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

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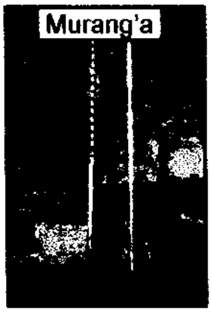

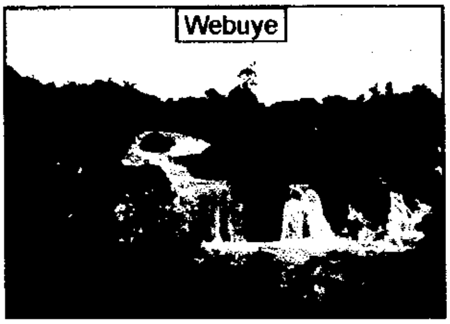

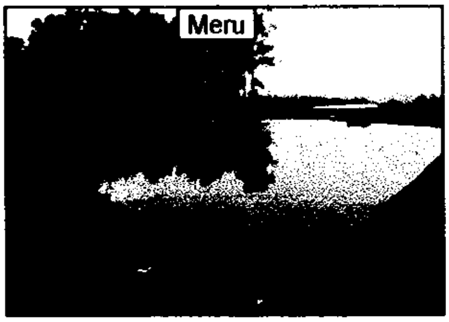

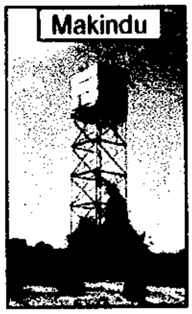

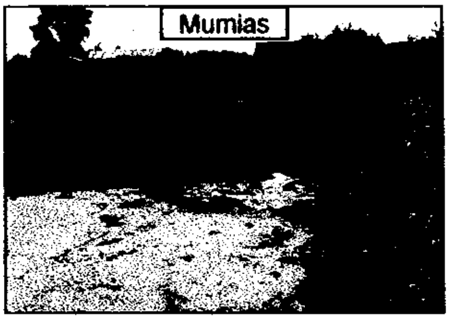

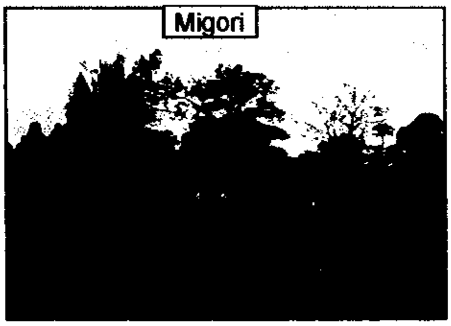

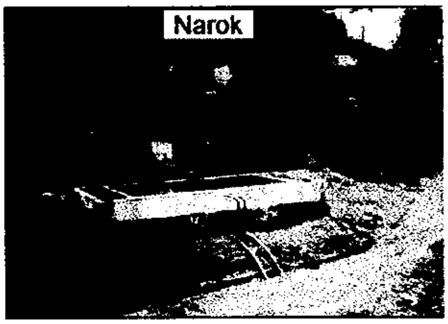

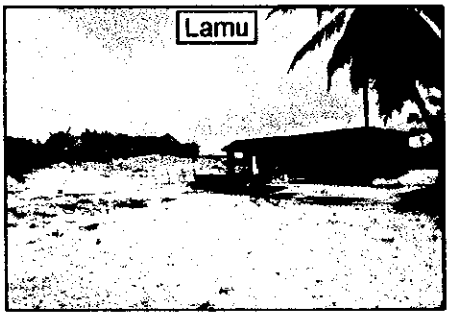

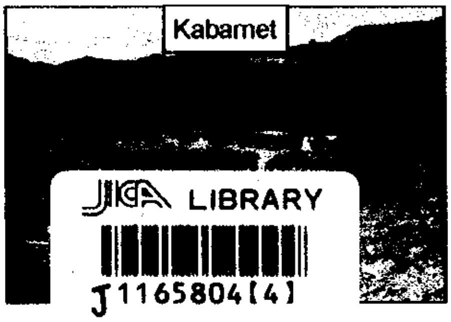

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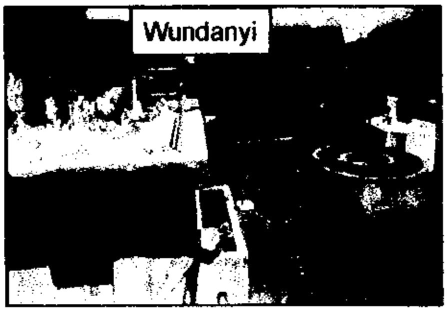

FINAL REPORT

Volume 2B : Main Report (including Appendices) - Meru Town

FEBRUARY 2001

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Engineering and Utility Management Ltd.

Gibb Eastern Africa Ltd.

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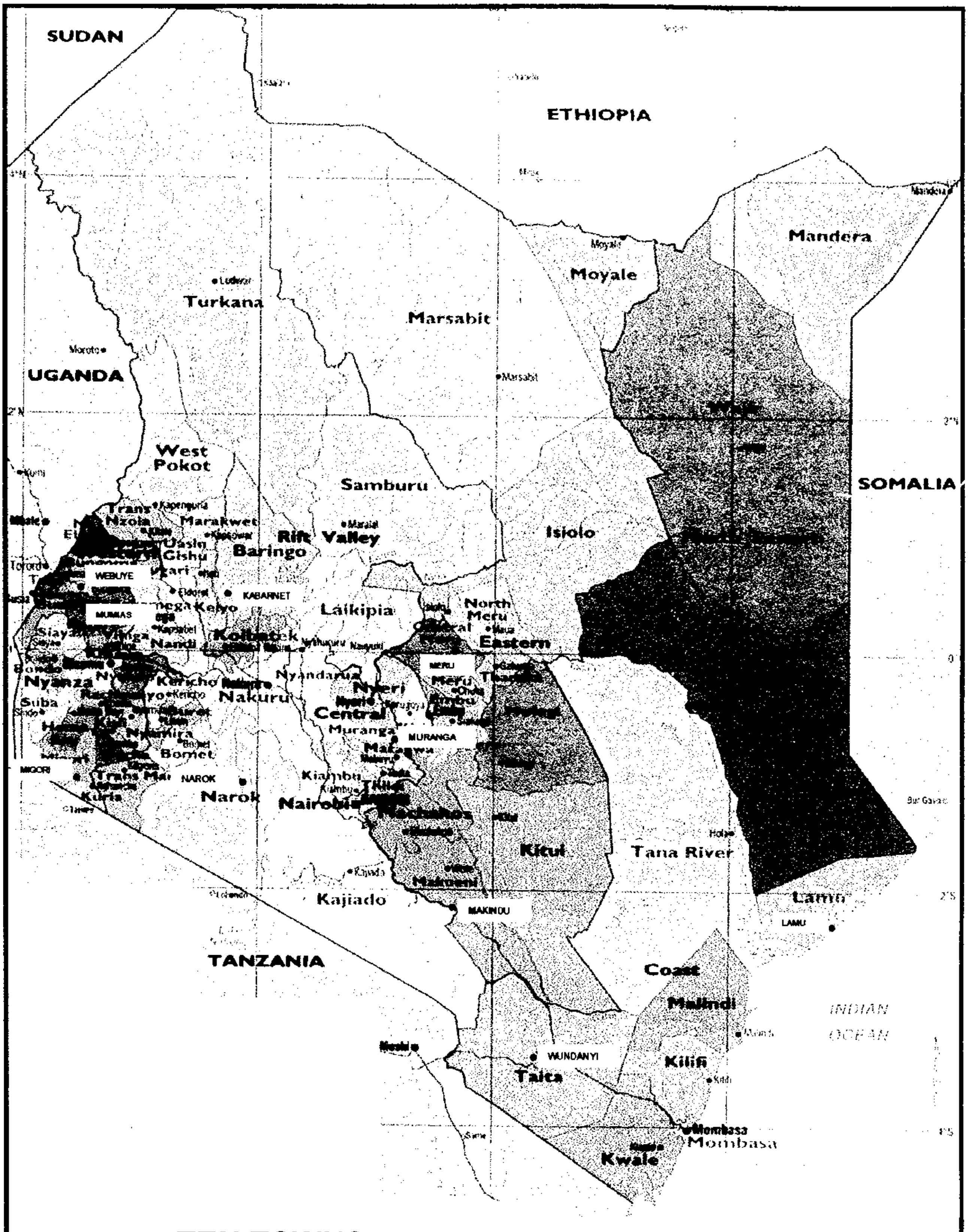

TEN TOWNS WATER & SANITATION STUDY

TOWNS LOCATION MAP

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MERU WATER SUPPLY

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

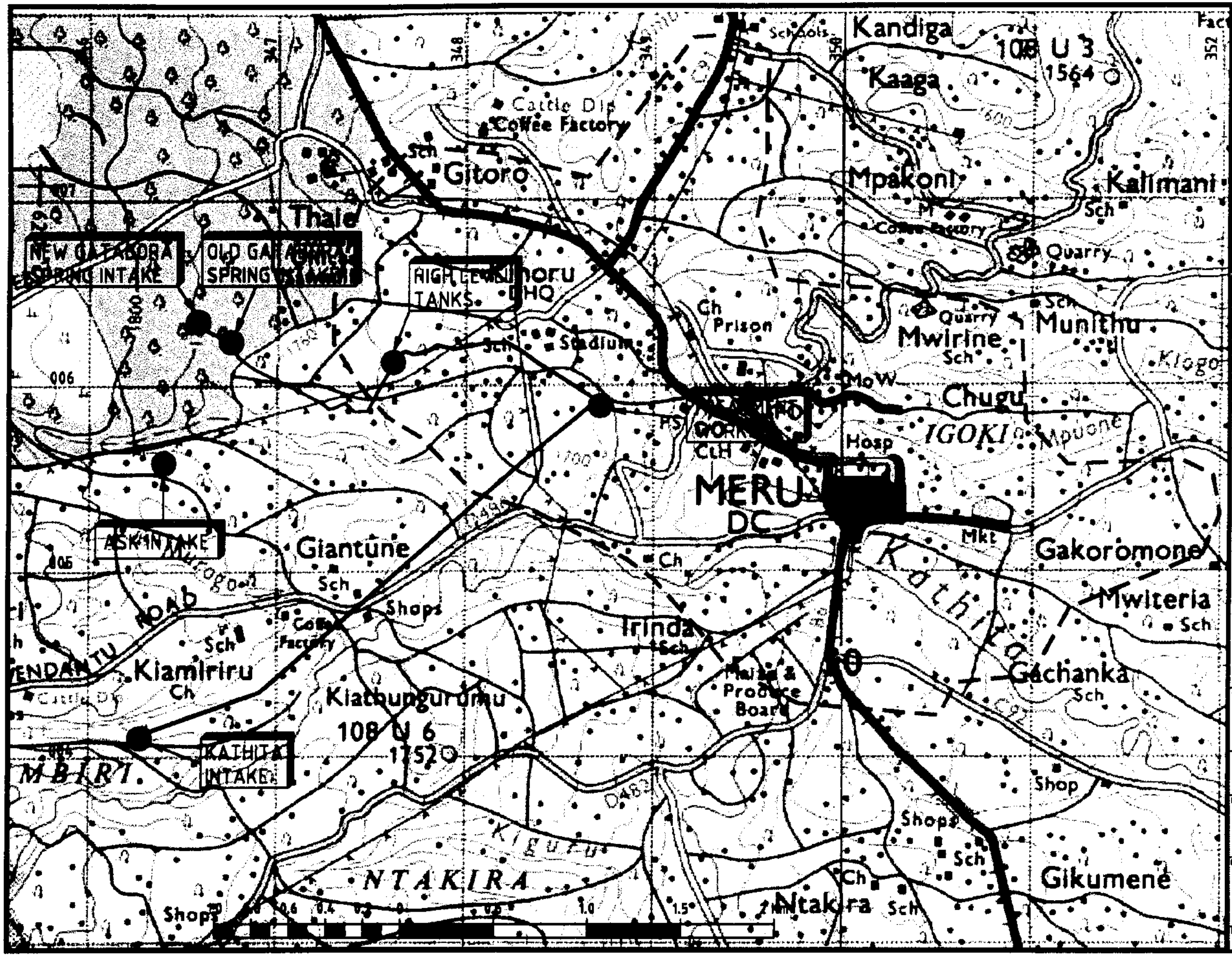
AC	Asbestos Cement (Pipe)
AFW	Accounted for water
AG	Attorney General
AIDS	Acquired Immune Deficiency Syndrome
AIE	Authority to Incur Expenditure
AMREF	African Medical Research Foundation
ASK	Agricultural Society of Kenya
ATP	Ability to Pay
bgl	Below ground level
BH	Borehole
BOT	Board of Trustees
BPT	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



LEGEND

WATER PIPELINE

DISTRIBUTION AREA

Client: JAPAN INTERNATIONAL CO-OPERATION AGENCY

GIBB Eastern Africa

Project Title: TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title: MERU TOWN EXISTING WATER SUPPLY

Date: JAN 2001

Fig. No.: 1.1

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

2.1 GEOGRAPHY OF THE STUDY AREA

2.1.1 Location

Meru Central District is located on the eastern slopes of Mount Kenya at elevations between 1,400 and 2,100m AMSL. Meru is situated approximately 280 km north - north - east from Nairobi.

2.1.2 Topography

The eastern slopes of Mount Kenya are deeply forested with numerous streams flowing in an easterly direction. These streams subsequently flow south-eastwards before their eventual confluence with the Tana River. The terrain around Meru shows a high relief comprising V-shaped gorges and steep mountainous ridges.

2.1.3 Geology

The town lies on a shield on volcanic flows of the Mt Kenya shield. These are mainly Tertiary volcanics comprising basalts, basaltic lavas, mugearites and trachytic tuffs. Mugearites are a pale grey fine - to very fine - grained aphyric rocks with small irregular vesicles. Their composition is close to that of basalt.

2.1.4 Climate

The area receives a mean annual rainfall of 1,260 mm. The rainfall occurs in a single long rainy season from October – May. Maximum temperature is about 24°C and minimum temperature is 13°C. Mean annual evaporation is approximately 1,440 mm, one of the lowest in Kenya.

2.2 PHYSICAL INFRASTRUCTURE

2.2.1 Roads

All weather surfaced roads are limited to the main Embu - Meru - Isolo road, the Meru - Maua secondary road, and lengths within Meru town. Other roads are unpaved and access can be difficult especially in the wet seasons. Maintenance of the road network is constrained by available resources.

2.2.2 Electricity

Electricity is provided in Meru through an extensive grid, however the socio - economic shows that the main consumers are commercial, institutional and industrial. Less than 5% of the population have electricity connections.

2.2.3 Telephones

The telephone infrastructure is similar to electricity with most connections being for business purposes. Approximately 5% of the population have telephone connections.

2.2.4 Water Supply and Sanitation

Water supplies are less than adequate. Approximately 10% of the population in the urban area are supplied from MENR sources, while 50% obtain untreated water from the large number of community water supply schemes (>200). Figure 2.2 shows 30 of the major community water supply areas. The remainder of the population take water from traditional sources and hand - dug wells.

Meru has a waterborne sewerage system with stabilisation ponds. The sewered area, which is the responsibility of the Municipal Council, serves approximately 30% of the urban area and in concentrated in the central business district. The majority of the population used pit latrines and septic tanks for waste disposal.

2.3 SOCIO-ECONOMIC CONDITIONS

2.3.1 Administration

Meru is a cosmopolitan town situated in the Eastern province of Kenya and established as a regional Methodist Mission Centre in 1929. The Methodist church was responsible for the early establishment of such essential social infrastructural services as hospitals, dispensaries, schools and water supply for the local population. It attained a municipality status in 1971 and the town currently covers an estimated area of 62 km2 It is the administrative headquarters of Meru Central District and forms a major business convergence centre for the hinterland economy. Its Central Business District (CBD) is home to the offices of the district commissioner, other district departmental heads, municipal and county council offices. The town has a high potential for growth as evidenced in the rapid establishment of major institutional, commercial and industrial enterprises.

2.3.2 Population Structure and Distribution[1]

According to results of the 1999 housing and population census, the population of Meru town was 126,427[2] people. This contrasts with the 1969, 1979 and 1989 censuses where the population stood at 4,475, 70,439 and 94,947 respectively representing an inter-censal growth rate of 2.9% per annum for the period 1989-1999. The urban population normally peaks on market days when urban visitation is high. The increase in the urban population between the 1969-1979 inter-censal periods was mainly due to the expansion of municipality boundaries to include more hinterland areas. The number of households on the other hand increased from 19,802 in 1989 to 26,017 1999 with a mean household size of 6.0. The distribution of the population and number of households on the basis of sub locations is shown in table 2.1 (See appendix B 1-1 for a map of the study area).

Table 2.1 Population Structure and Distribution (1999)

Location	Number of Households	Population in Municipality	Population in Service area
Mulathankari	2,369	11,167	
Chugu	2,716	12,678	
Munithu	1,949	9,364	
Thuura	2,119	9,606	
Giaki	1,712	7,540	
Kiburine	1,466	6,603	
Nthimbiri	2,421	10,937	58,532
Ntakira	4,414	17,371	
Igoki	2,047	7,600	
Municipality	6,823	24,295	
Ntima	2,953	9,266	
2.1 **Total**	**30,989**	**126,427**	

Source: District Statistical Office, Meru and Central Bureau of statistics, 2001

2.3.3 Population Projections to the Year 2010

The main determinants of urban population growth rates are fertility rates and rural–urban migration. For Meru town, it is assumed that the fertility rates and rural-urban migration in the area declined over the 1989-1999

[1] The demographic characteristics of the town (especially the population convergence patterns) form an important entry point in analyzing policy and formulation of action plans for the town's water and sanitation improvement programme.

[2] 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.

intercensal period in accordance with the national trend. The total effect is therefore a population growth rate that is more or less similar to the 1979-1989 intercensal growth rate of 2.9%. This rate captures other population growth dynamics, such as projected activities and is used by the District Development Committee and the municipal town planning department for their planning purposes. Table 2.2 below gives a breakdown of the population projections for a ten year period. For information on population densities, see the area map in appendix B 1-1

Table 2.2 Annualized population Projections to the year 2010

Year	Area under Urban Council
2000	130100
2001	133900
2002	137700
2003	141700
2004	145900
2005	150100
2006	154400
2007	158900
2008	163500
2009	168300
2010	173100

2.3.4 Economic and Commercial Activities

The economic and industrial potential of Meru town is enormous and is driven by activities within the hinterland. The land-use configuration of the peri-urban population enables them to produce and supply perishable crops as well as other consumables to the urban population. Given the high agricultural potential of the hinterland economy, both small scale and large-scale farming is practiced. Major crops grown are coffee and tea. Other marketable produce include potatoes, cabbages, vegetables and miraa. Dairy farming and sheep farming are also practiced. The ecological system of the hinterland economy provides suitable grounds for eco-tourism through the unique migratory patterns of elephants. Commercial activities are concentrated within the central business district and can be broadly categorized into retail shops, hardware, groceries, salons, spare parts and tyre dealers, dry cleaning, produce stores, metal works, bookshops, tailoring, carpentry and supermarkets. There are also various other medium and small scale enterprises, professional firms such as driving schools, tailoring schools, clearing and forwarding, warehousing, securicor guards, boarding and lodging, insurance firms and petrol stations. Through activities of the formal commercial sector, almost all the transactions in town are highly monetarised. Table 2.3 below gives a summary

Table 2.3: Number of Establishments by Sector

Sector	No. of Establishment
Manufacturing	6
Hotels (Major)	2
Open air markets	1
Filling (petrol) stations	11
Bus parks	1
Depots	2
Banks	7
Garages	18
Whole sale	49
Retail	509
Catering	42
Butcheries	14
Tailoring	27
Salons	27
Chemists	12
Super market	10
2.3 Book shops	14
Carpentry	21
Total	**758**

Source: District Trade Office Meru, 1999

2.3.5 Social Infrastructure

2.3.5.1 Communication

Meru town is linked to all weather A classification international trunk road from Nairobi through Embu to Isiolo and other northern frontier districts. The road network in the peri-urban and hinterland areas is poor and it is expected that this may slow down the rapid growth of the town. The town is also connected to an ultramodern STD telecommunications network, fax facilities, internet service bureaus as well as an airstrip. Electricity is tapped from the main grid

2.3.5.1 Social institutions

Meru town being the district headquarters of Meru central district is a rapidly growing urban center. The rapidly growing potential for economic and commercial investment is reflected the development of major social infrastructural institutions such as hospitals, schools and churches among others. Table 2.4 and 2.5 below gives a breakdown of the distribution of such institutions in the town.

Table 2.4 Distribution of Educational Facilities

Institution	Number
Pre primary schools	125
Primary schools	105
Secondary school	23
Teacher training college	1
Technical training institute	1
Youth polytechnic	1
Theological training institute	1
Multi purpose development training institute	1
Total	**258**

Source: District Development Office Meru, 1999

Table 2.5 Other Social Infrastructure

Institution	Number
Hospital	1
Other Health Facilities	6
GK prison	1
Dispensary	8
Nursing homes	3
Total	**19**

Source: District Development Office Meru, 1999

2.3.6 Income Levels

The distribution of income in the town is generally uneven. Pockets of households with high incomes comparable to those of urban households dominate the hinterland. Nonetheless the main sources income in urban areas are wages, salaries and profits particularly for the businessmen. This population forms a major consumer cohort for urban utilities including water consumption. With major income disparities revealed among the target population, it follows that the consumption propensities for basic goods also varies. The table 2.5 below shows the major sources of non-agricultural income for Meru town.

Table 2.6 Summary of aggregated mean household income in Meru

Income source	Mean Income	Percentage share
Wages, salaries, profits	4537.1	40.3
Other non-agricultural income	1114.6	14.8
Agricultural income	2296.4	32.0
Crop income	1372.6	12.9
Total	**9320.7**	**100.0**

Source: Welfare Monitoring Survey II, 1994

2.3.7 Willingness and Ability to Pay for Water Services

2.3.7.1 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 proportion of income that may be spent for 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 proportion of their income in real terms on water than households in the middle to high income group that are considered to spent approximately 2.2% and 1.4 % of their incomes respectively. Water use accounts for 9.5% of household non-food expenses per month for Meru, which is way above the national average of 5.0 for the low-income group. Nonetheless, this signifies the importance attached to water in the town.

2.3.7.2 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. Three methodologies were adopted and this were mainly focus group discussions especially with key personal dealing with water in the town, individual observations as well as use of elaborate questionnaires. Through questionnaire based interviews, each household head was asked questions on how much they would be willing and able to pay for a cubic meter of water under two scenarios. Questions asked in scenario one were based on the household's willingness to pay for water under existing circumstances where as in scenario two, households were asked questions relating to how much they would be willing top pay if the existing water supply conditions were improved. In both cases, the general conclusion of the survey was that most households were willing to pay more for an improved water service delivery system commensurate with the level of tariff. This was also found to be in tandem with consumer expectations and perception of the problem in a particular service area since not all consumers faced similar service delivery problems. Contingent valuations were household specific.

The preliminary analysis of information collected indicated that over 80% of the individual households interviewed were willing to pay up to Kshs. 500 for actual water consumption compared to an average estimated

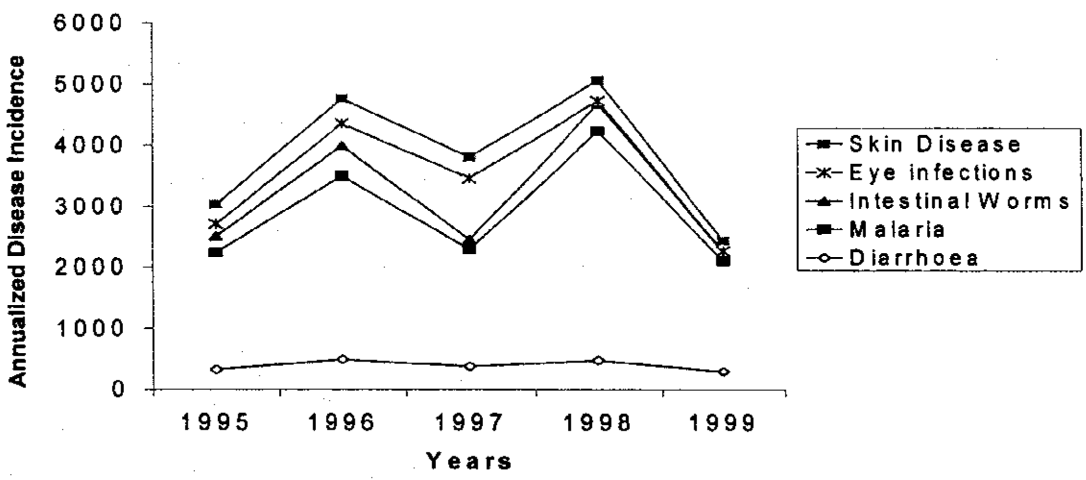
[3] The appropriate methodology in estimating willingness and ability to pay (W/ATP)/ willingness and ability to accept (W/ATA) is to use the contingent valuation (CV) approach. This approach is validated through asking water consumers at the household level hypothetical questions (which are a true reflection 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.

monthly bill of Kshs. 300. The study surveys in the areas not currently serviced established that a majority of the people would be willing to pay for water at the current general water tariff of Kshs. 20/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

2.3.8 Health and Sanitation Situation

The health and sanitation situation for the town was critically analyzed and found to be generally poor. Major diseases include malaria, diarrhoea, intestinal worms and other waterborne diseases due to the low accessibility to clean drinking water. Information from the welfare monitoring survey shows that 17.4% of the urban poor population is exposed to unsafe sanitary conditions and 55% to unsafe water. This contrasts with the non-poor urban population where only 31% are exposed to unsafe water and 10.8% to unsafe sanitary conditions. Data from a household survey conducted by the study shows that 48.8% of the households have access to piped water. Access to sanitation facilities shows 32.3% of the urban as well as peri urban households use the traditional pit latrine 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. Both the poor and non-poor use pit latrines. None of the peri urban poor population uses either cistern flush WC or pour flush squat plate sanitary facility.

Chart 1: Incidence of water Related Diseases in Meru Town



Source: Health Information systems unit, MoH and PHO's Meru 2000

2.3.9 Types of Settlements

Most land within the municipality is privately owned either under freehold or leasehold hence the development of the town is mainly based on individual owners preferences and financial capability. However, the town has KIE sheds. Residential land use occupies about 40% of the town. The town houses offices of various government ministries and departments, churches, NGO's and other civic organizations.

Table 2.7 Distribution of households on the basis of income

Income category	Number	Percentage
High income	20,229	16
Middle income	83,441	66
Low income	22,757	18
Total	**126,427**	**100**

2.3.10 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 Meru town like other parts of Kenya are traditionally responsible for collecting water for domestic use in the household.

It is considered that inadequate access to water in a household can therefore have negative repercussions on the length and hardship of an average day of a poor woman's working day. This therefore means that the rehabilitation exercise planned for the towns must meet societal expectations. Such that the impact of the planned programmes on an average woman's workload will remain as a key indicator since it affects their priorities in family care. Other than situations where donkeys are used, the burden for carrying water requires women to have a substantial amount of energy irrespective of whether one's focus is on urban or peri-urban focus.

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 EXISTING WATER RESOURCES, MANAGEMENT AND UTILISATION

2.4.1 Hydrology (surface water resources)

2.4.1.1 Catchment characteristics

Meru is located on the eastern slopes of Mt. Kenya. The area is underlain by the pre-Cambrian Basement System and is mostly covered by volcanic rocks and sediments from the eruption centres of Mt. Kenya and the Nyambene hills. The terrain shows high relief with deep V-shaped valleys and steep mountain ridges.

The principal river in the vicinity of Meru is the Kathita River. The river rises to the west on Mt. Kenya. The catchment falls within Sub - Drainage Area 4FA of the Tana River Basin.

Annual rainfall in Meru averages 1,448 mm. The rainfall increases to about 1,600mm in the upper parts of the catchment within the Mount Kenya forests.

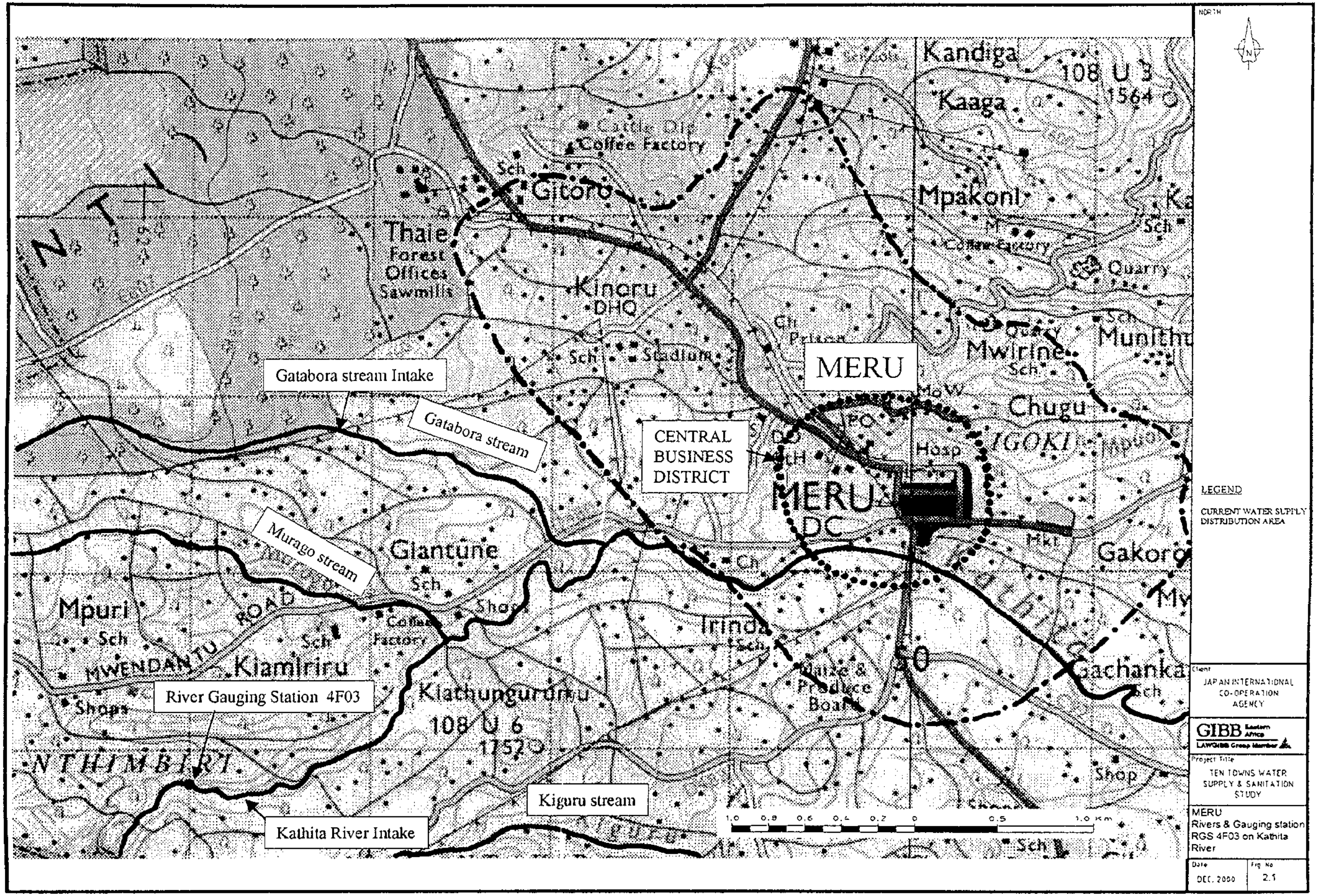
2.4.1.2 Assessment of water potential

The principal sources of water for public water supply in Meru town are the Kathita river and the Gatabora stream. The rivers in the Meru area are shown on the Figure 2.1. Details of the river gauging stations are presented in Table 2.8

Non-dimensionless flow duration curves for the Kathita, Thingithu and Mariara rivers are presented in Figure 2.3. These curves have been abstracted from the *"Aftercare Study on the National Master Plan conducted by Japan International Cooperation Agency (JICA), 1998"*. As very little additional data has been collected since the time of the JICA study, the curves are applicable today.

The flow duration curve shows the relationship between any given discharge and the percentage of time that the discharge is exceeded. The flow duration curve is derived from daily flow data by assigning daily discharges to class interval and counting the number of days within each interval. The proportion of the number of days above the lower limit of any given class interval is then calculated and plotted against the lower limit of the interval.

The flow duration characteristics are presented in Table 2.9



MERU
Rivers & Gauging station RGS 4F03 on Kathita River

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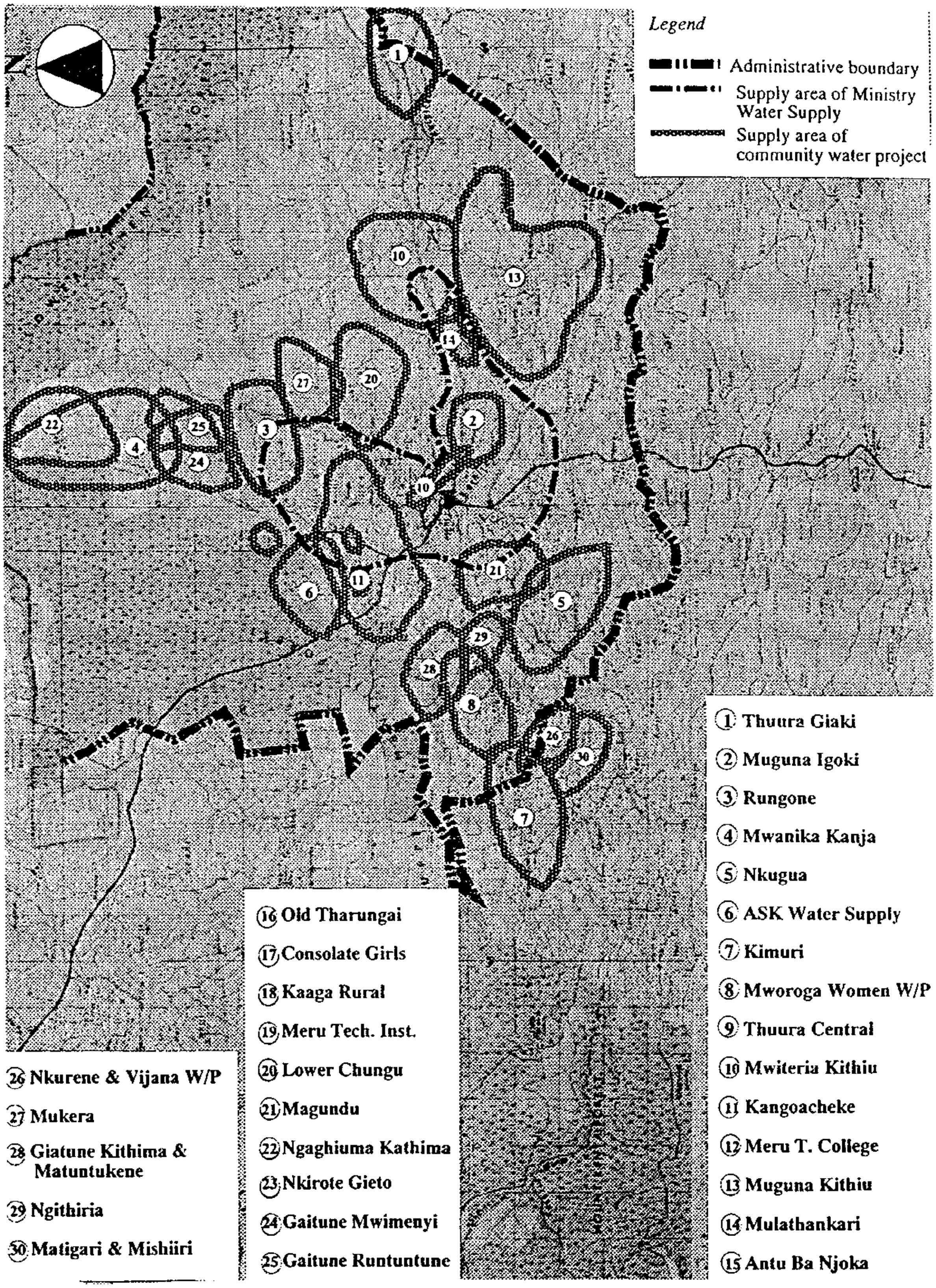
GIBB Eastern Africa — LawGibb Group Member

Project Title: TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title: MERU TOWN WATER SUPPLY — MENR & COMMUNITY W.S. SUPPLY AREAS

Date: JAN 2001

Fig No. 2.2



The comparison of source yields and demand is presented in Table 2.10.

The existing Kathita river water supply intake is located close to RGS 4F03. The catchment area at the intake is 206 km². Thus flow at the intake can be estimated to be 85% of the flow at RGS 4F03 - see Table 2.10.

In the absence of readily available or reported data, flow characteristics for the adjacent Gatabora stream can be estimated by adjusting the Kathita River flows proportionally according to the catchment areas. This is justified, given the close proximity and similarity of the two catchments in shape, topography and land use.

After the current El Nino emergency works are completed the abstraction capacity will be 5,000 m³/day.

The information in Table 2.10 shows that the river has a low flow capacity well in excess of current abstraction rates. It is interesting to record the comments by the following recent study:

- Technical Note entitled "The Basic Design Study on Meru Water Supply ", dated May 2000, prepared by Nippon Koei Co. Ltd. Under JICA funding.

The above study presented a detailed hydrological analysis for data from gauging station RGS 4F31. This station is located a short distance upstream of the existing River Kathita water supply intake. The key factors identified by the JICA funded study are:

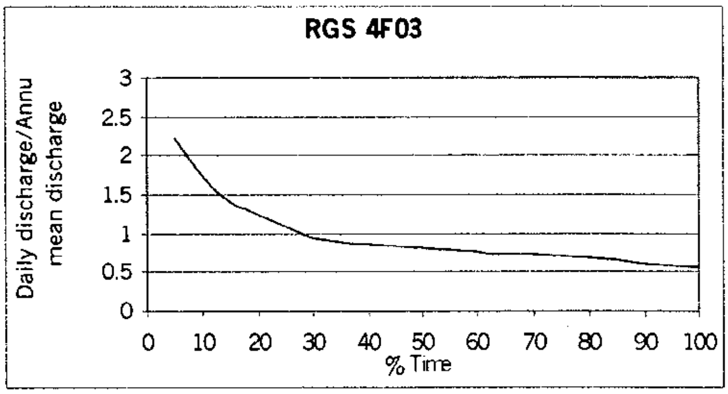
- Catchment area at RGS 4F31 is 191 km².
- 1981 to 1991: Minimum daily discharges 0.8to 1.2 m³/s.
- 1991 to 1996: Minimum daily discharges 0.2 to 0.5 m³/s.
- Probable 96% probability daily low flow: 74,200 m³/day.

The study noted a 50% decrease in minimum daily discharge since 1991, and this was attributed to an inaccurate stage discharge recorded in the latter period. Whilst this is possible, it is also pertinent to note the reported illegal logging within the Mount Kenya forests. If the Kathita catchment is one of these impacted, then a decline in low flows would be expected.

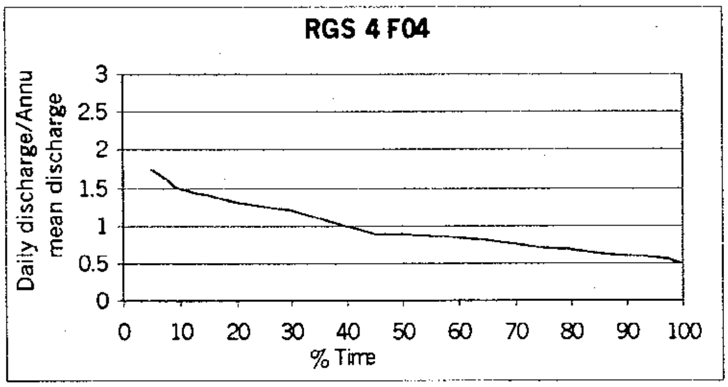
The lowest daily discharge of 0.2 m³/s equates to 17,280 m³/day. This is in excess of the current abstraction rate, but it is very low compared to the assessed 96% probability daily discharge of 74,280 m³/day. The concerns identified in the JICA funded study need to be rationalised by a programme of current meter gaugings to establish the current gauging station rating equation.

The Meru area is well endowed with surface water resources, but the long term low flow sustainability of rivers has been threatened by illegal deforestation. It is to be hoped that that under the custodianship of KWS there will be a greater degree of protection of these catchments.

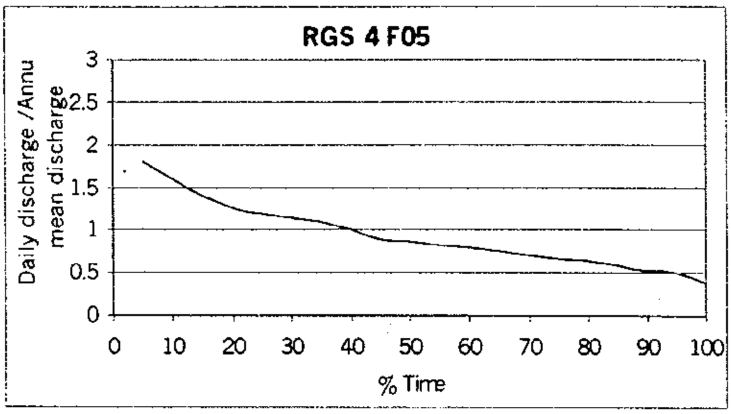
Flow duration curve for Kathita River.



Flow duration curve for Thinguthi River



Flow duration curve for Mariara River



Flow duration curve for Kathita at RGS 4F31

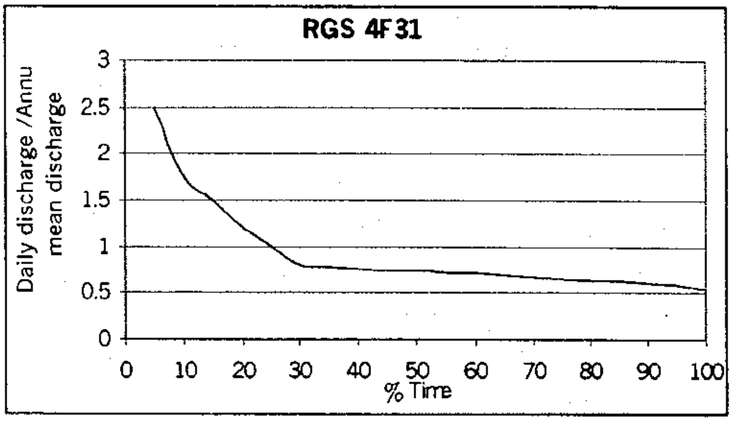


Figure 2.3 Flow Duration Curves

The 50% exceedence flow in Figure 2.3 is the daily discharge that was exceeded 50% of the time. The 100% exceedence flow is the flow that was exceeded 100% of the time during the flow sequence. Thus, the 100% exceedence value represents the lowest daily discharge on record.

The JICA "Aftercare Study" defined the yield of an unregulated river source as follows:

"The reliable flow at a given site of a given river is defined to be a 90% dependable flow deducted by river maintenance flow ...", and

"The 90% dependable flow is obtainable from the flow duration curve of the nearest gauging station ...".

The maintenance flow is defined as "... the recorded daily minimum runoff of the river concerned".

Thus, the difference between the 90% and 100% exceedence flows corresponds to the available water resource. For consistency of approach, the same definition of reliable flow is adopted for this project.

Table 2.8 Details of the gauging stations

River	Gauging station	Station opened	Station closed	Rated	Area (km^2)	Annual Mean Runoff (m^3/s)
Kathita	4F03	1952	1983	No	246	2.2
Thingithu	4F04	1952	1987	Yes	91	2.1
Mariara	4F05	1955	1987	Yes	-	1.3
Gatabora	-	-	-	-	29	0.26

(Source; The Aftercare Study on the National Water Master Plan Data Book, 1998)

Table 2.9 Flow duration characteristics

Station reference number	4F03	4F04	4F05	4F31
Mean annual runoff Q_{ave} m^3/sec	2.20	2.10	1.30	1.70
50 % exceedence flow ratio Q_{50}/Q_{ave}	0.82	0.90	0.9	0.74
90 % exceedence flow ratio Q_{90}/Q_{ave}	0.65	0.60	0.55	0.62
95 % exceedence flow ratio Q_{95}/Q_{ave}	0.57	0.57	0.50	0.60
100 % exceedence flow ratio Q_{100}/Q_{ave}	0.55	0.50	0.40	0.55

Table 2.10 Comparison of river yields and demand for Meru municipal water supply

Description	Flow (m^3/day)	
	Kathita River	Gatabora stream
90 % exceedence flow	123,552	14,865
100 % exceedence flow	104,544	12,324
Available water resource	19,008	2,240
Present abstraction capacity	5,000	
2000 demand	13,899	
2010 demand	18,334	

On inspection Table 2.10, it can be seen that the yield from the Kathita river and Gatabora stream discharges are enormous compared to the water abstraction requirements to reliably supply Meru town at present and the future.

2.4.2 Hydrogeology (Groundwater resources)

The major hydrogeologic units comprise fine to gravelly sediments intercalated in the volcanic flows, fine to coarse pyroclastics and weathered and fractured basalt. These are potentially good water-bearing materials in the right conditions of recharge. The area enjoys a good and extensive recharge catchment on the middle slopes of Mt Kenya. Thus aquifers hydraulically connected to this recharge zone have potential for high yielding boreholes. Due to the composite nature of volcanic geology, pockets of perched or limited aquifers also occur in the area.

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

- Depth range to the main aquifer: 15 – 100 m.
- Depth range of water rest level: 8 – 70 m.
- Discharge range: 1.5 – 25 m^3/hr.
- Water quality: generally expected to be fresh, slightly acidic to neutral sodium bicarbonate waters. The ionic concentrations of silica and may be high.

Aquifers are confined or leaky, and comprise basal flow units, intercalated sediments (old land surfaces), weathered, fractured or fault-zone material. Recharge to the aquifers occurs by lateral underflow from recharge catchments in the middle slopes of Mt Kenya and by seepage from surface water bodies into perched aquifers. Local infiltration also contributes to recharge.

No proper test pumping data was available for analysis. However, it is expected that the upper limit of discharge recorded so far of 25 m^3/hr can be easily exceeded in suitably site d boreholes.

2.4.2.1 Status of existing groundwater supply facilities

There is only one borehole operated by the Water Department in Meru Town – that at the Agricultural Society of Kenya (ASK) Show Ground. The borehole serial number is C 9085. The Diocese of Meru owns the other borehole in town, number C 3225.

The show ground borehole is operated seasonally for preparations of and during the annual ASK event. It is note used to directly and regularly augment the water supply from the surface water intakes.

Table 2.11 presents data for the existing water department and institutional boreholes.

Table 2.11 Completion data: Water department and institutional boreholes

SERIAL No.	Total depth (m)	Water strikes (m)	Rest level (m)	Tested yield (m^3/hr)	Owner
C 3295	21.3	19.8	8.5	5.5	Diocese of Meru
C 9085	120	39, 94	70.6	> 20	MENR

Data source: NAWARD, MENR, Nairobi.

2.4.2.2 Construction condition of C 9085

This borehole was drilled only 10 years ago and is till operational.

2.4.2.3 Potential for groundwater development

Very few groundwater sources have been constructed in the Meru Town area, mainly due to the currently abundant surface water resources. However, there is good potential for groundwater development. The limited data available indicates substantial yields can be obtained from perched aquifers, while yields of over 20 m^3/hr can be obtained where deep extensive aquifers are struck.

Groundwater in the area is generally fresh due to the minimal residence period between recharge and discharge. Few ions are expected to be found in greater concentration than the allowable limits for potable water. This has obvious advantages for chemical treatment.

2.4.3 Sources

Sources of Meru water supply are surface water from the Kathita River (the principal source), the Gatabora Stream and a smaller stream in the forest to the west of the town. Reports from MENR personnel indicate that the flows in the Gatabora Stream are diminishing.

2.4.4 Management

The water supply is managed by the Ministry of Environment and Natural Resources by the District Water Officer (DWO).

3 EXISTING WATER SUPPLY CONDITIONS

Schematics of the water supply system are shown in Fig. Nos. 3.1 and 3.2.

3.1 SOURCES AND INTAKES

3.1.1 Kathita river

The intake consists of a concrete weir across the river with a side entry intake. A DN300, mainly uPVC raw water gravity main, approximately 3,150 m long connects the intake to the Milimani treatment works.

3.1.2 ASK (Agricultural Society of Kenya)

A masonry collection chamber intercepts the flow from a small stream and a DN100 raw water gravity main conveys water to the showgrounds, and also serves consumers on the pipeline rout with untreated water.

3.1.3 Gatabora stream

A DN150 pipe runs from a masonry/concrete intake to the elevated backwash tanks at Milimani water treatment works.

3.1.4 Gatabora spring

A DN200 raw water gravity main runs from the masonry/concrete intake to the high level storage tanks at Kaithe site, a distance of approximately 1,000 m..

There are no bulk meters on any of the above sources.

All of the above intakes have been rehabilitated under the current El Nino emergency project.

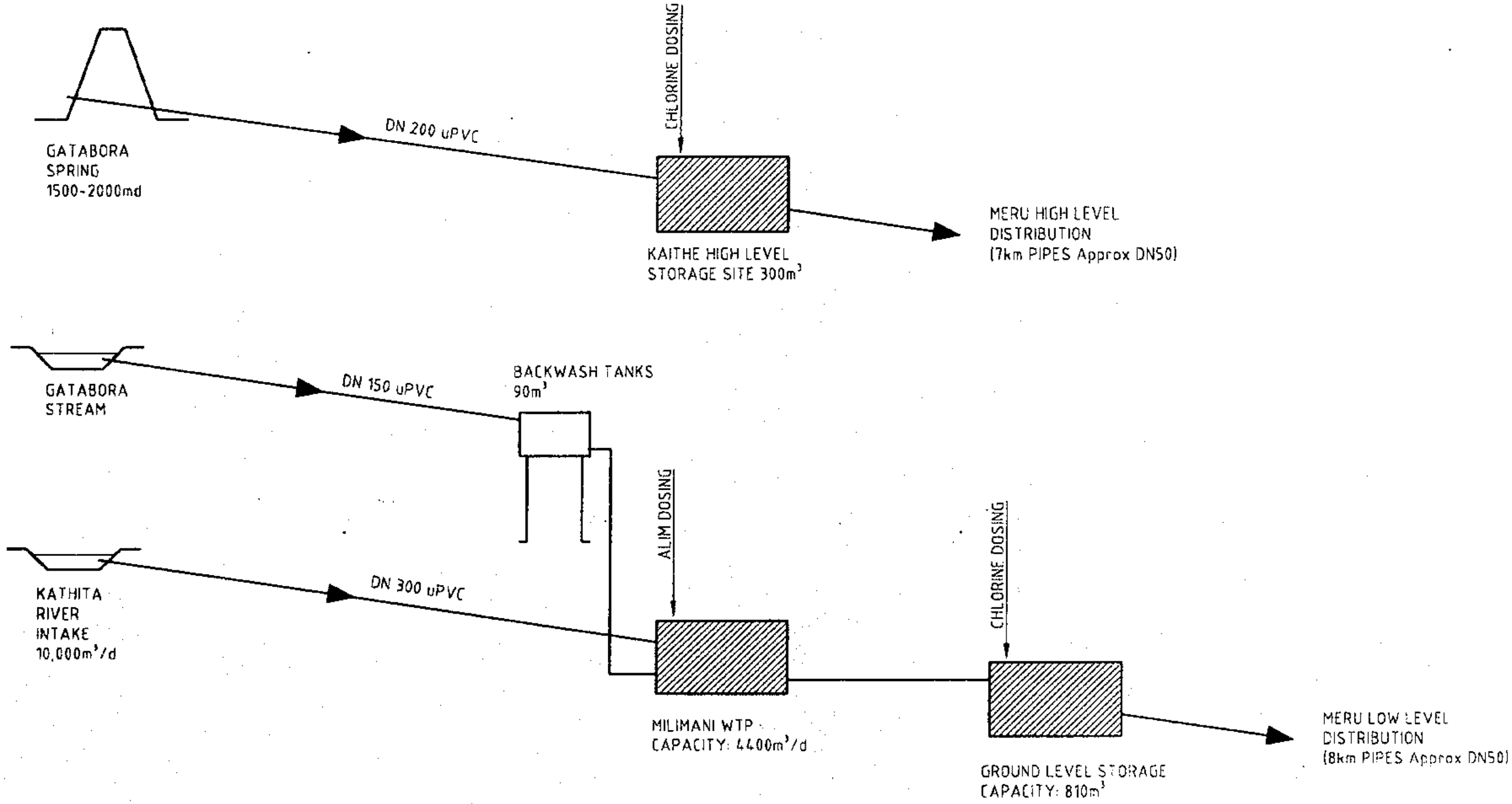
3.2 TREATMENT

The layout of Milimani treatment works is shown in Fig. 3.3.

3.2.1 General

Milimani treatment works is situated in the centre of the town near the DC's residence.

3.2.2 Treatment



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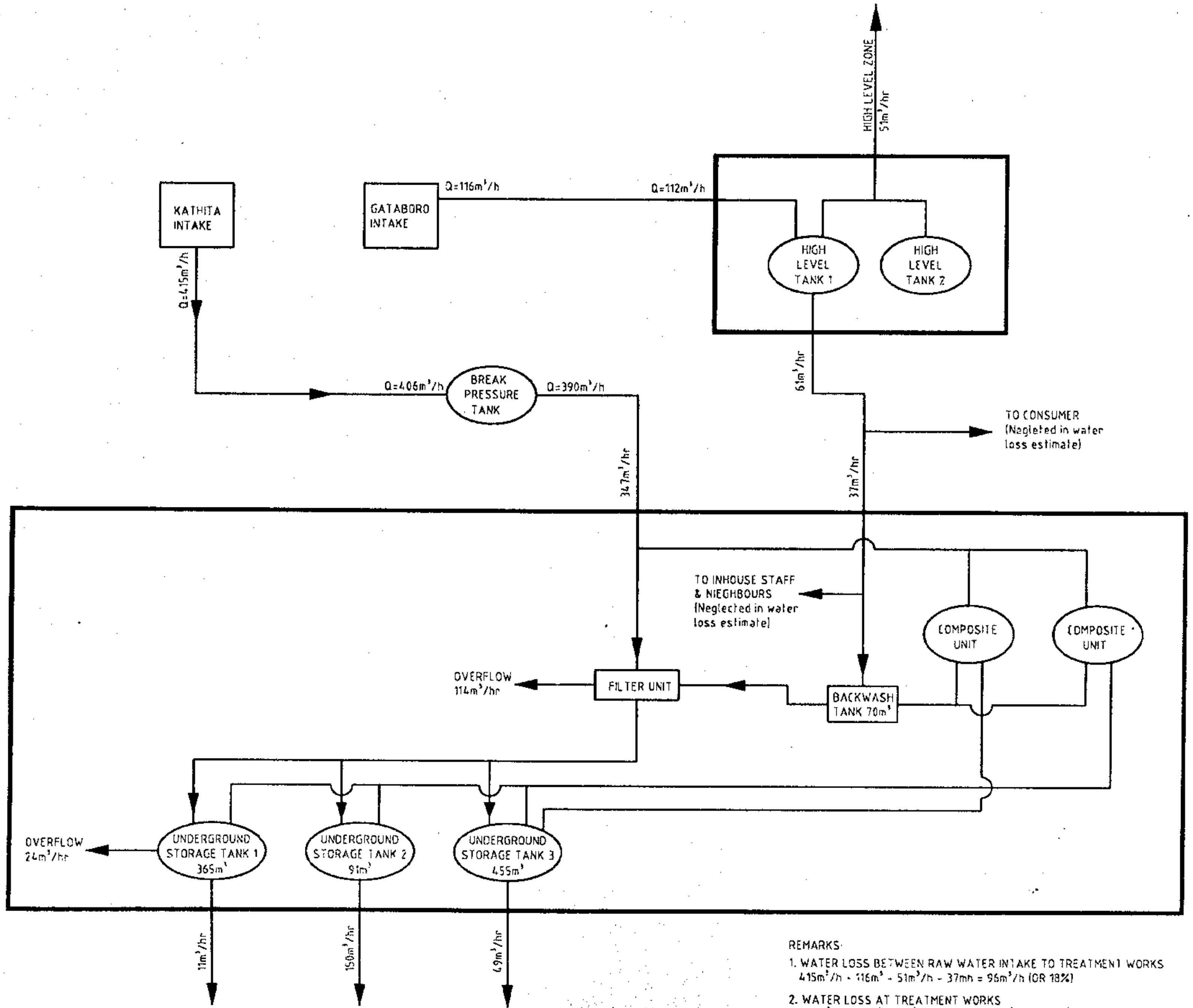
Project Title: TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title: MERU WATER EXISTING POSITION SHEMATIC

Date	Fig. No.
JAN 2001	3.1



REMARKS:

1. WATER LOSS BETWEEN RAW WATER INTAKE TO TREATMENT WORKS
$415m^3/h - 116m^3 - 51m^3/h - 37mh = 96m^3/h$ (OR 18%)

2. WATER LOSS AT TREATMENT WORKS
$347m^3/h + 37m^3 - 11m^3/h - 150mh - 49m^3/h = 174m^3/h$ (OR 33%)

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Project Title
TEN TOWNS WATER
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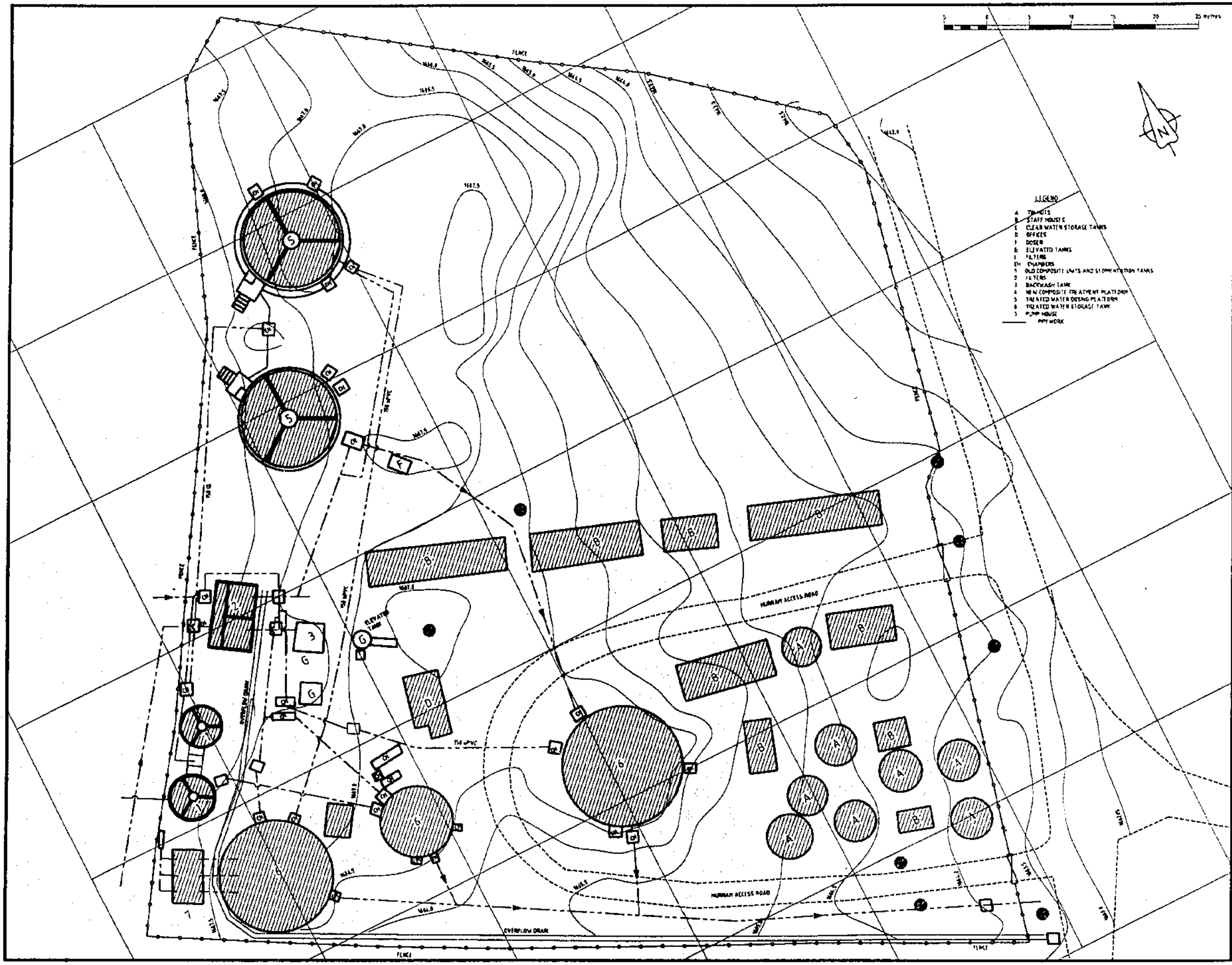
Drawing Title
MERU TOWN WATER
SUPPLY
MILIMANI WORKS EXISTING
POSITION SHEMATIC

Date	Fig. No
JAN 2001	3.2



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Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title
MERU TOWN WATER SUPPLY TREATMENT WORKS LAYOUT

Date	Fig. No.
DEC 2000	3.3

There is no inlet works, the raw water from the Kathita river is diverted into 3 groups of tanks as follows :

- 2 no. composite units (1952), total treatment capacity 450 m^3/day under rehabilitation,
- 2 no. rapid gravity filters (1978), total treatment capacity 1,800 m^3/day under rehabilitation,
- 2 no. composite units (1995), total treatment capacity 1,920 m^3/day in use,
- 2 no. composite units (2000), total treatment capacity 1,920 m^3/day under construction.

The circular composite units have flocculation, coagulation, sedimentation and filtration compartments.

Filtered water is stored in on-site circular masonry and concrete tanks, thence by a DN250 gravity transmission main into supply.

Filter backwashing is by gravity from elevated steel tanks.

The existing installed capacity of the treatment works is approximately 4,200 m^3/day. Capacity will rise to 6,000 m^3/day after current rehabilitation and expansion.

3.2.3 High level storage site

Raw water from the Gatabora stream flows directly into 2 no. ground level storage tanks at Kaithe total capacity 300 m^3 where manual chlorination using calcium hypochlorite takes place.

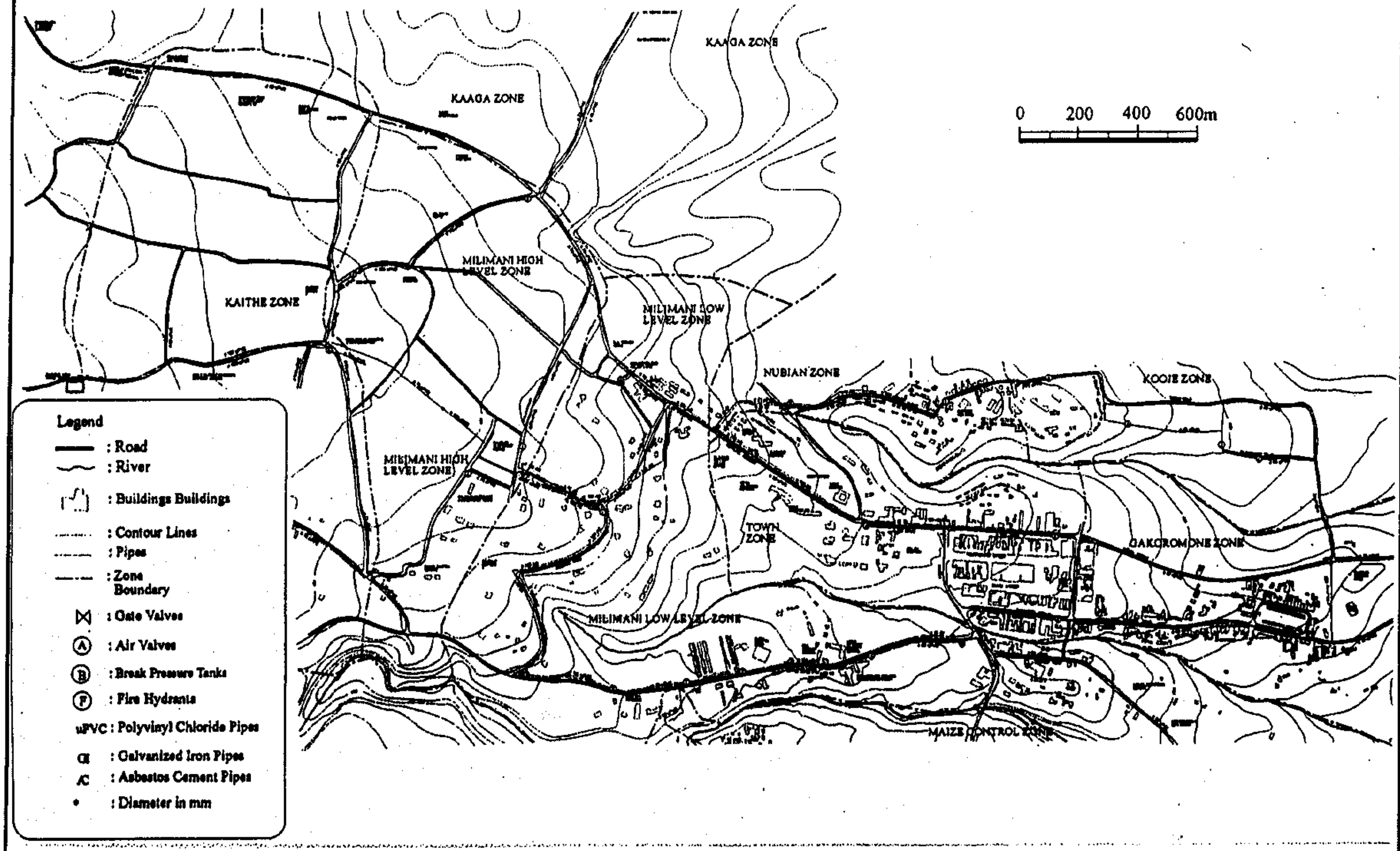
3.2.4 Chemical dosing

Treatment consists of flocculation, coagulation, sedimentation and filtration. Aluminium sulphate is added as a flocculant aid and calcium hypochlorite for disinfection. None of the chemical dosers is working and addition of chemicals is carried out manually.

3.3 DISTRIBUTION

The layout of the distribution system is shown in Fig. 3.4.

The distribution system comprises mostly small diameter pipes some of which were laid in the 1950s. These pipes are corroded and leaking and have come to the end of their working lives. They should be replaced by steel and uPVC pipes.



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Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title
MERU TOWN WATER SUPPLY

DISTRIBUTION LAYOUT

Date	Fig. No.
JAN 2001	3.4

Meru distribution is zoned into high level and low level areas. The high level zone consists of approximately 7,800 m of DN150 to DN50 pipes fed from the Kaithe high level storage site, and the low level area has approximately 18,400 m of DN200 to DN50 pipes fed from the Milimani treatment works.

The high level zone covers approximately 9 km^2 with some 400 house connections.

Replacement of the distribution system represents an extremely large investment in capital costs.

Lengths of distribution pipework are shown in Table 3.1.

Table 3.1 Lengths of distribution pipework

Zones	DN mm	Material	Length m
High level (3)	150	uPVC	1,185
	100	uPVC	1,040
	75	uPVC	2,790
	50	uPVC	2,770
Low level (8)	200	uPVC	560
	150	uPVC	1,010
	100	uPVC	2,105
	100	AC	1,440
	75	uPVC	1,495
	75	AC	610
	50	uPVC	8,755
	50	GI	2,435
Total			**26,195**

3.4 STORAGE

There are storage facilities at the treatment works site and at higher elevation :

- Treatment works site, 3 no. ground level masonry and concrete tanks - capacities 455 m^3, 365 m^3 and 90m^3.

- High level site, 2 no. ground level masonry and concrete tanks @ 150 m^3 each.

Total storage capacity 1,200m^3 approximately.

3.5 EXISTING O&M

3.5.1 Staff

The MENR water supply has approximately 160 personnel, in all cadres. See organisation chart Fig. 3.5.

O&M activities are restricted by lack of suitable transport and spare parts, including pipes and repair couplings, fittings, valves, etc.

3.6 ON-GOING OR PLANNED EL NINO WORKS

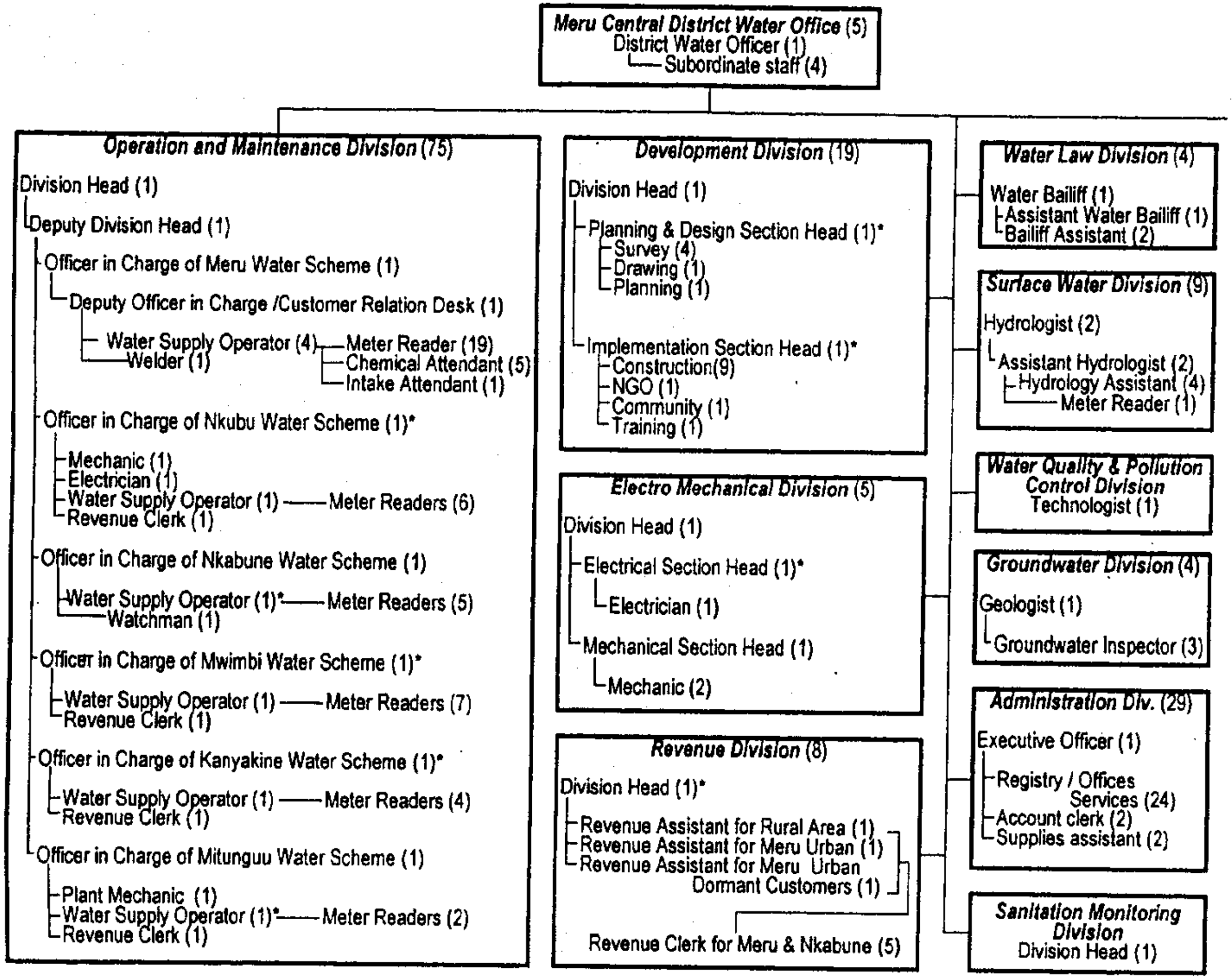
3.6.1 Works being carried out under the El Nino Rehabilitation Project (ENEP)

(a) Intakes and raw water mains

Kathita Intake	Replacement of screens, trash racks, compensation valves, repairs to body of weir, fencing.
Gatabora Stream Intake	Desilting reservoir, repair of intake chamber and replacement of screen, erosion protection and fencing.
Gatobora Spring Intake	Desilting reservoir, replacement of screen, repair of weir body and access ladders, erosion protection and fencing.
ASK Spring Intake	Desilting reservoir, replacement of screen, repair of weir body and access ladders, erosion protection and fencing.
Kathita Raw Water Main	Replace damaged pipe at river crossing.
Gatabora RW Main	Replace washed away and damaged sections of pipes.

(b) Milimani Water Treatment Plant

Composite units (1952)	Repair internal walls, refurbish underdrain system and filter media, replace all valves.
Filter units (1978)	Repair internal walls, refurbish underdrain system and filter media, replace all valves.
Composite units (1995)	Replace filter media and refurbish all valves.
Dosing equipment	Replace dosing equipment for 1995 and new units.



-Numbers in parenthesis show the number of employees deployed.
-Concurrent posts are shown by *
-Total staff number as of May 2000 is roughly 170.

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Drawing Title: MERU TOWN WATER SUPPLY ORGANIZATION CHART

Date	Fig. No.
JAN 2001	3.5

Treated water storage	Refurbish valves, repair cracks.
Highlift pumping	Provide 3 no. new pumps (10l/s v 90m head) complete with controls and cabling, refurbish building.
New treatment units	Construct 2 no. composite units each $960m^3$/day.
General site works	Install master meters, refurbish offices and laboratory, repair fence and security lighting, roads and drainage.

(c) Kaithe high level tanks

Install float valves and treatment equipment, refurbish valves and tank level recorder.

(d) Distribution system

Expose and repair as required DN100 rising main to Kaithe. Repair damaged sections of distribution pipes as instructed approximately 200 m.

The rehabilitation project does not include expansion or enlargement ofthe distribution system, nor flow control at the inlets to the various treatment units at Kilimani.

3.7 OTHER WORKS AND PROJECTS

None.

3.8 SUMMARY OF SHORTCOMINGS AND PRELIMINARY RECOMMENDATION FOR REHABILITATION

3.8.1 General

This study of existing water facilities seeks to identify and rehabilitate system components without consideration of expansion.

The JICA Master Plan (October 1997) specifically states that a full scale rehailitation of the Meru water supply system is considered to be both premature and impractical.

3.8.2 Raw water inlet control

The raw water flow from the Kathita River intake to the Milimani treatment works is >10,000 m^3/day and consequently there is a raw water overflow 4,000 m^3/day. This considerable overflow is seen as the population as a waste of water and MENR comes in for criticism. A flow control mechanism, be it in the form of weir control or control valves would ameliorate the situation.

3.8.3 Highlift pumping (treated water)

Pumping from the Milimani treatment works to the Kaithe storage site was discontinued in 1988. New highlift pumps have been installed under the El Nino Emergency Project but no rehabilitation works have been included for the pumping main. It is recommended that the 1,200 m DN100 pipeline be replaced under the proposed rehabilitation works.

3.8.4 Distribution

The distribution system is very old and undersized. The outlet mains from the treatment works storage tanks have a capacity of 5,000 m^3/day, which again gives rise to a substantial overflow of treated water. A topographical survey and network analysis will identify critical sections of pipelines which should be replaced or augmented.

3.8.5 Storage

Minimum storage for a gravity water supply is equivalent to 12 hrs average daily demand.

The average daily demand in 2010 has been estimated to be 27,400 m^3. Minimum storage capacity is 13,700 m^3.

Existing storage is 1,200 m^3, leaving a shortfall of 12,500 m^3. Under the proposed rehabilitation works construct 4,000 m^3 additional storage facilities.

3.8.6 Proposed rehabilitation works

Preliminary recommendations and listed below :

- identify sections of existing distribution pipework where diameters are too small and replace or reinforce,
- increase storage capacity by 4,000 m^3,
- install flow controls at the inlets to the various treatment streams at Milimani Treatment Works,
- install bulk and domestic water meters,
- replace DN100 pumping main.

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3.8.7 Proposed rehabilitation works

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- identify sections of existing distribution pipework where diameters are too small and replace or reinforce,
- increase storage capacity by 4,000 m^3,
- install flow controls at the inlets to the various treatment streams at Milimani Treatment Works,
- install bulk and domestic water meters,
- replace DN100 pumping main.

3.9 LEVELS OF SERVICE

3.9.1 Population served

According to the District Water Officer there are currently 3,218 connections in Meru, of which 2,419 are active.

The 1999 census gives the population of Meru as 126,427 (126,400) in 30,477 households, an average household size of 4.15.

The population of Meru living inside the water supply service area is estimated to be 58,532 (58,500), or 46% of the population.

The number of people with active connections is 2,419 x 4.15 = 10,039, or 17% of the people within the serviced area.

3.9.2 Per capita supplies

Daily production from the treatment works is approximately 4,000 m^3 and a further 1,000 m^3 is produced daily from the Kaithe site (high level zone). The average monthly production is of the order of 150,000 m^3. Monthly water consumption is estimated to be 60,000 m^3. Indicating massive quantities of unaccounted for water.

The per capita consumption for the estimated 'connected' population is equivalent to 200 lcd, or an average of 34 lcd for the population living within the serviced area.

4 PROPOSED STRATEGY FOR WATER SUPPLY REHABILITATION

4.1 DEMAND/CONSUMPTION PROJECTIONS TO 2010

4.1.1 Population projections to 2010

The population of Meru according to the 1999 census is 126,427 in 30,477 households. Annual growth rate is 2.9%.

Yearly population projections to 2010 (rounded to the nearest '00) are shown in Table 4.1.

Table 4.1 Population projections to 2010

Year	Population
1999	126,400
2000	130,100
2001	133,900
2002	137,700
2003	141,700
2004	145,900
2005	150,100
2006	154,400
2007	158,900
2008	163,500
2009	168,300
2010	173,100

4.1.2 Water demand projection

Demand rates are taken from the Ministry of Water Development Design Manual (1986) and are included in Appendix A2

Table 4.2 shows estimated daily demand from 2000 to 2010 compared with the current capacities of the various system components.

Demand has been calculated using the following percentages for different level income brackets of consumers, ascertained from data collected in the field.

Table 4.2
Meru Water Supply Projected Water Demands and Current System Capacities

Year	Population	Income brackets		Population	Demand rate lcd	Demand m^3/day	Institutional demand m^3/d	Total demand m^3/day	Production capacity m^3/day	Transmission capacity m^3/d	Storage capacity m^3
		Status	%								
1999	126,400	High	16	20,224	250	5,056					
		Middle	66	83,424	150	12,514	1,000	**20,276**	6,000	5,000	1,100
		Low	18	22,752	75	1,706					
2000	130,100	High	16	20,816	250	5,204					
		Middle	66	85,866	150	12,880	1,000	**20,840**	6,000	5,000	1,100
		Low	18	23,418	75	1,756					
2001	133,900	High	16	21,424	250	5,356					
		Middle	66	88,374	150	13,256	1,000	**21,420**	6,000	5,000	1,100
		Low	18	24,102	75	1,808					
2002	137,700	High	16	22,032	250	5,508					
		Middle	66	90,882	150	13,632	1,000	**21,999**	6,000	5,000	1,100
		Low	18	24,786	75	1,859					
2003	141,700	High	16	22,672	250	5,668					
		Middle	66	93,522	150	14,028	1,000	**22,609**	6,000	5,000	1,100
		Low	18	25,506	75	1,913					
2004	145,900	High	16	23,344	250	5,836					
		Middle	66	96,294	150	14,444	1,000	**23,250**	6,000	5,000	1,100
		Low	18	26,262	75	1,970					
2005	150,100	High	16	24,016	250	6,004					
		Middle	66	99,066	150	14,860	1,000	**23,890**	6,000	5,000	1,100
		Low	18	27,018	75	2,026					
2006	154,400	High	16	24,704	250	6,176					
		Middle	66	101,904	150	15,286	1,000	**24,546**	6,000	5,000	1,100
		Low	18	27,792	75	2,084					
2007	158,900	High	16	25,424	250	6,356					
		Middle	66	104,874	150	15,731	1,000	**25,232**	6,000	5,000	1,100
		Low	18	28,602	75	2,145					
2008	163,500	High	16	26,160	250	6,540					
		Middle	66	107,910	150	16,187	1,000	**25,934**	6,000	5,000	1,100
		Low	18	29,430	75	2,207					
2009	168,300	High	16	26,928	250	6,732					
		Middle	66	111,078	150	16,662	1,000	**26,666**	6,000	5,000	1,100
		Low	18	30,294	75	2,272					
2010	173,100	High	16	27,696	250	6,924					
		Middle	66	114,246	150	17,137	1,000	**27,398**	6,000	5,000	1,100
		Low	18	31,158	75	2,337					

Category	Proportion %	Population (1999)	Rate (lcd)	Demand (m^3/day)
High income	16	20,228	250	5,057
Middle income	66	83,442	150	12,516
Low income	18	22,757	75	1,707
Total domestic water demand m^3/day				**19,280**

An allowance of 1,000 m^3/day has been included for commercial, industrial and institutional consumption.

4.2 PRELIMINARY DESIGN OF RECOMMENDED REHABILITATION OPTIONS

4.2.2 High priority rehabilitation works

The recommended works comprise :

- installation of a flow divider (flow control valves),
- construction of additional storage,
- rehabilitation and replacement of the distribution system,
- installation of meters,
- lay new pumping main.

4.2.3 Flow divider (flow control valves)

4.2.4 4,000m^3 ground level storage tanks

A network analysis of the distribution system will indicate the optimum position for the tank(s). It is probable that 4 no. tanks on different sites will offer the best solution.

4.2.5 Distribution system

A survey and network analysis of the existing system using a population and housing distribution plan will indicate pipe sizes in the system. Decisions can then be made on replacement, augmentation, etc.

4.2.6 Meters

Bulk (master) meters will be installed in all pipes leaving the treatment works site and on the outlets from all storage tanks.

If the distribution system is zoned, zonal meters will be installed at strategic locations. Similarly, district meters will be installed to assist in leak detection.

Domestic meters will be installed in chambers just inside plot boundaries.

4.2.7 Pumping main

Lay a new pumping main, 1,200 m long DN100, from Milimani treatment works to the Kaithe tanks.

4.3 COSTING OF RECOMMENDED REHABILITATION PLAN

Table 4.3 Estimates for immediate rehabilitation

Ref	Description	Unit	Quantity	Rate (Kshs)	Amount (Kshs)
1.	**Water meters**				
1.1	Bulk meters (various diameters)	no.	12	250,000	3,000,000
1.2	Domestic meters	no.	3,000	6,000	18,000,000
2.	**Storage**				
2.2	1,000 m^3 ground level tank	no.	4	5,000,000	20,000,000
3.	**Pipes**				
3.1	DN100 uPVC pumping main	m	1,200	2,000	2,400,000
3.1	Distribution uPVC DN 50 - 100	Km	50	2,500	125,000,000
4.	**Logistical facilities and equipment**				
4.1	Rehabilitate existing office buildings	Sum		2,000,000	2,000,000
4.2	4WD twin-cab pick-ups	no.	2	2,500,000	5,000,000
4.3	Saloon car	no.	1	1,500,000	1,500,000
4.4	Motorcycles	no.	6	250,000	1,500,000
4.5	Computers	no.	8	200,000	1,600,000
4.6	Printers	no.	3	100,000	300,000
4.7	Computer software	Sum		500,000	500,000
4.8	Office equipment & furniture	Sum		1,000,000	1,000,000
		Total of works			**181,800,000**
Add	20% preliminaries and general items				36,360,000
		Sub-total			218,160,000
	15% contingencies				32,724,000
		Sub-total			250,884,000
	20% consultancy fee				50,176,800
		Grand Total			**301,060,800**
				Say	**300 million**

4.4 EXPANSION OF WATER SUPPLY FACILITIES

The design horizon for expansion of Meru water supply is 2010.

In October 1997 JICA produced the Final Report on the study on the water supply for seven towns in Eastern Province of Kenya.

The report includes a feasibility study on the water supply to Meru.

The feasibility report examines the existing (1997) water supply conditions, water demand projections to 2010, preliminary design of facilities and equipment, cost estimates and construction plan, organisation and management, environmental impact assessment, financial and economic evaluation and conclusions and recommendations.

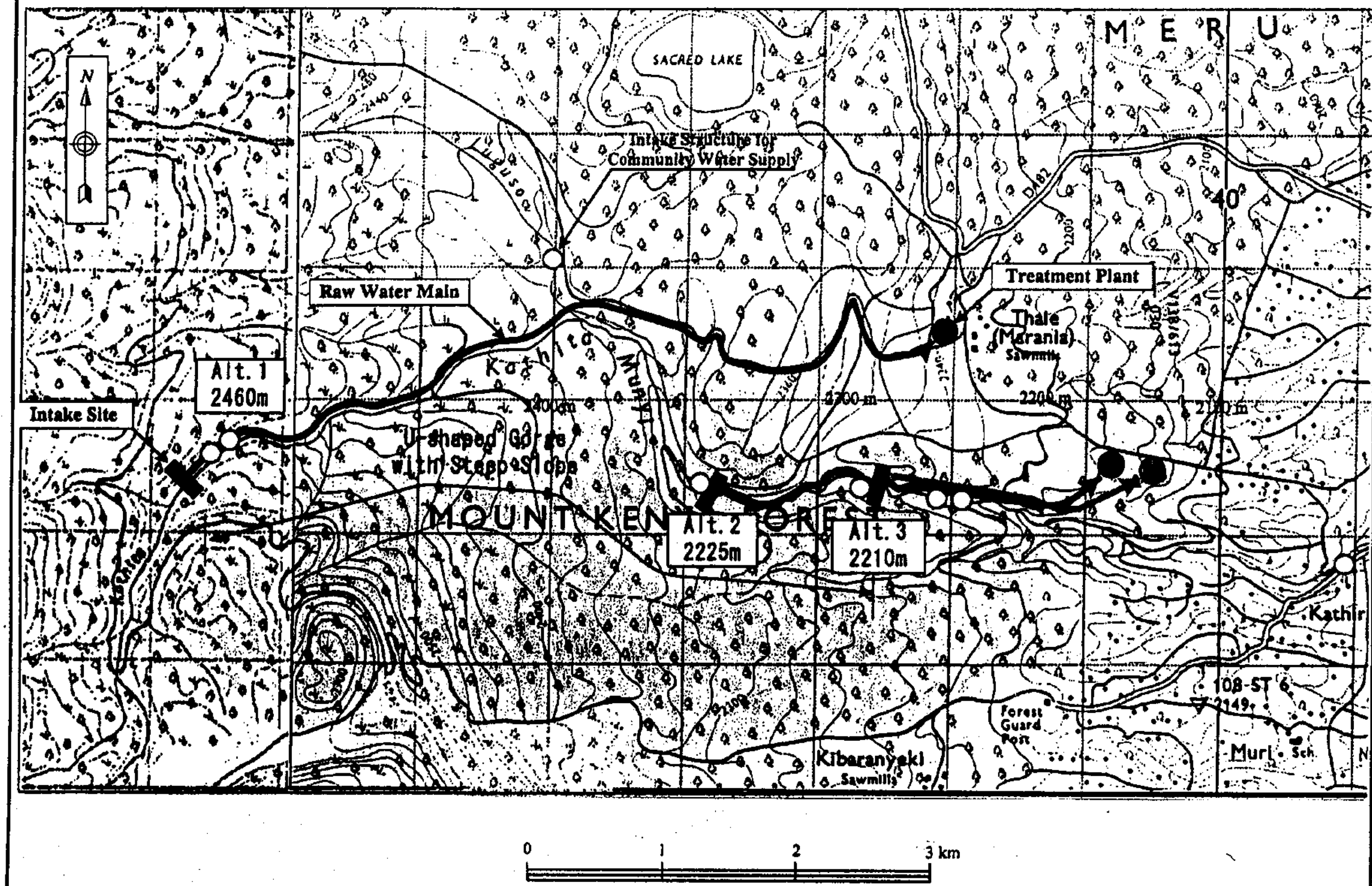
The investment costs of construction of a new gravity water supply system, with a new raw water intake on the Kathita River, new 10,000 m^3/day treatment works, storage facilities, distribution network, etc. was estimated to be approximately US$ 16.5 million.

In May 2000 JICA produced a Technical Note on the basic design study of Meru water supply. The format of the note followed the findings and recommendations of the above feasibility study but sought to clarify the following components:

- the improvement of managerial issues of an implementing organisation in terms of operations and maintenance, leakage reduction and revenue recovery essential for the sustainability of the project,
- the involvement of community water supplies in the project,
- a review of water demand projections based on the latest socio-economic based information, especially data from the 1999 census,
- the technical viability of the proposed intake and raw water transmission pipeline in the Mt. Kenya forest,
- clarification of distribution zones and the undertaking by GOK in provision of house connections and communal water points.

Alternative intake points on the Kathita River and sites for treatment works were identified and are shown on Fig. 4.1.

The contents of the above mentioned reports are very detailed, and this report is concentrated on the identification of immediate rehabilitation works, therefore it is considered that no further comment on the expansion of Meru water supply is necessary.



Client
JAPAN INTERNATIONAL CO-OPERATION AGENCY

GIBB Eastern Africa
LAWGIBB Group Member

Project Title
TEN TOWNS WATER SUPPLY & SANITATION STUDY

Drawing Title
MERU TOWN WATER SUPPLY

ALTERNATIVE NTAKE SITES

Date	Fig No.
JAN 2001	4.1

4.5 O&M COSTS AFTER REHABILITATION

Table 4.4 Cost estimates for O&M activities for Meru water supply

Ref	Description	Unit	Amount (Kshs)
1.	**Capital costs**		
1.1	Management consultancy (2 years)	sum	36,000,000
1.2	Vehicles, office equipment, etc.	sum	13,400,000
	Sub-total		**49,400,000**
2.	**Recurrent costs (monthly)**		
2.1	Salaries and allowances	sum	1,500,000
2.2	Electricity charges	sum	500,000
2.3	Chemical charges	sum	250,000
2.4	Vehicle running costs & maintenance	sum	150,000
2.5	Office running costs	sum	100,000
2.6	Housing maintenance	sum	100,000
	Sub-total		**2,600,000**
3.	**Spare parts (for 1 year)**		
3.1	Pipes	sum	1,000,000
3.2	Fittings	sum	200,000
3.3	Valves	sum	250,000
3.4	Meters		
3.4.1	bulk	sum	500,000
3.4.2	domestic	sum	2,000,000
3.5	Pumps		
3.5.1	impellers	sum	1,000,000
3.5.2	seals	sum	100,000
3.5.3	packing	sum	100,000
3.6	Electric motors, re-winding	sum	250,000
3.7	Pump controls, relays, MCBs, etc.	sum	250,000
3.8	Dosing equipment, spares	sum	200,000
	Sub-total		**5,850,000**