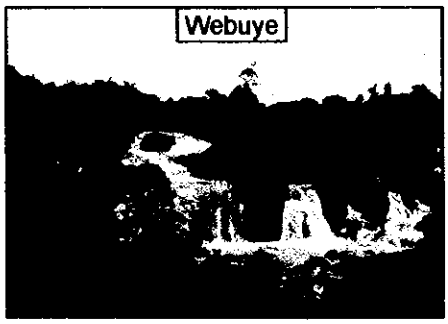
JAPAN INTERNATIONAL COOPERATION AGENCY

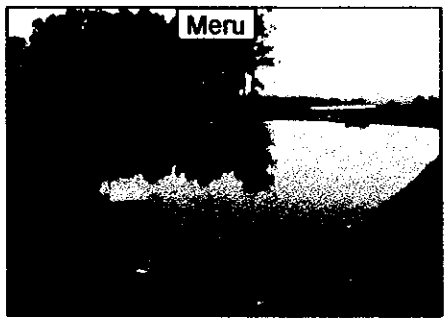
REPUBLIC OF KENYA

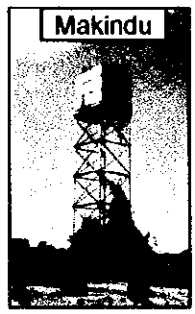
MINISTRY OF ENVIRONMENT AND NATURAL RESOURCES

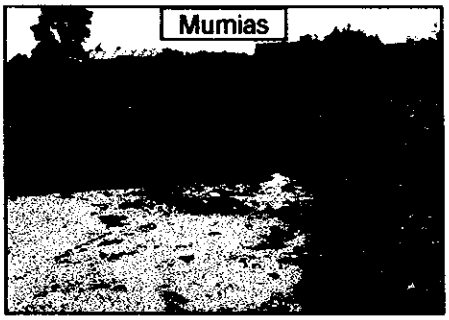
THE STUDY ON INSTITUTIONAL IMPROVEMENT AND REHABILITATION OF WATER SUPPLY SYSTEMS FOR 10 LOCAL TOWNS IN THE REPUBLIC OF KENYA

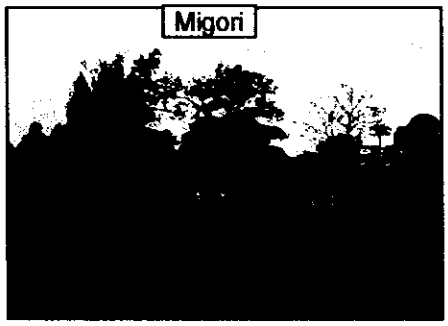
No.1

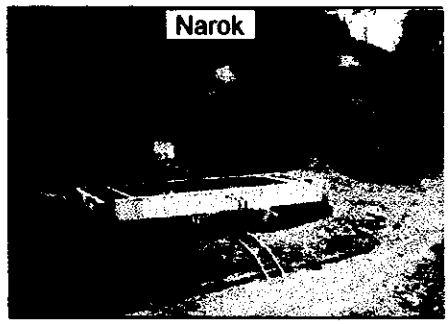


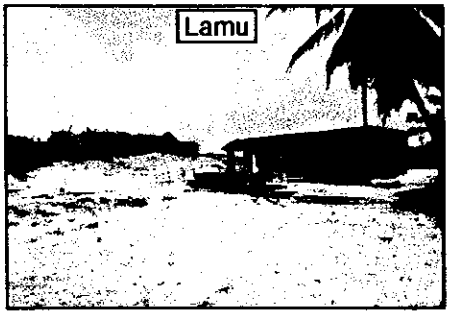


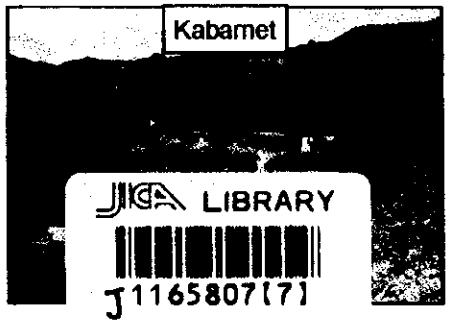


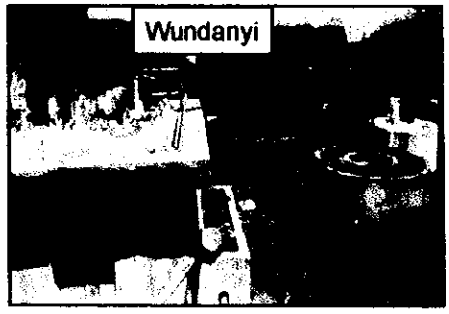












FINAL REPORT

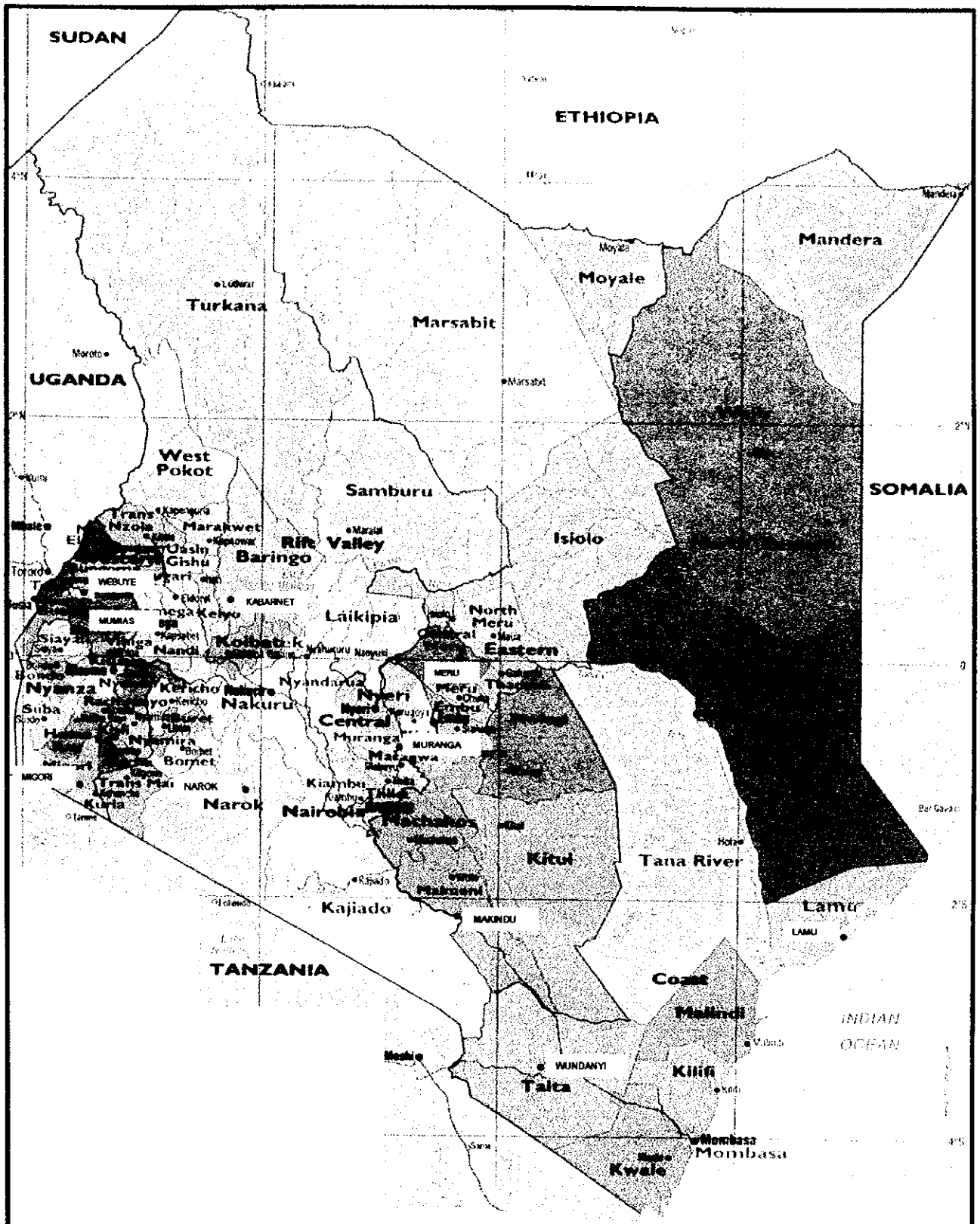
Volume 2E : Main Report (including Appendices) - Makindu Town

FEBRUARY 2001

Development Impact Consulting

Engineering and Utility Management Ltd.

Gibb Eastern Africa Ltd.



TEN TOWNS WATER & SANITATION STUDY

TOWNS LOCATION MAP

Development Impact Consulting

GIBB Eastern Africa

LAWGIBB Group Member

MAKINDU WATER SUPPLY

TABLE OF CONTENTS

LIST OF TABLES

Chapter 2

Chapter 3

Chapter 4

Chapter 7

Chapter 10

Chapter 11

Chapter 12

LIST OF FIGURES

LIST OF ABBREVIATIONS

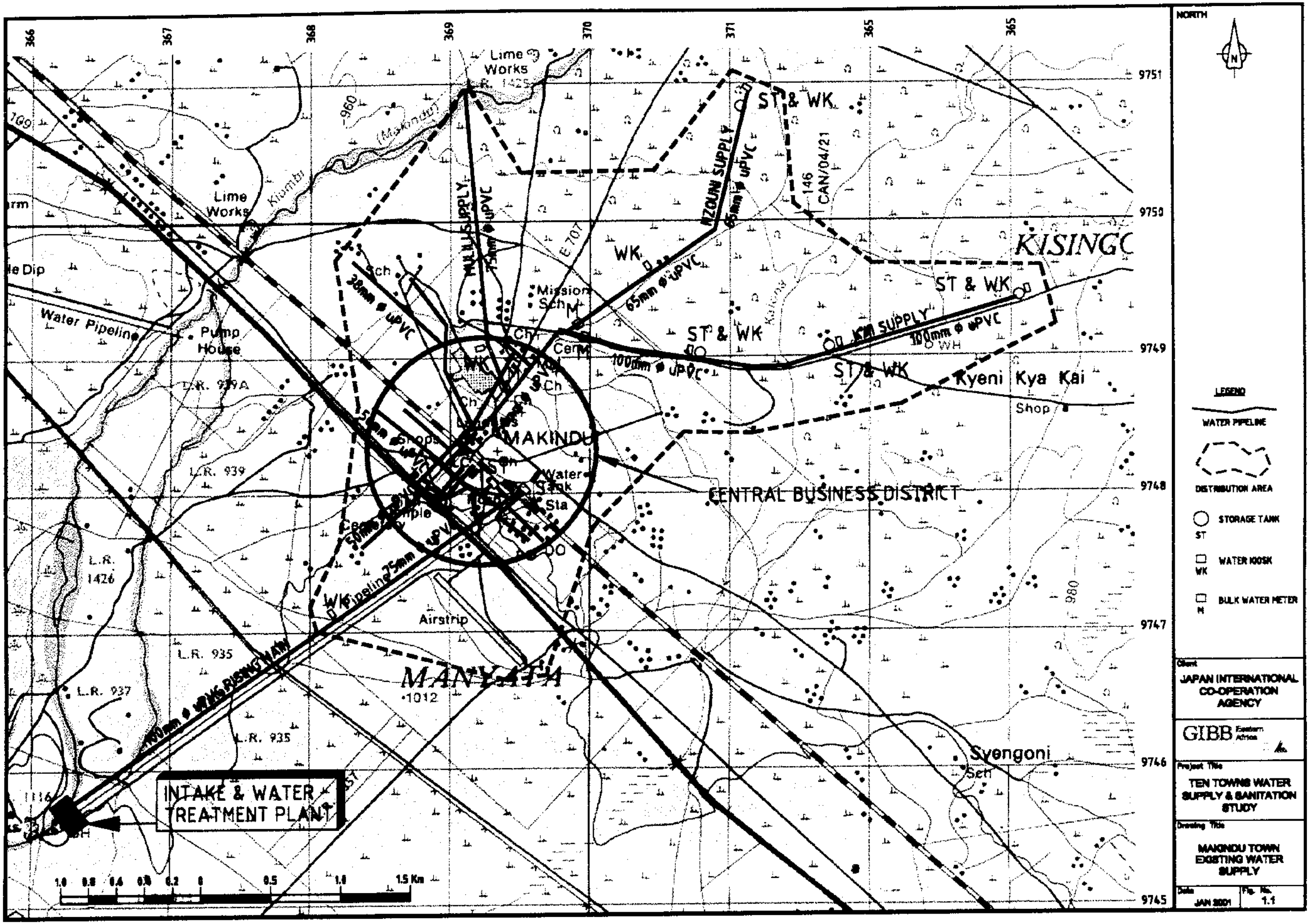
AC	Asbestos Cement (Pipe)
AFW	Accounted for water
AG	Attorney General
AIDS	Acquired Immune Deficiency Syndrome
AIE	Authority to Incur Expenditure
AMREF	African Medical Research Foundation
ASK	Agricultural Society of Kenya
ATP	Ability to Pay
bgl	Below ground level
BH	Borehole
BOT	Board of Trustees
BPT	Break Pressure Tank
CBD	Central Business District
CBR	Cost Benefit Ratio
CIM	Centre for International Migration
CMT	Core Management Team
CTB	Central Tender Board
CV	Contingent Valuation
CWS	Community Water Supplies
DAF	Daily Average Flow
DCO	District Commissioner's Office
DDC	District Development Committee

DWD	Department of Water Development
Dia	Diameter
DTO	District Treasury Office
DWE	District Water Engineer
DWF	Dry Weather Flow
DWO	District Water Office(r)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ENEP	El-Nino Emergency Project
FIRR	Financial Internal Rate of Return
FY	Financial Year
GAA	German Agro Action
GI	Galvanized Iron
GoK	Government of Kenya
Gph	Gallons per hour
GPS	Global Positioning System
GTZ	German Technical Assistance
H	Head
Ha	Hectares
HO	Head Office
HQ	Headquarters
IEE	Initial Environmental Examination
ITCZ	Inter-tropical Convergence Zone

JICA	Japan International Cooperation Agency
KEFINCO	Kenya-Finland Co-operation
KEWI	Kenya Water Institute
Km	Kilometer
Km^2	Square Kilometers
KP&LC	Kenya Power and Lighting Company
KR	Kenya Railways
Kshs	Kenya Shillings
L	litre
LA's	Local Authorities
L/c/d	Litres per capita per day
LPO	Local Purchasing Order
L/sec	Litres per second
M^3/day	Cubic meters per day
M^3/hr	Cubic meters per hour
MENR	Ministry of Environment and Natural Resources
MoLG	Ministry of Local Government
MTB	Ministerial Tender Board
MW	Mega-watts
NAWARD	National Water Resources Database
NEAP	National Environment Action Plan
NEMA	National Environmental Management Authority
NGO	Non-Governmental Organisation

NPV	Net Present Value
NTU	Nephelometric Turbidity Units
NWC&PC	National Water Conservation and Pipeline Corporation
NWMP	National Water Master Plan
ODA	Official Development Assistance
O&M	Operation and Maintenance
PE	Polyethylene Pipe
PSP	Private Sector Participation
PVC	Polyvinyl Chloride
PWO	Provincial Water Office(r)
Q	Discharge
RDF	Rural Development Fund
RER	Revenue Expenditure Ratio
RGS	River Gauging Station
RHS	Random Households Survey
SIDA	Swedish International Development Agency
SS	Subordinate Staff
STD	Subscriber Trunk Dialing
STW	Sewage Treatment Works
TDS	Total Dissolved Solids
ToT	Training of Trainers
T-Works	Treatment Works
UFW	Unaccounted for water

UNICEF	United Nations Children's Fund
WHO	World Health Organization
WMS	Welfare Monitoring Survey
WRAP	Water Resources Assessment Project
WS	Water System
WSS	Water Supply System
WTP	Water Treatment Plant


NORTH
LEGEND
WATER PIPELINE
DISTRIBUTION AREA
STORAGE TANK
ST
WATER KIOSK
WK
BULK WATER METER
M
Client
JAPAN INTERNATIONAL CO-OPERATION AGENCY
GIBB Eastern Africa
Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY
Drawing Title
MAKINDU TOWN EXISTING WATER SUPPLY
Date
JAN 2001
Fig. No.
1.1
MAKINDU
CENTRAL BUSINESS DISTRICT
KISINGO
MANYATTA
INTAKE & WATER TREATMENT PLANT
ST & WK
WK
NZOUNI SUPPLY
MULILI SUPPLY
65mm ø uPVC
100mm ø uPVC
38mm ø uPVC
75mm ø uPVC
50mm ø uPVC
100mm ø uPVC RISING MAIN
Water Pipeline
Pump House
Lime Works
Mission Sch
Water Tank
Airstrip
Kyeni Kya Kai
Shop
Svengoni
Sch
L.R. 939A
L.R. 939
L.R. 1426
L.R. 935
L.R. 937
CAN/04/21
E707
1012
Kiumbi
(Makindu)
9751
9750
9749
9748
9747
9746
9745
366
367
368
369
370
371
1.5 Km

1 INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Kenya's water and sanitation sector is in critically poor condition. Like in many developing countries, the sector is plagued by a series of problems. These problems have arisen because of lack of technically sound operation and maintenance practices resulting in a backlog in rehabilitation, and above all, poor utility management. The existing institutional framework and organizational procedures result in bottlenecks and failure to create required authority and responsibility capacity at the most beneficial levels. Lack of autonomy for the managers of water utilities at all levels is one of the key causes for sustained inferior performance.

The tremendous pressure occasioned by population increase, rural-urban migration and unplanned settlements have strained the water and sewerage schemes beyond the original design capacities.

Periodic technical and financial reviews of water services in Kenya and the Aftercare Study on Kenya's National Water Master Plan have revealed that there is need for serious re-evaluation of management of water and sanitation utilities to meet the targets of effective service delivery in support of the integrated development plans. Decentralization of decision making and management to the local levels and transferring to the private sector activities that can be carried out without compromising social, health or vital economic requirements of the population are of cardinal importance.

Against this background, the Government of Kenya recently approved the National Water Policy paving the way for legislative changes in the Laws of Kenya that touch on water activities. The changes aim at rationalizing management, decentralizing operations to the local level, creating the necessary regulatory framework and activating private sector participation in the sector, in order to obtain a more responsive management system that ensures efficient service delivery and project sustainability at the most economical cost.

JICA, one of Kenya's leading development partners, would like to help create a sustainable environment for water and sanitation service delivery systems, by supporting formulation and development of workable management arrangements in the water sector.

The Study on Institutional Improvement and Rehabilitation of Water Supply Systems for Ten Local Towns is being undertaken in order to provide Kenya with feasible, viable and implementable options that are sensitive to local conditions, especially social, environmental, economic and political.

The findings, recommendations and work plans derived from this study may then be used to develop a more comprehensive framework for rehabilitation and extension of water services to meet development objectives as enshrined in the National Poverty Eradication Plan for the rest of the nation.

The use of local initiatives such as Kitale and Nakuru to investigate the potential and/or constraints for commercialization of water services within local authority setting will be a useful barometer for the future of the National Water Policy, which envisions decentralization of water activities to local authorities in urban areas. Malindi, which is under a partnership between the National Water Conservation and Pipeline Corporation and Gauff Utility Services, will provide another alternative for comparison of performance and benchmarking.

1.2 OBJECTIVES OF THE STUDY

The objectives of the study are:

(1) To obtain the baseline information regarding the water supply systems for the ten local towns;

(2) To recommend the institutional arrangement for effective water service delivery and rehabilitation plan of the relevant facilities in the project areas;

(3) To give advice on the application of the recommendation to the other areas in the Republic of Kenya.

1.3 SCOPE OF THE STUDY

The fundamental philosophy of this study hinges on the fact that without appropriate intervention in the water supply and sanitation sector, no major improvements in service delivery will be realized. This study focuses on ten (10) towns in the Republic of Kenya namely: Meru, Lamu, Kabarnet, Webuye, Mumias, Migori, Narok, Muranga, Makindu, and Wundanyi as a pilot programme of implementing the desirable interventions which will serve as a show case for replication in the rest of the country.

The interventions entail three main components, which must go hand in hand:

(1) To restore the water supply and sanitation facility to its original technical and functional capacity by undertaking the necessary physical rehabilitation.

(2) To put in place an appropriate institution to run the water supply and sanitation facility. This institution should be more responsive to the needs of, and directly answerable to the consumers. The institution should have the legal backing and formed in line with the current National Water Policy, which advocates active private sector participation in the water sector for more efficient service delivery.

(3) To put in place an appropriate technical team of operators, with the necessary skills and equipment and tools to take over the day to day operation and maintenance of the rehabilitated facility. It is envisaged that a team starting with an efficiently functioning facility free of major repairs and replacements, and with a good management backing,

stands a better chance of achieving a self-sustaining facility within a reasonable time span.

In order to achieve the foregoing intervention goals and the overall project objectives, the study entails a two-phase strategy for collecting the relevant data and information: a Preliminary and a Pre-feasibility phase.

The preliminary study covers review of relevant data and information, diagnostic survey of existing water supply and sanitation facilities, water demand projection, revision of water supply facility plan, cost estimation and evaluation, identification of the laws and regulations of environmental impact assessment, legal and regulatory framework on facility performance. It entails basic data collection, field reconnaissance and field inspection of the utilities to assess the current condition and situation of the water supply and sanitation schemes.

The pre-feasibility study phase covers establishing the socio-economic characteristics of the study area, assessment of surface water and groundwater potential, identification of institutional and legal constrains that affect improvement in operations of water facilities and determination of viable financial and commercial plans that ensure long-term sustainability of the facilities.

The pre-feasibility phase includes review of existing data, evaluation of the technical, socio-economic, institutional and financial aspects, formulation of water supply and sanitation facility rehabilitation plans, and formulation of preliminary technical and institutional development plans on which recommendations will be based.

In addition to the ten towns that constitute the pilot programme, operational experiences have been obtained from the towns which have been undergoing the commercialization approach, promoted by GTZ, i.e. Malindi, Kitale and Nakuru, for comparison purposes. The year 2010 has been chosen as a planning horizon.

1.4 COMPOSITION OF THE FINAL REPORT

The final report comprises of a total of two volumes as follows:

Volume 1: Executive Summary
Volume 2: Main Report

As indicated by their titles, Volume 1 is a summary of the study while Volume 2 is a presentation of the full town report including supporting and back-up data.

2 EXISTING PHYSICAL AND SOCIO-ECONOMIC CONDITIONS

2.2 GEOGRAPHY OF THE STUDY AREA

2.1.1 Location

Makindu Township is located at co-ordinates 37° 50' E, 2° 17' S in Makindu Location, Makindu Division of Makueni District in the Eastern Province. The town is some 180 km from Nairobi on the A109 Nairobi (Athi River / Namanga road turnoff) to Mombasa highway.

The town boundary forms a square with sides 3.2 km long and the area straddles and is bisected by the major highway (A109) and rail link between Nairobi and Mombasa.

The Chyulu Hills lie some 20 km to the south of Makindu town centre and the Makindu (Kiumbi) River (part of the Athi River Basin) flows about 3 km to the northeast of the town. The spring feeding this river is the source of the town's water supply.

2.1.2 Topography

Ground levels within the town range from approximately 1,010 m above mean sea level (AMSL) to 970 mAMSL with the surface having a gentle down slope in the northerly direction. The railway station is at an altitude of 999 mAMSL while the raw water intake at the spring source is at about 1000 mAMSL.

2.1.3 Geology

Makindu is located east of the footslopes of the Chyulu Hills, and immediately east of the change in gradient that represents the change in geology in this area. To the west the land climbs steeply to the summit ridge of the Chyulu Hills; to the east, the topography is gently undulating, with moderately incised stream lines and rounded Basement interfluves. Further east the Basement *kopjes* of Mbui Nzau protrude through the saprolite cover, but do not directly affect the climate or water resources of the Makindu area.

Makindu Town itself lies on Basement system biotite gneisses, overlain by red Quaternary detrital soils. The weathered thickness of saprolite is variable and mimics the topography. A single north-south fault cleaves the Basement approximately 1200 metres west of the town, but is not easily distinguished on the ground.

The volcanic unit, of Recent age, comprises olivine basalts of the Ukati lava flow. These flowed down the bed of the Kiumbi River, and a finger of lava extends to within 3 km of the town. Limestones, deposited by springs leaching carbonates from the volcanic rocks, line the course of the river and were at one time worked for lime; these kunkar and travertine deposits range from 0.5 to 9 m in thickness.
There is insignificant alluvium in the stream bed, but partly-calcareous (calcrete) sands and gravels between the olivine basalts and gneisses in the river valley are believed to be relatively thick. They play an important role in transmitting water from the volcanic unit to Basement aquifers (all after: Temperley 1956: Saggerson 1963: Gunson *et al* 1988).

2.1.4 Climate

The annual rainfall is 610 mm per annum, minimum and maximum temperatures are 16.6°C and 28.6°C respectively with a mean annual evaporation of 2110 mm. Rainfall is distributed bimodally. The aridity ratio for Makindu (rainfall divided by evaporation) is 0.29, which makes it an arid area.

2.2 PHYSICAL INFRASTRUCTURE

2.2.1 Communications

2.2.1.1 Road links

Makindu lies on the A109 highway from Nairobi to Mombasa. It is about 80 km away by road from the district headquarters of Wote.

2.2.1.2 Rail links

The railway line from Mombasa to Uganda also passes through the town. Makindu railway station is situated at the centre of the original town boundary and was the focus of the town's growth.

2.2.1.3 Air transport

A small airstrip, catering only for light aircraft, is located immediately to the south of the A109 highway and serves Makindu and its environs.

2.2.1.4 Telecommunications

Telephone services are available in the town although subscriber trunk dialling (STD) facilities are yet to be installed. Currently, no cellular phone coverage exists for Makindu and the surrounding area.

2.2.2 Power Supply

Makindu is a major centre in the region and is connected to the national power grid.

2.2.3 Water Supply And Sanitation Infrastructure

Water supply and sanitation is the subject of the present study and a detailed evaluation of the infrastructure is included in the chapters that follow.

2.2.4 Existing And Planned Services

There are currently no known immediate plans for major expansion of the water supply and sanitation services within Makindu town and its environs.

2.3 EXISTING WATER RESOURCES, MANAGEMENT AND UTILISATION

2.3.1 Hydrogeology (groundwater resources)

The Makindu area is hydrogeologically complex, lying as it does near the junction between young volcanic and old Basement material. This short section briefly considers the range of aquifer types in the area, with a summary of the highest potential units.

2.3.1.1 Basement system hydrogeological units

There are two aquifer types present in Basement rocks: the saprolite (or regolith) aquifers, which occur in weathered material; and bedrock aquifers that are found where fracturing has occurred. Neither of these aquifer types is characterised by particularly high yields, although the peculiar recharge system prevailing in the Makindu area makes them considerably better than elsewhere in arid Basement areas. This is illustrated by the yields of the temple and mosque boreholes (see Table 2.1).

The fault west of the town offers the potentially best Basement groundwater target, particularly at the point it crosses the Kiumbi (Makindu) River.

2.3.1.2 Volcanic system hydrogeological units

The hydrogeological characteristics of the volcanic aquifers at Makindu are likely to be heterogeneous, varying considerably over relatively small areas. The young *pahoehoe* basalt lavas of the Ukati flow are known to be highly permeable, due partly to the thin soil cover. This enhances both vertical and horizontal movement of water in this unit. In addition to the

springs, it is considered very likely that the lateral movement of water from the volcanic to the Basement units enhances the latter.

2.3.1.3 Recharge

The recharge area is considered to range from 22 km^2 (Groundwater Survey (Kenya) 1988) to 70 km^2 (Carl-Bro 1982). Wright (1982), describing a detailed groundwater resources and geological study of the Chyulu Hills, calculated that mean annual recharge was approximately 15% of rainfall. Rainfall on the Chyulu hill mass rises to 1600 mm/year (*op. cit.*), but we should assume a mean rainfall less than this for calculation purposes, as rainfall declines sharply with eastward progression. We assume an average areal rainfall of 1000 mm/yr. This suggests that annual recharge ranges from 3.3 to 10.5 x 10^6 m^3/yr (105 to 330 litres per second). This is a conservative calculation: Carl-Bro (1982) assumes a generous recharge ratio of 20 to 25% - 4.4 to 17.5 x 10^6 m^3/yr.

Following is a summary of the hydrogeological conditions in the Makindu Town area:

- Depth range to the main aquifer: 20 m for unconfined, 50 – 100 m for confined aquifers.
- Depth range of water rest level: 2 – 20 m.
- Discharge range: 3 – 15 m^3/hr.
- Water quality: fresh, slightly acidic to neutral sodium bicarbonate waters from unconfined aquifers. Confined aquifers yield slightly brackish water whose quality deteriorates eastward. The ionic concentrations of sodium, chloride, sulphate, fluoride, total dissolved solids, hardness and possibly iron and manganese are likely to be high.

Aquifers are either confined or unconfined, and comprise basal volcanic flow units, old land surface at volcanic/gneiss contact, weathered and fractured gneiss and alluvial sediments. Recharge to the aquifers occurs by lateral underflow from recharge catchments on the Chyulu Hills and seepage from surface water bodies into perched aquifers. Local infiltration is expected to contribute minimal recharge.

2.3.1.4 Status of existing groundwater supply facilities

There is no borehole operated by the Water Department in Makindu Town. However, several public and private institutions own boreholes. These boreholes were not inspected because they do not constitute sources operated and maintained by the local water department.

Table 2.1 presents data for the existing institutional boreholes.

Table 2.1
Completion data for institutional boreholes

Serial No.	Total depth (m)	Water strikes (m)	Rest level (m)	Tested yield (m^3/hr)	Owner
P-130	154	12, 91	5.8	6.3	Railways Corporation
C-2194	34	8.5	4.5	13.6	Railways Corporation
C-2208	37	6	2.7	9.1	Railways Corporation
C-3815	91	18	18	8.2	Sikh Temple
C-4231	85	20, 78	17	9.0	Jamia Mosque

Data source: Groundwater Survey (Kenya) Ltd, 1988

2.3.1.5 Potential for groundwater development

It is reasonably certain that groundwater resources in the Makindu area constitute a viable bulk water source for public water supply purposes. However, all the groundwater would require some form of treatment if standards are to be maintained.

2.3.2 Hydrology (surface water resources)

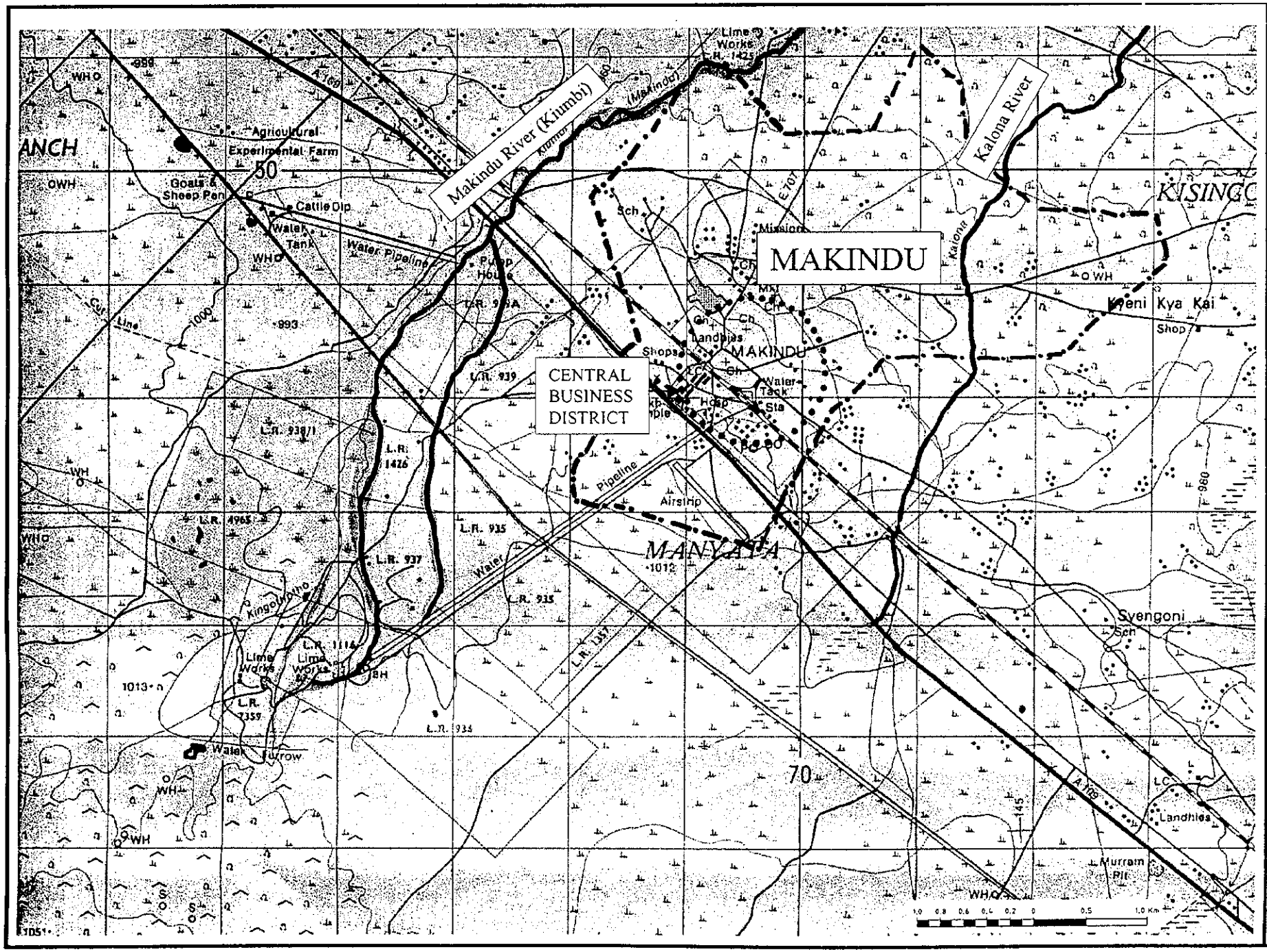
The principal watercourse in the vicinity is the Kiumbi (Makindu) River which is fed by springs located 2.5 km west of the town. The catchment falls within Drainage Area 3- the Athi River Basin. The springs emerge at the boundary of the Chyulu volcanics.

Mean annual rainfall averages 610 mm in Makindu. This rises to over 1,100 mm in the nearby Chyulu range to the west of the town.

The source of water for the Makindu water supply are the spring discharges feeding the Makindu River. The springs are fed from the lavas of the nearby Chyulu range. The Makindu springs are one of a number of springs emerging from the Chyulu volcanics - see Figure 2.1

The water resources of the area were studied in a comprehensive project entitled "*The Chyulu Hills Water Resources Study, Kenya*". The study was undertaken by British Geological Survey between 1984-87.

The mean spring discharges as measured between 1984-87 were reported to be as follows:



NORTH

LEGEND

CURRENT WATER SUPPLY DUSTRIBUTION AREA

Client
JAPAN INTERNATIONAL CO-OPERATION AGENCY

GIBB Eastern Africa

Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY

MAKINDU
Rivers & Gauging station
Makindu River not gauged

Date	Fig No.
DEC. 2000	2.1

- Lesser Kiboko 0.084 m^3/sec.
- Kibwezi 0.455 m^3/sec.
- Mtito Andei 0.082 m^3/sec.
- Lower Lolturesh 0.574 m^3/sec.
- Mzima Springs 4.587 m^3/sec.
- Makindu 0.090 m^3/sec.

The Makindu springs are similar in discharge to the Lesser Kiboko and Mtito Andei springs.

The spring discharge characteristics are contrasted with the water demand in Table 2.2.

Table 2.2
Makindu Spring discharge characteristics

Description	Flow rate (m^3/day)	Flow rate (m^3/sec)
Mean spring discharge	7,776	0.090
Minimum spring discharge	6,048	0.070
Maximum spring discharge	16,675	0.193
Current water abstraction for Makindu	400	0.004
2000 water demand	1,562	0.018
2010 water demand	2,016	0.023

On inspection of Table 2.2, it can be seen that the discharge capacity is well in excess of the demand for Makindu town at present and in the foreseeable future.

2.3.3 Raw water quality

The source is a spring supply but with some doubts as to quality due to waste water discharge from communities upstream of the Makindu water supply intake. No raw water quality analysis data was available and it is recommended that full chemical and bacteriological tests be done on a regular basis.

2.3.4 Treated water quality

A preliminary inspection of the treated water on site indicates that it appears to be potable. No treated water quality analysis data was available, however, and it is recommended that full chemical and bacteriological tests be done on a regular basis.

2.3.5 Water resource conclusions

There is ground water potential in the Makindu area. However, the spring discharges are well in excess of the water demand for Makindu and the peri-urban area now and even beyond the design horizon of 2010. It would thus be advisable to base any water source expansion on these springs, providing other water abstraction permits can continue to be satisfied.

2.4 SOCIO-ECONOMIC CONDITIONS

2.4.1 Administration

Makindu is a cosmopolitan town located in Makueni district in the Eastern province of Kenya. The administrative significance of the town is linked to the construction of the Kenya-Uganda railway line (see appendix E 1-1) as well as its proximity along the Mombasa highway. The town is the administrative headquarters of Makindu division and its Central Business District (CBD) houses offices of the district officer, other divisional departmental heads, railway station, Police College and offices of a few non-governmental organizations operating in the locality. It is a major business convergence centre for the hinterland and its infrastructural potential enables it to serve as a major economic hub for neighboring locations/towns especially on market days when urban visitation and water use is at its peak.

2.4.2 POPULATION DISTRIBUTION

Using the 1999 housing and population census, the population of Mumias town was placed at 6226[1] people. The town has a high population density (see appendices E 1-1 and E 1-2 for a map of the town). The town offers potential lucrative investment and employment opportunities. The distribution of the population and number of households on the basis of sub locations and water service area is shown in table 2.3 below.

[1] This excludes non-residential population but includes the special population. Special population in this regard based on the 1999 census enumeration procedures considered to include though not restricted to people in hotels/lodgings, bus stops, police cells, on transit, idlers and street urchins found within the town as at mid-night of the census enumeration day.

Table 2.3 Population Structure and Distribution

Sub-Location	Number of Households	Population in urban council	Population in Service area
Manyatta	1663	6226	5608
Total	**1663**	**6226**	**5608**

Source: District Statistical Office, Makueni and central Bureau of Statistics, 2001

2.4.3 Population Projections to the year 2010

The 1989-1999 inter censal growth rate for the town was 2.8%. This growth rate is in line with the declining national trend due to reduced fertility rates and a fall back in job opportunities in urban areas. Nonetheless, the main determinants of population growth in the town remain social infrastructure, investment potential, fertility rates and rural–urban migration. The presence of the police training college and the railway station among other amenities presents an important scenario for analyzing water demand viz. a viz. growth in other urban utilities. It is expected that the population growth will remain relatively stable over the next ten years. **Table 2.4** below gives a comparative trend of the population growth for the next ten years based on the water service area and overall population in the urban area using a growth rate of 2.8%.

Table 2.4 Population Projection[2] to the year 2010.

Year	Population under Urban Council
2000	6400
2001	6600
2002	6800
2003	7000
2004	7100
2005	7300
2006	7600
2007	7800
2008	8000
2009	8200
2010	8400

[2] Projections based on the following formula [$P_{projected} = P_{actual}(1+r)^t$] where r=rate of pop growth and t= year and the base year is the 1999 estimated population rounded off to the nearest 100.

2.4.4 Economic and Commercial Activities

Makindu town is located within a low potential agricultural hinterland. Existing infrastructure and other social facilities are better than the surrounding rural areas and this has an influence on the development of the town. The main land-use patterns within the CBD are limited to business/economic activities, schools, a college, a hospital, institutional offices and other essential social infrastructure. Commercial activities are geared towards meeting the needs of the population on transit as well as the farming community that form a significant consumer cohort. Major among them is distribution, wholesale, retail shops hard wares, hotels, bars, accommodation facilities, posho mills, carpentry shops, tailoring enterprises and metal works and lodgings. Makindu also has a cottage industry dealing with handicrafts. It is also renowned in the production and sale of pure honey. The growth of the informal sector is also an important source of income to the local residents and offers employment to several people especially the youth that are mainly self-employed.

2.4.5 Social Infrastructure

2.4.5.1 Communication

The town lies off A classification trunk road from commonly referred to as Mombasa highway and is therefore well connected to Mombasa and Nairobi. The feeder roads are not regularly maintained and may prove impassable during rainy seasons. However, the road network is generally motorable. The town is also linked to the Nairobi Mombasa railway line. Other services include Operator assisted telephone services.

2.4.5.2 Social Institutions

The growth of Makindu town is dependent on the outreach activities of the local sugar factory through rebates in the sugar levy. The growth in establishment of such institutions as schools and health facilities has been phenomenal. The main types of institutions and their numbers are summarized in the **Tables 2.5** and **2.6**.

Table 2.5 Educational Institutions

Type of institution	**Number**
Pre-Primary Schools	15
Primary Schools	3
Secondary Schools	2
Youth Polytechnics	3
Total	23
Total	**70**

Source: District Development Office Makueni, 1999

Table 2.6 Other Social Institutions

Facility	Number
Sub-District Hospital	1
Railway Station	1
Dispensary (GoK)	1
Churches	6
Private Clinics	7
Mosques	4
Social hall	1
Railway Police Training School	1
Total	**22**

Source: District Development Office Makueni, 1999

2.4.6 Income Levels

The distribution of income in the town is quite uneven as it reveals major disparities in household resource endowment. Urban households earn more income (through wages, salaries and profits) than their peri urban counterparts. According to the Welfare Monitoring Survey (WMS) II, the mean monthly household income for the town was estimated to be Kshs. 5520.1 as shown in table 2.6 below. 58% of the urban households mean monthly income is drawn from wages, salaries and profits. The income levels of the peri urban population in Makindu town are generally low since the town lies in a low potential ASAL area with unfavourable conditions for growing both food and cash crops. Most households derive their income from non-agricultural activities.

It then follows that, other than the extremely exceptional cases, most of the urban population of Makindu town are able to pay for water. A random sample survey of 80 households carried out by the study team revealed that more than half of the households interviewed earn an average income of over Kshs 5,000 per month. According to the DWO the problem at the moment is not the level of the tariff but the level of service. In fact, currently most of the households pay as high as Kshs 10 for a 20L jerricane of untreated water drawn from vendors.

Table 2.7 Mean Monthly Household Incomes (Kshs).

Main income category	Kshs.
Wages/salaries/profits	2,142
Other non-agriculture	1,200
Agriculture	2,060
Crops	1,19
Total household income	**5,520**

Source: Welfare Monitoring Survey II, 1994

2.4.7 Willingness and Ability to Pay for Water Services

2.4.7.1 Ability to Pay

Ability to pay is a function of level of household incomes, the acceptable share of water/sewerage services in total expenditures, tariffs and the target consumption levels. However, the main consideration in the ability to pay in this study is the household level of income. The ceiling on the budget share of income that may be spent on water/sewerage services is usually taken to be 5% though this varies from one income group to another. Comparatively, households in the lower income bracket spent a higher budget share of their income in real terms on water than households in the middle to high-income group who spent approximately 2.2% and 1.4 % of their incomes respectively.

41% of the population of this local town live in the low-income bracket and normally draw water from untreated sources in times of acute shortage. It is therefore important that a re-evaluation of their income levels W/ATA and W/ATP be carried out as it forms an integral component of the perceived water and sanitation improvement plan.

2.4.7.2 Willingness to pay

To get information on willingness to pay[3] the study team carried out a random survey on a sample of 80 households mainly within the service area. Through a questionnaire based interview, each household head was asked questions on how much they would be willing to pay for a cubic meter of water assuming improved service delivery. The general conclusion of the survey was that most households were willing to pay more for improved service delivery with the level of tariff increase depending on the perceived problem in a particular area.

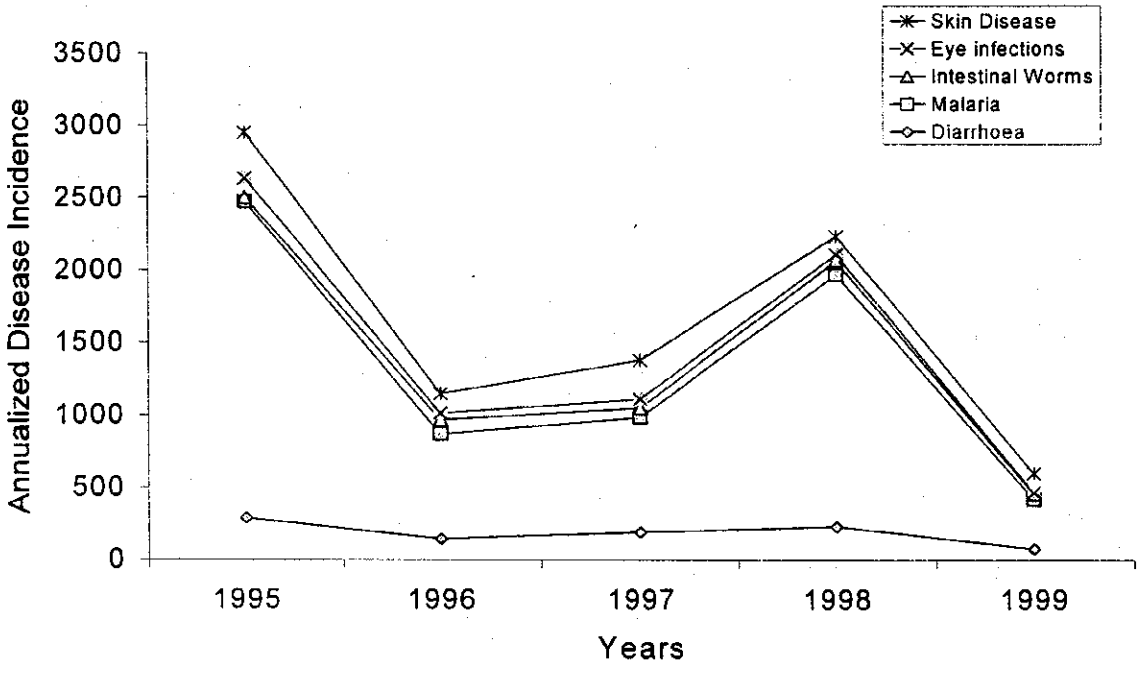
Further analysis of information collected indicated that over 80% of the households interviewed were willing to pay up to Kshs. 500 for actual water consumption compared to an average monthly bill of Kshs. 300. A similar survey in the areas not currently serviced established that majority of the households would be willing to pay for water at the current general water tariff of Kshs. 30/m^3. Simulations to establish the threshold tariff beyond which people would not be willing to pay revealed that even with increment of up to 30% in the tariff, people would still be willing to pay

[3] The appropriate methodology in estimating willingness and ability to pay (W/ATP)/ willingness and ability to accept (W/ATA) is to use the contingent valuation (CV) approach. This approach is validated through asking water consumers at the household level hypothetical questions (which are a true reflection of actual water consumption levels) how much they are paying for water as compared to how much they would be WTP if existing water supply externalities are internalized.

2.4.8 HEALTH AND SANITATION CONDITIONS

The health and sanitation situation for the town was critically analyzed and found to be generally poor. Most health facilities lack adequate personnel as the population is under-served in terms of health services and the health facilities are over-utilized. Infant mortality rates are high mostly because of low incomes leading to malnutrition. Other major diseases include malaria, diarrhoea, intestinal worms and other waterborne diseases due to the low accessibility to clean drinking water. Other water-related diseases are bilharzia and eye infections. The chart below shows the pattern of water borne diseases over a five year period. It is important to note that cases of diarrhoeal diseases were low due to either poor data capture or declining patterns of household health seeking behaviour since introduction of cost sharing in public hospitals. Nonetheless, the pattern of water related diseases is shown in chart 1 below

Chart 1: Incidence of Water Realated diseases in Makindu Town



Source: Health Information Systems Unit MOH and PHO, Makindu 2001

2.4.9. Types Of Settlements

The pattern and trend in settlement in town is poor with the peri urban areas dominated by mud walled and semi permanent structures. The pattern within town is dominated by permanent structures especially railway quarters and government residential areas.

Table 2.8 Distribution of populations based on income categories

Income category	Number	Percentage
High income	871	14
Middle income	2801	45
Low income	2554	41
Total	**6226**	**100**

2.4.10 Situation of Women in Society

Women make up a disproportionately large share of the poor and very poor in urban areas as they are particularly vulnerable to many factors that create and perpetuate poverty. Most families whether poor or not may not be able to survive without the help of female family members.

However, for the urban population, water collection remains a preserve of women and only forms one of their major social roles among many other economic activities within the household. Therefore, women in Makindu town, which is in a semi arid area, are traditionally responsible for collecting water for domestic use in the household. They are conceivably one of the most abused group with regard to water collection habits making them a major vulnerable group in society. Just like poverty, collecting water is a circumstance women find themselves in and which does not necessarily define them.

Collecting water for the household can therefore have negative repercussions on the length and hardship of an average poor woman's working day. Despite the government pre commitment that by the year 2010, all households should have access to water within a radius of 2 kilometres, this situation is yet to be realized especially within the peri-urban areas. This therefore means that the rehabilitation exercise planned for the towns must meet societal expectations in order to ease the excess burden on the woman and an average woman's workload should be a key monitoring indicator. Other than situations where hand cats, bicycles and donkeys are used, the burden for carrying water requires women to have a substantial amount of energy. This condition is energy sapping and causes considerable stress especially to pregnant women leading to multiple complications at childbirth. Other causes of stress include headaches, backaches, sometimes and deformation of the spine. Accidents do occur and these include slipped discs, paralysis, injury to

children carried on the back to extreme cases such as strangulation by the head strap. Improved water supply conditions would change all these and ease the burden on women, releasing time and energy for other development activities necessary in nation building.

2.4.11 Public Health Awareness and Mobilisation

The epidemiology of water borne diseases in Makindu which lies in a low potential agricultural area cuts across major socio economic groups and analysis of the health and sanitation conditions shows that over 60% of the poor are exposed to unsafe water and poor sanitary conditions. Considering the health and sanitation concerns enumerated in section 2.3.8, other common problems relating to urban environmental sanitation in this local town include but not restricted to excreta disposal, water supply, solid waste management, liquid waste and drainage and sewerage treatment.

The need to mount public health awareness and mobilization programmes was therefore found to be a critical component of the water rehabilitation programme. This when weighed against a backdrop of existing empirical evidence, which shows that about 15% of the urban poor have never attended formal schooling calls for a more focused public awareness programme.

The approach to this important exercise should be based on participatory methods with emphasis on use of consensus building techniques involving various stakeholders in town such as businessmen, private sector organizations, government agencies and individual households. These groups are considered to be actual beneficiaries of health and sanitation improvement programmes and must therefore be consulted. The major areas of focus for the sensitization programme should be on use of safe water, safe excreta disposal, personal and domestic hygiene, safe handling of food and safe waste disposal/drainage of excess water.

In this regard, it is important that the public health office (PHO) in collaboration with the office of the district social development officer (DSDO) be assisted and empowered to conduct rapid needs assessment surveys of the existing health and sanitary conditions. This situational analysis should form a basis for developing a comprehensive framework for mobilization and training of the community with a strong focus on the status of the woman. The training should be in the form of a manual to be developed by the consultants entailing among other things;

a) Training of facilitators
b) Training of trainers or catalytic/contact groups
c) Preparation of training materials (including visual aids) to be used in community training

3 EXISTING WATER SUPPLY CONDITIONS

3.1 HISTORY

Makindu water supply was originally designed in the 1950s, constructed and operated by the East African Railways and Harbours Corporation (later Kenya Railways) to primarily serve the railway community.

The system was taken over in the 1980s by the then Ministry of Water with the intention of supplying Makindu town and its environs. The Ministry of Environment and Natural Resources (MENR) currently owns and operates the scheme.

A map at the beginning of the report (Figure 1.1) shows the key current water supply features in the Makindu area and the present water supply distribution zone.

The salient details of the existing water supply system are shown in Figure 3.1.
The following is a detailed assessment and diagnostic evaluation of the existing water supply system. Chapter 4 recommends a rehabilitation plan in accordance with the terms of reference of this study.

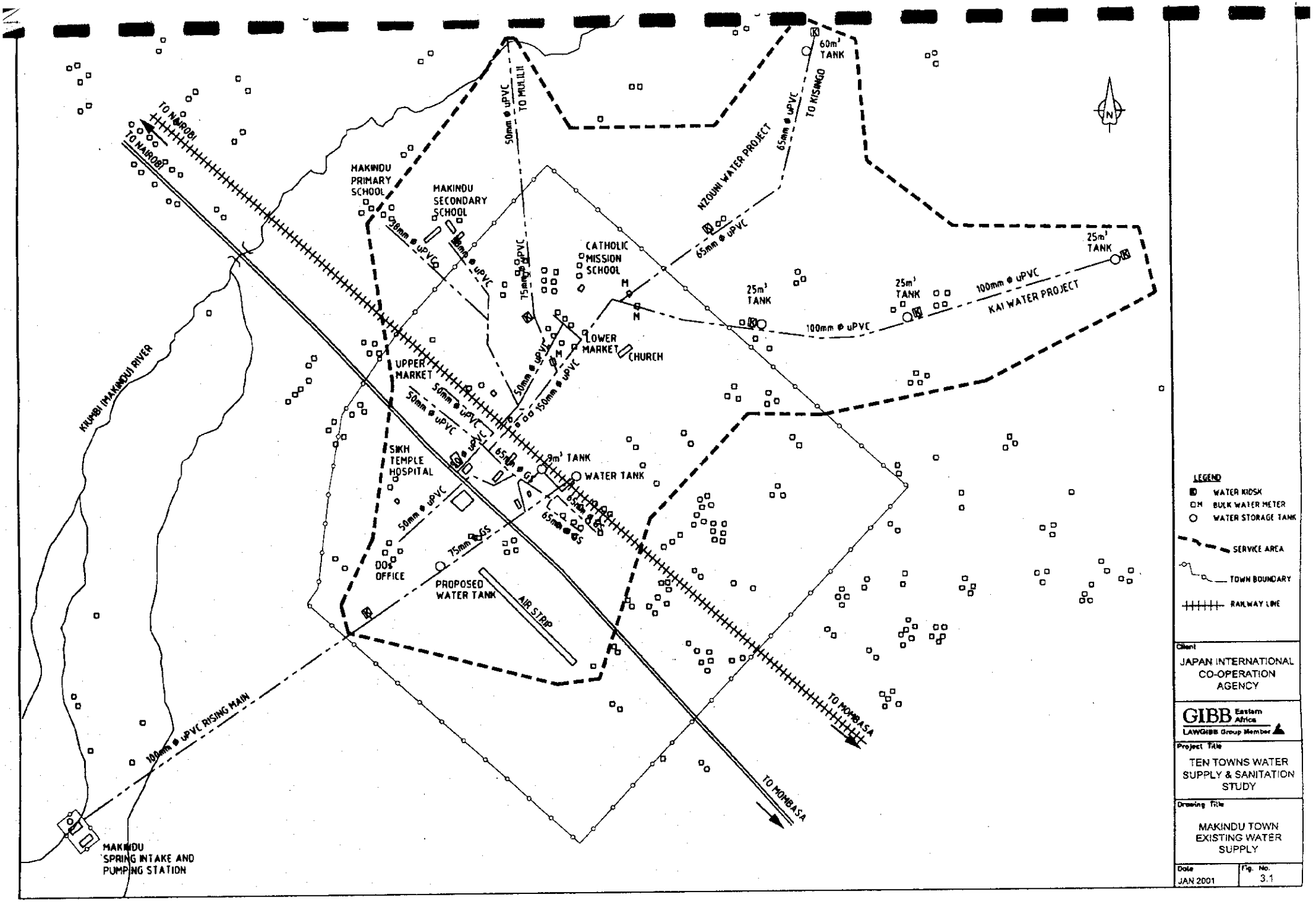
3.2 SOURCE AND INTAKE

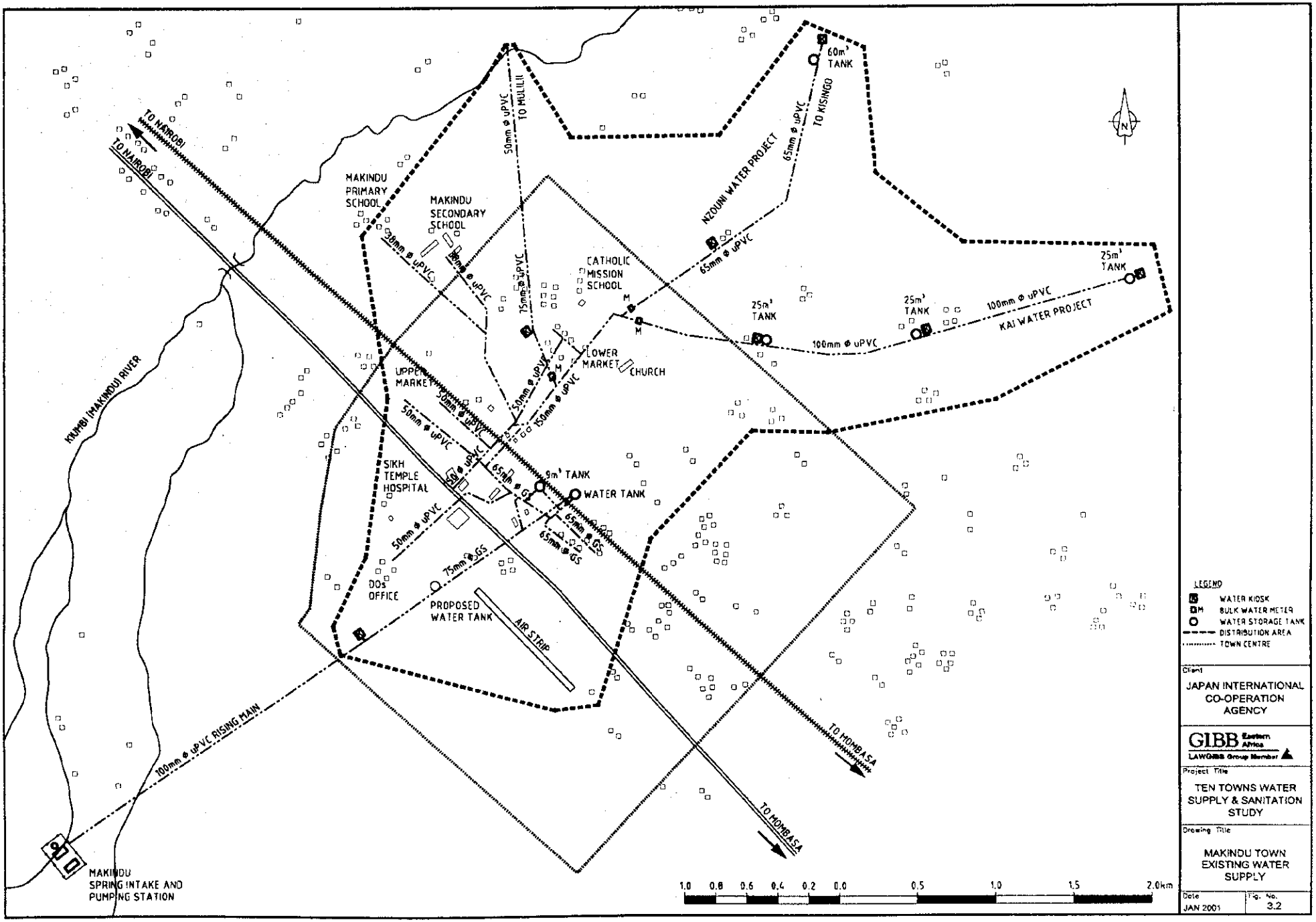
3.2.1 Intake at Makindu (Kiumbi) River

A concrete intake chamber is situated at the edge of a natural pool along the Makindu river just downstream of the original spring source feeding the river. The intake chamber is cylindrical in shape with an internal diameter of 12m and a depth of 4.2m. This spring source has never dried up even during the recent worst drought in decades. The quantity of flow is copious and far in excess of the current abstraction.

In the last few years a new spring has emerged and developed further upstream of the original spring source. Settlements have sprung up around this new spring source and the watercourse it forms. It is feared that waste water from these settlements poses a potential contamination hazard to the Makindu head works downstream. In addition the level of water in the natural pool has risen in the last few years resulting in flooding of the intake site.

The ground level at the intake (from the available 1:50,000 mapping) is approximately 1,000 mAMSL.


60m³ TANK
TO KISINGO
65mm ø uPVC
NZOUNI WATER PROJECT
50mm ø uPVC
TO MULILI
TO NAIROBI
TO NAIROBI
MAKINDU PRIMARY SCHOOL
MAKINDU SECONDARY SCHOOL
CATHOLIC MISSION SCHOOL
25m³ TANK
25m³ TANK
25m³ TANK
100mm ø uPVC
KAI WATER PROJECT
LOWER MARKET
CHURCH
UPPER MARKET
KIUMBI (MAKINDUI) RIVER
SIKH TEMPLE
HOSPITAL
9m³ TANK
WATER TANK
DOs OFFICE
PROPOSED WATER TANK
AIR STRIP
TO MOMBASA
TO MOMBASA
100mm ø uPVC RISING MAIN
MAKINDU SPRING INTAKE AND PUMPING STATION
LEGEND
WATER KIOSK
BULK WATER METER
WATER STORAGE TANK
SERVICE AREA
TOWN BOUNDARY
RAILWAY LINE
Client
JAPAN INTERNATIONAL CO-OPERATION AGENCY
GIBB Eastern Africa
LAWGIBB Group Member
Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY
Drawing Title
MAKINDU TOWN EXISTING WATER SUPPLY
Date
JAN 2001
Fig. No.
3.1


TO NAIROBI
TO NAIROBI
KUMBI (MAKINDU) RIVER
MAKINDU PRIMARY SCHOOL
MAKINDU SECONDARY SCHOOL
50mm ø uPVC
TO MULILII
60m³ TANK
TO KISINGO
65mm ø uPVC
NZOUNI WATER PROJECT
65mm ø uPVC
CATHOLIC MISSION SCHOOL
75mm ø uPVC
25m³ TANK
25m³ TANK
100mm ø uPVC
100mm ø uPVC
KAI WATER PROJECT
LOWER MARKET
CHURCH
UPPER MARKET
50mm ø uPVC
150mm ø uPVC
SIKH TEMPLE
HOSPITAL
9m³ TANK
WATER TANK
65mm ø GS
50mm ø uPVC
75mm ø GS
DO's OFFICE
PROPOSED WATER TANK
AIR STRIP
TO MOMBASA
TO MOMBASA
100mm ø uPVC RISING MAIN
MAKINDU SPRING INTAKE AND PUMPING STATION
1.0 0.8 0.6 0.4 0.2 0.0 0.5 1.0 1.5 2.0km
LEGEND
WATER KIOSK
BULK WATER METER
WATER STORAGE TANK
DISTRIBUTION AREA
TOWN CENTRE
Client
JAPAN INTERNATIONAL CO-OPERATION AGENCY
GIBB Eastern Africa
LAWGIBB Group Member
Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY
Drawing Title
MAKINDU TOWN EXISTING WATER SUPPLY
Date
JAN 2001
Fig. No.
3.2

The intake site is fenced off and contains a pump station, a twin unit staff house, a unihut store and a chlorine store. The pump station is semi submerged in the rising pool water level. As an emergency measure the pump plinths have been raised to keep them just above the water level. The location of the intake works needs to be shifted to higher ground.

3.2.2 Access to intake site

The 4km long access road to the intake site is generally motorable along most of its length. It has, however, several mud holes which become difficult to traverse, especially during the rainy season. Furthermore, it is difficult to cross a tributary of the Makindu river which lies on the way to the intake site. The access road currently crosses this small tributary in a marshy area. (see photo in Appendix E2).

3.2.3 Raw water main

There is no appreciable length of raw water main since disinfection is carried out along the pumping main soon after the pump station at the intake site.

3.3 TREATMENT AND TRANSMISSION

3.3.1 General

The only treatment that the abstracted spring water is subjected to is chlorination. The in - line displacement doser is located just after the pump station along the pumping main. It is reported to occasionally break down and has had to be replaced at least once.

3.3.2 Raw Water Quality

As mentioned earlier the waste water from the new upstream settlements is cause for concern to the Makindu consumers. It was recommended to the operation staff that periodic raw water samples should be taken for full chemical and bacteriological analysis, in order to establish whether further treatment of the source water is necessary.

3.3.3 Laboratory Facilities

The only laboratory equipment on site is the lovibond comparator used to measure residual chlorine levels. Lack of laboratory equipment and trained technical staff to monitor water quality is a major drawback and has potentially serious health consequences.

3.3.4 Pumping Plant

The details of the current pumping facilities at the intake pump station are summarised below:

- An old diesel driven (8HP) pumpset. The diesel engine has broken down although the pump is serviceable.
- 1nr 15HP electric motor driving a centrifugal pump installed in 1994 to augment the old diesel driven pumpset.
- 1nr 30 HP electric driven centrifugal pump installed in 1999 with the financial assistance of two NGOs, the African Medical and Research Foundation (AMREF) and German Agro Action (GAA).

The last two pump sets operate alternately during the day with the 15HP pump used at night.

3.3.5 Rising main

See also section 3.5.1 below.
The rising main is made up of an initial section of about 3km long uPVC class C pipe 100mm in diameter followed by an approximately 2km long section in 75mm diameter GI pipe. The 100mm diameter main is subject to frequent bursts and the lengthy submerged crossing of a swampy area is very difficult to access and therefore to maintain and repair. The 75mm diameter section is undersized and acts as a bottleneck to supply to Makindu town.

3.4 STORAGE

There are two elevated storage tanks in service, with reported capacities of 50 m^3 and 9 m^3 respectively.. The ground elevation at the railway station site (50 m^3 tank) is approximately 999 mAMSL. This pressed steel tank stands on a 14m high tower and the tank, tower and pipe work are in a dilapidated state. The 9 m^3 tank is on a 6m high tower and provides insignificant storage capacity.

Some consumers within Makindu, like the Sikh temple, have their own elevated storage tanks as do the three large community-based water supply schemes.

The existing 'railway station' 50 m^3 elevated tank is not serviceable and it will be futile to try and rehabilitate it. The tank and tower structure are poorly maintained and extensively corroded. The tank panels are leaking seriously and the tank itself is located in Kenya Railway's property which is not easily accessible. There is no access platform at the tank level, no safety cage for the absolutely vertical access ladder, the pipework is poorly anchored to the tower structure and some of the valves are

inaccessible. The level gauge has been disconnected and abandoned and, most importantly, the storage capacity is totally inadequate for the current town water demand.

3.5 DISTRIBUTION

3.5.1 Reticulation and pumping main

The details of the current reticulation and rising main facilities are summarised in table 3.1. The rehabilitation needs identified are also included within this table for ease in presentation.

The distribution system is generally old and consists of pipes with small diameters. Friction losses are therefore high, thus restricting flows. The reticulation network serves an area of approximately 4km^2, compared to a town area of 10km^2.

3.5.2 Consumer connections

Operational staff report that there are 597 registered connections to the reticulation system (at the time of the site visit). Of these:

- about 60 along the Makindu-Kibwezi highway were transferred to a Kibwezi – based community water supply system (Kikumbulyu water supply);
- approximately 90 are dormant connections (water cannot reach consumer or consumer decided to forego the public water supply service);
- a further 130 have been disconnected due to non-payment or for other defaults.

This leaves about 317 currently active water connections including bulk supplies to three peri-urban community-based water schemes:

- Kai water supply project;
- Nzouni water supply project;
- Mulili water supply project.

Table 3.1
Rising main / reticulation system - existing and rehabilitation needs

Type of pipe and class	Pipe dia. (mm)	Approx. length (km)	Rehabilitation needs/notes
uPVC pipe 'C' class	100	3	Rising main: change to 100mm GI.
GI pipe 'medium' class	75	2	Part of rising main: change to 100mm GI.
GI pipe 'medium' class	63	0.8	Main distribution line within the railway landhies. Change to 100mm uPVC class 'D'.
GI pipe 'medium' class	100	0.12	Tank scour and outlet within the railway compound corroded. Replace with new.
uPVC pipe 'B' class	150	0.6	Main distribution line to community water projects and the market centre.
uPVC pipe 'B'/'C' class	100	0.4	Part of main distribution line and connected to 150mm uPVC from Kikumbulyu.
uPVC pipe 'B' class	50	2.2	Distribution line to GAA, upper and lower market.
uPVC pipe 'B' class	75	0.2	Another distribution line to upper market from 150mm line.
uPVC pipe 'B' class	38	0.8	Distribution main from 150mm line to upper market along Mombasa - Nairobi road.

Others appurtenances	Qty. (No.)	Diameter (mm)	Rehabilitation needs/notes
Valves chambers	10	--	Repairs needed.
Bulk water meters	2	100	Replace.
Non return/foot valves	4	100	Replace.
Air valves	3	100	Replace.
Washouts	2	100	Replace.
Sluice valves	5	100	Replace.

3.6 EXISTING O&M

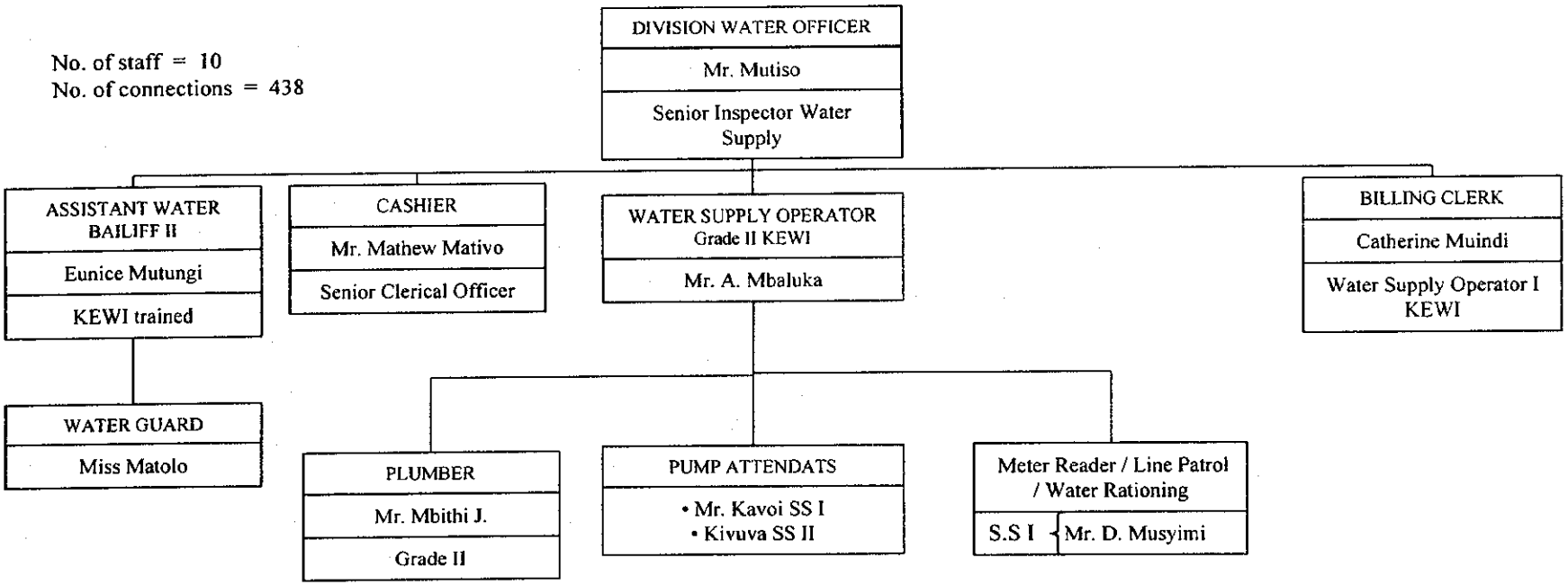
3.6.1 Organisation

The MENR (Ministry of Environment and Natural Resources) staff, headed by the DWO (District Water Officer) are based in the Makueni district headquarters at Wote and are responsible for the operation and maintenance of water supplies in the entire district. At Makindu the professional and technical staff consist of the Divisional Water Officer assisted by ten technical and subordinate staff. The organisation chart is presented in Figure 3.2

FIGURE: 3.2

MAKINDU WATER SCHEME ORGANISATION CHART

STUDY OF INSTITUTIONAL IMPROVEMENT ON REHABILITATION OF WATER SUPPLY SYSTEMS FOR TEN(10) LOCAL TOWNS IN KENYA



3.6.2 Procurement of chemicals

The only chemical required for treatment at the Makindu intake site is chlorine powder (tropical chloride of lime or TCL). This is procured in bulk by the MENR and kept at the intake site in a store.

3.6.3 Treatment process

The operation and maintenance staff use a lovibond comparator to monitor the residual chlorine at the intake sampling point and at selected points within the distribution system at the consumers' end. According to the schedule this exercise is to be carried out twice a day, in the morning and in the evening. The target minimum residual chlorine levels are set at 0.4 ppm at the intake and 0.2 ppm at the consumer points in town. The chlorine dosage rate at the intake is adjusted to maintain the target residual chlorine parameters.

3.6.4 Flow metering

3.6.4.1 Bulk flow meters

The bulk water meter at the intake is reported to be non-functional.

3.6.4.2 Consumer metering

All consumers purchase their own meters and, with technical help from the divisional water office staff, are responsible for the maintenance, repair or replacement of their individual meters. This is rather unique in Kenya but reduces the O&M cost burden on the water operator considerably. The ministry staff maintain no stock of consumer meters but monitor the quality and serviceability of the consumer's meter. There are no meter testing facilities in Makindu.

3.6.5 System operation and maintenance

Operations staff have established a daily regimen of water rationing to the different service areas in order to ensure that their customers do not miss this precious commodity. This is carried out by operating sectional valves in the distribution system on a rotational basis.

Maintenance involves, among other tasks, the repair of bursts and leaks in the pipe system. The uPVC section of the treated water rising main is particularly prone to bursts, especially where it crosses a tributary of the Makindu river at a very shallow angle (the pipe is submerged along this section).

3.7 LEVELS OF SERVICE

3.7.1 Population served

According to the Divisional Water Engineer, there are currently about 446 connections in Makindu,. The 1999 population and housing census gave the average household size as 4.07, so, in theory approximately 1,815 people benefit from the 446 piped water connections.

The 1999 census gave the town's population as 6,226 (projected to 6,400 in 2000), so approximately 28% of the population is provided with piped water. It should be noted, however, that these figures do not include for supply through the 15 water kiosks within Makindu town or through the 3 large community-based water supply schemes served in bulk from the Makindu supply. It is therefore estimated that at least 4,500 people are 'connected' in total. The current estimated service area population is 5,600, thus indicating that over 80% of the service area population is served.

3.7.2 Per capita supplies

The current total water production capacity is about 480 m^3/d. Assuming that actual water supplied averages 85% of production capacity (i.e. 400 m^3/d), the per capita consumption for the estimated 'connected' population of 4,500 is equivalent to 89 lcd for or a global average of 64 lcd for the total Makindu population of 6,226 (1999 population). These figures suppose no unaccounted-for water.

Assuming that about half the production volume comprises unaccounted-for water in Makindu then the per capita figures above work out to 45 and 32 lcd respectively.

3.8 ON-GOING OR PLANNED EL NIÑO WORKS

No work is being carried out in Makindu under the ongoing El Niño project.

3.9 OTHER WORKS AND PROJECTS

There are currently no known major water supply projects planned for Makindu.
Some NGOs operating in the area have expressed interest, however, in the financing and construction of water reservoirs and have in the past supported the extension of Makindu water supply into the peri – urban areas.

4 PROPOSED STRATEGY FOR WATER SUPPLY REHABILITATION

4.1 DEMAND/CONSUMPTION PROJECTIONS TO 2010

4.1.1 Population projections to 2010

The population of Makindu according to the 1999 census is 6,226. Yearly population projections to 2010 (rounded to the nearest '00) are shown in table 4.1. The annual growth rate has been taken as 2.8%.

Table 4.1 Population projections to 2010

Year	Population
1999	6,226
2000	6,400
2001	6,600
2002	6,800
2003	7,000
2004	7,100
2005	7,300
2006	7,600
2007	7,800
2008	8,000
2009	8,200
2010	8,400

4.1.2 Water demand projection

The population of Makindu is projected to rise to 8,400 by 2010. Demand rates are taken from the then Ministry of Water Development Water Design Manual (1986) which includes an allowance for unaccounted-for water (UfW).

The institutional demand for the boarding schools, sub-district hospital, dispensaries, clinics, railway station, railway police training school, churches, sikh temple and mosques has been estimated at 150m^3/day.

There are no industries in Makindu and commercial activity is of a level such that domestic water usage rates can be applied.

4.1.3 Comparison of projected demand with system capacities

Table 4.2 shows estimated unrestricted daily water demand for Makindu from 1999 to 2010 compared with the current capacities of the various system components.

Table 4.2 Makindu - Projected Water Demands and Current System Capacities

Year	Population	Income brackets		Population	Domestic demand rate (lcd)	Domestic water demand (m^3/day)	Institutional demand (m^3/day)	Total demand (m^3/day)	Production capacity (m^3/day)	Transmission capacity (m^3/day)	Storage capacity (m^3)
		Status	%								
1999	6,226	High	14	872	250	218					
		Middle	45	2,802	150	420	150	980	480	400	60
		Low	41	2,553	75	191					
2000	6,400	High	14	896	250	224					
		Middle	45	2,880	150	432	150	1,003	480	400	60
		Low	41	2,624	75	197					
2001	6,600	High	14	924	250	231					
		Middle	45	2,970	150	446	150	1,029	480	400	60
		Low	41	2,706	75	203					
2002	6,800	High	14	952	250	238					
		Middle	45	3,060	150	459	150	1,056	480	400	60
		Low	41	2,788	75	209					
2003	7,000	High	14	980	250	245					
		Middle	45	3,150	150	473	150	1,083	480	400	60
		Low	41	2,870	75	215					
2004	7,100	High	14	994	250	249					
		Middle	45	3,195	150	479	150	1,096	480	400	60
		Low	41	2,911	75	218					
2005	7,300	High	14	1,022	250	256					
		Middle	45	3,285	150	493	150	1,123	480	400	60
		Low	41	2,993	75	224					
2006	7,600	High	14	1,064	250	266					
		Middle	45	3,420	150	513	150	1,163	480	400	60
		Low	41	3,116	75	234					
2007	7,800	High	14	1,092	250	273					
		Middle	45	3,510	150	527	150	1,189	480	400	60
		Low	41	3,198	75	240					
2008	8,000	High	14	1,120	250	280					
		Middle	45	3,600	150	540	150	1,216	480	400	60
		Low	41	3,280	75	246					
2009	8,200	High	14	1,148	250	287					
		Middle	45	3,690	150	554	150	1,243	480	400	60
		Low	41	3,362	75	252					
2010	8,400	High	14	1,176	250	294					
		Middle	45	3,780	150	567	150	1,269	480	400	60
		Low	41	3,444	75	258					

4.2 PRELIMINARY DESIGN OF RECOMMENDED REHABILITATION OPTION

The principal design criteria for water engineering design is presented in Appendix C2-1.

The following comments summarise the main focus of the proposed rehabilitation plan for Makindu water supply.

Table 4.3 gives the summary schedule of the proposed rehabilitation works.

4.2.1 Key rehabilitation proposals

Key rehabilitation proposals include:

- The raw water quality needs to be monitored closely due to possible contamination from upstream users.
- The intake pump station should be raised to keep it well above the flood level and it should be relocated.
- New intake chamber;
- The staff houses at the intake require refurbishing and the septic tank is to be replaced.
- Replace diesel engine;
- Add 30 HP standby pump;
- Replace in-line chlorination facility;
- Construct aerial crossing along 100mm diameter treated water rising main;
- Replace and realign treated water rising main with 100mm diameter GI pipes;
- Rehabilitate access road to intake including drift with culverts at river crossing;
- New 1 no. 500m^3 elevated storage tank on a 12m high tower;
- Carry out a network analysis of the reticulation system, and replace or augment critical undersized lengths of pipes;
- Install new bulk water meters, AVs, NRVs, SVs, etc;
- O & M tools and equipment and laboratory equipment;
- Provide vehicles, office space, office equipment and office furniture.

4.2.2 Laboratory facilities

The Makindu water supply lacks the necessary laboratory equipment for routine determinations of water quality parameters. Procurement of the basic laboratory equipment and facilities should be arranged to ensure proper monitoring of water quality.

Table 4.3
MAKINDU WATER SUPPLY
SUMMARY SCHEDULE OF PROPOSED REHABILITATION WORKS

Item	Unit	Ref	Component	Condition	Proposed action	Comments
1.	Intake works and pumping facilities	1.1	Intake pump station	Flooded	Raise and relocate	New structure
		1.2	Intake chamber	Flooded	Relocate near pump station	New structure
		1.3	Diesel standby engine & pump	Out of order	Replace with 30 HP unit	To be used as backup
		1.4	Pump sets (15HP & 30 HP)	Augmentation needed	Add 30 HP pump as standby	To add to standby capacity
		1.5	Staff houses and septic tank	Need rehabilitation	Rehabilitate houses and connect to new septic tank	
2.	Water treatment and rising main	2.1	In-line chlorination facility	Subject to breakdowns	Replace with new unit	Rehabilitate old unit and keep as spare
		2.2	100mm and 75mm diameter rising main	Subject to bursts	Replace with 100mm GI and realign part of route	Also construct aerial crossing over river
3	Access road to intake	3.1	Dirt access road about 4km long	Several mudholes and river fording	Grade road, provide drainage and culverts	Include drift at river crossing
4	Distribution system	4.1	2 nr. Elevated tanks totalling 60 m3 storage	Inadequate storage and dilapidated tanks	Add new 500 m3 elevated storage tank	Decommission existing tanks and add another 500 m3 elevated tank
		4.2	Distribution pipework	Undersized in part and old mains subject to bursts	Replace & augment with 50 to 150mm uPVC pipes	As an option GI pipes may be used at a higher cost
		4.3	Bulk water meters	Out of order	Replace and add	For monitoring distribution losses
		4.4	AVs, NRVs and SVs	Few and some out of order	Replace and add	For operation and maintenance
		4.5	Laboratory equipment and materials	Minimal and inadequate	Provide new	For water quality control
		4.6	O & M toolkits and equipment	Minimal and inadequate	Provide new	For operation and maintenance
5	Logistical facilities & equipment	5.1	New office and laboratory	n/a	Provide new	For operation and maintanance
		5.2	Transportation including vehicles, motor cycles, bicycles	n/a	Provide new	Existing transport is inadequate and in poor condition
		5.3	Computer hardware and software	n/a	Provide new	To enable timely billing and record keeping
		5.4	Office equipment & furniture	n/a	Provide new	For operation and maintanance

4.2.3 Water pumps

It is proposed that, despite the reliability of power supply so far in Makindu, provision be made to rehabilitate the several diesel pumps and motors lying unused and put at least one of them into service as a standby set for the pumping system

4.2.4 Metering of treated water production

A new bulk water meter is proposed at the intake works along the 100mm rising main in order to monitor flow rates effectively

4.2.5 Rising main

The uPVC section of the treated water rising main is particularly prone to bursts, especially where it crosses a tributary of the Makindu river at a very shallow angle. The submerged pipeline is very difficult to maintain and repair. This section of pipe should be realigned to cross the reed – choked river perpendicularly and be replaced with 100mm diameter GI pipes in a well-designed aerial crossing.

4.2.6 Storage

The combined capacity of the two existing service reservoirs is 60 m^3. The Ministry's design manual requires the provision of a storage volume of eighteen hours of average demand for systems supplied by pumping. For a demand of 1,003 m^3/d, the required storage volume is therefore 750 m^3 or 690 m^3 more than the existing capacity. It is proposed that a new 500 m^3 elevated tank be constructed as an emergency measure to match the current production and transmission rates of flow per day. The balance of 250 m^3 storage volume can be taken care of by the storage volumes in the three community-based schemes and other large private consumers.

It is therefore recommended that the current tanks are replaced with a 500 m^3 elevated water storage tank on a 12m high tower located near the petrol station along the Nairobi-Mombasa highway or near the Makindu Children's Centre.

4.2.7 Distribution

4.2.7.1 Reticulation pipework

Section 3.5.1 summarises the rehabilitation requirements for the distribution system. The network has been laid over several decades and is in various states of disrepair. It is recommended that certain stock sizes of pipe mains (38mm to 150mm) be maintained for repair work. It would be advisable to replace sections of mains that are more prone to bursts

and leaks with uPVC class D pipes or GI pipes for the smaller diameter mains.

4.2.7.2 Consumer meters

Consumers purchase their own meters and, with technical help from the divisional water office staff, are responsible for the maintenance, repair or replacement of their individual meters. As the ministry staff maintain no stock of consumer meters but only monitor the quality and serviceability of the consumer's meter, there is no need for purchase of meters under this project. There is no need for meter testing facilities in Makindu at present due to the current small number of meters.

4.3 COSTING OF RECOMMENDED REHABILITATION PLAN

An indicative budget for rehabilitating the existing Makindu water supply system is Kshs 149,040,000 as per the following breakdown in Table 4.4

4.4 EXPANSION OF WATER SUPPLY FACILITIES

4.4.1 General

The tentative proposed expansion plan includes for the following:

- Augment works at intake pump station site;
- Add additional pumps;
- Lay an additional treated water rising main;
- New 2 no. 500m3 elevated storage tanks;
- Expand the distribution network to serve the whole of the populated area of Makindu town.

4.4.2 Intake and treatment

There will be an expansion of the raw water pumping and chlorination facilities with all the associated infrastructure. The intake site may be expanded to include new staff houses and a laboratory installation.

4.4.3 Rising main

A supplementary steel rising main, 200mm in diameter, will cater for the total water demand to 2010 and beyond. The existing rising main (after rehabilitation) could then be utilised as a distribution main in the long term.

4.4.4 Storage

It is proposed that 2 additional 500m^3 elevated storage tanks be sited at different locations of the town to serve different supply zones.

Table 4.4: Cost estimate for rehabilitation works for Makindu water supply

Description	Unit	Quantity	Rate (KShs)	Amount (KShs)
Intake works site facilities and raw/treated water pumps				
New intake chamber, raised pump station structure& store	Sum			2,000,000
Allow for extension to power mains	Sum			1,750,000
New 30 HP electrical pump set	nr	1	1,500,000	1,500,000
New standby 30 HP diesel engine and pump set	nr	1	2,000,000	2,000,000
Allow for addition and modification to existing control panel	Sum			400,000
Refurbish staff houses and new septic tank	Sum			1,200,000
subtotal				***8,850,000***
Water treatment and rising main				
Replace in-line chlorination facility	Sum			1,200,000
Replacement and realignment of rising main with 100 mm diameter GI pipe	m	3,820	10,000	38,200,000
Aerial crossing along rising main	m	180	15,000	2,700,000
subtotal				***42,100,000***
Access road to intake				
Rehabilitate at mudholes and grade with earth drain	Sum			4,500,000
Construct drift with 450 mm diameter culverts at river crossing	Sum			1,750,000
subtotal				***6,250,000***
Distribution system				
New 500m^3 elevated storage tank on 12m high tower plus site works	Sum			7,500,000
Rehabilitation and augmentation of ND 50 to 150mm uPVC distribution pipework	m	3,000	2,500	7,500,000
New bulk water meters, AVs, NRVs, SVs, etc	Sum			4,500,000
Laboratory equipment and materials	Sum			1,750,000
Tool kits	nr	2	250,000	500,000
subtotal				***21,750,000***
Logistical facilities and equipment				
New office and laboratory building facilities	m^2	150	25,000	3,750,000
4WD twin-cab pickups	nr	2	2,500,000	5,000,000
Motorcycles	nr	3	250,000	750,000
Multi-geared mountain bikes	nr	2	25,000	50,000
Desk top computer setups	nr	2	200,000	400,000
Printers	nr	2	100,000	200,000
Licensed standard computer software	Sum			300,000
Standard office equipment, furniture and fittings	Sum			600,000
subtotal				***11,050,000***
Overall Total				**90,000,000**
Add 20% P&G				18,000,000
sub-total				***108,000,000***
Add 15% Contingencies				16,200,000
sub-total				***124,200,000***
Add 20% consultancy design fees				24,840,000
GRAND TOTAL				**149,040,000**

4.4.5 Distribution

Allowance has been made for the augmentation and expansion of the distribution network to cover the whole of the developed area of Makindu by the year 2010. It is proposed that uPVC and steel pipes and fittings be used throughout for gravity and pumping mains respectively.

Zonal bulk meters are to be provided to monitor unaccounted for water.

4.4.6 Costs of expansion works

The cost details for expansion of the Makindu water supply system to 2010 are presented in table 4.5.

Table 4.5
Cost estimate for expansion works for
Makindu water supply
(2010 planning horizon)

Description	Unit	Quantity	Rate (Kshs)	Amount (Kshs)
Intake and treatment works				
Expansion of raw water intake, chlorination, high lift pumping and ancillaries	sum			18,000,000
Rising main				
DN 200mm steel pipe, valves and fittings	m	4,000	13,000	52,000,000
Storage				
Elevated storage tanks, capacity 500m^3	nr	2	5,000,000	10,000,000
Distribution				
uPVC, steel pipes DN 150mm – 50mm	m	12,000	3,000	36,000,000
Fittings	sum			5,400,000
Bulk meters DN 150mm – 75mm	nr	5	150,000	750,000
Sub-total				**122,150,000**
Add				
20% preliminary and general items				24,430,000
Sub total				***146,580,000***
15% contingencies				21,987,000
Sub total				***168,567,000***
20% consultancy fees				33,713,400
TOTAL				**202,280,400**
			say	**203,000,000**

5 EXISTING WASTE WATER DISPOSAL & SANITATION CONDITIONS

5.1 SANITATION SYSTEM

Makindu has no central waste collection or disposal system. Residents are served by on-plot sanitation facilities comprising of septic tanks and pit latrines.

5.2 ON-GOING OR PLANNED EL NINO WORKS

No work is being carried out in Makindu under the ongoing El Niño project.

5.3 OTHER WORKS AND PROJECTS

There are currently no known sanitation projects planned for Makindu

5.4 SUMMARY OF SHORTCOMINGS AND PRELIMINARY RECOMMENDATIONS FOR REHABILITATION

There is no provision nor any immediate justification, at present, for a centralised sanitation system. The on plot sanitation facilities could continue in existence for the next 10 years given the anticipated population increase. All that might be done is to urge and facilitate the basic upgrading of the pit latrines to VIP status.

6 PROPOSED STRATEGY FOR WASTEWATER DISPOSAL AND SANITATION REHABILITATION

6.1 DEMAND FOR SANITATION SERVICES

With the anticipated rise in population of Makindu and the peri urban areas which depend on its water supply, there will be added pressure to develop a centralised sewage collection and treatment facility. Until population densities and plot sub-divisions reach such critical levels, the current on – plot sanitation facilities are deemed to suffice with plot owners being encouraged to design and construct VIP type pit latrines to approved standards.

Salient features that make use of on plot sanitation facilities sustainable in Makindu are:

- the population densities are low
- the soil is sandy clay with moderate permeability
- the annual rainfall is low and the evaporation rates are high
- rock is lower than 20m below the surface
- plot sizes are large enough to accommodate percolation facilities

Groundwater pollution is the key hindrance to the long-term continued use of on plot sanitation facilities in the town. The groundwater is in an unconfined aquifer with depth in the region of 20m below the existing ground surface. The water quality deteriorates with eastward progresssion most likely due to pollution from the on plot sanitation facilities.

6.2 DEMAND FOR WASTEWATER DISPOSAL SERVICES

There is no waterborne sewerage in the town and no justification for one to be constructed in the immediate future as stated in section 6.1.

6.3 REHABILITATION REQUIREMENTS

Construction of a waterborne sewerage system is not necessary and is outside the scope of this study.

6.4 COSTING OF RECOMMENDED REHABILITATION PLAN

This is not applicable as rehabilitation or new sewerage works are not proposed under this study.

6.5 FUTURE EXPANSION

No expansion plans are envisaged to the design horizon year of 2010.

However, beyond that horizon and with the improvement and expansion of water supply facilities, there will be a corresponding increase in per capita consumption, resulting in an increase in quantities of grey and black water. Existing traditional methods of waste disposal will become overloaded and non-sustainable. The problem must be addressed at that stage, as failure to do so will lead to unhygienic conditions, a rise in the number of cases of waterborne diseases and a reduction in the quality of life of the population. Alternative solutions must be found for waste disposal.

- Traditional sewerage systems are expensive to construct and maintain. However the central business district will benefit from a conventional system, and the small area served will make construction more economically viable than in servicing the entire urban area.

- A community based small-bore sewerage system is probably the best solution for the remainder of the town.

7.0 LAWS AND REGULATIONS OF ENVIRONMENTAL IMPACT

7.1 GENERAL

The current Government of Kenya policy requirement stipulates that before any major development project is undertaken in the public or private sector, there is need to carry out Environmental Impact Assessment (EIA) on the project in order to ensure that each component conforms to good environmental management. This study involves mainly the identification of laws and regulations that govern the environmental impact assessment of water supply and sanitation projects.

7.2 LEGISLATION/REGULATIONS GOVERNING ENVIRONMENTAL IMPACT ASSESSMENT

7.2.1 General

A large number of Acts and organizations deal with issues of pollution, environmental degradation and conservation. These include among others:

- Constitution of Kenya (especially Section 71)
- Water Act (Cap 372)
- Agriculture Act (Cap 318)
- Irrigation Act (Cap 347)
- Forests Act (Cap 385)
- Lakes and Rivers Act (Cap 409)
- Maritime Zone Act (Cap 371)
- River Basin Development Authorities Act (e.g. Cap 443)
- Land Tenure and Land Use Legislation
- Wildlife (Conservation and Management) Act (1976 and 1989 Amendment)
- Public Health Act (Cap 242)
- Local Government Act (Cap 265)
- Environmental Management and Co-ordination Act (1999)

Effectiveness in enforcement has not been commensurate with the many acts and regulations; in some instances there have been contradictions when an institution has evoked its act at the expense of proper operation of facilities belonging to another institution. The reason for the foregoing situation is that each sector utilizing water, apart from the water authority, has different objectives; their primary focus is not water development. The need to harmonize the application of the various Acts and Regulations, for effective protection of the environment, has been felt and expressed for a long time; hence the birth of the Environmental Management and Co-ordination Act of 1999.

7.2.2 Environmental Management and Co-ordination Act (1999)

The most significant Act that specifically addresses environmental impact is the newly enacted Environmental Management and Co-ordination Act, 1999. Among the specific issues related to EIA procedures are stipulated in the Act as follows:

- Establishment of Environmental Management Authority (NEMA) to administer the Act.
- Submission of an EIA Report to NEMA by developers before undertaking any new project specified in the Act.
- Issue of an Environmental Impact License by NEMA if it is satisfied with the EIA Report.
- Environmental Impact Assessment to be conducted in accordance with the EIA guidelines and procedures provided in the 4th schedule of the Act.

7.2.3 Laws Relating Specifically to Water Supply and Sanitation

Within the Environmental Management and coordination Act, a number of sections dealing specifically with water and sanitation can be identified as follows:

- Part V Section 42 dealing with protection of rivers, lakes and wetlands,
- Part VIII Section 72 dealing with water pollution prohibition,
- Part VIII Section 74 dealing with effluents to be discharged into the sewerage system,
- Part VIII Section 86 dealing with standards for waste,
- Part VIII Section 87 dealing with prohibition against dangerous handling and disposal of wastes,
- Part VIII Sections 88 and 89 dealing with waste licenses and licensing of waste disposal sites,
- Part VIII Sections 91 – 93 dealing with hazardous wastes and their disposal,
- Part XIII dealing with environmental offences and related penalties.

In order to minimize the conflicts in enforcement (due to the many different Acts and Regulations) as mentioned before, the Environmental Management and Coordination Act stipulates that where the provisions of any existing law conflicts with the provisions of this Act, then the provisions

of this Act shall prevail. The foregoing proviso, in conjunction with the multi-disciplinary or composition of the Environmental Committees will hopefully enhance the effectiveness of administration and enforcement of the Act.

7.2.4 Environmental Impact Assessment (Guidelines and Administrative Procedures)

The format of the EIA Report has been set out in the guidelines and should include the following sections:

- Introduction
- Title of the Project
- Project Initiator
- Statement of Need
- Project Description
- Project Options
- Description of Existing Environment
- Results of Preliminary Assessment
- Detailed Examination of Impacts
- Suggested Mitigation and Abatement measures
- Residual Impacts
- Project Evaluation
- Summary Conclusions

In addition, the EIA guidelines and procedures describe procedures to be used in environmental planning and management in Kenya. It also gives a checklist of sectors, which can provide guidance to the public and private sector agencies involved in initiating development projects.

7.2.5 Objectives of Environmental Impact Assessment

The objectives of Environmental Impact Assessment Study for this project are identified as follows:

- To identify the existing environmental concerns which need to be taken into account in the proposals for rehabilitation of water supply and sanitation system.

- To evaluate the environmental impacts of the proposed rehabilitation works.

- To propose the counter measures to mitigate the impacts.

- To make recommendations for environmental conservation.

7.3 INITIAL ENVIRONMENTAL EXAMINATION

7.3.1 Water Quality of Existing Supplies

The spring source for Makindu Town is adequate to serve the town but it is polluted because it serves as a watering point for livestock. The programme for monitoring water quality both at source and within the distribution systems is in place at the town, however, implementation is generally poor because of lack of appropriate and adequate laboratory equipment and reagents. Water quality analysis results were not available except pH and residual chlorine.

7.3.2 Existing Sanitation Situation

Makindu depends on on-site sanitation systems comprising mainly pit latrines, cess-pits and septic tanks. The on-site systems generally provide inadequate service especially in public places like markets, institutions and bus parks.

7.3.3 Screening and Scoping for Environmental Impact Assessment

Many guidelines have been used in Kenya for EIA but especially those of the World Bank. Often, the sponsor of a development has stipulated the standards to be met, because in the past Kenya did not have specific guidelines. However, as mentioned before, the Environmental Management and Coordination Act (1999) has set out the guidelines for EIA in its 4th Schedule. The guidelines propose the checklist method for screening and scoping for EIA.

The general environmental concerns and a checklist for Makindu town have been provided. A comprehensive EIA will be undertaken at the feasibility stage, however, it is envisaged that almost all the project components will be of such small scale that their impacts will not be serious. Issues that require further study have been summarized in Section 7.8 of this chapter.

7.4 ENVIRONMENTAL CONCERNS IN MAKINDU TOWN

1. Commercial premises especially lodgings and hotels generate substantial quantities of wastewater making operation of the on-site sanitation systems expensive to operate because of frequent exhausting needed. Exhauster services can only be obtained from Makueni at high costs.

2. Solid waste is dumped haphazardly and there is no provision for its collection and proper disposal. The town council has no facilities for solid waste management.

3. The frequent dry weather promotes generation of a lot of dust, which is affecting the health of residents. There is quite a high prevalence of upper respiratory tract infections due to dust.

4. Generally, people do not have adequate income and peoples' concern is mainly survival rather than on environmental matters. However, local NGO's are sensitizing people to participate in their own development programmes including community water supplies and improved animal husbandry.

5. The current water source is contaminated because the spring is accessible to livestock. The chlorine dosing equipment does not function with the larger water pump because the high pressure generated breaks the chemical supply pipes.

6. The WC at the water intake point with its associated septic tank is not functioning properly causing risk of contamination of the intake.

7.5 RESULTS OF INITIAL ENVIRONMENTAL EXAMINATION

It has been noted that the water source for Makindu town is a spring, which is contaminated. The rising main is leaking in a number of places as evidenced by pools of water ponding along the line. Chances of contamination of the water in transit to the town are high with the current level of poor maintenance.

Sanitation is based on pit latrines and septic tanks. Sullage from hotels and similar business premises are discharged freely into storm drains causing nuisance especially during the rainy season. During the dry season, the wastewater quickly evaporates in the hot weather leaving cakes of food remains and similar solid waste. Summaries of initial environmental examination are presented in tables 7.1 and 7.2 for water supply and sanitation respectively.

Table 7.1 IEE Checklist - Water Supply Component

ITEM	EVALUATION	COMMENT
1. Human Settlement	5	No negative impact expected
2. Economic Activities	5	No negative impact expected
3. Transport	4	Need consideration during construction
4. Water and Common Rights	2	Water sources are scarce in the project area
5. Sanitation	5	Sanitation shall be improved by increased water supply
6. Waste	4	No impact expected
7. Hazards / Dangers	4	No impact expected
8. Topography and Geology	5	No impact expected
9. Soil Erosion	5	No impact expected

10. Groundwater	5	No impact expected
11. River and Wetlands	5	No impact expected
12. Coastline and Sea	5	No such sites exist in the area
13. Flora and Fauna	5	No impact expected
14. Weather	5	No impact expected
15. View	5	No impact expected
16. Air Pollution	5	No impact expected
17. Water Pollution	1	Existing source is polluted
18. Soil Contamination	5	No impact expected
19. Noise and Vibration	4	No impact expected
20. Ground Subsidence	3	Not clear
21. Noxious Odours	5	No impact expected
22. Cultural and Archeological Assets	5	No impact expected
23. Conflicts with community Aspirations	5	No impact expected

KEY:

1. Serious impact expected
2. Minor impact expected
3. Uncertain (investigation needed to clarify)
4. Almost no impact expected if proper construction procedures are used
5. Almost no impact expected (no need for EIA)

Table 7.2 IEE Checklist - Sanitation Component

ITEM	EVALUATION	COMMENT
1. Human Settlement	5	No negative impact expected
2. Economic Activities	5	No negative impact expected
3. Transport	4	No negative impact expected
4. Water and Common Rights	4	No negative impact expected
5. Sanitation	1	Aim of project is to improve sanitation

6. Waste	3	Sludges from exhausted pits and septic tanks need attention
7. Hazards / Dangers	4	No impact expected
8. Topography and Geology	5	No negative impact expected
9. Soil Erosion	4	No impact expected
10. Groundwater	5	No impact expected
11. River and Wetlands	5	No negative impact expected
12. Coastline and Sea	5	No such sites exist in project area
13. Flora and Fauna	4	No impact expected
14. Weather	5	No impact expected
15. View	5	No impact expected
16. Air Pollution	4	No impact expected
17. Water Pollution	4	No negative impact expected
18. Soil Contamination	3	Exhausted sludges may spill and contaminate soil
19. Noise and Vibration	4	No impact expected
20. Ground Subsidence	5	No impact expected
21. Noxious Odours	5	No impact expected
22. Cultural and Archeological Assets	5	No impact expected
23. Conflict with community Aspirations	5	No impact expected

KEY:

1. Serious impact expected
2. Minor impact expected
3. Uncertain (investigation may clarify)
4. Almost no impact expected if construction undertaken properly
5. Almost no impact expected (no need for EIA)

7.7 INITIAL ENVIRONMENTAL IMPACT ASSESSMENT

By and large, the proposed rehabilitation project will have positive impacts by providing improved sanitation, reducing incidence of disease, and general improvement of the environment. However, from the results of IEE, four main items of potential impacts of the proposed rehabilitation works are be identified for study as listed below:

(i) Impacts resulting from abstraction of water from river or groundwater sources during operation.

(ii) Impacts arising from the increase in wastewater generation that would result from the improved water supply.

(iii) Impacts resulting from the operation of wastewater management and sanitation facilities.

(iv) Impacts resulting from construction activities during implementation of rehabilitation works.

7.7.1 Impacts Resulting from Water Abstraction

Demand analysis indicates that the existing water source is more than adequate, in quantitative terms, to meet the current and future needs of the town. However the deterioration in water quality at this source will make it more expensive to utilize the source in terms of additional treatment requirements. Hydrogeological analysis of the catchment area reveals that there is high potential for groundwater utility, which can be exploited. The alternative is to locate the raw water intake further upstream at a point less prone to access by livestock. The impact of the latter alternative is not quite clear.

7.7.2 Impacts from Increased Wastewater Generation

Although the current level of water service is too low to justify a sewerage system for a large part of the town, the proposed rehabilitation will definitely make more water available to the consumers. The resulting increased wastewater flow will present disposal problems by putting pressure on the capacity of the existing on-site sanitation systems especially in the more densely settled areas e.g. the CBD, District Hospital area, Makindu Mosque and surrounding area. For these areas a sewerage system should be considered in the near future.

7.7.3 Impacts from Operation of Sanitation Facilities

The risk of groundwater contamination by on-site sanitation systems in areas where people draw water from shallow wells is real. Hence in the absence of a sewerage system, intensified public education on proper waste management is needed for protection of the environment. There is no evidence that current operation of the existing on-site sanitation system is polluting the environment except those that serve public places like the market. However, increased wastewater flow will aggravate the situation.

There is need to install a sewerage system in the densely settled areas to forestall pollution, and to intensify monitoring the operation of on-site sanitation facilities by invoking the Public Health Act.

7.7.4 Impacts from Construction

At the rehabilitation stage construction will be concentrated along pipeline wayleaves and areas sited for storage tanks. These constructions will not be of any large scale as to adversely affect human settlements. Excavations for pipelines may cause interruption to traffic flow but this will be on a temporary scale. Serious traffic inconveniences will be avoided by appropriate construction methods.

Disturbance of the soil during construction may also give rise to soil erosion but this will be minimal because no large-scale earthworks are anticipated in the rehabilitation phase. The noise and vibrations are common features of most construction works and there are no unusual works that need special attention with respect to noise and vibration.

7.8 ISSUES FOR FURTHER INVESTIGATION

1. There is need to institute a study of alternative water sources for the town especially groundwater utilization. An investigation into the possibility of relocating the spring intake further upstream should be undertaken, taking into consideration prior water permits issued on the source.

2. Reasons for water quality deterioration in the spring source should be investigated with a view to instituting protection measures that would reduce pollution and ensure improved raw water quality for Makindu town.