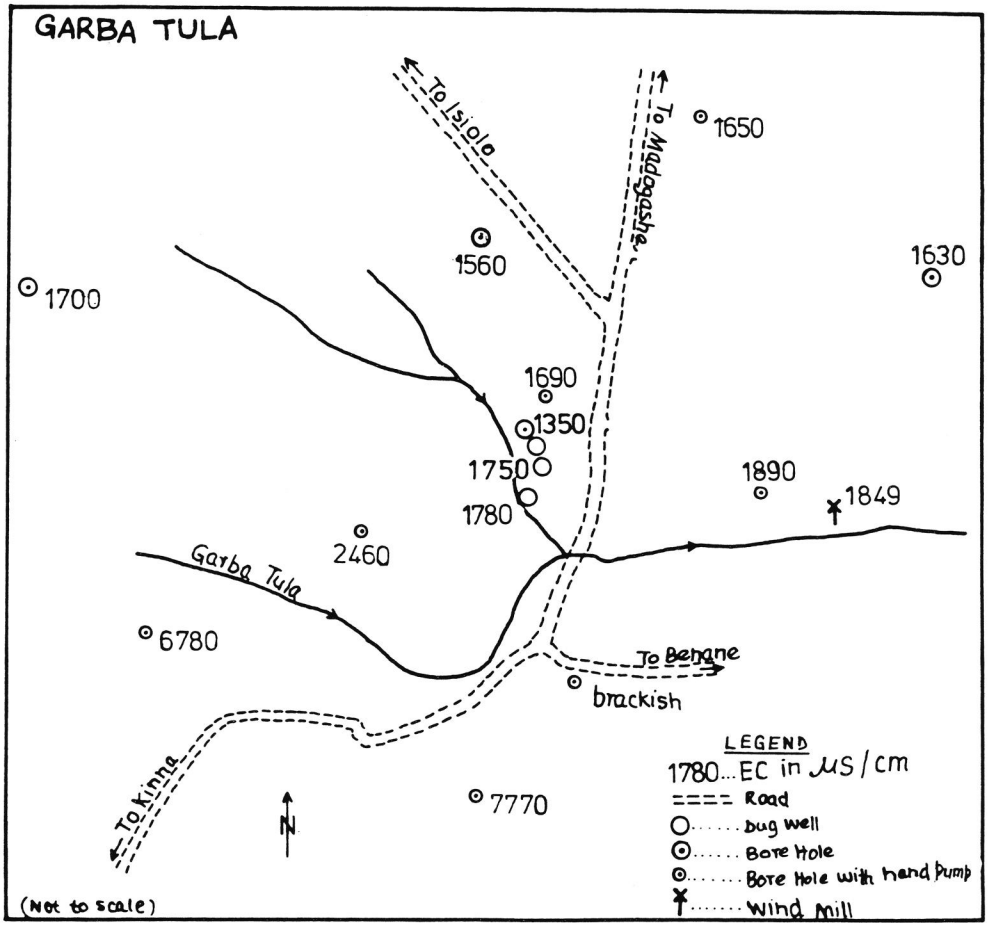
The EC of most of the wells and boreholes was checked and is indicated on the map below. The salinity of the groundwater is acceptable north of the Galana Gof. However the salinity is too high south of the river.
Chemical analysis data is available only for some wells. This data indicates that the groundwater is hard. The fluoride level is okay.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HCO3 (mg/l)	F (mg/l)	Remarks
SA 10	34.4	13.7	12.5	6.8	-	-	-	Not operated since 1987
SA 18	19.5	12.5	11.9	9.1	2.1	-	-	Filled with stones
SA 32	20.7	13.7	12.8	13.6	-	-	-	Casing destroyed
C3665	18.3	11.3	8.7	11.2	2.1	-	-	MoWD Supply Garba Tula
C4423	11.4	7	6.8	7.2	-	-	-	MoWD Range Water Camp
C9573	25	8	8.1	>15	1.56	-	-	Drilled by WRAP
C9574	20	8.5	6.4	>15	1.35	-	-	Drilled by WRAP
C9575	18	12	7	>15	1.63	-	-	Drilled by WRAP
W2	-				1.85	356	0.4	High School well w. windmill
W3	-				1.9	804	0.4	MoWD well on bank of river
W4	-				1.9	798	0.4	Cath. mission well

4.2 Surfacewater

The Galana Gof lagga flows only during the wet season.

Electric Conductivity of the Groundwater



5. WATER DEMAND

5.1 Human Population

The population to be taken into account for the demand calculation is 5600. Though the population in and near the centre is estimated at only 3,500. A population growth rate of 4% is assumed for the project area until 1995. After 1995 the growth rate is assumed to rise to 5%, taking into account the effect of the proposed improvement of the Maua-Kinna road.

5.2 Education

The student population including teachers is 1,659. It is assumed that the institutional demand will increase at a higher rate than the population of 6% and maximum 40% of the total population will be attending school in future.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. The number of livestock in Garba Tula Location is estimated at 15,000 TLU. An estimated 10% of this livestock shall be taken into account to estimate the required capacity of the Garba Tula water supply.

5.4 Health

The growth rate of the health centre attendance is taken to increase with the population. A growth rate of 4% is taken.

5.5 Commerce

The present number of shops and other utilities are taken to increase during the design period by 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	280	340	1,109	3,615
	using Communal Water Points	5,320	6,472	9,988	14,461
Education	Primary Schools: Students	1,207	1,615	2,892	4,658
	Other Schools : Students	452	605	1,084	1,765
Livestock	Indigenous Cattle	1,300	1,300	1,300	1,300
	Sheep	1,500	1,500	1,500	1,500
	Goats	2,000	2,000	2,000	2,000
	Camels	1,300	1,300	1,300	1,300
	Donkeys	500	500	500	500
	Total Livestock Units	1,516	1,516	1,516	1,516
Health	No. of Beds	12	15	22	36
	No. of Outpatients	40	49	73	119
Commerce	Shops	30	33	40	49
	Tea rooms	7	8	10	12
	Butcheries	6	7	8	9
	Bars	2	2	3	5
	Hotels (No. of beds)	12	15	22	36
Administration	Number of staff	150	182	269	438

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	11.2	13.6	44.4	144.6
People using C.W.P's	53.2	64.7	99.9	144.6
Primary School	6.8	9.0	16.2	26.4
Boarding School	15.3	20.4	36.6	59.6
Health Centre	7.0	7.5	8.7	16.0
Administration	3.8	4.6	6.7	11.0
Shops	3.0	3.3	4.0	4.9
Butcheries	3.0	3.5	4.0	4.5
Bars / Tea rooms	4.5	5.0	6.5	8.5
Hotels (Low Class)	0.6	0.8	1.1	1.8
Livestock	75.8	75.8	75.8	75.8
Total	184.2	208.2	303.8	497.6

6. EXISTING WATER SUPPLY

6.1 Technical Description

Garba Tula rural water supply has a borehole and a well source both equipped with a diesel pump. The borehole pump is rated at 7.5 m^3/hr with a prime mover of 9 HP. The well source is not currently operating due to low yield and also the pump broke down. An average of 70 m^3/day are produced. There is also a 50 m^3 storage tank, a 3,000 m, 75 mm ϕ rising main and 2,000 m, 38 mm ϕ and 2,000 m, 25 mm ϕ distribution lines. No treatment is undertaken.

6.2 Potential and Actually Served Beneficiaries

During its commissioning the project was designed to serve a population of less than 2,000 people but according to the DDO's 1988 projection the project is currently serving a population of 5,600 people. There are 73 metered consumers serving about 500 households and 58 non-metered serving the rest of the households. The secondary school has increased in population and the water from the well is not enough so it has to be supplemented by the existing borehole.

6.3 Livestock Use

About 30% of the water produced in this water supply is used by livestock. This is mostly during the dry season because during the rainy season the lagga has water.

6.4 Functional Analysis

This water supply covers an area of 35 km^2 and it's performance and reliability are poor, due to irregular diesel supply and breakdowns. The operation seems to have improved however, since recently local operators were employed.

6.5 Financial Analysis

The revenue earned in the 1988/89 financial year was Ksh. 27,426 against an expenditure of Ksh. 73,426. Staff cost was Ksh. 55,080, while Ksh. 18,346 was used for fuel. Analysis of the monthly operation and maintenance reports indicates that 97% of the water produced was sold while the balance 3% was unaccounted for.

6.6 Institutional Analysis

There are four pump attendants and one water supply operator grade II, all employed by the Ministry of Water Development. The secondary school has dug its own well and have equipped it with a pumping set. The Ministry of Water Development through the assistance of RDF is doing rehabilitation of the distribution lines.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Boreholes: The groundwater potential at Garba Tula seems sufficient for the supply of the town. The existing borehole is pumped with a submersible pump driven by a generator. The new boreholes could also be equipped with pumps driven by a generator, but it is advisable to consider also solar driven pumps. It is possible to install two pumps in one borehole, one driven by a generator and one driven by a solar system. It is not possible to use the same pump for both a solar system and for a generator, because the solar system requires a special type of pump, which can not be driven by a generator.

Infiltration galleries: These could be laid across the lagga to improve the production of wells constructed in the banks of the lagga.

7.2 Recommended Systems

The existing system should continue to be utilized and in addition the new boreholes drilled by WRAP near the town can be equipped and connected to the distribution system. The crossing of the pipeline under the lagga should be made more secure. An additional storage tank may be required north of the river to serve the institutions.

Solar powered pumps could greatly reduce the operating costs. These are recommended to be installed in the new boreholes. One of these boreholes will have been equipped already in 1991 with a submersible pump driven by a generator.

The solar pumps are expected to yield 30 m^3/day each. The remaining 240 m^3/day will be supplied by the diesel pumps.

The existing handpumps on small diameter boreholes should continue to be used. Better aprons and proper drainage should be constructed around the handpumps.

The groundwater bearing layers are shallow and not protected by an impervious layer on top. In fact the limestone has a very high permeability. Therefore stringent measures are required around the boreholes to avoid contamination of the ground-water.

Livestock are expected also to continue using the water from the lagga.

8. COST ESTIMATES

8.1 Capital Costs

The estimate is made on the understanding that the existing facilities including storage and reticulation shall be utilized. It is also assumed that one of the new boreholes will have been equipped with a submersible pump driven by a generator in 1991.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	50,000
Install pump sets solar (2 no.)	1,200,000
Construct additional storage (150 m^3)	675,000
Additional Pipework (1 km)	300,000
Sub-Total	2,225,000
10 % Contingencies	222,500
Total	2,500,000

With a population of 5,600, the per capita construction costs will be about Ksh. 450.

8.2 O & M Costs

Five water supply attendants of various training and experience have been found to be necessary. The attendants should include a mechanic, a pipe fitter and an electrician.

It is assumed that the existing diesel powered system shall be used in combination with the solar system.

MONTHLY O&M COSTS

Description	Amount Ksh.
Staff salary	7,500
Fuels for pumping 16 hours per day	9,000
General maintenance	5,000
Total	21,500

With the present population the per capita monthly O&M cost would be about Ksh. 4. An annual O&M cost per household (of five members) would be in the range of Ksh. 230, which should be affordable for most of the community members.

More emphasis should be put on the revenue collection. The District Water Board should come up with a suitable solution to meet the cost recovery criterion.

DUSE / BIBI

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT
ISIOLO

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1. INTRODUCTION

1.1 Background

Duse / Bibi is a settlement area of Kinna Location. Duse once used to be a flourishing centre due to mining activities nearby as well as prominent grazing land with a lot of grass. The mine has since closed. Mainly due to security problems the population moved to Kinna and deserted the centre. However current plans to reactivate the centre have included Duse / Bibi in the pre-feasibility studies.

Some 4,000 TLU around Bibi / Duse find their pasture within Kinna and Bibi sub-location getting water from Kinna, Moliti wells, Duse pan and natural depressions. Most of the inhabitants are Borans.

This water supply being along the livestock route coming from Wajir and Garissa District when completed, will serve a fairly high potential area.

1.2 Social Economic Stratification

The wealthiest households hold 40% of the livestock, the poorest group making up over quarter of all households hold only 3% of livestock and the rest wealth group taking the remaining percentage.[1]

Livestock forms the basis of local wealth and it can be said to be evenly distributed. Most of the animals migrated to the side of Bibi where the Moliti wells are found.

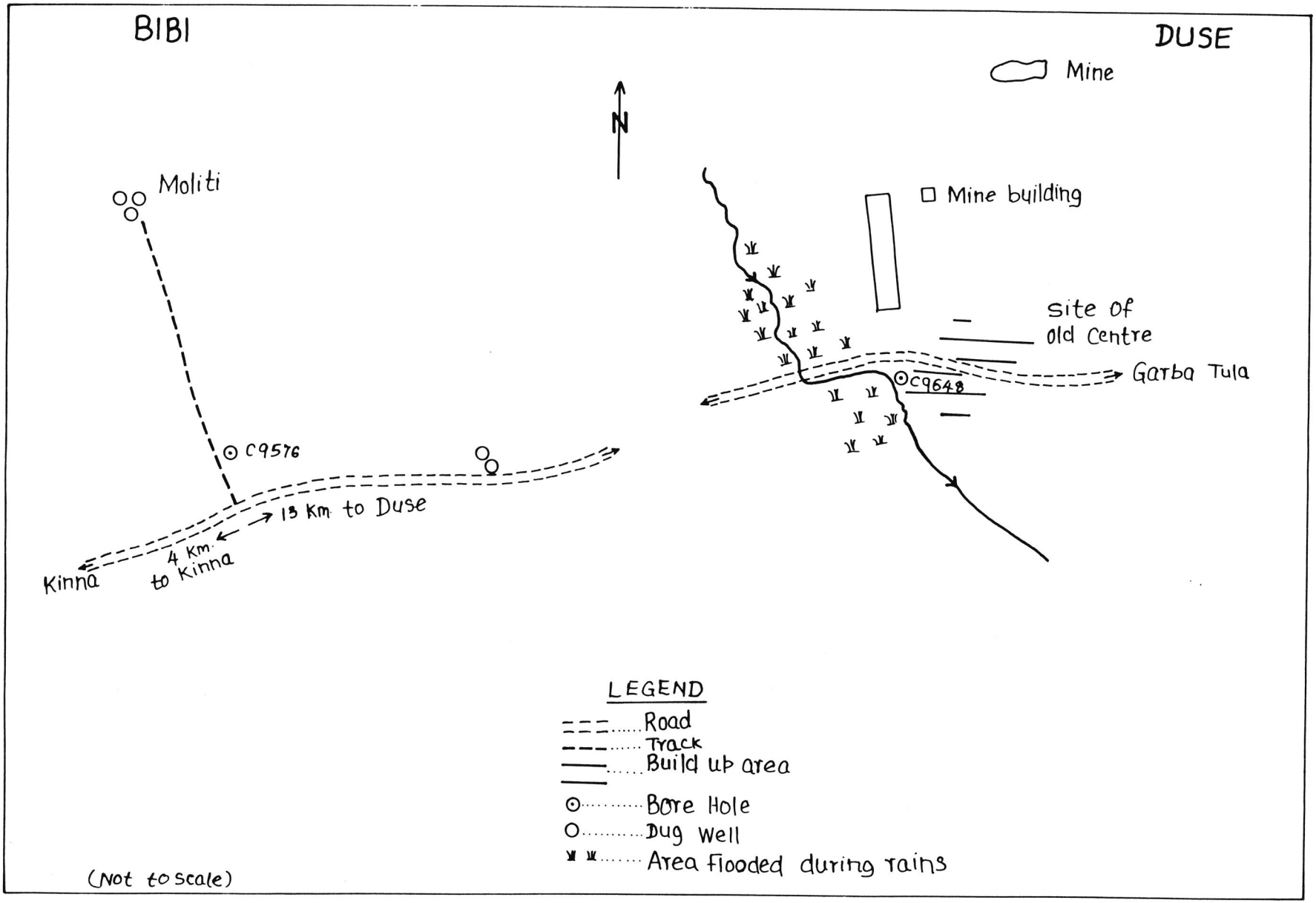
The local Women groups have expressed their wish to start irrigated cultivation around the Moliti wells if output is improved.

1.3 Scope of the Report

The report covers the domestic water supply to Bibi / Duse and includes a water resource assessment, a demand estimate, a description of the possible systems and a tentative cost estimate.

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[1] Source: Isiolo Livestock Development Project



Sketch of the Project Area

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located near the Maua - Garbatulla dry weather road. Duse is located about 25 km South-West of Garbatulla town by road and 20 km North-East of Kinna market. Bibi is 6 km North-East of Kinna market, being near the border of Isiolo and Meru Districts. Duse is on latitude 0° 24' 40" N and longitude 38° 14' 50"E.
Both are in Duse sub-location of Kinna Location of Garbatulla Division East of the Nyambeni Hills.

2.2 Topography

The project area is located on a plain grassland with medium to thick bushes and is part of lower Nyambeni slopes.

The plain is tilted toward the South - East direction and is dissected by seasonal streams in the same direction. The area lies at 600 m above the mean sea level.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 500-1000 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 18 - 30°C. There is a very high annual potential evaporation of about 2000 mm and since evaporation from soil surface and vegetative cover exceeds annual precipitation, the area is dry.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

There are two types of vegetation ranging from medium to thick bushes. The trees are mainly scattered thorny acacias. The grass is mainly short in height due to constant grazing by the numerous livestock.

The soils found in these area vary from black cotton to brown loam depending on their parent material.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

There is no established administration post around these areas and no government services. The chief of Bibi / Duse Sub-location who is currently stationed at Kinna is ready to move with his team as soon as the water supply is improved.

3.2 Education

There are no education institutions here since the community is predominantly mobile pastoralists. It is expected that with the improvement of the water supply education facilities would be erected.

3.3 Health

Health facilities do not exist in the project area. People go for medical attention to Kinna. With availability of water there would be need to cater for this aspect.

3.4 Commerce

There does not exist a trading centre and this forces people to travel up to Kinna for their shopping. There used to be mining activities in the area but the mine was closed.

3.5 Transport

The project area is on the Maua - Garbatulla road. There exists no public transport except for occasional government vehicles going to either Maua or Garbatulla. Transport is mainly by donkeys and camels for those who can afford. The rest carry their loads on their backs.

3.6 Agriculture

There is no agricultural activity in the area and most of the inhabitants are pastoralists Women groups have expressed their wish of starting irrigated agriculture incase the output of Moliti wells is improved.

3.7 Livestock Husbandry

There are no veterinary services in these areas. There however exists a cattle dip, a cattle crush and a veterinary laboratory which is not equipped at Kinna.

4. WATER RESOURCES

4.1 Surfacewater

There are no permanent streams in this area apart from those rising at the foot of Nyambeni range, which pass near Kinna in south-eastern direction to join Bisanadi (tributary of river Tana). It is not feasible to tap these sources due to the distance involved (about 30 km) and terrain to be crossed.

The only surface water source is the Duse pan in this area. However, this is not a reliable source during the dry period since the pan dries up regularly.

4.2 Groundwater

Bibi and Duse fall under zone 1b of the geologic formation. This zone is comprised of old land surface deposits and sediments interbedded between the lava flows or outcropping limestones overlying the metamorphic rocks. However at Duse lava deposits are not present.

At Bibi the borehole C 9577 struck water in the weathered Basement. The yield and the water quality are good.

At Duse an extensive geophysical survey was carried out at the site of the old centre. A borehole was drilled but as expected did not yield water of any significant quantity. The little water struck was even saline. Local people confirmed that dug wells which were tried in the past also yielded saline water. The results show that there are no prospects for groundwater at Duse.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC ($\mu S/cm$)	Remarks
C9576	18	16	13	0	4,450	Drilled by WRAP, abandoned
C9577	51.5	40	29	5	785	Drilled by WRAP

The Moliti wells are located about 3 km. from the road north of Bibi, along a dry river bed. There are six wells, which are thought to derive water from the volcanic rock. The depth of the wells is 10.5 m., which is shallow probably due to a fault in the underlying rock. They are reported to have been dug in 1962 and do not dry up. The EC of the water is 915 μS/cm. The wells serve both livestock and population.

5. WATER DEMAND

5.1 Human Population

A population growth rate of 4% is assumed for the project area. Water being made available; a population of 1,800 is assumed to settle here out of which 360 will settle in the trading centre.

5.2 Education

Currently there are no institutions but with pastoralists settling, a primary school is expected to be established. An initial population of 200 is assumed for the purposes of this study.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. An estimated 10% of this livestock shall depend on the Duse/Bibi water supply.

5.4 Health

For the purpose of the demand calculation a health centre is assumed. The growth rate of the health centre attendance is taken to increase with the population. A growth rate of 4% is taken.

5.5 Commerce

At present there are no shops and other utilities. Future numbers were assumed as hereunder.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	90	109	324	959
	using Communal Water Points	1,710	2,080	2,917	3,839
Education	Primary Schools: Students	200	268	480	711
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	1,000	1,000	1,000	1,000
	Sheep & Goats	1,400	1,400	1,400	1,400
	Camels	20	20	20	20
	Donkeys	10	10	10	10
	Total Livestock Units	440	440	440	440
Health	No. of Beds	-	-	-	-
	No. of Outpatients	10	12	18	27
Commerce	Shops	2	2	2	2
	Tea rooms	2	2	2	3
	Butcheries	1	1	1	1
	Bars	1	1	2	2
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	3.6	4.4	13.0	38.4
People using C.W.P's	17.1	20.8	29.2	38.4
Primary School	1.0	1.3	2.4	3.6
Health Centre	5.2	5.2	5.4	5.5
Administration	0.1	0.2	0.2	0.3
Shops	0.2	0.2	0.2	0.2
Butcheries	0.5	0.5	0.5	0.5
Bars / Tea rooms	1.5	1.5	2.0	2.5
Hotels (Low Class)	-	-	-	-
Livestock	22.0	22.0	22.0	22.0
Total	51.2	56.1	74.8	111.4

6. EXISTING WATER SUPPLY

6.1 Technical Description

There is no conventional water supply in this area, and the water sources used by people and their livestock currently are:

- Moliti wells
- Duse Pan
- Natural Depressions

6.2 Potential and Actually Served Beneficiaries

The Moliti wells were at first being used by a small group of pastoralists who were well organised. Presently different groups use them at times with problems and tensions as water is not enough.

6.3 Livestock Use

Livestock are not allowed to get water from the Moliti wells. They get their water from Duse pan.

6.4 Functional Analysis

Since this water supplies are not protected chances of pollution are many.

6.5 Financial Analysis

Only labour is needed when digging the wells. The rich among the pastoralists employ others to dig for them.

6.6 Institutional Analysis

These wells are well managed by the inhabitants through the Manyatta headman. Each well is associated with specific users although the digging of a well is a communal affair. Offenders are punished in accordance with Boran customary law.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

The following alternative sources exists at Bibi / Duse:

- Improvement of the existing wells at Moliti
- Borehole at Bibi
- Pans.

The investigations by the geophysical team and the drilling by WRAP at the old site of Duse centre have indicated that boreholes are not an option here. The quantity of water is insufficient and also the quality is unsuitable.

7.2 Alternative Technologies

- Instal a diesel pumping set.
- Install wind pump
- Use solar pump
- Use hand pumps

7.3 Recommended Systems

The recommended system must include the protection and equipping of the existing Moliti wells with hand pumps. The borehole which was recently drilled at Bibi by WRAP should also be equipped. A solar pumping set with a standby diesel generating set would be very sustainable. A storage tank of suitable size should also be incorporated in the design.

7.4 Operation & Maintenance Procedures

It is expected that the recommended system shall be operated and maintained by the community with minimum problems. Two water supply attendants are adequate for the manning of the proposed water supply. The operation and maintenance cost is expected to be in the range of Ksh. 8,000 per month.

8. COST ESTIMATES

8.1 Capital Costs

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	50,000
Install pumping set Solar	600,000
Stand-by Diesel	500,000
Construct storage tank (50 m^3)	225,000
Pipework	150,000
Protection and equipping of Moliti Wells	75,000
Sub-Total	1,600,000
10 % Contingencies	160,000
Total	1,760,000

With a population of 1,800, the per capita construction costs will be Ksh. 1,000.

8.2 O & M Costs

The proposed water supply should provide a primary level of service. The revenue collection and appropriate tariff should be made by the community itself.

The solar pump is estimated to provide 24 m^3/day, the remaining demand will be provided by the diesel pump.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendants 2 no.	3,000
Fuel for pump 10 hrs. per day	2,000
General maintenance	3,000
Total	8,000

With an expected population of 1,800 the per capita monthly O&M cost would be about Ksh. 4. An annual O&M cost per household (of five members) would be in the range of Ksh. 270, which should be affordable for most of the community members.

KINNA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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8. COST ESTIMATE

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1. INTRODUCTION

1.1 Background

Kinna is situated on the Garbatula - Meru road and serves as the outlet for livestock from North-Eastern Province to Meru and other parts of the country.

About 7,000 people live within a radius of 20 sq km of Kinna Trading centre. Most of the inhabitants are Borans. Some 17,000 TLU find their pasture within Kinna location getting water from Kinna stream and Bisanadi river. Both rivers are spring fed from the Nyambene hills.

The population of the centre (1988) was estimated at 2,500 in the 1989-1993 District Development Plan.

1.2 Social Economic Stratification

The majority of the trading centre residents have no or few livestock and depend for their livelihood on farming in the Kinna irrigation scheme. Others depend on retail trade, hotels, wage employment, miraa selling and livestock marketing. The majority of the population in the sub-location live on pastoral economy.

1.3 Scope of the Report

This report covers the supply of water to Kinna Trading centre only. The inhabitants of the project area are composed of a population which depends entirely on the Kinna and Bisanadi rivers which are fed by a spring.

It is important to note that no livestock water demand is included since the Bisanadi and Kinna stream are within the project area.

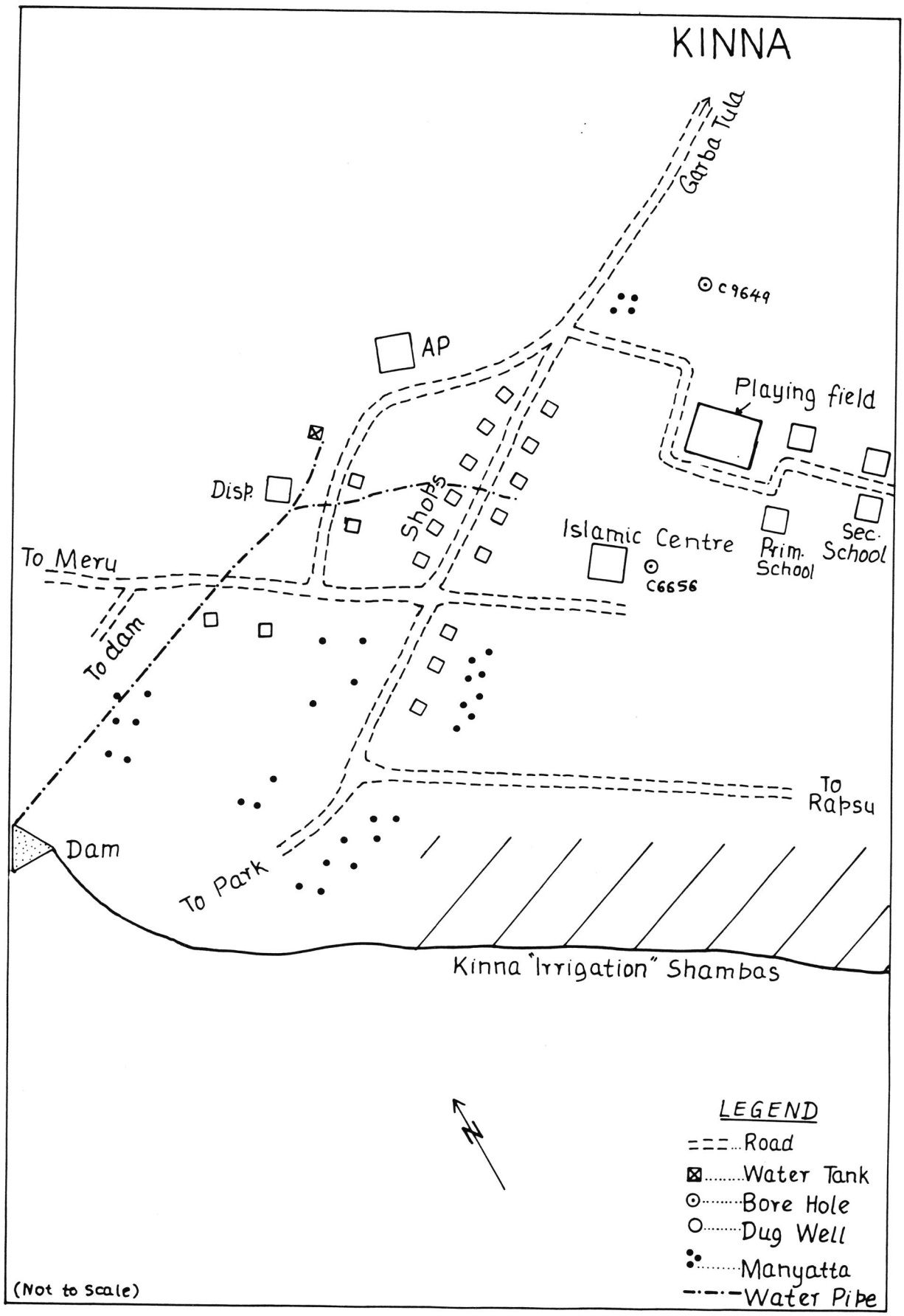
2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located along a dry weather road 25 km from Garba Tula Town on the Garba Tula-Meru road (145 km from Isiolo). It is situated on latitudes 0° 18'N and longitude - 38° 12'E. to the South East of the Nyambene Hills. It is in Kinna Sub-location of Kinna Location of Garba Tula Division.

2.2 Topography

Kinna is located east of the Nyambene Range and the area slopes gently in South-Eastern direction. The elevation is about 690 m above sea level.



Sketch of the Project Area

2.3 Climate

The project area falls under the arid climatic zone with an average annual rainfall of 450 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean maximum temperatures range between 29°C - 32.5°C.

2.4 Soils and Vegetation

The ecological land unit is described as lava flow and ash slopes. Limestone is found on the surface in the northern part of the area near the spring. Vegetation consists of (Acacia thomasili - Chrysopogon archer) with physiognomic type of wooded grassland.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

Kinna trading centre has a chief who is in charge of Kinna Location. The other public offices include an administration police post, a dispensary (M.O.H), two primary schools and one secondary school. In addition to this, there are county council staff (3), social development officers, a range management officer and veterinary technical assistant. The assistant Chief of Bibi/Duse Sub-location currently resides here.

3.2 Education

There are 2 Primary Schools with a population of over 800 students and 25 teachers. Kinna Boarding Secondary School is the only High School in the area with a population of 80 students and 7 Teacher's. The Danish International Development Authority has been approached for assistance in upgrading the Secondary School's water supply.

3.3 Health

There exists a dispensary in the project area. The average daily outpatient attendance is 25 people. The most common disease is Bilharzia.

3.4 Commerce

The Kinna trading centre is the only trading centre in Kinna sub-location and serves the people in the project area. There are 20 shops, 5 tea shops and one butchery.

Kinna trading centre also serves as the route of livestock from North-Eastern province and as such is the second largest livestock market in the District.

3.5 Transport

Kinna trading centre is situated along Garba Tula-Meru road. There exists no proper public transport except a few Toyota's and Landrovers which operate between Garba Tula and Maua in Meru District, and Government vehicles. The DDC have recommended the improvement of the Meru-Kinna road which is expected to improve livestock marketing.

3.6 Agriculture

There is Kinna irrigation scheme using Kinna river and hence most of the inhabitants are agro-pastoralists. The following products are grown: sorghum, onions, bananas, maize and green grains - all are marketed at Kinna. 120 hectare is under irrigation.

3.7 Livestock Infrastructure

Veterinary infrastructures existing in Kinna trading centre are:

(i) Cattle Dip
(ii) Cattle Crush
(iii) A new veterinary laboratory built by ILDP but not equipped.

4. WATER RESOURCES

4.1 Groundwater

Kinna Centre falls under zone 1b of the geologic formation. This zone is composed of old land surface deposits and sediments interbedded between the lava flows or outcropping limestones overlying the metamorphic rocks.

Data from the boreholes drilled at the centre indicates that the groundwater rest level is between 10-20 m. below the surface. The yield of the boreholes is reported at 3.6 and 12 m^3/hr. The quality of the water is acceptable.

The borehole drilled by WRAP was installed with casing and screen, but only until 19 m. depth due to caving of the borehole. The yield of the borehole is adequate, but could have been larger if also the deeper aquifer had been screened.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (μS/cm)	Remarks
C6656	120	20	22	12	1,120	Located in the centre with submers. pump
C7755	-	10	-	7	-	Located in Meru Distr. at the police st.
C7769	-	46	15.8	1.4	-	Located in Meru Distr. at the shops
C9578	54	12	10.7	7.6	985	Drilled by WRAP

4.2 Surfacewater

The spring at Kinna (Kithima ya Magombo, Kanchoradi) emerges from limestone and has a discharge of 36 m^3/h. The water quality is good: EC = 0.814 μS/cm, HCO3 = 192 mg/l, F = 0 mg/l.

There is a dam constructed below the spring but due to the siltation of the dam, this supply is not adequate. It is further understood that the water in the dam is infected with bilharzia.

5. WATER DEMAND

5.1 Human Population

The population used for the purpose of the demand calculation was estimated at 2,500. A population growth rate of 4% is assumed for the project area.

5.2 Education

The student population including teachers is taken to be 950 for the purpose of forecasting water demand. It is assumed that the institutional demand will increase at a higher rate as the growth in population: 6%.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. The livestock will use existing surface water sources and is therefore not included in the demand calculation.

5.4 Health

There is one dispensary at Kinna with a daily outpatient attendance of 25.

5.5 Commerce

The present number of shops and other utilities are assumed to increase during the design period at a rate of 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	125	152	450	1,333
	using Communal Water Points	2,375	2,889	4,052	5,332
Education	Primary Schools: Students	833	1,064	1,574	2,330
	Other Schools : Students	120	153	227	336
Livestock	Indigenous Cattle	-	-	-	-
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	-	-	-	-
Health	No. of Beds	-	-	-	-
	No. of Outpatients	25	30	44	65
Commerce	Shops	20	22	27	33
	Tea rooms	5	6	6	8
	Butcheries	1	1	1	1
	Bars	-	-	2	2
	Hotels (No. of beds)	-	-	10	15
Administration	Number of staff	10	12	18	27

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	5.0	6.1	18.0	53.3
People using C.W.P's	23.8	28.9	40.5	53.3
Primary School	4.4	5.6	8.3	12.2
Boarding Secondary Sch.	4.0	5.1	7.6	11.2
Health Centre	5.5	5.6	5.9	6.3
Administration	0.3	0.3	0.5	0.7
Shops	2.0	2.2	2.7	3.3
Butcheries	0.5	0.5	0.5	0.5
Bars / Tea rooms	2.5	2.5	4.0	5.0
Hotels (Low Class)	-	-	0.5	0.8
Livestock	-	-	-	-
Total	48.0	56.8	88.4	146.6

The ultimate demand is 146.6 m^3/day

6. EXISTING WATER SUPPLY

6.1 Technical Description

Kinna Water Supply has a spring source with a concrete weir. The intake weir is L shaped and measures about 30 m x 435 m. It has a depth of 2 meters. The off-take is 50 mm ϕ G.I pipe and is later reduced to 32 mm ϕ. The supply consist of Diesel pumping unit which pumps water from the weir to a 50 m^3 storage tank, from where the water is gravitated to the consumers. The pumping set is currently out of order.

6.2 Potential and Actually Served Beneficiaries

During its commissioning in 1973 by the public health authority the project was designed to serve 2,000 people but currently it is serving a larger population. There are no metered consumers and the town residents fetch their water from the dam, from the Kinna River and from the borehole at the islamic centre.

6.3 Livestock Use

Livestock do not use this water supply since the Kinna stream is within the Town.

6.4 Functional Analysis

This water supply covers an area of 4 km^2 and it's performance and reliability are not good. The system needs a complete overhaul and a new pumping set.
From interviews with the local people it was learnt that previously on average the supply operates for 15 days per month due to lack of diesel or pumping set breakdown.

6.5 Financial Analysis

No revenue is earned by the Isiolo county council and details of expenditure per year could not be given. The production of water is also not known.

6.6 Institutional Analysis

The Kinna water supply was started in 1973 by the local health authority. There is only one pump attendant employed by the local authority. The County Council has expressed its wish to assist in equipping and operating a borehole should one be drilled. In fact the local authority has reserved some funds for equipping a borehole, which has been necessitated by the poor quality of the existing water supply which is infested with BILHARZIA.
The County Council of Isiolo, currently the water undertakers of Kinna, has been urging the MoWD to take over the running of Kinna water supply since 1980's but the MoWD has not been willing to take over the water supply.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

1. Improvement of the existing spring by;

   (i) Weir to be redesigned and constructed to eliminate chances of breeding snails which are the carriers of Bilharzia.

   (ii) Constructing an intake on the upstream of the spring where pollution is less.

2. Surface water intake from Bisanadi River which is four kilometres away. This alternative is however expensive because it shall require treatment and pumping.

3. Borehole - This is a feasible alternative since it would require no treatment and the ground water potential is also good. There is already one existing borehole drilled by WRAP.

7.2 Alternative Technologies

1. Solar - Installing a solar powered pump which can meet the total water demand since there is enough sunshine in the project area.

2. Windmill - or installing a wind powered pump.

3. Diesel Engine - Because electricity is not available in the project area a diesel pumping set is a practical alternative.

7.3 Recommended Systems

The most sustainable system would be the one which would not use any external power. The second best would be a system that uses locally available and cheap power source. Consideration of the quantity and quality of the water must also be taken into account. The cost of implementation and that of operation and maintenance is also a limiting factor. In this connection therefore the following systems are recommended.

1. **Spring protection with gravity distribution.**
   This system is strongly recommended because although the source is subject to pollution, with more community awareness and education the pollution can be contained. More study is recommended to be done on the possible ways of protecting this spring because in case of breakdown the town residents will return to this traditional source. A suitable protection is suggested by burying the whole spring source with graded gravels and infiltration pipes with suitable outlets. The water may be pumped to the centre with a solar system. The supply is estimated at 62 m^3/day.

2. **Borehole with solar pump**
   This system is good in that borehole water requires no treatment and the solar

pump would operate reasonably well at Kinna. An appropriate storage tank should be included to supplement the water supply when the sky is overcast. The solar pump was estimated to yield 28 m^3/day.

3. **Borehole with hand pump**
This system is recommended for the schools and other institutions.

7.4 Operation & Maintenance Procedures

During implementation, some of the local people should be identified and trained either on site or taken to an existing scheme similar to the one under construction, so that when the project is complete the operators are ready. This can be achieved through a local water committee organized by the beneficiaries themselves.

The water committee should manage the scheme and some of their responsibilities are:

1. Employ the water supply attendants.
2. Setting tariff - what should be paid by the people using the system.
3. Collecting and depositing the revenue earned in a safe place.
4. They should seek technical advice from the MoWD when necessary.

8. COST ESTIMATES

8.1 Capital Costs

The existing reticulation system should be used. Equipping of the borehole should be the priority.
The supply from the spring may be by gravity, but the head is probably insufficient to fill the tank. At times of overcast skies supply may therefore continue, albeit at a lower rate. An additional diesel pump set is in that situation not necessary.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	100,000
Spring protection	500,000
Equip pump station with a solar pump	600,000
Equip existing borehole with a solar pump	500,000
Construct additional storage (50 m^3)	225,000
Additional Pipework (1 km)	300,000
Sub-Total	2,225,000
10 % Contingencies	222,500
Total Say	2,500,000

With a population of 2,500, the per capita construction costs will be Ksh. 1,000.

8.2 O & M Costs

The proposed water supply should provide a primary level of service, while allowing the individual users the opportunity to pay for higher services if they wish so. The revenue collection and appropriate tariff should be made by the community itself.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendants 3 no.	4,500
General maintenance	3,000
Total	7,500

With the present population the per capita monthly O&M cost would be about Ksh. 3. An annual O&M cost per household (of five members) would be in the range of Ksh. 180, which should be affordable for most of the community members.

BOJI

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Boji is situated on the Isiolo-Wajir road (25 km beyond Kulamawe) in Kulamawe Location of Garba Tula Division.

The total population of Boji Deda is estimated at 1,800 people, of which 1,100 live in urban/settlement areas. The majority of this urban population lives in Garba Tula, which is situated in the south-eastern corner of the deda. A small population of 200 people living in Boji trading centre depends on retail trade, tea shops, miraa business while the majority live on pastoral economy. There has been no agricultural activities in Boji. Most of the inhabitants are Borans.

Some 533 TLU find their pasture within and around Boji Trading Centre getting water from hand dug wells during wet and dry seasons.

1.2 Social Economic Stratification

Livestock forms the basis of local wealth and this is unevenly distributed. The ILDP Deda Dossier describes the wealth ranking of two samples of the pastoral population. Half of the total livestock in the deda is owned by 18 percent of the households, while at the other end of the scale the poorest group (making up 20% of the households) hold only 2% of livestock. The wealthy group has been taken as those families with over 50 TLU. The poorest group holds less than approximately 7 cattle or 50 sheep or goats, which is taken as the minimum household herd required for independent pastoral livelihood.[1]

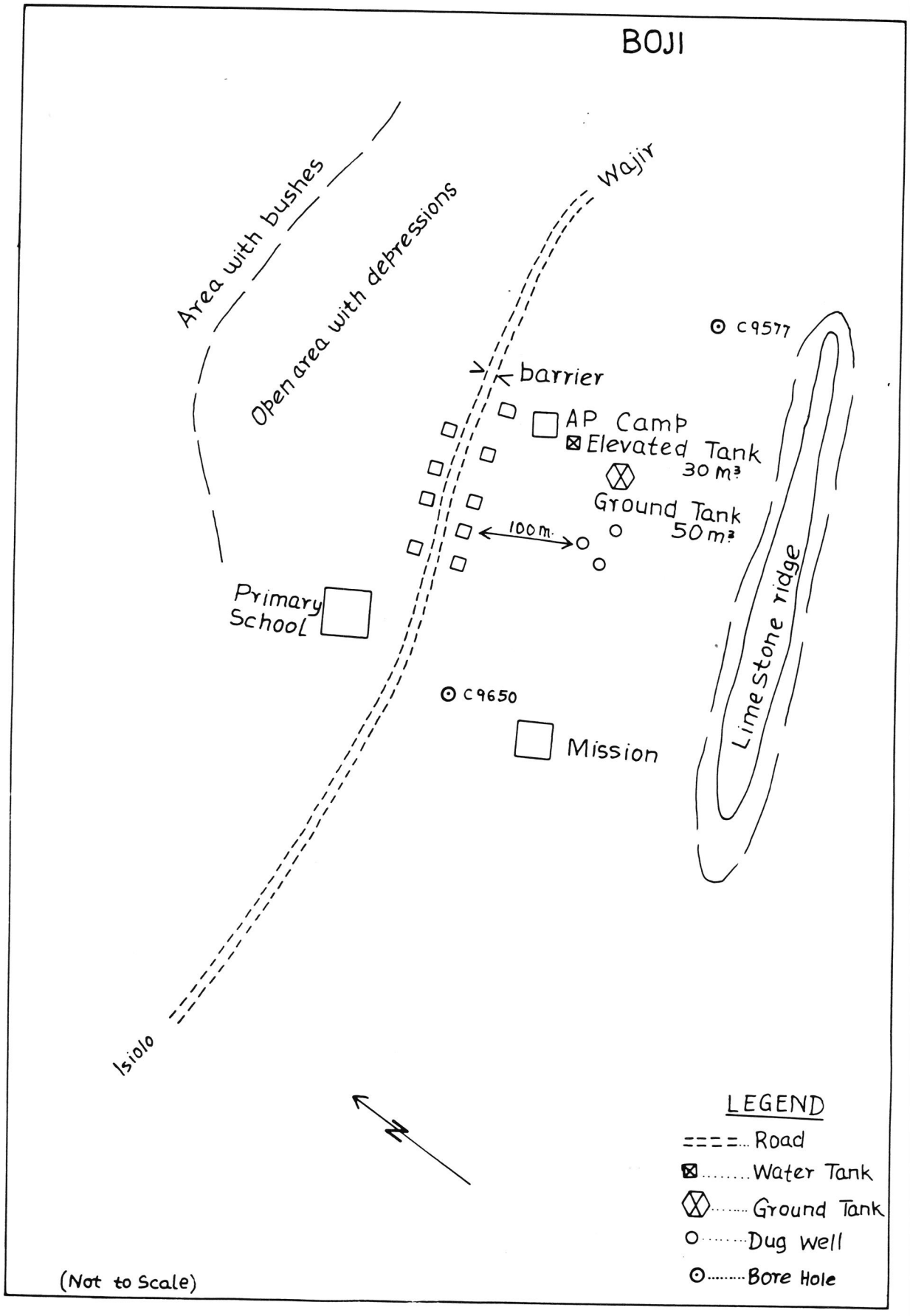
1.3 Scope of the Report

This report covers the supply of water to Boji Trading Centre only. The inhabitants of the project area are composed of a pastoralist population which depends entirely on the hand dug wells (shallow) of Boji for their water supply needs. These shallow wells at Boji market centre are hand operated by the pastoralists themselves.

Since most of the people in this area depend on livestock, some water demand for livestock is to be taken into account. This will be from the Hawicha or milk herd, which is left behind when the others are driven out of the area for pasture.

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[1] Source: Isiolo Livestock Development Project



Sketch of the Project Area

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located 80 km from Isiolo town along the Isiolo - Wajir dry weather road. It is situated on latitude 0° 34'N - and on longitude 38° 20'E. It is on a stock route for livestock from Wajir and Garissa to Meru and Isiolo markets.

Boji trading centre is in Boji Sub-location of Kulamawe Location of Garba Tula Division to the south of the Ewaso Nyiro River downstream of Chanler's Falls.

2.2 Topography

Boji trading centre lies between 610 m - 670 m above the sea level and the area is relatively flat. During the rains most of the area is flooded.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 120 mm and 600 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 29°C and 32.5°C.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

The Ecological land unit is described as alkaline valleys (acacia tortillas - Sporobolus-marginatus) with bushland. The soils are composed of limestone giving the surface a white outlook.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

There is an administration police post at Boji trading centre, under the supervision of the assistant chief of Boji sub-location. Other public offices include a public health technician and two adult Education Teachers.

3.2 Education

Boji has only one primary school situated at Boji market centre. The school was begun in 1986 with 25 students. Presently the school has 115 pupils and six teachers employed by the teacher service commission.

3.3 Health

The centre has no health facilities. There is only one public health technician whose work is to inspect meat before it is sold to the public.

3.4 Commerce

Boji trading centre is the only trading centre in Boji sub-location and mostly serves the people in the sub-location apart from the transit traffic to and from Wajir. There are 3 shops, no bars, few eating places, and one butchery (all are made of mud and corrugated iron sheets or sometime of interwoven twigs or grass).

3.5 Transport

Boji trading centre is situated along the Isiolo-Wajir road. There exist no public transport except for occasional Government vehicles. Transport is by donkeys and camels within and outside the sub-location, for the few who can afford them. The rest carry their loads on their backs.

3.6 Agriculture

There is no agriculture activities at Boji and most of the inhabitants are pastoralists.

3.7 Livestock Husbandry (Infrastructure)

The only existing cattle handling facility is a cattle crush. There are no other veterinary related structures like dips, yards or veterinary clinics.

4. WATER RESOURCES

4.1 Surfacewater

No source of surface water in this area.

4.2 Groundwater

Boji centre falls under zone 1b of the geologic formation. The zone is comprised of old land surface deposits and sediments interbedded between the lava flows or outcropping limestones overlying the metamorphic rocks. At Boji lava deposits are not present.

Two boreholes have been drilled at the centre by WRAP. The boreholes penetrated 9 m. of limestones and weathered Basement. Unfortunately one borehole was dry. The water is chemically fit and acceptable, although the salinity is higher than what is desirable.

Three dug wells exist at the centre penetrating the limestone layer. The depth to water is 2.5 to 3 m. The EC of the water is 1,470 μS/cm. The wells should be improved, to protect the water quality. Handpumps installed on these wells however have been removed, reportedly because of low pump yields.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC ($\mu S/cm$)	Remarks
C9639	9	3	2.3	2.9	1,780	Drilled by WRAP
C9640	9	dry	-	-	-	Drilled by WRAP, abandoned
Wells	6	-	2.5	-	1,470	Three hand dug wells exist

5. WATER DEMAND

5.1 Human Population

The population using this supply when in operation is assumed to be 1,100. A population growth rate of 4 % is assumed for the project area.

5.2 Education

The student population including teachers is 115 and it is the same number which is used for forecasting water demand. It is assumed that the demand will increase at a higher rate than the growth in population: 6%.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. An estimated 10 % of the total livestock in the Boji Deda shall depend on the Boji water supply. This is about 1,600 cattle or 533 TLU.

5.4 Health

There used to be a mobile clinic but its services were stopped. It is therefore assumed for the purposes of estimating water demand that there are 20 outpatients per day in the initial year. A growth rate of 4% is also assumed.

5.5 Commerce

The present number of shops and other utilities are expected to increase during the design period at a rate of 2 %.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	55	67	198	586
	using Communal Water Points	1,045	1,271	1,783	2,346
Education	Primary Schools: Students	115	154	276	409
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	1,600	1,600	1,600	1,600
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	533	533	533	533
Health	No. of Beds	-	-	-	-
	No. of Outpatients	20	24	36	53
Commerce	Shops	3	3	4	5
	Tea rooms	1	1	1	1
	Butcheries	1	1	1	1
	Bars	-	-	-	-
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	2.2	2.7	7.9	23.4
People using C.W.P's	10.5	12.7	17.8	23.4
Primary School	0.6	0.8	1.4	2.0
Dispensary	5.4	5.5	5.7	6.1
Administration	0.1	0.2	0.2	0.3
Shops	0.3	0.3	0.4	0.5
Butcheries	0.5	0.5	0.5	0.5
Bars/Tearooms	0.5	0.5	0.5	0.5
Hotels (Low Class)	-	-	-	-
Livestock	26.7	26.7	26.7	26.7
Total	46.8	49.9	61.1	83.4

6. EXISTING WATER SUPPLY

6.1 Technical Description

Boji trading centre has three hand dug (shallow) wells situated at the trading centre and an engine operated borehole at Taiboto (owned by the L.M.D) about 10-15 km from Boji market centre on the Boji - Garba/Tula road. This wells are hand operated by the pastoralists. The wells have been reinforced with concrete and the top covered and protected. It is important also to mention that the three shallow wells were equipped twice with hand pumps (1988-9) but were broken by the locals, and so at the moment are fetching water with their hands. There is a storage tank (30 m^3) and 2 cattle troughs.

6.2 Potential and Actually Served Beneficiaries

This system serves the trading centre's residents including the primary school. Some livestock water demand is also met by these wells.

6.3 Livestock Use

About 50% of the water produced in this water supply is used by livestock.

6.4 Functional Analysis

This water supply covers an area of 7 km^2 but due to lack of proper human waste disposal and the numerous livestock that use the water supply possibility of pollution are great. The area around the wells already is covered with a thick layer of dung. The handpumps that were installed were broken and removed due to their low output. Water is scooped from the wells using buckets.

6.5 Financial Analysis

No revenue is earned, but in future the users should be charged a little amount for maintaining the system - this will give them a sense of responsibility and ownership.

6.6 Institutional Analysis

In Boji there is a strong and active water committee formed in 1989 by the assistant chief. The purpose of this water committee is to regulate and control water use of Boji wells. The twelve man committee was appointed on the basis of Boran customary law on water management. This committee draws water drinking schedules and also instils disciplinary measures against anybody who misuses the wells. Disciplinary action taken by this committee ranges from imposing a fine to reporting to the area chief for further disciplinary action.
So in view of the above, it is very important that, the above committee are consulted and involved in any new water scheme in Boji.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

(1) **Boreholes:** Two boreholes to be drilled at Boji trading centre, already this proposals have been expressed by two independent groups from this area. It is also said by the inhabitants that there is a borehole drilled in Boji in 1963 with sufficient water but it has never been used and hence should be reassessed.

(2) **Wells:** More shallow wells should be dug and together with the existing ones should be protected satisfactorily from pollution. According to the inhabitants, Boji wells have a lot of water although digging one is very difficult because of the hard rocks. Boji water is also said to be fit for all types of animals.

7.2 Alternative Technologies

(1) **Handpumps:** Due to the high cost of fossil fuel and the unavailability of electricity for motor driven pumps, hand pumps are an appropriate technology for nomadic people because, no fuel and electricity are required and they are easy and simple to maintain.

(2) **Solar Pump:** This is another alternative because no fuel or electricity is required hence it is cheap and easy to maintain and sun shine is abundant.

(3) **Windmill:** Windmill operated pumps could be installed but the frequency of wind of sufficient speed limits its use at Boji.

7.3 Recommended Systems

(1) **Borehole equipped with hand pump:**
This technology is sustainable and flexible; meaning that the system could be upgraded in future to a mechanically powered pumping set as the population increases. This may be very soon as the population of the centre alone is estimated at 200. It should therefore only be used as an intermediate solution. Livestock would meanwhile continue using the existing wells.

(2) **Borehole equipped with solar pump:**
This system would be cheap to operate and maintain but would work very well if one of the wells was protected and equipped with a handpump to serve as a stand-by in case of overcast sky. The other wells could continue to be used for livestock. This system could be upgraded in future by using the borehole for domestic supply and siting another one for livestock use.

7.4 Operation & Maintenance Procedures.

In view of the Government policy of cost sharing it is intended that the project should be run by the local community. The beneficiaries of the scheme are expected to be involved from the beginning of the planning stage upto the end of commissioning of the project. The existing 12 men water committee should be consulted during all the stages of the development initiative.
Two water supply attendants should be locally recruited at a total monthly salary of Ksh. 3,000.

8. COST ESTIMATES

8.1 Capital Costs

The following cost estimate is made on the assumption that the existing wells shall be used for livestock and the borehole shall be used for domestic supply only. A cattle trough could however be constructed to be fed by an overflow from the storage tank. The existing storage tanks should be used and the community should contribute unskilled labour.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Ksh.
Preliminaries and General	50,000
Install pumping set: Solar	600,000
Stand-by diesel pump set	250,000
Additional storage	225,000
Pipework	100,000
Sub-Total	1,225,000
10 % Contingencies	122,500
Total Say	1,350,000

With a population of 1,100, the per capita construction costs will be Ksh. 1,225.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the solar system will provide 24 m^3/day. The remaining demand should be supplied by the diesel pump.

MONTHLY O&M COSTS

Description	Amount Ksh.
Staff salary	3,000
Fuel for diesel pump	1,000
General maintenance	3,000
Total	7,000

With the present population the per capita monthly O&M cost would be about Ksh. 6. An annual O&M cost per household (of five members) would be in the range of Ksh. 380, which should be affordable for most of the community members.

GAFARSA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

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8. COST SUMMARY

   8.1 Capital Costs
   8.2 O&M Costs

1. INTRODUCTION

1.1 Background

Gafarsa is located in Garba Tula Division, Kulamawe Location and Gafarsa Sub-location of Isiolo District.
The population of Gafarsa Deda is about 1,700 persons in 1989. The population of the centre is about 700. There are about 50 houses with corrugated iron roofs. The remaining population is living in manyattas not far from the centre. The majority of the population are borans.

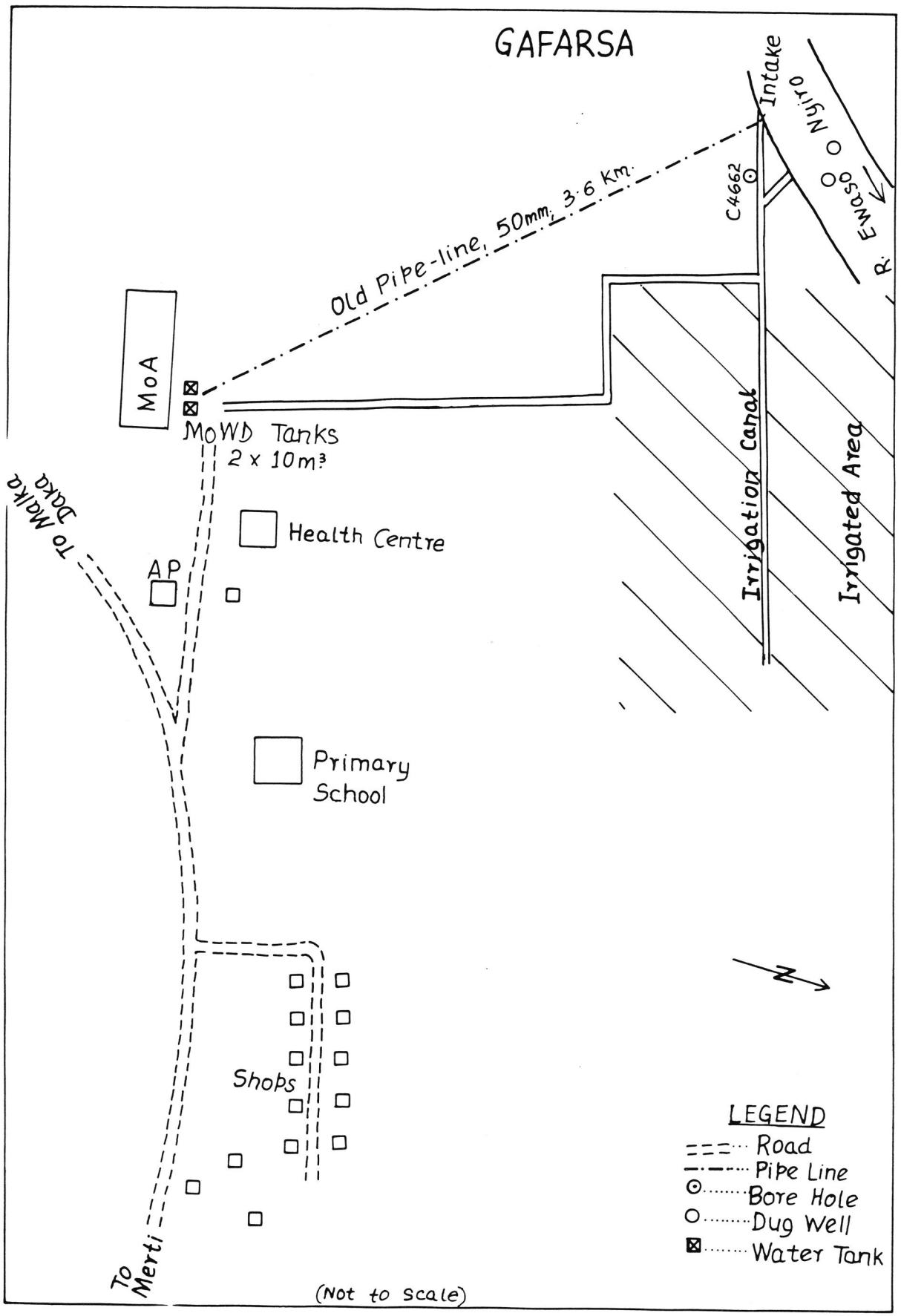
1.2 Social Economic Stratification

According to ILDP, Gafarsa is an agro-pastoral deda combining irrigated agriculture with pastoralism. The water of the Ewaso Nyiro is used to irrigate between one and two hundred hectares of land at Gafarsa. The irrigation scheme was began in 1972 by 8 poor farmers, former members of the Bulesa irrigation scheme that failed due to poor soil conditions. Irrigation farming is a hazardous exercise, on the Ewaso Nyiro, as the flow of the river is not regular. In some seasons the river and silts up all the drainage channels; at other times the flow drops and fails to reach the irrigation channels. The river also changes course.
The Gafarsa scheme failed totally in l972, 1983, 1984 and l985. In l979 the Ministry of Agriculture helped to enlarge the canals, and the United Nations sent a volunteer to Gafarsa. In l980, the EEC aided Gafarsa but this contributed to the collapse of the project in l984. In l985, EEC volunteers restarted the project.

The main crop grown is now maize, although in l981 cotton was more important. Farmers abandoned cotton as the main cash crop because the price of cotton was poor and payment for crop deliveries was late. These farmers organised themselves into a shamba committee, and started allocating land to new poor farmers who wished to join the scheme. In 1984 the farmers of Gafarsa started a co-operative committee in which all the registered shamba owners vote. The registered shamba owners also vote for the shamba committee. The co-operative committee works with help from the Ministry of Agriculture. Every farmer is given one hectare of irrigation land. The committee decides on various important communal tasks, when these tasks shall be done, and whom they should be done. These tasks usually involve seasonal dredging of the irrigation canals. Gafarsa uses manual labour to get this done and these tasks are heavy and time consuming.

Most of the maize grown in Gafarsa is not sold outside Gafarsa, but is consumed by the farmers. Some exchange of maize for goats takes place between farming and pastoral households.

Livestock holdings in Gafarsa are quite small and most of the Gafarsa herd stays near Gafarsa centre. Most Gafarsa families do not even have a basic milk herd, and the Gafarsa pastoral ola appear just as poor as the agro-pastoralists. However livestock is still the preferred and prestige economic pursuit. The most successful households in Gafarsa are those that have an interest in both irrigation farming and livestock; these farmers buy stock with any surplus from their agricultural production. Livestock herders with viable herds divide their herds into a dry and milking herd, and the milk herd stay close to Gafarsa village (from ILDP Deda dossier).



Sketch of the Project Area

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The centre is located on the southern bank of the Ewaso Nyiro river, to the north of Garba Tula, to the west of Iresa Boru and to the east of Malka Daka.

The grid reference for Gafarsa is E 38° 40', N 1° 03'.

2.2 Topography

The topography of the area is characterised by an extensive plain with no ridges or hills. The Ewaso Nyiro flows at about 4 km from the centre.
The altitude of Gafarsa is approximately 300 m above sea level.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of about 250 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 20 - 30°C.

2.4 Soils and Vegetation

The soil is loam - sandy. The vegetation around the centre is characterised by bushes and tall dense acacia trees. The soil is fertile and cultivation is possible with the use of irrigation.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

Gafarsa rural trading centre is the residence of the sub-chief. There is an administrative police post and an agricultural technical assistant.

3.2 Education

Gafarsa Primary School (including pre-primary) has 226 students and a teaching staff of 10. It is the only education institution in the area.

3.3 Health

There is a dispensary which was sponsored by the British Government and built in 1985. It is in good condition and has three staff. It has an annual attendance of 4,139. The most common diseases are malaria, URTI and worms and in the wet season: diarrhoea, and in the dry season: scabies.

3.4 Commerce

There are nine shops at the centre which trade mainly in sugar, tea, maize meal and clothing.

3.5 Transport

Gafarsa is situated on the Malka Daka - Iresa Boru dry weather road. Except for rare government vehicles, there is no public transport. Camels are used for transportation in this area.

3.6 Agriculture

The Gafarsa irrigation scheme currently has a cultivated hectarage of about 150. The project aims at increasing the hectarage and production, improving seed quality, improving extension services and training farmers in all aspect of crop production. The main crop is maize.

3.7 Livestock Husbandry

There is no organised trade in animal drugs or other livestock inputs. This trade is carried out by irregular and unlicensed traders within the pastoral system.

Gafarsa has no livestock market, but uses the market at Malka Daka.

4. WATER RESOURCES

4.1 Groundwater

Gafarsa centre falls under zone 1a of the geologic formation. This zone is comprised of pervious alluvial sediments, encountered at different levels of confinement by clay layers. The water in this formation is highly saline and not suitable.

Data from borehole C4662 drilled in this formation at about 100 m. from the river indicates that water was struck at 28 metres. The water rest level was 18 metres below ground level. Yield of the above borehole was 1.2 m^3/hrs. The water is reported to have been of high salinity.

Fresh groundwater is found at shallow depths in the sandy riverbed of the Ewaso Nyiro. It seems that this water is the only suitable source for Gafarsa. Handdug wells 3 m. deep exist and are of good water quality.

The sediments below the sands are dry and the next groundwater zone has highly saline water. Borehole C9381 drilled by WRAP just across the river at Bulesa was dry until 35 m. depth. Apparently there is no connection between the river water and the deeper sediments due to a heavy clay layer.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	Remarks
C4662	50	28	18	1.2	High salinity, borehole abandoned
C9381	35	dry	-	-	Drilled by WRAP

4.2 Surfacewater

The Uaso Nyiro river has water in the entire period of the year.

The last time the river dried up at this point was in 1984 during the drought period.

Gauging records are not readily available for this river at this point, but it is a reliable source of surface water.

5. WATER DEMAND

5.1 Human Population

The population of the centre and the surrounding manyattas is 1700. A population growth rate of 4% is assumed for the project area.

5.2 Education

The student population including teachers is 236. It is assumed that the institutional water demand will increase at a rate of 6%.

5.3 Livestock

The number of livestock in Gafarsa Deda is not known. For the demand calculation an estimate of 6,000 LU was used. It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. An estimated 10 % of this livestock shall depend on the Gafarsa water supply.

5.4 Health

The growth rate of the health centre attendance is taken to increase with the population. A growth rate of 4% is taken.

5.5 Commerce

The present number of shops and other utilities are to increase during the design period at a rate of 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	85	103	306	906
	using Communal Water Points	1,615	1,964	2,754	3,624
Education	Primary Schools: Students	236	316	566	838
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	1,800	1,800	1,800	1,800
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	600	600	600	600
Health	No. of Beds	-	-	-	-
	No. of Outpatients	12	15	22	33
Commerce	Shops	9	10	12	15
	Tea rooms	2	2	3	3
	Butcheries	1	1	1	1
	Bars	-	-	-	1
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	10	12	18	27

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3 /day			
	1990	1995	2005	2015
Individual Connections	3.4	4.1	12.2	36.2
People using C.W.P's	16.2	19.6	27.5	36.2
Primary School	1.2	1.6	2.8	4.2
Health Centre	5.2	5.3	5.4	5.7
Administration	0.3	0.3	0.5	0.7
Shops	0.9	1.0	1.2	1.5
Butcheries	0.5	0.5	0.5	0.5
Bars / Tea rooms	1.0	1.0	1.5	2.0
Hotels (Low Class)	-	-	-	-
Livestock	30.0	30.0	30.0	30.0
Total	58.7	63.4	81.7	117.0

The ultimate water demand is 117 m^3/day

6. EXISTING WATER SUPPLY

6.1 Technical Description

Gafarsa used to have a water supply using the surface water from the river. The intake was washed away by floods in 1986, but the 50 mm. ϕ GI rising main and the two 10 m^3 GI tanks are still there. The intake was situated at the intake of the irrigation system.

Currently donkeys are used to ferry the water from the river to the centre.

The dispensary has three 20 m^3 roof tanks, which were all observed to be leaking. The school has five GI roof tanks of 10 m^3 each. Water is brought from the river to augment the rain water.

6.2 Livestock Use

Livestock depend on the Ewaso Nyiro river.

6.3 Institutional Analysis

There is no Water Committee at Gafarsa. Some communal activities take place (co-operative shop, maendeleo women group), but on the whole the community appears not much ready to work together.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Surface water: The Ewaso Nyiro river is not a reliable source of water in most of the years. Therefore it can not serve as a source for a water supply.

Groundwater: The deep groundwater is saline and is not an option. The only groundwater of good quality is found at shallow depths in the sediments near the Ewaso Nyiro river. This source should also be available during droughts, but the quantity may be restricted.

Rainwater: Although rainfall is limited this source may provide during part of the year an additional quantity of drinking water. The few shops and institutions at the centre which have iron sheet roofs should construct appropriate structures for collecting and storing rain water.

7.2 Alternative Technologies

Infiltration galleries with pumping: The abstraction of the shallow groundwater below the Ewaso Nyiro may be done using infiltration galleries (pipes) buried across the riverbed. The depth of the pipes depends on the minimum groundwater levels in the riverbed sands, and also on the depth of the clay layer(s) below the sands. This depth is not known, but may be only a few meters.

The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration pipes may also serve Bulesa at the other side of the river by constructing a collector well on that side. The number of required infiltration pipes is not known as it depends on the groundwater depth and the permeability of the sands.

Handdug wells with handpumps: Handdug wells suitably located and constructed on the banks of the Ewaso Nyiro may be used to tap the shallow groundwater. The yield of the wells may be low and thus only handpumps should be installed. This would replace the current use of untreated water from the Ewaso Nyiro.

Pump systems:
- Generating set with submersible pump
- Solar powered pumpset, which is favoured due to it's low maintenance requirement
- Windmill, but the low frequency of the wind with suitable speed limits it's use here.

7.3 Recommended System

The Ewaso Nyiro river is the only reliable source of good quality water in the area. The abstraction of the water may be done using infiltration galleries (pipes) buried across the riverbed. The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration pipes may also serve Bulesa at the other side of the river by constructing a collector well on that side.

This system would eliminate the need for treating the Ewaso Nyiro water and also tap the sub-surface flow in case the river dried up. A solar pumping set with a stand-by generating set are recommended.

The feasibility of hand dug wells on the bank of the river should also be investigated. It is recommended to construct some of these wells and equip them with handpumps in addition to any other prestigious system recommended.

8. COST ESTIMATES

8.1 Capital Costs

The cost would be greatly reduced if Gafarsa and Bulesa centre were to have a common system. The cost of an independent system is however estimated below.

The construction of the intake (infiltration galleries and clear water well) should be a priority. The siting and flood protection of this should be done by qualified personnel. It was assumed that the old pipeline can still be used.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	50,000
Construction of infiltration galleries 300 m.	450,000
Construction of collector well	25,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct additional storage 50 m^3	225,000
Additional pipework 500 m.	150,000
Equip handdug wells with handpumps (5 no.)	125,000
Sub-Total	1,875,000
10 % Contingencies	188,000
Total Say	2,100,000

With a population of 1,700, the per capita construction costs will be Ksh. 1,200.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the solar system will provide 35 m^3/day. The remaining demand will be supplied from the diesel pump.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	2,000
Other maintenance	3,000
Total	8,000

With the present population the per capita monthly O&M cost would be about Ksh. 5. An annual O&M cost per household (of five members) would be in the range of Ksh. 280, which should be affordable for most of the community members.

KULAMAWE

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Kulamawe is situated on the Isiolo-Wajir road and was started as a livestock marketing outspan when the Wajir - Modogashe stock route was opened by the Livestock Marketing Division.

About 1,500 people live within a radius of 10 km of Kulamawe centre. A small population circa 450 living in the trading centre depends on retail trade, hotels or wage employment while the majority live on pastoral economy. There has been insignificant agricultural practice at Kulamawe. Most of the inhabitants are Borans.

Some 5,000 TLU find their pasture within Kulamawe Location getting water from hand dug wells, the Grissa pans, natural depressions during the wet seasons and the Kulamawe borehole.

1.2 Social Economic Stratification

Livestock forms the basis of local wealth and this is unevenly distributed with 10% of the households holding half of the total livestock in the Location while the poorest of the poor making up 13% of the population hold 2% of the total livestock. The wealthy group has been taken as those families with over 50 TLU. The poor group holds less than 5 TLU (approximately 7 cattle, or 50 sheep or goats) which is taken as the minimum household herd required for independent pastoral livelihood. The small percentage suggest that the Kulamawe residents are better off as compared to the rest of the District.[1]

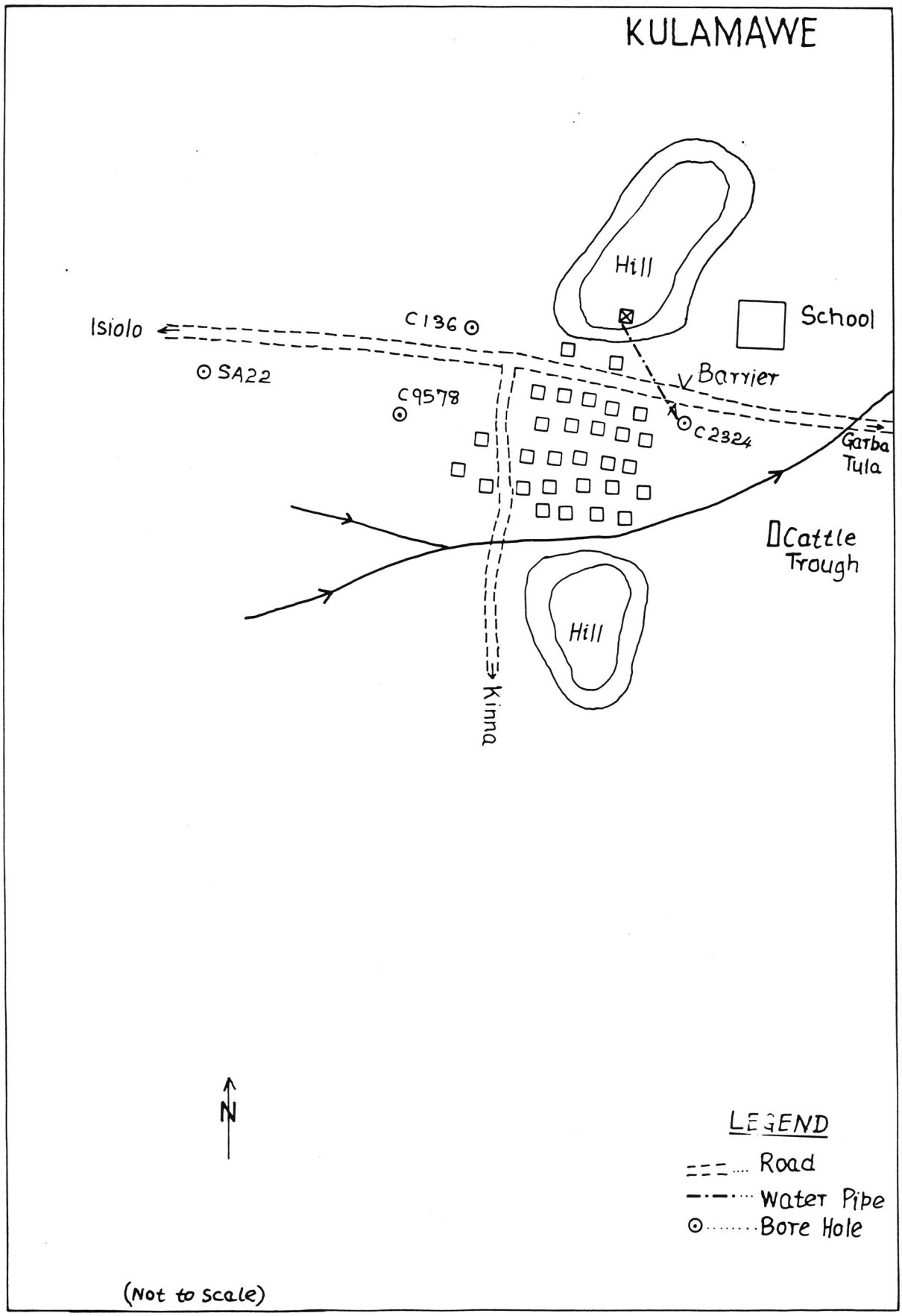
1.3 Scope of the Report

This report covers the supply of water to Kulamawe Rural Trading Centre only. The inhabitants of the project area are composed of a population which depends entirely on the Kulamawe borehole for their water supply needs.

It should further be noted that since most of the people in the area depend on livestock a small percentage of livestock is taken into account while calculating the water demand. This is to meet the water demand for the livestock that is left behind when the others are driven out of the area for pasture. This has been taken as 10% of the livestock in the area.

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[1] Source: Isiolo Livestock Development Project



Sketch of the Project Area

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located along a dry weather road about 70 km from Isiolo Town on the Isiolo - Wajir road. It is situated on latitudes 0° 35'N - 38° 12'E.

It is in Kulamawe Sub-location of Kulamawe Location of Garba Tula Division on the Southern bank of the Ewaso Nyiro River downstream of the Chanler's Falls.

2.2 Topography

The centre is located between two hills of volcanic origin. Otherwise the area is generally flat.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 300 - 350 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 24 - 30°C.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

There are two types of vegetation being bushed grassland and wooded bush grasslands occurring on the lava flows and ash slopes and on the contact line between the volcanic and the basement ridges respectively. The main tree species is the Acacia with dense dwarf shrub undergrowth in the wooded bushland. The grass cover is mainly perennial.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

An assistant chief is stationed at the Kulamawe trading centre. The other public offices include an administration post, a health centre, MoWD and a primary school. There are also a social development officer and a range management technical assistant.

3.2 Education

Kulamawe primary school is the only educational institution in the project area. It's enrolment in 1988 was 271 students and 7 teachers.

3.3 Health

There exists a well-equipped health centre in the project area. The average daily outpatient attendance is 30 people.

3.4 Commerce

The Kulamawe trading centre is the only trading centre in Kulamawe sub-location and serves the transit traffic to Wajir apart from the people in the project area. There are six shops, two butcheries and four tea shops.

There is no open air market.

3.5 Transport

Kulamawe town is situated along the Isiolo-Wajir road. There exists no public transport except for occasional Government vehicles. Transport is by donkeys and camels for the few who can afford them. The rest carry their loads on their backs.

3.6 Agriculture

There is insignificant agriculture at Kulamawe and most of the inhabitants are pastoralists.

3.7 Livestock Husbandry

No significant livestock marketing infrastructure exists in Kulamawe. However herds of trade cattle move through the area towards Isiolo. There are no livestock facilities, such as a dip or a crush.

4. WATER RESOURCES

4.1 Groundwater

Kulamawe centre is within zone 1b of the geologic formation. This zone is comprised of old land surface deposits and sediments interbedded between the lava flows or outcropping limestones overlying the basement system rocks. In Kulamawe deposits of volcanic origin predominate.

Data from boreholes indicate that water struck levels range from 40 to 60 m., while water rest levels range between 35 and 50 m. below ground level. Yields are reasonable but sufficient to serve the local demand.

Water is of acceptable chemical quality.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HCO3 (mg/l)	F (mg/l)	Remarks
SA 66	91.4	59	48.8	6.7	-	-	-	Casing filled with stones
C136	56.7	-	-	-	-	-	-	No records
C2324	52	40.8	38	5.5	2.1	244	0.2	MoWD Water Supply
C9641	76	51	44.7	2.1	1.4	-	-	Drilled by WRAP

4.2 Surfacewater

No surface water source exists near the centre.

5. WATER DEMAND

5.1 Human Population

The population taken for the purpose of the demand calculation was estimated at 1,500. A population growth rate of 4% is assumed for the project area.

5.2 Education

The student population including teachers is taken to be 300 for the purpose of forecasting water demand. It is assumed that the institutional demand will increase at a rate of 6%.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. An estimated 10% of this livestock shall depend on the Kulamawe water supply.

5.4 Health

The growth rate of the health centre attendance is taken to increase with the population. A similar growth rate of 4% is taken.

5.5 Commerce

The present number of shops and other utilities are assumed to increase during the design period at a rate of 2%.

Numbers used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	75	91	270	799
	using Communal Water Points	1,425	1,733	2,430	3,198
Education	Primary Schools: Students	300	401	718	1,063
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	1,500	1,500	1,500	1,500
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	500	500	500	500
Health	No. of Beds	-	-	-	-
	No. of Outpatients	30	36	53	78
Commerce	Shops	6	7	9	11
	Tea rooms	4	5	6	7
	Butcheries	2	2	3	3
	Bars	-	-	-	1
	Hotels (No. of beds)	-	6	9	13
Administration	Number of staff	10	12	18	27

5.6 Summary of Water Demand

Type of Facility	Consumption m^3 /day			
	1990	1995	2005	2015
Individual Connections	3.0	3.6	10.8	32.0
People using C.W.P's	14.3	17.3	24.3	32.0
Primary School	1.5	2.0	3.6	5.3
Health Centre	5.6	5.7	6.1	6.6
Administration	0.3	0.3	0.5	0.7
Shops	0.6	0.7	0.9	1.1
Butcheries	1.0	1.0	1.5	1.5
Bars / Tea rooms	2.0	2.5	3.0	4.0
Hotels (Low Class)	-	0.3	0.5	0.7
Livestock	25.0	25.0	25.0	25.0
Total	53.3	58.4	76.1	108.7

6. EXISTING WATER SUPPLY

6.1 Technical Description

Kulamawe rural water supply has a borehole source and diesel pumping. The borehole pump is rated at 7.5 m^3/hr with a prime mover of 12.5 HP. An average of 34 m^3/day are produced. There is also a 25 m^3 storage tank and 300 m 40 mm ϕ Distribution. The old 50 m^3 storage tank is not used any more due to leakage caused by corrosion. No treatment is undertaken.

In the centre about 30 water jars are used for storing rain water from the roofs. These serve as a good additional source for drinking water.

6.2 Potential and Actually Served Beneficiaries

During its commissioning in 1971 the project was designed to serve a population of 1,511 people and according to the DDO's 1988 projection the project is currently serving a population in the region of 1,500 people. There are 46 consumers on metered connections serving approximately 300 households.

6.3 Livestock Use

About 80% of the water produced in this water supply is used by livestock.

6.4 Functional Analysis

This water supply covers an area of 40 km^2 and it's performance and reliability are good so long as diesel is available. The population has taken over the running of the water supply and provides the diesel. However it seems still problems exist at times that there is no demand for water from livestock.

6.5 Financial Analysis

The revenue earned in the 1988/89 Financial year was Kshs 16,000 against an expenditure of Kshs. 112,000. Staff cost was Ksh 85,000, while Kshs. 27,000 was used for fuel. Analysis of the monthly operation and maintenance reports indicates that 54% of the water produced was sold while the balance 46% was either distributed freely or unaccounted for. This indicates that due to the low percentage of water sold unit production and sales cost differ significantly.

Since the population took over the running of the supply only charges are levelled for supply of livestock.

6.6 Institutional Analysis

There are two water supply operators and two pump attendants all employed by the Ministry of Water Development. The community does not employ any staff.

The borehole use by livestock is controlled by a strong borehole committee, made up of 12 elders representing the camps that use the borehole on a day to day basis. he chairman of the committee is known as Aba Hirega or water manager. The borehole committee ensures that only local hawicha water at Kulamawe. These lactating herds provide milk for the population settled around the borehole with school children. The committee also arranges a watering timetable for livestock and ensures it is followed.[2]

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

The alternative sources at Kulamawe are limited to boreholes and roof catchments in the absence of a suitable surface water source near the centre. Two boreholes exist at the centre, one equipped and the other not yet equipped, as it was drilled by WRAP in 1991. The depth to the groundwater is about 45 m., which means that a solar pump will not yield enough water.

7.2 Recommended Systems

Borehole with diesel pump: The existing borehole has adequate capacity to continue supplying the centre and the livestock. The new borehole increases the supply capacity and therefore no new sources will be needed in the near future.

The new borehole may be equipped with a diesel pump, although the yield of the borehole is only 2.1 m^3/hr. Additional storage will be required.

Roof catchment: Provision for storage of rain water should be made for the numerous iron sheet covered houses. Water jars may be used, similar to the already existing ones.

7.3 Operation & Maintenance Procedures

The old existing borehole should continue to be used for livestock supply. It may also serve the centre, at times of a break down of the other pump. The diesel pump on the new borehole should serve the centre only and should not be used for the supply of livestock.

Emphasis should be put on the revenue collection. The District Water Board in liaison with the borehole committee should come up with a suitable solution to meet the cost recovery criterion.

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[2] Source: Isiolo Livestock Development Project

8. COST ESTIMATES

8.1 Capital Costs

The estimate is made on the understanding that the existing facilities including storage and reticulation shall be utilized. The new borehole may already have been equipped with a submersible pump driven by a generator in 1991, but nevertheless the purchase of a pump unit is included.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	20,000
Install diesel pump set	250,000
Construct additional storage (50 m^3)	225,000
Additional Pipework	300,000
Sub-Total	795,000
10 % Contingencies	79,500
Total Say	900,000

With a population of 1,500, the per capita construction costs will be about Ksh. 600.

8.2 O & M Costs

The Kulamawe water committee should employ two local water supply attendants and meet their salaries.

MONTHLY O&M COSTS

Description	Amount Ksh.
Staff salary	3,000
Fuels for pumping 8 hours per day	5,000
General maintenance	5,000
Total	13,000

With the present population the per capita monthly O&M cost would be about Ksh. 8.5. An annual O&M cost per household (of five members) would be in the range of Ksh. 520, which should be affordable for most of the community members, as most of the operational expenses are for the supply of their livestock. A suitable mode of payment for the water supply of livestock should be made by the water committee to cover the total operation and maintenance cost.

MALKA DAKA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

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8. COST SUMMARY

   8.1 Capital Costs
   8.2 O&M Costs

1. INTRODUCTION

1.1 Background

Malka Daka trading centre is situated in Kulamawe Location. It has a population of about 1,100. The total population in the deda is 1,850. The main ethnic group is the Boran. The pastoral population is relatively more mobile than in other parts of the district and the manyattas are smaller.

Malka Daka centre was flooded in 1986 and there is a proposal to move the centre away from the river towards the south. The same flood also destroyed the irrigation system and the abutment of the bridge.

1.2 Social Economic Stratification

Pastoralism is the main economic activity in Malka Daka since the irrigation scheme collapsed. The population is primarily composed of victims from the shifta war and the failure of the irrigation scheme has caused young men to migrate to urban settlements in search of employment. Due to this the traditional Boran social organisation and practices of animal husbandry and land use pastoral production systems have collapsed and large tracts of their land is unused.

The wealth ranking of the population, studied by ILDP from samples of two urban camps (manyattas near the centre) showed that the richest 35% of the households hold 72% of the livestock and the poorest 47% of the households hold only 8% of the livestock.

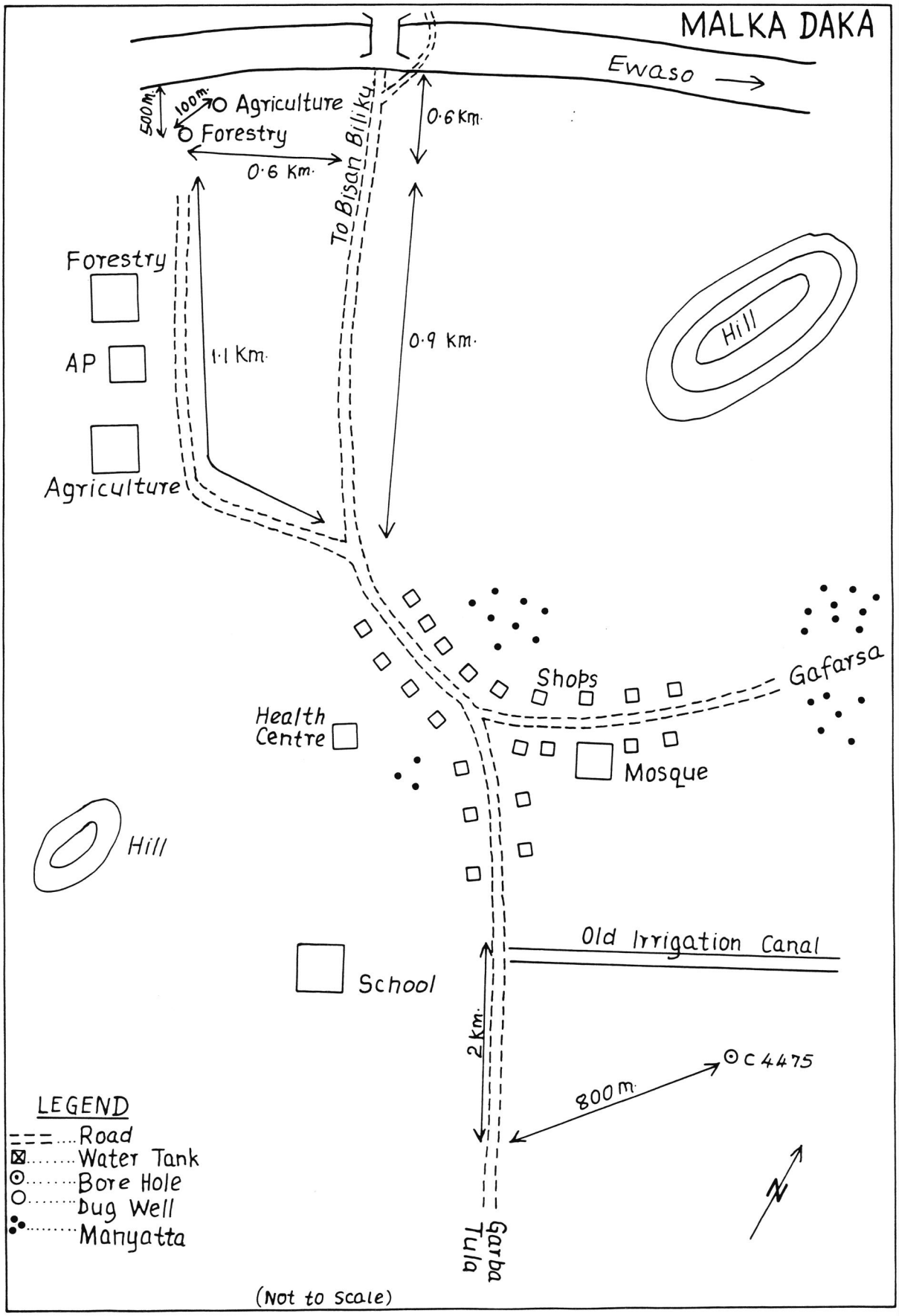
Wealth Rank	% of HH	Livestock Unit	Est. % of LU
III	6	20 - 30	20
IV	29	10 - 20	52
V	18	5 - 10	19
VI	47	under 5	8

There is a school management committee which functions and duties are to reserve pastures for the school hawicha herd, plan and implement school development programmes and monitor the academic progress and performance of each class. This committee is accountable to the parents who elected them. It can stay in office as long as the parents need them. The committee is at present the strongest formal institution, only inferior to the various informal but highly organised clan leadership hierarchies.

The only other social institution based in Malka Daka is the Malka Daka islamic religious institution that has an elected five-member management committee whose tasks are:

- to oversee the running of the food programme for muslim students attending madarasa.
- to coordinate the management of the madarasa, mosque and other islamic activities e.g. zaka (alms) collection and distribution to the poor.

In Malka Daka deda there are 3 women's and 1 men's self help groups and are normally registered with the department of social services. Their main objectives are to improve the social economic life of its members through undertaking income-generating activities but they are limited by lack of investment capital.



Sketch of the Project Area

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located in Kulamawe Location of Garba Tula Division and is situated about 1.5 km from the southern bank of the Ewaso Nyiro. Grid reference is E 38° 40', N 0° 48'.

2.2 Topography

The topography of the area is generally flat, crossed by small incised stream valleys Some low hills are found to the west and the east of the centre. The altitude is about 350 m above sea level.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of about 250 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 20-30°C.

2.4 Soils and Vegetation

The area around the centre is composed of alluvial deposits of the Ewaso Nyiro. The deposits consist of sand, silt, clay and gravel.

The vegetation is dense scrub with few acacia tree. The vegetation along the river is very dense. The area favours browsers, like goats.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

The Malka Daka Sub-location assistant chief lives at Malka Daka trading centre. There is an administration police post.

3.2 Education

There is one primary school situated at Malka Daka market centre. The school has a varying number of students, as they move with there parents. The number indicated by ILDP is 250 students distributed in 8 classes. In April 1991 this was 136 only and 40 children in pre-primary. The number of staff is 12.

3.3 Health

Malka centre has no proper health facilities. The residents have temporarily converted one of their private temporary buildings into a store for keeping drugs administered by a ministry of health officer.

3.4 Commerce

Malka Daka market is an important trading centre in food stuff oriented goods. Major food stuff sold in fairly numerous canteens includes tea, sugar maize floor, beans and maize. Small hotels also play an important role in earning income, especially on market days (Tuesdays and Saturdays), when many goats and sheep are traded.

3.5 Transport

Malka Daka is served by earth tracks. The first one is the main Garba Tula - Merti track which passes through Malka Daka centre. The bridge across the Ewaso Nyiro can not be used at present, because the bank of the river on the Malka Daka side was washed away. The other track connects to Garfasa and Iresa Boru. There is no public transport.

3.6 Agriculture

Very few agricultural activities go on here after the collapse of the Malka Daka irrigation scheme. The scheme was started in 1978 and taken over by the Ministry of Agriculture in 1980. Water was pumped from the Ewaso Nyiro to a canal. The canal caused the flooding of the centre in 1986.

3.7 Livestock Husbandry

There are no veterinary personnel in Malka Daka. Although Malka Daka is an important livestock market centre, there are no dips and the crush is in poor condition.

4. WATER RESOURCES

4.1 Groundwater

Malka Daka centre falls under zone 1a of the geologic formation. The zone is comprised of alluvial sand and clay layers. This is underlain by rocks of the Basement Complex.

Boreholes drilled at some distance from the Ewaso Nyiro indicate highly saline groundwater. The only fresh groundwater is found in the sediments in the river and on the banks. Dug wells in the dry river bed have a good water quality.

Two lined dug wells are found at about 500 m. from the river. The EC of the water was not measured, but they are reported to contain water similar as that in the Ewaso Nyiro. The depth to water is about 8 m.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HCO3 (mg/l)	Fe (mg/l)	Remarks
C4475	147	18	14	5.5	6	1,053	2.96	
C9382	40	17	-	4.0	20	-	-	Drilled at Bisan Biliku

4.2 Surfacewater

The Ewaso Nyiro is almost always flowing at this point. Drying of the river is rare. A miscellaneous gauging at 27th January 1990 gave a flow of 8.0 m^3/second.

The flow in April 1991 at the end of the dry season was about 2 m^3/second. The EC of the water was 873 μS/cm.

5. WATER DEMAND

5.1 Human Population

The population of the centre is 1100. A population growth rate of 4% is assumed for the project area.

5.2 Education

The number of students and staff in the primary school is taken at 300 for the demand calculations. The growth rate of the school is taken to be 6%.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock shall continue using the Ewaso Nyiro river or dug wells in the riverbed.

5.4 Health

There is no health centre at Malka Daka. For the purpose of the water demand calculation one has been included with an out-patient attendance of 15 people per day. A growth rate of 4% is taken.

5.5 Commerce

The present number of shops and other utilities are to increase during the design period at 2%.

Basic Data and Projectios

Consumer Type		1990	1995	2005	2015
Population	with individual connections	55	67	198	586
	using Communal Water Points	1,045	1,271	1,783	2,346
Education	Primary Schools: Students	300	401	718	1,063
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	-	-	-	-
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	1,000	1,000	1,000	1,000
Health	No. of Beds	-	-	-	-
	No. of Outpatients	15	18	27	40
Commerce	Shops	16	18	22	27
	Tea rooms	14	15	18	22
	Butcheries	2	3	3	3
	Bars	-	-	1	2
	Hotels (No. of beds)	-	-	5	10
Administration	Number of staff	10	12	18	27

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	2.2	2.7	7.9	23.4
People using C.W.P's	10.5	12.7	17.8	23.4
Primary School	1.5	2.0	3.6	5.3
Health Centre	5.3	5.4	5.5	5.8
Administration	0.3	0.3	0.5	0.7
Shops	1.6	1.8	2.2	2.7
Butcheries	1.0	1.5	1.5	1.5
Bars / Tea rooms	7.0	7.5	9.5	12.0
Hotels (Low Class)	-	-	0.3	0.5
Livestock	-	-	-	-
Total	29.4	33.9	48.8	75.3

The ultimate daily demand is 125 m^3/day

6. EXISTING WATER SUPPLY

6.1 Technical Description

The MoWD has never constructed a water supply at Malka Daka. A borehole was drilled to the south of the centre, but yielded saline water.

The population uses the Ewaso Nyiro river as source of water, by digging shallow wells (mados) in the riverbed. These wells are not lined and are destroyed whenever the river flows.

The Ministry of Agriculture and the Forestry Department each operate a lined dug well located about 100 m. apart at about 500 m. from the river. The wells are similar and have a depth of more than 8 m. The water is pumped with diesel power from the wells to tanks at the compound of the Ministries through 50 mm ϕ GI pipes. At the time of the field visit in April 1991 both pumps were out of order.
The yield of the wells is low and it is reported that pumping of the wells needs to be interrupted to allow for recharge.

The livestock uses the Ewaso Nyiro river for their water supply.

6.2 Institutional Analysis

Access points for livestock watering along the river, called malkas have no restrictions governing their use by the Borans. Except the two malkas of Guniya and Jana near the market centre which are reserved for the use of the population of the settlement. Other mados in the deda used during the wet season and early dry season have a temporary water committee formed only for that period of use (from ILDP Deda dossier).

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Surface water: The Ewaso Nyiro river is a reliable source of water in most of the years, but during droughts the surface flow does not reach Malka Daka. This may occur more often in future, because of an increase in water use upstream along the river.

Groundwater: The deep groundwater is saline and is not an option. The only groundwater of good quality is found at shallow depths in the sediments near the Ewaso Nyiro river. This source should also be available during droughts, but the quantity may be restricted.

Rainwater: Although rainfall is limited this source may provide during part of the year an additional quantity of drinking water.

7.2 Alternative Technologies

Infiltration galleries with pumping: The abstraction of the shallow groundwater below the Ewaso Nyiro may be done using infiltration galleries (pipes) buried across the riverbed. The depth of the pipes depends on the minimum groundwater levels in the riverbed sands, and also on the depth of the clay layer(s) below the sands. This depth is not known, but may be only a few meters.
The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration pipes may also serve Bisan Biliku at the other side of the river by constructing a collector well on that side. The number of required infiltration pipes is not known as it depends on the groundwater depth and the permeability of the sands.

Handdug wells with handpumps: Handdug wells suitability located and constructed on the banks of the Ewaso Nyiro may be used to tap the shallow groundwater. The yield of the wells may be low and thus only handpumps should be installed. This would replace the current use of untreated water from the Ewaso Nyiro.

Surface water intake with treatment and pumping: Although this would require treatment, the ease of abstraction of larger quantities makes it a good system for future development. The drawback of the system is that surface water is not always available and also that intake structures in the river are liable to damage from floods. The use of a common intake and treatment for both Malka Daka and Bisan Biliku would lower the capital costs. The technologies involved are however beyond what the communities can handle at the moment.

7.3 Recommended System

The construction of infiltration galleries is recommended because of:

- the reliable supply of sufficient quantity and
- the good water quality which does not need treatment and
- the possibility to combine the supply with Bisan Biliku.

Pumping may be done using a solar system as this gives the lowest O&M costs. The water should be supplied at the centre, therefore the system should include a rising main, an elevated storage tank and a distribution system with individual and communal connections.

A small diesel driven submersible pump may be added to the system to ensure supply at times that the solar system is not operational. The yield of the solar system is estimated at 45 m^3/day (total head 25 m.).

7.4 Operation & Maintenance Procedures

The community should employ two local water supply attendants with a salary of say Ksh. 1,500. The Divisional Water Engineer's office should provide advice whenever necessary. A suitable tariff should be arrived at by the community to enable continuous maintenance of the water supply.

Due to their nomadic nature it is unlikely that the residents of the town centre will always be there. It is therefore necessary that the community leaders decide on a suitable mode of collecting revenue. An annual payment system may be tried.

8. COST ESTIMATES

8.1 Capital Costs

It is assumed that the existing pipework of both the Ministry of Agriculture and Forest Department shall be used where possible.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	50,000
Construction of intake (including infiltration pipes collector well)	475,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct additional storage	225,000
Pipework	200,000
Equip handdug wells with handpumps (5 no.)	125,000
Sub-Total	1,925,000
10 % Contingencies	192,500
Total Say	2,150,000

With a population of 1100, the per capita construction costs will be Ksh. 1,900.

8.2 O & M Costs

The proposed water supply should provide a primary level of service, while allowing the individual users the opportunity to pay for higher services if they wish so. The revenue collection and appropriate tariff should be made by the community itself.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	500
Other maintenance	3,000
Total	6,500

With the present population the per capita monthly O&M cost would be about Ksh. 6. An annual O&M cost per household (of five members) would be in the range of Ksh. 350, which should be affordable for most of the community members.

BISAN BILIKU

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Bisan Biliku is a local trading centre located some 40 km west of Merti and 9 km west of Bulesa. The centre was established in April 1988 after the Sub-location was gazetted. The inhabitants come from Malka Daka which is just on the other side of the river.

The centre has about 30 houses with corrugated iron roofs. The population is about 500. The total population of the Sub-location is around 2,700, but this varies from season to season since the area is inhabited by the nomadic tribe of Boran.

The centre relies on the Ewaso Nyiro for its water supply. The river is about 2.5 km from the centre.

The livestock at the centre is mainly goats. There is no hawicha herd and only goats are used for milk. The main herd goes to Kom for grazing.

1.2 Social Economic Stratification

Pastoralism is the main way of life in this area. The area is of low potential (very arid) and mainly used for livestock rearing. The number of goats per household is reportedly 350.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

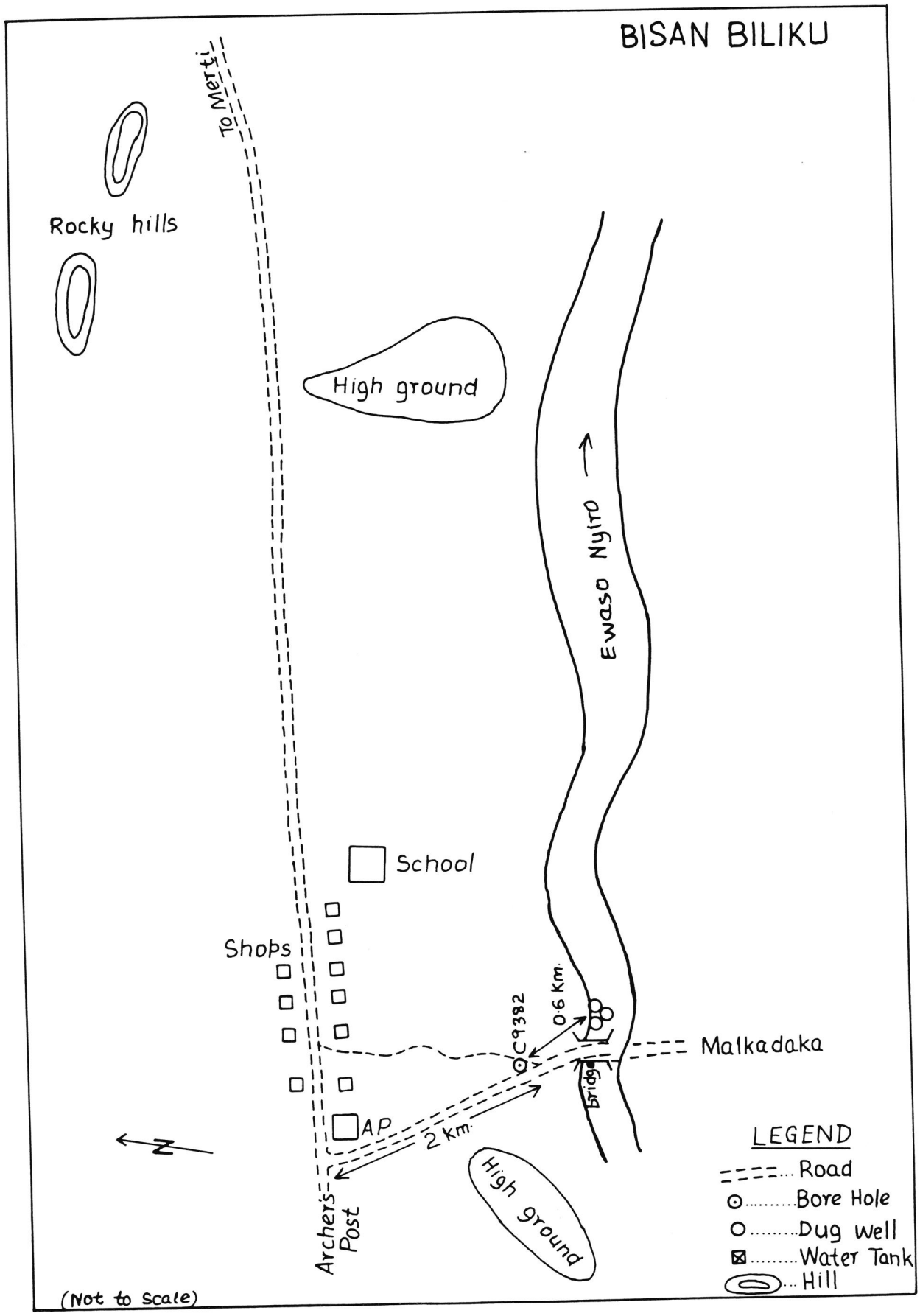
The centre is located on the Merti - Isiolo road. It is in Kom Sub-location of Bisan Biliku Location of Merti Division and lies approximately on longitude 38° 35' and latitude 0° 55'.

2.2 Topography

The centre is located to the north of the Ewaso Nyiro river in an area with is generally flat with some elevated Basement outcrops. The Merti Plateau is approximately 10 km to the north. The elevation of the centre is about 360 m A.S.L.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 300 - 350 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 25 - 30°C.



Sketch of the Project Area

2.4 Soils and Vegetation

The soils found in the area are greyish clay with medium to fine sand. They are derived from the Basement rocks.

The vegetation is scrubs, typical for Basement areas.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

The Locational and Sub-locational chief's office are located at the centre. There is also an administration police post.

3.2 Education

There is a primary school of which the number of students varies due to the nomadic way of life of the inhabitants. In April 1991 there were about 56 children and 9 teachers.

3.3 Health

There is no health centre, but one is being organised through self-help. A public health technician is stationed at the centre. The drugs would come from the Government Hospital. The most common disease is malaria.

3.4 Commerce

There are 6 shops at this centre, with very little commercial activities. There are also 3 tea rooms.

3.5 Transport

There is no public transport except for occasional Government vehicles. Transport is by donkeys.

3.6 Agriculture

No agricultural activities are practised at the moment.

3.7 Livestock Husbandry

No livestock facilities are present. A livestock technician is supposed to stay at the centre, but he is at Merti.

4. WATER RESOURCES

4.1 Groundwater

Bisan Biliku centre is within zone 2 of the geologic formation. This zone is comprised of fissured and/or weathered metamorphic rocks of the Basement System.

Geophysical investigations have been done by WRAP and also a borehole was drilled. The yield was about 4 m^3/h. The water was highly saline (EC= 19 mS/cm), despite the proximity to the Ewaso Nyiro River. Apparently there is no recharge from the river to this aquifer.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	Remarks
C9382	40	34	-	4.0	19	Borehole abandoned

The possibility to use groundwater at this centre is very unlikely. The only fresh groundwater is found in the sandy sediments of the Ewaso Nyiro River.

4.2 Surfacewater

The Ewaso Nyiro is almost always flowing at this point. Drying of the river is rare. A miscellaneous gauging at 27th January 1990 gave a flow of 8.0 m^3/second.

The flow in April 1991 at the end of the dry season was about 2 m^3/second. The EC of the water was 873 μS/cm.

5. WATER DEMAND

5.1 Human Population

The population of the centre used for the demand calculation is 1,500. A population growth rate of 4% is assumed for the project area.

5.2 Education

The number of students used for the demand calculation is 150. The school is assumed to grow at a higher rate as the population: 6%.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock shall use water directly from the Ewaso Nyiro. Therefore demand from livestock is not taken into account.

5.4 Health

If a dispensary will be constructed the daily attendance is assumed to be 15 outpatients per day. The growth rate of the health centre attendance is taken to increase with the population growth of 4%.

5.5 Commerce

The present number of shops and other utilities are assumed to increase during the design period at 2 %.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	75	91	270	799
	using Communal Water Points	1,425	1,733	2,430	3,198
Education	Primary Schools: Students	150	201	360	533
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	-	-	-	-
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	-	-	-	-
Health	No. of Beds	-	-	-	-
	No. of Outpatients	15	18	27	40
Commerce	Shops	6	7	9	11
	Tea rooms	3	3	5	6
	Butcheries	-	-	1	2
	Bars	-	-	1	1
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	10	12	18	27

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3 /day			
	1990	1995	2005	2015
Individual Connections	3.0	3.6	10.8	32.0
People using C.W.P's	14.3	17.3	24.3	32.0
Primary School	0.8	1.0	1.8	2.6
Health Centre	5.3	5.4	5.5	5.8
Administration	0.3	0.3	0.5	0.7
Shops	0.6	0.7	0.9	1.1
Butcheries	-	-	0.5	1.0
Bars / Tea rooms	1.5	1.5	3.0	3.5
Hotels (Low Class)	-	-	-	-
Livestock	-	-	-	-
Total	25.8	29.8	47.3	78.7

6. EXISTING WATER SUPPLY

6.1 Technical Description

The population uses the Ewaso Nyiro river as source of water, by digging shallow wells (mados) in the riverbed. These wells are not lined and are destroyed whenever the river flows.

6.2 Livestock Use

There are no cattle troughs or pans in this area since the livestock takes water directly from the river.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Surface water: The Ewaso Nyiro river is a reliable source of water in most of the years, but during droughts the surface flow does not reach Bisan Biliku. This may occur more often in future, because of an increase in water use upstream along the river.

Groundwater: The deep groundwater is saline and is not an option. The only groundwater of good quality is found at shallow depths in the sediments near the Ewaso Nyiro river. This source should also be available during droughts, but the quantity may be restricted.

Rainwater: Although rainfall is limited this source may provide during part of the year an additional quantity of drinking water. The few shops and institutions at the centre which have iron sheet roofs should construct appropriate structures for collecting and storing rain water. Investigations into the feasibility of rock catchments (e.g. at Milima Tatu) should be carried out.

7.2 Alternative Technologies

Infiltration galleries with pumping: The abstraction of the shallow groundwater below the Ewaso Nyiro may be done using infiltration galleries (pipes) buried across the riverbed. The depth of the pipes depends on the minimum groundwater levels in the riverbed sands, and also on the depth of the clay layer(s) below the sands. This depth is not known, but may be only a few meters.

The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration pipes may also serve Malka Daka at the other side of the river by constructing a collector well on that side. The number of required infiltration pipes is not known as it depends on the groundwater depth and the permeability of the sands.

Handdug wells with handpumps: Handdug wells suitably located and constructed on the banks of the Ewaso Nyiro may be used to tap the shallow groundwater. The yield of the wells may be low and thus only handpumps should be installed. This would replace the current use of untreated water from the Ewaso Nyiro.

Surface water intake with treatment and pumping: Although this would require treatment, the ease of abstraction of larger quantities makes it a good system for future development. The drawback of the system is that surface water is not always available and also that intake structures in the river are liable to damage from floods. The use of a common intake and treatment for both Malka Daka and Bisan Biliku would lower the capital costs. The technologies involved are however beyond what the communities can handle at the moment.

Pump systems:
- Generating set with submersible pump
- Solar powered pumpset, which is favoured due to it's low maintenance requirement
- Windmill, but the low frequency of the wind with suitable speed limits it's use here.

7.3 Recommended System

The Ewaso Nyiro river is the only reliable source of good quality water in the area. The abstraction of the water may be done using infiltration galleries (pipes) buried across the riverbed. The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration pipes may also serve Malka Daka at the other side of the river by constructing a collector well on that side.

This system would eliminate the need for treating the Ewaso Nyiro water and also tap the sub-surface flow in case the river dried up. A solar pumping set with a stand-by generating set are recommended.

The feasibility of hand dug wells on the bank of the river should also be investigated. It is recommended to construct some of these wells and equip them with handpumps in addition to any other prestigious system recommended.

8. COST ESTIMATES

8.1 Capital Costs

The cost would be greatly reduced if Bisan Biliku and Malka Daka centre were to have a common system. The cost of an independent system is however estimated below.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	50,000
Construction of infiltration galleries 300 m.	450,000
Construction of collector well	25,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct additional storage 50 m^3	225,000
Pipework	600,000
Equip handdug wells with handpumps (5 no.)	125,000
Sub-Total	2,325,000
10 % Contingencies	189,000
Total Say	2,600,000

With a population of 1,500, the per capita construction costs will be Ksh. 1,700.

8.2 O & M Costs

The proposed water supply should provide a primary level of service, while allowing the individual users the opportunity to pay for higher services if they wish so. The revenue collection and appropriate tariff should be made by the community itself.

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the use of the solar system will limit the fuel requirements to a minimum.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	500
Other maintenance	3,000
Total	6,500

With the present population the per capita monthly O&M cost would be about Ksh. 4. An annual O&M cost per household (of five members) would be in the range of Ksh. 260, which should be affordable for most of the community members.

DADACHA BASSA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Dadacha Bassa is situated in the flood plain of the Ewaso Nyiro which has deposits of various alluvial soils. The centre relies on the Ewaso Nyiro river which however floods the area. The centre shifted to a new site in April 1989 due to the flooding. The old centre was 4 km from the old site of Malka Galla, another local centre. Now it is about 19 km from the new site of Malka Galla.

The population of Dadacha Bassa Deda was estimated by ILDP at about 1400 people in 1990. They live both in the centre and surrounding areas. If a water source is established the whole population is assumed to depend on it since there is no better source.

1.2 Social Economic Stratification

Livestock forms the basis of local wealth, but the population also depends on some irrigated agriculture. The area is of low potential (very arid) and the main land use activities are used for livestock rearing. Any farming without irrigation is impossible.

The wealth ranking exercise by ILDP showed that wealth in Dadacha Bassa is understood primarily in terms of livestock holdings. Average herds are moderate however with an individual average household owning about 18 cows and 34 sheep and goats.

The wealth data from two samples shows a general agreement in the distribution of households in most of the different wealth ranks. Thus the richest wealth rank had less than 20% of the households, the second richest about 30%, the middle group about 20%, the poor about 30% and the very poor about 10%.

The two richest groups dominate the economy. 70% of the sample's livestock wealth is held by these two groups. The two poorest groups on the other hand, own only 20% of the total sample livestock holdings. Both groups are however equal in numerical standing - the two richest household groups and the two poorest household groups both contain about 40% of the sample Population.[1]

1.3 Scope of the Report

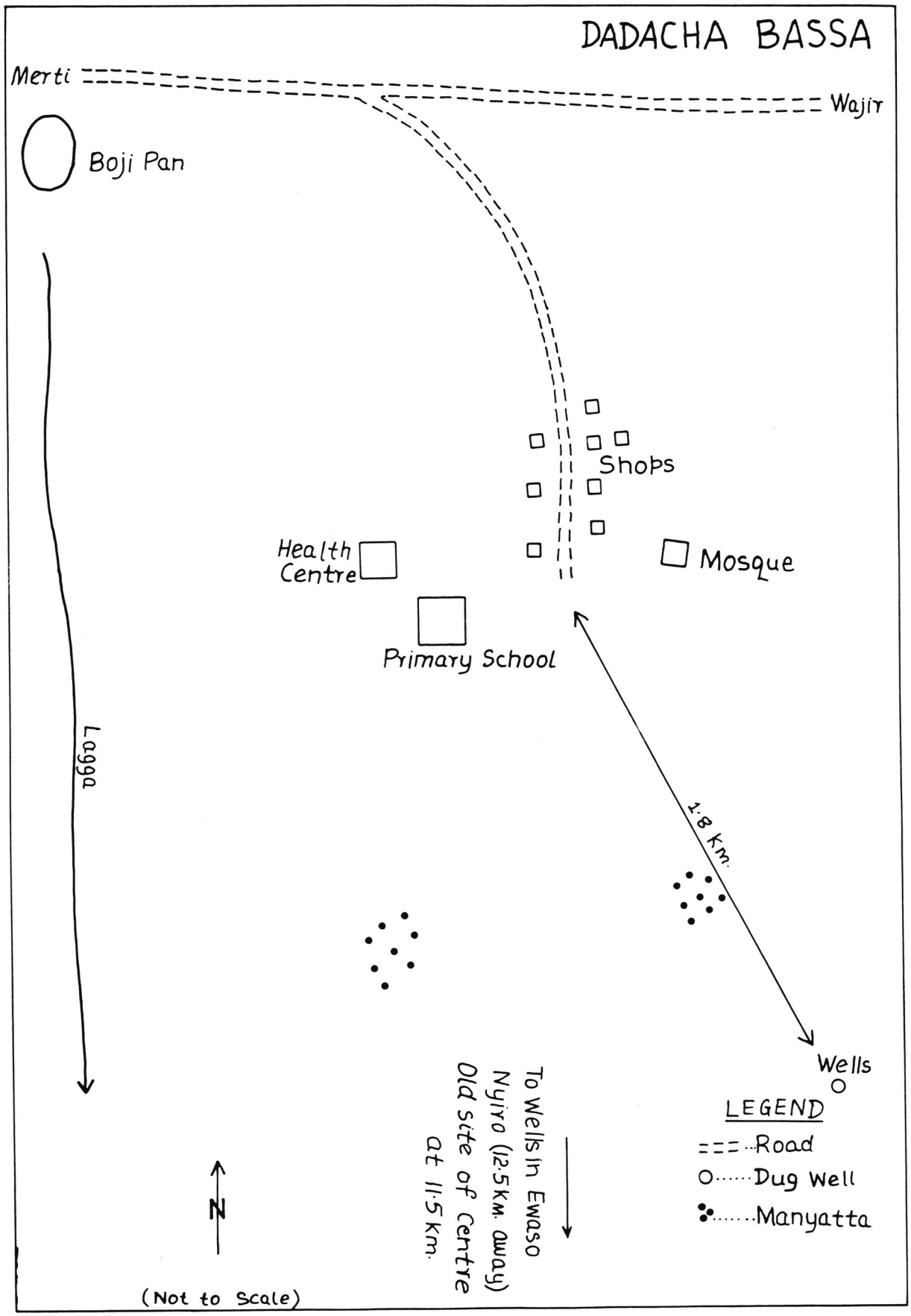
This report covers the supply of water to Dadacha Bassa local centre.

The river is approximate 2 km from the centre. The water supply in the centre will be for domestic use only and a few livestock which are left behind for milking and meat.

Dadacha Bassa is like Malka Galla in that they are both surrounded by grazing blocks which have boreholes and pans for livestock use during the dry seasons.

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[1] Source: Isiolo Livestock Development Project



Sketch of the Project Area

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The centre is located in Malka Galla Sub-location of Malka Galla Location of Merti Division, at about 50 km from Merti Divisional headquarters.

It is situated on latitudes 1° 10'N and 39° 10' E.

2.2 Topography

The area around the centre is generally flat. The seasonal swamp starts at about 3 km from the centre. The main channel of the Ewaso Nyiro is at 12.5 km, about 1 km from the old site of Dadacha Bassa. Large parts of the area are flooded in the wet season. Increasingly from year to year the flooding extends more north.
The elevation of the centre is 300 m a.s.l.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of about 250 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 25 - 30°C.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

The vegetation of the area is bushed grassland and wooded bush occurring on the deposits of various alluvial soils of Ewaso Nyiro river. The grass cover of the plains is mainly perennial.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

Dadacha Bassa trading centre has no public offices. The assistant chief of Yamicha Sub-location resides in Dadacha Bassa, because there are no Boran pastoralists living in Yamicha. By local arrangement the assistant chief is responsible for Dadacha Bassa Deda, although this Deda belongs to Malka Galla Sub-location. There are no other public servants or agents working in the centre.[2]

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[2] Source: Isiolo Livestock Development Project

3.2 Education

The primary school has 120 children and the nursery has 14 children. There are 8 teachers.

3.3 Health

There is no health centre. A dispensary is under construction. When this is finished the daily attendance is assumed to be 15 outpatients.

3.4 Commerce

There are 8 shops. The centre serves as a transit route for traded livestock coming from Wajir District heading for Isiolo and other southern markets.

3.5 Transport

There exists no public transport except for very occasional Government vehicles. Transport is mainly by donkeys.

3.6 Agriculture[3]

A total of 114 farmers were involved in irrigation agriculture in late 1989. 160 families were registered as being members of the irrigation scheme. There are two irrigation schemes in Dadacha Bassa deda. These are the old Dadacha Bassa irrigation scheme which was 160 acres, and the new Bassa scheme which is composed of 80 acres of farm-land. Before the 1989 rains, Dadacha Bassa had 140 acres of land.

The old Bassa site has been deserted by the farmers however as the shift of the Ewaso Nyiro river to the north led to flooding and obliteration of the old scheme. A new scheme has been prepared by the farmers that will cover 80-90 acres land, and that will have 120 farmers. The average acreage per farmer is from half acre to two acres.

When the Bassa farms yield a crop, eight up to twelve bags of maize per acre will be realized. In the short rains of 1989, 1500 bags of maize were realized.

All other problems of irrigation agriculture pale beside the overwhelming troubles farmers face in the uncontrollable Ewaso Nyiro river. Floods, swamping sudden unforeseen shifts in the river's course from one to another of many possible channels in the vast Rako make farming a very hazardous prospect.

3.7 Livestock Husbandry

This area has no livestock facilities. They use the crushes at Merti. Drugs and veterinary services are provided by mobile livestock officials.

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[3] Source: Isiolo Livestock Development Project

The grazing of the cattle in the plains north of the centre is preferred to grazing in the swamp of the Ewaso Nyiro. This is because of the more nutritious grasses in the plains and the biting flies in the swamp.
The area near the centre is not very good for sheep and goats.

4. WATER RESOURCES

4.1 Groundwater

The centre falls under zone 1a of the geologic formation. This zone is comprised of pervious sedimentary rocks encountered at different levels of confinement by clay layers, underlying alluvial sand and clay layers.

Currently a group of shallow dug wells about 1.5 km to the south-east of the centre are used. They were dug by the women on their initiative, but they dry quickly. alternatively the people go to the Boji Pan which is at 2.7 km to the west of the centre.

The wells at the old site of the centre are the most reliable source, but they are 12.5 km from the present centre. The depth to water was 3 m. and they last during long dry periods. The EC measured was 771 μS/cm and in a well with the water somewhat deeper 1119 μS/cm.

Possibilities for groundwater only exist in the alluvial sediments near to the Ewaso Nyiro river. However due to the movement of the river course in northern direction, these may not be accessible. There are no prospects for groundwater near the centre.

4.2 Surfacewater

No source of surface water. The Ewaso Nyiro is difficult to reach when flowing due to flooding.
The Boji pan is at 2.7 km to the west of the centre. It is a small pan and needs maintenance.

5. WATER DEMAND

5.1 Human Population

The population was estimated at 1,400 for the purpose of the demand calculation. A population growth rate of 4% is assumed for the project area.

5.2 Education

The school is assumed to grow at a higher rate as the population: 6%.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that 10 % of the livestock shall depend on the water supply.
The number of animals provided with water will be constant and thus will not grow.

5.4 Health

The health centre attendance is taken to increase with the population.

5.5 Commerce

The present number of shops and other utilities are assumed to increase during the design period at a rate of 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	70	85	252	746
	using Communal Water Points	1,330	1,617	2,268	2,985
Education	Primary Schools: Students	142	190	340	503
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	3,000	3,000	3,000	3,000
	Sheep	1,000	1,000	1,000	1,000
	Camels	-	-	-	-
	Donkeys	150	150	150	150
	Total Livestock Units	1,126	1,126	1,126	1,126
Health	No. of Beds	-	-	-	-
	No. of Outpatients	15	18	27	40
Commerce	Shops	8	9	11	13
	Tea rooms	0	2	2	3
	Butcheries	0	-	1	1
	Bars	0	-	1	1
	Hotels (No. of beds)	0	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	2.8	3.4	10.1	29.8
People using C.W.P's	13.3	16.2	22.7	29.8
Primary School	0.7	1.0	1.7	2.5
Health Centre	5.3	5.4	5.5	5.8
Administration	0.1	0.2	0.2	0.3
Shops	0.8	0.9	1.1	1.3
Butcheries	-	-	0.5	0.5
Bars / Tea rooms	-	1.0	1.5	2.0
Hotels (Low Class)	-	-	-	-
Livestock	56.3	56.3	56.3	56.3
Total	79.3	84.4	99.6	128.4

6. EXISTING WATER SUPPLY

6.1 Technical Description

Currently a group of shallow dug wells about 1.5 km to the south-east of the centre are used. They were dug by the women on their initiative, but they dry quickly. alternatively the people go to the Boji Pan which is at 2.7 km to the west of the centre.

The wells at the old site of the centre are the most reliable source, but they are 12.5 km from the present centre. The wells were visited in April 1991. The depth to water was 3 m. The EC measured was 771 μS/cm and in a well with the water somewhat deeper 1119 μS/cm. They are reported to last during long dry periods.

6.2 Livestock Use

There are no cattle troughs in this area. The livestock takes water directly from the river or from the pan.

6.3 Institutional Analysis[1]

Management systems for different water points are different. Three patterns can be identified.

1. The shallow hand dug wells in the river beds are managed and controlled through the traditional customary systems. The Aba-Hirega or area water manager, and Aba-konfi or owner/controller/ founder of a well system operates to manage the hand dug wells.

2. The Malkas or access points for livestock watering in Dadacha Bassa are not actively controlled by any particular group although in part of the river in Dadacha Bassa, some control the access paths is exercised by the ola just opposite the site on the river.

3. Dams and pans are not managed by any system, although traditionally the Boran have very elaborate dam maintenance customary regulations.

4. Boreholes are managed by various committees that are chosen from among the pastoralists. However in the Bassa region, the last time there was a borehole committee was during the drought of l987.

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[1] Source: Isiolo Livestock Development Project

7. PROPOSED WATER SUPPLY

7.1 Recommendations

The new site of Dadacha Bassa centre offers very limited potential for adequate water sources. Surface water seems not possible, because a pan would not provide water during long dry periods, and also because good sites for a pan in the immediate vicinity are not known. Using surface water would also necessitate treatment of the water.

Groundwater is available at the site of the dug wells 1.5 km to the east of the centre and in the Ewaso Nyiro River. The dug wells are reported to dry up during the year and therefore this area probably does not offer enough groundwater to satisfy the demand all year around.

The area along the Ewaso Nyiro may provide enough groundwater potential to supply the centre, but the problem here is the flooding and the distance to the centre. However a supply system may be designed using boreholes of which the casing extends above the highest flood level and which are pumped with a submersible pumps driven by a generator or by a solar system. The generator or solar panels, together with a storage tank should be constructed at a higher ground or maybe on a platform, and should be accessible during prolonged periods of flooding. Obviously such a system will be expensive.

The distance from the present site of the centre to the proposed boreholes in the flood plain of the Ewaso Nyiro is not known exactly, but may be more than 5 km. The costs of a pipeline to cover this distance and of the required pump capacity may be very high. The study for improving the water supply should therefore also consider whether the present location of the centre can be changed to a location more close to the water sources.

To summarise the recommendations for further studies:

- determine groundwater potential at dug wells 1.5 km east of the centre
- locate a site near the Ewaso Nyiro with sufficient fresh groundwater
- determine the viability and sustainability of a complete water supply system
- consider whether the location of the centre can be changed to ensure a water supply system at lower costs.

8. COST ESTIMATES

8.1 Capital Costs

The cost estimate presented here is very preliminary, because more studies are needed to determine the most viable water supply. The estimate is based on a proposed system similar to other nearby centres, with a borehole as source.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	200,000
Construction of a borehole 40 m. deep	150,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct storage 100 m^3	450,000
Pipework 5 km	1,500,000
Sub-Total	3,150,000
10 % Contingencies	315,000
Total Say	3,500,000

With a population of 1,400, the per capita construction costs will be Ksh. 2,500.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the use of the solar system will limit the fuel requirements to a minimum.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	5,000
Other maintenance	3,000
Total	11,000

With the present population the per capita monthly O&M cost would be about Ksh. 8. An annual O&M cost per household (of five members) would be in the range of Ksh. 470, which should be affordable for most of the community members.

MALKA GALLA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Malka Galla is situated in the flood plain of the Ewaso Nyiro which has deposits of various alluvial soils. The centre relies on the Ewaso Nyiro river which however floods the area. The centre shifted to a new site in April 1989 due to the flooding. The old centre was 4 km from the old site of Dadacha Bassa, another local centre. Now it is about 19 km from each other.

The population of Malka Galla Deda was estimated by ILDP at about 1600 people in 1989. They live both in the centre and surrounding areas. If a water source is established the whole population is assumed to depend on it since there is no better source.

1.2 Social Economic Stratification

Livestock forms the basis of local wealth, but the population also depends on some irrigated agriculture. The average herds are small with an individual owning about ten cows and fifty goats and sheep (source: ILDP).

1.3 Scope of the Report

This report covers the supply of water to Malka Galla local centre. The inhabitants of the project area are composed of a population which depends entirely on the hand dug wells on Ewaso Nyiro river bed when the river is dry. The river is approximate 6 km from the centre. The water supply in the centre will be for domestic use only and a few livestock which are left behind for milking and meat. Malka Galla is surrounded by grazing blocks which have boreholes and pans for livestock use during the dry seasons.

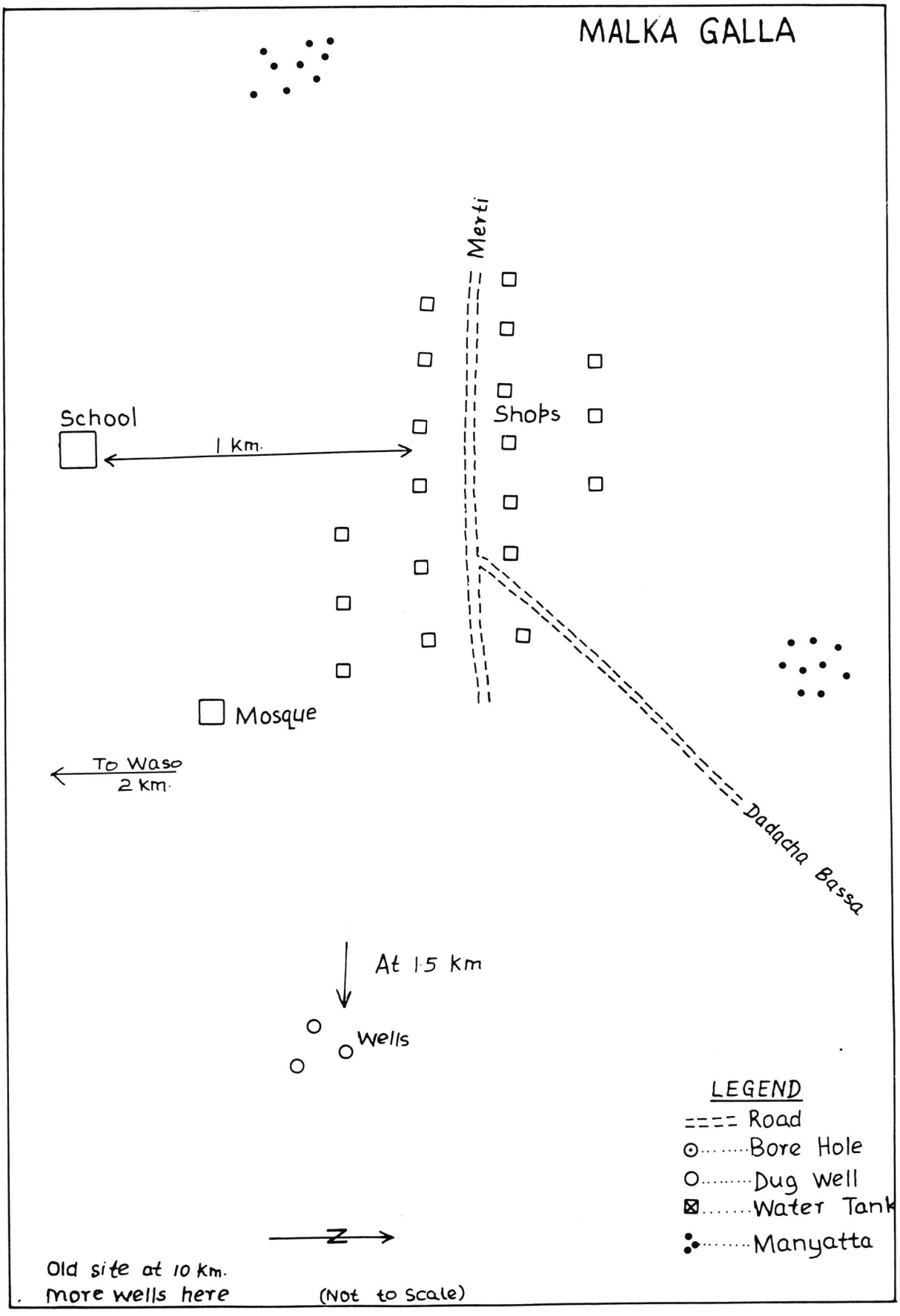
2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located north of the Ewaso Nyiro at 31.5 km from Merti Divisional headquarters. It is in Malka Galla Sub-location of Malka Galla Location of Merti Division. It is situated on latitudes 1° 10' N - 38° 55' E.

2.2 Topography

The area around the centre is generally flat. The Ewaso Nyiro is at about 6 km. and it floods large parts of the area in the wet season. Increasingly from year to year the flooding extends more north.
The elevation of the centre is 320 m a.s.l.



Sketch of the Project Area

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 300 - 350 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 25 - 30°C.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

The vegetation of the area is bushed grassland and wooded bush near the river and grass plains to the north. The grass cover is mainly perennial.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

An assistant chief is stationed at Malka Galla local centre. There is also an administration post. A mosque is being built by the Merti Quran Centre.

3.2 Education

There is a primary school with 158 children and 8 teachers. A pre-primary unit has 34 children and 2 teachers.

3.3 Health

There is no health centre. A dispensary has been proposed to be constructed soonest possible. If a dispensary will be constructed the daily attendance is assumed to be 20 out-patients. Currently a mobile clinic visits the centre twice a month.

3.4 Commerce

Malka Galla is a trading centre and serves as a stop on the transit route for traded livestock coming from Hadado of Wajir District heading for Isiolo and other southern markets. There are 8 shops.

3.5 Transport

There is a matatu commuting between the centre and Merti.

3.6 Agriculture

An irrigation scheme along the Ewaso Nyiro river covers 244 acres. The main crops are maize and beans.

3.7 Livestock Husbandry

This area has no livestock facilities. They use the crushes at Merti. Drugs and veterinary services are provided at Merti 31 km away.
The hawicha (milk) herd at the centre numbers about 700 cows.

4. WATER RESOURCES

4.1 Groundwater

The centre falls under zone 1a of the geologic formation. This zone is comprised of pervious sedimentary rocks encountered at different levels of confinement by clay layers, underlying alluvial sand and clay layers.

A borehole C4425 was drilled at the site of the old centre. Test pumping and chemical analysis were not carried out.

Currently a group of shallow dug wells about 1.5 m deep is the only source used at the centre. They are located about 1.5 km to the east of the centre and last about 6 months. The EC is 872 μS/cm.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	Remarks
C4425	180	34.5	33	-	In alluvial sediments, abandoned
C6952	-	dry	-	-	In tertiary sediments

Possibilities for groundwater only exist in the alluvial sediments near to the Ewaso Nyiro river. However due to the movement of the river course in northern direction, these may not be accessible. There are no prospects for groundwater near the centre.

4.2 Surfacewater

No source of surface water. Nearest source is Uaso Nyiro when not dry which is approximately 5 km from the centre.

5. WATER DEMAND

5.1 Human Population

Approximate growth rate of 4% is assumed for the project area. The total population in 1990 is 1600 people.

5.2 Education

The growth of the primary school is assumed to be higher than the population growth: 6%.

5.3 Livestock

The hawicha herd of about 700 cows is assumed to depend on the new water supply. The number of animals provided with water will be constant and thus will not grow.

5.4 Health

The health centre attendance is taken to increase with the population at 4%.

5.5 Commerce

The present number of shops and other utilities are assumed to increase during the design period at 2 %.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	80	97	288	853
	using Communal Water Points	1,520	1,849	2,593	3,412
Education	Primary Schools: Students	166	222	398	588
	Other Schools : Students	36	48	86	128
Livestock	Indigenous Cattle	700	700	700	700
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	233	233	233	233
Health	No. of Beds	-	-	-	-
	No. of Outpatients	20	24	36	53
Commerce	Shops	8	9	11	13
	Tea rooms	2	2	2	3
	Butcheries	0	1	1	1
	Bars	0	-	-	-
	Hotels (No. of beds)	0	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3 /day			
	1990	1995	2005	2015
Individual Connections	3.2	3.9	11.5	34.1
People using C.W.P's	15.2	18.5	26.0	34.1
Primary School	1.0	1.4	2.4	3.6
Health Centre	5.4	5.5	5.7	6.1
Administration	0.1	0.2	0.2	0.3
Shops	0.8	0.9	1.1	1.3
Butcheries	-	0.5	0.5	0.5
Bars / Tea rooms	1.0	1.0	1.0	-
Hotels (Low Class)	-	-	-	
Livestock	11.7	11.7	11.7	11.7
Total	38.4	42.9	60.1	93.2

6. EXISTING WATER SUPPLY

6.1 Technical Description

Currently a group of shallow dug wells about 1.5 m deep is the only source used at the centre. They are located about 1.5 km to the east of the centre and last about 6 months. The EC is 872 μS/cm.

Other hand dug wells exist in the river bed of Ewaso Nyiro river. The wells are approximate 6 m deep. The people draw water from these wells using buckets.

6.2 Potential and Actually Served Beneficiaries

The Boran community are the ones using these wells for domestic and their livestock. The wells in the Ewaso Nyiro are only used during dry seasons because during the wet season the river flows.

6.3 Livestock Use

No cattle troughs near the wells. Pans and boreholes are found in the grazing areas, which are about 50 km from the market centre.

6.4 Institutional Analysis

The Boran community dig the wells for their own use and their livestock. Each family or group digs and controls their own well using Boran customary laws.

7. PROPOSED WATER SUPPLY

7.1 Recommended Systems

The new site of Malka Galla centre offers very limited potential for adequate water sources. Surface water seems not possible, because a pan would not provide water during long dry periods, and also because good sites for a pan in the immediate vicinity are not known. Using surface water would also necessitate treatment of the water.

Groundwater is available at the site of the dug wells 1.5 km to the east of the centre and in the Ewaso Nyiro River. The dug wells are reported to dry up during the year and therefore this area probably does not offer enough groundwater to satisfy the demand all year around.

The area along the Ewaso Nyiro may provide enough groundwater potential to supply the centre, but the problem here is the flooding and the distance to the centre. However a supply system may be designed using boreholes of which the casing extends above the highest flood level and which are pumped with a submersible pumps driven by a generator or by a solar system. The generator or solar panels, together with a storage tank should be constructed at a higher ground or maybe on a platform, and should be accessible during prolonged periods of flooding. Obviously such a system will be expensive.

The distance from the present site of the centre to the proposed boreholes in the flood plain of the Ewaso Nyiro is not known exactly, but may be more than 5 km. The costs of a pipeline to cover this distance and of the required pump capacity may be very high. The study for improving the water supply should therefore also consider whether the present location of the centre can be changed to a location more close to the water sources.

To summarise the recommendations for further studies:

- determine groundwater potential at dug wells 1.5 km east of the centre
- locate a site near the Ewaso Nyiro with sufficient fresh groundwater
- determine the viability and sustainability of a complete water supply system
- consider whether the location of the centre can be changed to ensure a water supply system at lower costs.

8. COST ESTIMATES

8.1 Capital Costs

The cost estimate presented here is very preliminary, because more studies are needed to determine the most viable water supply. The estimate is based on a proposed system similar to other nearby centres, with a borehole as source.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	200,000
Construction of a borehole 40 m. deep	150,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct storage 100 m^3	450,000
Pipework 5 km	1,500,000
Sub-Total	3,150,000
10 % Contingencies	315,000
Total Say	3,500,000

With a population of 1,600, the per capita construction costs will be Ksh. 2,200.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the use of the solar system will limit the fuel requirements to a minimum.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	5,000
Other maintenance	3,000
Total	11,000

With the present population the per capita monthly O&M cost would be about Ksh. 7. An annual O&M cost per household (of five members) would be in the range of Ksh. 400, which should be affordable for most of the community members.

BULESA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
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8. COST ESTIMATES

   8.1 Capital Costs
   8.2 O&M Costs

1. INTRODUCTION

1.1 Background

Bulesa is a local trading centre located some 22 km west of Merti Divisional Centre. The population of this centre varies from season to season since the area is inhabited by the nomadic tribe of Boran.

About 1,700 people live within and near the centre and some 400 at Buke Molu at about 3 km to the east. The centre has about 50 houses with corrugated iron roofs.

Several NGO's are active in the centre, such as the catholic mission (Macci Centre), the Merti Quran Centre, the NCCK and Action Aid.

1.2 Social Economic Stratification

Wealth in Bulesa is understood primarily in terms of livestock holdings. Average herds are very small however, with an average household owning about eight cows and thirty sheep and goats. The richest households have about 30% of the livestock while the poor groups have about 40% of the livestock.

The Bulesa rural population is very poor. About 40% is considered to be below the minimum acceptable livelihood, while another 25% is hanging on to the edge of pastoral existence. Agricultural activities supplement the traditional livestock economy. A few people are able to earn something through temporary jobs.[1]

1.3 Scope of the Report

This report covers the supply of water to Bulesa local trading centre only.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

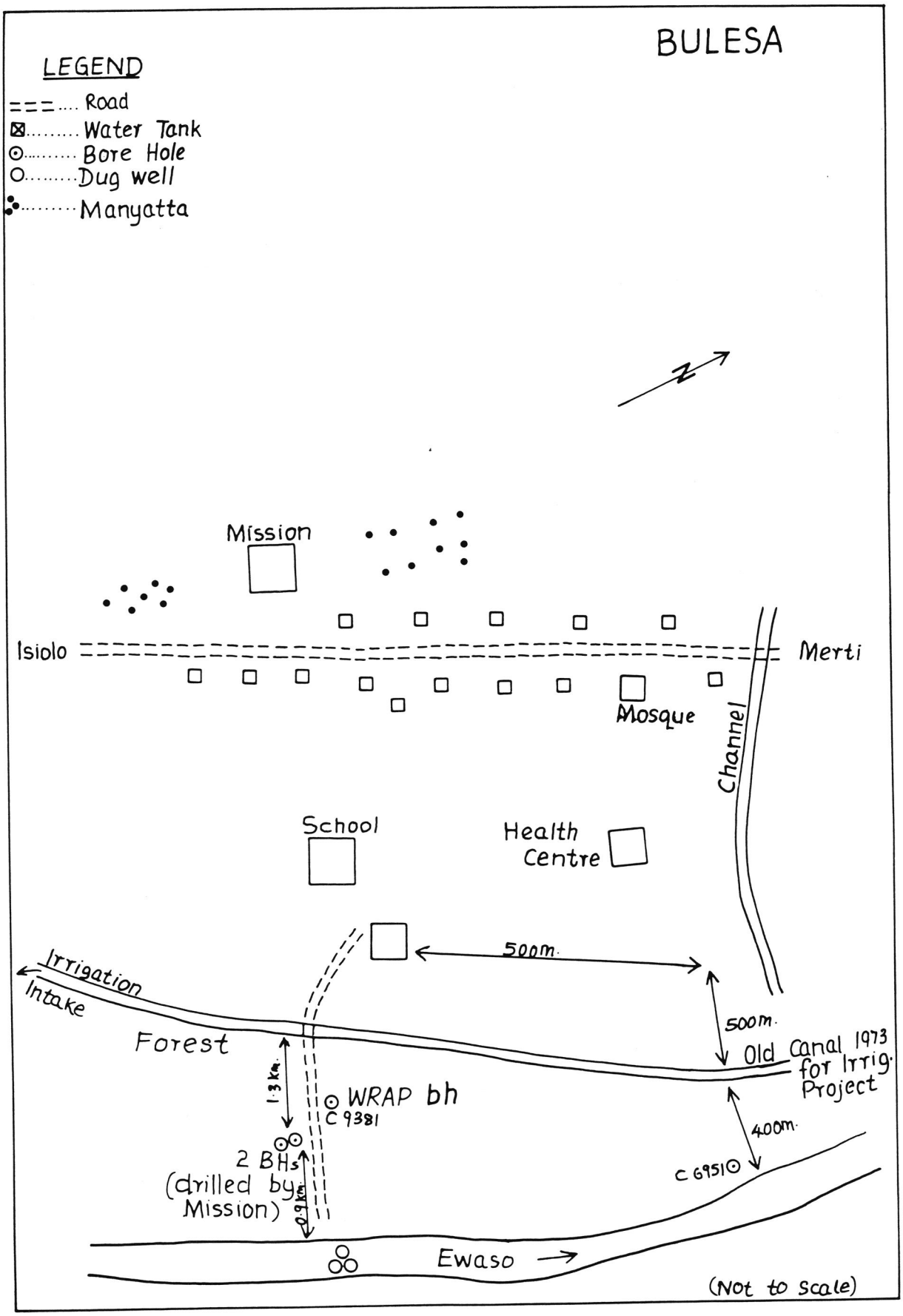
Bulesa is a Sub-location of Merti Location of Merti Division. The centre is located along the dry weather road between Archer's Post and Merti, at about 4 km north of the river Ewaso Nyiro.

2.2 Topography

The area is very flat since it is situated in the flood plain of the river Ewaso Nyiro. North of Bulesa is the Merti Plateau.

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[1] Source: Isiolo Livestock Development Project



Sketch of the Project Area

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 300 - 350 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 25 - 30°C.

2.4 Soils and Vegetation

The soils found in the area are greyish clay with medium to fine sand.

As is characteristic of the river Ewaso Nyiro and the laggas drawing into it in the area, there is alternating layers of clay and sand which are unconsolidated.

The area is covered by scrubland of medium bush and the monotony of this is broken by tall acacias. The grasses covering the area are tall and mainly perennial.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

An assistant chief is stationed at Bulesa local trading centre. The other public offices include an administration post, primary school, health centre and NCCK centre and an adult education teacher from Ministry of Culture and Social Services.

3.2 Education

Bulesa primary school is the only educational institution in the project area. Its current enrolment is 405 students. The pre-primary has 85 children.

3.3 Health

There is a GOK health centre which is not well equipped. The average daily outpatient attendance is about 20 people. The centre is run by two nurses.

3.4 Commerce

Bulesa local centre serves the people in the project area. There are 10 shops and 1 tea shop.

3.5 Transport

Bulesa local centre is situated along Isiolo - Merti earth track. There exists no public transport except occasional Government vehicles. Transport is by donkeys.

3.6 Agriculture[1]

Bulesa was the site of the first attempt by the NGO's in Isiolo to try irrigation farming, in 1960's. However, irrigation in Bulesa has not been a success due to the many problems associated with the shifting course of the Ewaso Nyiro river. In 1989 there ware 24 farmers working the Bulesa irrigation scheme. A total of 165 farmers were registered to be members of this scheme, which should be 137 acres. However, in 1989, only 50 acres were being prepared for irrigation.

The Godha irrigation scheme also in Bulesa has currently 42 farmers. The scheme has 30 acres, but only 22 acres were under crop. A new scheme has been developed in Bulesa, the Bulesa new scheme, but no crop has been planted as yet. Maize is the favourite crop grown.

Bulesa farming enterprises face two major problems:

1. Declining yields / Fields exhaustion problem.

Yields per area of land goes down very quickly after only a few crops. This has been suspected to be due to low soil fertility and / or a growing salinity problem. Various soil surveys have been under taken. These include a study by a Kenya Soil Survey team and an independent assessment by the FAO.

2. Flood water / Unreliable river regime problem

The uncontrollable nature of the Ewaso Nyiro and it's flooding pattern have led to the greatest problems in attempts to sustain irrigation agriculture. After the irrigation canals drainages and furrows are laid down, and farming commences, hardly a season will pass before the river Ewaso nyiro will flood carrying a lot of silt with it. Substantial amounts of this silt then ends up in the irrigation works. As a result the irrigation system either becomes paralysed or it becomes imperative that a lot of work shall be done before another crop can be expected. When it doesn't flood, the river may slightly change it's sandy river bed levels. Usually no water may enter the canals after any such shift.

3.7 Livestock Husbandry

Bulesa has no livestock market. Livestock handling facilities (crushes) and dips are not available. There is no organized outlet for animal health drugs as this is carried out by irregular unlicensed traders within the pastoral system.

Bulesa herds will use the Ewaso Nyiro during the dry seasons. In the wet season livestock will move to the Kom common grazing area. Hawicha herds will however remain in the vicinity of Bulesa, even though the herd hardly satisfies the demand for milk. There is only one camel herd resident at Bulesa, it belongs to the Goda Ola's.

Livestock graze on the plateau top but come down to the river for watering in the dry season. Paths are cut into the plateau to enable livestock to climb into the hill. These parts are destroyed by rains every wet season.

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[1] Source: Isiolo Livestock Development Project

4. WATER RESOURCES

4.1 Groundwater

Bulesa centre is situated in the contact zone between zone 1a and zone 2 of the geologic formations. Zone 1a is comprised of pervious sedimentary rocks encountered at different levels of confinement by clay layers. Zone 2 is comprised of fissured and/or weathered metamorphic rocks.

Boreholes C4662 and C6951 indicate that the aquifer in zone 2 is confined due to weathering of Basement system rocks into clayey material which forms an impervious layer above the aquifer. Water is of poor quality due to high value of salinity and iron.

The sediments of zone 1 are dry. Borehole C9381 drilled by WRAP at Bulesa was dry until 35 m. depth. Apparently there is no connection between the river water and these sediments due to a heavy clay layer. This aquifer has no potential.

The only fresh groundwater is found at shallow depths in the sandy riverbed of the Ewaso Nyiro. It seems that this water is the only suitable source for Bulesa. Hand dug wells 3 m. deep exist and are of good water quality.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HCO3 (mg/l)	Fe (mg/l)	Remarks
C4662	50	28	18	1.2	saline	-	-	High salinity, bh. abandoned
C6951	50	16.5	11.5	2.4	11.52	790	8.8	Backfilled to 20 m., Capped
C9381	35	dry	-	-	-	-	-	Drilled by WRAP, abandoned

4.2 Surfacewater

The only surface water source for this centre is the Ewaso Nyiro river, approximately 4 km from the town. The Ewaso Nyiro river has water in the entire period of the year. The last time the river dried up at this point was in 1984 during the drought period. Gauging records are not readily available for this river at this point, but it is a reliable source of surface water.

The Ewaso Nyiro itself is a migratory channel. After the Kismitir in Kom grazing Area, the Ewaso Nyiro enters a floodplain. From here the river may take any of a number of possible channels on its way to the lower Bassa swamps and the Rako of the Galana systems where it disappears as a flowing river. This unpredictable pattern has a great negative impact on the potential for irrigation agriculture in Isiolo.[1]

[1] Source: Isiolo Livestock Development Project

5. WATER DEMAND

5.1 Human Population

The population is taken for the purposes of the demand calculation at 1,700. A population growth rate of 4% is assumed for the project area.

5.2 Education

The student population including teachers is taken to be 500.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that 10% of the livestock will depend on the proposed water supply. The total number of livestock in the area is estimated at 1,700 LU.

5.4 Health

The growth rate of the health centre attendance is taken to increase with the population. A growth rate of 4% is taken.

5.5 Commerce

The present number of shops and other utilities are assumed to increase during the design period at a rate of 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	85	104	306	906
	using Communal Water Points	1,615	1,964	2,756	3,626
Education	Primary Schools: Students	500	669	1,198	1,773
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	510	510	510	510
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	170	170	170	170
Health	No. of Beds	-	-	-	-
	No. of Outpatients	20	24	36	53
Commerce	Shops	10	11	13	16
	Tea rooms	1	1	2	3
	Butcheries	-	-	1	2
	Bars	-	-	1	2
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	10	12	18	27

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	3.4	4.1	12.2	36.2
People using C.W.P's	16.2	19.6	27.5	36.2
Primary School	2.5	3.3	6.0	8.9
Health Centre	5.4	5.5	5.7	6.1
Administration	0.2	0.3	0.5	0.7
Shops	1.0	1.1	1.3	1.6
Butcheries	-	-	0.5	1.0
Bars/Tearooms	0.5	0.5	1.5	2.5
Hotels (Low Class)	-	-	-	-
Livestock	8.5	8.5	8.5	8.5
Total	37.7	42.9	63.7	101.7

6. EXISTING WATER SUPPLY

6.1 Technical Description

The people in the centre use water drawn from shallow dug wells in the Ewaso Nyiro. Donkeys are used to ferry the water from the river to the centre.

6.2 Livestock Use

The livestock uses the Ewaso Nyiro.

6.3 Financial Analysis

Currently water brought with donkeys from the river costs 3.- Shs per jerry can.

6.4 Institutional Analysis

The water supply to the centre has not been organised. The mission has tried to drill some boreholes, but were not successful. Non-governmental (NGO's) activities have had a decided impact on Bulesa society. The shamba committee organized through the Ministry of Agriculture are important resource use management bodies.

Several self help groups have been started in Bulesa and these are coordinated by the Ministry of Social Development through the Divisional social development assistant in Merti.

The main institutions governing resource use in Boran society operate in Bulesa as well. However, poverty in Bulesa has limited much of the elaborate interweaving of traditional law and customs. Pastoral camp are very large in Bulesa, partly because of the effect of irrigation systems, but also because of the fact that livestock numbers are low.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Surface water: The Ewaso Nyiro river is not a reliable source of water in most of the years. Therefore it can not serve as a source for a water supply.

Groundwater: The deep groundwater is saline and is not an option. The only groundwater of good quality is found at shallow depths in the sediments near the Ewaso Nyiro river. This source should also be available during droughts, but the quantity may be restricted.

Rainwater: Although rainfall is limited this source may provide during part of the year an additional quantity of drinking water. The few shops and institutions at the centre which have iron sheet roofs should construct appropriate structures for collecting and storing rain water.

7.2 Alternative Technologies

Infiltration galleries with pumping: The abstraction of the shallow groundwater below the Ewaso Nyiro may be done using infiltration galleries (pipes) buried across the riverbed. The depth of the pipes depends on the minimum groundwater levels in the riverbed sands, and also on the depth of the clay layer(s) below the sands. This depth is not known, but may be only a few meters.

The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration pipes may also serve Garfasa at the other side of the river by constructing a collector well on that side. The number of required infiltration pipes is not known as it depends on the groundwater depth and the permeability of the sands.

Handdug wells with handpumps: Handdug wells suitably located and constructed on the banks of the Ewaso Nyiro may be used to tap the shallow groundwater. The yield of the wells may be low and thus only handpumps should be installed. This would replace the current use of untreated water from the Ewaso Nyiro.

Pump systems:
- Generating set with submersible pump
- Solar powered pumpset, which is favoured due to it's low maintenance requirement
- Windmill, but the low frequency of the wind with suitable speed limits it's use here.

7.3 Recommended System

The Ewaso Nyiro river is the only reliable source of good quality water in the area. The abstraction of the water may be done using infiltration galleries (pipes) buried across the riverbed. The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration pipes may also serve Gafarsa at the other side of the river by constructing a collector well on that side.

This system would eliminate the need for treating the Ewaso Nyiro water and also tap the sub-surface flow in case the river dried up. A solar pumping set with a stand-by generating set are recommended. The solar pump is estimated to provide 35 m^3/day.

The feasibility of hand dug wells on the bank of the river should also be investigated. It is recommended to construct some of these wells and equip them with handpumps in addition to any other prestigious system recommended.

8. COST ESTIMATES

8.1 Capital Costs

The cost would be greatly reduced if Gafarsa and Bulesa centre were to have a common system. The cost of an independent system is however estimated below.

The construction of the dug wells should have priority, in order to provide the centre with a supply of reliable water quality. The intake (infiltration galleries and clear water well) should have priority if funds are available. The siting and flood protection of this should be done by qualified personnel.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	50,000
Construction of infiltration galleries 300 m.	450,000
Construction of collector well	25,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct storage 100 m^3	450,000
Pipework 6 km	1,800,000
Equip handdug wells with handpumps (5 no.)	125,000
Sub-Total	3,750,000
10 % Contingencies	375,000
Total	4,125,000

With a population of 1,700, the per capita construction costs will be Ksh. 2,400. This is an expensive supply, mainly due to the distance between centre and source.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the use of the solar system will limit the fuel requirements to a minimum.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	2,000
Other maintenance	3,000
Total	8,000

With the present population the per capita monthly O&M cost would be about Ksh. 5. An annual O&M cost per household (of five members) would be in the range of Ksh. 300, which should be affordable for most of the community members.

KORBESA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Korbesa is on the major transit route for livestock coming from Wajir and Marsabit Districts through Isiolo to the southern markets. Korbesa centre is located about 20 km to the east of Merti and comprises about 30 houses with corrugated iron roofs. Around the centre many more or less permanent manyattas are constructed. The centre was moved in April 1989 about 2 km to the north due to flooding of the area. The health centre is still at the old site.

The population residing in the centre is about 1000, and about 800 pastoral people live around the centre.

1.2 Social Economic Stratification

The population in this area is mainly pastoral, but is also increasingly involved in irrigation (small scale). Korbesa is one of the most populated, rich and heavily grazed deda in the District.

The wealth survey by ILDP shows for the whole deda that the livestock is evenly distributed between the wealth classes. The richest class with over 50 TLU/household comprises 9% of the population and the poorest class with below 5 TLU/household comprises 27% of the population. This last relatively large group is considered to live below the minimum pastoral livelihood.

1.3 Scope of the Report

The report is to cover domestic water supply to Korbesa shopping centre alone.

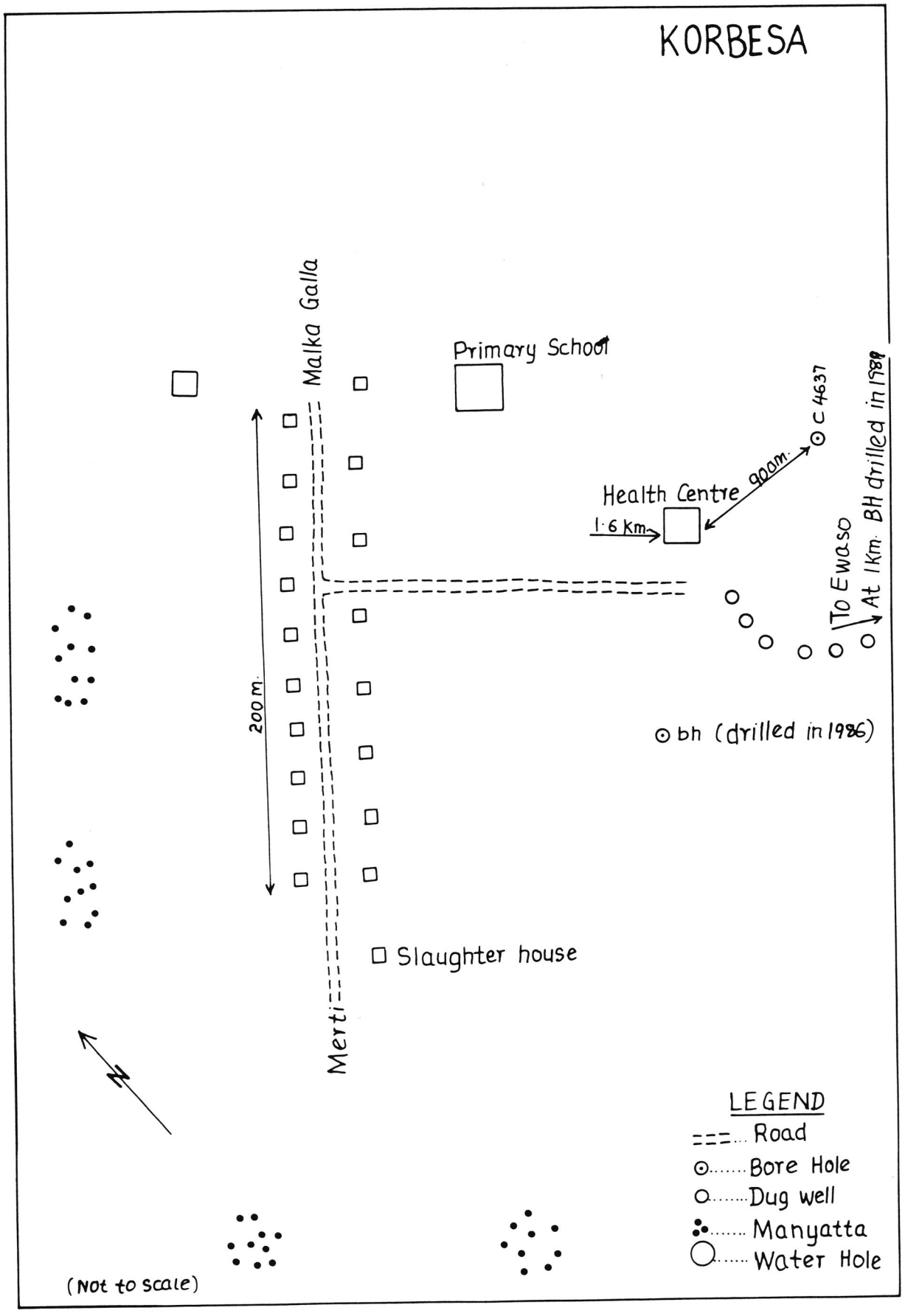
2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

Korbesa is located in Merti Location of Merti Division and is situated on the north bank of the Ewaso Nyiro River, at about 2 km from the edge of the river vegetation. The river is often dry at this point.

2.2 Topography

Korbesa is in a relatively flat area that is sloping towards the south to the Ewaso Nyiro river and gently rising towards the north.



Sketch of the Project Area

2.3 Climate

The project area falls under the arid climatic zone with an average annual rainfall of about 300 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures are about 31°C.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

The soils in Korbesa are mostly sandy clays. Vegetation in the Ewaso floodplain is characterised by open bushes. The plains to the north of the centre are covered by grasses.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

Korbesa Trading Centre is the residence of the Assistant chief. There are no other public offices.

3.2 Education

Korbesa has a Primary School and a Pre-primary School whose population are 175 persons and 55 persons respectively as per July 1989.

3.3 Health

The dispensary has an average out-patient attendance of 40 people per day. It is staffed by one clinical officer and one sub-ordinate staff. The building is infested by bats and urgently needs maintenance. The most common diseases are malaria, URTI and skin diseases (seasonal).

3.4 Commerce

There are five shops in the centre.

3.5 Transport

Korbesa is served by an earth track from Merti Trading Centre that is barely passable during the rainy season.

3.6 Agriculture

The project area has four irrigation schemes and a total of 138 families were in canal irrigation as by May 1989. After 1989 two schemes were damaged by the floods. Action Aid is engaged in providing extension services. The main crops are maize, cowpeas and beans.

3.7 Livestock Husbandry

The main economic activity is livestock husbandry in form of pastoralism. Cattle, sheep and goats are the main stock. The herding system follows the typical Boran husbandry pattern, with livestock primarily divided into a dry (fora) and a lactating (hawicha) herd. The hawicha is grazed within the range of the camps. In the morning in the plains north of the river, in the afternoon in the swamps along the river, when they are also watered. The fora herd is deliberately kept away from the camps and may be moved to Yamicha in the dry season.

Korbesa has no livestock market. This is at Merti. There is also no organised outlet for animal drugs and this trade is carried out by irregular unlicensed traders within the pastoral system.[1]

[1] Source: Isiolo Livestock Development Project

4. WATER RESOURCES

4.1 Groundwater

Korbesa centre falls under zone 1a of the geologic formation. This zone is comprised of pervious sedimentary rocks encountered at different levels of confinement by clay layers, underlying alluvial sand and clay layers.

Boreholes, C4637 and C6952 were drilled near the centre, however they turned out to be dry, and no casing was installed. Another borehole was drilled in 1989, 1 km. south of the centre. It was also reported to be dry to a depth of 100 m.

Possibilities for groundwater only exist in the alluvial sediments at the Ewaso Nyiro. However due to the movement of the river course in northern direction, these may not always be accessible.

At the time of the field visit in April 1991 wells were used which were dug in a zone extending from near the dispensary to about 1.5 km into the riverine vegetation. The depth to the groundwater was 3 m. The water quality of this shallow groundwater improved towards the river. Near the dispensary the EC was 2,840 μS/cm, at the edge of the forest 1,246 μS/cm, and at 1 km inside the forest 736 μS/cm. The "old" wells were located at 1.5 - 2 km inside the forest. Some of the wells had been flooded by some local rain in the previous week and the people were using this water during our visit. The EC of this water was only 500 μS/cm.

4.2 Surfacewater

The Uaso Nyiro river is the only surface water source nearby at a distance of approximately 6 - 8 km from the centre.

During the rain season, the health centre uses water from the roof catchment.

5. WATER DEMAND

5.1 Human Population

The initial population for the purpose of the demand calculations has been taken as 1,800 persons. A population growth rate of 4% is assumed for the project area.

5.2 Education

The number of students is assumed to increase at the same rate as the population

5.3 Livestock

The number of livestock in Korbesa is estimated at 1,600 LU. It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. An estimated 10% of this livestock shall depend on the Korbesa water supply.

5.4 Health

The growth rate of the dispensary attendance is taken to increase with the population, a growth rate of 4%.

5.5 Commerce

The present number of shops and other utilities are to assumed to increase during the design period at the same rate as the population, hence an increase of 4% p.a.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	90	109	324	959
	using Communal Water Points	1,710	2,080	2,917	3,839
Education	Primary Schools: Students	230	308	552	817
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	480	480	480	480
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	160	160	160	160
Health	No. of Beds	-	-	-	-
	No. of Outpatients	40	49	73	108
Commerce	Shops	5	6	7	9
	Tea rooms	0	-	2	3
	Butcheries	0	-	1	1
	Bars	-	-	-	-
	Hotels (No. of beds)	0	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	3.6	4.4	13.0	38.4
People using C.W.P's	17.1	20.8	29.2	38.4
Primary School	1.2	1.5	2.8	4.1
Health Centre	5.8	6.0	6.5	7.2
Administration	0.1	0.2	0.2	0.3
Shops	0.5	0.6	0.7	0.9
Butcheries	-	-	0.5	0.5
Bars/Tearooms	-	-	1.0	1.5
Hotels (Low Class)	-	-	-	-
Livestock	8.0	8.0	8.0	8.00
Total	36.3	41.5	61.9	99.3

The ultimate demand, 99.3 m^3/day shall be used for design purposes.

6. EXISTING WATER SUPPLY

6.1 Technical Description

Dug wells in the flood plain of the Ewaso Nyiro supply the centre with water. The water is collected in jerry cans using donkey trains to cover the distance to the camps. These unlined wells, some as deep as 6 m, yield varying amounts of water.

The boreholes drilled near the centre have not been successful.

The dispensary has two ferro cement roof tanks, 10 m^3 each. They were observed to leak and the officer said he uses also water from the wells.

6.2 Potential and Actually Served Beneficiaries

There is a high demand, while no amounts of water exist at convenient distances and quality.

6.3 Livestock Use

Access points for livestock watering along the river, called malkas, are the major watering places in Korbesa. Generally there are no restrictions governing the use of these points by Boran. However, in practice as the olas are spread in a line parallel to the river, every access point is associated with a group of olas some five to eight kilometres distant which control access into the swampland. No major or minor constructed water away from the river in Korbesa exists.

6.4 Financial Analysis

Water from the dug wells is sold at 2 Shs per jerry can, which may go up to 3 Shs in time of shortages.

6.5 Institutional Analysis

In the dry season the flow of the Ewaso Nyiro in Korbesa is reduced considerably. Mados or shallow hand dug wells are dug. Customary regulations govern the process of constructing and managing the wells. Water is still plentiful and most of the time even in the dry season there are some river channels with flowing water.

Organised groups or households (or herdsmen) led by a group leader assist themselves to have a source of water in an organised manner. Spacing of wells to avoid interruptions among livestock herds is decided upon depending on the group's influence. Local residents at the centre also monopolise wells used for sale of water if others fail to participate in the digging.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Surface water: The Ewaso Nyiro river is not a reliable source of water.

Groundwater: The deep groundwater is saline and is not an option. The only groundwater of good quality is found at shallow depths in the sediments near the Ewaso Nyiro river. This source should also be available during droughts.

Rainwater: Although rainfall is limited this source may provide during part of the year an additional quantity of drinking water. The few shops and institutions at the centre which have iron sheet roofs should construct appropriate structures for collecting and storing rain water.

7.2 Alternative Technologies

Handdug wells with handpumps: The currently used unprotected handdug wells situated in the flood plain of the Ewaso Nyiro may be protected to improve the water quality. However, because these wells are also used for livestock, the installation of handpumps may not be acceptable to the population, because of their low output.

Borehole or Dug Well with submersible pump: A shallow borehole or dug well with sufficient output may provide the required quantity of water for domestic use. The borehole should be located in the flood plain of the Ewaso Nyiro, which makes it necessary to find a site which will not flood. Alternatively the casing should be higher than the maximum flood level and the pump connected with a cable to a solar system or generator on a location which is safe from flooding.

Pump systems:
- Generating set with submersible pump
- Solar powered pumpset, which is favoured due to it's low maintenance requirement
- Windmill, but the low frequency of the wind with suitable speed limits it's use here.

7.3 Recommendations

The solution of the water supply to the centre may be found similarly to the system installed at Sericho. This would require drilling of boreholes in the Ewaso Nyiro sediments and the construction of a pipeline, storage tanks and water kiosks. A solar pumping set with a stand-by generating set are recommended.

For the siting of the boreholes a geophysical survey may be carried out, although the usefulness of such survey may be limited due to the thin water bearing zones in the sediments.

8. COST ESTIMATES

8.1 Capital Costs

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	100,000
Construction of a borehole 40 m. deep	150,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct storage 100 m^3	450,000
Pipework 4 km	1,200,000
Sub-Total	2,750,000
10 % Contingencies	275,000
Total Say	3,000,000

With a population of 1,800, the per capita construction costs will be Ksh. 1,700.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the solar system will provide 25 m^3/day. The remaining demand will be supplied by the diesel pump.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	2,000
Other maintenance	3,000
Total	8,000

With the present population the per capita monthly O&M cost would be about Ksh. 4.5. An annual O&M cost per household (of five members) would be in the range of Ksh. 270, which should be affordable for most of the community members.

MERTI

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

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ISIOLO

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8. COST ESTIMATES

- 8.1 Capital Costs
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1. INTRODUCTION

1.1 Background

Merti is a market centre that has grown from a small livestock market. The centre has a rapid growth in relation to other rural centres in the district. The population was 1,383 in 1979 and was estimated at 2,600 in 1988 (District Development Plan).

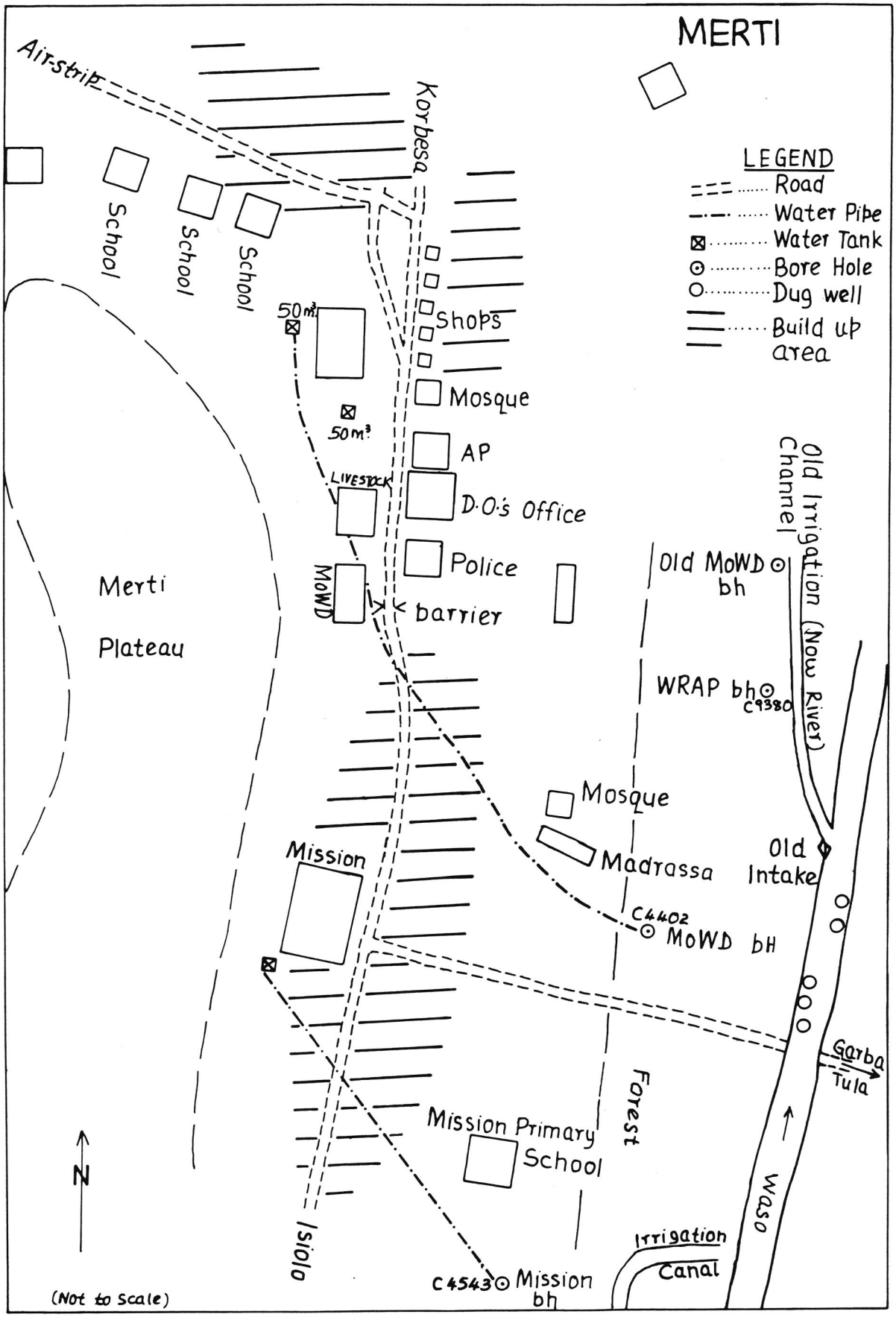
The development of the centre is stimulated through activities by the catholic mission and the Merti Quran Centre. Merti is more or less divided in a christian and a moslem part.

1.2 Social Economic Stratification

Merti is the main market north of the Ewaso Nyiro River. Part of the population therefore finds employment in trading or in wage labour. However the majority are pastoralists and depend on their livestock. Data on wealth ranking or household size is not available for Merti.

1.3 Scope of the Report

This report covers the provision of clean domestic water to Merti Market Centre and the surrounding area. This area is estimated at 10 sq. km and has a current population of 3,000 persons. The total livestock number in the area is assumed to be 5,400 T.L.U.



Sketch of the Project Area

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located in Merti Location of Merti Division, on latitude 1° 18' N and longitude 38° 30'E. It lies north of the Ewaso Nyiro river which is only 2 km away from Merti Trading Centre. The distance to Isiolo Town is about 160 km.

2.2 Topography

The centre is situated at the foot of the Merti plateau which extends to the west. The Ewaso Nyiro is about 2 km away. Generally the area is flat. Extensive plains exist to the north of the centre.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 300 - 350 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean maximum temperatures range between 30 and 35°C in the coldest and hottest months respectively.
Between July and September the climate is characterized by the presence of very dry winds and dust.

2.4 Soils and Vegetation

The soils are characterised by sandy clays of sedimentary origin covered with grass and scattered bushes.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

Merti is the Headquarters for Merti Division. It has the following administrative offices: District Officer's Office, Chief's Office, MoWD, Agriculture, Livestock, among others. There is an estimated 60 government staff in the project area.

3.2 Education

There are 4 primary schools with 312 children in pre-primary and 1,249 in primary, 1 secondary school with 67 children and a polytechnic with 8 students. The total number of teachers is 82 (information from Ministry of Education).

3.3 Health

The Merti Health Centre had in 1988 an attendance of 17,531. Also in the project area is a Catholic dispensary with an estimated daily attendance of 50 out-patients per day.

3.4 Commerce

There are 35 shops and 4 bars or hotels in the project area.

3.5 Transport

There are no public transport means in the project area. Transport is only by Government vehicles going to the various government offices in the project areas. The earth track leading to the centre is dusty during the dry seasons and barely passable during the rains.
Merti is served with telephone.

3.6 Agriculture

An irrigation project funded by CEFA is under implementation.

3.7 Livestock Husbandry

This is the main economic activity in Merti. There is a total of 5,400 L.U in the project area.

4. WATER RESOURCES

4.1 Groundwater

Merti centre falls under zone 1a of the geologic formation. This zone is comprised of pervious sedimentary rocks encountered at different levels of confinement by clay layers, underlying alluvial sand and clay layers.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HCO3 (mg/l)	F (mg/l)	Remarks
C3853	67	30.2	21.6	4.6	26.4	2,640	12.5	Abandoned
C3864	42.7	11.3	12.3	13.6 ?	0.87	483	0.4	Casing pulled, due to low yield
C4402	50	42	15	8.2	0.93	-	-	MoWD Water Supply
C4543	50	20 & 38	14	4.0	0.89	-	-	Cath. Mission borehole
C4561	50	8 & 26	17.5	4.6	0.94	164	1.1	Damaged by flooding
C9380	45	30	15	15	-	-	-	Drilled by WRAP

Boreholes should be drilled only in the alluvial sediments, otherwise the water quality is likely to deteriorate.
The borehole drilled by WRAP may be equipped to boost the centres water supply.

4.2 Surfacewater

The Ewaso Nyiro river is approximately 2 km from the town and less than 1 km from the MoWD-borehole to the river.

The river sometimes dries up at Merti, making it not very reliable as water source during the dry period. The dry period happens to be longer than the wet period in this area.

There used to be a surface water supply from the river but due to the unpredictable drying of the river and the breakdown of the pumping machine, the source was abandoned.

River gauging at Merti on 28th January 1990 was 4.73 m^3/second. In April 1991 the river was flowing at Bulesa but not at Merti.

Due to the risk of crocodiles while wading, and lack for boats to enable gauging, not much of gauging records are available on this part of the river.

5. WATER DEMAND

5.1 Human Population

A population growth rate of 5% is assumed for the project area. The current population is taken to be 3,000 persons.

5.2 Education

All education institutions in the project area have a total of 1,700 pupils and teaching staff. This number appears to be exaggerated therefore a figure of 1200 was used for the demand calculation. The number of pupils is assumed to increase at a higher rate of 6% as the population.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock shall use the Ewaso Nyiro or an independent water supply.

5.4 Health

The two health centres have a total out-patient attendance of 100 per day. The growth rate of the health centre attendance is assumed to be equal with the population growth.

5.5 Commerce

The present number of shops and other utilities are likely to increase during the design period. Growth rate is taken as 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	150	182	594	1,936
	using Communal Water Points	2,850	3,467	5,350	7,747
Education	Primary Schools: Students	1,120	1,363	2,017	2,986
	Other Schools : Students	80	97	144	213
Livestock	Indigenous Cattle	-	-	-	-
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	-	-	-	-
Health	No. of Beds	-	-	10	15
	No. of Outpatients	100	122	180	266
Commerce	Shops	35	39	48	59
	Tea rooms	4	5	6	8
	Butcheries	2	2	2	2
	Bars	-	-	1	1
	Hotels (No. of beds)	20	24	36	53
Administration	Number of staff	60	73	108	160

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	6.0	7.3	23.8	77.4
People using C.W.P's	28.5	34.7	53.5	77.5
Primary School	6.0	7.3	10.8	16.0
Health Centre	12.0	12.4	19.6	26.8
Administration	1.5	1.8	2.7	4.0
Shops	3.5	3.9	4.8	5.9
Butcheries	1.0	1.0	1.0	1.0
Bars / Tea rooms	2.0	2.5	3.5	4.5
Hotels (Low Class)	1.0	1.2	1.8	2.7
Livestock	-	-	-	-
Total	61.5	72.1	121.5	215.8

The ultimate water demand is taken for design purposes to be 216 m^3/day

6. EXISTING WATER SUPPLY

6.1 Technical Description

The MoWD operates a borehole with a submersible pump with a 12 HP diesel generating set. The water is pumped to two 50 m^3 storage tanks, through a 75 mm diameter rising main.

The Catholic Mission operates a borehole which supplies only the mission with water. The borehole is equipped with two pumps driven by a generator set and by a solar system with 35 panels.

6.2 Potential and Actually Served Beneficiaries

Most of the beneficiaries are schools, public offices, catholic mission health centre and the business premises in the market centre. There are 87 individual connections.

6.3 Livestock Use

No livestock uses this water supply since most of the livestock get water from the Ewaso Nyiro river.

6.4 Functional Analysis

This MoWD water supply covers an area of 7½ km^2 and it's performance and reliability are good. It pumps ten hours but still the water is not enough, possibly due to leakages or misuse of water by not closing taps.

On average the supply operates 30 days per month.

6.5 Financial Analysis

The MoWD water supply earned in 1988/89 financial year Ksh. 22,000 from water sales. Ksh. 125,000 was spent on running the supply. This is presumably due to the nature of the connections which are not metered resulting to users being charged less than what they actually consume.

6.6 Institutional Analysis

The MoWD runs one of the boreholes. It has a water inspector, 1 water supply operator and 2 pump attendants attached to the water supply. A new workshop is built in 1991 to serve the whole of Merti Division.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Boreholes: The groundwater potential at Merti seems sufficient for the supply of the town. The existing borehole is pumped with a submersible pump driven by a generator. The new borehole could also be equipped with a pump driven by a generator, but it is advisable to consider also a solar driven pump. It is possible to install two pumps in one borehole, one driven by a generator and one driven by a solar system. It is not possible to use the same pump for both a solar system and for a generator, because the solar system requires a special type of pump, which can not be driven by a generator.

Infiltration galleries: These could be laid across the lagga to improve the production of wells constructed in the banks of the lagga. This is expensive and probably therefore not a feasible option at Merti.

Roof catchment: Rain water could be an additional source of drinking water for institutions etc. with a large enough roof. Rainfall quantities are low however and therefore this source remains limited.

7.2 Recommended Systems

The existing system should continue to be utilized and in addition the new borehole drilled by WRAP near the town can be equipped and connected to the distribution system. It is recommended to use different energy sources for pumping to enhance the reliability of the system. An additional storage tank may be required.

8. COST ESTIMATES

8.1 Capital Costs

The estimate is made on the understanding that the existing facilities including storage and reticulation shall be utilized. The system should be repaired immediately to limit the excessive leakages observed during the field visit. Extension of the system should be started only in case the existing system operates satisfactorily after these repairs. Equipping the new borehole with a solar system should be the priority.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	50,000
Install pump sets solar	600,000
Construct additional storage (100 m^3)	450,000
Additional Pipework (1 km)	300,000
Sub-Total	1,400,000
10 % Contingencies	140,000
Total	1,540,000

With a population of 3,000, the per capita construction costs will be about Ksh. 500.

8.2 O & M Costs

Five water supply attendants of various training and experience have been found to be necessary. The attendants should include a mechanic, a pipe fitter and an electrician.

It is assumed that the existing diesel powered system shall be used in combination with the solar system. The solar system is estimated to yield 25 m^3/day.

MONTHLY O&M COSTS

Description	Amount Ksh.
Staff salary	6,000
Fuels for pumping 4 hours per day	4,000
General maintenance	7,500
Total	17,500

With the present population the per capita monthly O&M cost would be about Ksh. 6. An annual O&M cost per household (of five members) would be in the range of Ksh. 350, which should be affordable for most of the community members.

More emphasis should be put on the revenue collection. The District Water Board should come up with a suitable solution to meet the cost recovery criterion.

ELDERA

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

Available records, dating back to early 70's, indicate that Eldera Water Supply Project was included under District Development grant aided project. Attempts to secure an adequate and reliable water source have been previously made but no success has been registered.

The residents of the centre continue to suffer hardships related to unavailability of adequate water; further evidenced by reports from Education, Health and Livestock Division officeS. All mention seriousness of the prevailing water shortage.

The ethnic composition of the residents is mainly Somali and Boran. With a few employed mixed group at the centre. Main resident population is composed of elderly people and children while the youths look after livestock in far off places in the grazing areas. During wet seasons or immediately after rains, the pastoralists might graze near the centre, hence reside there.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project area is located midway between Garba Tula and Modogashe trading (40 km from each) centres; it is 160 km from Isiolo Town along the main road from Isiolo to Wajir. Rough location on topographical maps indicate the centre to be at 38° 45'E and 0° 35'N.

2.2 Topography

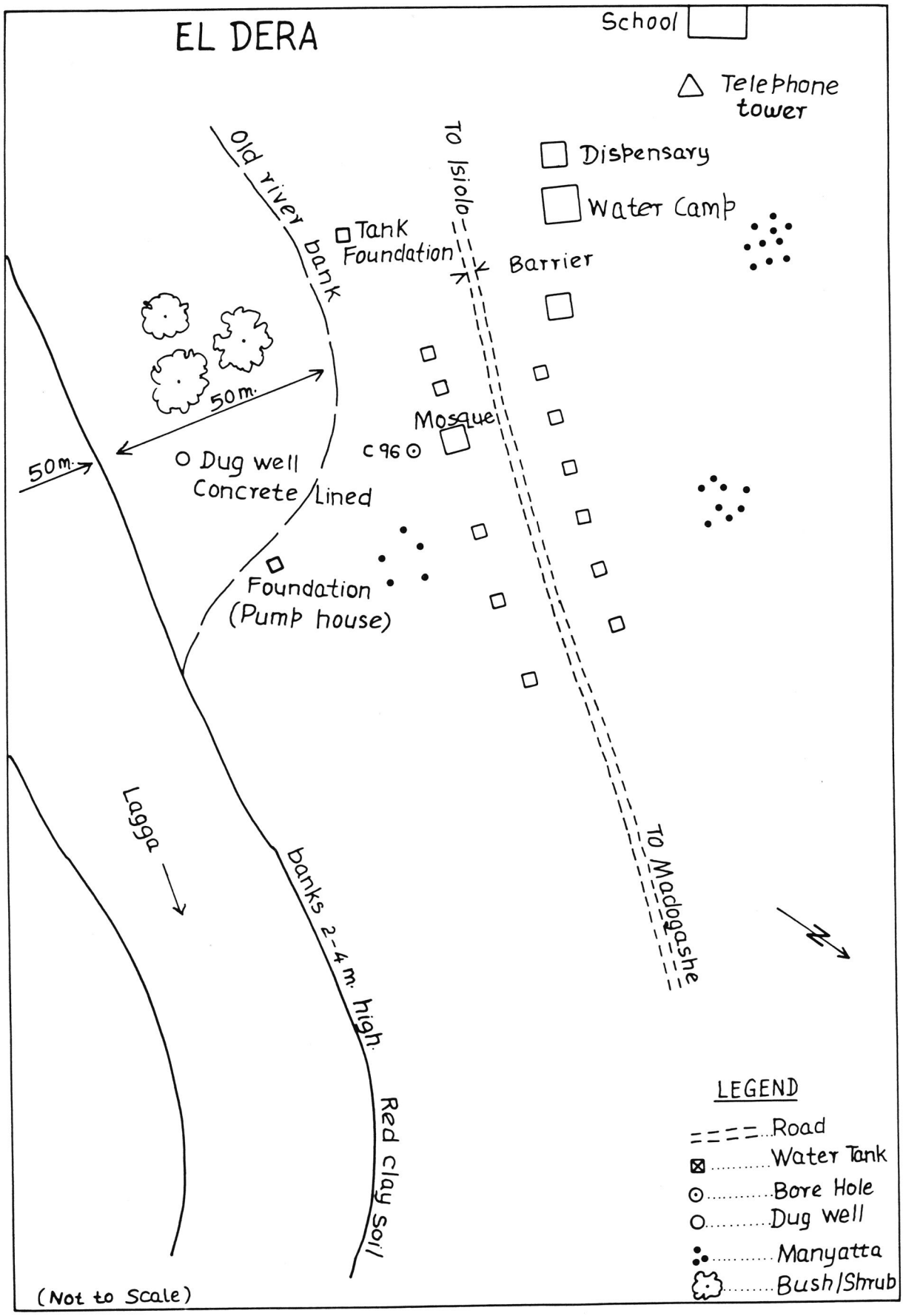
Eldera lies in a semi-arid to arid landscape at about 360 m a.s.l. Generally, the land is flat with few water channels running in the north east along (and some joining) the Galana Gof (seasonal water course).

2.3 Climate

The project area falls in the arid climatic zone with a rainfall of between 150 - 230 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 20 - 30°C.

2.4 Soils and Vegetation

The vegetation of the area consists of scattered bushes, of the thorny acacia type. The area is characterised by poor sandy soils that can not support any agricultural crops; thus no attempts are made to do any agriculture.
Severe erosion was observed between the centre and the Galana Gof. The chief had tried to stop this by planting 100 seedlings, but all died in spite of being watered.



Sketch of the Project Area

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

The centre is situated in Modogashe Location of Sericho Division. The centre is the administrative home of the Eldera sub-location assistant chief. There is an administrative police post with on average 25 personnel.

3.2 Education

There is a single primary school with one stream and a student population of 130 and staff numbering 7. Prospects of increasing the number of stream/classes are high, thus a 5% growth rate will be used for projections.

3.3 Health

A single dispensary serves the centre; with a total staff of about 4 persons on average during most occasions. Attendance records and trends are not available readily.

3.4 Commerce

There are 2 tea rooms, 6 shops, 1 butchery and 2 hotels. Supply of goods is mainly from and via Isiolo along the dusty earth road. Trade commodities are usually brought in during the dry period to avoid disruptions during the wet unmanageable road conditions.

3.5 Transport

The main road from and to Isiolo serves the centre; a track branching 10 km before Modogashe runs north towards Sericho. The only problem is during wet season when they become almost impassable.

3.6 Agriculture

Due to the arid nature of the area no agriculture activity is possible.

3.7 Livestock Husbandry

This is the major economic activity of the area. A small herd grazes in the vicinity of the centre. According to the chief it numbers 100 cattle, 300 goats and 5 donkeys. There are no livestock handling facilities at the centre.

4. WATER RESOURCES

4.1 Groundwater

Eldera centre falls under zone 1a of the geologic formation. This zone comprises of pervious sedimentary rocks encountered at different levels of confinement.

As at Modogashe the main aquifers found are:

- a shallow aquifer with good quality water, but with limited potential; shallow wells dug in this aquifer are currently used to supply the town;
- a deep aquifer with saline water; groundwater from this aquifer is not suitable for consumption.

A dug well lined with concrete rings was constructed in 1976 from RDF funds. The depth is about 3.5 m., and was dug until a clay layer. The waterlevel was at 1.5 m. in March 1991 and drops about 1 ft. in the dry season. The well is mainly used in the dry season. The EC of the water was 1269 μS/cm.
The EC of a shallow well (0.5 m. deep) dug in the sands of the lagga was 347 μS/cm. If available this water is preferred by the people for drinking.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	Remarks
C96	124.4	108.2	-	3.3	Borehole casing was backfilled

4.2 Surfacewater

The Galana Gof lagga flows only during the heavy rains period in March/April and November/December. The riverbed changes and it appears to be returning to the old course. The banks are composed of clays and appear unstable.

5. WATER DEMAND

5.1 Human Population

Human population currently stands approximately at 1,250 persons. This includes about 250 people on the Garissa side.

A population growth rate of 4% is assumed for the project area, to match with the general trend for the whole District.

5.2 Education

The current primary school, with a day-time population of about 130 pupils and 7 staff is the only education facility that would need supply in year (1995). Using a growth rate of 6%, another stream would be needed in the 10th year and a new school in year 20.

5.3 Livestock

The number of animals depending on the water supply is based on information from the chief. This number is assumed not to increase.

5.4 Health

The growth rate of the health centre attendance is taken to increase with the population. A growth rate of 4% is taken.

5.5 Commerce

The present number of shops and other utilities are to increase during the design period at a rate of 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	62	76	225	666
	using Communal Water Points	1,187	1,444	2,025	2,665
Education	Primary Schools: Students	137	183	328	486
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	100	100	100	100
	Sheep & Goats	300	300	300	300
	Camels	-	-	-	-
	Donkeys	5	5	5	5
	Total Livestock Units	55	55	55	55
Health	No. of Beds	-	-	-	-
	No. of Outpatients	15	18	27	40
Commerce	Shops	6	7	9	11
	Tea rooms	2	3	4	5
	Butcheries	1	1	1	1
	Bars	-	-	-	1
	Hotels	2	2	2	2
Administration	Number of staff	30	36	53	78

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	2.5	3.0	9.0	26.6
People using C.W.P's	11.9	14.4	20.3	26.6
Primary School	0.7	0.9	1.6	2.4
Health Centre	5.3	5.4	5.5	5.8
Administration	0.8	0.9	1.3	2.0
Shops	0.6	0.7	0.9	1.1
Butcheries	0.5	0.5	0.5	0.5
Bars / Tea rooms	1.0	1.5	2.0	2.5
Hotels (Low Class)	1.0	1.0	1.0	1.0
Livestock	2.8	2.8	2.8	2.8
Total	26.9	31.1	44.9	71.8

6. EXISTING WATER SUPPLY

Currently there is no existing conventional water supply. Residents obtain water from shallow hand dug wells along the Galana Gof (seasonal/dry river bed). In the dry season they also use a lined dug well near the centre.

6.1 Technical Description

Existing wells - shallow; up to about 6 m deep, present a danger of collapsing since there is no lining to support the sandy strata. The method of elevating water to the surface is by step ladders or by scooping with containers and tagging using ropes.

6.2 Potential and Actually Served Beneficiaries

The current demand of the consumers is low. The demand would increase if there is an adequate source, because part of the moving pastoral community would tend to settle if water is availed.

There is already a water committee to organise the water supply of livestock and people.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Surface water: The Galana Gof is not a reliable source of water.

Groundwater: The deep groundwater is saline and is not an option. The only groundwater of good quality is found at shallow depths in the sediments near the Galana Gof. This source should also be available during droughts.

Rainwater: Although rainfall is limited this source may provide during part of the year an additional quantity of drinking water. The few shops and institutions at the centre which have iron sheet roofs should construct appropriate structures for collecting and storing rain water.

7.2 Alternative Technologies

Infiltration galleries with pumping: The abstraction of the shallow groundwater below the Galana Gof may be done using infiltration galleries (pipes) buried across the riverbed. The depth of the pipes depends on the minimum groundwater levels in the riverbed sands, and also on the depth of the clay layer(s) below the sands. This depth is not known, but may be only a few meters.

The infiltration pipes will be connected to a collector well constructed on the bank of the river, from where the water may be pumped to a storage tank. The infiltration

pipes may also serve the other side of the river by constructing a collector well on that side. The number of required infiltration pipes is not known as it depends on the groundwater depth and the permeability of the sands.

Handdug wells with handpumps: The currently used unprotected handdug wells may be protected to improve the water quality. However, it must be verified that the well is not used for livestock, because then the installation of handpumps may not be acceptable to the population, because of their low output.

Pump systems:
- Generating set with submersible pump
- Solar powered pumpset, which is favoured due to it's low maintenance requirement
- Windmill, but the low frequency of the wind with suitable speed limits it's use here.

7.3 Recommended systems

The following system may be recommended:

One or more infiltration galleries across the Galana Gof lagga, connected to collector wells preferably on either side of the lagga. The depth of the galleries should be such that water supply is guaranteed even in drought situations. The suitability of the sediments in the lagga need to be confirmed during the feasibility study.

A sub-surface dam should be considered in case the permeable sediments (sands) have insufficient thickness.

The water may be pumped from the well with a diesel pump or preferably with a solar pump. For easiness of supply the water could be pumped to an elevated tank near the centre. Also handpumps may be fitted, but only as an extra to the main pump, for cases of breakdown.

The construction of the collector wells on the banks will have to be combined with measures to stop the on-going erosion of the area along the bank.

In addition institutions and residents with appropriately roofed houses should also be encouraged to have simple household storage tanks to store harvested rain water on the few occasions when it rains.

8. COST ESTIMATES

8.1 Capital Costs

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	100,000
Construction of infiltration galleries 300 m.	450,000
Construction of 2 collector wells	50,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct storage 100 m^3	450,000
Pipework 2 km	600,000
Sub-Total	2,500,000
10 % Contingencies	250,000
Total Say	2,750,000

With a population of 1,250, the per capita construction costs will be Ksh. 2,200.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the solar system will provide a supply of 45 m^3/day, which corresponds with the future demand. The diesel pump may be used at times when the solar pump does not work, e.g. during cloudy days.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	500
Other maintenance	3,000
Total	6,500

With the present population the per capita monthly O&M cost would be about Ksh. 5. An annual O&M cost per household (of five members) would be in the range of Ksh. 300, which should be affordable for most of the community members.

MODOGASHE

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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8. COST SUMMARY

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1. INTRODUCTION

1.1 Background

Concern for water provision to residents of Modogashe town has been raised by many authorities for a very long time; available correspondence in District water office dates back to 1974. Attempts to solve the problems have been made but viable long time solutions have not been produced.

Aridity of the region, complexity of geological conditions and a rapidly increasing urban population; hence high water demand, have all compounded the problem. Some studies have been carried out in the past, but they have not come up with a conclusive result.[1] The 1990 population of the centre is estimated at 7,000.

1.2 Social Economic Stratification

The centre forms a strategic stop point for travellers to and from North Eastern towns of Wajir and Mandera. This is the meeting point of main roads from Nairobi through Garissa and through Nanyuki to Isiolo and Garbatulla.

There are telephone facilities, a health centre, administrative offices, schools and public amenities such as hotels, lodgings and shops. This centre is shared between Isiolo District of Eastern Province and Garissa District of North Eastern Province and is one of the rapidly growing ones inhabited by a mixed local population comprising mainly Boran and Somali communities.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

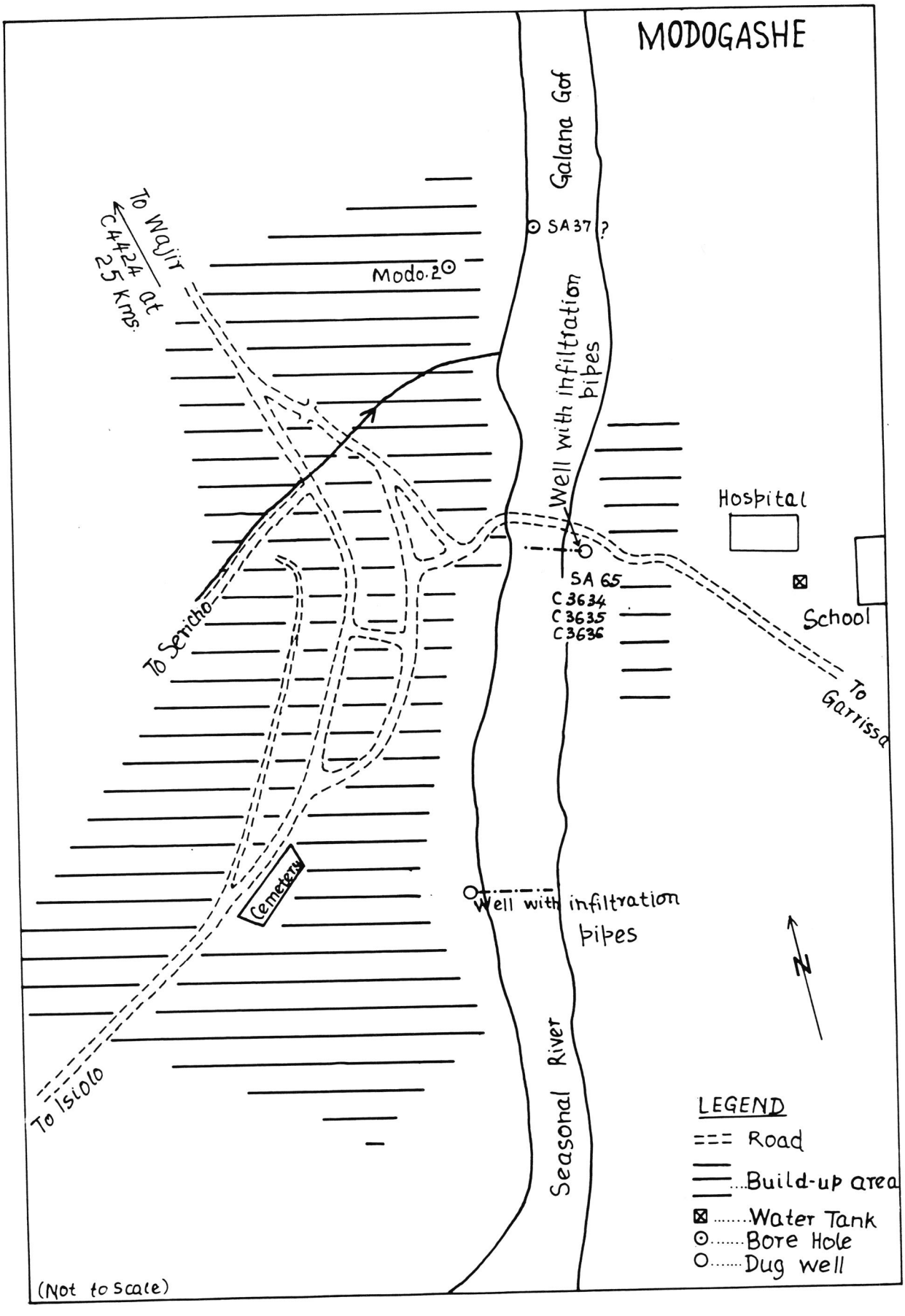
The project is located at the border of Eastern and North Eastern Provinces, map sheet series Y633, on latitude 0° 14' N and longitude 39° 10' E approx. Altitude by contours is about 320 m. The Isiolo - Mandera main road meets the Garissa - Mandera road here, hence good communication is ensured; besides being an overnight stopping point for travellers both ways.

2.2 Topography

The general area is almost flat with few high points, mainly on the Garissa side, that are no more than a few metres above general ground level. There are several natural water courses running in north-eastern direction; some joining the Galana Gof (seasonal river/water course). In all, the general land gently slopes in this direction, cutting small channels that enlarge in some areas with much sand.

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[1] Ref. Wanyeki, S.G., 1973, Report on Mado Gashi Town Water Supply
Gachanja, A., 1985, Geophysical Survey Modogashe Water Supply



Sketch of the Project Area

2.3 Climate

The project area falls under the Arid climatic zone with a rainfall of on average 250 mm. per year. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 24 - 30°C.

Between July and September the climate is characterised by the presence of very dry winds with dust.

2.4 Soils and Vegetation

The top soils are sandy in most parts with fine clay patches that support scattered vegetation; mainly the drought resistance types. Subsoils consist of fine sand, silt and clays. It is reported in geological investigation reports that this is due to "the nature of the source of rocks in the sedimentary basins which consists of mudstones and shales". The topsoil is not very porous and this in combination with high intensity rainfall over a short duration reduces chances of ground water recharge through infiltration.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

The centre is divided into two administrative units; the western side falls under Sericho District Officer of Isiolo District and the eastern side falls under Modogashe District Officer of Garissa District. Each side has regular police and administrative police stations along with locational chiefs and assistant chiefs.

3.2 Education

There are two boarding primary schools at Modogashe. Omara Boarding Primary School of Isiolo District is reported to be double stream with a total enrolment of 256 pupils in 1985, 396 in 1988 and 503 in 1990 and an average staff of 20 teachers. No figures are available for Modogashe Boarding Primary School of Garissa District. There is no Secondary School, but one is proposed.

3.3 Health

There is only one health centre, located on the Garissa side but nevertheless serves the whole centre's population. It has two wards and 4 beds. Maternity wards have been proposed. The daily out-patients attendance is 100-130. The most common diseases are malaria, diarrhoea and worms.

3.4 Commerce

This is a thriving commercial centre and all the out-lying small centres rely on it for their supplies. There are about 9 low class hotels, 100 local shops, one bar and two low class lodgings.

Trading is mainly on domestic consumables and few clothing and hardware shops. Most of the goods have to be brought from Nairobi and other areas, except for the plentiful meat supply.

3.5 Transport

Communication routes are good in dry weather but impossibly difficult during wet season. As mentioned above the route to Nairobi through Garissa is reportedly easier than that passing through Nanyuki and Isiolo. Further onwards to Wajir and Mandera, the route is reportedly more rough as that between Isiolo and Modogashe. Generally, any movement should be limited to dry season for convenience, even when driving four-wheel drive vehicles.

3.6 Agriculture

The area is described as too arid for any meaningful rain fed agriculture to be undertaken. In the absence of even drinking water, irrigation supported agriculture is unheard of here.

3.7 Livestock Husbandry

The influx of livestock from the neighbouring District of Garissa makes it practically impossible to estimate the livestock numbers. Modogashe is a stock-route for animals from Garissa and Wajir. Since there is very little vegetation animals rarely graze here, preferring Sericho.

4. WATER RESOURCES

4.1 Groundwater

Modogashe centre falls under zone 1a of the geologic formation. The zone is comprised of pervious sedimentary rocks encountered at different levels of confinement by clay layers.

The main aquifers found at Modogashe are:

- a shallow aquifer with good quality water, but with limited potential; well A and B are currently used to supply the town;
- a deep aquifer with saline water; groundwater from this aquifer is not suitable for human consumption.

The shallow aquifer has been investigated with geophysics and by augering. It appears that the sediments contain much clay and therefore have a low permeability.

The drift connecting the Garissa side was constructed with scrapers and was apparently also meant to act as a sub-surface dam. It is reported to extend upto the clay layer, but it's effectiveness is however not known. Groundwater is currently abstracted from lined dug wells on the banks of the lagga and from shallow hand dug wells inside the lagga. None of the boreholes drilled is used for water supply.

The conductivity of the water in the lined dug wells was 498 μS/cm on the Garissa side and 369 μS/cm on the Isiolo side.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HCO3 (mg/l)	F (mg/l)	Remarks
SA 37	108	-	-	-	-	-	-	Abandoned
SA 65	41.8	-	-	-	-	-	-	Abandoned
C3634	13.4	dry	-	-	-	-	-	Abandoned
C3635	13.1	-	-	-	-	-	-	Abandoned
C3636	188	?& 181.4	135	-	17	3,100	2	Abandoned, casing pulled
C4424	161	58&136	-	-	10.9	2,252	8	at 25 km. NE
Modo. 1	-	-	-	-	-	-	-	Drilled in 1989
Modo. 2	52.6	-	5.6	3.6	2.16	-	-	Drilled in 1989

The Gebaba wells are about 5 km. to the west of Modogashe. In 1984 water was taken from here to the town as the wells at the town had dried up or had become saline. Some boreholes were drilled here in 1990 (?), but they were not successful (data was not found).

4.2 Surfacewater

The Galana Gof lagga flows only during the heavy rains period in March/April and November/December and is therefore not a reliable source of supply.

5. WATER DEMAND

5.1 Human Population

1979 census figures indicate Modogashe to have a population of 4,600 and 486 households. For 1990 this was estimated at 7,000. A population growth rate of 4% is assumed for the project area.

5.2 Education

The presence of two primary schools with a total population of about 780 (assumed 1 stream of 250 pupils and 10 teachers for Modogashe Primary School of Garissa District) indicates that a secondary school will be needed in the near future. A single stream of 200 students may be anticipated; thus the total student and staff population will be about 1,000 in the initial year.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that no livestock shall depend on the Modogashe water supply, except for 100 donkeys.

5.4 Health

The growth rate of the health centre attendance is taken to increase with the population. A growth rate of 4% should be taken.

5.5 Commerce

The present number of shops and other utilities are 112, to increase during the design period at an average rate of 2% per year.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	350	425	1,260	3,732
	using Communal Water Points	6,650	8,091	11,346	14,928
Education	Primary Schools: Students	780	1,044	1,870	2,768
	Other Schools : Students	200	268	480	711
Livestock	Indigenous Cattle	-	-	-	-
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	100	100	100	100
	Total Livestock Units	40	40	40	40
Health	No. of Beds	4	5	7	10
	No. of Outpatients	100	122	181	268
Commerce	Shops	100	110	134	163
	Tea rooms	9	10	11	13
	Butcheries	3	3	4	5
	Bars	1	1	2	3
	Hotels (No. of beds)	25	30	44	65
Administration	Number of staff	60	73	108	160

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	14.0	17.0	50.4	149.3
People using C.W.P's	66.5	80.9	113.5	149.3
Primary School	39.0	52.2	93.5	138.4
Secondary School	1.0	1.3	2.4	3.5
Health Centre	7.4	7.9	9.3	10.4
Administration	1.5	1.8	2.7	4.0
Shops	10.0	11.0	13.4	16.3
Bars / Tea rooms	5.0	5.5	6.5	8.0
Butcheries	1.5	1.5	2.0	2.5
Hotels (Low Class)	1.2	1.5	2.2	3.2
Livestock	2.0	2.0	2.0	2.0
Total	149.2	182.7	297.9	487.9

6. EXISTING WATER SUPPLY

6.1 Technical Description

There is no conventional water supply existing at Modogashe.

The lined well, about 12 m deep, located on the bank of the lagga (dry sandy river bed) on the Garissa side, equipped with a pumping set, supplies water to most of the population. Water is pumped to the AP-lines and into a (leaking) pressed steel tank located on a raised earth fill and then gravitated to the school and the health centre on the Garissa side. The population uses a tap near the pump house. The rest of the population draws water from hand dug wells along the lagga.

There are two wells on the Garissa side, but only one is pumped due to a faulty footvalve in one of the wells. They are connected to infiltration pipes extending under the lagga at about 20 ft. deep. The well which was pumped is reported to be dry after a dry period of 6 months. It was dry in 1983, 1984 and 1986.

The health centre (built in 1983) has roof tanks (10 m^3)and a concrete paved ground catchment with ground tank (50 m^3). The latter is not being used now, because the pumps are out of order. The ferro cement roof tanks were observed to leak at the floor. The centre also has an elevated tank, which however cannot be filled properly from the well.

The lined dug well on the Isiolo side is also connected to infiltration pipes under the lagga. There also seems to be a clay sub-surface dam constructed with clay excavated when building the drift. The well is being pumped with a diesel pump. There is also a destroyed windmill and a small tank on a raised earth fill. The well is reported to dry up if there is no rain for longer than 3 months.

6.2 Potential and Actually Served Beneficiaries

There is a large water demand, Modogashe being the second largest town in Isiolo District. The pinch is felt when there is drought and the water level in the sand falls below the ability to which shallow wells can be hand dug. Currently a large number of the population do not get adequate supply. An estimated 45% of the residents are served by the well on the Garissa side; but only to about 15% of their actual need.

6.3 Livestock Use

Herdsmen with private hand dug well water a limited number of stock along the Galana Gof. However the main herds are kept away in areas with water such as near Sericho or at the border at Habaswein.

6.4 Functional Analysis

The pump in the well on the Garissa side is currently run for 4 hrs per day. The diesel normally has to come from Garissa, but this was last so in April 1989. Nowadays fuel is supplied by the AP. The operator is employed by the MoWD in Garissa.

The dug well on the Isiolo side is pumped only 45 minutes per day. The supply is to the DO's house, the AP (there is another elevated tank (5 m^3) near the camp) and the Police. Fuel is supplied by the AP. The last time fuel was received from Isiolo MoWD was June 1990. It was run then for about 2 hours per day. There is an askari/ operator, but a policeman has been trained to start and stop the engine.

6.5 Financial Analysis

The water is supplied free of charge. Spares are bought by the MoWD. It would be very hard at the moment to collect any revenue because the water supply is unreliable.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

The time which has lapsed since initial attempts were made to obtain a reliable source gives a good indication on the limitation of possible sources. Worthwhile attempts have been made but were not successful. A major decision on the only possible source - ground water - needs to be supported by thorough hydrogeological investigations. Hydrogeological reports (refer PWE's letter, report EWRG 84-023/10 dated 18/01/90 and EWRG 84-023/11 dated 14/03/90) indicate that the only possible sites for ground water exploitation are located at or near Habas and two other sites east of Modogashe.

The distance to these sites is about 20-30 km and pumping of water over long distances is not a very encouraging prospect. But when the terrain is favourable and local sources inadequate, there is no alternative but to pump. The general flatness of the area will minimise the pumping head from the boreholes.

The above mentioned sources, if found to yield enough suitable water can be exploited even if pumping over long pipelines will have to be done; since ferrying will be much more uneconomical.

7.2 Recommended Systems

As a short term solution (before a concrete adequate source is found) the following is recommended:

(a) Installation of solar pumps on the two existing wells

(b) Construction of more handdug wells equipped with handpumps along the lagga. The equipping of protected handdug wells should commence only after the existing wells start operating fully. In the absence of another reliable system no attempt should be made to install handpump systems because they would fail due to their low yields as compared to the demand.

(c) Roof catchment to be encouraged for those with appropriate roofed houses such that they do not rely on water supply only. Where ever possible existing facilities should be rehabilitated.

As a long term solution it is recommended that more infiltration pipe units be laid preferably upstream of the existing ones. The infiltration pipes are connected to collector wells located on the bank of the lagga or alternatively lead to a main collecting pipe. The water will be pumped from the wells by a combination of solar powered pumps and diesel generated pumps to elevated tanks. About five wells with infiltration pipes are estimated to be required

The alternative with a main pipe should direct the water to a main ground reservoir by gravity from where the water should be pumped to an elevated tank. The use of one main collecting pipe would eliminate the need of several pumping units and create a central pumping station where a combination of solar powered pumps and diesel generated submersible pumps would ideally pump the water to the elevated tank. As the demand increases the collecting pipe can be extended and more infiltration pipes

could be laid.

The necessity of a subsurface dam which would retain the groundwater is doubtful, because groundwater flow will be towards the infiltration pipes during pumping. Groundwater flow in downstream direction will thus be negligible. The determination of the number of infiltration pipes per unit has been left for further study. In any case no suitable site for the construction of a subsurface dam was identified during the field visit.

7.3 Operation & Maintenance Procedures

To operate and maintain a water supply, various components have to be checked on how they interact. The following have been identified as needing interaction.

(a) Pumping Vs Demand - The proposed source(s) must at least meet the anticipated demand or part of it.

(b) Pumping Vs efficiency - The output of the combined pumping units must equal or exceed the acceptable efficiency in the piping system.

(c) Running costs Vs revenue - The cost of water production and revenue to be collected should be thoroughly analysed, to determine the cost charged to the consumer, and also to enable a decision, in case the supply is not economically viable, to run the system on humanitarian grounds irrespective of costs involved.

(d) Technical viability Vs public water demand - whereas many consumers would wish to have water at their doorsteps (Individual Connections) possible source(s) might not allow this, when considering the head necessary to reach the tap outlet or house cistern. Communal water points are proposed though some would prefer otherwise.

8. COST ESTIMATES

8.1 Capital Costs

Since the availability and allocation of funds are unlikely to be sufficient to build the proposed scheme for the year 2015 demand in one phase, it is recommended that the project be built in phases as the demand increases. Solar pumping sets should be installed in the two existing wells as a priority while the two pumping sets could remain as stand by units. Work on the main collecting pipe and the laying of the infiltration pipes could then commence followed by the construction of the ground reservoir.

The proposed system covers only the existing demand of 150 m^3/day. The coverage of the full demand for the year 2005 will involve investments of more than 10 million shillings (see costings in Part 2 of the DWDS).

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	100,000
Install pumping sets 2 No. Solar	1,000,000
1 No. Diesel	300,000
Construct infiltration galleries (750 m)	1,125,000
Construct main collection pipe (1 km)	600,000
Construct 100 m^3 ground reservoir	500,000
Construct elevated tank (50 m^3)	700,000
Reticulation (2 km)	600,000
Protection and equipping of hand dug wells	250,000
Total	5,175,000
10 % Contingencies	517,500
Say	5,700,000

With a population of 7,000, the per capita construction costs will be about Ksh. 800.

8.2 O&M Costs

The solar pumps are estimated to yield 50 m^3/day each. The diesel pumps should yield 200 m^3/day.

MONTHLY O & M COSTS

Description	Amount Ksh.
Salaries	7,500
Diesel for running pump unit	5,000
Other maintenance	10,000
Total	22,500

Assuming the number of households to be 1,400 the expected monthly payment required per family to meet the expenses is Ksh. 16, which is reasonable.

IRESA BORU

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Iresa Boru centre serves as the local shopping centre of the pastoral community inhabiting the eastern banks of the Ewaso Nyiro seasonal river between Garfasa and Sericho. There is a general acute shortage of a reliable and adequate water source; forcing many of the residents to spend much time digging shallow wells. These get flooded and hence silt up when the seasonal river waters arrive.

The trading centre is very small. It was moved about 3 km. from a site near the riverine forest to the present site some years back because of the flooding hazard. The centre comprises about 20 houses with corrugated iron roofs. Several manyattas are located nearby. The total population in and around the centre is about 1000 people. The total population of the deda is 1500.

1.2 Social Economic Stratification

The population is reportedly (information from ILDP) divided into 36 pastoral camps within the Iresa Boru deda; about 9 households per camp in average and 5 persons per household. Some households have large influence over others in terms of livestock wealth. Within the Iresa Boru centre, the same households extend business and hence blend uniformly with the mobile herdsmen.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

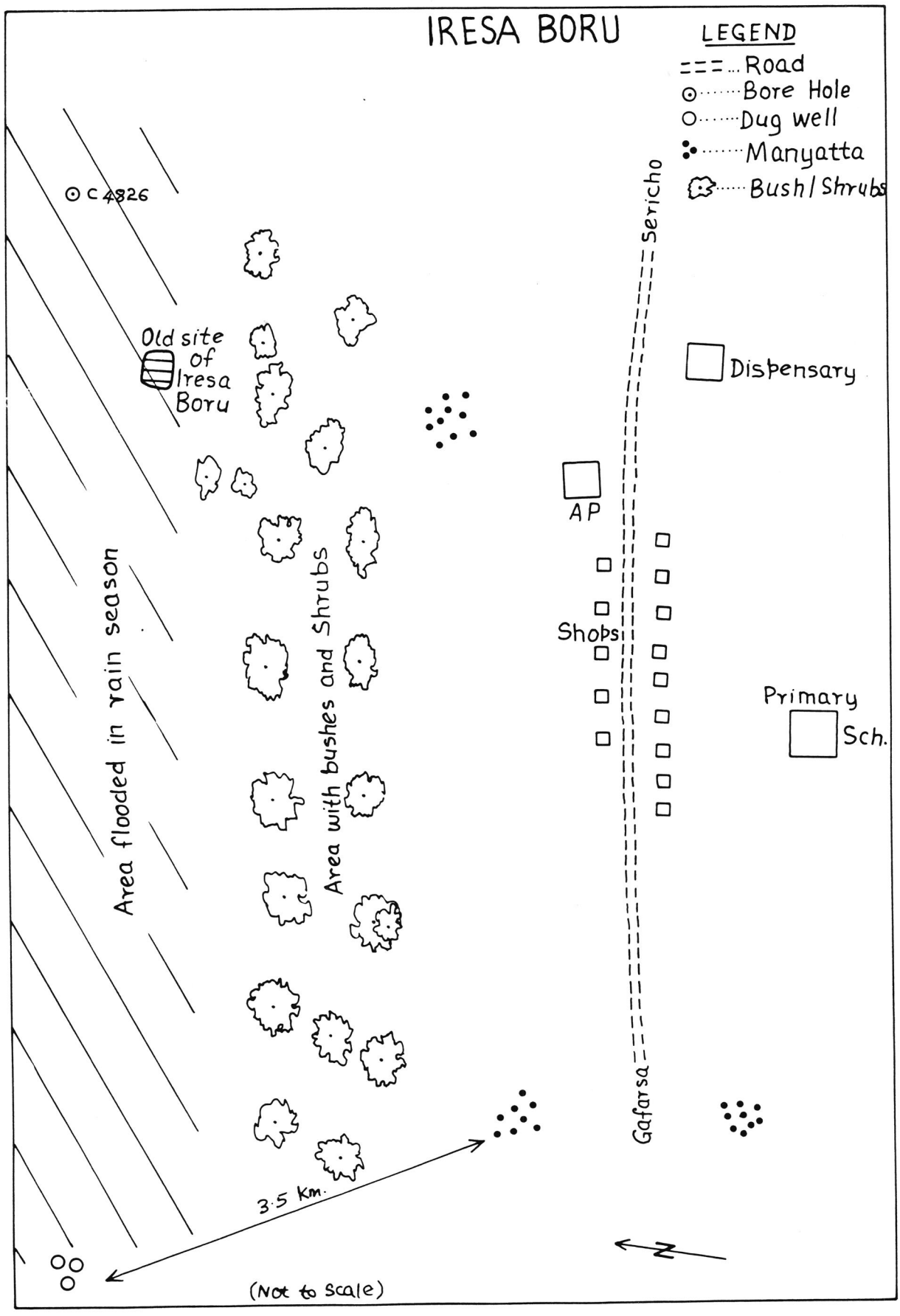
The project is located in Sericho Location of Sericho Division. Approximate location of the centre on map sheet No. 4633 - 82 is E 38° 45' and N 1° 10'. The seasonal Ewaso Nyiro river flows nearby, regularly changing course in unpredictable instances. Sometimes forcing movement of the temporary manyattas, while on other occasions the water course is quite far away.

2.2 Topography

The elevation of the centre is at slightly below 300 m A.S.L. The centre is situated in the flood plain which is almost flat to very flat such that no point is higher than the other by more than 3 m.

Such a situation readily allows flood waters to rapidly spread when the river over flows during the wet season. It also implies that an all gravity water system is out of question; only pumping into an elevated storage tank.

The general slope/trend is from west to east but very gentle; in the same direction of Ewaso Nyiro.



Sketch of the Project Area

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 150 - 250 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 20 - 30°C. This accounts for the very high evaporation rates recorded.

2.4 Soils and Vegetation

The vegetation is bushland, grassland and thinly wooded land occurring on the alluvial soils deposited by flood waters. The grass cover is mainly tufted and perennial.

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

There are no established administrative offices; only the sub-chief resides here with a few administration police men. There is no postal nor telephone services; the nearest such being at Modogashe, 80 km away or at Merti 30 km across Ewaso river.

3.2 Education

A single stream primary school with 295 pupils and 8 teachers serves the centre and its environs. Most of the pupils are non-residents of the centre; hence they trek long distances from their homesteads within the area, thus boarding facilities are needed.

3.3 Health

A dispensary with currently only one clinical officer serves the centre and environs; with a reported daily attendance of 15. Prevalent illnesses are malaria, symptoms related to drinking unboiled milk, URTI and skin diseases. Diarrhoea is common in the rainy season. The condition of the dispensary is poor, and it is not clean due to bats.

3.4 Commerce

There is a varying number of local shops numbering about 5 on average. No butchery exists nor bar. There are 3 tea rooms and one local hotel, mainly for those frequenting the centre from the surrounding areas to purchase items. Generally, trading and its potential is very low.

3.5 Transport

An earth road connects the centre to Garfasa and on to Sericho. This stretch is through alluvial soil, hence becomes impassable during wet periods.

3.6 Agriculture

Iresa Boru used to have minor irrigated farms along the river, which were spontaneously started by pastoralists. These farms have now great problems, because the Ewaso Nyiro has taken a new course to the north (information from ILDP).

3.7 Livestock Husbandry

This is the main economic activity of the residents. Fodder such as grass, shrubs and others is available for most periods of the year. This results in the influx of livestock from other far off areas such as north-eastern districts in the event of prolonged dry periods. Consequently water demand for livestock increases tremendously; necessitating ceaseless water searches (by digging wells in the river course).

4. WATER RESOURCES

4.1 Groundwater

Iresa Boru centre falls under zone 1a of the geologic formation. The zone is comprised of alluvial sand and clay layers.

The water quality of the shallow groundwater is reasonable. Dug wells about 5-6 m. deep in the flood plain of the Ewaso Nyiro had an EC ranging from 890 to 1323 μS/cm. The water level in these wells reportedly are fairly stable.

The water quality in the deeper aquifer is expected to be poor with water being of high salinity. No available chemical analysis data. The water from the old borehole near the old site of the centre was reportedly a bit salty.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	Remarks
C4514	106	34	34	7.2	Borehole abandoned
C4826	-	-	-	-	No data, in flood area

4.2 Surfacewater

There is no source of water near the centre. The nearest source is the Uaso Nyiro river which is approximately 4 km away. Nowadays the river is dry most of the time.

5. WATER DEMAND

5.1 Human Population

Human population in and around the centre is about 1,000.

A population growth rate of 4% is assumed for the project area, in conformity with the general trend in the District. The centre is deep in the rural area with very few incentives for more settlement at the centre.

5.2 Education

The primary school with 295 pupils and 8 staff members will be taken to expand at a rate of 6%. A new primary school or second stream will be needed in year 10, bringing a projected total pupil population of about 725. A secondary school is expected in year 20; with a possible student population of 350.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. An estimated 10% of this livestock shall depend on the Iresa Boru water supply.

5.4 Health

The growth rate of the dispensary attendance is taken to be 4%.

5.5 Commerce

The present number of shops and other utilities are to increase during the design period at a rate of 2%.

Basic Data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	50	60	90	133
	using Communal Water Points	950	1,155	1,710	2,532
Education	Primary Schools: Students	303	405	725	1,073
	Other Schools : Students	-	-	-	-
Livestock	Indigenous Cattle	630	630	630	630
	Sheep	-	-	-	-
	Goats	-	-	-	-
	Camels	-	-	-	-
	Donkeys	-	-	-	-
	Total Livestock Units	210	210	210	210
Health	No. of Beds	-	-	-	-
	No. of Outpatients	15	18	27	40
Commerce	Shops	5	6	9	13
	Tea rooms	3	3	4	5
	Butcheries	-	-	-	-
	Bars	-	-	-	-
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2005	2015
Individual Connections	2.0	2.4	3.6	5.3
People using C.W.P's	9.5	11.5	17.1	25.3
Primary School	1.5	2.0	3.6	5.4
Health Centre	5.3	5.4	5.5	5.8
Administration	0.1	0.2	0.2	0.3
Shops	0.5	0.6	0.7	0.9
Butcheries	-	-	-	-
Bars / Tea rooms	1.5	1.5	2.0	2.5
Hotels (Low Class)	-	-	-	-
Livestock	10.5	10.5	10.5	10.5
Total	31.0	34.1	43.2	56.0

6. EXISTING WATER SUPPLY

6.1 Technical Description

Dug wells in the flood plain of the Ewaso Nyiro supply the centre with water. The water is collected in jerry cans using donkey trains to cover the 4 km. distance. The wells are used for two to three months in the dry season. Some wells are known to collapse due to the unstable alluvial strata.

These unlined wells, some as deep as 6 m, yield varying amounts of water; but on average a herd of 50 livestock can be watered in a day (implying a total of 2.5 m^3/day).

A borehole was drilled near the old site of the centre, but it has hardly been in operation. The pump was removed about two years ago. The borehole still seems serviceable (the rods are left inside), although attempts have been made to open the steel cover. It is reported to have a good yield, but the water is a "bit" salty.

The dispensary has two ferro cement roof tanks, 10 m^3 each. They were observed to leak and the officer said he uses also water from the wells.

6.2 Potential and Actually Served Beneficiaries

There is a high demand, while no amounts of water exist at convenient distances and quality. Most of the wells, though privately owned rarely yield adequate amounts. About 50% of the residents have private of communal wells; those without purchase reportedly at Ksh. 5.00 for 2 x 20 litre containers.

6.3 Livestock Use

Most livestock owners have private wells from where they water their livestock during the dry season while others use the river water when floods arrive. However, there is a general hardship on livestock owners especially when large herds invade the area. More pans could alleviate the problem.

6.4 Financial Analysis

It is a very laborious, costly and time consuming exercise to construct a handdug well and draw water out (at all occasions) using no mechanical aids. Still some can afford to pay other people to dig the wells for them and to fetch the water.

6.5 Institutional Analysis

Organised groups or households (or herdsmen) led by a group leader assist themselves to have a source of water in an organised manner. Spacing of wells to avoid interruptions among livestock herds is decided upon depending on the group's influence. Local residents at the centre also monopolise wells used for sale of water if others fail to participate in the digging.

7. PROPOSED WATER SUPPLY

7.1 Alternative Sources

Surface water: The Ewaso Nyiro river is not a reliable source of water.

Groundwater: The deep groundwater is saline and is not an option. The only groundwater of good quality is found at shallow depths in the sediments near the Ewaso Nyiro river. This source should also be available during droughts.

Rainwater: Although rainfall is limited this source may provide during part of the year an additional quantity of drinking water. The few shops and institutions at the centre which have iron sheet roofs should construct appropriate structures for collecting and storing rain water.

7.2 Alternative Technologies

Handdug wells with handpumps: The currently used unprotected handdug wells situated in the flood plain of the Ewaso Nyiro may be protected to improve the water quality. However, because these wells are also used for livestock, the installation of handpumps may not be acceptable to the population, because of their low output.

Borehole or Dug Well with submersible pump: A shallow borehole or dug well with sufficient output may provide the required quantity of water for domestic use. The borehole should be located in the flood plain of the Ewaso Nyiro, which makes it necessary to find a site which will not flood. Alternatively the casing should be higher than the maximum flood level and the pump connected with a cable to a solar system or generator on a location which is safe from flooding.

Pump systems:
- Generating set with submersible pump
- Solar powered pumpset, which is favoured due to it's low maintenance requirement
- Windmill, but the low frequency of the wind with suitable speed limits it's use here.

7.3 Recommendations

The solution of the water supply to the centre may be found similarly to the system installed at Sericho. This would require drilling of boreholes in the Ewaso Nyiro sediments and the construction of a pipeline, storage tanks and water kiosks. A solar pumping set with a stand-by generating set are recommended.

For the siting of the boreholes a geophysical survey may be carried out, although the usefulness of such survey may be limited due to the thin water bearing zones in the sediments.

Water from the existing borehole should be analysed first to determine its potability.

8. COST ESTIMATES

8.1 Capital Costs

The existing borehole is not included in the cost estimate. Its condition must be checked first, before it can be considered to be used.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General	100,000
Construction of a borehole 40 m. deep	150,000
Install pumping set Solar	600,000
Stand-by Diesel	250,000
Construct storage 100 m^3	450,000
Pipework 5 km	1,500,000
Sub-Total	3,050,000
10 % Contingencies	305,000
Total Say	3,400,000

With a population of 1,000, the per capita construction costs will be Ksh. 3,400.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. It is expected that the solar system will provide 25 m^3/day. The remaining demand will be provided by the diesel pump.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no.	3,000
Diesel for running stand-by unit	1,000
Other maintenance	3,000
Total	7,000

With the present population the per capita monthly O&M cost would be about Ksh. 7. An annual O&M cost per household (of five members) would be in the range of Ksh. 420, which should be affordable for most of the community members.

SERICHO

PRE-FEASIBILITY STUDY OF WATER SUPPLY DEVELOPMENT

MAY 1991

WATER RESOURCES ASSESSMENT
& PLANNING PROJECT
NAIROBI

MINISTRY OF WATER DEVELOPMENT

ISIOLO

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1. INTRODUCTION

1.1 Background

Sericho centre is situated in Sericho Location in Sericho Division, Isiolo District in Eastern Province of Kenya. The centre lies in dry part of Kenya and the area has a low agricultural potential. The temperatures are high about 30°C. Sericho trading centre has a population of about 480. There are about 50 houses with corrugated iron roofs. The indigenous people of this area are the Borans.

1.2 Social Economic Stratification

Pastoralism is the only economic activity pursued by the majority of the households of Sericho. Since Sericho lies away from the main livestock trade stock route the main market is at Modogashe. The average livestock ownership per household in Sericho is 20 - 30 head of cattle and 70 - 100 head of sheep and goats.

2. DESCRIPTION OF THE PROJECT AREA

2.1 Location

The project is located in Sericho Location, about 49 km from Modogashe town. It is situated on the southern bank of Ewaso Nyiro river. The approx grid reference is E 38° 0' and N 1° 07'.

2.2 Topography

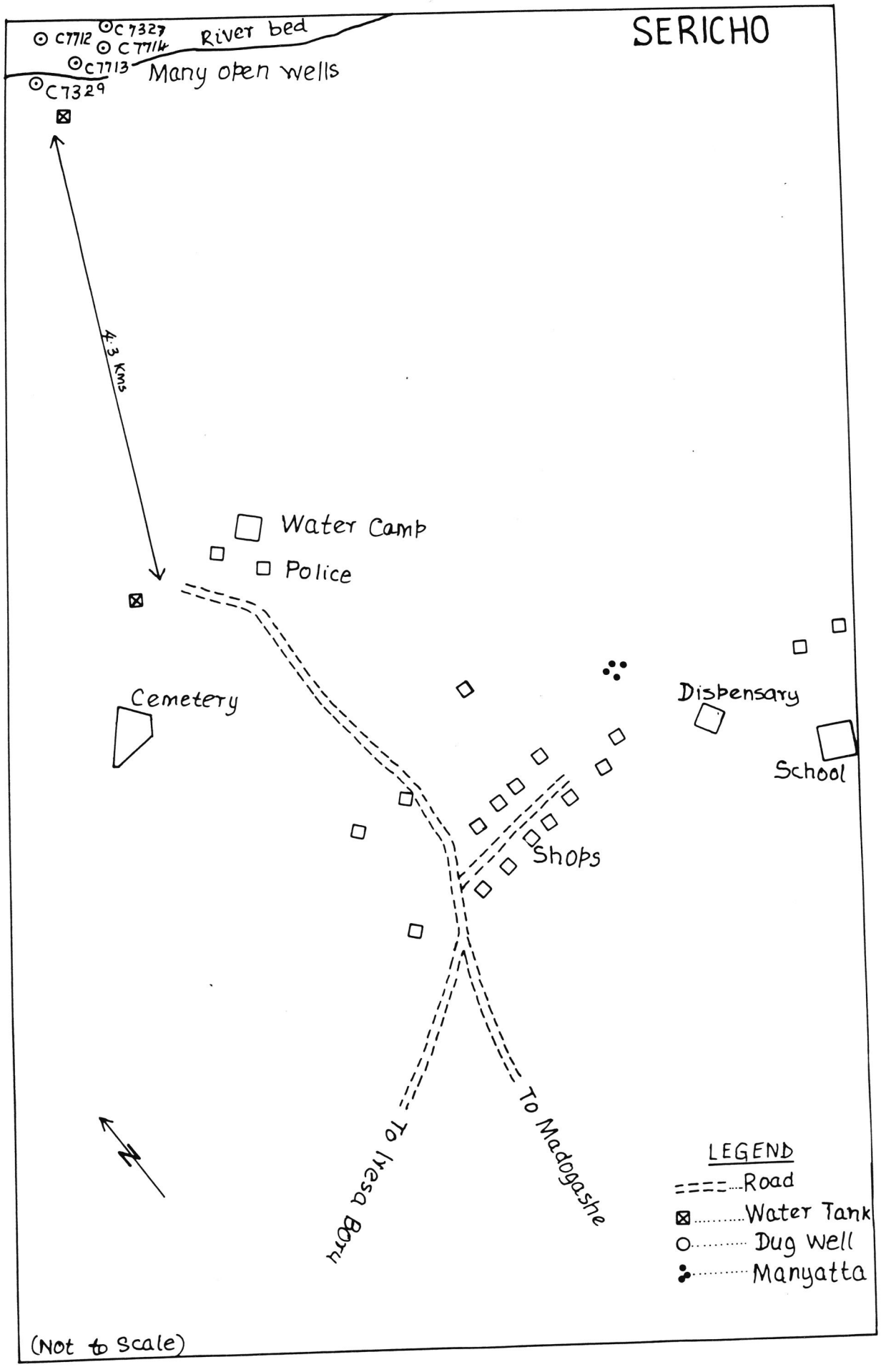
Sericho is located on the northern end of open grass plains and at about 4 km south of the Ewaso Nyiro swamp.

2.3 Climate

The project area falls under the arid climatic zone with a rainfall of between 150 - 250 mm. There are two wet seasons with the long rains falling between March and May and the short rains falling in November. The mean annual temperatures range between 20 - 30°C.

2.4 Soils and Vegetation

The project area is composed of alluvial deposit of the Ewaso Nyiro Matakone flood plain. The deposit consists of sand, silt, clay and gravel. The main tree species is acacia. Grass covers most of the area. Vegetation along the Ewaso Nyiro is swampy.



Sketch of the Project Area

3. SOCIAL ECONOMIC INFRASTRUCTURE

3.1 Administrative and Public Service

Sericho trading centre is the administrative headquarters of Sericho Location and is the residence of the chief of Sericho Location as well as the assistant chief of Sericho Sub-location.

Sericho has an administrative police post. There is also a community development assistant from Ministry of Culture and Social Services.

3.2 Education

Sericho Primary School has a student population of 238, a teaching staff of 8 and a non teaching staff of 4. The pre-primary has 87 students.

3.3 Health

The staff working in the newly built rural health unit are housed in permanent building. The annual attendance is 4,010.

3.4 Commerce

There are 11 shops, 5 tea rooms, 2 butcheries and 1 slaughter house in Sericho trading centre. The main items bought are tea leaves sugar and maize meal flour. Few people are employed in retail trade or local hotels.

3.5 Transport

Sericho is served by two main tracks. One lead to Modogashe trading centre, which is on the main Wajir - Isiolo road. From Sericho, the track continue northwards up to the boreholes at the Ewaso Nyiro river. An earth track running parallel to the river connects Sericho to Gubatu in the east and Iresa Boru in the west. This track continues through Gafarsa to join the Merti road at Malka Daka. There are no regular commuter vehicles to Sericho.

3.6 Agriculture

There are no agricultural activities in Sericho.

3.7 Livestock Husbandry

Even though the Ministry of Livestock has an animal health assistant in Sericho, there are no licensed traders in animal health drugs. The trade is carried out by unorganized and irregular traders within the pastoral system. There are two cattle dips and two crushes.

4. WATER RESOURCES

4.1 Groundwater

Sericho centre falls under zone 1a of the geologic formation. This zone is comprised of pervious sedimentary rocks encountered at different levels of confinement by clay layers, underlying alluvial sand and clay layers.

(a) Boreholes C3805, C3814 and C3822 which have been drilled further from the Ewaso Nyiro Rivers have more than two water struck levels.

Yields from these boreholes range between 3.0 and 4.6 m^3/h. Unfortunately water quality is poor due to high fluoride (12-37 mg/l) and salinity (8.1-14.0 mS/cm) values.

(b) Boreholes C7325, C7327, C7329, C7712, C7713 and C7714 which have been drilled to smaller depths near the Ewaso Nyiro river have water struck levels ranging from 18.5 to 20.5 m. while water rest level is 11 - 12 m. below ground level.

Yields from these boreholes range between 1.0 and 9.2 m^3/h. Water from these boreholes is of acceptable quality: EC = (1.1 - 1.47) mS/cm, fluoride content is between 1 and 2 mg/l.

Borehole Number	Total Depth (m)	Water Struck Level (m)	Water Rest Level (m)	Tested Yield (m^3/h)	EC (mS/cm)	HCO3 (mg/l)	F (mg/l)	Remarks
C3805	91.4	19.8 35 50.3	22.3	4.6	8.1	2050	20	Location not known
C3814	51.4	15.2 33.5 42.7	26.5	4.6	14	2430	12	Location not known
C3822	125	100.6 118.9	79.8	3.0	10.4	2920	37	Backfilled to 60 m., is open
C4010	61	-	-	-	-	-	-	-
C4011	56.4	-	-	-	-	-	-	Abandoned
C7325	21	19.5	11.4	3.3	1.1	688	1.2	Abandoned
C7327	24	20.5	11.4	1.4	-	746	2.0	Equipped with handpump
C7329	23	18.5	11.7	9.2	0.9	588	2.0	Equipped with solar pump
C7712	24	18.5	11.7	1.0	1.6	804	1.5	Equipped with handpump
C7713	24	20.0	11.7	3.6	1.2	710	1.0	Equipped with handpump
C7714	24	20.0	11.8	6.3	1.9	1008	3.0	Equipped with handpump

Boreholes should be drilled only in the alluvial sediments, otherwise the water quality is likely to deteriorate.

4.2 Surfacewater

The Ewaso Nyiro river at this point is mostly a dry course and only flows during the rainy season. The riverbed is composed of black clays and is shallow.

5. WATER DEMAND

5.1 Human Population

The population of the centre is estimated at 450. The pastoral population of the whole Sericho Deda is 2,020. The population using the supply is estimated at 50% of this. A population growth rate of 4% is assumed for the centre.

5.2 Education

The primary school has a student population and staff of 250. The student population in the pre-primary is 87. The growth rate of this institution is assumed to be 6%.

5.3 Livestock

It is assumed for the purpose of the preparation of this feasibility study that the livestock population shall remain constant in the project area. An estimated 10% of this livestock shall depend on the Sericho water supply.

5.4 Health

The growth rate of the dispensary attendance is taken to increase with the population. A growth rate of 4% is taken.

5.5 Commerce

The present number of shops and other utilities are expected to increase during the design period at a lower rate of 2% as the population.

Basic data and Projections used for Demand Calculation

Consumer Type		1990	1995	2005	2015
Population	with individual connections	50	61	181	539
	using Communal Water Points	960	1,167	1,637	2,154
Education	Primary Schools: Students	250	335	599	887
	Other Schools : Students	87	116	209	309
Livestock	Indigenous Cattle	500	500	500	500
	Sheep & Goats	1,200	1,200	1,200	1,200
	Camels	-	-	-	-
	Donkeys	48	48	48	48
	Total Livestock Units	265	265	265	265
Health	No. of Beds	-	-	-	-
	No. of Outpatients	11	13	19	
Commerce	Shops	11	12	15	18
	Tea rooms	5	6	7	9
	Butcheries	3	3	3	3
	Bars	-	-	1	1
	Hotels (No. of beds)	-	-	-	-
Administration	Number of staff	5	6	9	13

5.6 Summary of Water Demand

Type of Consumer	Consumption m^3/day			
	1990	1995	2000	2010
Individual Connections	2.0	2.4	7.2	21.6
People using C.W.P's	9.6	11.7	16.4	21.5
Primary School	1.7	2.3	4.0	6.0
Health Centre	5.2	5.3	5.4	5.6
Administration	0.1	0.2	0.2	0.3
Shops	1.1	1.2	1.5	1.8
Butcheries	1.5	1.5	1.5	1.5
Bars / Tea rooms	2.5	3.0	4.0	5.0
Hotels (Low Class)	-	-	-	-
Livestock	13.4	13.4	13.4	13.4
Total	37.1	41.0	53.6	76.7

The daily demand is 77 m^3/day (3.21 m^3/hr).

6. EXISTING WATER SUPPLY

6.1 Technical Description

At the Ewaso Nyiro at about 4 km from the centre there are five boreholes, four installed with hand pumps and the other installed with a submersible pump which uses solar energy. Two of the handpumps are working, however the rods were removed because the concrete slab was not yet constructed.

The 28 solar panels are mounted on a frame, which can be turned manually to face the sun. The water is pumped to a 15 m. high tank, from where the water gravitates to a 10 m. high tank at the centre. In order to have the tank at the centre filled in the morning, the supply from the water kiosks is interrupted in the afternoon of the previous day. This may be necessary due to some leakages along the 4 km long pipeline. The water tested at a kiosk had an EC of 1,095 μS/cm.

The boreholes are drilled in the same area with a large number of about 5 m. deep dug wells. In total about 30 wells were counted which are used for watering the livestock. Water from four wells was tested on the EC, which ranged from 617 to 920 μS/cm.

6.2 Potential and Actually Served Beneficiaries

The beneficiaries of the project are the residents of Sericho trading centre and the pastoral community in the vicinity of centre. This may be estimated at 1000 people in total. The total population of Sericho sub-location is about 2000.

6.3 Livestock Use

Since river Ewaso Nyiro is just nearby most of the livestock water at the river. They are supplied with water from the dug wells, which is put in clay cattle troughs by three to four men standing in the well. During the visit it appeared that newly constructed cattle troughs are not yet connected to the borehole.

6.4 Functional Analysis

This water supply covers an area of 8 km^2 and it's performance and reliability are good. However the quantity supplied does not satisfy the demand.

6.5 Financial Analysis

There are four water kiosks which sell water to the residents at a rate of 20 cents per jerry can. The revenue collected varies from 1,400 Shs in dry months to 700 Shs in wet months and periods with little sunshine.

6.6 Institutional Analysis

The project was implemented by SIDA and presently it is maintained with assistance from KWAHO by two people permanently stationed there. One is employed by the Sericho Water Committee, the other by KWAHO. Their salary is 900 Shs.

To improve the output of the system the Water Committee is proposing to install a diesel powered pump to supplement the existing solar pump. Diesel and salary of pump attendant would be paid for by the Committee. The purchase of the diesel set however is expected to be done by the District or by donors.

Information from the Deda-dossier by ILDP: The watering of the livestock from the dry season wells at Sericho is subject to detailed customary rules. Every well has an owner, the abba Konfi. He is the first person to dig a well at that site. Wells fill up with sand each year when the river floods. but the well site is preserved for the owner, and nobody else may dig a well there. Ownership of well sites can be inherited. But lapse if the site is abandoned.

The abba konfi decides who will have access to the water. Close agnatic (i.e paternal) kin and in-laws have priority, and others may be denied water.

The area immediately surrounding the well is also the protected property of the abba konfi; this consists of the dargula or resting shade trees, and the itis or area where cattle wait before they are allowed to drink. Neither of these areas or their resources, such as trees, can be used by anyone other than the legitimate users of the well, under the authority of the abba konfi.

An abba hirega or water manager is appointed for each group of wells. At the start of each dry season he organises a meeting which decides:

- which wells will be dug.
- the costs (in goats and money) of digging them
- how the costs will be shared among households
- how the communal labour for digging is to be shared out

Every household participates, but contributions need not be equal; female-headed households are at a disadvantage in this process.

Once the wells are dug, representatives of each household meet with the abba hirega and decide on the watering schedule (how often herds will drink) and rota (the order in which herds will drink). The abba hirega ensures this schedule and rota are respected.

7. PROPOSED WATER SUPPLY

7.1 Recommendations

The present supply system caters for the domestic demand in the centre, although the supply capacity seems to be somewhat reduced by leakages. This shows that more effort is needed to maintain the existing facilities, in order to keep the required supply level.

The proposed increase in supply capacity is intended mainly to include supply for livestock. Considering that Sericho Deda has the largest herds in Isiolo District, the purchase of a diesel powered system should be done by the community themselves. The investment should be retrieved from the sale of the water.

7.2 Operation & Maintenance Procedures

The maintenance of the water supply system is carried out by two attendants. One of these is employed by KWAHO, which has organised the O&M. KWAHO is expected to cease it's involvement in the near future, to enable the community to carry out the O&M independently.

The maintenance seems currently not to be without it's problems, as during the field visit in April 1991 leakages were observed at the valve on the tank at the centre.

8. COST ESTIMATES

8.1 Capital Costs

The cost estimate represents the extension of the system required to cover the demand until 2015.

SUMMARY OF CAPITAL COST - PROPOSED SCHEME

Description	Amount Kshs.
Preliminaries and General Stand-by Diesel Additional Works	20,000 250,000 200,000
Sub-Total	470,000
10 % Contingencies	47,000
Total Say	517,000

With a population of 1,010, the per capita construction costs will be Ksh. 500.

8.2 O & M Costs

A minimum of two water supply attendants are required for the proper operation of the system. The installation of a diesel pump will require expenditures for fuel. The solar pump is estimated to provide 25 m^3/day, the diesel pump would have to provide the remaining demand.

MONTHLY O&M COSTS

Description	Amount Ksh.
Salary water supply attendant 2 no. Diesel for running stand-by unit Other maintenance	3,000 1,400 3,000
Total	7,400

With the present population the per capita monthly O&M cost would be about Ksh. 7. An annual O&M cost per household (of five members) would be in the range of Ksh. 440, which should be affordable for most of the community members.