JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF LOCAL AUTHORITIES
KISUMU MUNICIPAL COUNCIL
THE REPUBLIC OF KENYA

THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM IN THE REPUBLIC OF KENYA

FINAL REPORT

Volume 2

Master Plan

September 1996

NIHON SUIDO CONSULTANTS CO., LTD.
NIPPON KOEI CO., LTD.

No.

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PREFACE

In response to a request from the Government of the Republic of Kenya, the Government of Japan decided to conduct a master plan and feasibility study on the Kisumu Water Supply and Sewerage System in the Republic of Kenya and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kenya a study team headed by Mr. Ichiro Yokota, Nihon Suido Consultants Co., Ltd., and Nippon Koei Co., Ltd., three times between July 1997 and July 1998.

The team held discussions with the officials concerned of the Government of Kenya, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Kenya for their close cooperation extended to the team.

September, 1998

Kimio Fujita
President
Japan International Cooperation Agency

September, 1998

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We are pleased to submit this Final Report on Kisumu Water Supply and Sewerage System of the Republic of Kenya. This report incorporates the views and suggestions of the authorities concerned of the Government of Japan, including your Agency. It also includes the comments made by the Ministry of Local Authorities, Kisumu Municipal Council and other government agencies concerned in the Republic of Kenya during the meetings organised by Project Steering Committee in Nairobi where the Draft Final Report was discussed.

The Final Report comprises a total of five volumes as listed below.

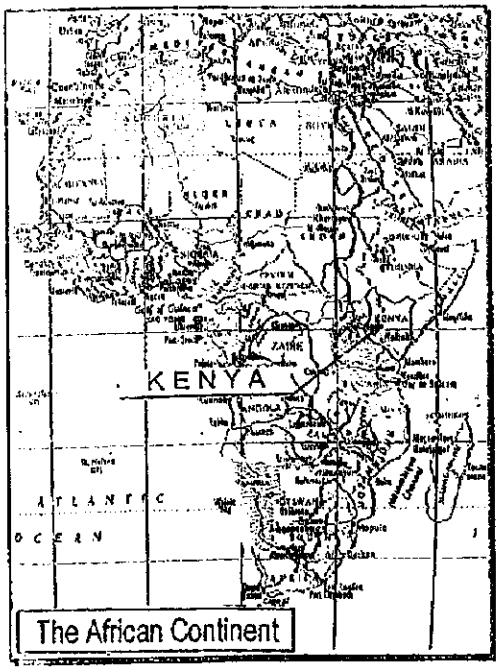
Volume 1: Executive Summary
Volume 2: Master Plan
Volume 3: Feasibility Study of Phase I Project
Volume 4: Appendices (1)
Volume 5: Appendices (2)

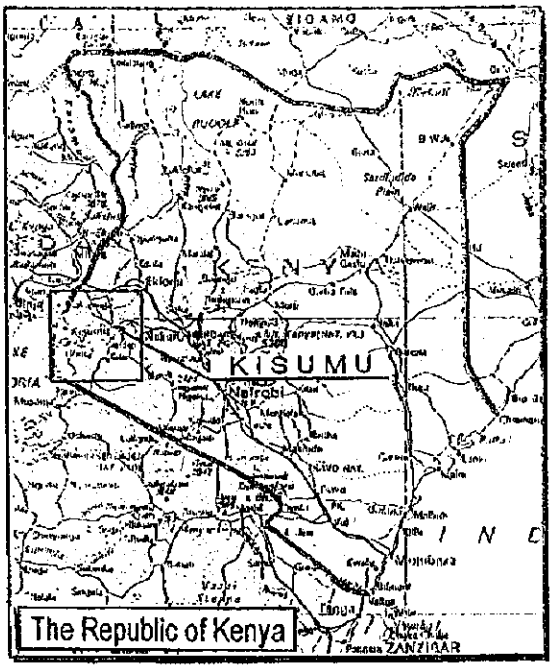
This report forms Volume 2 and contains the Study Team's findings, conclusions and recommendations derived from the Phase 1 Study, of which main objective was to investigate current situations, to formulate a long term master plan and to identify priority projects which will be examined the feasibility during the next course of the Phase 2 Study.

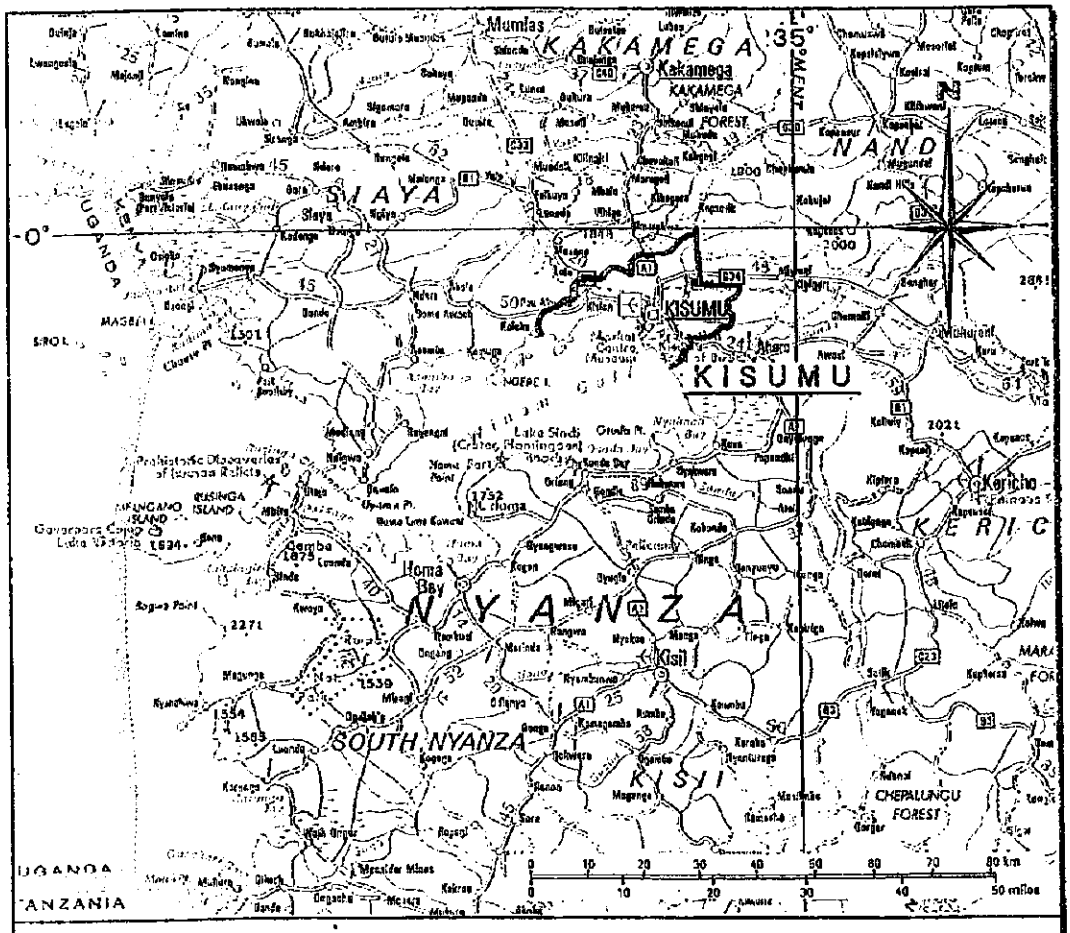
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Welfare of the Government of Japan for their valuable advice and suggestions. We would also like to express our deep appreciation to the relevant offices of the Ministry of Local Authorities, Kisumu Municipal Council and other agencies of the Republic of Kenya for their cooperation and assistance extended to us throughout our Study.

Very truly yours,

Ichiro YOKOTA
Team Leader, Study on Kisumu
Water Supply and Sewerage System
in the Republic of Kenya







Location Map : Kisumu Municipality in the Republic Kenya

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Location Map

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF LOCAL AUTHORITIES
KISUMU MUNICIPAL COUNCIL
THE REPUBLIC OF KENYA

THE STUDY
ON
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LIST OF ABBREVIATIONS AND ACRONYMS USED

ORGANISATIONS

ALGE	-	Association of Local Government Employers
DDC	-	District Development Committee
DFID	-	Department for International Development of United Kingdom (formerly ODA-Overseas Development Administration)
DPM	-	Directorate of Personnel Management
ESAMI	-	East and South Africa Management Institute
FIDIC	-	International Federation of Consulting Engineers
GOJ	-	Government of Japan
GOK	-	Government of the Republic of Kenya
GTZ	-	Deutsche Gesellschaft fur Zumasammenarbeit (German Agency for Technical Cooperation)
HDD	-	Housing Development Department of Kisumu Municipal Council
HLR	-	Housing Loan Department of Kisumu Municipal Council
IDA	-	International Development Agency
IUCN	-	International Union for Conservation of Nature
JICA	-	Japan International Cooperation Agency
JKUAT	-	Jomo Kenyatta University of Agriculture and Technology
KARI	-	Kenya Agricultural Research Institute
KCCT	-	Kenya College of Communication Technology
Ken U.	-	Kenyatta University
KEWI	-	Kenya Water Institute
KfW	-	German International Development Bank
KIA	-	Kenya Institute of Administration
KIM	-	Kenya Institute of Management
KLGWU	-	Kenya Local Government Workers Union
KMC	-	Kisumu Municipal Council
KMFRI	-	Kenya Marine and Fisheries Research Institute
KPLC	-	Kenya Power and Lighting Company
LBDA	-	Lake Basin Development Authority
LGLA	-	Local Government Loan Agency
LVWT	-	Lake Victoria Wetlands Team
MMI	-	Modern Management Institute
MoiU	-	Moi University

MOLA	-	Ministry of Local Authorities (former Ministry of Local Government)
MOWR	-	Ministry of Water Resources
NEMA	-	National Environmental Management Authority
NES	-	National Environmental Secretariat
NWCPC	-	National Water Conservation and Pipeline Corporation
OECF	-	Overseas Economic Cooperation Fund of Japan
ONRI	-	Netherlands Association of Consulting Engineers
OSIENALA	-	Friends of Lake Victoria
PSC	-	Public Service Commission
SIDA	-	Swedish International Development Agency
UDD	-	Urban Development Department of Ministry of Local Government
UNai	-	University of Nairobi
UNICEF	-	United Nations Children's Fund
UNDP	-	United Nations Development Programme
WAB	-	Water Apportionment Board
W&S Dept.	-	Water and Sewerage Department of Kisumu Municipal Council
WRB	-	Water Resources Board
WSOU	-	Water and Sanitation operations Unit of Ministry of Local Government

PROGRAMMES AND PROJECTS

CSRP	-	Civil Service Reform Programme
GEF	-	Global Environmental Facility
KLGRP	-	Kenya Local Government Reform Programme
KMRP	-	Kenya Municipal Reform Programme
LVEMP	-	Lake Victoria Environmental Management Programme
NEAP	-	National Environmental Action Plan
NWMP	-	National Water Master Plan
PAMNUP	-	Partnership Approaches to Meeting the Needs of the Urban Poor
PHRD	-	Policy and Human Resources Development Project
RDWSSP	-	Rural Domestic Water Supply and Sanitation Programme
UWASAM	-	Urban Water and Sanitation Management Project

OTHER ABBREVIATIONS

AC	-	Asbestos Concrete
AP	-	Anaerobic Pond
ASS	-	Atomic Absorption Spectrophotometry
ATP	-	Affordability-to-Pay
B/C	-	Benefit Cost Ratio
BOD	-	Biochemical Oxygen Demand
BOT	-	Build-Operate-Transfer
CBM	-	Cubic Meter
CCTV	-	Closed Circuit Television
Central WTD	-	Central Wastewater Treatment District
COD	-	Chemical Oxygen Demand
Conventional STW	-	Conventional Sewage Treatment Works
DIP	-	Ductile Iron Pipe
DO	-	Dissolved Oxygen
DR	-	Distribution Reservoir
DSR	-	Debt Service Ratio
Eastern WTD	-	Eastern Wastewater Treatment District
EIA	-	Environmental Impact Assessment
EIRR	-	Economic Internal Rate of Return
EL	-	Elevation
F/C	-	Foreign Currency Portion
FIRR	-	Financial Internal Rate of Return
FP	-	Facultative Pond
F/S	-	Feasibility Study
FTT	-	Flavour Threshold Test
GDP	-	Gross Domestic Product
G. L.	-	Ground Level
GM	-	General Manager
GMS	-	Galvanised Mild Steel
GRP	-	Glass Reinforced Plastic
HP	-	Horse Power
HRD	-	Human Resources Development
HWL	-	High Water Level
IEA	-	Initial Environmental Assessment
IEE	-	Initial Environmental Examination
IER	-	Initial Environmental Report

IRR	-	Internal Rate of Return
Kajulu WTW	-	Kajulu Water Treatment Works
Kanyakwar DR	-	Kanyakwar Distribution Reservoir
Kibuye DR	-	Kibuye Distribution Reservoir
Kibuye WTW	-	Kibuye Water Treatment Works
Kogony DR	-	Kogony Distribution Reservoir
Lake WTW	-	Lake Water Treatment Works
LA	-	Local Authority
L/C	-	Local Currency Portion
MC	-	Municipal Council
MGD	-	Million Gallons (English) per Day
M/P	-	Master Plan
MP	-	Maturation Pond
MSL	-	Above Mean Sea Level
ND	-	Not Detectable
NGO	-	Non-Governmental Organisation
NPV	-	Net Present Value
NTU	-	Nephelometric Turbidity Units
NRW	-	Non-Revenue Water
Nyalenda STW	-	Nyalenda Sewage Treatment Works
O/M	-	Operation and Maintenance
Otongolo STW	-	Otongolo Sewage Treatment Works
PAO	-	Public Administration Officer
PDWF	-	Peak Dry Weather Flow
PS	-	Pumping Station
PSP	-	Private Sector Participation
PST	-	Primary Sedimentation Tank
PVC	-	Poly Vinyl Chloride
RCP	-	Reinforced Concrete Pipe
SCF	-	Standard Conversion Factor
SDB	-	Sludge Drying Bed
SDT	-	Sludge Digester Tank
SP	-	Steel Pipe
SS	-	Suspended Solids
STW	-	Sewage Treatment Works
TDS	-	Total Dissolved Solids
TF	-	Trickling Filter
T-N	-	Total Nitrogen

TOR	-	Terms of Reference
T-P	-	Total Phosphorous
TS	-	Total Solids
UFW	-	Unaccounted for Water
uPVC	-	Unplasticised Poly Vinyl Chloride
VAT	-	Value Added Tax
VIP Latrine	-	Ventilated Improved Pit Latrine
Western WTD	-	Western Wastewater Treatment District
WSP	-	Waste Stabilisation Ponds
WTP	-	Willingness-to-Pay
WTD	-	Wastewater Treatment District
WTW	-	Water Treatment Works

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Being the third largest town in Kenya, Kisumu is the Provincial Headquarters for Nyanza Province and the District Headquarters for Kisumu District. The town has considerable strategic importance for the re-establishment of meaningful East African Cooperation. It is connected to the rest of Kenya by air services and a network of roads, it is a railhead and has connecting lake steamer services to Entebbe in Uganda and Mwanza in Tanzania.

There has been considerable expansion of the industrial sector in Kisumu, but this is being constrained by lack of an adequate water supply. The Government of the Republic of Kenya (GOK) recognises that water is a primary input for industrial transformation which is high on its priority list. In addition, a safe water supply and adequate sewerage system is a vital necessity for the health and wellbeing of an increasing population to man the industrial expansion.

The need for a water supply and sewerage system in Kisumu is amply demonstrated by the foregoing, bearing in mind that the level of service in the town is currently about 40 % of what is necessary to afford the population a decent and healthy lifestyle, and that there have been several outbreaks of cholera and many reported cases of other water-related diseases, such as typhoid and amoebiasis in Kisumu in recent years.

The GOK has in recent years presented its direction in economic reforms by the publication of Policy Framework Paper on Economic Reforms (February 1996) and Sessional Paper No.2 on Industrial Transformation to the Year 2020 (1996) covering the whole spectrum of infrastructure development. This was culminated by the launch of the 8th National Development Plan covering the period 1997-2001. The theme of the Plan is Rapid Industrialisation for Sustainable Development, and thus the Plan focuses its attention on industrialisation as a strategy for achieving rapid and sustained economic growth. These papers and the Plan demonstrate the government's commitment to address concerns in all sectors, including the water sector.

With respect to the water sector, the government estimates that by 1994 there were about 1,780 water supplies under major operators countrywide, and that 75 % of the country's urban population and 50 % of the rural population have access to potable water. The government recognises that an adequate and reliable supply of clean water in both urban and rural areas is an essential requirement not only for industrial establishments but also in all sectors of the economy, and that there is the need for a comprehensive investment plan for the rehabilitation and expansion of existing water supply and sewerage services.

Against the background mentioned above, the Government of the Republic of Kenya made an official request to the Government of Japan (GOJ) concerning the needs of Kisumu.

In response to the request of the GOK, the Japanese Preparatory Study Team sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA") visited Kenya from 18th to 31st January, 1997. The objectives of the Team was to discuss the Scope of Work for the Study on Kisumu Water Supply and Sewerage System in the Republic of Kenya (hereinafter referred to as "the Study").

Through a series of discussions with the Kenyan authorities concerned such as the Ministry of Local Authorities (the former Ministry of Local Government, hereinafter referred to as "MOLA") and Kisumu Municipal Council (hereinafter referred to as "KMC"), the implementing arrangement termed "The Scope of Work for the Study on Kisumu Water Supply and Sewerage System in the Republic of Kenya (hereinafter referred to as "the Scope of Work" or "S/W")" was agreed upon between the Kenyan authorities and JICA on 30th January 1997. The Scope of Work and the Minutes of Meeting on S/W are compiled in Appendix T.

JICA entrusted implementation of the Study, based on the Scope of Works, to a consortium of Japanese consultants (hereinafter referred to as "the JICA Study Team") comprising Nihon Suido Consultants Co., Ltd. as the managing company and Nippon Koei Co., Ltd. This consortium was selected through open tendering in Japan.

1.2 OBJECTIVES OF THE STUDY

The objectives of the Study are as follows:

1) to formulate a Master Plan for Kisumu Water Supply and Sewerage System up to the target year 2015
2) to conduct a Feasibility Study on the Priority Project identified in the Master Plan
3) to pursue technology transfer to the Kenyan counterpart personnel in the course of the Study

1.3 THE STUDY AREA

The Study Area is limited to the administrative area of Kisumu Municipality but not limited to the site for the water resource development, as shown in Figure 1-1. Kisumu Municipality with a

land area of 297 km2 consists of twenty six sub-locations.

1.4 OVERALL FRAMEWORK OF THE STUDY

The Study comprises two phases. The first phase was completed in 1997 and the second phase in 1998. The overall work schedule of the Study is presented in Figure 1-2.

(1) Phase 1: Formulation of a Master Plan

Phase 1 comprised the first field survey in Kenya from 27th July 1997 to 24th October 1997 and the subsequent home work in Japan from 25th October 1997 to 23rd November 1997.

The scope of work under Phase 1 included the following:

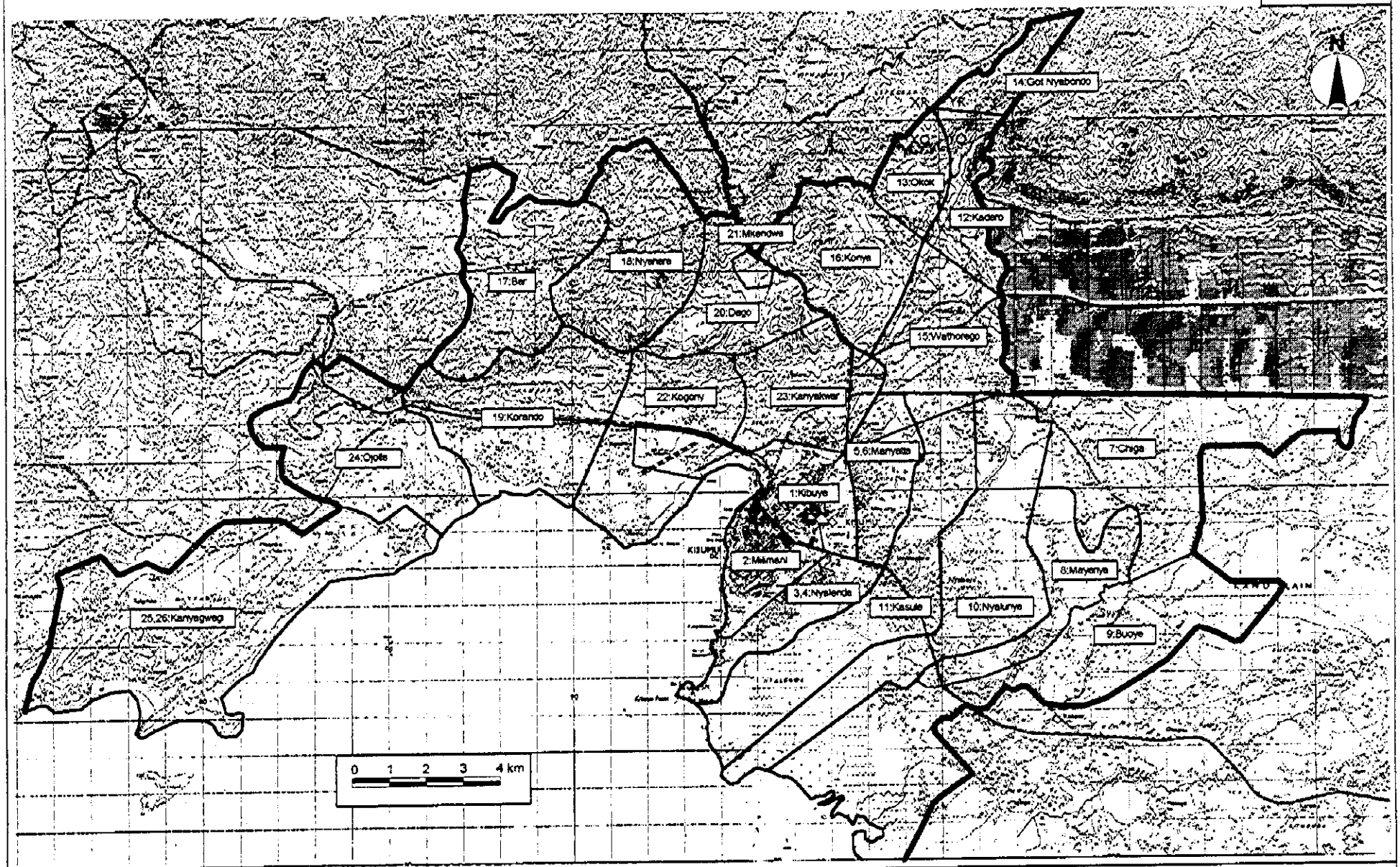
- collection and analysis of existing data and information on the water supply and sewerage sector in Kenya and the Study Area
- understanding of existing services
- preliminary field surveys and analysis
- formulation of a Master Plan
- identification of a Priority Project/s

(2) Phase 2: Feasibility Study on Priority Project

Phase 2 comprises the second field survey in Kenya from 10th January 1998 to 25rd March 1998 and the subsequent home work in Japan from 11th May 1998 to 15th June 1998, as well as the third field survey in Kenya from 21st June 1998 to 5th July 1998 and the subsequent home work in Japan from 4th August 1998 to 15th August 1998.

During Phase 1, a Priority Project was identified and agreement was reached with the Kenyan authorities that it should be the subject of subsequent Feasibility Study. The scope of work under Phase 2 centers around Feasibility Study of the Priority Project which includes an environmental impact assessment of the proposal, plans for institutional development, proposals for implementation, cost estimates, a financial analysis of the proposed scheme and an overall evaluation and recommendations concerning implementation.

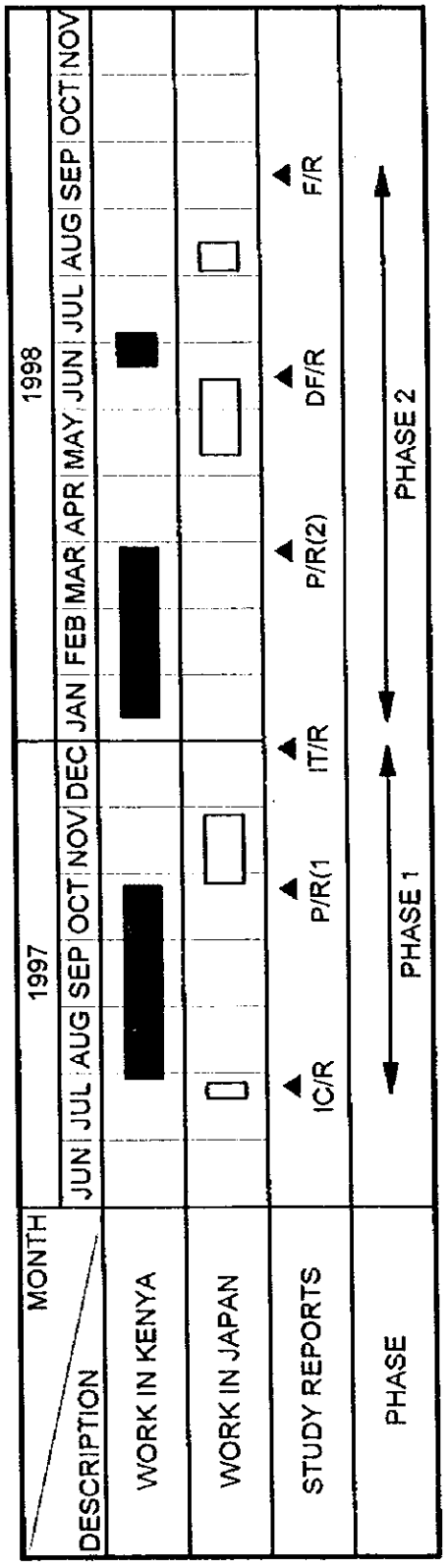
Figure 1-1



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Study Area

Figure 1-2

WORK SCHEDULE



NOTE IC/R : Inception Report P/R : Progress Report IT/R : Interim Report
DF/R : Draft Final Report F/R : Final Report

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION	TITLE : WORK SCHEDULE

(3) Study Milestones

Various reports which have been produced by the JICA Study Team during Phases 1 and 2 form key milestones for the Study. These reports and their respective dates are as follows:

Inception Report	: July 1997
Progress Report (1)	: October 1997
Interim Report	: December 1997
Progress Report (2)	: March 1998
Draft Final Report	: June 1998
Final Report	: September 1998 (This report)

The first five reports have already been issued and discussed with the Kenyan authorities during the following meetings:

Meetings on Inception Report	: 29th and 30th July 1997 and 4th August 1997
Meetings on Progress Report (1)	: 16th and 20th October 1997
Meetings on Interim Report	: 15th, 16th and 21st January 1998
Meetings on Progress Report (2)	: 12th, 19th and 22nd March 1998
Meetings on Draft Final Report	: June 1998

The minutes of these meetings are compiled in Appendix T.

1.5 STUDY MANAGEMENT STRUCTURE

The management structure for the Study is shown in Figure 1-3.

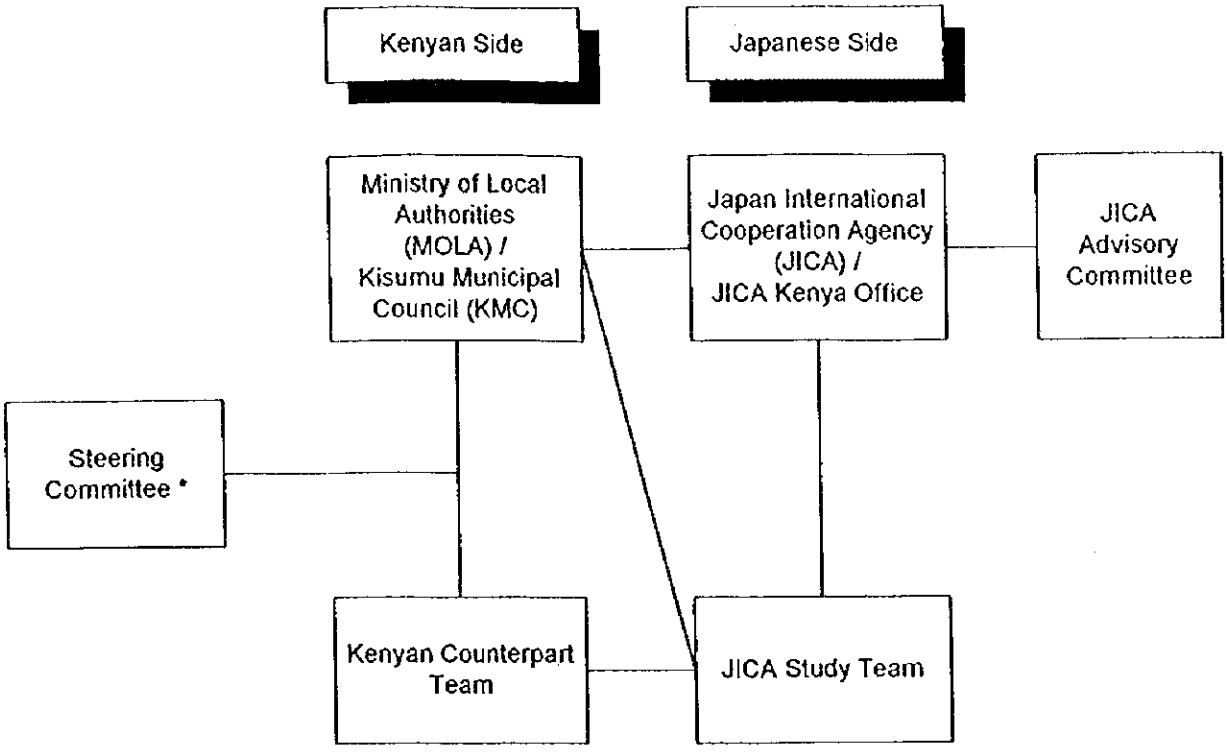
- Steering Committee

This committee is organised by the Kenyan authorities to formulate basic policies for the Study and to coordinate Kenyan institutions concerned. Representation in the committee is shown in Figure 1-3.

- Kenyan Counterpart Team

This team comprises officials from MOLA and KMC and is formed to facilitate technical transfer and to assist the JICA Study Team in conducting field surveys in Kenya.

Figure 1-3



* Steering Committee consists of representatives from :

Ministry of Local Authorities (MOLA)
Kisumu Municipal Council (KMC)
Ministry of Land Reclamation, Regional and Water Development (MLRRWD)
Ministry of Health
Ministry of Environment and Natural Resources
Ministry of Agriculture, Livestock Development and Marketing
Lake Basin Development Authority
Ministry of Tourism and Wildlife
Kenya Railways
Kenya Breweries (Kisumu)

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Study Management Structure

- JICA Advisory Committee

This committee is organized by JICA to extend technical advice on all aspects of the Study.

1.6 COMPOSITION OF THE FINAL REPORT

The Final Report comprises a total of five volumes. They are as follows:

Volume 1: Executive Summary
Volume 2: Master Plan
Volume 3: Feasibility Study of Phase I Project
Volume 4: Appendices (1)
Volume 5: Appendices (2)

The Executive Summary contained in Volume 1 summarises the conclusions and recommendations of the Study as a whole. Volume 2 and Volume 3 are self-contained so as to facilitate access by those concerned with only individual parts of the overall study. Volumes 4 and 5 compile all the supporting and back-up information with respect to Volumes 2 and 3.

This Report forms Volume 2 of the Final Report and is concerned with the Master Plan.

1.7 ACKNOWLEDGEMENTS

Many organisations and agencies have extended excellent support to the Study and contributed to the work of the Study Team. Whilst taking responsibility for this report, the Study Team wishes to acknowledge the help and support of the following:

(1) Japanese Government

- Embassy of Japan in Kenya
- JICA Head Office
- JICA Kenya Office
- JICA Advisory Committee

(2) Ministry of Local Authorities

- Urban Development Department
- Provincial Office in Nyanza Province

(3) Kisumu Municipal Council (KMC)

- KMC-Management
- Water and Sewerage Committee
- Water and Sewerage Department

(4) Other Agencies and Organisations

- Ministry of Land Reclamation, Regional and Water Development (MLRRWD)
- Ministry of Health
- Ministry of Environment and Natural Resources
- Ministry of Agriculture, Livestock Development and Marketing
- Lake Basin Development Authority
- Ministry of Tourism and Wildlife
- Kenya Railways
- Kenya Breweries in Kisumu

CHAPTER 2

STUDY AREA

2. STUDY AREA

2.1 NATURAL CONDITIONS

2.1.1 Topography

Kisumu District is located between the Kendu-Nyabondo Escarpment in the south and Nyando Escarpment in the north. In the middle, the area forms a very flat low-lying alluvial plain known as Kano Plain with the elevation between EL 1,135 m and 1,300m.

Kisumu Municipality is bordered by the Nyando escarpment in the north; the elevation above the escarpment exceeds EL 1,500 m. The southwestern part consists of piedmont narrow plain bordering on the Winam Gulf. The eastern part falls onto the low-lying Kano Plain. The Kisumu old town is located on a hill lying to the east of Kisumu Bay with the elevation from around EL 1,160 m to 1,200 m.

2.1.2 Meteorology

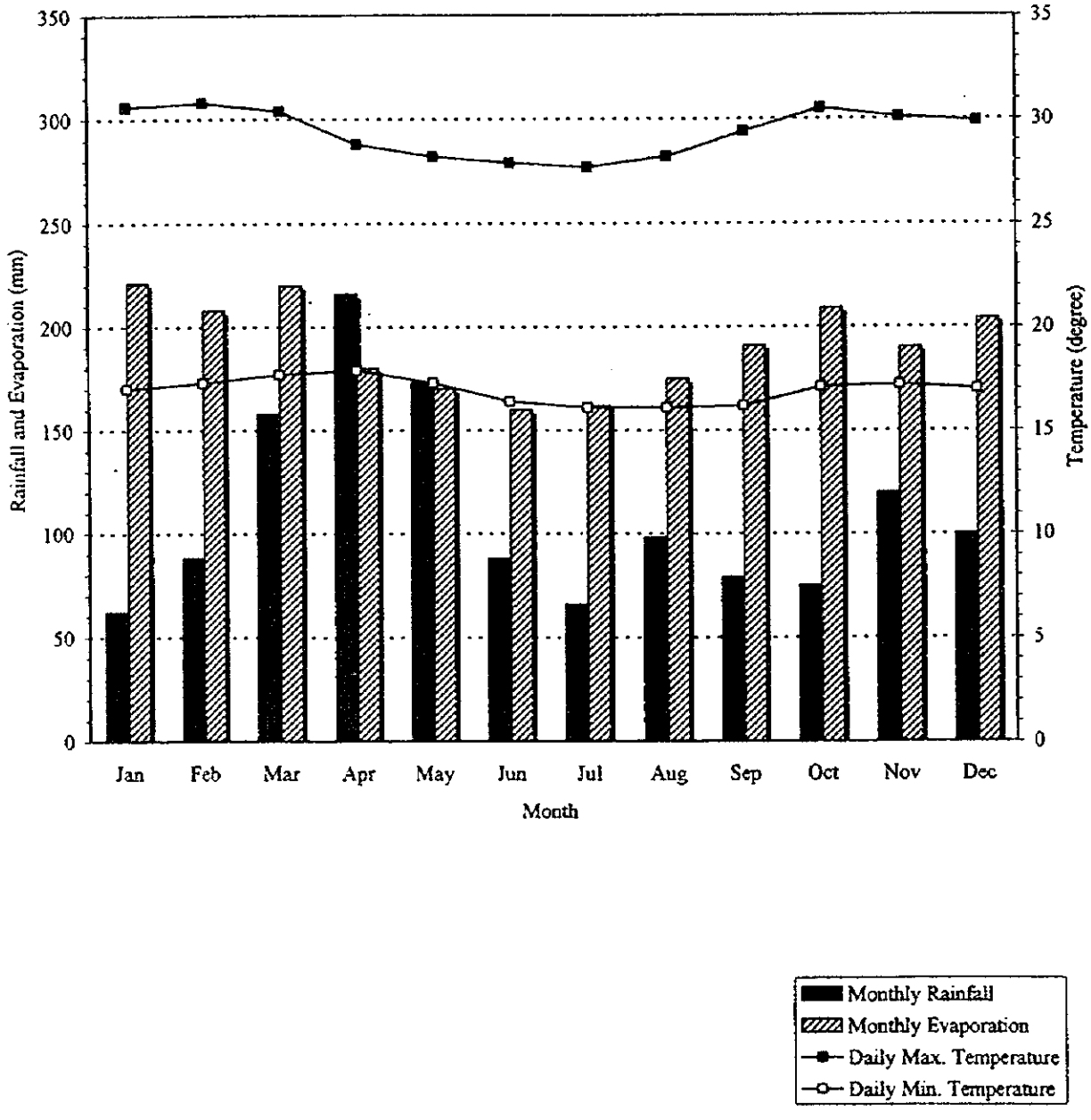
General meteorological conditions observed at Kisumu Airport Meteorological station are shown in Figure 2-1. An isohyetal map covering the Lake Basin area is shown in Figure 2-2.

Annual rainfall is influenced by the local topography, varying from over 1,800 mm in the northern plateau and around 1,200 mm on the Winam Gulf. About 40 % of annual rainfall is measured during the first rainy season from March to May; the second rainy season from November to December is indistinct.

2.1.3 Geology

Figure 2-3 shows geological conditions in and around the Kisumu municipal area.. The area can be divided into three zones from a geological viewpoint:

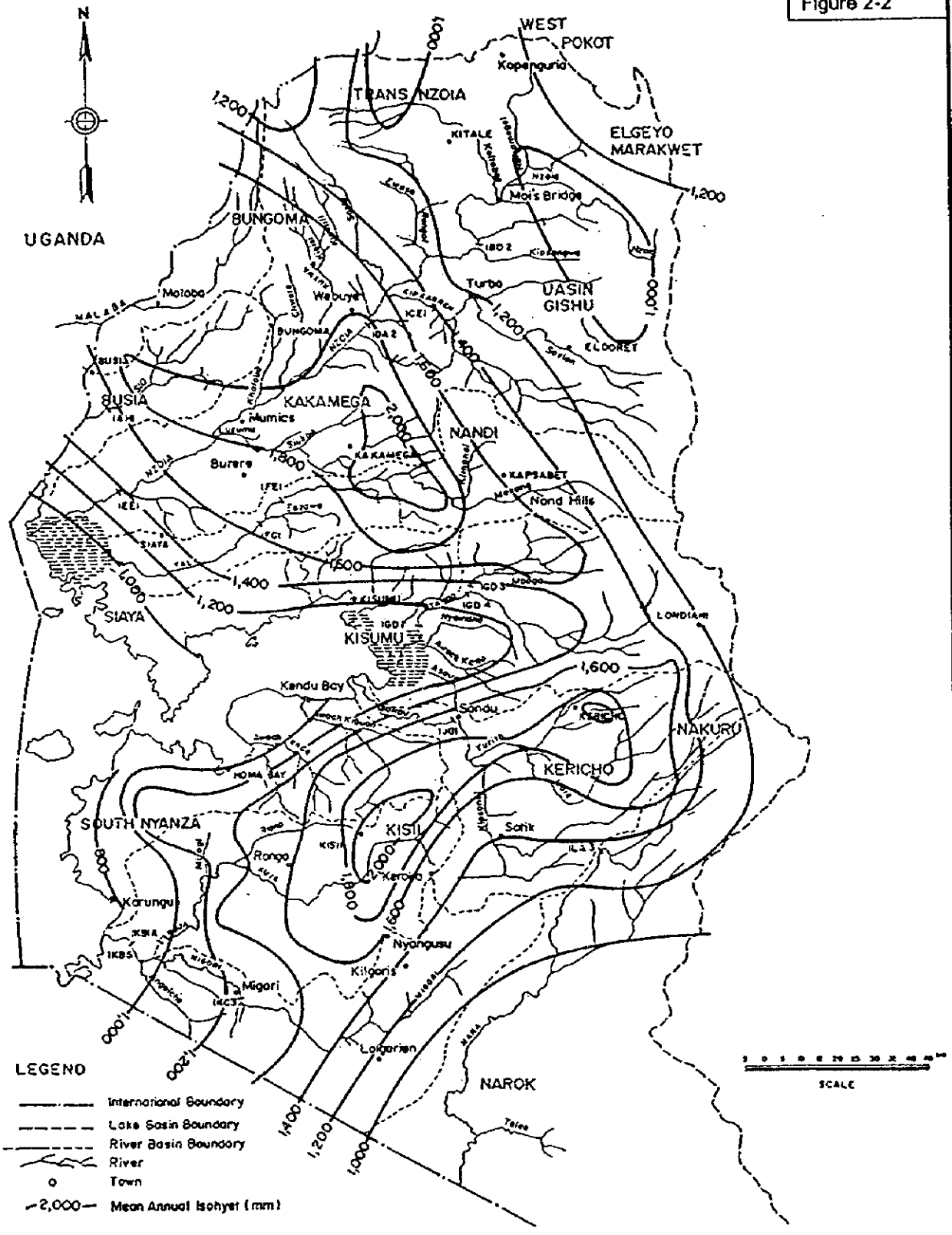
Figure 2-1



Data Source: MOWD (1992, July) "The Study on the National Water Master Plan - Data Book (DB.1) Hydrological Data (Study Supporting Data)". JICA.

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Meteorological Condition in Kisumu

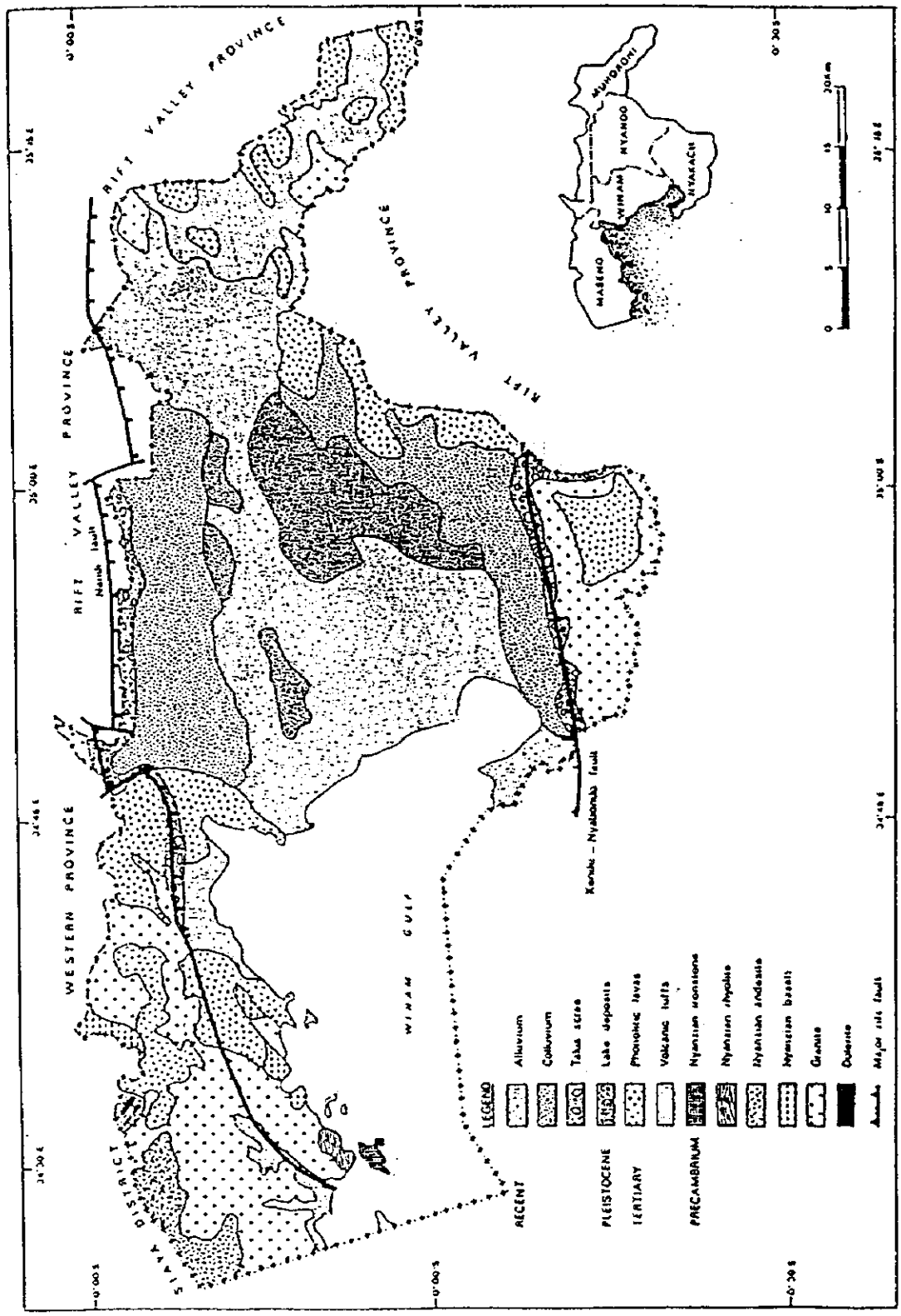
Figure 2-2



Source: LBDA (1987, October) "The Study of Integrated Regional Development Master Plan for the Lake Basin Development Area - Final Report Vol. 5, Sector Report 3, Water Resources/Transportation/Energy". JICA.

THE REPUBLIC OF KENYA	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM	TITLE Isohyetal Map of Lake Basin
THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	JAPAN INTERNATIONAL COOPERATION AGENCY	

Figure 2-3



Source; MOLG (1988, March) "Kisumu Water Supply and Sanitation Study - Feasibility Study, Vol. II A, Background Papers 1-9". JI P Gauff Gmbh & Co Consulting Engineers.

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Geological Map

(1) High Plateau

This is largely composed of a pre-Cambrian suite comprising Kavirondian and Nyanzian sediments. To the northeast of the Study Area are truncated by the NNW-SSE trending Nandi fault. In the vicinity of Kisumu and the Kisyan-Nyando scarps, a Tertiary lave flow was extruded over the granite terrain contemporaneously with the down faulting of the Kavirondo rift. The high plateau area has been extensively faulted and invaded by later intrusions.

(2) Escarpment

These marked features are comprised in the main of dissected granites and represent the walls of the Kavirondo rift system. Down faulting of the rift along well-defined east trending fault lines have produced the spectacular scarp features. Sympathetic faulting is evident in and beyond the scarps but these have been truncated in the northeast by the major Nandi fault.

(3) Lake Victoria and Kano Plain

Beneath the alluvial blanket are the down-faulted granites and Kavirondian/Nyanzian sediments at indeterminate depth. The lake has progressively retreated to the west with the deposition of material carried by the numerous rivers.

2.2 SOCIO-ECONOMIC CONDITIONS

2.2.1 Population

Table 2-1 shows the population census data for 1969, 1979 and 1989. According to 1989 census data, average yearly population growth rate was 5.06% between 1979 and 1989 and the same during the decade from 1969 to 1979 was 3.45%, indicating an increasing trend. Table 2-2 shows the distribution of 1989 census population by gender and sub-location.

2.2.2 Land Use and Economic Activities

The administrative area of Kisumu Municipal Council includes a large rural area and a relatively small town centre. Over 80 % of the administrative area is rural in nature. The municipal area was expanded in 1992 from 268.2 km^2 to 297 km^2 . Figure 2-4 shows the land use existed in 1995 prepared by the Ministry of Planning and National Development.

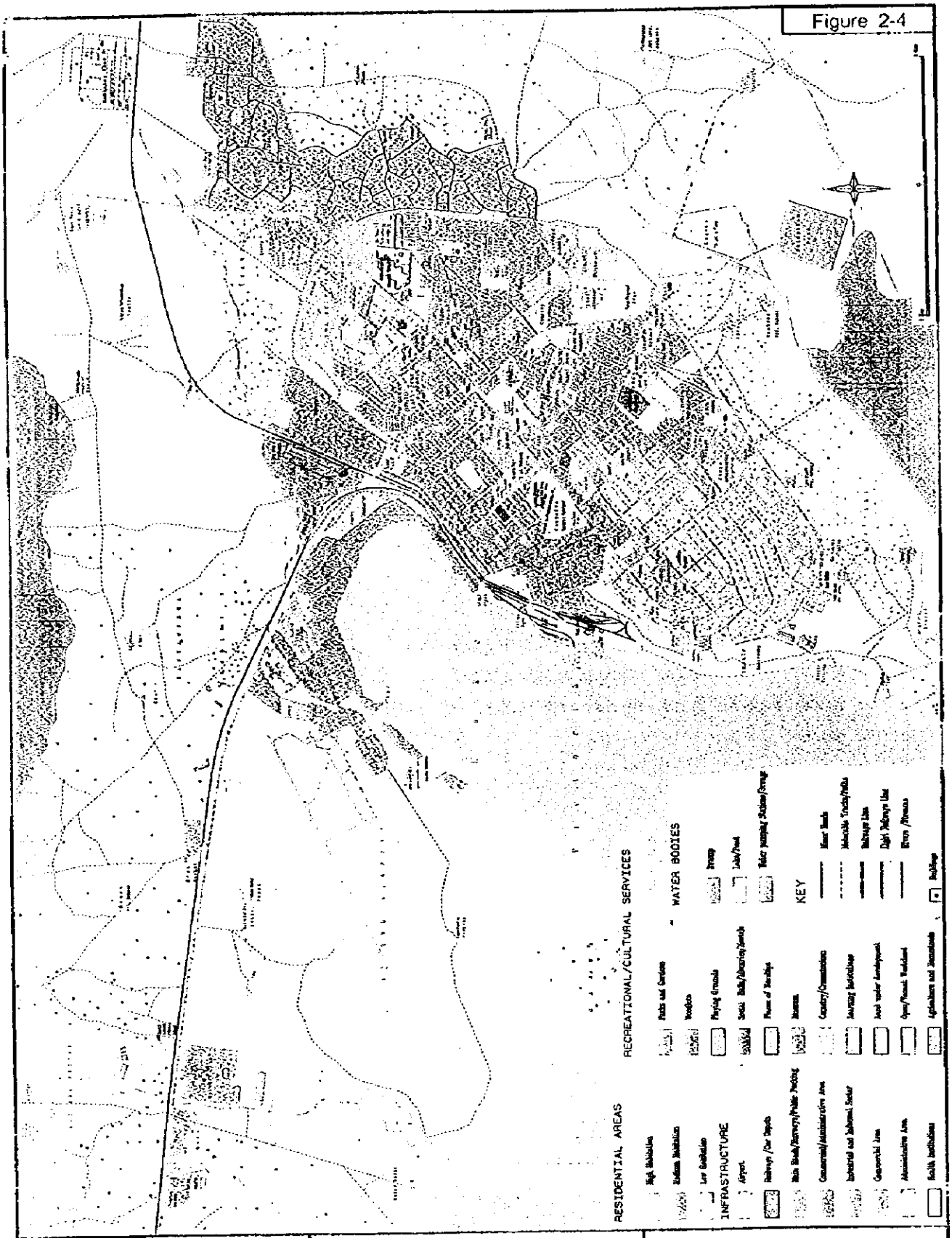
Table 2-1 Population Growth Rates in Kisumu Municipality (1969, 1979 and 1989 Census)

SUBLOCATION		Category	1969 CENSUS population	population growth rate %	1979 CENSUS population	population growth rate %	1989 CENSUS population
1	Kibuye	Urban					30,074
2	Milimani	Urban	32,431	2.17	40,188	1.34	15,856
3	Nyalenda B	Peri-urban					17,276
4	Nyalenda A	Peri-urban	12,046	6.11	21,788	5.83	21,109
5	Manyatta A	Peri-urban					37,913
6	Manyatta B	Peri-urban	7,942	11.22	23,008	8.52	14,225
7	Chiga	Rural	6,680	-1.78	5,582	1.64	6,571
8	Mayenya	Rural					4,168
9	Buoye	Rural	3,949	2.56	5,084	4.78	3,942
10	Nyalunya	Rural	4,070	0.21	4,155	6.30	7,656
11	Kasule	Rural	3,949	0.89	4,317	1.94	5,230
12	Kadero	Rural					2,951
13	Okok	Rural					2,719
14	Got Nyabondo	Rural	3,393	4.75	5,397	-6.60	2,726
15	Wathorego	Peri-urban	7,676	1.38	8,800	1.68	4,951
16	Konya	Rural	2,637	5.03	4,309	5.04	7,045
17	Bar	Rural	-		-		6,075
18	Nyahera	Rural	-		-		7,717
19	Korando	Peri-urban	7,934	-1.66	6,708	7.15	13,382
20	Dago	Peri-urban	1,677	4.92	2,711	2.76	3,558
21	Mkendwa	Rural	317	3.00	426	3.33	591
22	Kogony	Peri-urban	3,913	5.83	6,897	4.66	10,879
23	Kanyakwar	Urban	5,014	3.61	7,147	9.19	17,215
24	Ojolla	Rural	3,274	2.10	4,031	2.62	5,221
25	Kanyagwegi	Rural	5,711	2.77	7,505	2.78	9,873
Total			**112,613**	**3.45**	**158,053**	**5.06**	**258,923**

Table 2-2 Distribution of Population by Sub-location and Gender (1989 Census)

No.	Sub-location	Males	Females	Total	Area km²	Population Density person/km²
1	Kibuye	14,817	15,257	30,074	11.5	2,620
2	Milimani	8,046	7,810	15,856	5.5	2,880
3	Nyalenda B	9,245	8,031	17,276	4.6	3,760
4	Nyalenda A	11,393	9,716	21,109	2.2	9,600
5	Manyatta A	19,492	18,421	37,913	3.3	11,490
6	Manyatta B	7,632	6,593	14,225	4.0	3,560
7	Chiga	3,194	3,377	6,571	24.7	270
8	Mayenya	2,057	2,111	4,168	11.6	360
9	Buoye	1,913	2,029	3,942	23.6	170
10	Nyalunya	3,689	3,967	7,656	17.4	440
11	Kasule	2,574	2,656	5,230	17.5	300
12	Kadero	1,347	1,604	2,951	6.9	430
13	Okok	1,297	1,422	2,719	4.0	680
14	Got Nyabondo	1,325	1,401	2,726	4.5	610
15	Wathorego	2,514	2,437	4,951	7.6	650
16	Konya	3,481	3,564	7,045	13.3	530
17	Bar	2,933	3,142	6,075	12.1	500
18	Nyahera	3,767	3,950	7,717	16.7	460
19	Korando	7,348	6,034	13,382	20.2	660
20	Dago	1,702	1,856	3,558	11.0	320
21	Mkendwa	304	287	591	1.1	540
22	Kogony	5,571	5,308	10,879	12.8	850
23	Kanyakwar	9,163	8,052	17,215	10.4	1,660
24	Ojolla	2,528	2,693	5,221	17.5	300
25	Kanyagwegi	4,687	5,186	9,873	32.7	300
26	Kanyagwegi				0.9	
Total		132,019	126,904	258,923	297	870

Figure 2-4



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Land Use of Kisumu Town in 1995

The central city has a fairly compact urban form. It consists of the old town area and is surrounded by low income housing areas. The city is surrounded by slums in the south and east. These slum areas have grown rapidly in recent years. The high growth rates of population were accommodated by a corresponding increase in densities.

There has been little expansion in industrial activity in recent years. The industrial activity is dominated by agro-processing and beverages. There is limited activity in other manufacturing activities.

Two resource based industries where large expansion is expected are fisheries and mineral based (soapstone) industries. Agro-processing based on tea, coffee, pyrethrum, sugarcane and cotton is also expected to provide new employment. The distribution of the people employed is given below :

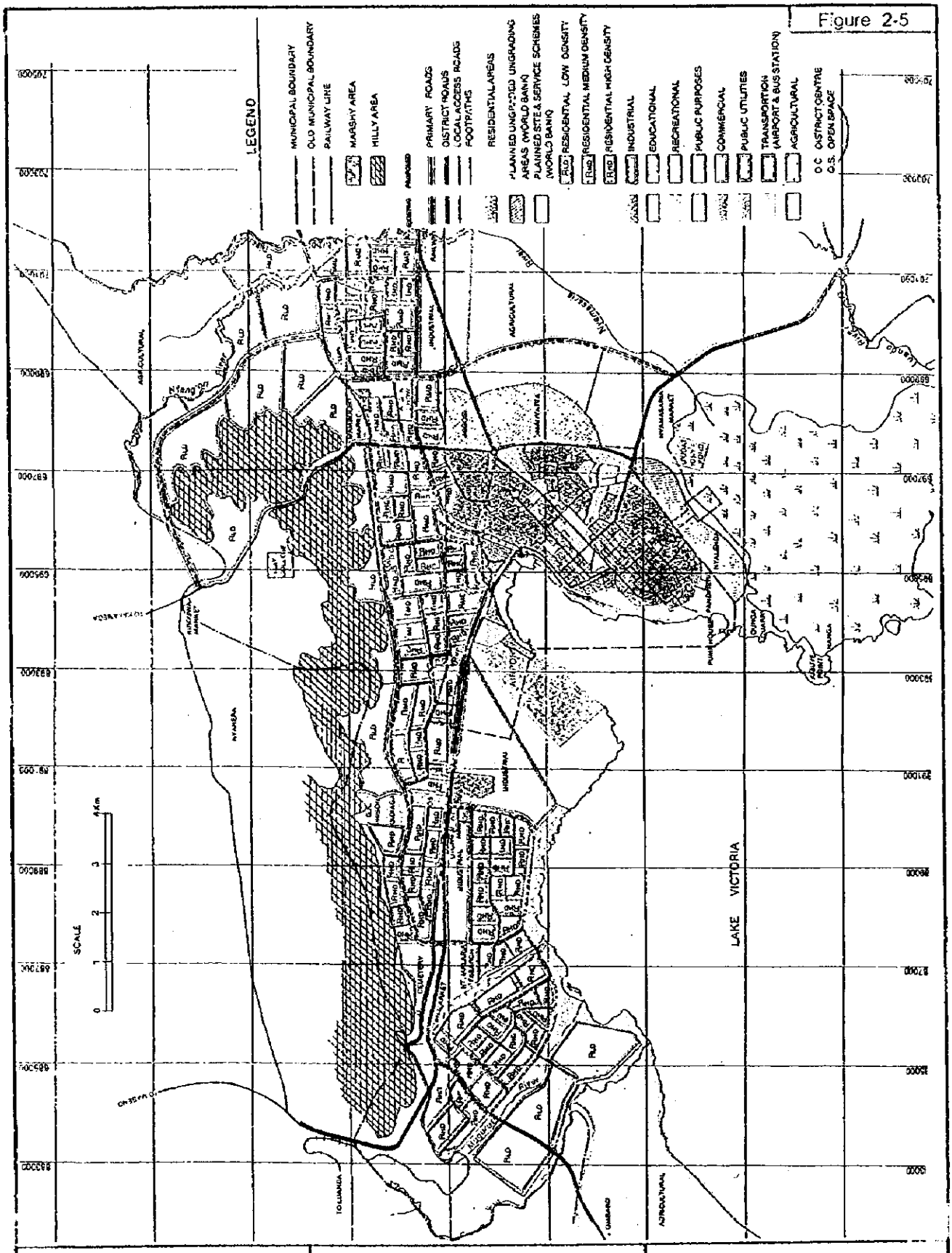
	Kisumu town (% of workers)	
	1969	1979
Manufacturing	19.5	15.2
Communication	14.0	13.7
Construction	17.7	6.5
Transportation and utilities	19.7	10.3
Services	24.4	45.8
Others	4.2	2.3
	100	100

The main impetus for commercial growth is expected to derive from international trade. The dormant East Africa Free trade economic zone has been reactivated in recent years. Kisumu is expected to be a major center for trade with Tanzania and Uganda.

The planned development of both housing and industry/commerce has occurred in the north and east along the lakeshore. The Structure Plan for the Year 2013 prepared by the Kisumu Municipal Council is shown in Figure 2-5. The plan envisages the extent of the future urban growth, as well as the directions of development.

The dominance of administrative functions is also reflected in the land use pattern. Institutional development has required large urban tracks. The land area occupied by major institutional users such as schools and hospitals, and commercial activities is expected to exceed that of industry in the year 2013. The Structure Plan has allocated 873 ha to industry to accommodate growth up to the year 2013 while the same to institutional land use is 1,115 ha.

Figure 2-5



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Structure Plan of Kisumu Municipal Council in 2013

2.2.3 Public Health

Public health situation in Kisumu Municipality is shown in Table 2-3 in terms of disease cases reported. Malaria is endemic to this area. Water-borne diseases like typhoid, diarrhoea, dysentry etc. are the most common diseases affecting the population.

Table 2-3 Number of Reported Cases of Diseases in Kisumu Municipality

Disease	1990	1991	1992	1993	1994	1995
Malaria	67,041	60,130	55,850	57,341	46,970	70,784
Dysentry	15,800	21,900	25,300	12,341	17,360	10,301
Typhoid fever	4,160	4,580	5,130	6,729	7,100	5,514
Amoebiasis	5,630	3,024	3,820	4,691	3,500	5,755
Intestinal Worms	1,708	890	1,050	1,130	1,250	1,560
Billharzia	150	380	225	315	345	383
Infective Hepatitis	110	210	157	515	129	212
Salmonellosis	492	635	875	715	61	1,394
Brucellosis	168	115	160	114	57	135
Filariasis	26	30	41	39	35	38

Source : Public Health Department, KMC

Other than above, several outbreaks of cholera occurred in recent years and public health situation in Kisumu Municipality is pathetic. During the first study period, in the second week of October 1997, in Kisumu and in adjacent areas, several deaths and infections were reported. Most of the victims came from Kibos, Nyamasaria, Manyatta, Nyalenda, Obunga and Nyawita. Unavailability of safe water in sufficient quantities is considered to be one of the causes of the outbreaks. Other causes are unsanitary conditions, resulting from poor garbage management, wastewater disposal, drainage etc. Newspaper cuttings on the recent outbreaks of cholera in Kisumu are presented in Appendix S.

Despite the above situation, most of the respondents in the Public Attitude Survey conducted by the JICA Study Team were aware of the causes of water-borne diseases and the necessity of sanitary habits, such as boiling water for drinking, washing hands with soap and etc. This implies that even though they are aware of the causes of diseases and sanitary habits, they do not practice them. Some of them have pointed out that there is not enough water for washing hands or cannot afford to buy fuel for boiling water.

2.3 INSTITUTIONAL SITUATIONS

2.3.1 General

Kenya has over many years developed laws related to Water Supply and Sewerage and these are to be found in almost 30 different Acts, the most important of which are: -

- The Water Act (Cap. 372)
- The Public Health Act (Cap. 242)

The Water Act was first introduced in 1951, and is undergoing its second major revision to bring it into line with current sector policy. The Public Health Act regulates Public Sewers and pollution, and this will be further strengthened by the Environmental Management and Co-ordination Bill scheduled for presentation to parliament during 1998.

KMC is a local authority and one of several municipalities constituted as a Water Undertaker and regulated by the Local Government Act (Cap. 265). As such it is empowered to issue by-laws related to the provision of water and sewerage services.

With a view to consolidating development of the water sector, JICA produced a study on the National Water Master Plan in July 1992, with Sectoral Report (P) making recommendations on Laws and Institutions. This document is currently being updated by JICA in the "Aftercare Study on the National Water Plan".

The current laws are adequate for KMC to operate as a Water Undertaken but revisions to allow for greater autonomy and commercialisation with regulation through central government are required.

2.3.2 Institutional Framework

At national level, MOLA is the major institution through which KMC operates. For its function as a Water Undertaker, KMC acts in liaison with the Urban Development Department (UDD) of MOLA which also handles matters requiring the involvement of the Ministry of Water.

For many years, Local Authorities in Kenya have failed to provide basic municipal services, and infrastructure facilities have deteriorated to the extent that major investment is now required on

rehabilitation as well as expansion. This is particularly true of Kisumu.

This situation has long been recognised and a Local Government Reform Programme (KLGRP) has been underway since 1991 with support from the World Bank and implementation through MOLA. Project management and co-ordination of the programme is the responsibility of a secretariat in MOLA comprising of officers in various disciplines. The secretariat uses consultants in some areas and considerable progress has been made with implementation of some reforms already in hand.

Concentration is on an integrated programme to achieve, amongst other things, improvement of the fiscal relationship between local authorities and central government, the improvement of overall financial management reform of the Local Government Loans Authority (LGLA).

Kisumu is one of 11 pilot towns for testing the reforms and it is hoped that KMC will benefit and thus become less dependent on revenue from the W&S Dept.

The national institutional arrangements for the delivery of water and sewerage services are still somewhat unclear. MLRRWD, NWCPC and local authorities have non-harmonised roles because of unclear ownership, maintenance, pricing policies, and rates and tariff structures.

However, there are now clear guidelines on the direction to be taken by local authorities who are Water Undertakers. The initiative has come from the Urban Water and Sanitation Management (UWASAM) Project being undertaken by MOLA with support from GTZ.

This technical co-operation has been ongoing since the late 1980's and has recently focused on assisting local authorities to establish fully fledged W&S Departments (WSD's), and to provide motivation for a more commercial approach to the provision of services.

The project has now moved on to the establishment of Water & Sewerage Companies (WSC's) in the three pilot towns of Eldoret, Kericho and Nyeri. This is aimed to achieve financially and institutionally autonomous and commercially oriented WSC's.

UWASAM is continuing to provide technical assistance on the operation and management of water and sewerage services to the remaining six local authority water undertakers, including Kisumu.

2.3.3 KMC and the W&S Department

(1) KMC

Kisumu is the third largest town in Kenya after Nairobi and Mombasa. It is the Provincial Headquarters for Nyanza Province, and headquarters for Kisumu District and the Lake Basin Development Authority. Kisumu has developed a sizable industry and is strategically located at the rail head with a lake service to Tanzania and Uganda.

Unfortunately, due to a multitude of historical, institutional, economic and political factors, KMC has deteriorated to the point where it can no longer provide the basic municipal services required to support the economic and social development of the town.

The activities of the Council are severely restrained due to inadequate staffing at top management level, and the inability to collect sufficient revenue to finance the provision of education, health, housing and social services, and water and sewerage.

The council depends heavily on revenue from the water and sewerage department to maintain minimum services to the people.

The institutional set up of the council is given below and shown in Figure 2-6.

The council consists of 17 elected and 5 nominated councilors, with the Mayor and Deputy Mayor being elected from their number by the councilors.

The council conducts its business through the following standing committees: -

Finance, Staff & General Purpose; Education; Environmental; Public Health; Works; Housing Development; Social Services and Housing; Water and Sewerage.

The council is organised into 8 departments reporting to the above committees as follows; -

Town Treasurer; Town Clerk; Education; Public Health; Town Engineer; Housing Development; Social Services and Housing; Water and Sewerage. (NB There is no separate Environmental Department) Committees are formed of councilors with voting powers, and chief officers of the council who participate and act as advisers but do not vote.

In keeping with the national policy of ongoing reforms in local government, water and sewerage

was taken out of the Town Engineers Department in 1993 to become a separate department reporting to its own water and sewerage committee.

In May 1994 MOLA further directed, amongst other things, that a separate autonomous water and sewerage account be operated as a first step in creating a self sustaining water and sewerage department.

(2) W & S Department

After its formation in 1993, the WSD obtained some measure of autonomy including greater control of its financial affairs. However for a variety of reasons the department slipped back into a situation of control by the council particularly in respect of finances.

There have been moves recently to build up an independent department with more control over its own finances, but progress has been slow. Since KMC have not yet benefited financially from the KLGRP, council still remains heavily reliant on revenue from the WSD, hence the administrative will to create an autonomous department is overshadowed by the financial necessity to continue subsidising other council services with WSD revenue.

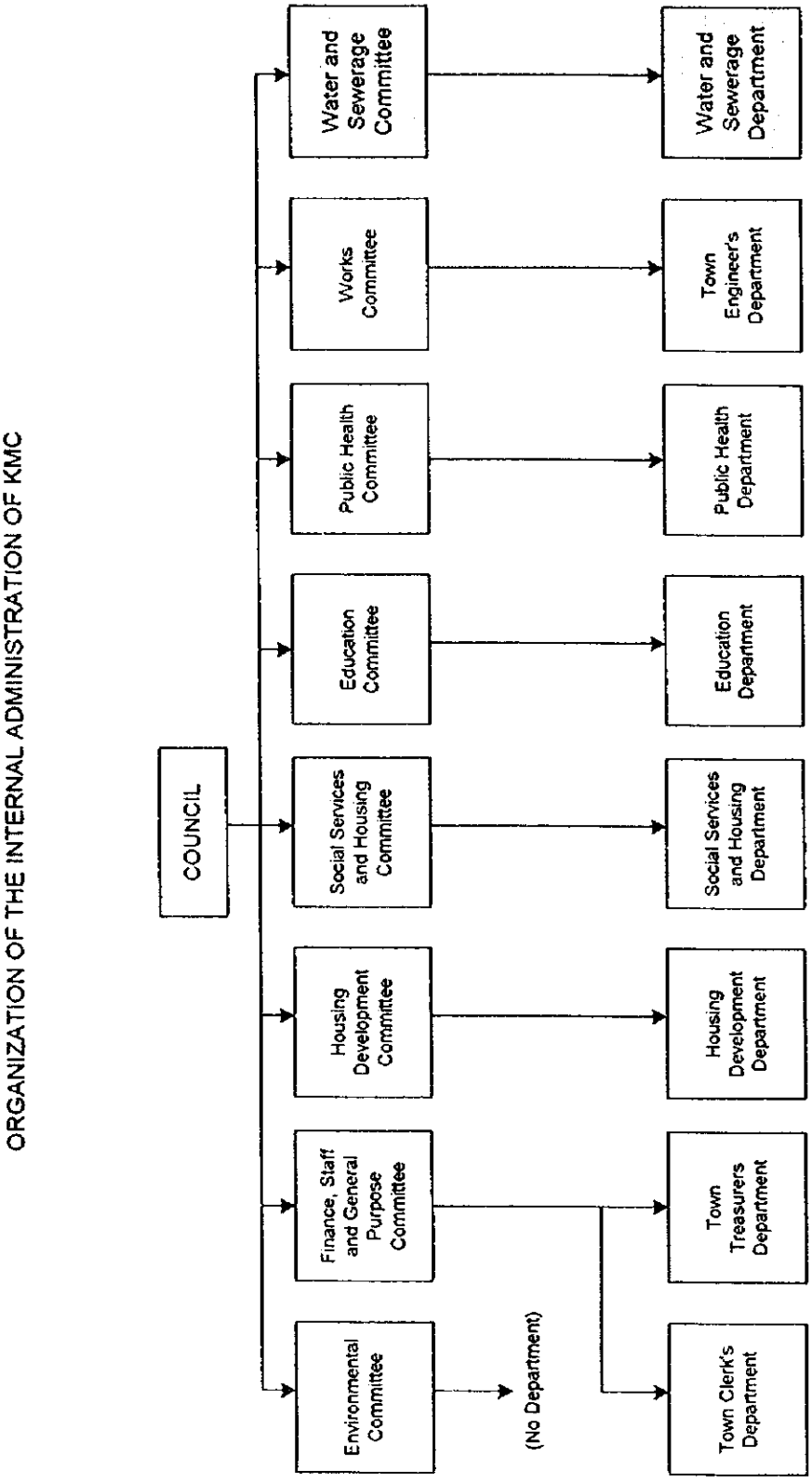
This is regrettable but hardly surprising since most of the senior and middle management positions in the WSD are vacant and there is no capacity to run its own affairs effectively. The Traditional method of recruiting through the PSC has not been successful and KMC was recently given authority from MOLA to advertise for and recruit staff.

The lack of financial autonomy is further complicated by poor billing and revenue collection, hence there are insufficient funds for proper operation and none whatsoever for maintenance, except in the case of breakdowns when monies must be found.

Unaccounted for water (UFW) has reached unacceptable levels, not only by way of leakage, but also illegal connections and malpractice in meter reading. The service level is shrinking with the bulk of the water being diverted to the lower elevation and more wealthy sections of the town and to industry, whilst more and more of the distribution system dries up.

The level of competence at superintendent and operator level is generally satisfactory, but there are no clear directions given, and no motivation for them to operate the system for the benefit of the many under the prevailing conditions.

Figure 2-6



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Organization of the Internal Administration of KMC

2.4 Previous and On-going Projects

2.4.1 Previous Projects

(1) Kisumu Water Supply and Sanitation Study

Feasibility study on water supply and sanitation of Kisumu Municipality titled 'Kisumu Water Supply and Sanitation Study' was conducted by JB Gauff K.G. funded by KfW (German International Development Bank) in 1988. Target year of that study was year 2005. Implementation was carried out on a limited scale in 1988 and thereafter no major development or improvement on water supply and sanitation were made due to unavailability of funds. This study is the comprehensive document on Kisumu water supply and sanitation and referred in this study as well.

Other projects related to the Study are as follows:

(2) Kisumu Structure Plan 1983 - 2013

This is the most recent physical structure plan of Kisumu municipality and was prepared by Physical Planning Department of KMC and MOLA in 1983. It outlines the development scenario in the year 2013 and a land use map for the year 2013 is also shown.

(3) Other Related Studies

List of other related studies are as follows:

- National Water Master Plan, 1992, was funded by JICA. MLRRWD was the counterpart agency. Water supply sources for Kisumu was also studied.
- Kenya/Rural Domestic Water Supply & Sanitation Programme I and II (RDWSSP), 1992. This project was funded by the Government of Netherlands. Counterpart agency was Lake basin Development Authority.
- Integrated Regional Development Master Plan for Lake Basin Development Area, 1987, was funded by JICA. Lake Basin development Authority was the counterpart agency.
- Detail Design and Preparation of Tender Documents for Sondu/Miriu Hydropower Project, 1991, Kenya Power Company Limited.
- Feasibility Study on Kano Plain Irrigation Project, 1992. Lake Basin Development

Authority.

2.4.2 On-going Projects

On-going projects within the Kisumu Municipality are:

(1) Urban Water and Sanitation Management (UWASAM) Project

Aid Agency : Deutsche Gesellscahft fur Technische Zusammenarbeit (GTZ) of the Federal Republic of Germany
Implementing Agency : Urban Development Department of MOLA

This project is aimed at strengthening the management of water and sanitation systems which are owned and operated by selected local authorities (LA's) so as to make them self-sustaining in their operations and investments. The project is started in the late 1980's and is in the fourth phase.

GTZ has assisted nine LA's who are also Water Undertakers with training programmes, including a Financial Management Training Programme (1996-1997), and a range of consultancy services in legal issues, marketing, asset valuation and liabilities, and public awareness. The main thrust of the fourth phase of this project is to create autonomous commercialised water and sanitation companies. Currently three pilot projects are in progress in Eldoret, Nyeri and Kericho. Kisumu has benefited from the financial management training programme and a tariff study but is not in the mainstream initiative.

(2) Kenya Local Government Finance Study

Aid Agency : World Bank and International Development Agency (IDA)
Implementing Agency : MOLA

In recognition of the importance of Local Authorities in national development, the Government of Kenya and the World Bank undertook a comprehensive review of the entire Local Government system particularly its financing. The findings of this review are contained in the report Kenya: Local Government Finance Study, (Report No. 8997 - KE, April 23 1992).

Based on the findings and recommendations of this and other studies, the GOK is pursuing a programme of Local Government reform as part of its broader efforts towards public sector decentralisation, liberalisation and privatisation which is named as Kenya Local Government Reform Programme (KLGRP).

The KLGRP has been evolving since 1991 with the support of the World Bank. Japanese Grant Funds from the Policy and Human Resources Development project (PHRD) enabled the engagement of consultants to initiate some studies with limited scope related to financial management and infrastructure needs assessment. With the funding support now available through the International Development Association (IDA) credit for the Kenya Urban Transport Infrastructure Project and the availability of funding from the World Bank Project Preparation Facility, KLGRP is now positioned to launch the major initiatives that are essential to achieve the needed reforms.

Objectives of KLGRP are:

- to improve financial, managerial, and institutional capacities of Local Authorities (LA)
- to advise MOLA and the GOK on policy, legislative reforms and actions
- to recommend options for reform of existing intergovernmental financial and institutional arrangements
- to improve the effectiveness and efficiency of LA infrastructure service delivery (including training)
- to implement demonstration micro investments in selected towns

Some revenue sharing proposals put forward by the programme are already adopted by the GOK. Direct involvement is that Kisumu is one of eleven (11) KLGRP partner towns for phased implementation of reforms. Phase 1 will establish the basis for major investment in upgrading basic services in phases 2 and 3.

(3) Lake Victoria Environmental Management Programme (LVEMP)

Aid Agency : Global Environmental Facility (GEF) of World Bank
Implementing Agency : Ministry of Environment and Natural Resources

This regional programme consists of various components including wastewater management to protect the lake ecosystem. It is being implemented in Kenya, Tanzania and Uganda. Total funding for the project is US$70 million and that for Kenya is US$27 million.

Direct involvement with Kisumu is removal of water hyacinth in Lake Victoria (US$ 0.5 million, released) and US$2.0 million allocated for rehabilitation of Kisumu Sewage Treatment Works.

(4) Partnership Approaches to Meeting the Needs of the Urban Poor (PAMNUP)

Aid Agency : Department for International Development (DFID, formerly Overseas Development Administration (ODA)) of United Kingdom
Implementing Agency : a local steering committee in Kisumu (including KMC, NGO's etc.)

Objective of the project is to address the high priority needs of the urban poor who primarily resides in informal settlements through dialogue with the community. One of the components is to assist the staff of KMC to identify and assess alternative ways of improving the access of residents of the targeted informal settlements to water and sanitation. Selection of the areas and their implementation is expected to be finalised in the end of 1997. The project is expected to be implemented for a period of four years including one year for immediate actions and preparation of broad-based action plan. Since the areas identified are within the Study Area, close coordination is required. Discussion was made at the end of the field study in Kenya and it was agreed to coordinate especially in the beginning of feasibility study.

(5) Kenya/France Development Cooperation Task Force for Human Resource Development in the Water Sector

Aid Agency : French Government
Implementing Agency : MLRRWD (Ministry of Land Reclamation, Regional and Water Development)

Objective of the project is establishment of human resources development units within the key actors in the water sector and strengthening of relevant training institutions including some short courses. Project will have a duration of two years. Total funding is US$1.67 million and that for the first year is US$ 0.23 million. Training programme will benefit 556 personnel from LA's and it is hoped to include key personnel from Water and Sewerage Department of KMC.

CHAPTER 3

WATER SOURCES

3 WATER SOURCES

3.1 General Description of Water Sources

Potential water sources to meet the future water demand of Kisumu Municipality are selected as below;

(1) Lake Victoria (Winam Gulf)
(2) Kibos River
(3) Awach River
(4) Sondu River
(5) Nyando River
(6) Yala River

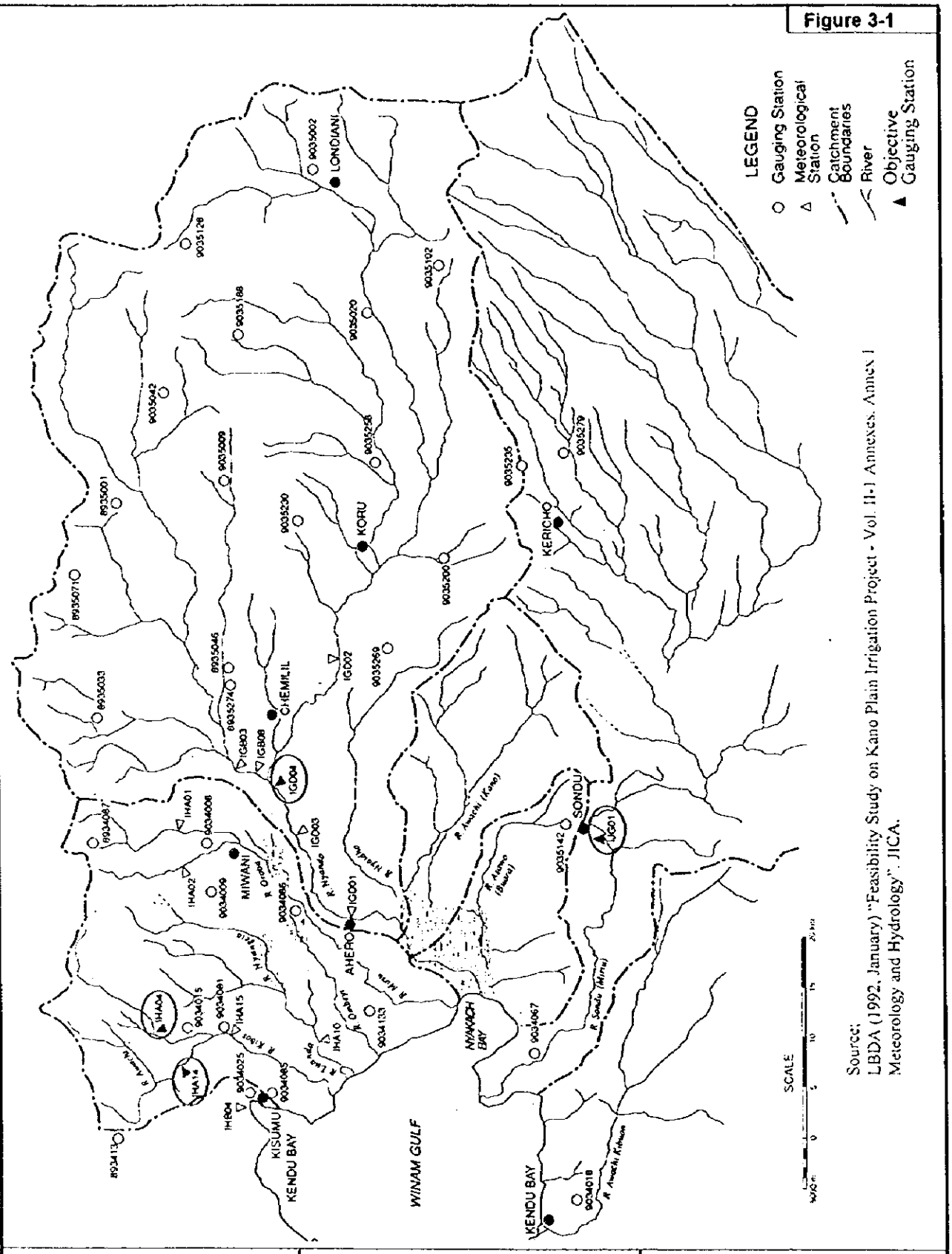
The location of water sources and water level gauging stations are shown in Figure 3-1, and are described respectively in this section. Figure 3-2 shows the potential intake sites for each resource. The catchment area, basin mean rainfall and annual mean flow of the lake and rivers are shown in Table 3-1.

Table 3-1 General Information of Water Sources

Name of Water Source	Catchment Area at Objective Gauging Station (km^2)	Annual Mean Basin Rainfall (mm)	Annual Mean Flow (m^3/d)
Lake Victoria	180,950	500 – 2,000	-
Kibos River	117	1,860	160,000
Awach	108	1,800	116,000
Sondu River	3,287	1,500	3,688,000
Nyando River	2,520	1,460	1,024,000
Yala River	1,577	1,570	1,434,000

Source: JICA Study Team

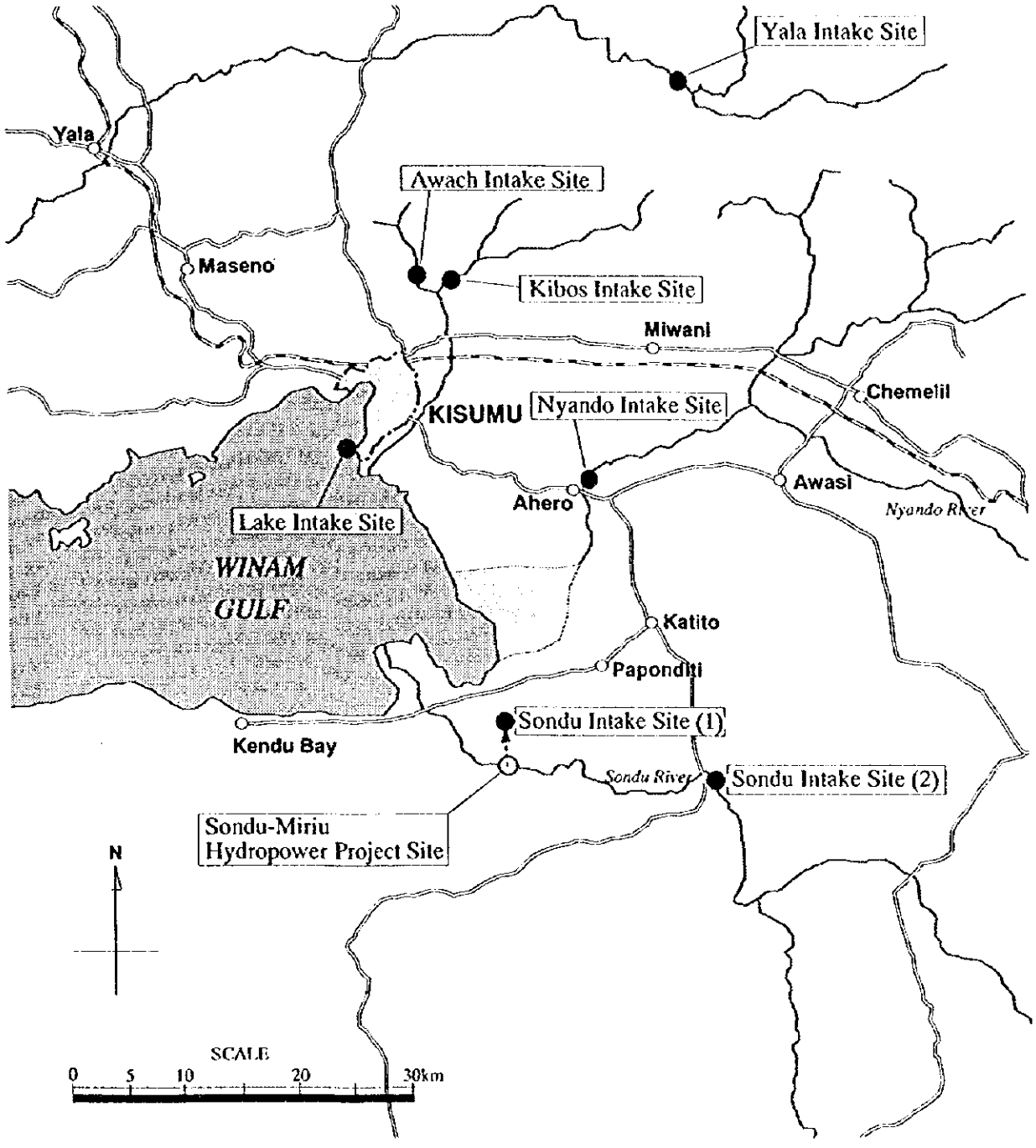
Figure 3-1



Source:
LBDA (1992, January) "Feasibility Study on Kano Plain Irrigation Project - Vol. II-1 Annexes, Annex 1 Meteorology and Hydrology". JICA.

THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Location of Objective Water Level Grauging Station

Figure 3-2



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Location Maps of Intake Sites

3.1.1 Lake Victoria (Winam Gulf)

Winam gulf with a surface area of 1,400 km^2, is a part of Lake Victoria with 68,800 km^2. It is relatively shallow with a mean depth of 6.8 m. The Winam Gulf is fed by three major rivers including the Nyando, Sondu and Awach. These rivers and the direct rainfall provide water inputs to the Gulf. The Gulf is already important source of water supply and fish resource for a large population, and acts also as recipient of effluent from the catchment area. The Gulf is surrounded by the densely populated area and agricultural lands. The urban activities and farming around the lake have tremendous impact on the water quality and the general integrity of the lake ecosystem. Kisumu Municipality is most populated area in the catchment, and one of most serious pollution source.

3.1.2 Kibos River

The Kibos river catchment is amounts to 117 km^2 at intake site (gauging station 1HA04) where present Kajulu Water Treatment Works (WTW) is located. The river falls from northeast to southwest and the elevation varies from EL 1,940 m (Kobujoi market) to EL 1,273 m at Kajulu WTW. There is no major pollution in the catchment at present. The river has been one of the safe water sources for Kisumu Municipality through the existing Kajulu WTW.

3.1.3 Awach River

The Awach River is the biggest tributary of the Kibos River. The catchment area amounts to 104 km2 at the proposed intake site (gauging station 1HA14), falling from EL 1,700 m in the north to EL 1,180 m at the confluence with the Kibos river. The basin of Awach River is expanded in the west part of Kibos River basin.

3.1.4 Sondu River

The river has three major tributaries, Yurith, Ainabkoi (Chemosit) and Kipsonoi. Total catchment of Sondu River is about 3,287 km^2. After the confluence of the tributaries, the river flows into the narrow gorge, and falls in cascade to the flood plain and finally flows into Lake Victoria. The rivers drain extensive tea plantations in Kericho and Sotik. Major pollution source of this river is considered to be agricultural pollution load, and small scale industrial pollution from tea and coffee processing factories in the catchment area.

3.1.5 Nyando River

Origin of the river is in Nandi hills, Kericho and Western Mau areas. As the river flows downstream it passes through an extensive sugarcane growing area. The catchment of Nyando River is about 2,520 km^2. Fertiliser inputs in the sugar-belt is the major contributor of high nutrients into the lower parts of the river. The river acts as recipient of industrial effluent from East African sugar industries (Muhoroni) and Agro-chemical Food and Allied Company. Chemelil sugar company also discharges at Mbogo, a tributary which joins the main Nyando at its downstream. The semi-treated industrial load from these factories is adversely affecting the water quality of the river at its downstream. This is one of the heavily polluted rivers, especially downstream of the above industries. The river water is abstracted for domestic purpose, irrigation and livestock watering.

3.1.6 Yala River

The Yala River catchment area at gauging station 1FE02 amounts to 1,577 km^2 which results from 942 km^2 of Remonde River, 549 km^2 of Mokong River and 86 km^2 of the residual basin. Agricultural and natural vegetation cover about one third and two third respectively in the both of subcatchments. The agricultural vegetation consist of tea, maize and sorghum etc.

3.1.7 Groundwater

Groundwater is also considered as one of the water resources for Kisumu Municipality. But water yield of the groundwater is slight low against water demand of urban area. Extensive investigations were carried out in the study, "Rural Domestic Water Supply and Sanitation Programme (RDWSSP)" (LBDA, 1987 - 1988) conducted by Netherlands. Groundwater condition in the study area can be summarised as follows:

(1) Western Area

It was found that shallow groundwater of good water quality occurs throughout the area. Accordingly, it is possible to exploit the shallow ground water by hand dug wells which may range in depth from 12 to 20 m. It is also possible to develop the deeper, preferably faulted or fractured, aquifers by 40 - 60 m deep boreholes.

(2) Eastern Area

There are shallow aquifers in the fine-grained alluvial deposits, from which water of poor quality is withdrawn by existing wells. It is recommended to withdraw water from deeper Pleistocene aquifers.

3.2 Low Flow Condition at Proposed Intake Sites

The low flow conditions of the selected rivers are compiled here by quoting from various previous hydrological studies.

General condition of seven available intake sites are described in this section. The locations are shown in Figure 3-1 and catchment area are shown in Table 3-2.

Table 3-2 Catchment Area of Rivers

	Catchment Area (km^2)	
	At Objective Gauging Station	At Proposed Intake Sites
Kibos River	117	117
Awach River	108	82
Sondu River	3,287	3,345
Nyando River	2,520	2,598
Yala River	1,577	1,491

Source: JICA Study Team

3.2.1 Lake Victoria

Basically, the possible yield from Lake Victoria can be considered as unlimited.

3.2.2 Kibos River

The present intake weir at Kajulu WTW with the elevation of 1,273 m is considered optimum place for gravity water supply. The catchment amounts to 117 km^2; the distance from the intake to the centre of Kisumu municipality (Kibuye) is around 11 km.

"Kisumu Water Supply and Sanitation Study, 1988" has estimated the various probable drought

discharges at 1HA04 by using daily flows for 49 years. Based on the data in the feasibility study report, the 96 % (25-year) probable daily minimum discharge of the Kibos River at the proposed intake site is roughly estimated as follows at 0.025 m^3/s (2,200 m^3/d). "The Study on the National Water Master Plan" (NWMP) as well as "Kisumu Water Supply and Sanitation Study – Feasibility Study, 1988" have proposed the construction of the Kibos dam at the site with the elevation of about 1,450 m. NWMP has envisaged the water supply of 82,080 m^3/d (0.95 m^3/s).

3.2.3 Awach River

The possible intake site with the elevation of about 1,300 m has been proposed by "Kisumu Water Supply and Sanitation Study – Feasibility Study, 1988"; the intake has initially planned only for rural water supply. The distance from the intake to the Kisumu municipality (Kibuye) is around 11 km. The catchment area at the proposed intake amounts to 82 km^2.

The 96% (25-year) probable daily minimum discharge of Awach River at the proposed intake site is roughly estimated at 0.017m^3/s (1,500m^3/d) based on the calculation as <0.025m^3/s * 82km^2/117km^2).

3.2.4 Sondu River

The Sondu-Miriu hydropower station is expected to be completed in 2002. There are two alternatives of intake sites on Sondu River, one is located downstream of Sondu-Miriu Hydropower station proposed site, and another is located upstream of the station as described below.

(1) Downstream of the Station

The outflow from the hydropower station can be used for any water demand. However, pumping facilities are required for transmission of water to Kisumu Municipality. The distance from the intake to the Kisumu municipality is over 50 km. The catchment area at the proposed intake amounts to 3,345 km^2.

(2) Upstream of the Station

If the intake is constructed upstream of the Power Station, water taken from the intake can be sent to Kisumu Municipality by gravity. However, the intake upstream of the Power Station will reduce water flow and resulting loss of power generation as envisaged in the Hydropower Project. The water right for the Hydropower Project is expected to be registered soon. This alternative can be hardly allowed

"Detailed Design and Preparation of Tender Documents for Sondu/Miriu Hydropower Project" (Kenya Power Company Limited, 1991) has estimated the probable drought discharges at 1JG1 by using daily flows for 43 years. The 96 % (25-year) probable daily minimum discharge, at on-going Sondu-Miriu Hydropower Station is estimated 0.87 m^3/s (75,100 m^3/d) based on the probable drought discharge at 1JG01 and unit discharge.

3.2.5 Nyando River

The location around Ahero bridge can be proposed as the only reasonable and available water intake site along the Nyando River from the view point of the transmission to Kisumu Municipality. However, pumping is required for transmission to Kisumu Municipality. The catchment area at the proposed intake amounts to 2,598 km^2.

Feasibility Study on Kano Plain Irrigation Project (LBDA, 1992) has estimated the probable monthly drought discharges of the Nyando River at 1GD04. The safe yield at Ahero bridge is estimated around 0.63 m^3/s (54,400 m^3/d) indirectly based on the previous analysis of the Sondu River, since no analysis on probable daily minimum discharge of the Nyando river is available. The procedures are described in Appendix A - Water Resources.

3.2.6 Yala River

The possible intake site with the elevation of about 1,778 m has been studied for gravity water supply by "Kisumu Water Supply and Sanitation Study – Feasibility Study, 1988". Diversion of Yala River water is to supplement the flow in Kibos River by which intake rate of Kibos River can be increased. Distance from the intake to the discharge point to Kibos River is around 22.7 km. The catchment area at the proposed intake amounts to 1,491 km^2.

"Kisumu Water Supply and Sanitation Study – Feasibility Study, 1988" has estimated the

probable drought discharges of the Yala River at proposed intake site by using the data at 1FE02 on the Yala River. The safe yield of the Yala River at proposed intake site is estimated to be 1.22 m^3/s (105,400 m^3/d) indirectly based on the previous analysis. Procedures are described in Appendix A on Water Resources.

3.3 Water Quality and Pollution Source in Catchment Area

The water quality survey on proposed intake sites were carried out in September by Jomo Kenyatta University of Agriculture and Technology as part of the Study. The results of the survey are described in Appendix N. The survey will be carried out again at same points in January, 1998.

Based on Drinking Water Standard in Kenya, the results of the survey are evaluated as follows:

- Water quality of all alternative water sources are generally acceptable for raw water abstraction, because none of the water quality items do not exceed the level of Drinking Water Quality Standard on constituents of health significance.
- Organic matter (BOD and COD) of Lake Victoria and Nyando River are higher than other water resources. Causes are domestic and industrial waste discharge in the drainage basin and progressive eutrophication of the lake. Pollution sources need to be controlled (treatment of wastewater), if these water resources are to be used for water supply in future.

3.4 Evaluation of Water Sources

Each water resources are evaluated from the view points of transmission, water quality and possible yield.

3.4.1 Transmission

Assuming that water is sent from the intakes to centre of Kisumu Municipality, distance of transmission and pumping requirement are summarised as below:

Table 3-3 Evaluation of Transmission from Each Water Source

Name of Water Source	Elevation of Proposed Intake (m)	Distance to Centre of Municipality (Kibuye) (km)	Pump Requirement
Lake Victoria	1,134	5	necessary
Kibos River	1,273	11	no
Awach	1,300	11	no
Sondu River (1)	1,210	55	necessary
(2)	1,460	55	no
Nyando River	1,150	21	necessary
Yala River	1,778	22.7 (to Kibos River)	no

Source: JICA Study Team

3.4.2 Water Quality

Basically, water quality of all the water sources are acceptable for raw water abstraction. But, the basin of Lake Victoria and Nyando River have pollution source which will deteriorate water quality. If those resources are to be used for water supply, pollution source control shall be carried out. Details of the water qualities are described in Appendix N. The summary of evaluation is shown in Table 3-4:

Table 3-4 Evaluation of Water Quality of Each Water Source

Name of Water Source	Present Water Quality	Future Water Quality
Lake Victoria	△	△
Kibos River	O	O
Awach	O	O
Sondu River	O	O
Nyando River	△	X
Yala River	O	O

Source: JICA Study Team O: good △: acceptable X: doubtful

3.4.3 Water Yield

For evaluation of yield of the alternative water resources, "Annual Mean Discharge", "96% Probability Daily Low Flow" and "Dependability 96% Possible Water Amount" are estimated as

shown below.

Table 3-5 Evaluation of Yield of Each Water Source

Name of Water Source	Annual Mean Flow (m^3/d)	96% Probability Daily Low Flow (m^3/d)	Dependability 96% Possible Water Amount (m^3/d)
Lake Victoria	-	-	-
Kibos River	160,000	2,200	38,900
Awach River	116,000	1,500	27,200
Sondu River	3,688,000	75,100	345,600
Nyando River	1,024,000	54,400	(269,600)*
Yala River	1,434,000	105,400	304,100

Source: JICA Study Team

Note :

* Denotes estimated value based on the data of the Sondu River

96% Probability daily Low Flow : Minimum daily flow with the probability once in 25 years.

Dependability 96% Possible Water Amount : Daily flow equalled or exceeded 96% on flow duration curve

According to the "Design Manual for Water Supply in Kenya" (MOWD, 1986), safe yield for principle towns and urban centres with a population over 10,000 is described as follows:
"The 96% - probability daily low flow shall be regarded as the safe yield of a river. The flow frequency analysis shall be made by using the lowest recorded daily flow of each calendar year for which records are available for the dry season."

The 96% probability daily low flow is, in other words, 25-year probable daily minimum discharge. The amount of 96% probability daily low flow is considered about only several percent of Annual Mean Discharge, as shown in Table 3-4. Under that concept of safe yield, possible water development amount shall be limited too strictly in spite of strong water demand in Kisumu Municipality.

If habitants in the municipality allow water supply system to operate below the capacity for two weeks a year (dependability 96%), possible water development capacity becomes more than 5 times of 96% probability daily low flow.

CHAPTER 4

EXISTING WATER SUPPLY AND SEWERAGE SYSTEM

4 EXISTING WATER SUPPLY AND SEWERAGE SYSTEM

4.1 INTRODUCTION

In this chapter description of existing water supply and sewerage system is made. It includes the summary of the results of field surveys, description of facilities, related organisations and institutions including their financial situation. Key issues for improvement of water supply and sewerage system are identified.

4.2 WATER SUPPLY SYSTEM

Water supply system in Kisumu will be categorised into two systems. One is municipal water supply system which is operated by KMC and it covers limited area including central part of Kisumu. The other system is sub-urban water supplies which consists of several small scale water systems operated by communities, MLRRWD, and church. These small scale water supply schemes cover several villages outside of the service area of the municipal water supply system. Existing condition of these two systems will be described below separately.

4.2.1 Municipal Water Supply System

(1) Supply Area and Conditions

Figure 4-1 shows the locations of major existing water supply infrastructure as well as the area which could be potentially supplied by the municipal water supply system.

Although distribution pipes have been laid over a wider extent, water is currently supplied on a continuous basis only in limited areas. Outside such areas, water is supplied only on an intermittent basis or not supplied at all.

A survey conducted by the JICA Study Team during the Master Plan stage indicated that, although the system pressure is as low as 5 meters of water column, the municipal water supply is currently available on a continuous basis in two separate areas marked out in Figure 4-1. The survey also indicated that, even within these two areas, there are a significant number of population who are not connected directly to the municipal water supply system, but are acquiring their water from water vendors.

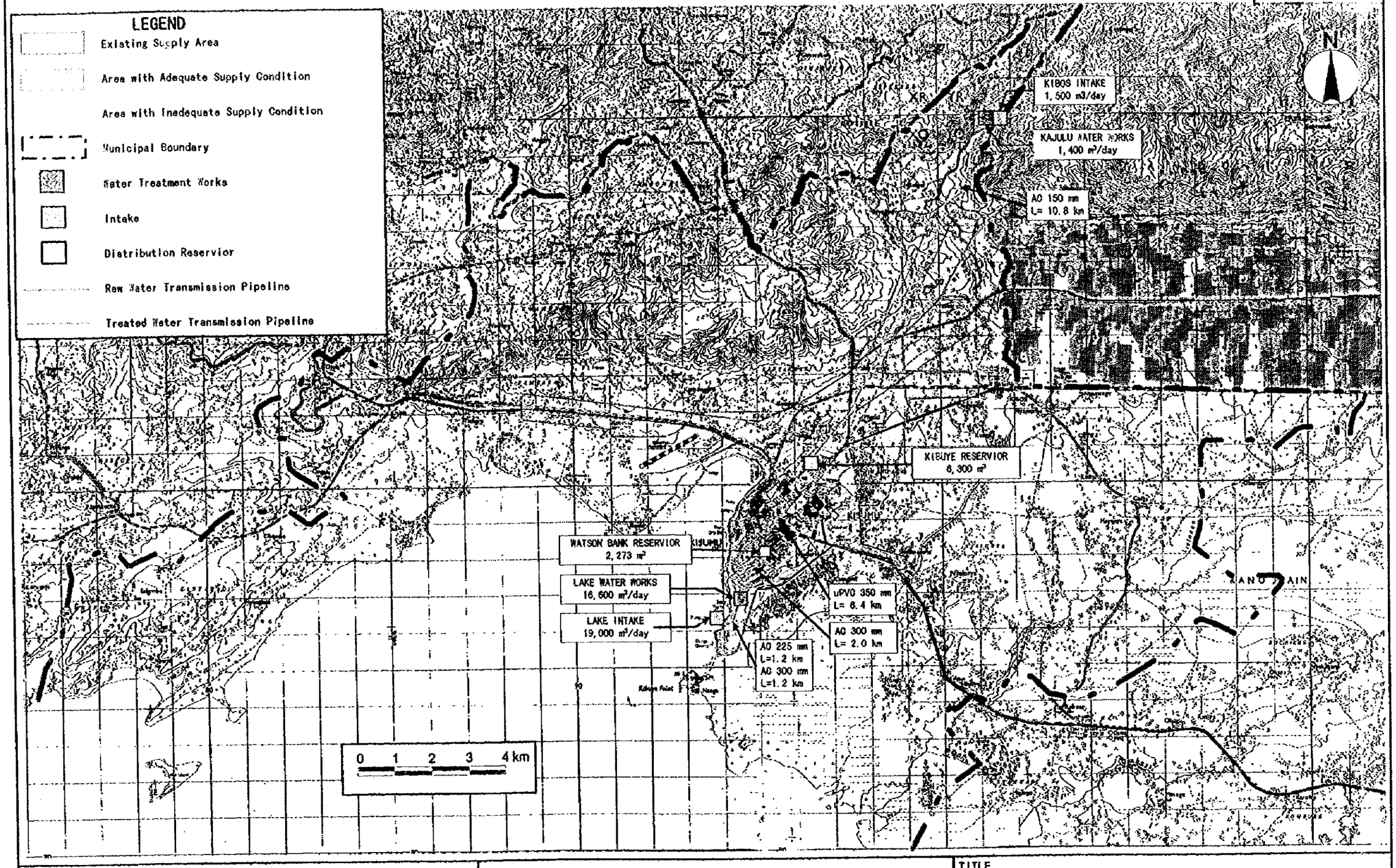
Outside the two areas, water vendors are the major source of portable water. More than a hundred of water kiosks are currently being connected to the municipal water supply system. Only four of them are currently being operated by the KMC, with the remainder by either registered or unregistered operators. Of the four water kiosks operated directly by the KMC, three are retail sale kiosks and one is a bulk sale kiosk for water tankers. These kiosks are operated between 6 a.m. and 7 p.m. and 365 days a year. At present, the KMC sells retail water at a rate of 0.8 Ksh per 25-litre container. The rate for bulk water is 50 Ksh per m3. Currently, the average daily turnover at one retail sale water kiosk amounts to Ksh 300 to 500. At each kiosk, money is collected by an operator who has been assigned by the KMC. Money collected daily is delivered to the KMC on the following morning. Major customers are water vendors who sell water to end users at a rate of approximately 5 Ksh per 25-litre container, which is about 6 times higher the purchasing price. The rate is totally uncontrolled at present and tends to increase at the time of draught or other water constraints. Several newspaper cuttings which report on the recent water crisis in Kisumu have been included in Appendix S.

There are a total of 96 registered water kiosks within the municipal water supply system. At present, the KMC requires a deposit of Ksh 14,000 for registration. The KMC currently sells water to these registered operators at an average rate of 40 Ksh per m3.

Apart from the above, it is estimated that there are also a considerably large number of unregistered water kiosks being operated within the municipal water supply system. The source of water for those kiosks is largely the municipal water supply system and partly water taken from nearby rivers and private shallow wells.

All in all, these water kiosks, except for some unregistered ones, are making a great contribution to filling the gap between the actual demand for potable water and the present inadequate supply capacity of the municipal water supply system.

Figure 4-1



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE Exisiting Water Supply System

(2) Water Use

Domestic water use : To investigate the water use in the supply area, a survey was made on 309 households in the Milimani area which receives comparatively good water supply throughout the day. Table 4-1 shows summary of the results. Milimani is a high-income residential and commercial area in Kisumu Municipality and water consumption is not representative. However, the results can be used as reference for water supply planning in the future.

Table 4-1 Results of Sample Survey of Existing Water Consumption in Central Kisumu under Usual Condition for House Connections

Survey Item		No. of Household	Component, %	L/(capita•d)
Number of Household visited		309		
Water Meter	Working meter	192	62.1	
	Malfunctioning or Stopped Meter	117	37.9	
	Total		100.0	
Average Household Size		6.45		
Water Consumption, lpcd	160 or above average	31	10.0	192
	80- 160 average	162	52.4	118
	40- 80 average	79	25.6	64
	0 - 40	37	12.0	32
	Total Average Consumption		100.0	101

Source : JICA Study Team

Investigation on the existing use of commercial, industrial and institutional categories proved futile for the following reasons. They are:

- about 40% of the consumer meters were not working
- about 30% of the consumers were disconnected due to non-payment etc.

Under these circumstances, estimation of water consumption for each category was made based on water production in treatment works and meter reading register, hearing from large-scale consumers etc. as follows.

Institutional water use : Institutional demand includes those used by public and private institutions which include schools, government offices, hospitals etc. There are about 150 institutions in Kisumu Municipality. Table 4-2 shows their water use. Average daily

consumption is 253 m^3/d based on actual record. However, there are institutions ①whose water supply is disconnected for non-payment, ②whose meters are not working, ③whose consumption is estimated without meter readings, and ④which are not registered. Therefore, existing potential institutional water use is estimated at 600 m^3/d referring to hearing in the field, analysis of revenue collection etc.

Commercial water use :Based on the analysis of meter reading register, hearing survey etc., existing commercial use is estimated at 2,600 m^3/d.

Industrial water use :There are about thirty industries in Kisumu Municipality and most of them are fish (food) processing. The largest one is Main Factory of Kenya Breweries and use 26,000 m^3/month or about 870 m^3/d. The lowest consumption is approximately 50 m^3/month or 1.7 m^3/d, showing huge difference. Existing industrial water use is estimated at 3,600 m^3/d.

Table 4-2 Water Consumption Estimates by User Category of Kisumu Municipal Water Supply in 1997 (by analysis of field survey)

Main Category	Sub-Category		No. of Persons	Average Consump-tion (lpcd)	L/(house • d)	Average daily Consump-tion (m^3/d)
Domestic Use	Usual Supply Area	High (house connection)	2,000	200	1,300	400
		Medium (house connection)	6,000	120	780	720
		Low (house connection)	5,000	60	390	300
		Kiosk and Others	4,838	20	130	100
		Sub-total	17,838	85	553	1,520
	Limited Supply Area		76,220	30	195	2,287
	Kiosk and Others		130,397	10	65	1,304
	Sub-total (domestic)		224,455	27	176	5,111
Commercial Use						2,600
Industrial Use						3,600
Institutional Use						600
TOTAL						11,911

Note : Daily water supply = 17,000 x 0.7 = 11,900 m^3/d

Gross average water consumption = (11,900 x 1000 L)/ 224,455 = 53 L/(capita • d)

(3) Water Sources and Treatment

There are two surface water treatment works within the municipal water supply system. They are the Kajule WTW in the Kadero Sub-location and the Lake WTW in the Millimani Sub-location. Treatment process of these two WTWs is shown on Figure 4-2. Groundwater is

not currently being used for the municipal water supply system.

a. Kajule WTW

The Kajule WTW is located almost on the equator in the north of the Kadero Sub-location at an altitude of approximately 1,300 meters above the mean sea level. Layout of the Kajule WTW is shown on Figures 4-3 and 4-4. It was first constructed in 1922 and, since then, has undergone several times of refurbishment and expansion. It is situated on the right bank of the Kibos river and is abstracting the river water from an existing intake weir located about 100 meters upstream of the treatment works. Seasonally, water form the Kibos river is mixed with water from a nearby spring. Water from the spring, although it was the only source of raw water when the works was originally constructed and its water quality is far superior to that of the Kibos river, is limited in yield and available only during the rainy season. The treatment works therefore depends its operation almost entirely on the river water.

Water from the Kibos river and from the spring, when it is available, gravitate through a 9-inch and a 4-inch pipelines respectively to a small concrete chamber where they are supposed to be mixed each other. Water form the chamber further gravitates through a 6-inch pipeline to the influent channel of a flocculation basin. Aluminum sulfate is dosed at a V-notch plate located at the end of this open channel, and thus the waterfall from the notch is providing the energy for mixing of the chemical. A small rectangular-shaped, up-down flow flocculation basin is directly connected to the influent channel. Water from the basin is conveyed to a circular-shaped, sludge-blanket type sedimentation basin through twin 6-inch pipelines. Chlorine and soda ash are added at the outlet of the sedimentation basin.

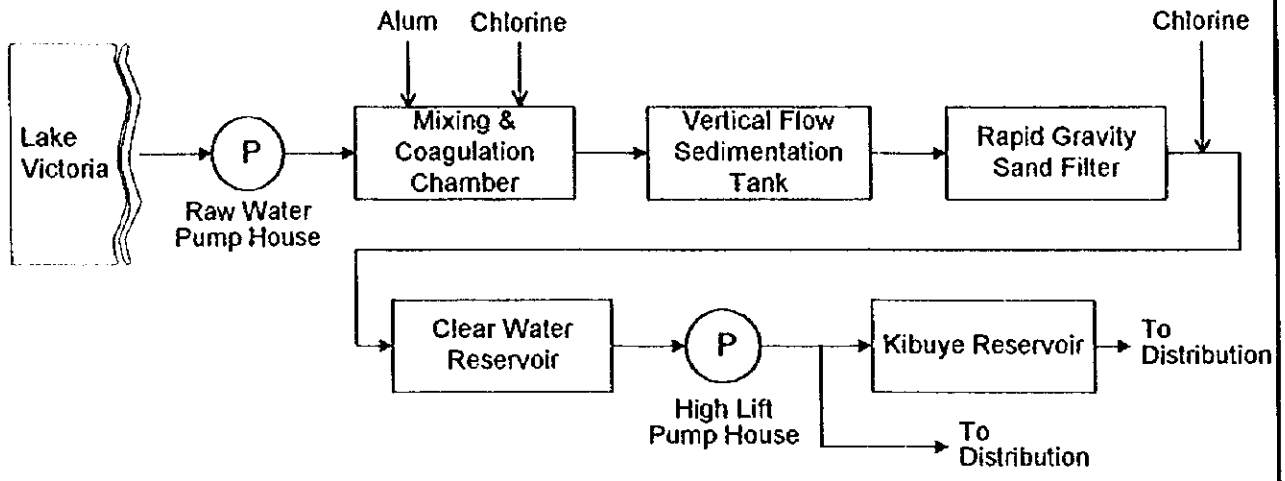
Twin 6-inch pipelines connect the outlet to a filter house which is located about 300 meters to the south. The filter house accommodates five units of pressure-filters, each equipped with a filter media comprising sand and gravel. These filters are washed once a day by means of air scoring and water backwash. When the sedimentation basin is put out of service for inspection or cleaning, water after the flocculation basin is bypassed directly to the filters. The header for the outlets of these filters is sized 4 inches within the house and it is increased to 6 inches immediately after the house.

At present, the works daily consumes about 100 kg of aluminum sulfate, 5 to 10 kg of chlorine and 15 kg of soda ash. Except for chlorine which is imported, these chemicals are locally manufactured.

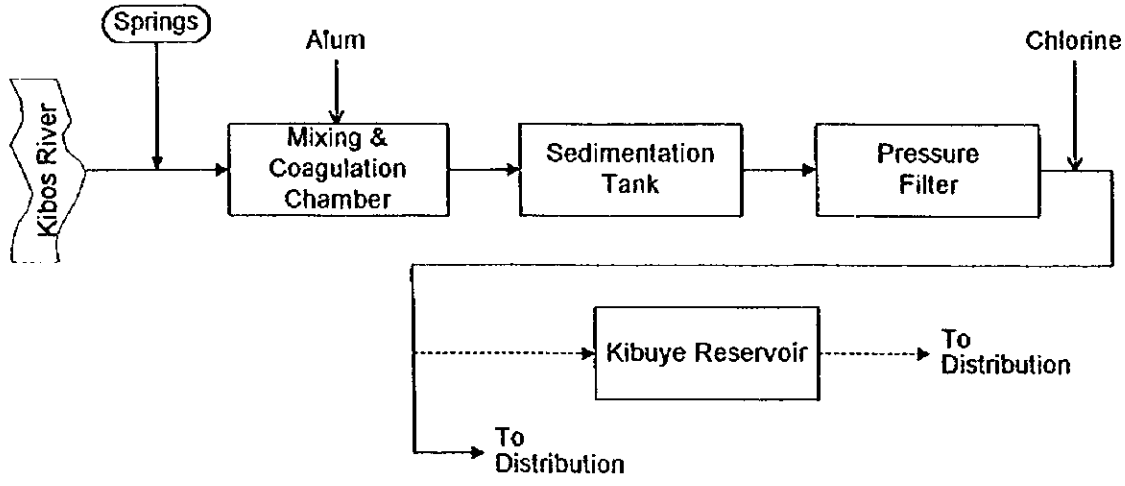
The current treatment capacity of the works is estimated to be 1,400 m3/day.

Figure 4-2

Treatment Process of Existing Lake Water Treatment Works

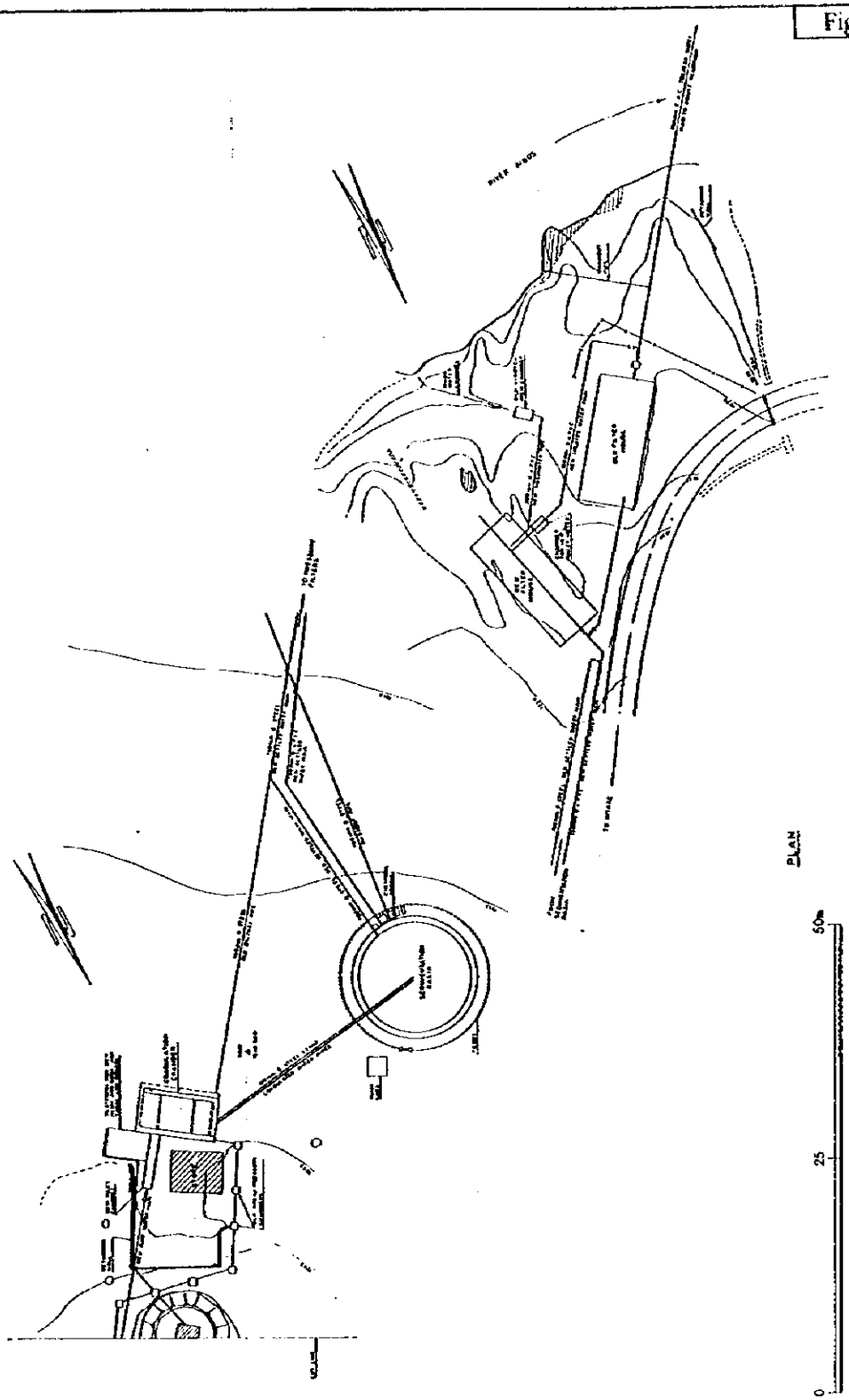


Treatment Process of Existing Kajulu Water Treatment Works



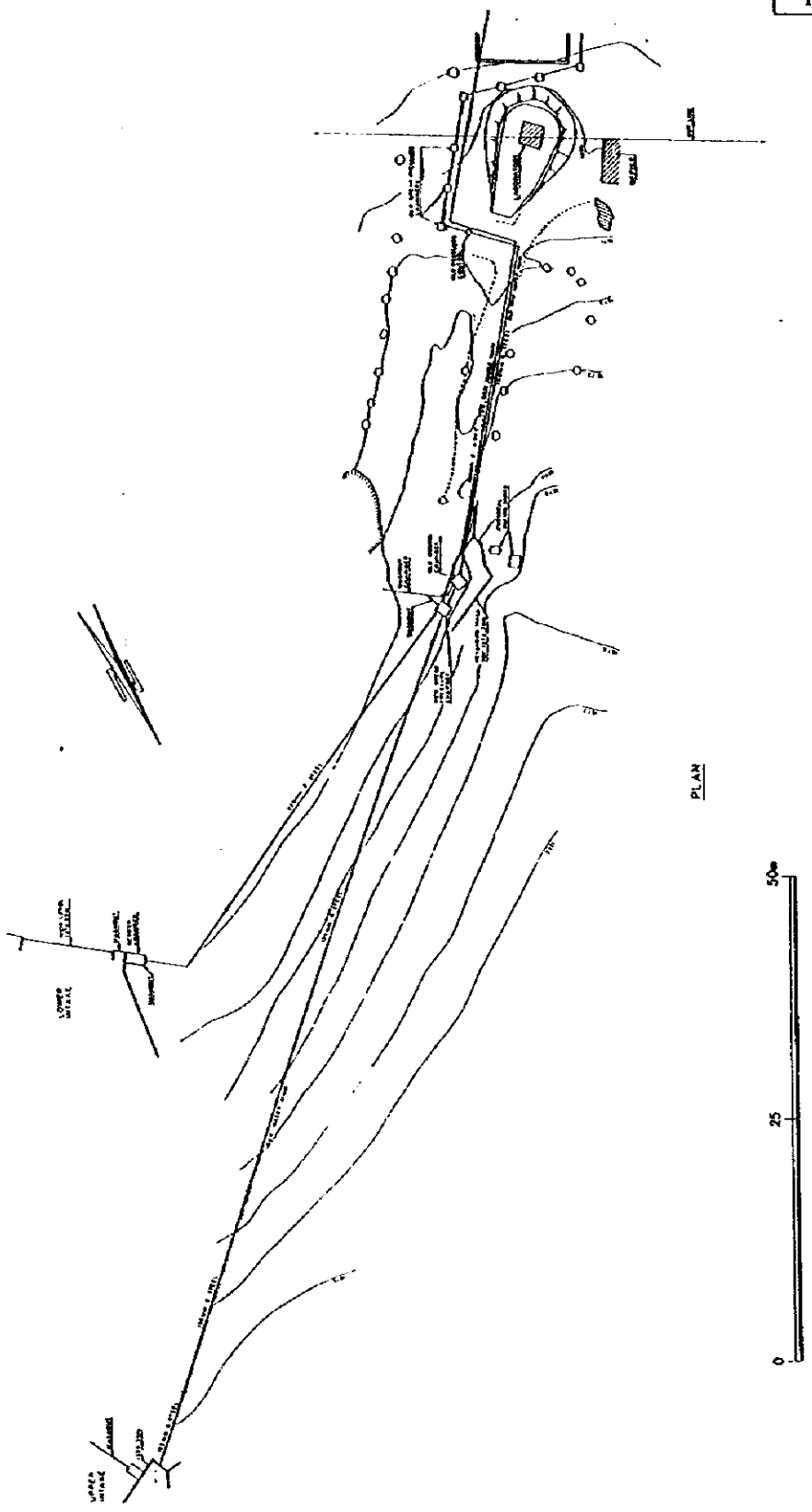
THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Schematic of Water Treatment Processes in Lake WTW and Kajulu WTW

Figure 4-3



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Layout of Kajulu Water Treatment Works(1/2)

Figure 4-4



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Layout of Kajulu Water Treatment Works(2/2)

b. Lake WTW

The Lake WTW is located at the southernmost of the Milimani Sub-location and is treating raw water being abstracted from the Lake Victoria. Layout of Lake Intake and Lake WTW are shown on Figures 4-5 and 4-6, respectively.

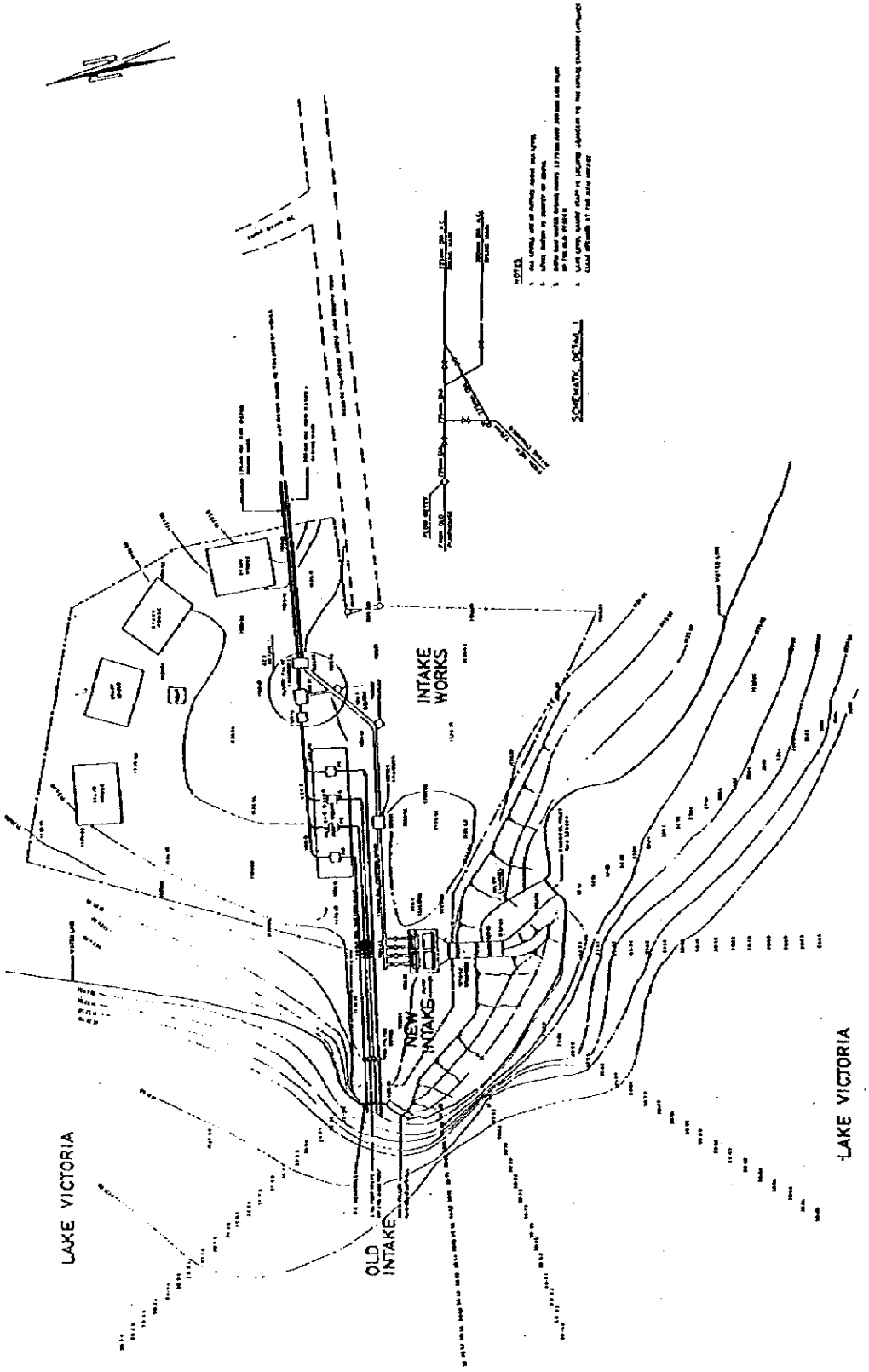
The works was initially built in 1953 and since then has undergone two times of major expansion each in 1968 and 1980. As a result, the works now has 3 separate groups of water treatment facilities, each corresponding to the time it was developed. The first group developed in 1980 is currently being operated at an average rate of 9,000 m3/day and is the largest among the three. It has 3 units of sludge-blanket type sedimentation basins and 4 units of gravity sand filters.

Each of the other two groups is provided with 4 units of sludge-blanket type sedimentation basins and 4 units of gravity sand filters. They are currently operated at a combined production rate of 7,000 to 8,000 m3/day.

Aluminum sulfate, chlorine and soda ash are currently used at the works. At present, the works daily consume about 1,200 kg of aluminum sulfate, 45 kg of chlorine and 100 kg of soda ash. The current total production capacity of the Lake WTW is estimated to be 16,600 m3/day.

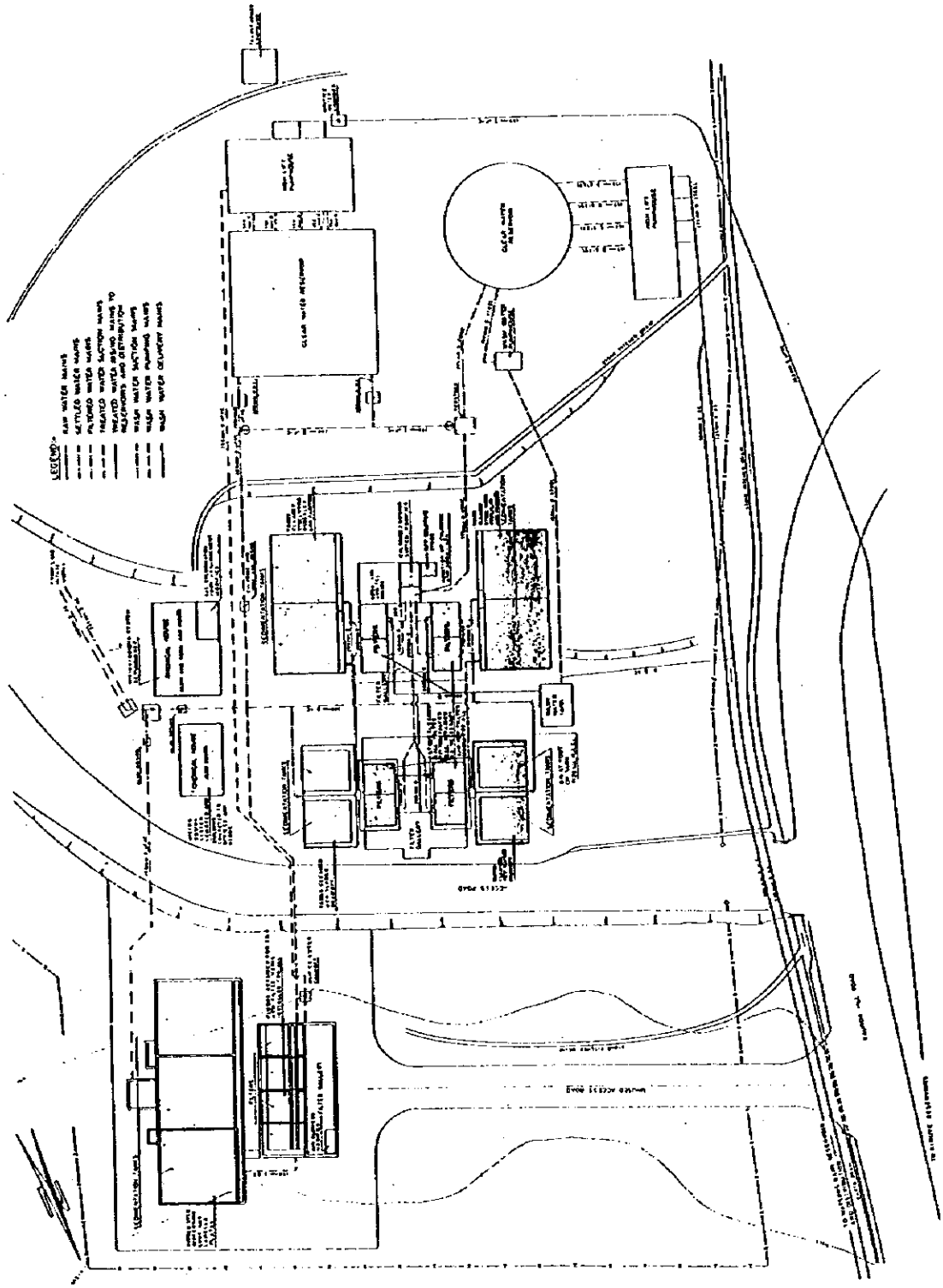
Two AC pipelines each sized 12 inches and 9 inches convey raw water from the Lake Intake Station to the Lake WTW. At the Lake Intake Station, a total of 8 intake pumps have been installed. Frequent breakdowns of the intake pumps is causing serious operational problems both at the intake and at the treatment works. At present, water hyacinth is seriously undermining the operation both at the Lake Intake Station and at the Lake WTW. The plant first emerged in late 1996 and since then has been steadily growing in number. They now cover up the lake surface up until half a kilometer offshore. At the bottom, dead leaves and roots of the plant have been decomposed into small pieces, getting the strainers of intake pumps easily clogged when the pumps are operated. For this reason, strainers had to be removed and water containing the decomposed substances has now free access to the Lake WTW. At the Lake WTW, plant-based fiber-like flocs are too light to settle in the sedimentation basins and carried over to filters, causing serious operational problems at the filters as well as taste and odor problems in its finished water.

Figure 4-5



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Layout of Existing Lake Intake Works

Figure 4-6



THE REPUBLIC OF KENYA THE MINISTRY OF LOCAL AUTHORITIES KISUMU MUNICIPAL COUNCIL	THE STUDY ON KISUMU WATER SUPPLY AND SEWERAGE SYSTEM JAPAN INTERNATIONAL COOPERATION AGENCY	TITLE : Layout of Existing Lake Water Treatment Works

(4) Treated Water Transmission and Distribution

a. Treated Water from Kajule WTW

In its early years of operation, treated water from the Kajule WTW gravitated through a 6-inch (150 mm) pipeline to the ground reservoirs at Kibuye. Water received at the reservoirs was then pumped to an nearby elevated tank and distributed by gravity towards the western part of the city as far as up to the Kisumu airport and beyond.

As the water demand along the pipeline from the Kajule WTW increased, however, the distance water could gravitate from the WTW gradually decreased. At present, water from the Kajule WTW reaches only up to the area near the junction of the Jomo Kenyatta Highway and the road leading to the Migosi area, where three water kiosks: two operated by individual operators and one by a women's club are located.

The above 6-inch pipeline is the only distribution main which currently serves finished water from the works.

b. Treated Water from Lake WTW

Treated water from the Lake WTW is pumped to the distribution network through three pipelines. One of them is 14-inch (350 mm) pipeline to the Kibuye reservoirs compound. En-route, the pipeline is serving several customers. The Kibuye reservoirs compound is located at about 6.4 km to the north of the Lake WTW and comprise three ground reservoirs, two elevated pressed steel tanks and three pump stations. The two units of rectangular-shaped ground steel tanks, each 228 m3 in capacity, which used to receive water from the Kajule WTW by gravity has been abandoned. The 14-inch pipeline from the Lake WTW is first connected to a 5,000 m3 rectangular-shaped RC ground reservoir and then to two other round-shaped ground RC reservoirs, each having a capacity of 910 m3 and 455 m3. An 12-inch pipeline from the 5,000 m3 reservoir is currently serving the Manyatta area by gravity. Another 12-inch pipeline from the reservoir is serving the Kenyan Brewery Limited (KBL) and its neighbors by gravity. Occasionally, water in the reservoir is pumped to the Kibuye and Migosi areas. Water in the two other reservoirs is pumped to two elevated steel tanks, each sized 278 m3 and 109 m3. Water in the larger tank gravitates to the Provincial Hospital, Shaurimoyo Government Quarter and other customers en-route. Water in the smaller tank gravitates to the Senior Government Quarter and its surrounding areas.

One of the two other pipelines that departs from the Lake WTW is a 12-inch AC pipeline which, while functioning as part of the distribution system and reducing to 9 inches in size on its way, is finally connected to the Watson Bank Balancing Reservoir at about 2 km to the north

of the Lake WTW. The reservoir was constructed in 1968 on a hill near the municipal council building. The reservoir is a round-shaped ground RC structure and has a capacity of 2,273 m3. Under normal conditions, the reservoir serves as an storage reservoir. When the pressure in the distribution network drops suddenly due to power failure at the clear water pumping station in the Lake WTW, however, the reservoir is supposed to act as a surge tank, injecting water rapidly into the distribution network by gravity to protect distribution pipelines from possible damages. The third pipeline from the Lake WTW is a 9-inch GSP pipeline which is directly connected to the distribution network immediately after the treatment works.

c. Existing Distribution Network

The existing distribution network comprises about 112 km of distribution mains, ranging from 80 to 350 mm in diameter. Pipe materials are uPVC (25.3%), asbestos cement (26.5%) and galvanised mild steel (48.2%). Table 4-3 shows a summary of the existing distribution mains by diameter, pipe material and year of construction. Pipes laid in or before 1970 accounts for 81% of the total in terms of the length.

Figure 4-7 shows the locations of the existing trunk distribution mains in the municipal water supply system.

d. Leakage

To investigate the existing condition of leakage in water distribution network, investigations were made at eight different locations. Detailed results are reported in Appendix B. As a result of the survey, average leakage ratio is estimated as 30 % to 40 %.

Identification and repair of visible leaks is carried out as part of the regular maintenance of Water and Sewerage Department. About two to three groups each consisting of two people patrol over the distribution area. Other than identification and repair of visible leaks, no other activity is undertaken for leakage control. Distribution mains of about 112 km is more than 20 years old except for about 7 km mains.

As described in the previous section, 24-hour supply is available only in the centre of the town and most parts of the distribution network is either dry or supplies water only for a few hours in a day at very low pressure.

Table 4-3 Summary of Existing Distribution Mains in Municipal Water Supply System

Diameter	Material	Length, m							
		1950-1955	1956-1960	1961-1965	1966-1970	1971-1975	1976-1980	1981 Onwards	Total
350 mm	GMS				450				450
350 mm	uPVC	130				1,050	3,890		5,070
300 mm	AC	1,330							1,330
300 mm	uPVC								580
250 mm	uPVC						2,280		2,280
225 mm	AC	4,575							4,575
200 mm	uPVC					2,223	240		2,463
150 mm	AC	15,070							15,070
150 mm	GMS				4,090			5,720	9,810
150 mm	uPVC			1,760		1,360	2,250		5,370
125 mm	GMS				1,580				1,580
100 mm	AC	2,155	1,310		360				3,825
100 mm	GMS	220			5,470				5,690
100 mm	uPVC			2,090			285	1,000	3,375
80 mm	AC	3,610	525		630				4,765
80 mm	GMS	7,170	2,900		25,079			800	36,254
80 mm	uPVC			8,500			570		9,070
TOTAL		**34,260**	**4,735**	**12,350**	**37,659**	**4,633**	**9,515**	**7,520**	**111,557**
Percentage of Total length		31%	4%	11%	34%	4%	9%	7%	100.0%

Material	350 mm	300 mm	250 mm	225 mm	200 mm	150 mm	125 mm	100 mm	80 mm	TOTAL	%
uPVC Pipe	5,070	580	2,280		2,463	5,370		3,375	9,070	28,208	25.3
AC Pipe		1,330		4,575		15,070		3,825	4,765	29,565	26.5
GMS Pipe	450					9,810	1,580	5,690	36,254	53,784	48.2
TOTAL	5,520	1,910	2,280	4,575	2,463	30,250	1,580	12,890	50,089	111,557	100.0