JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

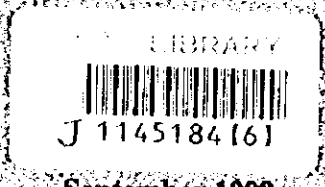
MINISTRY OF LOCAL AUTHORITIES
KISUMU MUNICIPAL COUNCIL
THE REPUBLIC OF KENYA

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

FINAL REPORT

Volume 1

Executive Summary



September 1998

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

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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 1 and contains the Study Team's findings, conclusions and recommendations derived from the Phase 1 and Phase 2 Studies. The main objectives of the Phase 1 Study was to investigate current situations, to formulate a long term master plan and to identify priority projects, whilst that of the Phase 2 Study was to examine the feasibility of the priority project which had previously been identified in Master Plan during the course of the Phase 1 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

The Essence of the Final Report
On
The Study on Kisumu Water Supply and Sewerage System
In
The Republic of Kenya

1. Background

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 and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kenya a study team third 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 final report have been prepared.

2. Study period

21 July 1997 – 15 August 1998

3. Study Area

Kisumu Municipality

4. Counterpart Agency

Ministry of Local Authorities & Kisumu Municipal Council

5. Contents of the Study

Water Supply and Sewerage Master Plan (Target year : 2015)

Feasibility Study of Phase I Project (Target year : 2005)

6 Existing Situations

(1) General

- Water shortage and inadequate wastewater management have emanated water borne diseases and restricted the growth of economy and employment opportunities.

(2) Management

- Unstable water and sewerage charge collection
- Vacancy in important posts of Water and Sewerage Department
- Lack of financial autonomy. Some part of water charge collected has been transferred to the general account of the municipality. This has resulted in delayed payment to employee, arrears of electric charge and chemical and undermined sound O/M.

(3) Water supply:

• Actual Service Area:	40	km^2
• Actual Daily Consumption:	12,000	m^3/day
• Capacity of Supply Amount:	18,000	m^3/day
• Total Population:	363,159	
• Population Served:	224,455	
• Service Coverage:	62	%
• Service Condition		
Population with continuos supply:	17,838	(8 %)
Population with limited supply:	76,220	(34 %)
Population supplied by Kiosk and others:	130,397	(58 %)
• Water Leakage (under 5 m water pressure):	30	%

(4) Wastewater Management

- Wastewater collected and treated: 8,500 m^3/day
- All existing pumping stations have not been operated.

7. Main Counter Measures

(1) Improvement of service coverage

- Inclusion of high population density areas and low income households with low water consumption rate.

- Establishment of two kinds of supply system, namely Municipal Water Supply System and Sub-urban Water Supply System.
- Introduction of two different service levels: Individual House Connections and Communal Taps.

(2) Maximum use of existing facilities for both water supply and sewerage system

(3) Introduction of Appropriate Technology and Operation and Maintenance
- Use of gravity flow to the maximum extent possible
- Separation of the clear water transmission function from that of water distribution
- Use of Pipe Materials which are locally available

(4) Establishment of financial autonomy

(5) Establishment of appropriate water tariff on the basis of people's affordability

(6) Inclusion of appropriate costs for improvement of institutional capacity, training programme and reduction of unaccounted-for water

8. Master Plan and Priority Project (Phase I Project) for Municipal Water Supply and Sewerage System

(1) Water supply system

① Water resources: Lake Victoria and Kibos/Awach river

② Water supply and demand:

		Existing 1997	Potential 1997	Phase I 2005	Phase II 2015
Municipal Area	km^2	296.5	296.5	296.5	296.5
Service Area by Piped System	km^2	40.0	87.7	87.7	87.7
Total Population		363,157	363,157	526,195	869,166
Population Served		224,455	280,844	414,530	690,628
Service Coverage	%	62	77	79	80
Ave. Daily Demand	m^3/day	12,000	27,462	41,865	72,252
Ave. Daily Supply Amount	m^3/day	18,000	39,233	59,174	96,336
Max. Daily Supply Amount	m^3/day	18,000	43,156	65,091	105,970
Capacity of Facilities	m^3/day	18,000	44,000	67,000	107,800

③ Facilities Plan

Facilities			Existing 1997	Phase I 2005	Phase II 2015
Water Treatment Works	Kajulu	m^3/d	1,400	2,800	2,800
	Lake	m^3/d	16,600	25,000	25,000
	Kibuye	m^3/d	-	40,000	80,000
	Total	m^3/d	18,000	67,800	107,800
Distribution Reservoir	Kibuye	m^3	6,300	33,300	52,300
	Kanyakwar	m^3	-	5,000	8,000
	Kogony	m^3	-	3,500	7,500
	Kajulu	m^3	-	700	1,400
	Total	m^3	6,300	42,500	69,200
Transmission Mains	ϕ 200- ϕ 900	km	0.6	20.6	27.0
Conveyance Mains	ϕ 150- ϕ 550	km	16.0	35.2	35.2
Distribution mains	ϕ 150- ϕ 800	km	63.0	112.4	139.9
Distribution sub-mains	ϕ 80- ϕ 100	km	49.0	379	611

(2) Sewerage System

①Sewerage Master Plan

	Existing 1997	Phase I 2005	Phase II 2015
Sewerage Service Area (ha)	599	1,795	5,036
Population served by Municipal Water Supply System	224,455	414,530	690,630
Population served by Sewerage System		133,270	373,850
Population Coverage Ratio (%)		32	54
Wastewater Generation (m^3/day)		38,890	66,665
Wastewater Collection (m^3/day)	8,500	23,220	55,070
Sewerage Coverage Ratio (%)		60	83

② Facilities Plan for Phase I Project

Rehabilitation Component

- Trunk Sewers : Replacement (Pipe Dia. 375 mm, Length 420 m)
- Pump Stations in the Central WTD: Three Pump Stations (Sunset Hotel, Kendu Lane and Mumias Road Pump Stations)
- Sewage Treatment Works: Conventional STW and Nyalenda STW

Expansion Component

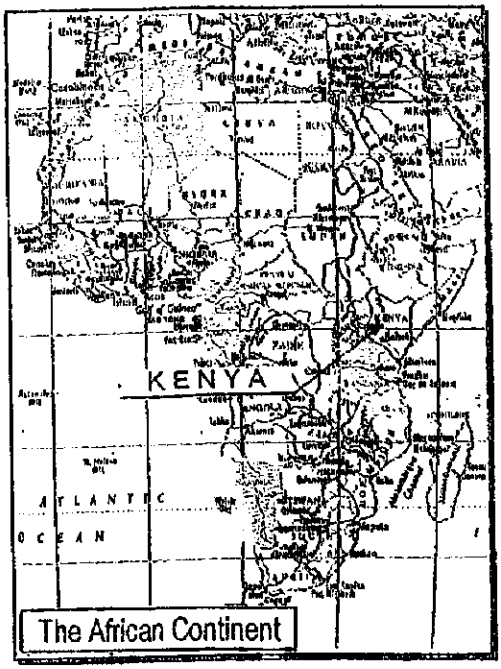
- Trunk Sewers in Central WTD: Pipe Diameter=250～400 mm, Length=2.6 km
- Trunk Sewers in Eastern WTD: Pipe Diameter=125～1,000 mm, Length=23 km
- Branch Sewers: Pipe Diameter=200 mm, Length=123 km
- Shallow sewers: Pipe Diameter=100 mm, Length=91 km
- Pump Stations: Labour College PS and Nyalenda STW PS
- Sewage Treatment Works: Conventional STW and Nyalenda STW

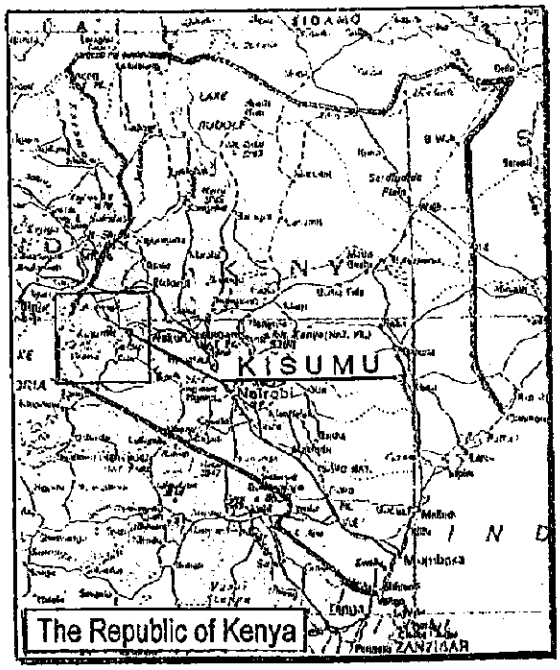
(3) Project Cost on Phase I Project

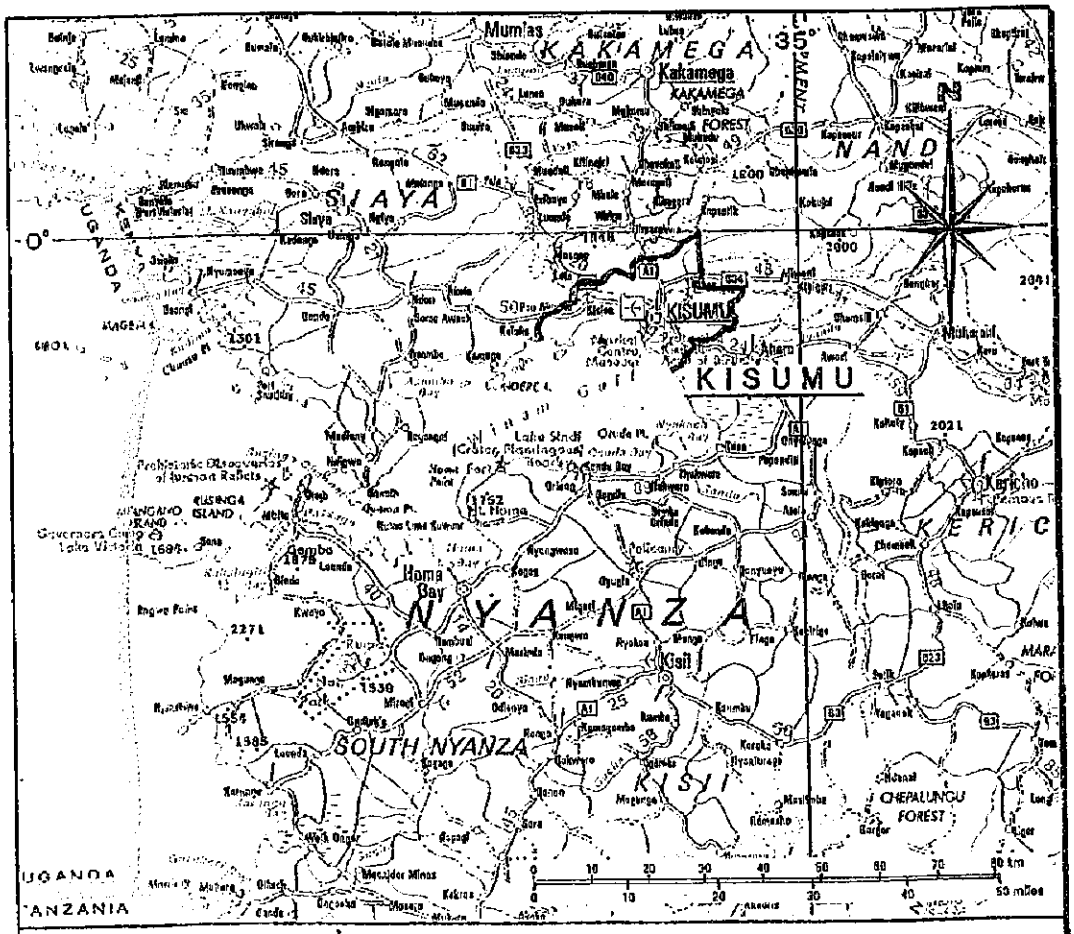
Direct Construction Cost		Unit: Thousand US$
Rehabilitation Component	Water Supply system	7,952
	Sewerage System	1,388
Sub- Total		9,340
Expansion Component	Water Supply system	40,178
	Sewerage System	12,846
Sub- Total		53,024
Total		62,364
Consultancy services		7,844
Contingency		21,015
Grand Total		**91,223**

(4) Financial Evaluation

Financial Internal Rate of Return (FIRR)	
Base Case (Loan Project):	6.45 %
Sensitivity Analysis	
Cost exceed the estimates by 20 %:	4.98 %
Revenue are 80 % of the base case:	3.95 %
Sale of water delayed by two years:	5.18 %
Special Case (without Rehabilitation Component):	7.69 %







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

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LIST OF FIGURES

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 and Objectives

Kisumu is the third largest city in Kenya. It is the administrative center of Nyanza province and Kisumu district. The city plays a strategic role in economic links between the three East African countries: Kenya, Uganda and Tanzania.

The city has suffered severe water shortages in recent years. There has been no expansion in water supply capacity in the last 10 years, though the population is estimated to have grown by more than 3% per annum. This has created serious shortages with the resultant water borne diseases and lack of water has constrained the growth of industry and employment opportunities.

Recognising the situations in Kisumu, the government of Kenya has requested for Japanese technical assistance. In response to this request, a Japanese Preparatory Study Team was sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA") which 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.

The Team had a series of discussions with the Kenyan authorities concerned- particularly 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"). Kenyan authorities and JICA agreed on 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")" on January 30, 1997. 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.

The Study aims to prepare a Master Plan covering the requirements of Kisumu up to the year 2015. Priority projects for immediate implementation need to be identified. The priority projects are designed to meet the requirements up to the year 2005. Technology transfer to the Kenyan counterpart personnel in the course of the Study was an important objective.

The Study was carried out in two phases. The first phase was completed in 1997 and the second phase in 1998.

The scope of work under Phase I included the following: a) collection and analysis of existing data and information on the water supply and sewerage sector in Kenya and the Study Area; b) understanding of existing services; c) preliminary field surveys and analysis; d) formulation of a Master Plan; and e) identification of a Priority Project/s.

During Phase I, Priority Projects were 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 II focuses on 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.

1.2 Composition of the Report

The Final Report consists of five volumes. They are:

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 Executive Summary presents the main conclusions and recommendations of the Study as a whole. Volumes 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.

1.3 Project Management Structure

Key decisions on the overall content of works and approach of the the Study were guided by the Steering Committee. This committee was formed by the Kenyan authorities to formulate basic policies for the Study and to coordinate Kenyan institutions concerned.

The government of Kenya appointed a Counterpart Team which worked with individual members of JICA Study Team. This team included 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.

Guidance to the Study Team was provided by the JICA Advisory Committee. This committee is organised by JICA to extend technical advice on all aspects of the Study.

CHAPTER 2

MASTER PLAN

2 MASTER PLAN

2.1 Study Area

Kisumu District is located between the Kendu-Nyabondo Escarpment in the south and the Nyando Escarpment in the North. Kisumu Municipality is bordered by the Nyando Escarpment in the North. The southwestern part consists of piedmont narrow plains bordering on the Winham Gulf of Lake Victoria, and the eastern part falls onto the low lying Kano Plain. Kisumu old town is located on a hill to the east of Kisumu Bay.

Kisumu lies just south of the equator, 35 degrees east of Greenwich at an elevation around 1,100 MSL. Temperatures are fairly constant all year round with daily maximums and minimums of about 30 and 17 degrees Celsius respectively. Annual rainfall averages 1,500 mm and falls mainly between March and May; evaporation is high.

National census data for Kisumu shows a population of 112,613 in 1969, 158,053 in 1979, and 258,923 in 1989, indicating an increasing growth rate from 3.45% to 5.06%. The administrative area of Kisumu Municipality was increased from 268.2 to 297 km2 in 1992, bringing the rural type area to over 80% of the total area. Population densities in 1989 were between 170-680 persons/km2 in rural type areas, 1,500-3,000 in urban areas, and approximately 10,000 in the densely populated peri-urban areas of Nyalenda A and Manyatta A which are located on the fringe of the fairly compact old urban centre.

Information on land use shows that industrial activity is dominated by agro-processing and beverages, and has not expanded significantly in recent years. Future expansion is expected in the fisheries and mineral based (soapstone) industries. Commercial growth will be linked to the revival of the East African free trade economic zone as Kisumu is strategically located for trade with Tanzania and Uganda. As the Provincial capital for Nyanza province, institutional land use will continue to be considerable for administrative functions.

In the past, planned development for housing and industry/commerce has been to the north and east. The structure plan prepared by KMC for the year 2013 shows future development in the north, east and west.

Public health information on Kisumu shows that malaria is endemic, and water borne diseases are the most common. Kisumu is at risk from cholera outbreaks, due to the lack of safe water, poor drainage, and poor wastewater and solid waste disposal.

KMC is a registered Water Undertaker. For many years KMC has failed to provide adequate basic municipal services, including water and sewerage, and infrastructure facilities have deteriorated to such an extent that major investment is now required on rehabilitation as well as expansion. This situation is being improved by the KLGRP at municipal level, but KMC has not yet benefited financially and still relies heavily on the transfer of revenue from the WSD to finance its other services. Hence, despite efforts over the last few years to create an autonomous WSD in line with national policy, this has still not been achieved.

The financial situation of KMC is far from satisfactory, and as in other local authorities in Kenya, the municipal revenue base is very weak. The major source of income is from rates which are in fact real estate taxes. The overall municipal rate is determined by the revenue shortfall in the budget after all other income and expenditure has been calculated.

Improvements have been made to the budgeting process, but the setting of excessive budget provisions is still practiced. A major source of extra financing in the past was through loans by central government, using the local government loan agency. Loans were seldom repaid and this agency no longer operates.

The government policy at present is to improve the local revenue base rather than augment this through loans. The whole issue of the role of municipal councils in local service delivery and its financing is being studied under the KLGRP.

As far as the WSD is concerned, the central government encourages local authorities to operate these departments as viable commercial entities with the pricing of water such that it takes into account the ability to pay by the water users in different parts of the country. In Kisumu, the tariff should be set to cover operation and maintenance, and capital investment costs on a long-term recovery basis.

The water production and sales records produced by the department are not very useful and require immediate improvement. Despite this, the WSD generates substantial revenue which is used mainly for the councils general operations, where the main expenditure items are on health and general administration. This revenue could be substantially increased merely by improved billing and collection.

There are several on-going projects which directly affect Kisumu, and they have been integrated into this study where necessary; these are: -

- Urban Water and Sanitation Management (UWASAM) Project - Aid Agency; GTZ
  This project is aimed at strengthening management systems, and the Kisumu WSD has benefited from a training programme and tariff study but is not in the mainstream initiative.
- Kenya Local Government Reform Programme (KLGRP) - Aid Agency; World Bank
  Kisumu is one of eleven partner towns for phased implementation of reforms which will include improvements to financial, managerial and institutional capacities.
- Lake Victoria Environmental Management Programme - Aid Agency; World Bank
  The main project is to protect the lake ecosystem.
- Partnership Approaches to Meeting the Needs of the Urban Poor - Aid Agency; DFID
  The project objective is to address the high priority needs of the urban poor in Kisumu.
- Kenya/France Development Cooperation Task Force for Human Resource Development in the Water Sector - Aid Agency; French Government
  A Training Programme will benefit 556 WSD personnel from local authorities.

2.2 Water Sources

Six major sources of water are identified as having the potential to meet the future water requirements of Kisumu. Key features of these sources are:

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

Although a promising source, Sondu was discarded as a water source early in the Study. Water from the downstream of Sondu/Miriu dam under construction would require excessive pumping. Part of the time all available water from Sondu river is used by the dam, and taking water from upstream would reduce the electricity produced by the dam.

Nyando is the most polluted of all rivers. Thus, the most attractive sources for Kisumu seem to be the Kibos/Awach rivers. Detailed analysis of the flow and dependability were undertaken for these two rivers. Evaluation of the data for these two rivers confirmed that with "dependability 96% water amount" it would be possible to abstract 38,900 cubic meters per day from Kibos River and 27,200 from the Awach river. This implies that the supply system on these two rivers will operate below capacity only for two weeks a year.

2.3 Existing Water Supply and Sewerage System

Water supply in Kisumu may be categorised into two systems. One is the municipal system which is operated by KMC and covers a limited area including the central part of the town. The other is the rural system which consists of several small scale water supplies.

Water sources for the municipal piped water system are the Kajulu WTW which abstracts water from the Kibos river, and the lake WTW drawing water from Lake Victoria. The waterworks are old, Kajulu having been first constructed in 1922, and the lake WTW in 1953. Both have undergone rehabilitation and expansion over the years, the last being in 1980.

With the increase in water demand the gravity fed water from Kajulu no longer reaches the main distribution reservoirs at Kibuye, likewise, the pumped supply from the lake is mainly fed direct into the system.

The distribution network is also old and comprises about 112 km of pipes ranging from 80 to 350 mm diameter. Pipes laid before 1970 accounts for 81% of the total length. Although laid over a wide area of the town, water is currently supplied on a continuous basis only in limited areas, other areas receive water intermittently, or not at all. Water supply to a significant proportion of the population is provided via Kiosks and vendors, using water from the piped system, private shallow wells and nearby rivers. There is no effective control of the kiosks or the charges levied which tend to disadvantage the low-income group.

Equipment necessary for the operation and maintenance of the system is inadequate. Water quality testing equipment is insufficient even for basic operation. Routine maintenance is lacking with leaking steel tanks, broken down pumps, and silting at the Kajulu intake serving as examples. Investigations into leakage revealed average losses of between 30-40%, with little remedial action taken. A recent survey of consumer meters revealed that only 32% were in working order, a further 32% were faulty or not registered, with the remaining 36% having been disconnected due to non-payment or no water available from the distribution system. Tap water

quality is variable across the town and improvement is necessary to meet the drinking water quality standards in Kenya. Historical information on water use by category was not available, hence water use had to be thoroughly investigated by surveys, interviews, and analyses of the more reliable records. The resulting estimates were found to be very close to the figures given in the Design Manual for Water Supply in Kenya.

The small-scale rural water supply systems cover several villages outside of the service area of the municipal water supply system, and are operated by communities, government institutions, and church organisations. A survey shows a mixture of sources being springs, small streams, shallow wells, boreholes, and the lake. Water quality is generally not suitable for drinking, and some sources dry up during the dry season.

The existing municipal sewerage system covers a very limited area of the central part of Kisumu, with the remainder having on-site sanitation. The municipal system comprises two wastewater treatment districts (WTD's), namely the central and eastern WTD's. The central WTD collects wastewater by gravity from the area north west of the old town, and by pumping from the low-lying areas along the shore of Lake Victoria. The area covered is 390 ha, with 8.5 km of trunk sewers, and treatment at the conventional sewage treatment works (STW). All three existing pumping stations are not operational resulting in overflows from manholes and direct discharge into Lake Victoria. Intrusions of storm water and infiltration of ground water overloads the STW in the rainy season and effluent quality is below standard due to industrial wastewater which is not pretreated.

The eastern WTD collects wastewater from the south east of the old town for treatment at the Nyalenda STW. The area covered is 214 ha, with 8.0 km of trunk sewers. Lack of adequate water supply in the eastern WTD, is mainly responsible for the STW operating at 20% of its design capacity. Another major problem is wastewater overflows due to collapsed or blocked sewers.

There are several on-site community sewage treatment systems, the main ones being septic tanks and pit latrines. Septic tanks are used in low-density residential areas and some institutions. They operate satisfactorily and the municipal health department provides an emptying service with the one remaining vehicle. Pit latrines are commonly used in the peri-urban areas, but in locations subject to flooding they are prone to collapse. Another problem is the reduction of pit volume where the ground water level is high. Emptying of pits is problematic due to limited or no vehicular access, and contamination of ground water takes place seriously affecting nearby shallow wells and boreholes. In rural areas where population densities are low, the on-site facilities generally function well where ground conditions are favourable.

2.4 Planning Policies and Assumptions

This project aims to create a sustainable water supply and sewerage system. There are four key characteristics of this system: a) benefits are realized early given the urgency of water shortage; b) appropriate technologies are carefully selected for the project; c) the project includes the necessary elements of strengthening the local institutional and management capability; and d) it is designed to serve all residents of Kisumu.

The estimates of population projections adopted in this report will accommodate rapid growth in population of Kisumu. The projected population and its spatial distribution within Kisumu were checked against the policies contained in the Structure Plan of Kisumu. The Structure Plan was used as a basis of geographic distribution of the projected population with appropriate modifications. The modified 1997 municipal population is estimated as 363,157. This is projected to increase to 526,195 in 2005 and 869,166 in 2015. The implied growth rate between 1989 and 2015 is 4.77% per annum.

The municipal water supply is planned to supply areas where population density is higher than 40 persons/ha in 2015. With this definition, the municipal water supply system will cover virtually all the sub-locations classified as urban and peri-urban. It will also cover part of the adjacent rural sub-locations, such as Konya, Chiga, Nyalunya, Kadero and Okok. Each sub-location is categorised into seven land use types: residential, commercial, industrial, agricultural, wet, hilly and airport areas. Wet, hilly areas and the airport is assumed to be uninhabited. The total extent of the proposed service area is estimated to be 87.7 km^2.

All of the areas remaining outside this area will be served by the rural water supply schemes. These are grouped into five areas for planning purposes and schemes are proposed for each.

The second key parameter determining the size of service contained in the Master Plan is standards. Target water consumption levels are specified on the basis of Kenya Design Manual. These are:

	Per capita consumption: litters/day	
	Urban Area	Peri-urban area
Individual connections		
High-income	200	120
Medium-income	120	60
Low-income	60	50
Communal taps	20	15

The target consumption levels designated for the peri-urban areas were also used for the rural areas. The estimates of population distribution by income groups derive from the original data collected by the Study Team.

It is estimated that in 2005 approximately 70 % (289,728) of the total population in the municipal water supply area will be supplied through individual house connection with an average consumption rate ranging from 50 to 200 lcd. The remaining 30 % will be served by communal taps with an average consumption rate of 15 to 20 lcd. The ratio of individual house connection supply is estimated to be 92 % in urban areas and 63 % in peri-urban and rural areas in 2005.

The domestic water demand estimated on the basis of these parameters is 24,873 m3/day in 2005 and 41,952 in 2015. The other major components for the total demand are industry/commerce, and institutions. This is estimated from the expected land use in the modified Structure Plan. The total demand thus estimated is:

Total Water demand in Municipal Water Supply System (m3/day)

Year	Domestic Water Demand	Non-domestic Water Demand				Total Water Demand
		Institutional	Commercial	Industrial	Sub-total	
2005	24,873	2,860	5,680	8,480	17,020	41,893
2015	41,952	6,500	8,300	15,500	30,300	72,252

Day maximum water demand and peak hourly flow is derived from the average demand given above. Peak hourly flow is used for the planning of distribution pumps and pipelines while day maximum demand determines planning of distribution reservoirs and clear water transmission pumps and pipelines. For planning the water treatment works, an allowance of 5 % is added to the day maximum water demand to compensate water losses at the works. For water intake and raw water transmission facilities, another 3 to 5 % allowance for water losses is added to the treatment capacity required.

The sewerage system designed aims to achieve high environmental standards. The proposed system will collect more than 80% of wastewater generated in the Project area in 2015.

The proposed service area is divided into three wastewater treatment districts, namely Central, Eastern and Western Wastewater Treatment Districts (WTDs), taking topographic conditions, locations of existing trunk sewers and sewage treatment works, future water supply service area and future land use plan.

Domestic wastewater generation volumes are estimated for different domestic water consumption rates. They are basically the same as the projected per capita consumption rates, except that wastewater generation from households who consume 200 lcd is assumed to generate 190 lcd or 95 % of water consumed.

Non-domestic wastewater comprise wastewater generated from institutional, commercial and industrial activities. The first two are estimated from the projected water demands multiplied by ratios of 0.80 and 0.85 respectively. Wastewater from general industries is assumed to be 80 % of the projected water demand. Wastewater from large industrial users is estimated through interviews with factories and from the results of previous studies. It is assumed that the proposed municipal sewerage system will collect most of the non-domestic wastewater generated within the municipal water supply system.

The consistency of the quality of outflow depends on controlling the inflow parameters. The Study Team has, therefore, proposed standards for industrial effluents.

The future industrial loads on treatment works have been calculated assuming that the present day discharges will comply with the proposed trade effluent standards. General industrial effluents have been estimated at having the following estimated qualities: BOD 500 mg/l; SS 600 mg/l ; and the absence of substances which would adversely affect biological treatment processes, and thus they are reflected in the proposed effluent standards.

The ultimate disposal location for the sewage treatment works effluent is Lake Victoria. The standards set out below for the effluents are drawn up to prevent pollution of the lake waters and to protect public waters.

- Biological Oxygen Demand (BOD) Concentration -20 mg/l
- Suspended Solids (SS) concentration -30 mg/l
- Faecal Coilform concentration (pond effluents only) -5,000 CFU/100 ml

2.5 Water Supply and Sewerage Master Plan

The analysis of existing conditions, requirements, constraints and the planning policies and assumptions formulated by the Study Team are fully reflected in the proposed Master Plan. The Master Plan addresses key engineering issues of the planned water and sewerage system, its management, and financial viability of the proposed investments. Priority projects to be implemented during the first Phase of the Master Plan are also identified on the basis of these findings, and the criteria formulated together with the representatives of Government of Kenya.

Water Supply

The average water amount supplied in 2015 is estimated to be 96,300 m3/day. This requires treatment capacity of 108,000 m3/day. The existing supply capacity in Kisumu is around 18,000 m^3/d. It is planned to increase this by around 10,000 m^3/d under rehabilitation works. This will be followed by creating an additional capacity of around 40,000 m^3/d. The total supply capacity will thus increase to around 68,000 m^3/d in Phase I. This capacity is planned to be completed by the year 2003. Demand at the end of Master Plan period requires that an additional capacity of 40,000 m3/day is created during the second half of the Master Plan period. This will increase the total supply capacity to 108,000 m3/day.

The possible sources of water for two times of expansion, each by 40,000 me/day are Sondu, Kibos/Awach and Yala rivers. The likely water sources and all possible combinations of these were evaluated based on costs, flexibility of facility expansion, reliability and control over source, water quality, management requirements and environmental impact.

For all alternatives, the location of new treatment works is fixed at the site of existing Kibuye distribution reservoir. The downstream facilities including water transmission and distribution facilities do not vary with the alternative selected. The most desirable alternative was found to be intake through two weirs to be built on Kibos and Awach rivers during Phase I. This is followed by additional capacity to be built on the Lake for the Second Phase of Master Plan.

Key parameters of the proposed plan are given below. Further details of works involved in each are given in Volume 2, Chapter 6.

ITEM			1997	PHASE I	PHASE II
Target Year			-	2005	2015
Total Population in the Study Area			363,157	526,195	869,166
Population Served			224,456	414,530	690,628
Service Ratio		%	61.8	78.8	79.5
Service Area		Km^2	88.0	88.0	88.0
Water Demand	Day Average	m^3/d	11,900*	59,174	96,336
Water Treatment Works	Kajulu	m^3/d	1,400	2,800	2,800
	Lake	m^3/d	16,600	25,000	25,000
	Kibuye	m^3/d	-	40,000	80,000
	Total	m^3/d	18,000	67,800	107,800
Service Reservoirs	Kibuye	m^3	6,300	33,300	52,300
	Kanyakwar	m^3	-	5,000	8,000
	Kogony	m^3	-	3,500	7,500
	Kajulu	m^3	-	700	1,400
	Total	m^3	6,300	42,500	69,200
Raw Water Trans. Mains	o 200 mm - o 900 mm	km	0.6	20.6	27.0
Treated Water Trans. Mains	o 150 mm - o 550 mm	km	16.0	35.2	35.2
Water Distribution Mains	o 150 mm - o 800 mm	km	63.0	112.4	139.9
Service Mains	o 80 mm - o 100 mm	km	49.0	379	611

In addition to the central distribution system presented above, five sub-urban water supply areas are proposed for the Master Plan. Two water supply options have been developed for each of these areas. One involves drilling a deep well around 50 m in depth and will be equipped with a hand pump. The other option is based on introduction of submergible pump to increase the abstraction capacity. The evaluation of these two options indicates that they have similar costs each may be appropriate for a different area depending on water availability and water demand.

Implementation arrangements for these sub-urban water supply systems have been proposed. These heavily rely on community participation in management.

Wastewater management

The proposed wastewater collection and treatment facilities differentiate between the requirements in high and low density areas. The proposed wastewater plan will collect, with the combined use of conventional sewerage system and shallow sewers, 60 % of the total wastewater generation in 2005. This percentage will increase to 83 % in 2015. In this context, conventional sewerage system is assumed to collect most of non-domestic wastewater as well as domestic wastewater from households whose water consumption rates are 100 lcd or greater. Shallow sewers will collect domestic wastewater from those who consume 50 to 60 lcd, and those who consume 15 to 20 lcd will be served with on-site sanitation facilities.

The wastewater collection system is conceived in three parts. These are Central, Eastern, and Western WTDs. Of the above three wastewater treatment districts, the Central and Eastern WTDs are currently existing although wastewater collection systems in these districts are not functioning properly and require extensive improvements under Phase I. The Western WTD is proposed to be installed in Phase II to increase the wastewater collection from 60 % after Phase I to 83 % in 2015.

The details of rehabilitation works required for the three existing pumping stations are included in the Master Plan. In addition three new stations are proposed in Kombedu, Labour College and at Nyelanda STW.

A priority concern for sewerage works is the treatment system. The sewage treatment works have been subjected to severe overloading in terms of sewage volume and loads. The quality of effluent far exceeds the wastewater standards. Therefore, the rehabilitation of existing facilities is highlighted to raise their efficiency and is proposed for early implementation. The inlet, primary sedimentation tanks, and secondary sedimentation tanks will need to be expanded to cope with the projected inflows to the plant.

A new treatment plant is proposed for Phase II in Otongole. Under Phase II, sewerage collection and treatment facilities will be installed in a new wastewater treatment district called "Western WTD". This district will cover most of residential areas in Kanyakwar, Korando and Kogony and part of industrial area in Kibuye near the Kisumu Airport and Otongolo Industrial Estate. The Otongolo STW will be located to the west of the Kisumu Airport and treat wastewaters to be collected in this newly installed wastewater treatment district.

Operation and maintenance plan

The proper functioning of the proposed facilities will depend on strict adherence to the O/M requirements of the system. The Master Plan provides O/M guidelines for water quantity and quality management; maintenance of equipment; leakage reduction program; and water meter improvement plans for the water sector. Separate O/M guidelines are provided for sewers; pumping stations; and sewerage treatment works. For the last, a detailed assessment of comparative advantages of waste stabilisation ponds vs. conventional treatment has been provided.

Investment requirements and financing

The total direct investment cost of all projects covered by the Master Plan is estimated to be $112.4 million in 1997 prices. Considering the overall investment period, price and physical contingencies are added to the estimated investment costs. Other costs are also separately

estimated and added to derive the overall costs. This is $ 164.2 million over the master plan period. The breakdown between various components is as follows:

	(Costs in Thousand dollars)		
	Phase I	**Phase II**	**Total**
Direct construction costs			
Water Supply system	48,476	26,735	75,211
Sewerage system	14,234	23,001	37,235
Consultancy services	7,844	6,221	14,065
Contingencies			
Price contingency	11,096	8,900	19,896
Physical contingency	8,130	6,448	14,576
Administration cost	1,789	1,419	3,208
Overall total	**91,596**	**72,624**	**164,193**

It is assumed that foreign loans extended at favourable terms will finance 85% of the total costs. The rest will be provided by the government of Kenya as a loan to the Kisumu Council. The project will not be able to pay the interest during the construction phase. Interest during that period is capitalised. This increases the total financing requirements to $174.1 million and the total foreign loan requirement to $ 148 million.

Organisation and management

The proper management of the proposed system will require major improvements in management and staff capability of the water and sewerage department. Key institutional and legal issues include revisions of water act and introduction of an environmental management and co-ordination bill. A new organisation structure is proposed for the w/s department. The large number of vacancies in key posts is a major issue.

The need for further staff training is acute. The type of training required and the available facilities are noted for different levels of staff. A large number of training programs required already exist in various government departments.

Public participation

There is a need to strengthen the ties between the w/s department and the public. This is required for the maintenance of the system as well as better management. Increased public participation will improve the system's responsiveness to public needs. Awareness of water borne diseases and environmental hygiene is not sufficiently developed. It is recommended the Council and the w/s department should undertake new campaigns for this purpose.

Implementation schedule and overall evaluation

The Study Team has prepared an implementation schedule that recognises the urgent needs, and yet takes the requirements of international funding agencies. Realistically, it is expected that the loan arrangements will be completed by the end of 1999. This will be followed by detailed design. Actual construction will commence late in the year 2000.

Financial and economic evaluation show that the proposed project is viable . For the Master plan as a whole the IRR is estimated to be 3.6%. Detailed estimates were conducted on expected project revenues and expenditures for components covered by the feasibility study. The IRR was found to be even more favourable for this component. The base case IRR is 5.15 in this case. The estimated IRR remains positive under all likely adverse scenarios in tariffs, increases in costs and possible delays in project implementation.

2.6 Initial Environmental Examination

An Initial Environmental Examination (IEE) was carried out to identify potential impacts of the proposed Master plan and to prepare information for the Environmental Impact Assessment (EIA) for the Phase I project identified in the Feasibility Study. In order to identify the potential impacts a checklist method was applied for 23 environmental items defined by the JICA Environmental Guidelines.

The IEE looked into the impacts during the construction stage, and the impacts by the water supply and sewerage components during operation. Impacts were assessed over a wide range of items including water rights and common rights, water pollution, lake, marsh and river, flora and fauna, waste disposal, groundwater and soil contamination, and offensive odor. The project is expected to have some positive impacts on the human and social environment, for example in economic activities and sanitation.

As a result of the IEE, environmental items requiring further investigation were carried forward to the EIA at feasibility study stage.

CHAPTER 3

FEASIBILITY STUDY OF PHASE I PROJECT

3 FEASIBILITY STUDY OF PHASE I PROJECT

3.1 Feasibility Study Area

The JICA Master Plan envisages that the Feasibility Study Area, although in terms of area is only 30% of the total municipal area of 297 km2, will accommodate approximately 80% of the total municipal population in the year 2005 with an average population density of 47 persons/ha.

The Master Plan also envisages that the extension of the municipal water supply system to areas beyond this feasibility Study Area is not an economical solution, as the population density in those areas is estimated to remain very low in the future. For this reason the Master Plan recommended that those rural areas be provided with rural water supply schemes based on local groundwater, which will be completely separate from the municipal water supply system.

3.2 Population, Water Demand and Wastewater Generation

The municipal population of Kisumu was projected up to the year 2015, using the last three population census and various other related reports. The total municipal population in 1997 was estimated to be 363,157, increasing to 526,195 by the feasibility target year of 2005, at an average growth rate of 4.74 %. The population in the feasibility study area was estimated at 414,531 (79% of total population) with only a few of the less densely populated rural type areas being excluded from Phase I.

With a policy of "some for all rather than more for some," 100% of the study area is to be supplied with water. 70% of households will be supplied via individual connections, whilst the remaining 30% will purchase water from common taps grouped into kiosks. Non-domestic water supply was calculated on the basis of studies of land use growth rates of institutions, commerce and industry. Total water demand was estimated to be 41,893 m3/day in 2005.

In 2005, it is estimated that almost the whole amount of water that is domestically consumed will be generated as wastewater, and 46% of this will be collected by the municipal sewerage system. Non-domestic wastewater generation is estimated to be 85% of commercial water supplied, 80% of institutional, and between 80 and 100% of industrial water. Overall, 60% of the total wastewater generated of 38,900m3/day in the year 2005, will be collected by the municipal sewerage system.

3.3 Water Supply Improvement Plans and Costs

The Study Team evaluated various water sources by reviewing previous studies. At the end of these reviews, the Study Team selected the Kibos and Awach/Nyangori Rivers (hereinafter referred to as the "Awach River"), and Lake Victoria as the most preferable water sources for the priority project. Hydrological analyses based on raw hydrological data are conducted to confirm the availability of raw water from the Kibos and Awach rivers.

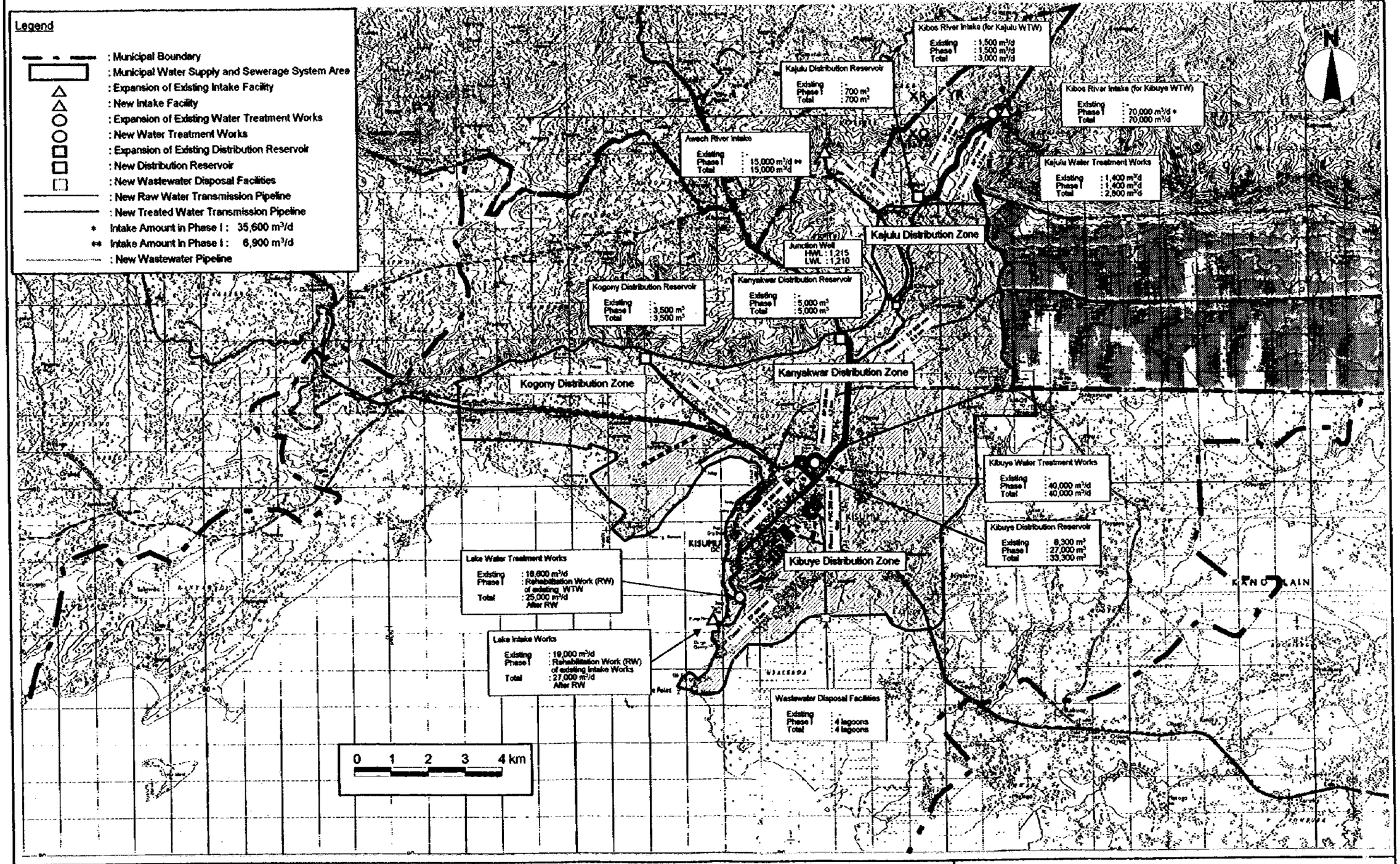
The analysis of water resources concluded that 45,000 cubic meters of water could be abstracted from these two rivers with 96% probability. The amount of water drawn from these rivers can be further increased during the second half of Master Plan provided that dry period requirements are partially met by abstraction from the Lake.

The present supply capacity of water is 18,000 cubic meters per day. The implementation of rehabilitation component of the priority projects will increase this capacity to 27,800 cubic meters per day. A further component of 40,000 cubic meters per day will be added through the expansion component. The total supply capacity will increase to a total of 67,800 cubic meters per day when the implementation of Phase I is completed in the year 2002. The increased capacity will be on-stream at the beginning of 2003.

The major components of the improvement plan are given in Figure 1. A third water treatment plant will be added in Kibuye to the two existing ones on the Lake and Kajulu. The treatment capacity of the existing facility on the lake will be increased from the current 16,600 to 25,000 per day and on Kajulu from 1,400 to 2,800 per day. Treated water from the lake water treatment works will be pumped to Kibuye distribution reservoir through a new 550 mm pipeline over a distance of approximately 5.2 km. Treated water from the Kajulu works will gravitate to the Kajulu distribution reservoir through a new 200 mm pipeline approximately 3.6 km in length.

The new water treatment works, with a capacity of 40,000 m3/day, will be constructed at Kibuye immediately adjacent to the existing Kibuye reservoir site. Raw water for the new Kibuye WTW will be taken from the Kibos and Awach rivers at the locations about 15 km to the north of the water works.

Figure 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 Water Supply Improvement Plan Proposed under Phase I Project

A new water intake will be constructed on the Awach river at about 1.3 km downstream of the confluence where the Joprok and Kepkerer rivers meet. Water from the new Awach intake will gravitate through a new 400 mm steel pipeline to a junction well to be provided at 6 km to the southeast. The existing intake on the Kibos river will be renovated and 35,600 m3/day of raw water will be taken for treatment at the new Kibuye WTW. Water from the intake will gravitate through a new 700 mm steel pipeline to the above junction well; will be mixed with water from the Awach river; and will further gravitate to the Kibuye WTW through a new 900 mm raw water transmission main over a distance of 5.9 km. Both of these intakes and all of the raw water transmission pipelines which will connect them to the new Kibuye WTW will be sized, from the outset, to meet the raw water requirement of the Phase II Project, which is 85,000 m3/day.

With respect to the water distribution, the entire municipal water supply system area will be divided into four separate distribution zones, i.e. Kibuye, Kanyakwar, Kogony and Kajulu Distribution Zones. In each distribution zone, water will be distributed by gravity from a distribution reservoir which will be located within the zone.

The Kibuye Distribution Reservoir is expected to play a key role. The reservoir will receive treated water both from the Lake WTW and from the new Kibuye WTW. It will be located on a hill at an elevation of 1,190 m. This provides enough hydraulic head for water from the reservoir to gravitate to the entire Kibuye Distribution Zone. Water from the reservoir will be also pumped to Kanyakwar and Kogony Distribution reservoirs. From these, water will gravitate to the respective distribution zones.

The fourth distribution reservoir, i.e. the Kajulu Distribution reservoir will be constructed in the Okok sub-location at an elevation of 1,220 m. This reservoir will receive treated water from the Kajulu WTW by gravity and further distribute it to the Kajulu Distribution Zone by gravity.

The estimated population of each zone in 2005 and the projected water consumption is given below.

		Day Ave.			Day Max.
Distribution Zone	Population	Domestic	Non-domestic	Total	
Kibuye	331,632	19,742	14,271	34,013	52,846
Kanyakwar	33,011	2,819	1,321	4,140	6,432
Kogony	34,762	1,612	1,275	2,887	4,485
Kajulu	15,128	702	153	855	1,329
Total	414,533	24,875	17,020	41,895	65,092

The Phase I also includes substantial expansion in the distribution system to provide service to the households currently not connected to the system. This includes installation of 49 km of trunk distribution mains and 330 km of secondary distribution mains.

The total direct cost of the water supply component is estimated to be $46.5 million in constant 1997 prices. The rehabilitation component is projected to cost $7.9 million and the rest is allocated to the expansion component.

Municipal Water Supply System - Rehabilitation Works Component

Package No.	Description of Works Included	Construction Base Cost (US$)
RW-S1	• Supply and installation of equipment for rehabilitation of Kajulu and Lake WTWs	4,029,000
RW-C1	• Rehabilitation of Kajulu water intake and Kajulu WTW • Construction of Kajulu Distribution Reservoir (700 m3) • Construction of treated water transmission main (SP 200 mm, L=3.6 km) from Kajulu WTW to Kajulu Distribution Reservoir	273,000
RW-C2	• Rehabilitation of Lake water intake and Lake WTW • Construction of raw water transmission main (SP 450, L=1.2 km) from Lake water intake to Lake WTW • Construction of treated water transmission main (SP 550 mm, L=5.2 km) from Lake WTW to Kibuye Distribution Reservoir	3,650,000
Total		**7,952,000**

Municipal Water Supply System - Expansion Works Component

Package No.	Description of Work Included	Construction Base Cost (US$)
EW-S1	• Supply and installation of equipment for construction of new Kibuye WTW	6,076,000
EW-C1	• Construction of new water intakes on Awach and Kibos rivers	1,680,000
EW-C2	• Construction of new raw water transmission mains (SP 400 to 900 mm, L=18.8 km) from new Awach and Kibos water intakes to Kibuye WTW, including construction of a junction well	7,443,500
EW-C3	• Construction of new Kibuye WTW (40,000 m3/day) including high lift distribution pump station at Kibuye WTW to pump treated water to Kanyakwar and Kogony Distribution Reservoirs, wastewater disposal facilities at Nyalenda, and wastewater disposal main from Kibuye WTW to Nyalenda (PVC 200 mm, L=4.0 km)	5,491,000
EW-C4	• Construction of new distribution reservoir at Kibuye (27,000 m3/day)	1,440,600
EW-C5	• Construction of new Kanyakwar Distribution Reservoir (5,000 m3) • Construction of new treated water transmission main (SP 350 mm, L=4.2 km) from Kibuye Distribution Reservoir to Kanyakwar Distribution Reservoir	1,022,200

EW-C6	• Construction of new Kogony Distribution Reservoir (3,500 m3) • Construction of new treated water transmission main (SP 400 mm, L=6.2 km) from Kibuye Distribution Reservoir to Kogony Distribution Reservoir	1,488,600
EW-C7	• Installation of new trunk distribution mains (PVC & SP 160 to 800 mm, L=49 km)	8,913,625
EW-C8	• Installation of new secondary distribution mains (PVC 63 to 110 mm, L=330 km) including construction of 223 communal taps (water kiosks)	5,022,000
Total		**38,577,,525**

3.4 Sewerage Improvement Plans and Costs

Rehabilitation of the existing system is emphasized in the sewerage improvement plan in Phase I. At the same time, almost the entire urban and suburban area within the municipal boundaries is included in the service coverage of the sewerage system. A substantial part of the water supplied by the municipal water supply system will be collected and treated by the system.

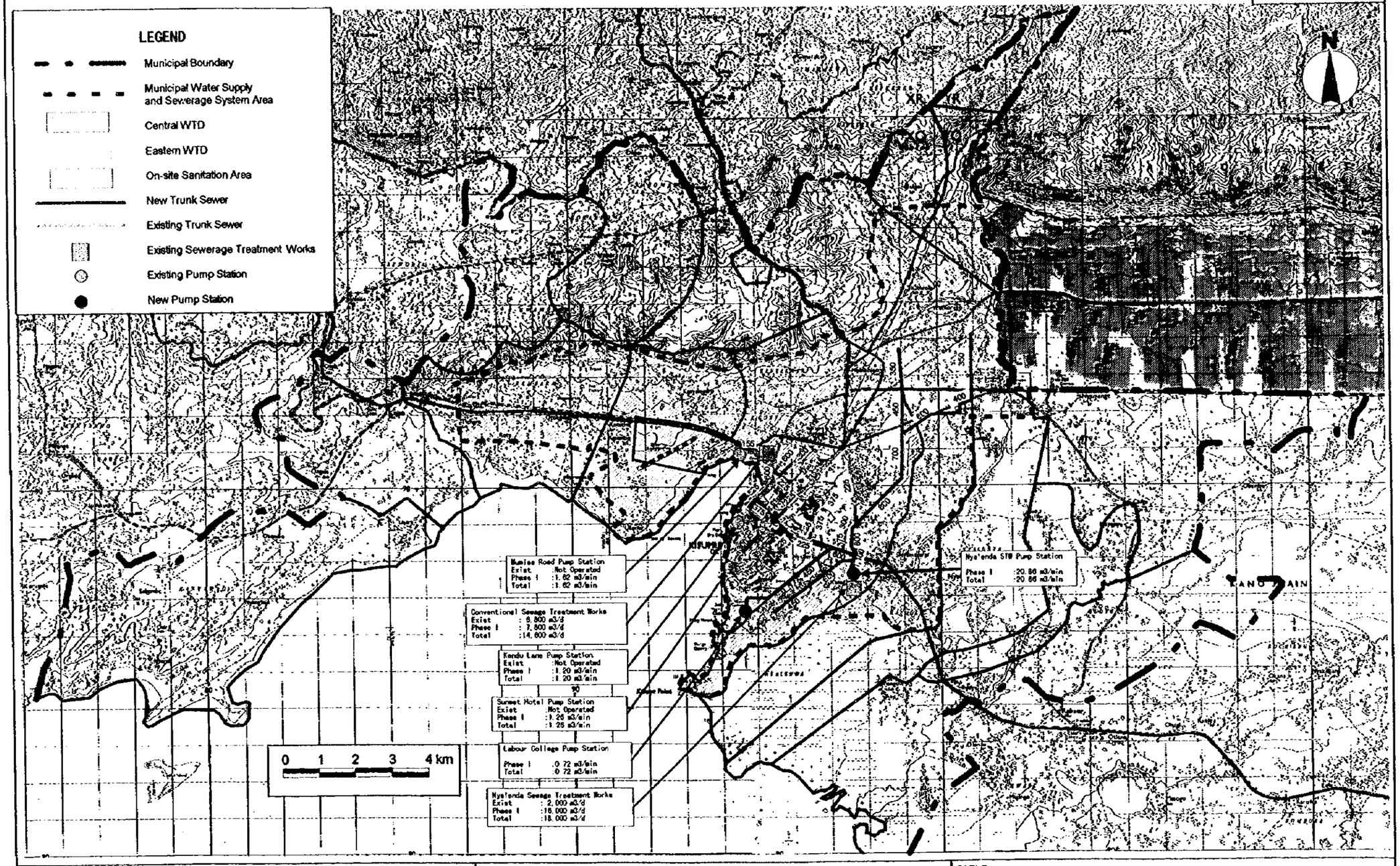
The present coverage of sewerage services in the central WTD is quite extensive and a modest expansion is needed for this district. In the relatively less developed Eastern district, in contrast, the Project provides substantial expansion: from the existing 214 to 1,358 ha. by 2005.

The rehabilitation component under the sewerage system includes replacement of 420 meters of trunk sewers that are broken/collapsed in Eastern WTD. Three existing pumps in the Central WTD which are not operative will be rehabilitated. This will prevent direct discharge of wastewater into Lake Victoria and sewage outflows from manholes upstream of the stations.

The expansion works will replace 2.6 km of trunk sewers in Central WTD. The replacement will provide pipes with a larger diameter in the light of expected design flow in 2015. A total of 23 km of new trunk sewers will be installed in Eastern WTD. A total of 123 km of branch sewers will also be installed in this district. The major components of the sewerage improvement plan are given in Figure 2.

Both the Central and Eastern WTD will be supplied with shallow sewers of 100 mm in diameter and 91 km in total length. These will be installed within private premises to collect domestic wastewater from households whose water consumption rate is between 50 and 60 lcd. It is estimated that a total population of 82,700 (13,785 households assuming 6 persons per household) will fall within this category.

Figure 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 Sewerage System Improvement Plan Proposed under Phase I Project

Kisumu town and Lake Victoria are facing major environmental problems due to serious problems in sewerage treatment facilities. Consequently, detailed proposals have been developed to rehabilitate the existing treatment facilities and expand their capacity. These are specified separately for the conventional treatment works and Nyalenda treatment works.

The total direct cost of sewerage system improvements in Phase I is estimated to be $14.2 million. A small part of this will be needed for rehabilitation ($1.39 million). The expansion work is conceived in four packages. These are:

Municipal Sewerage System

	Component	Construction Base Cost (1,000 US$)
I.	• Supply and Installation of Equipment for Conventional STW and Nyalenda STW • Supply and Installation of Equipment for Construction of New Labour College Pump Station and Nyalenda STW Pump Station	957
II.	• Installation of Trunk Sewers: Eastern WTD (uPVC & CP 125 to 1,100 mm, L=22.7 km) Central WTD (uPVC & CP 250 to 400 mm, L=2.6 km)	3,942
III.	• Installation of Branch Sewers in Eastern and Central WTDs (uPVC 200 mm, L=123 km) • Supply of shallow sewer pipes (uPVC 100 mm, L=91 km)	5,524
IV.	• Expansion of Conventional STW and Nyalenda STW • Construction of Labour College Pump Station and Nyalenda STW Pump Station	2,423
Total		**12,846**

3.5 Strengthening of Institutional Capacity

Neither KMC nor the WSD presently have the institutional capacity to provide for the proper implementation and control of the proposed rehabilitation and expansion project. Strengthening must take place in two separate stages.

The first stage should commence immediately, and will be entirely controlled by the Kenyan side. The financial and management capacity of KMC must be improved by the KLGRP through its secretariat within MOLA. This will ensure that a stronger municipal institution is in place with a healthier revenue base.

The WSD must be strengthened in parallel with recruitment of suitably qualified and experienced staff to manage the Commercial Division, and the Operation and Maintenance Division. These two Deputy General Managers may then make recommendations for the recruitment of other support staff within their divisions. This capacity building within WSD will ensure that the information from the Block Mapping programme can be used effectively to update the information on water meters. This will lead to a reduction in the unaccounted for water in respect of incorrect meter readings and illegal connections, and result in increased revenue. In addition, the suggested restoration of direct pumping to Kibuye reservoir will make it possible to give intermittent supplies to a much larger proportion of the distribution system, with an increase to the number of consumers and consequent increase in revenue.

With a stronger management team and increased revenue, good progress may be made towards the formation of a WSD which is truly autonomous both operationally and financially. KMC will not suffer any loss of revenue transfers from the WSD to the council's general fund, and can control the new management team through the councillors and chief officers on the Water and Sewerage Committee.

With a reasonably efficient and fully autonomous WSD in place, Further institutional strengthening may then take place effectively through the provisions of the Phase I project.

During the design stage, two important programmes are planned to provide both physical improvements and capacity building. The Unaccounted for Water (UFW) Reduction programme will provide leak detection/repair equipment, and will develop a special task force within the WSD which will become a permanent unit to control UFW. In addition the programme will provide 11,000 water meters to replace the existing meters, and form a meter installation unit which will be needed for the years to come as the number of installed meters will increase dramatically, particularly during the first few years after Phase I is commissioned.

The second Phase I programme is specifically aimed at institutional strengthening with respect to management and financial control. This Management and Institutional (M/I) improvement programme will first assist with the formation of a Project Management Unit. This unit will provide for KMC's co-ordination of the project, reporting to the Water and Sewerage Committee. The programme will then set up a special management consultancy for staff recruitment as necessary, and the drawing up of salary scales, terms and conditions of service etc. The financial improvement programme will prepare and introduce a commercialised computer accounting system, and supply the computers. Assistance and advice will be given on commercial objectives and strategic plans, including the annual budget and a 5 year corporate plan.

The M/I programme will conclude with the drawing up of the legal documentation for the formation of a private company, wholly owned by KMC, but operated as a Water and Sewerage Company, under the Companies Act. The programme will follow closely the MOLA/GTZ UWASAM methodology, and liaise closely with the personnel of MOLA who have been involved with the UWASAM project.

The institutional capacity will be considerably strengthened by an intensive training programme, during the Phase I design and construction period. On the job (OTJ) training will take place throughout the UFW and M/I progammes, and the construction period. Training needs for technical staff will be assessed during the M/I programme, and training will take place at KEWI. Overseas training for senior management may be effected by the JICA counterpart training programme.

3.6 Project Implementation Schedule

Figure 3 presents the overall implementation of the Phase I project. The schedule is based on the assumption that a large portion of the cost will be financed through an international lending agency. The JICA Feasibility Study is scheduled to be completed in late August 1998. It will then be subjected to an appraisal by the Kenyan Government, and, if it gains the government's consent, an application for a financial loan will be submitted to an international lending agency.

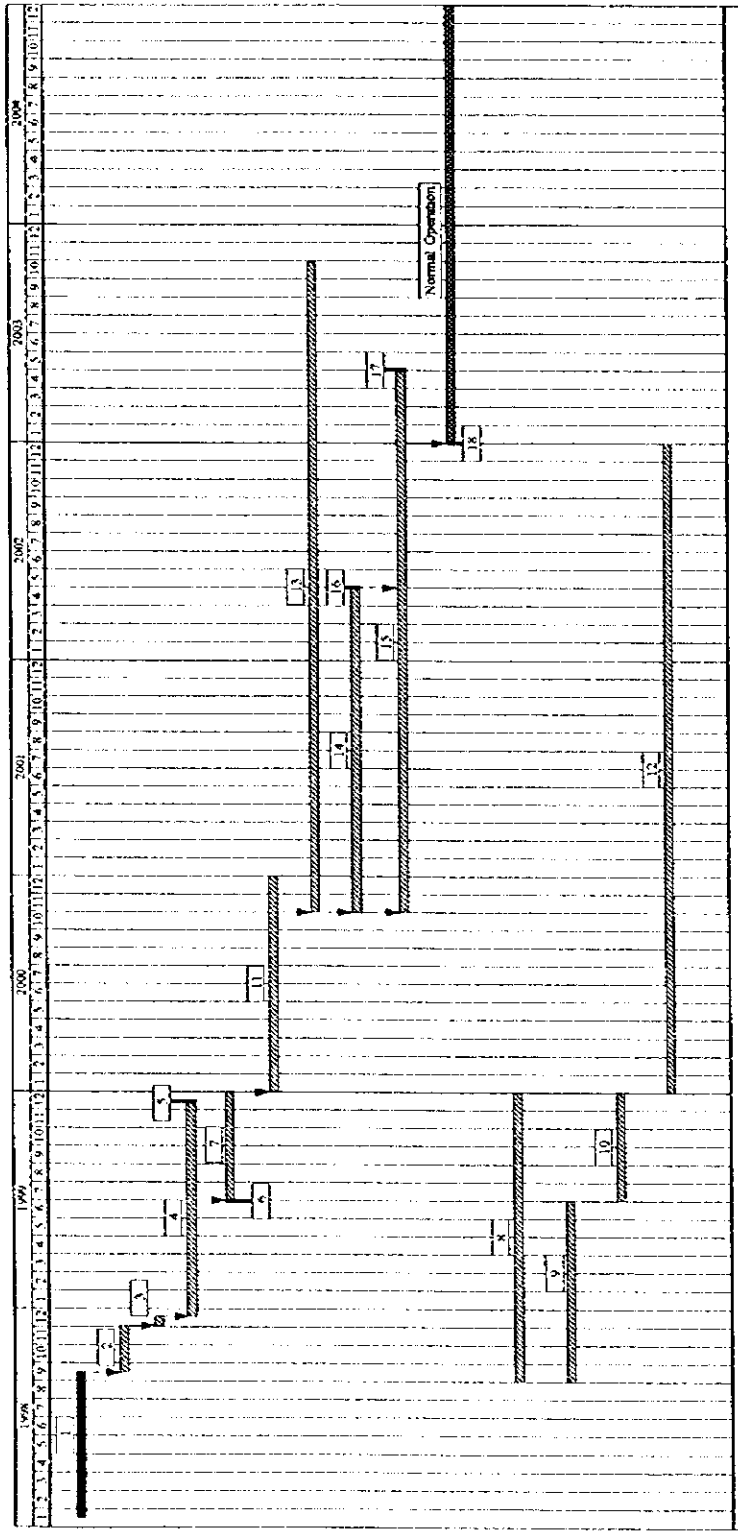
The process of employing consultants normally takes one year if it follows the normal selection procedures recommended by the lending agencies guidelines. However, given the urgency of the project, it is assumed that consultants will be selected on the basis of a direct appointment, and that the same consultants will be appointed for both detailed design and construction supervision on the basis of one contract.

Detailed design should take approximately one year, and the total input is estimated to be 48 man-months of expatriate engineers and 120 man-months of local engineers and draftsmen.

For the construction stage it is estimated that the total input will comprise, 140 man-months of expatriate engineers, 180 man-months of local engineers, and 400 man-months of local inspectors, draftsmen and surveyors.

The total cost for both of these consultancy services is estimated at US$ 6,000,000.

Figure 3



EVENTS

1. JICA Feasibility Study
2. Appraisal by Kenyan Government
3. Application for loan by Kenyan Government
4. Appraisal by Lending Agency
5. Signing of Loan
6. Pledge of Loan by Lending Agency
7. Employment of Consultants for Detailed Design and Construction Supervision and for Other Consultancy Services (Time required is base on Direct Appointment)
8. Support to on-going institutional improvements (See Figure 7-4 for more details)
9. Formulation of fully autonomous WSD
10. Employment of Consultants for UFW Reduction Programme and Management / Institutional Improvement
11. Detailed Design
12. UFW Reduction Programme & Management / Institutional Improvement (See Figure 7-4 for more details)
13. Construction Supervision
14. Supply and Installation of Mechanical and Electrical Equipment (Including Tendering)
15. Civil Works and Pipe Installation Works (Including Tendering)
16. Delivery of Mechanical and Electrical Equipment to Construction Sites
17. Completion of Construction Works
18. Commissioning of Phase I Project

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 : Implementation Schedule of Phase I Project

In addition to the physical construction works, consultants are also required for the improvement of the institutional and management capacity, and for the reduction of unaccounted for water. These will take place over a two year period during the design period and through into the construction phase. Total cost of these services including equipment is estimated to be US$ 1,844,000.

The earliest possible timing for an increase in the water supply capacity, by both rehabilitation and expansion, will be the beginning of 2003, and Phase I would meet the projected water demand to the target year of 2005. Figure 4 presents an overview of the projected water demand against the supply capacity in terms of water treatment.

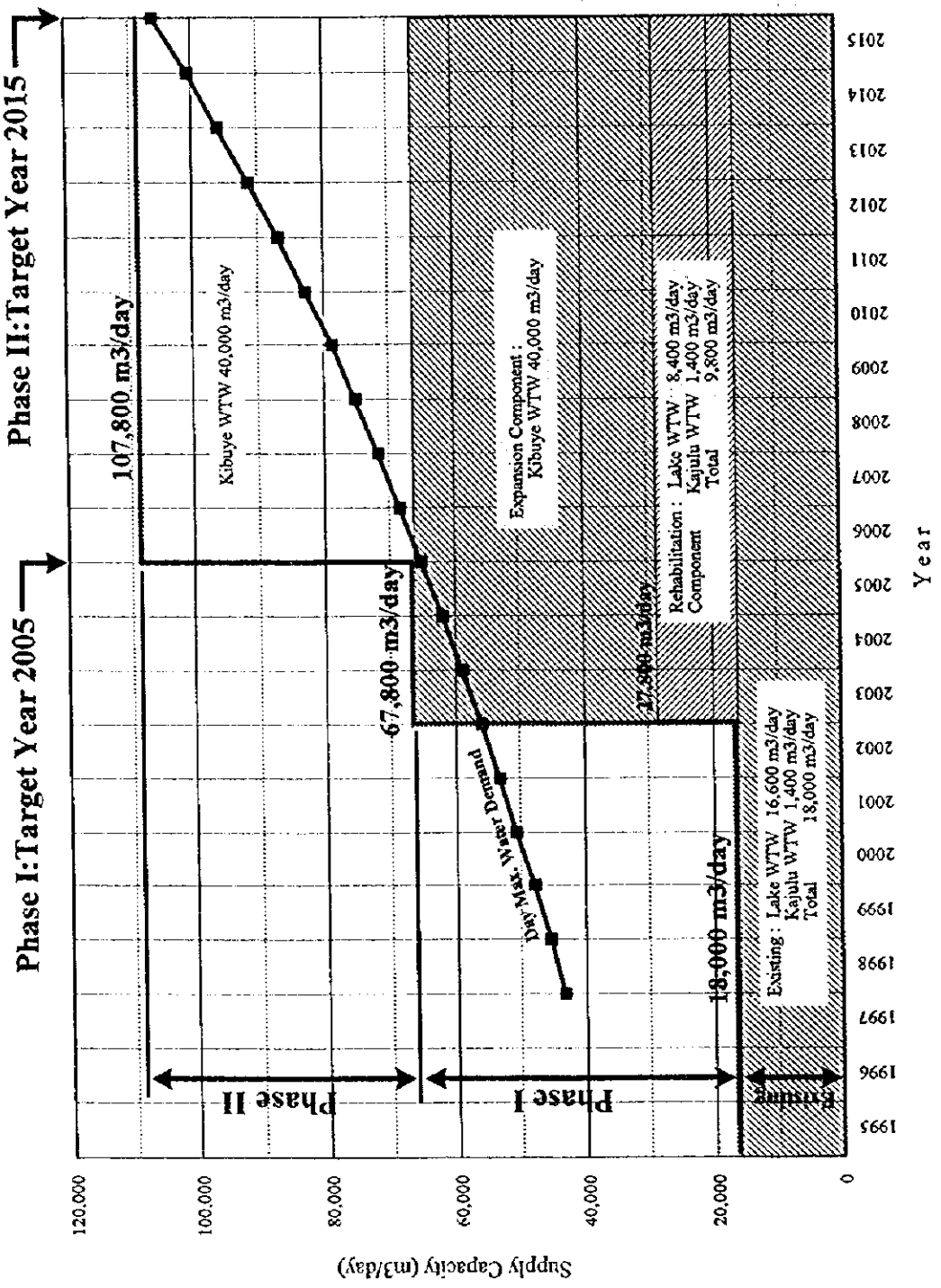
Most of the sewerage improvements in Phase I are focused on the rehabilitation of major existing sewerage facilities to recover their original design functions. Major extensions will be required later, mainly in the western part of the municipality, and will form part of the Phase II project.

3.7 Project Costs and Financial Analysis

The direct construction cost of Phase I is estimated to be $62 million in constant 1997 prices. The estimates of other costs are derived from these direct costs.

	.....Cost Estimates in thousand dollars.....		
	Rehabilitation	Expansion	Total
Direct construction costs			
Water supply System	7,952	40,178	48,130
Sewerage System	1,388	12,846	14,234
Sub-total	9,340	53,024	62,364
Consultancy Services			7,844
Contingencies			
Price Contingency			11,096
Physical Contingency			8,130
Administration Cost			1,789
Sub-total			21,015
Total			**91,223**

Figure 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 : Day Maximum Demand VS Supply Capacity

The project revenue is estimated basis of proposed water tariffs, expected changes in demand, and the incremental supply capacity to be generated by the project. Excluding the sales from the existing capacity, the project is estimated to generate additional revenues of around $ 11 million in constant 1997 prices. Operating costs are low by comparisons (one-third of the revenue) and the balance will be used to service a possible loan. As is typical of infrastructure, the project is capital intensive and has a long economic life. This is reflected in the planned financing system.

The revenue from water sales is an indispensable source of income for the Kisumu Municipality at present. The Council officials have agreed to a scheme whereby the income for the Council will be confined to a part of the sales from the existing capacity. All of the incremental income generated by the new project will be managed separately.

Kenya is among the "least developed" of the developing countries. As such, it is eligible for financing on favourable terms from the development finance sources. It is assumed that external funds will finance 85% of the total project costs with on interest rate of 1.6% per annum, 10-year grace period and 20-year repayment period. The rest is assumed to be provided as a loan from the central government of Kenya to the Municipal Council of Kisumu, which carries the similar loan conditions.

The project will start to generate sufficient funds to pay the interest on the loan four years after the expansion is initiated. At full development, the project will generate an operating surplus of $8.5 million per annum. At its peak, the loan service requirement, for both interest and repayment of the principal, is estimated to be $6.3 million.

3.8 Environmental Impact Assessment

The results of an Initial Environment Examination carried out as part of the Master Plan identified items of potential environmental impact of Phase I. It was assessed that potential impacts would be caused by construction works, water abstraction from rivers, increase of wastewater generation, and operation of sewage treatment works.

Construction works are of a temporary nature and the countermeasures proposed will be enforced during the construction period. Countermeasures for river abstraction are proposed as the maintenance of a flow not less than the recorded daily minimum flow in the river. Phase I has a positive impact on water pollution by wastewater generation where this is directed to treatment works. For the 40% of wastewater generation treated on site, it is recommended that the municipality promote proper installation of such facilities. Correct operation of the sewage

treatment works, control of industrial effluent, and a sludge management plan will be used as counter measures to the impacts of operation of the sewage treatment works.

3.9 Project Evaluation

The basic engineering strategy of this project has been the design of a system that is appropriate with respect to the level of skills required for construction, operation and maintenance. The project design aims to enhance the sustainability of the municipal water supply and sewerage system as a whole. These have required the use of locally available construction materials, reliance on gravity distribution for water and hydraulic energy in treatment works, and building reservoir capacity rather than relying on pumping. Sewerage system development is based on maximum use of the existing facilities and minimisation of excess capacity by integrating the system development with the water supply plans.

The proposed project is financially viable with a reasonable level of management. The base case financial IRR of the project is estimated at 6.45%. The project remains financially viable under conceivable adverse scenarios. Despite the substantial contingencies included in the cost estimates, the impact of further cost overruns is simulated by increasing the costs by a further 20%. In this case the IRR declines to 4.98%. Another potential risk in public utilities is the reluctance of political initiative to adjust the tariffs in line with inflation. Reducing the projected revenue to 80% of the base case simulates the impact of this on project performance. In this case the estimated IRR is 3.95%. The last likely risk is that the construction schedule will be delayed. This will delay the project income while most of the investment costs may have already been incurred. In case of a two-year delay in water revenue while the investment costs are incurred according to the initial schedule, the IRR will decline to 5.18%.

The basic strategy of the project is attainment of equity. The project is based on the principle of "some for all rather than more for some". A practical implication of this is to target the highest possible coverage of service. Special attention has been paid to the needs of people who have very low incomes and consume little water. Different levels of service have been conceived for the central distribution area with individual connections, water kiosks for those who can not afford the individual connections, and a separate system for the rural areas within the Municipal boundaries.

The Project contains a carefully balanced package of investment not only to provide water but also to safely discharge the wastewater generated. This is not only critical for the health of people of Kisumu but it is essential for reducing the flow of pollutants into Lake Victoria.

3.10 Conclusions and Recommendations

The Study Team has undertaken a careful review of all water sources for Kisumu to meet the projected demand up to the end of Master Plan period. As a result, the sources that are most reliable, with desirable water quality and are economically efficient to operate have been recommended for development.

The water source development, water treatment and distribution, and the sewerage system proposed in this feasibility study has been subjected to careful screening from engineering, financial, institutional, social, and environmental perspectives. The proposed project serves important social objectives and is viable. Special attention has been paid to project requirements for training, institutional development, and management changes to insure that the project is sustained with local resources and management.

A number of practical steps that should be undertaken have been identified and discussed with Kenyan counterparts. In particular, it was agreed that a reasonably efficient and fully autonomous Water and Sewerage Department (WSD) should be in place by mid 1999. To this end, the Council should establish, and strictly adhere to, a set of rules on the financial relationship between the WSD and the Council. Up to 40 % of the gross income of the WSD revenue generated from the operations of the existing water supply and sewerage system may be contributed to the Council's General fund.

This should be followed by strengthening of management and financial control, with a strong commercial orientation, by way of consultancy services and training to be provided in Phase I of the project.