JAPAN INTERNATIONAL COOPERATION AGENCY
REPUBLIC OF MALAWI
MINISTRY OF LOCAL GOVERNMENT

BASIC DESIGN STUDY REPORT
ON
THE LILONGWE SEWERAGE PROJECT
IN
THE REPUBLIC OF MALAWI

JANUARY, 1994

NIPPON JOGESUIDO SEKKEI CO., LTD.

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PREFACE

In response to a request from the Government of the Republic of Malawi, the Government of Japan decided to conduct a basic design study on the Lilongwe Sewerage Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Malawi a study team headed by Mr. Yoshikatsu Nakamura, Director, First Basic Design Study Division, Grant Aid Study and Design Department, JICA, and constituted by members of Nippon Jogesuido Sekkei Co., Ltd. from August 24 to September 22, 1993.

The team held discussions with the officials concerned of the Government of Malawi, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Malawi in order to discuss a draft report, and as this result, the present report was finalized.

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 Malawi for their close cooperation extended to the teams.

January, 1994

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

January, 1994

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Lilongwe Sewerage Project in the Republic of Malawi.

This study was conducted by Nippon Jogesuido Sekkei Co., Ltd., under a contract to JICA, during the period of August 16, 1993 to January 28, 1994. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Malawi and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

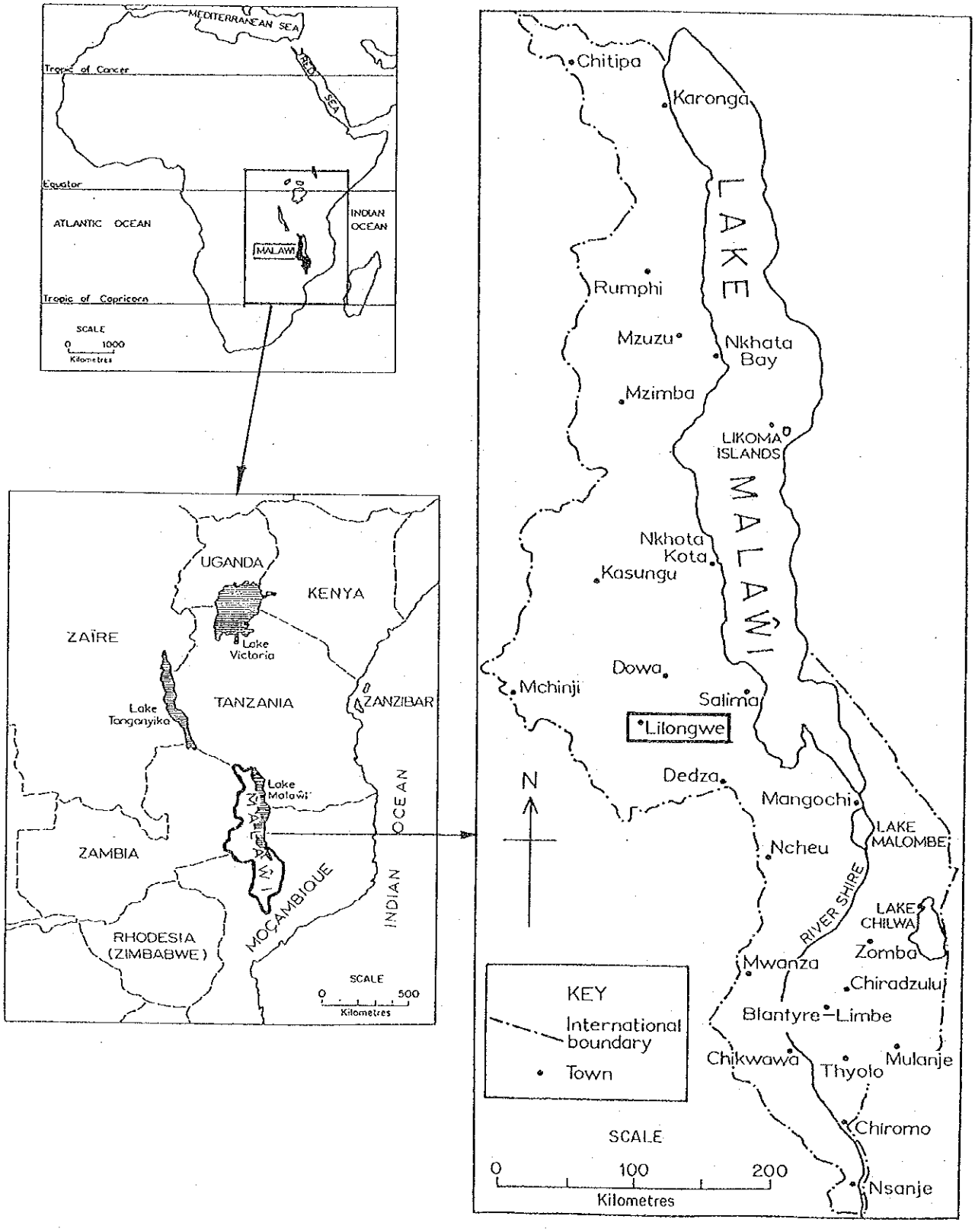
We wish to take this opportunity to express our sincere gratitude to the officials concerned of JICA, the Ministry of Foreign Affairs, and the Ministry of Construction. We would also like to express our gratitude to the officials concerned of Lilongwe City Council, Ministry of Local Government, Ministry of Finance, the JICA Malawi office and the Embassy of Japan in Zambia for their cooperation and assistance throughout our field survey.

Finally, we hope that this report will contribute to further promotion of the project.

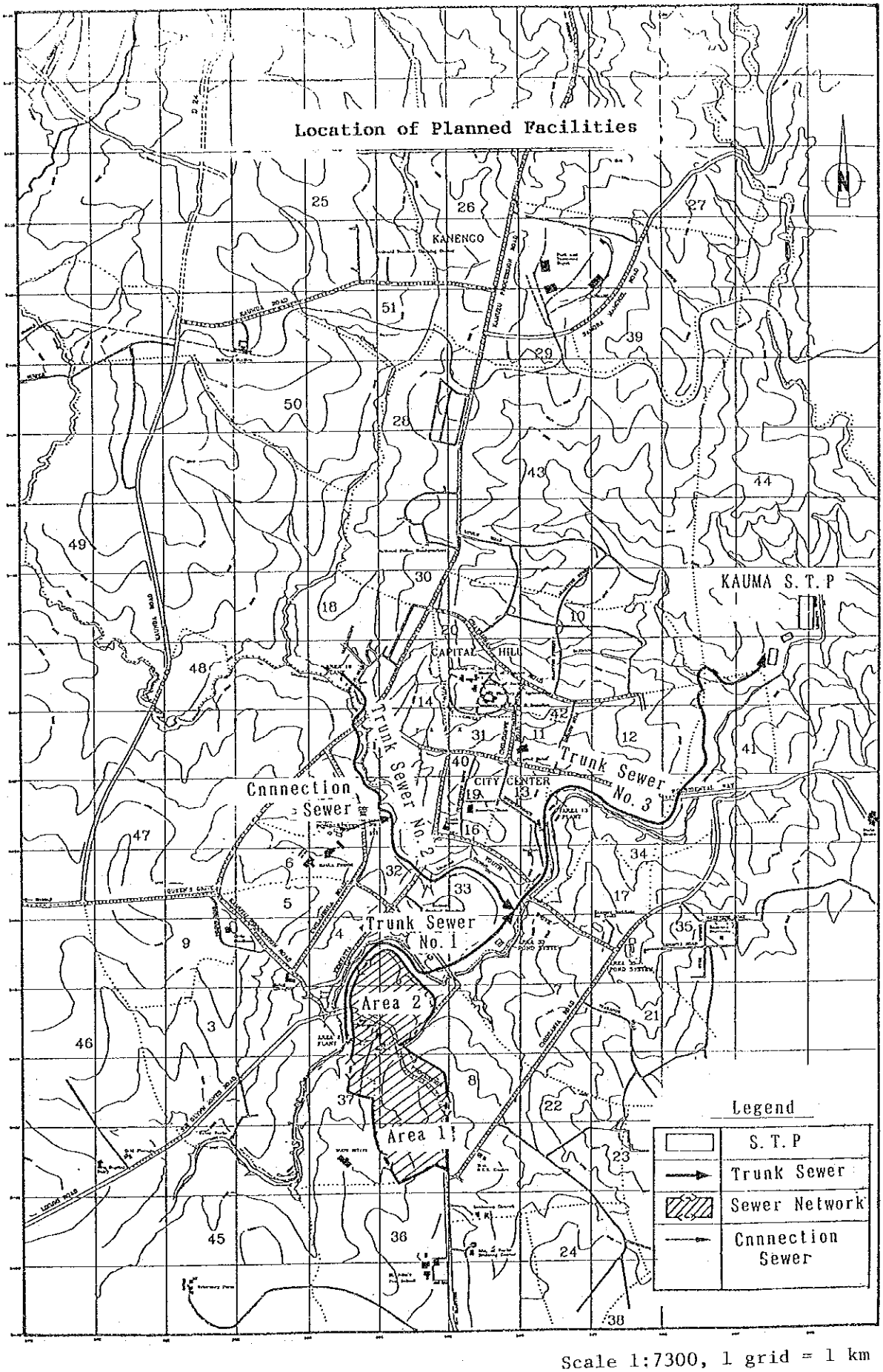
Very truly yours,

T. Yanagida

Tetsuo Yanagida
Project Manager,
Basic design study team on
the Lilongwe Sewerage Project
Nippon Jogesuido Sekkei Co., Ltd.



Location of Lilongwe



Scale 1:7300, 1 grid = 1 km

SUMMARY

SUMMARY

The City of Lilongwe is the capital of the Republic of Malawi and is situated near the center of the country. Since it became the official capital of the country in 1975, the population of Lilongwe has been growing rapidly. According to the national census, the population of 99,000 in 1977 had increased to 234,000 by 1987, with an annual growth rate of 8.7%. This trend is expected to continue for the foreseeable future.

In response to the growth in population, the Lilongwe City Council prepared the Lilongwe Water Supply & Sanitation Master Plan during the period of 1983 to 1986. Water supply facilities with a capacity of 62,000 m^3/day were provided with the financing of the World Bank.

Sewerage facilities were provided to the major facilities, such as hospitals, governmental offices, the airport, etc. and to some of the developing areas. Eleven sewage treatment plants and approximately 37km of sewer network have been constructed. No proper improvement or rehabilitation work, however, has been done because of the shortage of funds, which has led to a degradation in the treatment capabilities at most of the treatment plants. This has resulted in higher levels of water pollution in the Lilongwe and Lingadzi Rivers and in the worsening of the hygienic conditions of the people living along both rivers.

To improve such circumstances, the City Council prepared a feasibility study (F/S) in 1992, composed of three kinds of sanitation facilities, namely, a sewerage system, septic tanks and pit latrines.

The intent of the F/S was to abandon 6 of the 11 existing sewage treatment plants along the Lilongwe and Lingadzi Rivers and to carry the sewage therefrom to a plant to be newly constructed downstream of the Lilongwe River through new trunk sewers. The plan was based on the idea that it was necessary to make a radical improvement in the existing system and expand the existing facilities so as to be able to use the existing plants in the future. The F/S also formulated a staged construction plan for the sewerage facilities with target years of 2000 and 2005.

Despite these plans, there has been little progress on the Project because of a shortage of funds. For this reason, the Government of Malawi requested

grant aid assistance from the Government of Japan for the implementation of the Project, aiming to integrate and expand the existing sewage treatment system in line with the F/S plan.

In response to the request from the Government of Malawi, the Government of Japan decided to conduct a preliminary study on the Lilongwe City Sewerage Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Malawi a preliminary study team from May 18 to June 8, 1993 for confirmation of the contents of the request and to perform a study on the appropriateness of its contents.

Based on the results of the preliminary study, the Government of Japan decided to conduct a basic design study and sent to Malawi a basic design study team from August 24 to September 22, 1993. The team held detailed discussions with the relevant officials of the Government of Malawi following the results of the preliminary study, conducted a detailed survey indispensable to the design and a collected data and information in the field. This prompted further work in Japan, including the confirmation of the appropriateness of the Project and the basic design of facilities and equipment. And the Basic Design Report was then prepared to present the results of the study to the relevant government agencies.

As a result of the study, the deviations from the contents of the request in the basic design study are as follows:

(1) Sewage Treatment Plant

Request: Construction of facilities corresponding to the design flow in a target year of 2005

Study: A target year shall be 2000 due to uncertainty in the future sewer network provision, and the design flow shall be estimated based on the sewage volume from the areas where the sewer network will have been certainly provided by that time.
The layout of facilities at the treatment plant shall take account of the design flow in 2005.

(2) Pumping Station

Request: Construction of a lift pumping station on the premises of the treatment plant

Study: There is no need for a lift pumping station based on the study of the invert elevation of the incoming trunk sewer and the design water level of treatment facilities.

(3) Trunk Sewer

Request: Installation of ϕ600mm and ϕ800mm asbestos cement pipes/ ductile cast iron pipes with a total length of 17.8km

Study: The routes will be as requested but the invert elevations will be higher.

The pipe size shall vary from ϕ525mm to ϕ825mm and the pipe type shall be asbestos cement pipes for the underground portion and ductile cast iron pipes for the exposed portion. The total length of the trunk sewer will be approximately 17.5km.

(4) Sewer Network

Request: Construction of a sewer network within the area to be provided by 2000 in the design service area of the new treatment plant

Study: The sewer network shall be provided in Areas 1 and 2, and the connection pipes in Area 6, with high priority given to the housing areas which have been already built in the design service area of the new treatment plant.

The total length of the sewer network will be approximately 25.3km. Service connections between sewers and the boundaries of house plots will be provided simultaneously.

(5) Maintenance Equipment

Request: During the field survey of the study team, a request for equipment supply was made for water quality analysis instruments, sewer cleaning equipment, and plant maintenance vehicles.

Study: The request is considered reasonable.

The outline of the Project including the deviations from the contents of the request are as follows:

(1) Design Scale

		Project	Future
Design Target Year		2000	2005
Design Service Area	(ha)	500	2,153
Design Service Population	(prs.)	22,000	67,000
Design Sewage Flow (Daily Average)	(m^3/day)	6,100	15,600

(2) Outline of Facilities

1) Sewage Treatment Plant

The location and treatment method shall be Kauma District in Area 44 and stabilization pond process, respectively.

The treatment facilities will be composed of two trains for the design flow of 6,100m^3/day. Major facilities involved are: one grit chamber, one parshall flume, three anaerobic ponds, four facultative ponds, six maturation ponds, and two septage lagoons.

2) Trunk Sewers

There are three routes for trunk sewers: (a) No.1 Trunk Sewer from the Area 2 plant to the Area 33 plant, (b) No.2 Trunk Sewer from the Area 18 plant to the Area 33 plant, and (c) No.3 Trunk Sewer from a confluence of No.1 and No.2 trunk sewers to the Kauma plant, as follows:

No.1 Trunk Sewer	φ525mm - φ600mm	4,220m
No.2 Trunk Sewer	φ525mm - φ600mm	5,410m
No.3 Trunk Sewer	φ825mm	7,870m
Total		17,500m

3) Sewer Network

Area 1	φ150mm - φ450mm	14,830m
Area 2	φ150mm - φ200mm	9,310m
Area 6 Connection Pipe	φ250mm	1,200m
Total		25,340m

4) Maintenance Equipment

Water quality analysis instruments, sewer cleaning equipment, plant maintenance vehicles, etc.

The Project period will be about 38 months including about 7 months for detailed design and about 28 months for construction.

The expenses to be borne by the Malawi side for the Project will be approximately MK2.8 million, excepting the expenses for land acquisition necessary for the facility construction, and the compensation for the private land utilized in the sewer network construction and for the disposal site of surplus soil. The operation and maintenance costs of the treatment plant are estimated at MK145,000 per year.

The contract will not be phased, since the benefits of the Project will not come on line until the Project is completed.

The implementation of the Project will bring the following benefits:

1) Of the total population of about 25,000 persons now living in the design sewerage service area, the sewage produced by half of the populace, or about 13,000 persons, is treated relatively well. The implementation of the Project will permit the sewage produced by about 34,000 persons to be well treated.
2) Stable sewage treatment at the new treatment plant can be counted on to improve the water quality in the rivers and provide healthier and more sanitary conditions for the roughly 100,000 persons living downstream who use the river water for domestic uses.
3) The Project, which will construct the frame work of a sewerage system for Lilongwe, is one which anticipates future growth in

service coverage of trunk sewers, so that the City Council will be able to extend the sewer network and increase the service coverage without difficulty using other funds to extend the sewer network and expand the treatment plant in the future.

4) The Project can indirectly contribute to the improvement of the health and sanitation of the people in the region by permitting the City Council to fund the expansion of the water supply system: a project which can only be carried out if the sewerage system is also improved.

Because, as stated above, the Project will contribute to broad improvements in the people's living standards and bring about a healthier and more sanitary environment, it would be extremely significant and highly appropriate to implement the Project using grant aid assistance from the Government of Japan.

The Government of the Republic of Malawi must implement the following measures in order to achieve the goals of the Project and to maximize its effects.

1) To obtain funds to pay for the work to be undertaken by the Malawi side.
2) to carefully deal with the residents living in the hamlets (squatter hamlets on the government-owned land) close to the construction site.
3) To obtain permission for the construction work in the Nature Sanctuary.
4) To involve the Malawian engineers in the Project from its design stage so that they will understand and learn the details of the Project thoroughly.
5) To vigorously collect the sewage charge that will provide the funds to operate and maintain the facilities.
6) To conduct systematic training programs and practice for key personnel so that the facilities will be properly maintained.
7) To expand the sewer network and to increase influent to the sewage treatment plant to conserve the river water quality.

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ORGANIZATION

ESCOM	Electric Supply Committee of Malawi
IDA	International Development Association
JICA	Japan International Cooperation Agency
LCC	Lilongwe City Council
MOLG	Ministry of Local Government
UNDP	United Nations Development Programme

STANDARD

BS	British Standard

UNIT

hh	household
kV	kilo-volt
kWh	kilo-watt-hour
lpcd	litter per capita per day
min	minutes
MK	Malawi Kwacha
mo	month
MPN	most probable number
pr	person
prs.	persons
PS	power
Vmax	maximum velocity
Vmin	minimum velocity
yr	year

OTHERS

ACP	asbestos cement pipe
Bio	biological
BOD	biological oxygen demand
CBR	California bearing ratio test
coli.	coliform

COM	commercial wastewater
com.	commercial
cont'd	continued
consump.	consumption
DCIP	ductile cast iron pipe
excl.	excluding
F/S	Feasibility Study
labo.	laboratory
Ind.	industrial
Inst.	institutional
LCSDP	Lilongwe City Sanitation Development Plan
HDT	high density traditional (housing area)
HDP	high density permanent (housing area)
MDP	medium density permanent (housing area)
LDP	low density permanent (housing area)
M/P	Master Plan
OD	oxidation ditch
WD	water depth
SP	stabilization pond
pH	hydrogen ion exponent
ORP	Oxidation-Reduction Potential
Pjt	project
SS	suspended solid

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1.1 Background of the Project

Lilongwe, the capital of the Republic of Malawi has experienced a rapid increase in population since it became the capital in 1975, and had a population of 234,000 by 1987, or about 2.4 times that of one decade ago. This trend is considered to continue in the future.

The present sewerage system of Lilongwe is composed of 11 sewage treatment plants and approximately 37km of sewer network, but neither proper improvement or rehabilitation work has been done, due to a funding shortage. This has led to the degradation of the treatment function of most of the treatment plants. Consequently, there is a high level of water pollution in the Lilongwe and Lingadzi Rivers and a worsening of hygienic conditions for the people who get their domestic water from those rivers. In addition, the discharged sewage volume has increased as water supply facilities have been provided. This urgently requires a radical expansion of the sewerage system. For this purpose, the Lilongwe City Sanitation Development Plan Feasibility Study was prepared in 1992, but there has been no progress of the Project because of the lack of the funds. It is difficult for the Lilongwe City Council to integrate and expand the existing sewage treatment plants with its own funds due to the tight financial conditions. Accordingly, the Government of Malawi requested assistance from the Government of Japan in the form of grant aid assistance for the implementation of the major parts of the Project.

1.2 Dispatch of the Study Team

In response to the request from the Government of Malawi, the Government of Japan decided to conduct a preliminary study on the Lilongwe City Sewerage Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Malawi a preliminary study team, which was headed by Mr. Hideo Miyamoto, a deputy director of First Basic Design Study Division, Grant Aid Study & Design Department, JICA. The JICA study team stayed in Malawi from May 18 to June 8, 1993. The team held discussions with the concerned officials of the Government of Malawi, conducted a study on the background,

contents and implementation system of the Project, investigated the budgetary measures for the Project as well as other projects relevant to the Project. The contents of the projects assisted by other foreign donors were also studied. The study team confirmed the reasonability of the Project and determined the scope of the work in which it was possible to cooperate, and then prepared the Preliminary Study Report to submit in July 1993.

Based on the results of the preliminary study, the Government of Japan decided to conduct a basic design study and sent the Basic Design Study Team, which was headed by Mr. Yoshikatsu Nakamura, a director of First Basic Design Study Division, Grant Aid Study & Design Department, JICA. This JICA team visited Malawi from August 24 to September 22, 1993. The Team held detailed discussions with the relevant officials of the government of Malawi following the result of the preliminary study, obtained detailed data and information in relation to the Project in Lilongwe, prompting further work in Japan. The Basic Design Report was then prepared to present the result of the study.

The member list of the Basic Design Study Team, survey schedule, the member list of the concerned officials of the government of the Republic of Malawi, and the minutes of the meeting are as shown in Appendices 1 to 4 attached hereto.

1.3 Contents of the Study

(1) Reconfirmation of the Contents of the Request

Confirmed that there was no change in the objective and contents of the request, confirmed the contents of the plans for sewerage and other relevant infrastructures, and their consistency with the Project.

(2) Investigation on Existing Sewerage Facilities

Investigated the present status of the existing sewerage facilities through a field survey including water quality analysis and hearings with their Malawian counterparts.

(3) Study on Construction Material and Condition

Interviewed the Ministry of Works, the Lilongwe Water Board, the Lilongwe City Council and the local contractors. Studied the procurement condition of major construction materials and the construction capabilities of the local contractors.

(4) Survey on Sanitation-related Facilities

Surveyed the condition of the sanitation provisions in each area of the city, conducted flow measurements and water quality analysis on the Lilongwe and Lingadzi Rivers and determined the degree of water pollution therein.

(5) Survey on Power Supply and Telecommunication Conditions

Discussed with the concerned officials about the availability of power supply, telecommunications and water supply at the proposed sewage treatment plant site and investigated the surrounding conditions.

(6) Study on Operation and Maintenance System

Studied the organization and financial conditions of the agencies concerned with the Project in order to determine the operation and maintenance system that would exist after the completion of the Project.

(7) Survey on Proposed Sites for New Facilities

Studied the proposed sewage treatment plant site and routes for trunk sewers and branch sewers to be constructed in the Project by field reconnaissance and conducted a topographical survey at the proposed sewage treatment plant site and on the routes of the trunk sewers.

CHAPTER 2

BACKGROUND OF THE PROJECT

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2.1 Background of the Project

Lilongwe is the capital of the Republic of Malawi and is situated near the center of the country. In 1965 it was decided to transfer the capital from Zomba to Lilongwe and the construction of the infrastructures required for the capital started in 1969. Lilongwe officially became the capital of the Republic of Malawi in 1975. The population of Lilongwe has grown rapidly since it became the capital. According the national census, the population of 99,000 in 1977 had increased to 234,000 by 1987, demonstrating an annual growth rate of 8.7%. This trend is expected to continue.

The Lilongwe Water Supply & Sanitation Master Plan was prepared by the Lilongwe City Council during the period of 1983 to 1986. Water supply facilities were provided so as to have a water supply capacity of 62,000 m^3/day under the auspices of the World Bank (IDA).

The sewerage system of Lilongwe has been provided mainly in the high-density residential areas, whose sewerage system were built at the time of their development, and to major facilities such as hospitals, governmental offices, the airport, etc., but the population served by sewerage was estimated at only 25,000 persons or 9.5% of a total population in 1989, of which the remainder was served by septic tanks and pit latrines. The existing sewerage system is composed of approximately 37km of sewer networks covering an area of about 123ha and 11 sewage treatment plants with capacities varying from 290m^3/day to 1,770m^3/day (two plants are not known). Each sewage treatment plant, which is managed by the City Council, the Ministry of Works or a private company, has various kinds of problems. These problems include: worn-out or stolen equipment, lack of spare parts, improper maintenance, overloaded operation and so on, and most are not well operated and maintained. In addition to the above conditions, there has been scarcely any proper improvement or rehabilitation work done to these facilities since their construction, due to funding shortages, which has led to the degradation of the treatment function of most of the treatment plants. This has resulted in a high level of water pollution in the Lilongwe and Lingadzi Rivers and in the deterioration of the living and hygienic conditions of the people who get their domestic water from these rivers. In addition, the sewage volume discharged into these rivers has shown a tendency to increase

incidental to the provision of water supply facilities. The radical improvement and expansion of the sewerage system is now urgently need.

Under such circumstances, the Lilongwe City Council prepared the Lilongwe City Sanitation Development Plan Feasibility Study in 1992, but there has been no progress of the Project because of funding difficulties. The integration and expansion of existing sewage treatment plants seems to be very difficult for the City Council to implement under the Project using its own funds. The Government of Malawi was consequently requested that the Government of Japan provide grant aid assistance for the implementation of the main portion of the Project.

2.2 Contents of the Request

The contents of the request were confirmed as follows based on the application and the result of the preliminary study:

(1) Objective

The objective of the Project is to improve the water quality of the rivers, the local environment and sanitation through the construction of a sewage treatment plant and sewer networks.

(2) Executing Agency

The Lilongwe City Council is the executing agency of the Project under the jurisdiction of the Ministry of Local Government.

(3) Outline of the Request

The request is for the construction of sewerage facilities with a target year of 2005 in a part of the city that is within the basins of the Lilongwe River and its tributaries or the Lingadzi River. At present there are six existing sewage treatment plants within the above basins but they require radical improvement and expansion of their facilities. For this reason, all the existing plants shall be abandoned and a new sewage treatment plant shall be constructed downstream of the Lilongwe River with connecting trunk sewers. A pump station shall be constructed as required and branch sewers shall be

installed in a part of the area to be served by the sewerage system within the above basins.

(4) Description of Requested Facilities

The requested facilities confirmed in the preliminary study are as follows:

1) Construction of Sewage Treatment Plant

treatment capacity : 12,900m^3/day

treatment process : wastewater stabilization pond process

2) Construction of Pump Station

location : Lift pump station

capacity : 200 lit./sec.

3) Construction of Trunk Sewers

size : 600mm, 800mm

type : ACP, DCIP

length : 600mm-9,320m, 800mm-8,500m, Total-18,820m

4) Construction of Sewer Network

2.3 Outline of the Project Area

2.3.1 Location and Socio-economic Condition

(1) Location and Transportation

Lilongwe is located at longitude 33°42' to 33°53' east and latitude 13°45' to 14°04' south, and stretches approximately 36km from north to south and approximately 19km from east to west with an area of about 350km^2.

The city is located in the approximate center of the Republic of Malawi, from which Blantyre, the southern core city, is about 350km away via Zomba through the national road Route 1 (M1 Road). Mzuzu, the northern core city, is 475km away by the M1 Road, and the west shore of Lake Malawi is about 110km east by the M14 Road.

The railway runs eastwards from the north of the city, then changes its direction south at Salima,to connect to Blantyre and Limbe. Westward, it connects with the neighboring country of Zambia via Mchinji.

The Kamuzu International Airport, located at north of the city, has three airlines to Europe, eight airlines to African countries. The domestic airlines serve Karonga, Mzuzu and Blantyre, but the people mainly use long-distance buses for domestic travel.

The general public usually depends on buses or walks when traveling in the city.

(2) Society

Lilongwe became a town in 1947 and a city in 1966. The city, which had originally developed centered in the old urban area, south of the Lilongwe River, was the core city of central Malawi. It was chosen to be the capital instead of Zomba, the old capital, in 1965. The construction of the capital started in 1969, centering on the northern area of the Lilongwe River, and the capital was officially transferred to Lilongwe in 1975, which has been showing rapid development since that time.

The city is divided into 55 zones called Area and the land use plan is defined by each Area. Table 2.1 shows the area, population and land use of each Area..

The population of Lilongwe was 99,000 in 1977 and 234,000 in 1987. It has a remarkable annual growth rate of 8.7% according to the national census.

(3) Economy

As the Capital of the Republic of Malawi, it is an administrative center with the offices of the ministries of the central governments, local governments, international agencies such as the United Nations Development Programme, etc., embassies of foreign countries, various

Table 2.1 Area, Population, Land Use and Sanitation in Lilongwe

Area No.	Area (ha)	Population (person)	Land Use	Sanitation Type SW=Sewerage, PL=Pit Latrines ST=Septic Tank
1	120	9,622	HDP	SW, ST, PL
2	212	5,368	Commercial, Office, MDP, Park	SW, ST
3	715	5,295	Commercial, Office, LDP, Leisure	ST
4	90	275	Commercial, Light Industry	ST
5	105	278	Comunity, LDP	ST
6	125	1,680	MDP, Prison	SW, partly ST
7	280	33,504	HDT	PL, partly ST
8	150	25,375	HDT	PL, partly ST
9	260	773	LDP, Comunity	ST
10	395	2,089	LDP	ST
11	57	1,216	MDP, Hotel	SW, ST
12	240	3,492	LDP	ST
13	140	1	Commercial, Comunity	SW
14	162	200	Comunity, MDP	ST
15	80	2,228	MDP	ST
16	(included in 13)	0	Commercial, Office	SW
17	133	0	Institutional	ST
18	228	12,185	HDP	SW, partly ST
19	(included in 13)	0	Commercial, Office	SW
20	166	0	Government Office	SW
21	270	26,926	HDT	PL, partly ST
22	380	6,157	HDT	PL, partly ST
23	382	12,170	HDT	PL
24	290	3,010	HDT	PL
25	2,237	27,077	HDT, HDP, MDP, Institute, Commercial	PL, ST
26	867	3,330	Village, Forest	PL
27	583	1,039	Village, Institute, Forest	ST
28	133	7	Industry	ST
29	200	940	Industry	ST
30	283	3,061	Police Head Quarter	SW, ST
31	55	0	Park	-
32	176	265	Sanctuary, Institute, Forest	ST
33	290	2,312	Hospital、Comunity、Forest	SW, ST
34	207	9	Forest	-
35	850	6,559	Army	SW, PT
36	837	9,113	Official, Farm, HDT	ST
37	204	1,701	Light Industry, Illegal Farm	ST
38	887	2,457	Village	PL
39	385	2,687	HDT, Forest	PL
40	(included in 13)	20	Office, Embassy	ST
41	193	1,079	River Side, Vacant, HDP	-
42	n.a.	0	(Government Office)	
43	1,083	1,240	LDP, Forest	ST
44	3,497	7,568	State House, Farm, Squatter	ST
45	1,300	536	Farm	-
46	910	2,459	Farm	ST
47	964	2,726	MDP(HDP)	ST
48	87	47	Forest	-
49	1,193	5,334	Village, Developing	PL
50	642	6,721	Squatter	PL
51	862	5,451	Squatter	PL
52	2,317	2,303	Airport, Village	SW
53	1,390	10,259	Village, MDP, HDP, Commercial, Industry	SW, ST, PL
54	1,677	2,911	Village, Farm	PL
55	5,541	9,945	Village, Farm	PL
others	1,285	—	—	-
Total	36,115	271,000		

Area、Land Use: Outline Zoning Scheme Monitoring Report, Pop : adjusted NSO data

kinds of foreign assistance agencies and so on. As for the educational facilities, there is a nurse's college, a professional school of medical technology, a training center for teachers and an institute of youth in addition to the ordinary elementary and secondary schools for the community.

From an economical viewpoint, the city has been developing as a collection and distribution center for the central region, namely as a base to collect the agricultural goods of other regions.

Lilongwe has some industries such as food processing, printing, textile production, raw agricultural product processing, etc. Small light industries are located in the mid-city and in the relatively large industrial estate that is situated in the northern suburb.

2.3.2 Natural Condition

(1) Climate

The climate of Lilongwe is temperate and mild due to an elevation of 1,050 m, notwithstanding its location in the savanna climatic region. A year consists of two seasons, a dry season and a wet season. The dry season is further divided into a hot season and a cool season as follows:

1) Wet season (November to April)
2) Cool dry season (May to August)
3) Hot dry season (September to October)

The monthly average temperature is 19.6°C; 23.0°C at maximum and 15.2°C at minimum and is stable throughout the year. However, there is a big difference in daily temperatures. The minimum temperature drops by less than 5°C in the coldest period of June to July but rises to some 25°C due to the sunshine in the dry season. The maximum temperature may be more than 35°C in the hottest period of October to November.

The rainfall is approximately 850mm per annum and the number of rainy days with a rainfall of more than 0.1mm is 71days. Of which 720mm and 57days, almost equivalent to the annual values respectively, occurs

during the four months of December to March.

The monthly average humidity is high from December to April (78 to 85%) and low from August to October (51 to 58%). The climatic fluctuation is shown in Figure 2.1 and Table 2.2.

Table 2.2 Climate in Lilongwe

Items	Unit	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Average
Average Temperature	℃	21.0	20.9	20.7	19.7	17.6	15.6	15.2	17.0	19.9	22.7	23.0	21.7	19.0
Monthly Precipitation	mm	215.3	202.9	133.8	41.9	8.8	1.0	1.0	1.0	3.3	6.0	66.2	166.3	215.3
Monthly Rainy Days														
0.03 mm	day	20	18	14	7	2	1	0	0	1	1	7	16	20
0.1 mm	day	17	14	10	6	1	0	0	0	0	0	6	16	17
10.0 mm	day	7	6	4	1	0	0	0	0	0	0	2	6	7
Average Sunshine Duration	hour	4.8	5.2	6.3	7.7	8.4	8.0	7.9	8.5	9.1	9.7	7.6	5.3	4.8
Average Relative Humidity	%	84.0	85.0	82.0	79.0	72.0	68.0	64.0	58.0	53.0	51.0	62.0	78.0	84.0

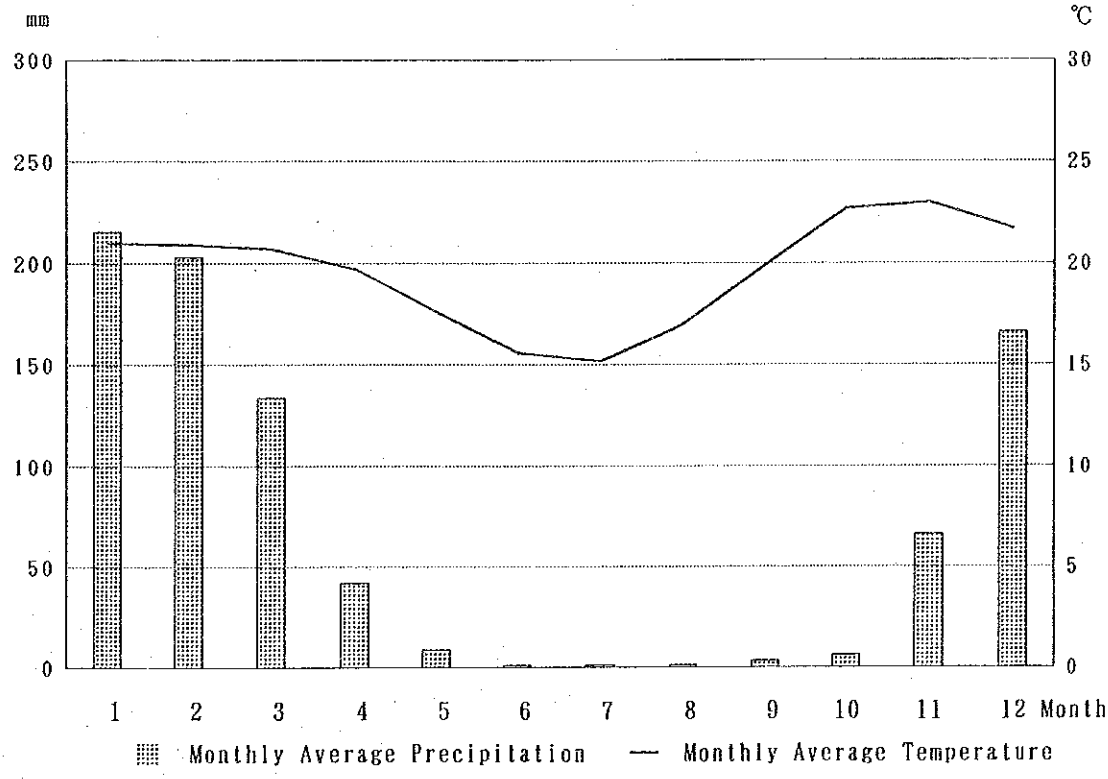


Figure 2.1 Climate in Lilongwe

(2) Topography

Lilongwe is located on gently rolling terrain at an elevation of between 1,000m and 1,200m. The City Hall (the Civic Office) has an elevation of 1,050m. The city is long and narrow in shape from north to south and has a core in the south. Kamuzu International Airport is in the north and the industrial area in the center. These three areas are connected with the M1 Road.

A number of small rivers runs in the city but dry up during the dry season. They enter into the Lilongwe River and finally pour into Lake Malawi. During the rainy season, swamps are formed along these rivers. The Lumbadzi River runs east and joins the Lilongwe River about 35 km east of the city boundary. The Lingadzi River flows east, south of the city, and joins the Lilongwe River near the city's core. The Lilongwe River provides water for the city water supply. As a whole, the city has a gently rolling topography but there are relatively steep slopes near the Lilongwe River and its tributaries.

(3) Geology

Geologically, the whole area of Lilongwe is covered with a sequence of reddish brown soils overlaying Precambrian metamorphic rocks including a layer of weathered rocks. However, there is exposed bedrock in the river bed of the Lingadzi and Lilongwe Rivers which have been eroded by the river.

2.3.3 Infrastructure

(1) Road

The M1 Road penetrates the city's core from the north to the south, from which the M14 and M12 Roads branch east towards Salima and west to Mchinji. The inner-city roads connecting each Area are provided in all directions south of the city, which have mostly asphalt-paved two lanes going two ways. Most of roads in each Area are also paved with asphalt. The traffic volume is relatively light except for the trunk roads and in the city's core. People without cars use buses for transportation.

(2) Railway

Lilongwe Station of Malawi Railways Limited, in Area 50, is located north of the city. Siding branches from Lilongwe Station to the industrial zone in Area 29 adjoining north of the railway. The railway runs both east and west from the station. The east line reaches to Nsanje via Salima in the east and Blantyre in the south. The west line stretches to Mchinji near the border with Zambia. However, most people use long-distance buses due to there being few trains and poor schedules.

(3) Power Supply, Communication and Mass-communication

The power supply condition is good in general, although there are many houses which have no service line for electricity. The electricity is supplied to general households at 230V, 50Hz. The electric charge for general use is MK11.5 per month as the basic charge, MK0.18 per kWh for a monthly consumption of less than 225kWh and MK0.14 per kWh for more consumption.

Likewise, the telecommunication condition is relatively good and telephones are provided in most offices, shops and governmental offices, but are less prevalent in general households, in which it takes more than half a year to have a telephone installed. The telephone charge for general use is MK375 for a connection and a flat rate of MK25 per month for use. Mail is not distributed, but is received by individuals using the P.O. Box. Until recently, only one English newspaper has been allowed to be published, but now it is permitted to publish several English newspapers. There are no television broadcasting services in Malawi, but the national radio service is available on FM, AM and SW.

(4) Gas

There is no gas supply service in the city except for the supply of liquefied petroleum gas in cylinders. Most households use firewood, charcoal or electricity for cooking.

(5) Garbage Disposal

The collection and disposal of garbage, as well as the cleaning of roads, is undertaken by the Cleansing Department of the City Council which employs all collectors. General garbage is collected twice a week as a rule, but more than half of residents (52%) dump garbage into pits dug in vacant lots near their houses. Some residents (18%) throw away their garbage in nearby vacant lots or bushes. The garbage collected by the City Council is dumped at the disposal sites in Areas 38 and 55.

(6) Water Supply

1) History of Water Supply Development

The municipal water supply system for Lilongwe was constructed in 1958 initially for a population of 15,000. In this system, the water was taken from the intake weir installed in the Lilongwe River, treated at the water treatment plant and then transmitted to the service reservoir.

The first phase of expansion work started in 1959 to cope with the rapid increase in water consumption incidental to the increase in population. Construction work commenced on the Kamuzu Dam in 1963 in Malingunde, approximately 30km west of the city, and was completed in 1966. The dam's objective was to control the flow of the Lilongwe River. The water discharged from the dam was taken to the water treatment plant for treatment and distribution. The outline of the facilities at that time is as follows:

- Kamuzu Dam
  storage capacity : 11,000,000m^3
  (4,500,000m^3 at present)
- intake weir/ water treatment plant (Plant A)
  treatment capacity : 5,675m^3/day
- clear water transmission pipe : 2 lines x ϕ225mm
- service reservoirs
  ground reservoir (reinforced concrete structure): 2,250m^3
  elevated tank (steel structure): 135m^3

The second phase of expansion work was done during the period of 1972 to 1975, being stimulated by the start of the construction work caused by transferring the capital to Lilongwe in 1968, and the following facilities were provided:

- water treatment plant (Plant B)
  incremental capacity : 3,700m^3/day
- service reservoir
  ground reservoir (RC) : 9,000m^3 x 1unit
  4,500m^3 x 1unit
  2,275m^3 x 1unit
  450m^3 x 1unit
- booster pump station : 2units

In 1976, the plant A was improved and expanded its treatment capacity by 18,000m^3/day to cope with the increasing water demand. Since that, the following facilities were constructed in 1983:

- service reservoir
  ground reservoir (RC) : 9,000m^3 x 4units
  950m^3 x 1unit
  50m^3 x 1unit
- booster pump station : 3units

To cope with the rapidly increasing population and water demand, the Government of Malawi started in 1980 to formulate the Lilongwe Water Supply & Sanitation Master Plan (M/P), of which the report was submitted in 1983 and revised in 1986. Meanwhile, the following facilities were constructed in 1984 as the immediate development project:

- expansion of treatment plant
  treatment capacity : 10,500m^3/day
- booster pump station : 3units
- transmission pipe : ϕ350mm x 2 lines
  ϕ450mm x 1 line
- extension of distribution pipes

In accordance with the M/P, the feasibility study for the second phase

expansion project started in 1984 and its report was submitted in 1986. As the target year of the M/P was 2005, the feasibility study formulated the facility development plan for the water demand in 1997 so as to reduce the initial investment and the following facilities were constructed based on that plan.

- Kamuzu No.2 Dam at Masra area downstream of Kamuzu Dam of Lilongwe River
  storage capacity : 9,000,000m^3/day
- new treatment plant
  treatment capacity : 27,000m^3/day

Therefore, the water supply capacity of the facilities constructed up to this point reaches to 62,000m^3/day, which is considered sufficient to cope with the water demand in 1997. The Lilongwe Water Board has just started the preparation for the third phase expansion project with a target year of 2005, taking into account the term required for construction, and expected financing from the African Development Bank to cover the project cost. However, it is difficult to get such a financing without the progress of the sewerage project.

2) Served Population and Amount of Water Supply

According to the data in 1992, the daily average treatment volume was as shown in Table 2.3. The data is considered to show the condition of the time, before the completion of the second phase expansion project, when the water consumption was restricted. The present performance is estimated to be greater since the ratio of water supply to demand has been improved.

Table 2.3 Average Treatment Volume

Particular	Volume (m^3/day)	Rate
Daily average treatment volume		
in a year	41,130	1.00
in a peak month	45,130	1.10
in a peak week	51,170	1.24
Daily peak treatment volume	53,550	1.30
Daily peak water supply volume	58,550	1.42

The change in the number of users from 1988 to 1992 is shown in Table 2.4 which indicates a rapid spread of water supply to the densely inhabited residential area and the decrease in the number of communal faucets (Kiosk) therein.

Table 2.4 Change in the Number of Users

User's Category	Residential Area				Ind.	Inst.	Communal Faucet	Total
	High	Middle	Low	Subtotal				
No. of Users								
Sept. 1988	6,965	1,429	1,409	9,803	826	269	109	10,807
Sept. 1992	10,200	1,760	1,648	13,608	809	317	81	14,815
Increase Rate (%)	46.5	23.1	17.0	38.8	29.2	17.8	-25.7	37.1
Annual Average Increase Rate (%)	10.0	5.4	4.0	8.5	6.6	4.2	-7.2	8.2

Table 2.5 shows the consumption by the user's category and its share of the total. The consumption in the residential area shares somewhat more than half of the total.

Table 2.5 Consumption by User's Category and Its Share

User's Category	Residential Area				Ind.	Inst.	Communal Faucet	Total
	High	Middle	Low	Subtotal				
x1000m^3/day Consump. in Sept. 1988	4.90	2.92	5.15	12.97	5.47	4.10	0.79	23.33
Percentage (%)	21.0	12.5	22.1	55.6	23.4	17.6	3.4	100.0
Lit./day Per User Consump.	704	2,043	3,655	1,323	8,738	15,242	7,248	2,159
x1000m^3/day Consump. in Sept. 1992	7.20	3.32	6.45	16.97	6.45	6.66	0.73	30.81
Percentage (%)	23.4	10.8	20.9	55.1	20.9	21.6	2.4	100.0
Lit./day Per User Consump.	706	1,886	3,914	1,247	7,973	21,009	9,012	2,080

According to the F/S, the house connection was used by a population of about 140,000 (25%), while the communal faucet was used by about 40,000 (16%) as of June 1989. However, the 20,000 squatters and the 55,000 people in the rural areas get their water from wells and rivers.

3) Water Charge and Unaccounted-for Water

The current water tariff, which adopts a meter rate system in principle, is as follows:

Residential	
by first 10 m^3	MK 0.78/m^3
by next 30 m^3	1.15/m^3
more than 30 m^3	1.61/m^3
Institutional (Flat Rate)	1.39/m^3
Commercial/Industrial	
by first 100 m^3	1.61/m^3
more than 100 m^3	2.04/m^3
Communal Faucet	1.00/m^3
	(1 tambala/10 Lit.)
Reconnection Charge	MK17.25
Meter Inspection Charge	17.25
Meter Security	
Conventional House	17.25
Others	40.25

The unaccounted-for water ratio is approximately 20% as shown below, although the goal is set at 16% for 1995.

1990/91	20.6%
1991/92	25.6%
1992/93	21.5%

4) Future Plan

As the feasibility study for the third phase expansion project with a target year of 2005 is currently in cessation, the details will be unknown until the results of the study come out, but the following is under consideration as of now to cope with the future increase in water demand:

a) to increase the treatment capacity of the existing treatment facilities to 75,000m^3/day by 1994,
b) to increase the storage capacity of Kamuzu No.2 Dam to 11,000,000m^3 by 1995 by raising the dam height,
c) to increase the treatment capacity to 108,000m^3/day by 1996 by expansion to cope with the water demand in 2002, and,
d) to review the water demand in 2000 and to add the treatment capacity of 66,000m^3/day by expansion to cope with the water demand in

2005, if necessary.

2.4 Outline of the Sewerage and Sanitation Sector

2.4.1 Present State

(1) Outline

In Lilongwe, sewerage service is mainly available in parts of high-density population residential area (H.D.P.) and those occupied by administrative offices and commercial buildings, but the service coverage is low, and many of the residents use septic tanks or pit latrines. According to the F/S, the percentage of the service population by various types of sanitation facilities in Lilongwe in 1989, was estimated at 9.5% by sewerage system, 19.8% by septic tanks, and at remaining 70.7% by pit latrines. These figures are considered to be substantially unchanged in 1993.

Sewerage users	25,000 persons	(9.5%)
Septic tank users	52,000 persons	(19.8%)
Pit latrine users	186,000 persons	(70.7%)
Total	263,000 persons	(100.0%)

(2) State of Sewerage Facilities

As for the sewerage facilities, there are 11 sewage treatment plants in Lilongwe (6 are operated by the City Council, 3 by the Ministry of Works and 2 by private companies), and approximately 37km of sewers are installed within an area of about 123 hectares. All sewers are gravity flow types, and no pumps are installed in the system. Figure 2.2 shows the distribution of the existing service area by sewerage and Figures 2.3 to 2.9 present the outlines of the existing sewers and treatment plants in each area.

1) Sewage Treatment Plants

Six of the 11 existing treatment plants are located inside the design service area to be included in the Project (those that will be abandoned after the proposed new treatment plant will be com-

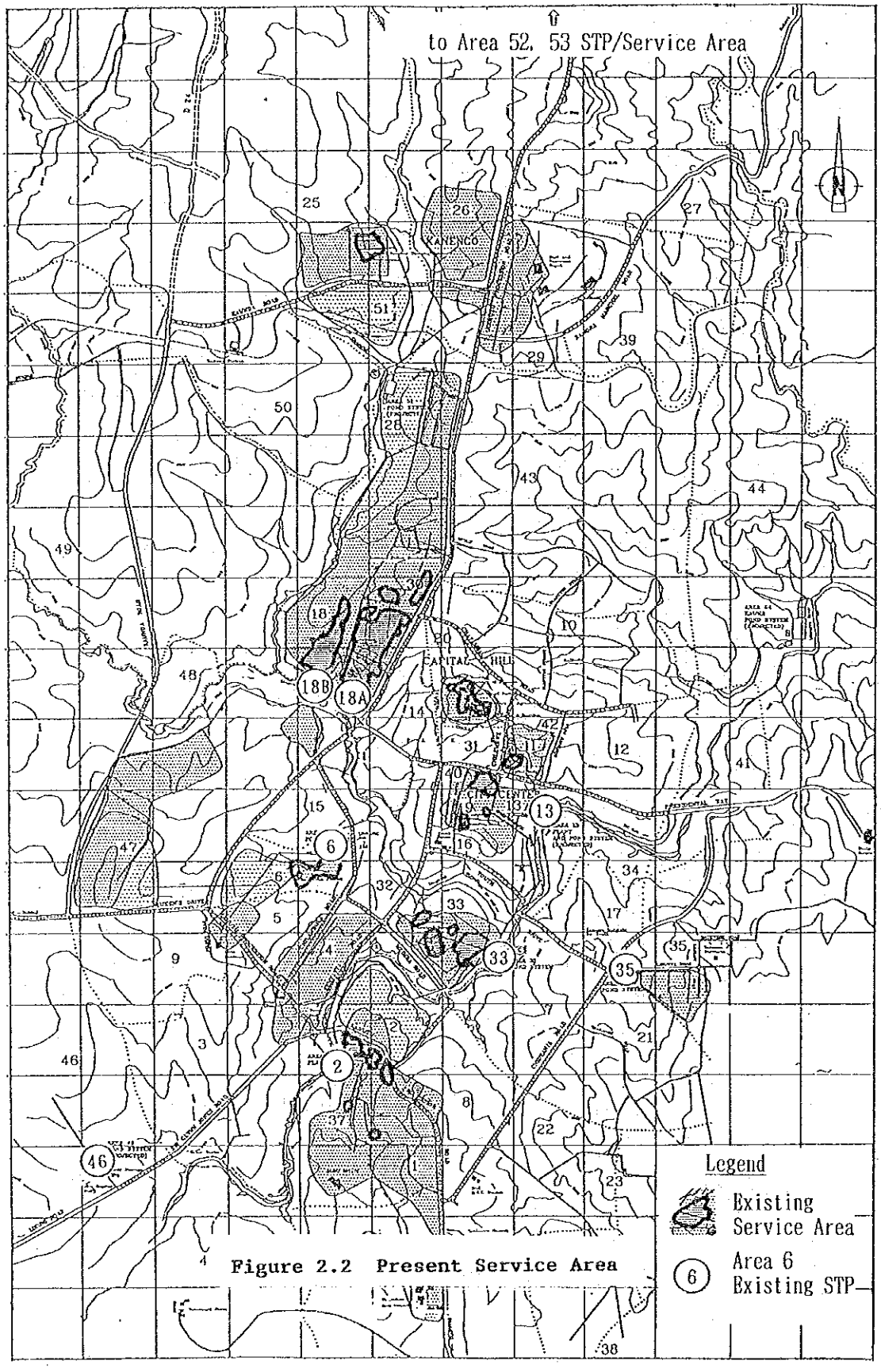


Figure 2.2 Present Service Area

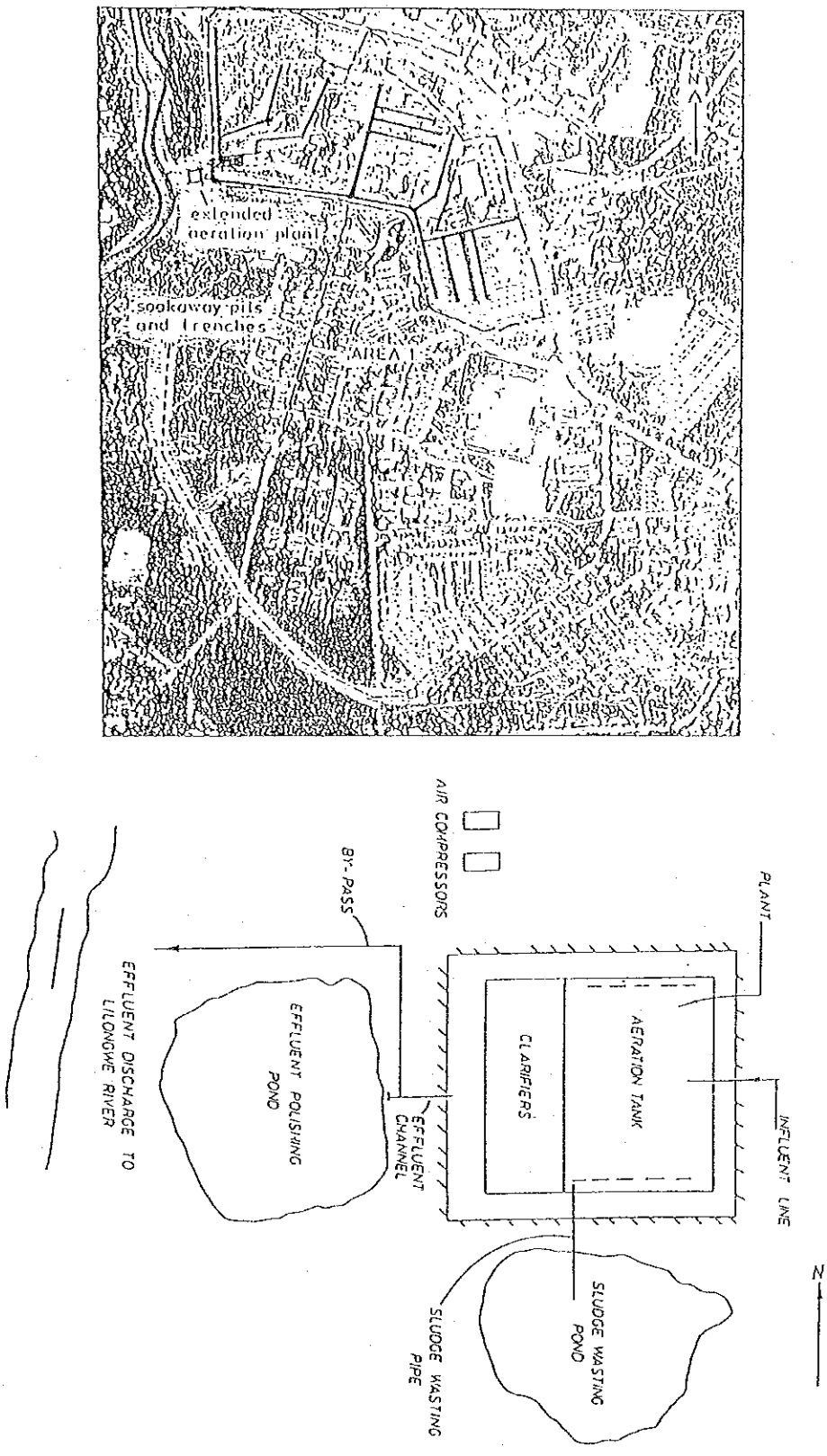
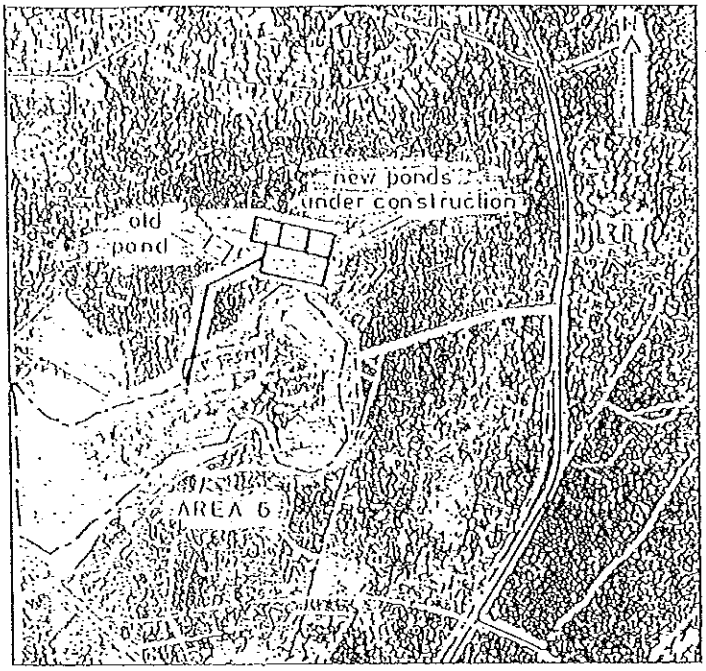


Figure 2.3 Service Area and STP for Areas 1 and 2



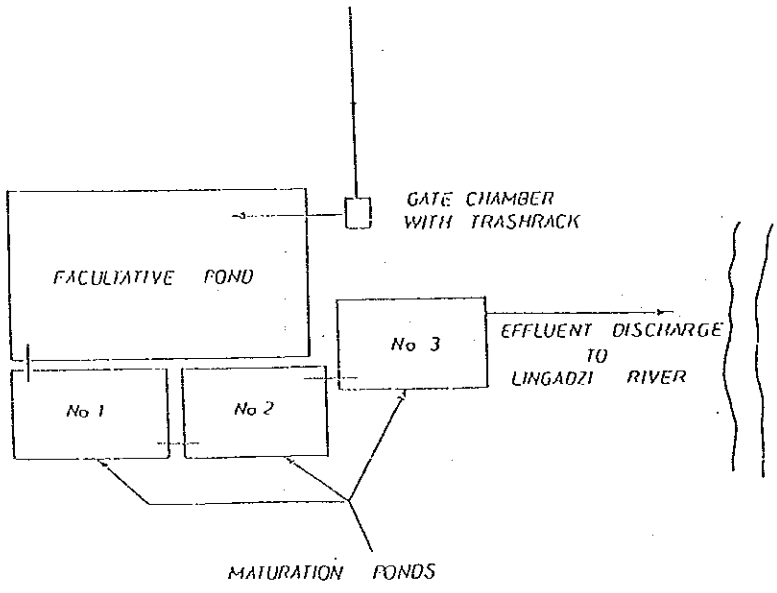


Figure 2.4 Service Area and STP for Area 6

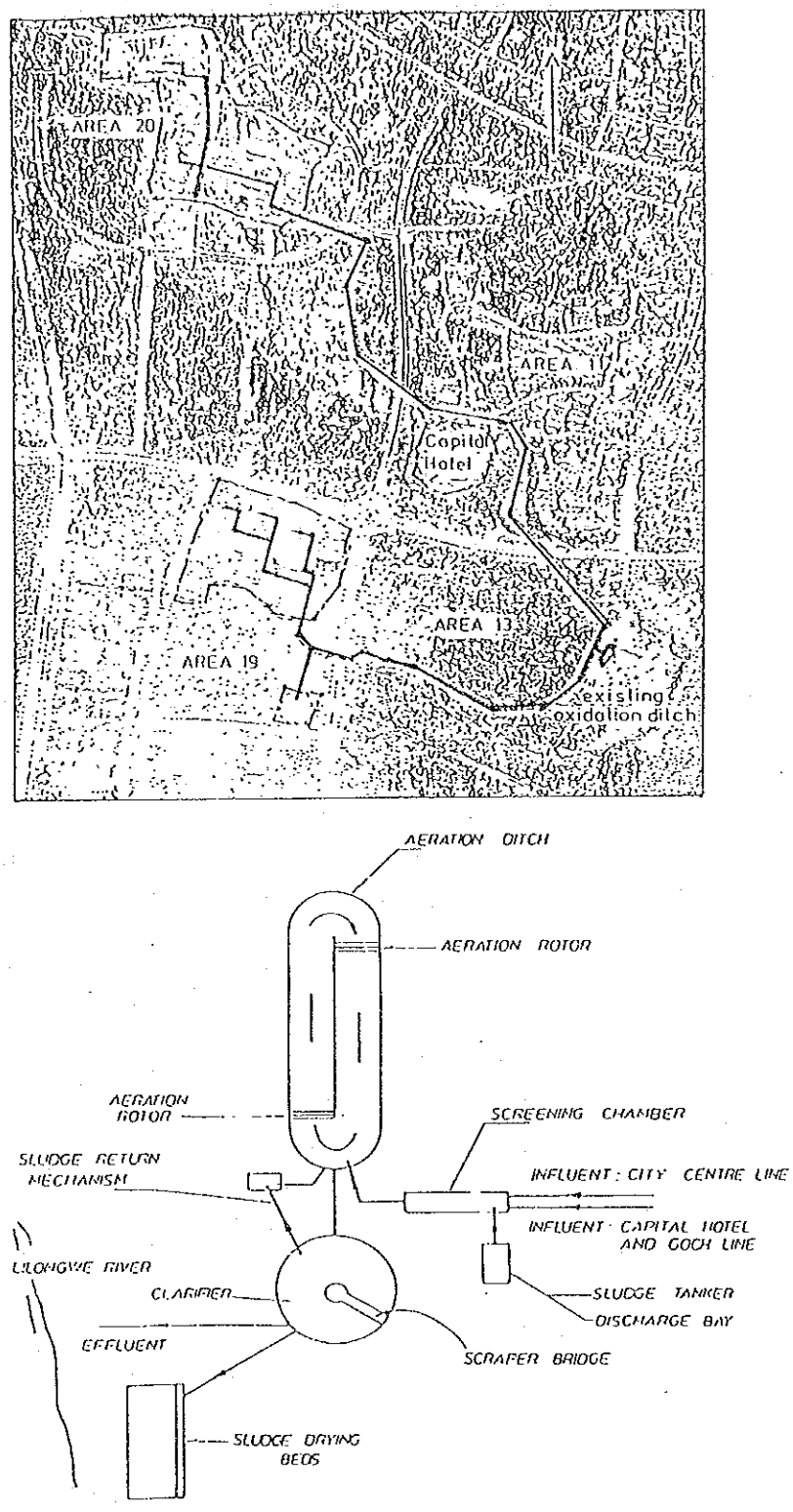
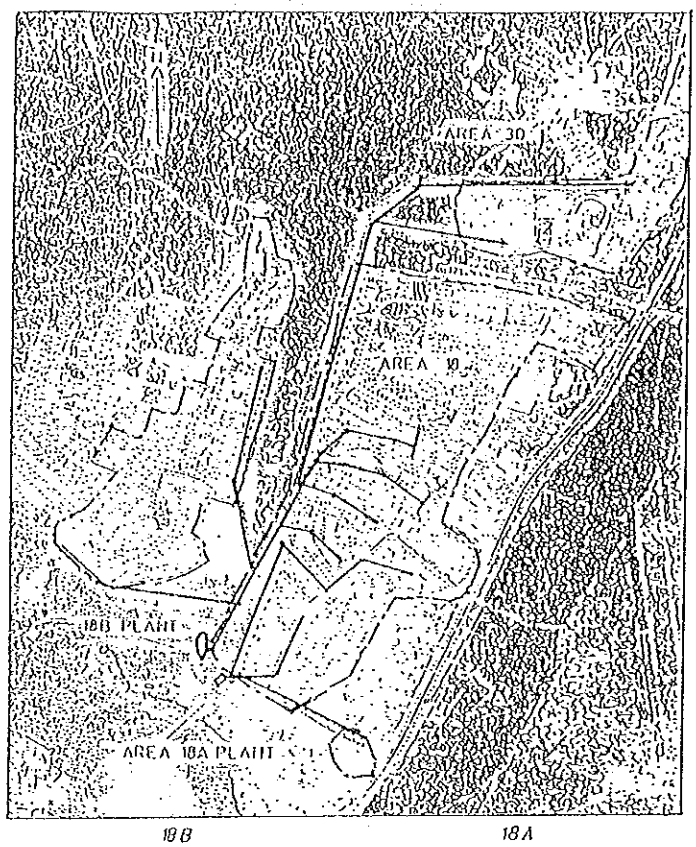


Figure 2.5 Service Area and STP for Area 13



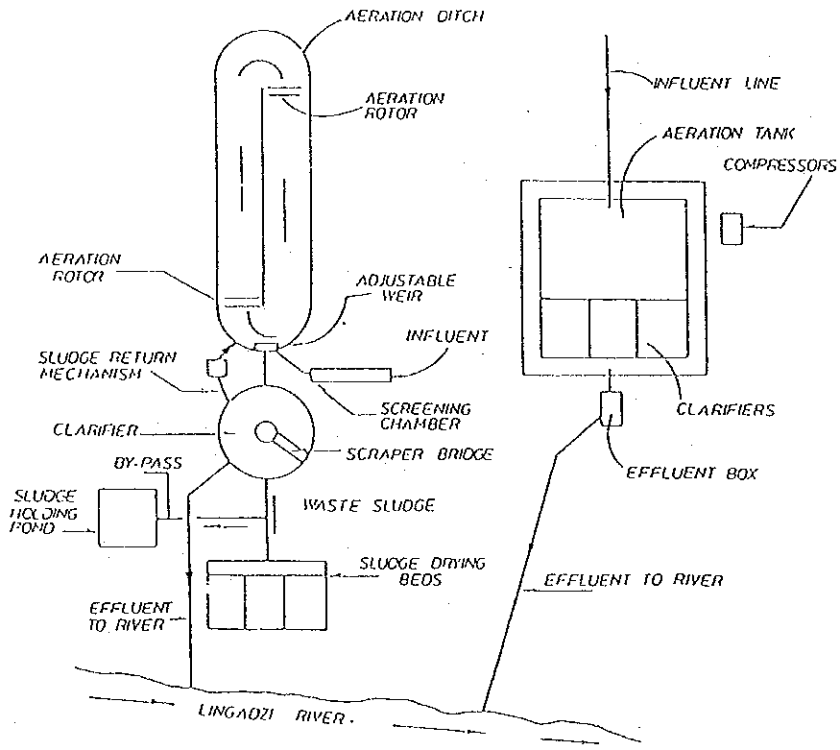
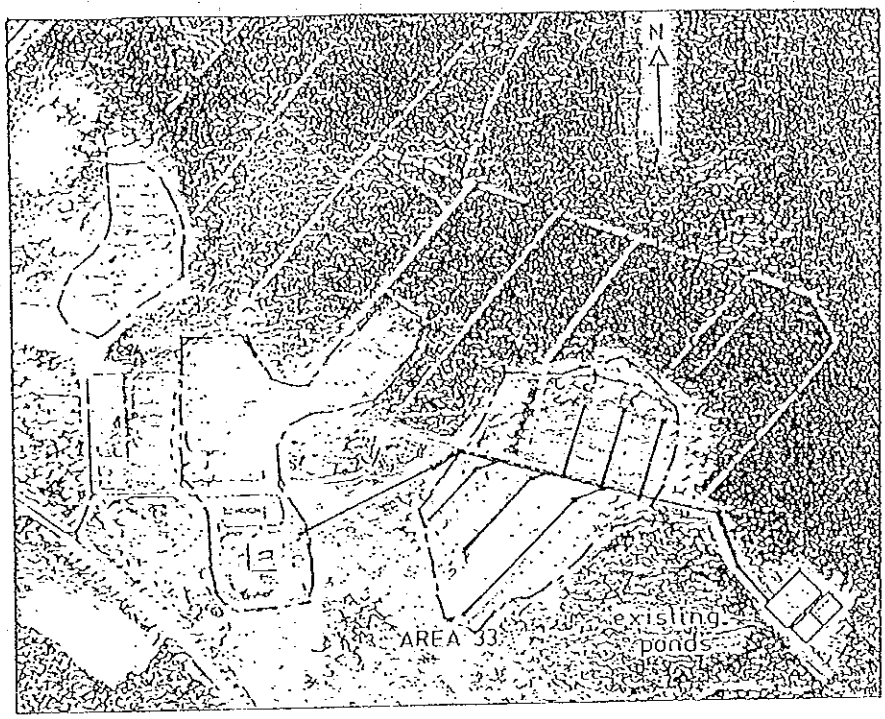


Figure 2.6 Service Area and STP for Area 18



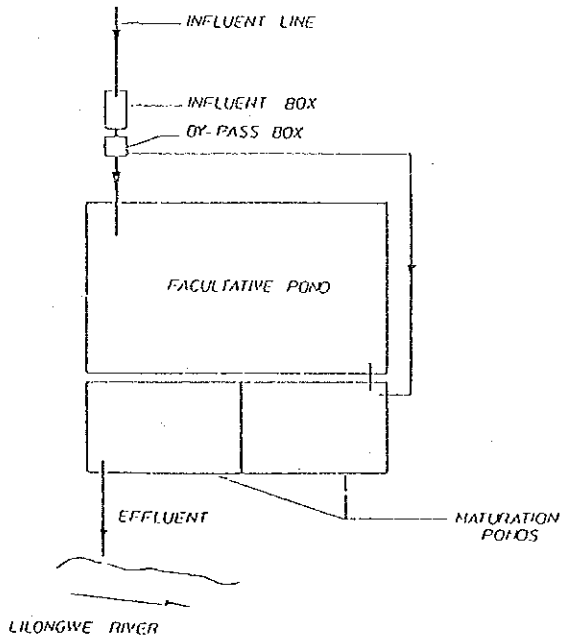
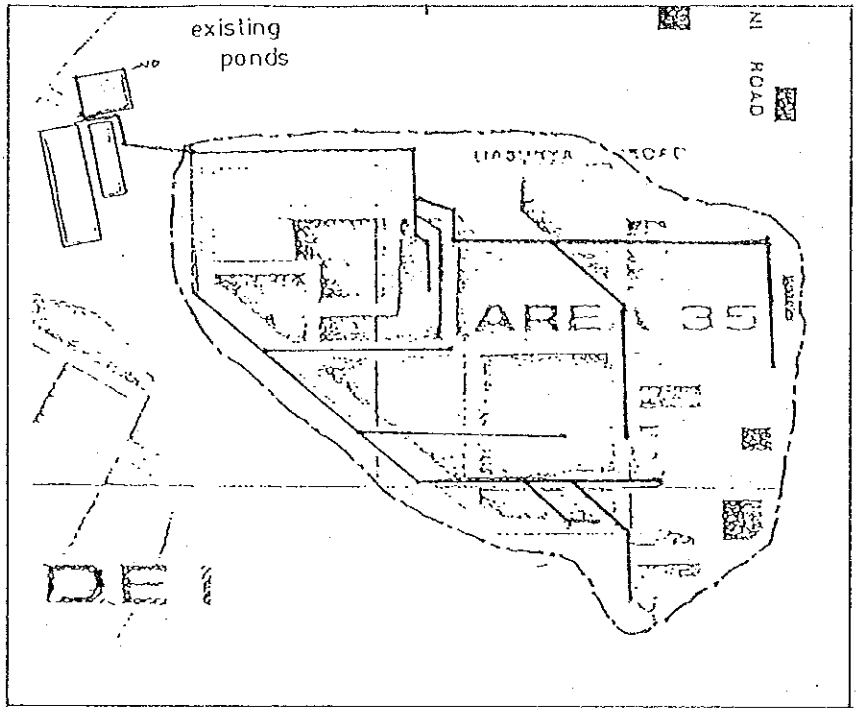


Figure 2.7 Service Area and STP for Area 33



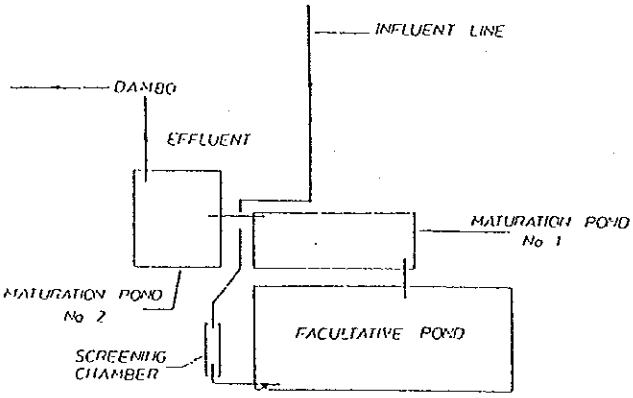


Figure 2.8 Service Area and STP for Area 35

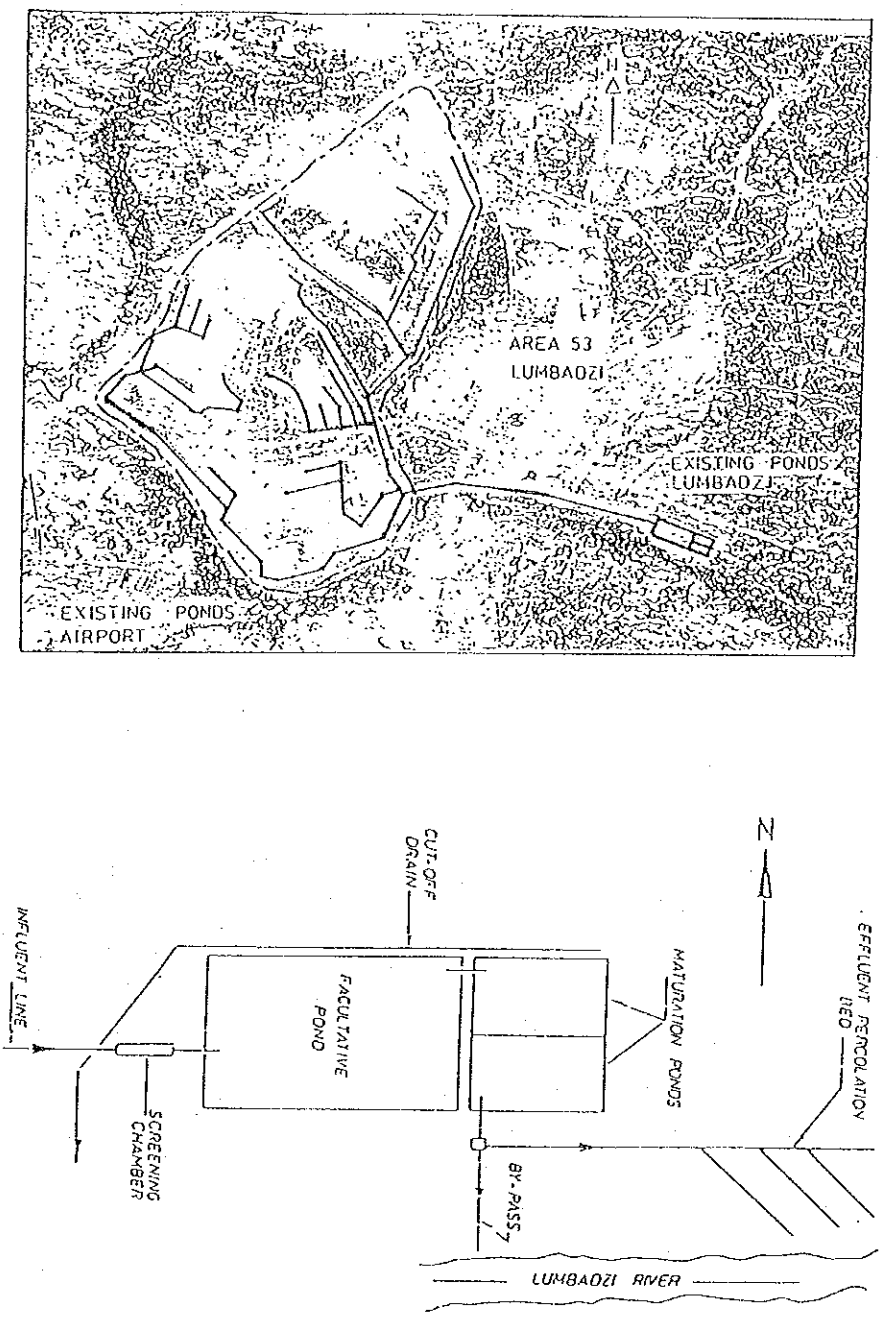


Figure 2.9 Service Area and STP for Area 53

pleted). Table 2.6 presents a summary of each treatment plant. Because of poor maintenance, difficulties with equipment, a shortage of spare parts, insufficient knowledge of operation and maintenance, etc., except for those plants using the stabilization pond process, the treatment is poorly performed, and the treated sewage from these treatment plants are discharged into the Lilongwe and Lingadzi Rivers flowing through the city and causes the water pollution of these rivers. The field survey on the 6 treatment plants in the study area provided the following findings.

a) Area 2 (Extended Aeration Process) - Operated by the City Council

This treatment plant is in Area 2 to treat the sewage from the Lilongwe Old Hospital and its attached residences located on the south side of the M1 road and is operated by the City Council.

Consisting of an aeration tank and a sedimentation tank, it is an integrated compact treatment facility made of steel structure.

It is equipped with a blower from which air is supplied into the aeration tank, and the sewage is treated by the activity of microorganisms, but because of poor maintenance, the sludge withdrawal and return are not performed properly and the treatment is resultantly ineffective. The process includes treatment by a maturation pond prior to the discharge of the treated sewage, but at this plant, this step has not yet been introduced.

Because of the compactness of the system in addition to the use of an extended aeration process, sophisticated technology is needed for its operation and maintenance. For operation of this system, its blower and motor must function well, and when either is broken, the system cannot function. Judging from the operation and maintenance technology and skill needed to maintain the equipment, this facility is not suitable for Lilongwe.

Table 2.6 Existing Sewage Treatment Plants

Plant	Tretment Method	Sewer Acces Area	Capacity (m^3/日)	Actual Flow (m^3/ 日)	Effluent Point	manage ment	Remark
Area 2	Extended Aeration	Area 1,2	290	230	Lilongwe river	L C C	bad treatment due to deterior-ation and poor maintenance
Area 6	Stabilization Pond	Area 6, Maula Prison	300	(80)	Dambo, Stream	Min. of Works	poor maintenance
Area 13	Oaxidation Ditch	Area 13 Capital Hill(A-20) Commercial(A-26) Capital Hotel (A-11)	1,770	521	Lilongwe river	L C C	bad treatment due to deterior-ation and poor maintenance
Area 18A	Extended Aeration	Area 18A	389	58	Lingadzi river	L C C	bad treatment due to deterior-ation and poor maintenance
Area 18B	Oaxidation Ditch	Area 18B	1,770	737	Lingadzi river	L C C	bad treatment due to deterior-ation and poor maintenance
Area 33	Stabilization Pond	Area 33 -Kamuzu Central Hospital	205	472	Lilongwe river	Min. of Works	poor maintenance shortage of capacity
Subtotal (within Project Area)			4,724	2,098			
Area 35	Stabilization Pond	Area 35 -Kamuzu Barracks	630	(250)	Dambo	L C C	not so bad
Area 46	Extended Aeration	Cold Storage Co.,Ltd	—	(58)	Infiltration	private	poor maintenance.
Area 46	Oaxidation Ditch	New Capital Dairy Co	—	(21)	Infiltration	private	poor maintenance. no operation
Area 52	Stabilization Pond	Area 52-Kamuzu Inter. Airport	330	—	Infiltration	Min. of Works	poor maintenance. broken equipment
Area 53	Stabilization Pond	Area53-Lumbadzi	1,200	133	Lumbadzi river	L C C	not so bad
Total			6,884				

L C C = Lilongwe City Council

b) Area 6 (Stabilization Pond) - Operated by the Ministry of Works

Constructed by the Ministry of Works in Area 6 to treat the sewage from the nearby Maula Prison and its staff residences, it is operated by the prison.

The treatment method is a stabilization pond process consisting of a series of ponds -- 1 facultative pond and 3 maturation ponds. It requires no power. For some unknown reason, the facultative pond and one maturation pond are not in use. But since the incoming sewage flow is far less than the design flow, treatment is performed relatively well.

A manual screen is installed at the inlet, but it is not well-maintained so that the screen is plugged with garbage and the sewage flows around it.

c) Area 13 (Oxidation Ditch Method) - Operated by the City Council

This treatment plant treats the sewage from the City Center, the Capital Hill, the Capital Hotel, and other buildings in the middle of the city. The oxidation ditch process is employed.

One of two aeration rotors installed in the oxidation ditch is broken so the treatment process cannot be provided with sufficient air. The sludge return equipment is also broken down, so that no activated sludge is returned. Consequently, the mixed liquor suspended solids (MLSS) in the ditch is substandard with the poor growth of the activated sludge, resulting in inefficient biological treatment of the organic matter.

The sludge collector for collection of the sludge settled in the bottom of the sedimentation tank is broken, and as a result, sludge withdrawal is not performed well. In this plant, the equipment that plays a vital role in sewage treatment is broken, so the treatment is performed extremely inefficiently. Not only that, the septage (sludge from septic tanks) is dumped into the grit chamber, resulting in even poorer treatment.

This treatment method requires the use of powered equipment and technical ability is required to operate and maintain it, so it is not a suitable method for Lilongwe.

A simple laboratory is provided on the premises of the treatment plant, but there is no way of transporting the samples and its instruments are unsatisfactory. The conducted analysis are for BOD and SS tests, which are done once a month on average.

d) Area 18A (Extended Aeration Process) - Operated by the City Council

This treatment plant consisting of an aeration tank and a sedimentation tank, was constructed to treat the sewage from Area 18A. Structurally, it is similar to that in Area 2, a compact steel structure facility. Like the Area 2 treatment plant, it does not perform good quality treatment, because it does not carry out the proper sludge withdrawal and return.

Like that in Area 2, the treatment method employed is not suit able, taking account of its operating and maintenance technology and the maintainability of the equipment.

e) Area 18B (Oxidation Ditch Process) - Operated by the City Council

This treatment plant employs the oxidation ditch process to treat the sewage from Area 18B. Like the Area 13 treatment plant, aeration is not sufficient because of a broken rotor and the sludge floc formation process is poor. The sedimentation tank is in a poor condition, because of almost no sludge withdrawal.

f) Area 33 (Stabilization Pond Process) - Operated by the City Council

Constructed to treat sewage from the Kamuzu Hospital, the nurse's school, the staff housing and other buildings in Area 33, it employs the stabilization pond process similar to that

used at the Area 6 treatment plant. The treatment process includes an anaerobic pond followed by a facultative pond. This treatment method requires no powered equipment.

It is poorly maintained; the anaerobic pond is almost completely filled with deposits, but the entire facility is functioning, providing relatively good treatment as a whole.

To confirm the effectiveness of the treatment performed at all six treatment plants described above, the study team took samples of the influent and effluent on August 31, 1993 for analysis (See Table 2.7). The treatment efficiency in terms of BOD removal was, on average, 23% for the extended aeration process, 70% for the oxidation ditch process, and 66% for the stabilization pond process, which showed that the stabilization pond process with no equipment achieved sewage treatment almost equal to that of an oxidation ditch process. But none of the treatment plants satisfied the effluent water quality standards (BOD 20mg/l, SS 30mg/l). The treatment performed at plants employing the extended aeration method is particularly poor.

To investigate the actual incoming sewage flow, the study team carried out a 24-hour continuous flow measurement at each treatment plant between September 2 and 16, 1993. As shown in Table 2.8, the results of these measurements are almost the same as those obtained in the F/S survey. Despite the passage of 4 years since the F/S survey, the sewage flow remained stable because the existing sewer network has not been extended and the new connections have been restricted due to the lack of capacity of the existing treatment plants.

Table 2.8 Flow Volumes at Existing Treatment Plants

Plant	F/S	JICA Survey
Area 2	165m^3/day	230.4m^3/day
Area 6	(80) "	----
Area 13	653 "	521.5m^3/day
Area 18A	*	58.3 "
Area 18B	728 "	736.5 "
Area 33	474 "	471.4 "

* included in Area 18A

Table 2.7 Treated Water Quality of Existing Sewage Treatment Plants

(sampled on August 31, 1993)

S.T.P.	Treatment Method	Sampling Point	Water Temp. (℃)	pH	BOD (mg/l)	SS (mg/l)	DO (mg/l)	E.C.*1 (S/cm)	NH_4-N (mg/l)	NO_2-N (mg/l)	Coliform Nos (Test Paper)	Gen. Bacteria (Test Paper)
Area 2	Extended Aeration	Influent	21.7	8.3	145	270	1.8	0.93	>8	ND	+++++	+++++
		Effluent	22.3	7.6	101	127	0.0	0.53	>8	ND	++++	++++
Area 6	Stabilization Pond	Influent	20.9	7.3	80	343	0.6	0.31	>8	ND	+++	++++
		Effluent	21.2	8.4	38	220	15.0	0.65	>8	ND	++++	++++
Area 13	Oxidation Ditch	Influent	22.2	7.6	102	163	0.7	0.41	>8	ND	+++++	+++++
		Effluent	22.7	7.5	50	24	1.1	0.38	>8	ND	+++	+++++
Area 18A	Extended Aeration	Influent	21.7	7.7	288	480	0.4	0.43	>8	ND	++++	++++
		Effluent	22.3	7.3	242	242	2.4	0.31	>8	ND	+++++	+++
Area 18B	Oxidation Ditch	Influent	22.2	7.6	260	260	0.8	0.41	>8	ND	++++	+++++
		Effluent	22.7	7.2	32	110	0.8	0.33	>8	ND	+++	++++
Area 33	Stabilization Pond	Influent	21.9	7.3	147	220	0.8	0.26	>8	ND	++++	++
		Effluent	22.5	8.5	33	77	14.0	0.54	>8	ND	+++	+++

Note: *1 E.C. =Electric Conductivity

2) Sewers

Sewers were almost all installed during the development period of each area, and were arranged in conformity with the local topography so that it is easy to collect the sewage (installation in topographically low-lying locations). They are installed without pumps at shallow depths with a maximum earth covering of 3m. These are not installed under the public roads except when crossing under roads.

The sewers are not maintained regularly, but because they are laid under open spaces and beside water channels, they are not damaged by live loads. At locations within Area 18 where the sewers are installed under fields, however, there are allegedly some case that the sewers are intentionally broken so as to overflow the sewage for the purpose of supplying water and organic substances to the crops. Area 18 is also subject to frequent blockages, perhaps because the manhole covers are stolen. The F/S pointed out that one cause of these problems was poor design and installation work.

The city officials explained that insufficient capacity at the sewage treatment plants limits house connections.

The present sewerage service area in the Project area is parts of Areas 1, 2, 3, 13, 18 and 33.

Asbestos cement pipes are used throughout the system, and in some sections, polyvinyl chloride pipes are installed. Manholes are of rectangular in-situ concrete boxes and are equipped with a cast iron square water-tight cover, but many of these are left open because of the cover having been stolen. The top of the manhole boxes are set about 10cm above ground, and where the cover is in place, there is little danger of stormwater intrusion into the system. Inverts are provided at the bottom of the manholes, so that the sewage flows smoothly.

(2) State of Septic Tanks and Pit Latrines

Septic tanks and pit latrines are used in those parts of Lilongwe not served by sewerage system. Pit latrine users comprise an overwhelmingly large proportion of the population. In areas with particularly high concentrations of traditional sun-dried brick houses, it is customary to treat urine in pit latrines, and to drain the sullage into the ground. However, because the people's only source of water are the communal faucets called Kiosks, they use little water, and it is not necessary to quickly provide a sewer system in such areas in the Project. The study team carried out an on-site survey on areas within the city where pit latrines are used, but did not observe any sewage on the surface of the ground, perhaps because it was done during the late period of the dry season. But because the pit latrines are not sealed, the team observed the presence of many flies.

Septic tanks are widely used in ordinary dwellings in parts of the city lacking access to the sewer system. Communal septic tanks are installed for use by many dwellings occupied by employees of organizations such as governmental agencies. They are, however, not well maintained, and a survey of one of these in Area 1 revealed that the sewage overflowed the tank and drained into a nearby water course.

The effluent from septic tanks usually permeates the soil, but because these overflow as a result of a high installation density, poor design and workmanship, inappropriate soil conditions, and high groundwater levels, there are many areas where it is necessary to frequently remove the septic tank sludge. In the M/P, areas of this type were identified as Areas 1, 2, 3, 4, 8, 12, 25 and 46.

(3) Maintenance System

In Lilongwe, the Sewerage Section of the City Engineer's Department is in charge of the maintenance of the sewerage system. Out of the approximately 1,500 City Council employees, the City Engineer's Department employs about 500 persons, 350 persons of whom work in the civil work related sections. Of these, 35 persons perform work related to the water quality and the engineering work for maintaining the sewerage system. Figures 2.10 to 2.12 show these organizations. The mechanical and electrical equipment in the sewerage facilities are maintained and improved by the personnel in the Mechanical Section and

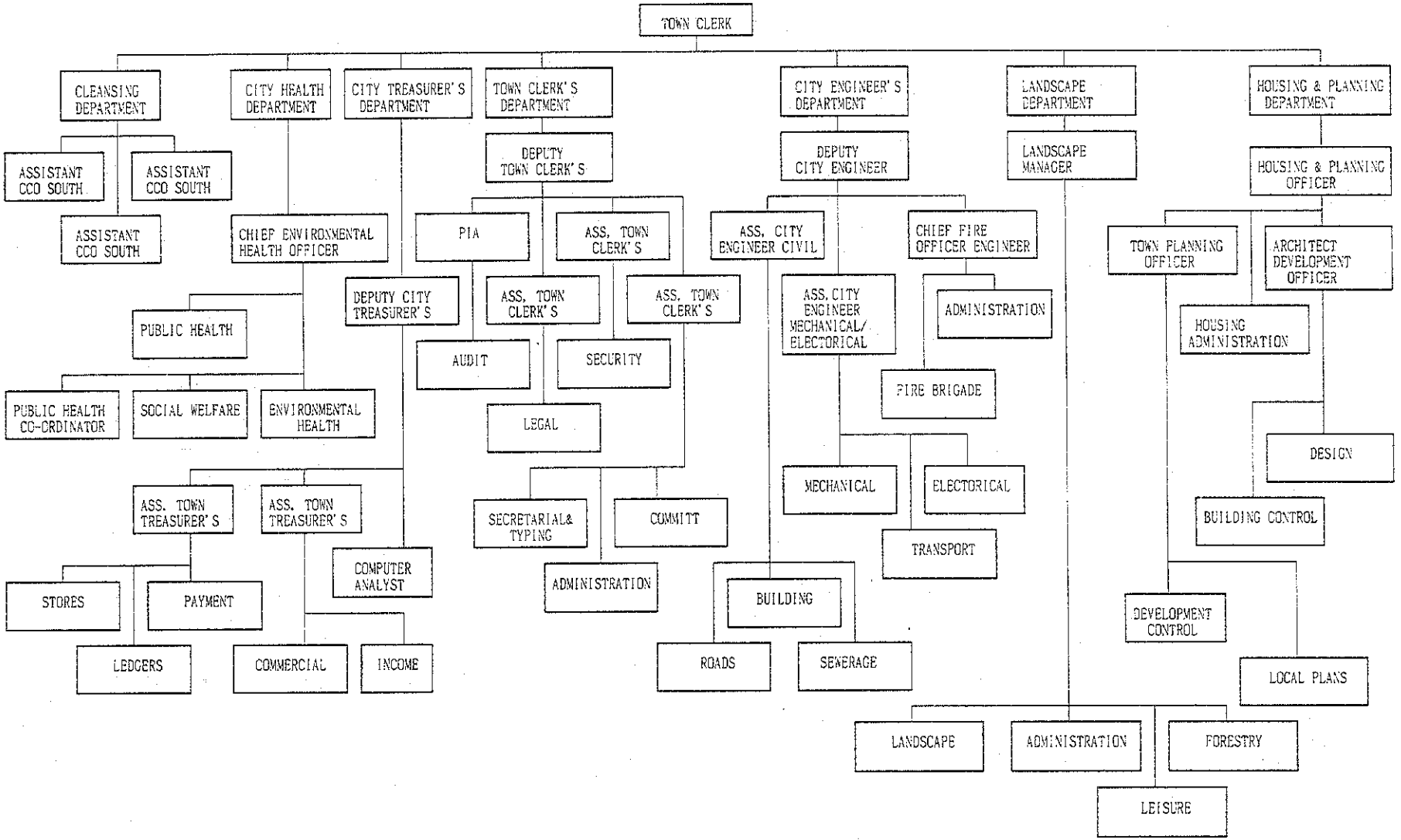


Figure 2.10 Organization Structure of Lilongwe City Council

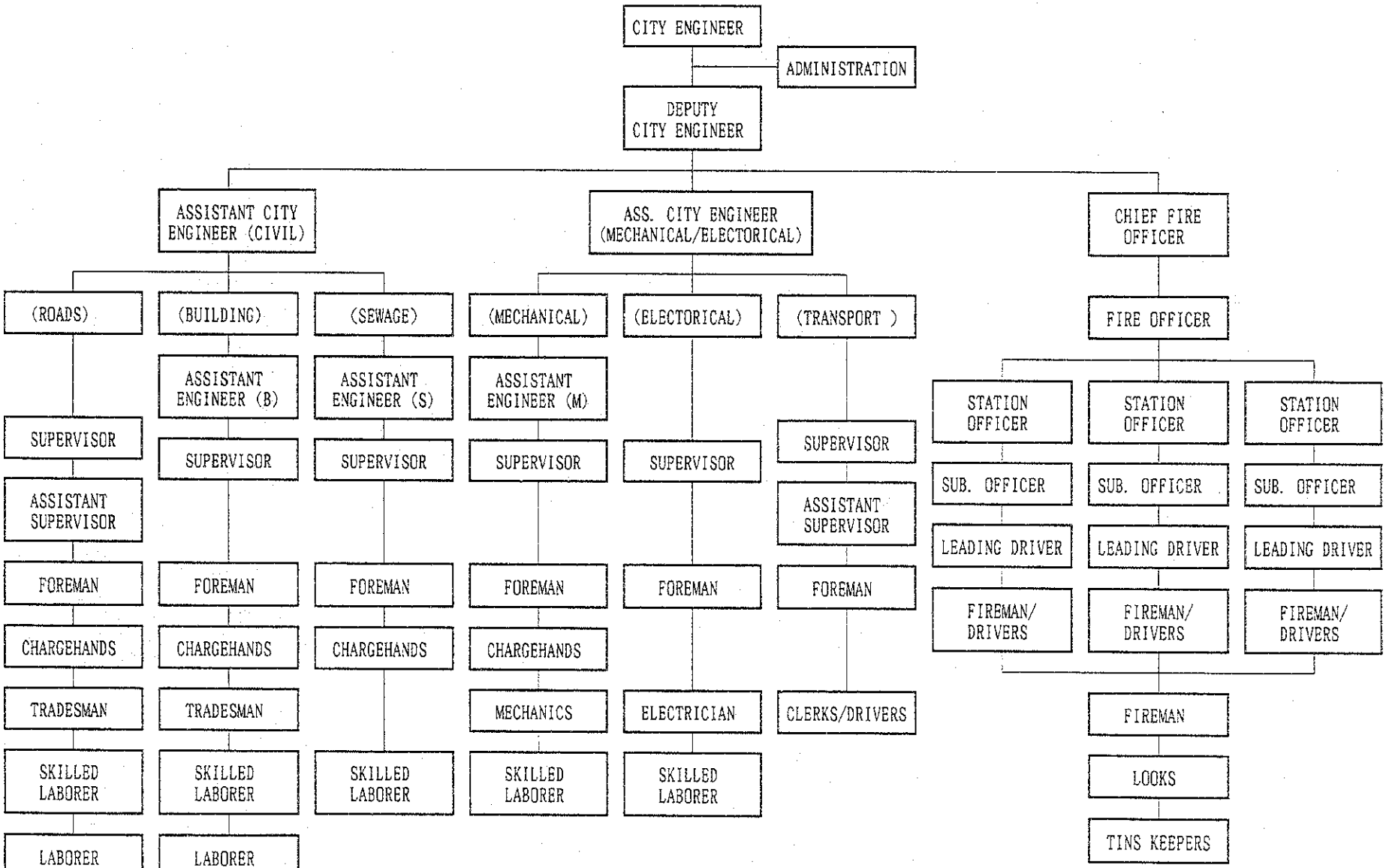


Figure 2.11 Organization Structure of City Engineer's Department

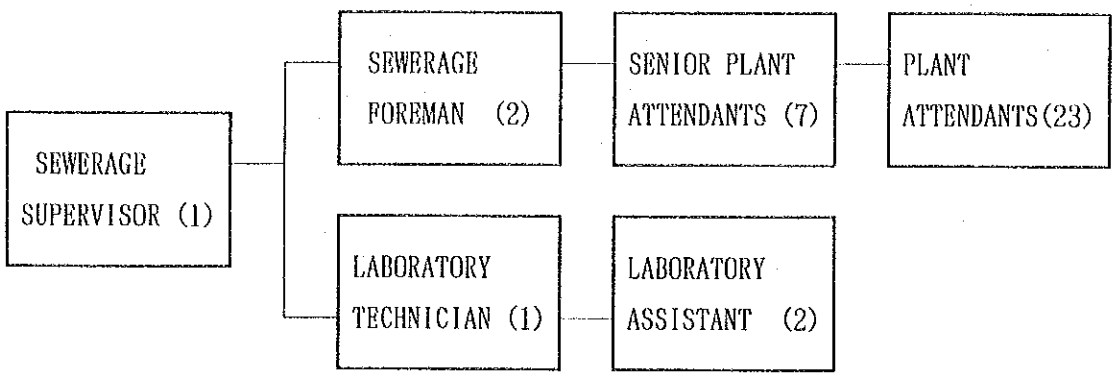


Figure 2.12 Organization Structure of Sewerage Section

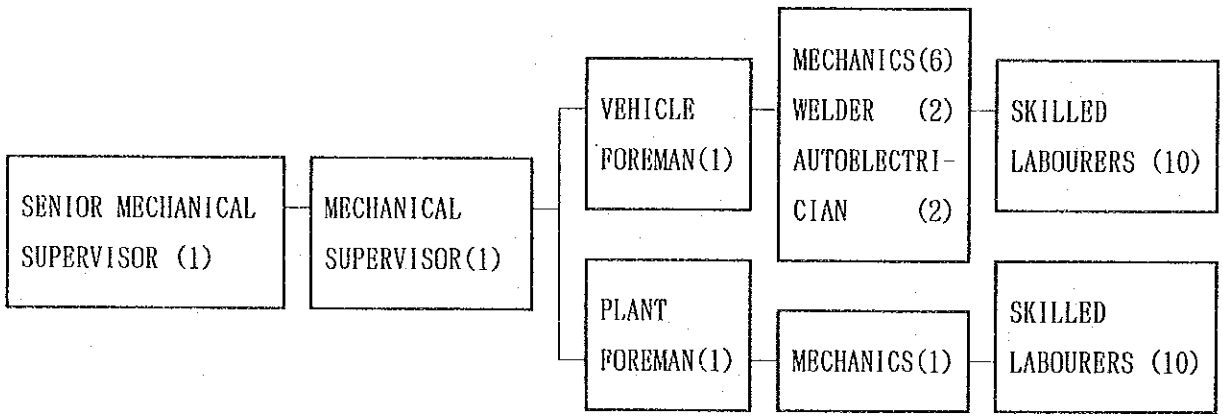


Figure 2.13 Organization Structure of Mechanical Section (Workshop)

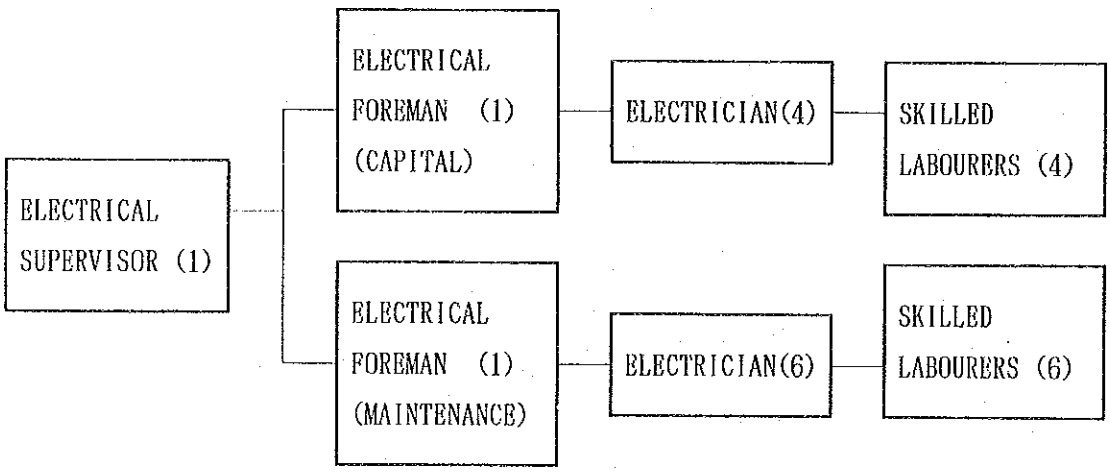


Figure 2.14 Organization Structure of Electrical Section

maintained and improved by the personnel in the Mechanical Section and the Electrical Section, respectively which make up the Mechanical/ Electrical Division. The organization charts of these two sections are shown in Figures 2.13 and 2.14.

The Cleansing Department is responsible for cleaning septic tanks and removing sludge from them along with garbage disposal and street cleaning. Its organization chart is shown on Figure 2.15.

The City Treasurer's Department has jurisdiction over the sewerage-related financing, and the sewage charges are handled as general revenue. Because all sewerage operating expenses are paid from general revenues, no independent financial analysis of the sewage works is performed. All users pay a flat rate for sewerage service which varies according to the user's category to which each belongs. Details are described in Section 3.2.2.

2.4.2 Improvement Projects

The following are improvement projects related to the sewerage system in the Project area.

a) Lilongwe Water Supply & Sanitation Master Plan (M/P) 1983/1986
b) Lilongwe City Sanitation Development Plan Feasibility Study (F/S) 1992

The M/P, a master plan for water supply, sewerage and sanitation facilities, estimated the population, water supply volume, sewage volume, etc. for the target year of 2005, and consists of a 1983 report and a 1986 supplementary study report. According to these reports, the water supply and sanitation facilities in the city will, by 2005, be as shown on Table 2.9.

In accordance with the M/P, a feasibility study for the second stage expansion project of the water supply system was carried out in 1986, and the construction related to the project was completed in 1992. In 1993 a feasibility study of the third stage expansion project, which will include a review of the M/P, has begun.

The F/S is the foundation for the Project. Table 2.10 presents a summary of

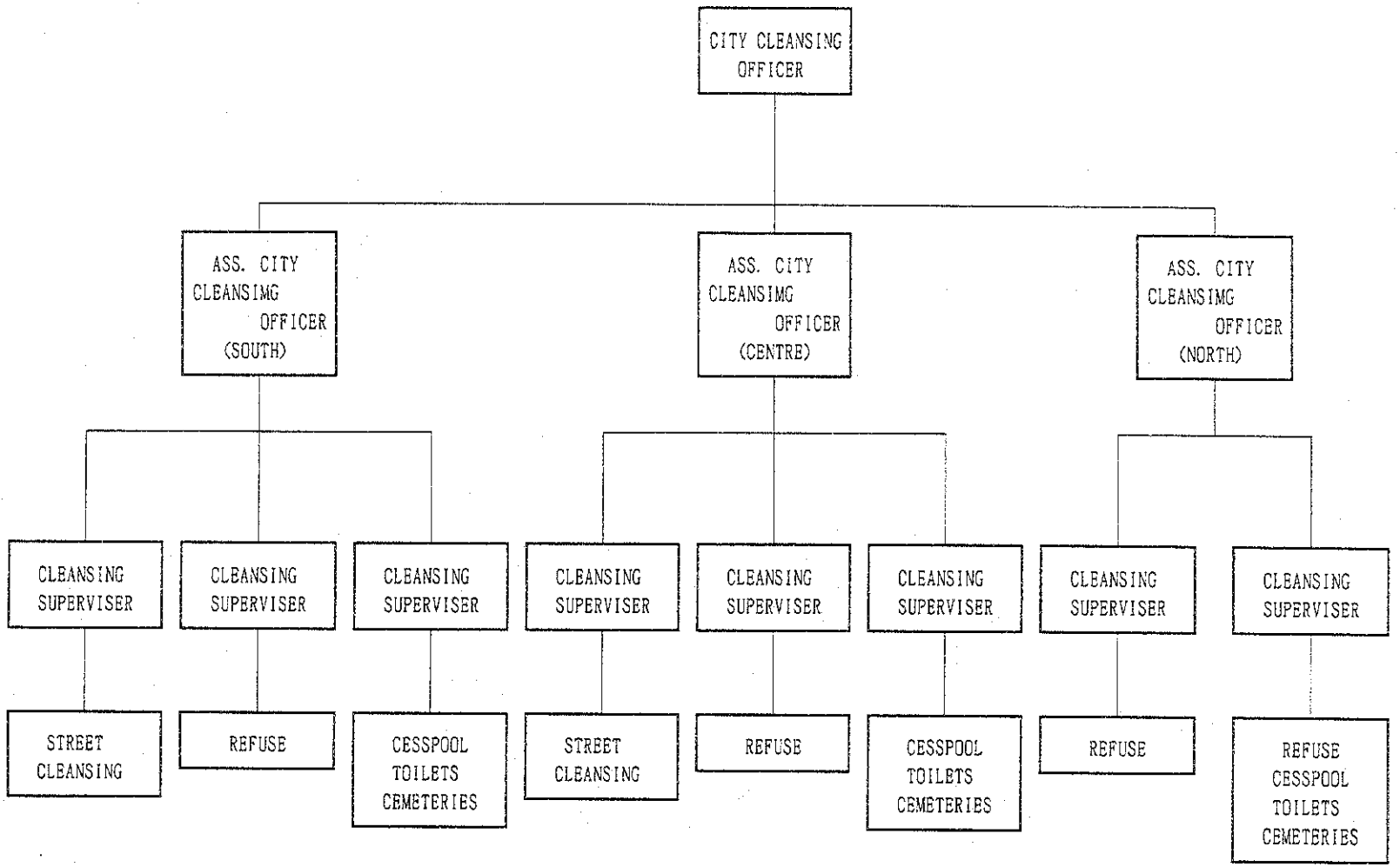


Figure 2.15 Organization Structure of Cleansing Department

Table 2.9 Outline of the Master Plan (2005)

Particular		Water Supply	Sewerage and Sanitation			
			Sewerage	Septic Tank	Pit Latrine	Total
Service Pop.	(prs.)	443,500	48,800	48,800	345,900	443,500
Design Flow	(m^3/d)	85,800	8,877	-	-	-

Per Capita Flow in the M/P

(Unit:lpcd)

	Water Supply	Sewerage
H.D.T.	(128)	100
H.D.P.	(174)	150
M.D.P.	(185)	160
L.D.P.	(263)	215
Other	*	*

( ) Revised in 1986
* Estimated based on the performance in similar projects
H.D.T.: High density traditional housing area
H.D.P.: High density permanent housing area
M.D.P.: Medium density permanent housing area
L.D.P.: Low density permanent housing area

Table 2.10 Outline of the Feasibility Study

Particular		2000	2005
Sewerage			
Design Service Pop.	(prs.)	70,000	80,000
Design Sewage Flow	(m^3/day)	14,415	17,978
		(8,428)	(12,914)
No. of Plants	(nos.)	7	7
Septic Tank Design Pop.	(prs.)	83,000	120,000
Pit Latrine Design Pop.	(prs.)	347,000	468,000
Total Pop.	(prs.)	500,000	668,000

Note:Figures for an overall plan and those in ( ) for the incoming design sewage flow to the new plant downstream of the Lilongwe River

Per Capita Flow in the F/S

H.D.T.	80 lpcd
H.D.P.	125 lpcd
M.D.P.	150 lpcd
L.D.P.	200 lpcd
Others	Estimated based on the performance in similar projects

the F/S. Figure 2.2 also shows the planned service area for the years of 2000 and 2005 in the F/S.

2.4.3 Pollution of the Rivers

The field survey was performed at the end of the dry season, so the flow in both the Lilongwe and Lingadzi Rivers, which flow through the city, was relatively small, and was polluted by wastewater. Residents of areas where houses are not directly connected to the water supply system individually use the river water for domestic purpose such as dish washing and laundry, so that polluted river water presents hygienic problems. The study team analyzed the water quality in both rivers to understand the actual state (See Table 2.11 and Figure 2.16). The results clearly revealed the influence of sewage discharged from the city, and in the Lingadzi River, which has a relatively small flow, its influence was particularly marked. In the case of the Lilongwe River, which has a relatively large flow, the sewage discharged from the city has a harmful effect on the water quality of the river, but downstream, the river's self-purification capacity tends to restore the water quality.

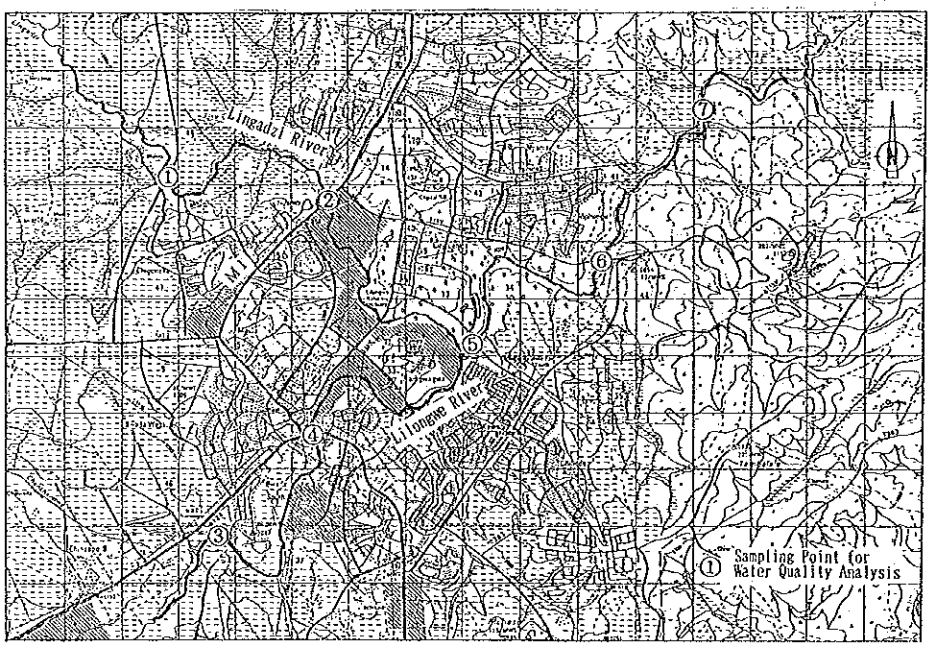


Figure 2.16 River Water Sampling Points

Table 2.11 Water Quality of Rivers

(sampled on September 8, 1993)

Loc. No.	Name of River	Sampling Point	Water Temp. (℃)	pH	BOD (mg/l)	SS (mg/l)	DO (mg/l)	E.C.*1 (S/cm)	NH_4-N (mg/l)	NO_2-N (mg/l)	COD (mg/l)	Coliform Number (MPN/100ml)	Gen. Bacteria (T.P.)*2	Gen. Bacteria (T.P.)
1	Lingadzi River/Upperstream	Kaunda Road	23.2	7.9	2.4	13.0	4.8	0.90	0.4	ND	5	210	+++	+++
2	/Downstream	Kamuzu P. Road	22.6	7.6	7.9	17.5	1.8	0.90	3.0	0.03	5	580	++++	+++++
3	Lilongwe River/Upperstream	Water Board	23.2	7.9	1.0	12.4	5.8	0.31	ND	ND	ND	110	+	+
4	/Midstream-1	Kamuzu P. Road	23.7	7.7	2.9	13.6	5.5	0.41	0.8	0.06	5	2,350	+++	++
5	/Midstream-2	Youth Drive	22.3	8.1	2.1	6.2	7.0	0.63	0.4	0.03	5	480	++	+++
6	/Midstream-3	President. Way	23.3	8.2	2.2	14.4	7.9	0.58	0.4	0.03	5	920	++	+
7	/Downstream	Proposed STP	22.7	8.5	1.1	11.0	7.7	0.47	ND	0.015	2	140	+++	+++

Note: *1E.C. = Electric Conductivity *2T.P. = Test Paper

But while this shows the situation in the dry season, it is reported that although the river flow rises substantially during the wet season, and that the effluent from septic tanks and pit latrines overflows without permeating into the soil and runs off into the river as it is, which actually worsens the water quality of the river. This deterioration of the river's water quality is particularly severe at the beginning of the wet season, when the contaminated materials on the ground surface are rapidly washed out into the rivers.

Table 2.12, which shows the numbers of residents in the Lilongwe River basin within the city who suffer from the bloody diarrhea caused by bacterial pollution, indicates that the number of patients leaps quickly with the start of the wet season in October. In this area, where there is no piped water supply, most water is taken from shallow wells or directly from the river, so the rise in the incidence of this disease suggests that the area is adversely effected by the deterioration of the quality of the groundwater or river water.

Table 2.12 Number of Patients by Bloody Diarrhea

Year/Month	Downstream of the Lilongwe River	Other Area
Aug. 1992	20	22
Sep.	23	52
Oct.	60	131
Nov.	17	62
Dec.	13	27

CHAPTER 3

OUTLINE OF THE PROJECT

CHAPTER 3 OUTLINE OF THE PROJECT

3.1 Objective

There are 11 sewage treatment plants scattered throughout the city, but the treatment functions of many of these plants have waned because the appropriate improvement and rehabilitation work have not been done, with the result that the treated sewage at these plants does not meet the effluent water quality standards established by the Water Resources Board of Malawi. Consequently, water pollution in the Lilongwe and Lingadzi Rivers, which receive the treated sewage, has been increased, causing a decline in the health and hygiene of the people who live in these basins and take their water from these rivers.

In an attempt to remedy this problem, the City Council has prepared the Lilongwe City Sanitation Development Plan (LCSDP) Feasibility Study. This project for the improvement of the existing sanitation facilities, including the sewerage system, is divided into two phases: (a) an emergency phase and (b) a facility expansion phase. Using its own funds, the City Council commenced work on the emergency phase in 1992, but because of a shortage of funds, the implementation of the majority of the project has been delayed.

The project for the facility expansion phase intends to integrate and expand the sewage treatment systems in the city and to treat all the sewage at a newly constructed integrated sewage treatment plant. Unfortunately, it is difficult for this project to be realized because of the severe financial constraints of the City Council. The Government of Malawi has therefore asked the Government of Japan to provide grant aid assistance to assist in the implementation of the major portions of the project.

This project aims to conserve the river water quality and thereby bring sweeping improvements to the living conditions of the residents in these river basins and to the hygienic level of the environment in which they live, by implementing the major components in the above-described facility expansion phase -- in short, the construction of an integrated sewage treatment plant, installation of trunk sewers and the extension of a sewer network.

3.2 Study of the Details of the Request

3.2.1 Appropriateness and Necessity of the Plan

(1) Harmony with Upper Level Plans

To cope with the rapid increase in the population of the city, the Government of Malawi prepared the Lilongwe Water Supply & Sanitation Master Plan with a target year of 2005 in 1983, and revised it in 1986 under the financial support from the United Nations Development Programme (UNDP) and from the International Development Association (IDA or Second World Bank).

Regarding the water supply sector of the project, the Lilongwe Water Supply Project Feasibility Study was conducted in 1986, based on the Master Plan. As the second stage expansion project, the construction of water supply facilities with the capacity to serve the projected 1997 population, was completed in 1992, with the financing of the IDA. But the actual population growth has sharply exceeded the forecast, so the City Council has been forced to enhance the capacity of these facilities immediately and subsequently has just launched the preparation of the plan for the third stage expansion project in 1993.

As for the sanitation sector, the Lilongwe City Sanitation Development Plan Feasibility Study was carried out in 1992. However, all that has been implemented so far are parts of the construction program for pit latrines for low income residential areas with financing by the IDA, and a part of the Part 1 of the Phase I sewerage development project (the emergency improvement project) which is a part of the sewerage development project composed of the phases consisting of three parts. At present, efforts are being made to obtain the funding for Part 2 of the Phase I improvement project, which will radically improve the sewerage system. The City Council is urged to improve the sewerage system without delay, because the increase in the sewage volume discharged by the expansion of the water supply system has caused the deterioration of the water quality of the river, and the progress of the sewage work is an essential prerequisite condition for financing further expansion of the water supply system.

The Project constitutes the main portion of the Part 2 of the Phase I improvement project with a target year of 2000 as described above. When the Project is implemented, it will be no longer necessary to carry out much of the delayed Part 1 of the Phase I improvement project and the Project will make it possible to carry out an efficient and effective sewerage system improvement. Except for the sewer network improvement work, it will be possible to come up to speed with the implementation schedule planned in the F/S with a two year delay. For these reasons, the implementation of the Project is considered to be in line with the basic policy laid down by the Government of Malawi.

(2) Benefits

1) Improvement of River Water Quality

Because the water quality of the effluent from the new water treatment plant will be far better than that from the existing ones and the increase in the population served by the sewerage system will largely alleviate the adverse effect of the sewage discharge on the water quality of the river. This will enable the people living in the river basins who use the water for the domestic purpose to look forward to improved health and hygiene.

Trial Calculation of the Possible Reduction of Pollution Load

---

a)Possible reduction in pollution load (BOD) discharged from existing treatment plants:

Present discharged pollution load;

Area 2	230m^3/day	x 101mg/l	=	23kg/day
Area 6	80m^3/day	x 38mg/l	=	3kg/day
Area 13	522m^3/day	x 50mg/l	=	26kg/day
Area 18A	58m^3/day	x 242mg/l	=	14kg/day
Area 18B	737m^3/day	x 32mg/l	=	24kg/day
Area 33	471m^3/day	x 33mg/l	=	16kg/day
Total	2,098m^3/day			106kg/day

Discharged BOD after completion of the Project;

2,098m^3/day x 20mg/l= 42kg/day

Possible BOD reduction;

106 - 42 = 64kg/day

Reduction Rate;

64 / 106 = 60.4%

b)Possible pollution load reduction by replacing septic tanks with a sewerage system:

Assumptions;
Sewage amount in 2000; 6,111m^3/day
Sewage amount to be treated by septic tanks (w/o Project);
6,111 - 2,098 = 4,013m^3/day
Quality of raw sewage; BOD 300mg/l
Quality of treated sewage; BOD 20mg/l
Overflow rate from septic tanks w/o treatment; 10%
Calculations;
BOD amount flown into rivers from septic tanks (w/o Project);
4,013 x 0.10 x 300 x 10^{-3} = 120kg/day
BOD amount discharged from planned STP for 4,013m^3/day of sewage (w/ Project);
4,013 x 1 x 20 x 10^{-3} = 80kg/day
Possible BOD reduction;
120 - 80 = 40kg/day
Reduction Rate;
40 / 120 = 33.3%

2) Increase of the service population

The present state of the sanitation service coverage in the city is shown below. Less than 10% of the population in the city is now served by sewerage. Because of the insufficient capacity of the existing treatment plants, even in the sewerage system service area, the number of connections to the sewer network is limited, and under present conditions, the number of persons served cannot be increased. Under these circumstances, if the administrative population of the city increases, the service coverage will unavoidably fall to 5%.

Table 3.1 Population by Sanitation Service Type

	Estimate 1989	F/S 2000	F/S 2005	w/o Pjt* 2000	w/ Pjt* 2000
Sewerage	25,000	70,000	80,000	25,000	34,000
	(9.5%)	(14.0%)	(12.0%)	(5.0%)	(6.7%)
Septic Tank	52,000	83,000	120,000	128,000	119,000
	(19.8%)	(16.6%)	(18.0%)	(25.6%)	(23.8%)
Pit Latrine	186,000	347,000	468,000	347,000	347,000
	(70.7%)	(69.4%)	(70.0%)	(69.4%)	(69.4%)
Total	263,000	500,000	668,000	500,000	500,000
	(100.0%)	(100.0%)	(100.0%)	(100.0%)	(100.0%)

* A natural increase of the population within the service area by sewerage is not considered.

The implementation of the Project will, as shown in Table 3.1, increase the sewerage service population by 9,000 persons in the year 2000. Because the implementation of the Project will provide the framework of a new sewerage system for Lilongwe, it will be possible for the city to increase the sewerage service population easily, and to readily increase the service coverage by carrying out the sewer system improvement work and treatment plant expansion work using its own funds or other funding sources. The Project will also eliminate the need for 80,000 residents to maintain septic tanks -- the final goal of the F/S plan. It is considered essential to implement the Project because it will permit the residents of the city to live free from the fear of a sewage overflow.

3) Expansion of Water Supply Facilities

The improvement of sewerage facilities will open the door to financing of the water supply system expansion project, for which the improvement of sewerage facilities is a prerequisite, and will permit the implementation of the third stage water supply system expansion project. As a result, the Project can be directly and indirectly counted on to improve the health and hygiene of the people in the area.

3.2.2 Implementation and Operation Plans

(1) Organization

The Project will be implemented by the Lilongwe City Council, under the direction of the Ministry of Local Government. At this time, the city is administered by the Town Clerk, who has the actual governing authority. The Mayor of Lilongwe is a position that is primarily honorary (the present holder is also a manager of a private company). The Town Clerk presides over 7 departments. The Sewerage Section, which is one of the sections under the City Engineer's Department, is responsible for managing the sewerage system (see Figure 2.11).

The Sewerage Section is composed of 35 persons: a Sewerage Supervisor, 3 persons concerned with water quality, and 31 persons involved in the

engineering works. They maintain the sewers and treatment plants.

If the City Council will implement the Project, it will have to be conducted by the members of the Sewerage Section. However, as this section has been primarily responsible for maintenance work, it would be appropriate to form a new project team to undertake the planning and construction work involved in the Project. The team leader will be assigned to the assistant engineer (Section Manager) who is now serving concurrently as a manager of the Building Section. Also, taking into consideration the maintenance of facilities after the completion of the Project, staff members of the Sewerage Section in charge of the maintenance of various facilities shall have to be assigned. In this regard, the manager of the Building Section shall be assigned. After the completion of the project, the team should be dissolved, and its members be assigned to take charge of the management of the treatment plant and sewers, respectively.

At present, the City Council maintains six treatment plants (Areas 2, 13, 18A, 18B, 35, and 53) and, when the Project will be implemented, 4 of these treatment plants (Areas 2, 3, 18A, and 18B) will be abandoned. Also the length of the sewers will be increased sharply from 37km to 80km, which means that the maintenance system will have to be improved. Consequently, as shown in Figure 3.1, a reorganization and a reassignment of personnel will be necessary.

The water quality control is now handled by one water quality analysis technician and two assistants at the Area 13 treatment plant, but the F/S plan recommends that they be transferred to the city's central laboratory, and the Sewerage Section will undertake the sampling and on-site analyses only. In order to well maintain the sewage treatment plants, however, it is essential to conduct a minimum level of water quality analyses continuously, and that those who understand the on-site situation should analyze water samples, interpret the results, and relay the results to the maintenance personnel. Therefore, a laboratory will be provided in the administrative building at the new sewage treatment plant, and will be staffed by a water quality analysis technician and one assistant.

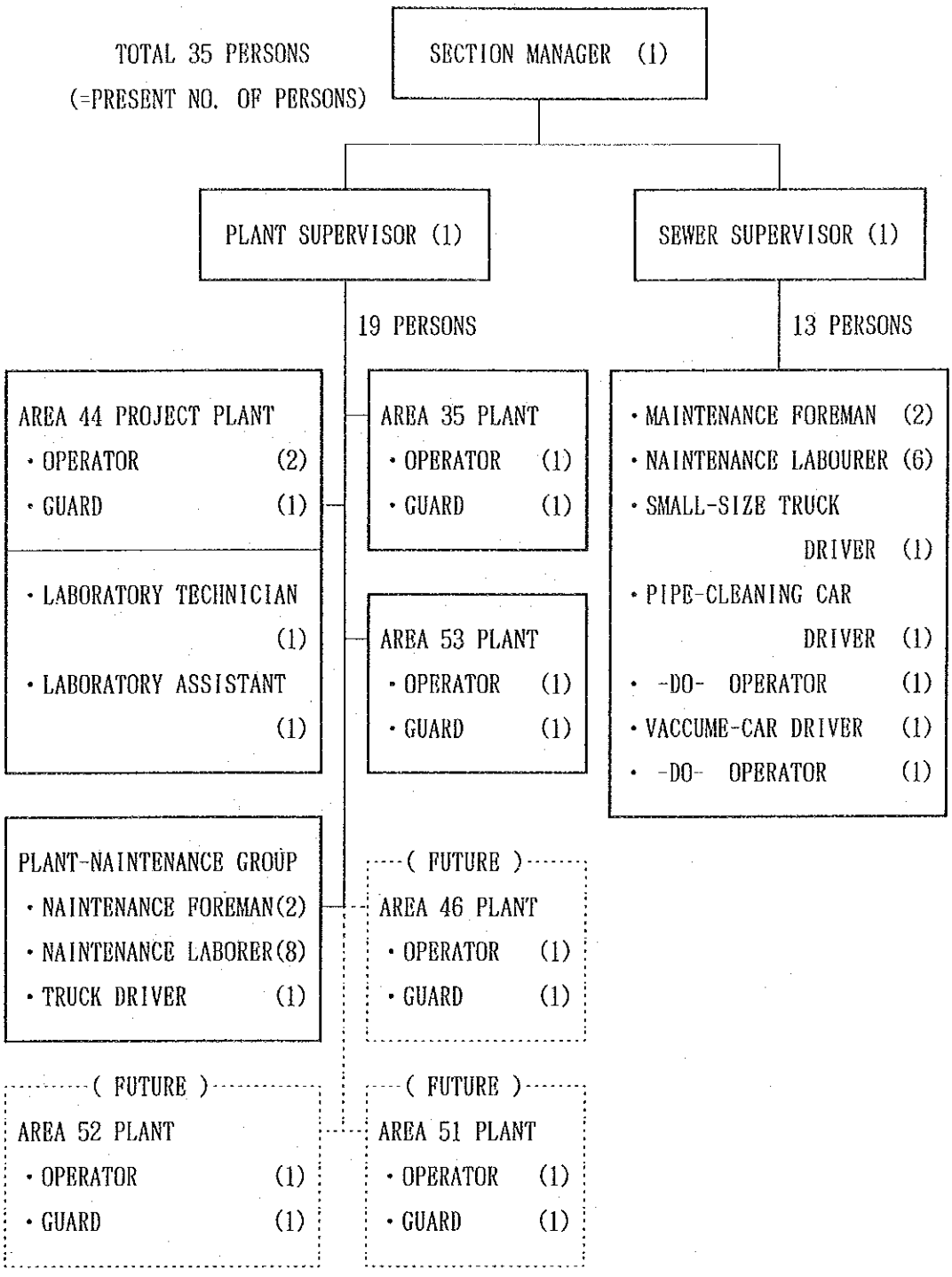


Figure 3.1 Recommended Organization Structure of Sewerage Section

(2) Budget

Table 3.2 shows the change in expenditure and income over the past six years for the sewerage system of the city.

Table 3.2 Sewerage-Related Expenditure and Income of the City

(Unit:MK)

Fiscal Year	Expenditure				Income	Balance
	Salary	Power & Fuel	Others	Total		
1987/88	42,070	144,020	75,860	261,950	261,830	-120
1988/89	53,840	78,800	71,180	203,820	247,030	43,210
1989/90	74,490	121,800	71,580	267,870	247,230	-20,640
1990/91	58,000	151,000	5,000	214,000	351,000	137,000
1991/92	70,000	100,000	53,000	223,000	342,000	119,000
1992/93*	107,000	323,000	55,000	485,000	303,000	-182,000

* Budget in 1992/93

The sewage charges are all collected by the City Treasurer's Department, and handled as part of the general revenue. The sewerage-related costs are paid for from the general account, and the equipment is not subjected to asset assessment or depreciation. The sewage rate system adopts a flat rate based on the following types of industry:

High Density Housing	10.00 MK/month
Other Housing	15.00 MK/month
Commercial and Industrial	20.00 MK/month
Hotels	25.00 MK/month
Hospitals, Schools, Etc.	15.00 MK/month
Other Institutional	10.00 MK/month

As Table 3.2 indicates, although the system operated in the black in 1990/91 and 1991/92, it is expected to suffer a deficit in 1992/93. This is caused by the inclusion of repair costs of MK140,000 for 1992/1993. Fluctuation of the income also implies an insufficient sewage rate collected by the City Treasurer's Department. Though number of sewerage system users paying sewerage charge is not definite, it may be calculated based on annual income amount as follows:

annual average sewage rate: MK12/hh/month x 12 = MK144/hh

maximum income record : MK351,000 (1990/91)

estimated number of users paying sewage rate:

351,000 / 144 = 2,438

number of sewerage users : 3,475 (F/S, excl. com. and ind.)

collection efficiency : 2,438 / 3,475 = 70%

As shown above, the collection efficiency of sewage charges seems to be less than 70%. In addition, the sewage rate decreased from 1990. Thus, an increase in collection efficiency is required.

Because, as stated previously, all sewerage-related expenditures are paid from the general account of the city, the deficit of the sewerage-related account will not interfere with operation of the system. With the present insufficient level of maintenance, however, the system is operating in the red, and it is clear that it will be impossible to carry out full-scale improvement and rehabilitation simply with the profit obtained from the operation of the sewerage system. The City Council kicked-off the Part 1 of the Phase I project in the F/S plan in 1992, which required a total of MK7,370,000, including the construction cost of MK960,000 for the first year (including the allowance for inflation), but in fact only MK690,000 was paid out. In 1993, as the second year of the project, MK4,350,000 was needed but no target has been established as to whether the funds will be obtainable.

The sewerage-related financial situation will be improved after completion of the Project because of following reason:

a) number of staff will be unchanged.
b) electric power consumption will be decreased.
c) increase of number of users will produce greater income.

The share of salaries to total expenditures was about 16% in 1987/88, but by 1991/92 this portion had climbed to about 31%, and the personnel costs per person will continue to rise. Also, when the city expands the sewer network and carries out sufficient maintenance of the sewerage facilities, the money demand will further increase and the financial situation will become increasingly inflexible and severe.

To rectify this situation, the present sewage rate system will have to be revised. As proposed in the F/S plan, the sewage rate system should not be a flat rate, but a meter rate as is used in water supply system. The sewage volume can be estimated from the water supply volume, so it is necessary to establish such a system to obtain the data from the Lilongwe Water Board.

To carry out the Project, the Malawi side will have to, at least, assure the funds needed for the construction to be undertaken by the Malawi side, but at this time, the City Council is experiencing financial difficulties. This means that the Government of Malawi will have to help with the financing.

Table 3.3 Finances of the MOLG and the Lilongwe City Council

(Unit:US$)

Fiscal Year	MOLG	Lilongwe City Council	
	Expenditure	Revenue	Expenditure
1988/89	2,203,582	3,773,000	3,453,500
1989/90	2,378,055	4,620,000	4,939,300
1990/91	1,924,517	5,038,000	3,701,000
1991/92	2,863,555	5,585,000	5,306,000
1992/93	---	7,359,000	6,822,000

3.2.3 Relationship to Similar Plans and Assistance Programs

As already explained, in 1983 the Government of Malawi prepared and in 1986 revised the Lilongwe Water Supply & Sanitation Master Plan with a target year of 2005 under the finances from the UNDP and the IDA.

As for the water supply sector, the Feasibility Study was prepared in 1986 based on the Master Plan, and as the second stage expansion project, the IDA-supported construction of facilities able to accommodate the number of users forecast for 1997 was completed in 1992. This was followed by the start of planning work for the third stage expansion project that began in 1993. Funds for the project will be financed by the African Development Bank on condition that the sewerage system is improved.

Turning to the sanitation sector, the Feasibility Study was carried out in 1992, but all that has been implemented so far are part of the IDA-financed

construction of pit latrines for the low-income residential area, and a part of the Part 1 of the Phase I improvement project (the Emergency Works) which is a part of the sewerage system development project composed of three staged works. In order to obtain funds for the Part 2 of the Phase I improvement project which constitutes the radical improvement project, the Government of Malawi has requested the Government of Japan to implement the Project.

The city is counting on rapid improvements to the sewerage system, because the increase in the volume of effluent discharged by the expansion of the water supply system will deteriorate the water quality of the river, and progress of the sewage works is an essential condition for the financing for the next expansion project of the water supply system.

3.2.4 Components of the Project

(1) Contents of Discussions during the Preliminary Study

The Government of Malawi has requested the following improvement and expansion of the sewerage facilities in the city.

1) Phase I (1992 to 1997)

a)Construction of Trunk Sewers
- No. 1 ϕ 600mm X 4.2km
- No. 2 ϕ 600mm X 5.1km
- No. 3 ϕ 800mm X 8.5km

b)Construction of Sewer Network

c)Construction of Sewage Treatment Plant
- Kauma Sewage Treatment Plant (Stabilization Pond)
- Kauma Pumping Station

2) Phase II (1997 to 2007)

a)Construction of Sewage Treatment Plants
- Area 51 Sewage Treatment Plant (Stabilization Pond)
- Expansion of the Kauma Sewage Treatment Plant
- Expansion of the Kauma Pumping Station

b)Extension of Sewer Network

The following are the results of the discussions concerning the above request during the preliminary study conducted by JICA.

a) The Area 51 sewage treatment plant shall be eliminated from the request.
b) The pumping station shall mean a lift pumping station to supply the water to the facilities in the Kauma sewage treatment plant.
c) The treatment capacity of 12,900m^3/day requested for the Kauma sewage treatment plant is based on the F/S plan with a target year of 2005. Because the project is not progressing in accordance with the F/S plan, it is not necessary to conform to the F/S plan, but it is necessary to consider the sewage flow to be treated during the period of 2000 to 2005.
d) The treatment proposed in the F/S plan is the stabilization pond process, but taking into consideration the cost, treatment efficiency and the easiness in maintenance, alternative treatment methods must be studied.
e) The site for the sewage treatment plant was proposed by the M/P, and considered appropriate through the F/S, but it is necessary to make a further study on whether or not there is a better site.
f) The scope of the provision of the sewer network will be studied as a part of a basic design study.
g) According to the F/S plan, a part of existing sewage treatment plants would be improved, and after the completion of the new sewage treatment plant, the primarily treated effluent from the existing plants will undergo final treatment at the new plant, but the policy was changed so that the existing sewage treatment plants would not be used after the completion of the Project.

(2) Results of Studies During the Basic Design Study

Based on the contents of discussions during the preliminary study and on the details of the request, the appropriateness of the components of the Project was studied with particular concern for the following points:

a) Identification of the design service area by sewerage (including the sewer network) and study on the design sewage flow

b) Location of the construction site for a sewage treatment plant
c) Study on treatment methods
d) Need for a pumping station
e) Routes for trunk sewers
F) Study on maintenance equipment required

Table 3.4 summarizes the results of the study on the components of the Project that will be required to achieve the objectives of the Project.

3.2.5 Details of the Requested Facilities, Equipment and Materials

(1) Sewage Treatment Plant

1) Sewage Treatment Plant Site

The site for the new sewage treatment plant was proposed by the M/P, and as a result of the F/S, Area 44/4 close to the hamlet of Kauma was selected as the most suitable site. Problems related to the construction of the treatment plant in this area are described below.

a) Because it is far from the center of the city, the trunk sewers will be long.
b) It will be expensive to provide the access road, power supply, telephone service, water supply, and other utilities.
c) It adjoins hamlets occupied by poor people.
d) The earth work will be expensive because the ground slope is relatively steep.

With the above problems in mind, the team carried out a field survey at the Kauma site for confirmation, and studied the possibility of locating the plant elsewhere. As a result, the team decided, for the following reasons, that it would be appropriate to choose the Kauma site.

a) Because the trunk sewer to the plant is to be constructed along the Lilongwe River, the site of the plant should be beside the Lilongwe River.
b) The Area 12 residential area is located 1.5 km upstream of the

Table 3.4 Contents of the Request and Results of Field Survey

Facilities	Purpose	Requested Items	Results of Field Survey
1. Sewage Treatment Plant	To treat sewage	Construction of STP which can cope with the projected sewage volume by the target year of 2005	Since future pipeline contruction schedule is unknown, sewage volume from the sewer system, which expected to be completed by the year of 2000, is adopted as target sewage volume to be treatd. However, facility layout plan should consider that of by the year of 2005.
		Shall be constructed in Area 44 (Kauma)	Area 44 (Kauma) is evaluated as optimum site for STP.
		Treatment Method shall be Stabilziation Pond Method	Stabilization Pond Method was adopted.
2. Pumping Station	To pump up of sewage to STP	Pumping Station shall be installed within STP site	By examination of Trunk Sewer profile and hydraulic profile of STP, Pumping Station was concidered unnecessary.
3. Trunk Sewer	To connect present and new sewer system to the new STP	Install Asbestos Cement Pipe (ACP) and Ductile Cast Iron Pipe (DCIP) with diameters of 600 mm and 800 mm along Lilongwe and Lingadzi River. Total length is 17.8 km.	Although pipeline route is almost same to that of designed in the F/S, invert elevation is shallower. Diameter ranges 500 mm to 800 mm. ACP is used for embedded portion and CDIP is applied for exposed porton. Total length is approximately 17.5 km.
4. Sewer Network	To flow user's sewage to trunk sewer	Construct sewer system within target service area by the year of 2000 which connected to the new STP	To construct sewer network in Area 1. Area 2 and Area 6 where housings are already built up with high service priority. Total lenth is approximately 25.3 km.
5. O&M Equipment (Additional request)	To maintain the completed facilities	Water quality analysis kit, Pipeline cleaning equipments, and VEhicles for O&M works in the new STP	These equipment are indispensable for appropriate O&M work of completed facilites

proposed site. Further upstream from this area, there is no suitable land with enough space for the implementation of the Project and a sufficient distance from the surrounding residential neighborhoods.

c) Because the land is owned by the government, it will be easily acquired.

d) From the relationship between the water level of the receiving water body and the invert elevation of the inflow sewer to the plant, a pumping station will not be necessary.

e) It will be relatively easy to provide the power supply and telephone service.

The following judgments were made concerning the above problems in selecting Kauma as the site for the treatment plant.

a) The trunk sewers are to be constructed along the Lilongwe and Lingadzi Rivers with a total length of 17.5km to the treatment plant site.

b) A approximately 3km long access road will be required to link the site to the end of the paved road in Area 12. Water supply piping with a total length of 2km will be required to connect the plant to the terminus of the Area 12 water supply pipes. Power supply and telephone service will be provided by installing the service lines of 1km and 2km, respectively from the lines passing near the site.

c) There are 2 hamlets near the treatment plant site. The hamlet residents are squatters illegally living on land owned by the government, occupying houses made of sun-dried bricks. Although the construction site does not extend within the hamlets, 1 hamlet will unavoidably be located extremely close to an anaerobic pond and other facilities that will produce offensive odors. The Malawi side holds that because they are squatters, it is not necessary to be concerned about them, but it will be necessary to landscape around the treatment plant to improve the appearance of the area. Aside from landscaping, any other odor protection measures involving the covering of facilities will, in fact, be impossible to implement due to the large water surface area of the plant. Therefore, it has been decided that in addition to the landscaping around facilities

generating offensive odors, other suitable measures should be implemented as part of the maintenance work -- adequate removal of accumulated sludge, for example.

d) Because the site is on an incline, the earth work volume should be minimized by careful water level planning and layout planning of the treatment facilities.

The high water level of the Lilongwe River into which the treated sewage will be discharged is not definite, but based on the results of a topographical survey at the treatment plant site, a site survey, a study on the elevation of the water intake facility at the near-by State House (President's residence), and interviews with employees of the State House and local residents, it has been determined that if the facility will be installed at 1,007m above sea level, it will be able to cope with the high water level during the rainy season.

2) Treatment Method

The treatment method requested for the new sewage treatment plant is the stabilization pond process. The sewage treatment method to be adopted in the Project should primarily be considered in relation to the post-construction maintenance, and it ought to satisfy the following conditions:

a) Easy operation and maintenance
b) Low energy consumption
c) Low construction and maintenance costs

The treatment method to be chosen should, therefore, not be one which requires the mechanical equipment to be operated. This conclusion is a natural one considering the fact that the mechanical equipment broken down at the existing treatment plants has not been repaired. For this reason, the selection of the stabilization pond process without any mechanical equipment to treat the sewage is a suitable decision. The method is also appropriate because the long retention time will lead to stable treatment effects even with load fluctuations -- a common problem at small-scale sewage treatment plants. Chapter 4 presents the detailed

results of the study.

3) Design Sewage Flow

In the request, the design sewage flow at the new sewage treatment plant is, based on the F/S plan, defined as about 8,400m^3/day by 2000 and about 12,900m^3/day by 2005. Considering that the Project is to be implemented as grant aid, however, a long term pre-investment is not advisable. Additionally considering the financial conditions of the City Council and the Government of Malawi, it will be difficult for them to expand and improve the sewer network in the present urbanized area with their own funds, and they will have to turn again to the international agencies for assistance, but the Government of Malawi has not taken such related steps at this time. It is not suitable to determine the design sewage flow, taking account of the uncertain sewer network improvements under such an assistance. Therefore, 1997 is set as the year the Project will be completed, assuming that the grant aid assistance by the Government of Japan will progress smoothly, and the design sewage flow is set at the time three years after the completion of the Project, namely in the year of 2000. As for the design sewage flow in the year of 2005, it will be coped with the future expansion of the new treatment plant. Detailed results of the study are presented in Chapter 4.

(2) Trunk Sewer

1) Routes for Trunk Sewers

In the request, the trunk sewers, based on the F/S plan, took routes running along the Lilongwe and Lingadzi Rivers with the Area 2 treatment plant and the Area 18 treatment plant as its upstream end, and its total length was approximately 17.8km. As a result of the topographical survey and site survey conducted during the basic design study, in order to collect and flow the sewage to the new Kauma sewage treatment plant without any pumping station, the best route is one along the river where the ground elevation is lower than anywhere else in the area. This route is almost the same as the one proposed in the F/S plan. Considering

the elevation of the Kauma sewage treatment plant site, however, the invert elevation of trunk sewer will be set so high that no pumping station will be required. The F/S proposed to repair the existing treatment plants for use and to discharge the effluent from these plants into the trunk sewers. However, in the Project, the F/S plan was changed so that the existing treatment plants would be finally abandoned, allowing the invert elevation of trunk sewers to be raised considerably.

The approximately 4km-long trunk sewers planned to run alongside the Lingadzi River must pass through a nature sanctuary because of topographical restrictions. Because any form of development is, in principle, prohibited in this nature sanctuary, consultations were held with officials of the office administering the nature sanctuary and the Ministry of Forest and Natural Resources, the upper agency, during the field study. These officials expressed the following views.

a) The prior approval of the topographical survey during the detailed design shall be obtained.
b) Because the improvements to the sewerage facilities to be carried out in the Project will alleviate the water pollution of the Lingadzi River which flows through the nature sanctuary, it is in principle, a desirable Project.
c) The approval of the construction work will be examined, after the details of the work (construction method, excavation section, amount of tree clearing, etc.) will be clarified for assessment which will be done by the Malawi side and will take about 3 months.

The above indicates that, when the Project is implemented, it will be necessary to define the details of the work immediately and consult with the responsible authorities.

2) Design Sewage Flow

The F/S plan used the design sewage flow for a target year of 2005 for trunk sewers. Because the cross-sectional area of the sewer pipe is proportional to the square of the pipe diameter, the cost

for pipe installation to handle the increased flow will rise only a little, therefore, a certain degree of pre-investment will be frequently economical. Because in the Project, it will be necessary to lay the trunk sewers on a slope along the river aligned with the topographic contour lines, it will be technically difficult to adopt a staged investment approach -- to install the sewer first corresponding to the initial flow, then after the flow increases, to install the sewers additionally. Accordingly, it is reasonable to use the design sewage flow for a target year of 2005 for trunk sewers. The hourly maximum/daily average flow ratio of 2.3 will be adopted, which is shown in the F/S plan.

(3) Sewer Network

1) Objects to be Designed

In the request, the sewer network to be installed was not clarified, so during the field survey, consultations were held on the issue with the Malawi side. As a result of discussions, it was agreed that the sewers are to be covered by grant aid, and the service connections (from sewers to boundaries oh housing plots) will be undertaken by the Malawi side. However, the service connections will also be covered by grant aid because of following reasons:

a) If a service connection work is done after the completion of the sewer installation work, any excavation and backfill work require a double investment.
b) If the installation work of sewers and service connections is not been carried out simultaneously, there will be a substantial danger of an increase in the number of obstacles disturbing the flow in the sewers and of an increase in infiltration into the sewers caused by damage to the sewers resulting from the poor service connection work.
c) Service connections installed under roads are generally considered as public property. In Japan, they are constructed by an administration authority of the sewerage system.
d) It is desirable that one contractor simultaneously carry out both the sewer work and the service connection work because of

the reasons a) and b). In that case, however, if the budget for the service connection work is not arranged well, the sewer installation work will be delayed.

e) House drains can be easily connected to sewers by the installation of drain pipes only in the housing plot, and the benefits of the Project will be quickly realized.

2) Scope of Development

According to the initial request, the scope of development for the sewer network would be extended within the districts which were to be improved by the year 2000, but because this includes areas that have not yet been built up and commercial and industrial areas with no residents, the study team carried out a field survey on these areas. As a result, the Area 1 and the Area 2 were selected as the development site of the sewer network because of following reasons:

a) Area 1 is a relatively high-density residential quarter adjoining the downtown of the old town, sewers are already provided with some staff houses. This is a district with a relatively large scale communal septic tank. Other houses use pit latrines or septic tanks for several houses.
Treated water of the large-scale communal septic tank should flow down to the area near the Lilongwe River where it soaks into the ground. However, it was observed to be overflowing at the tank into a stream flowing nearby without proper treatment. This area requires the frequent desludging of its septic tanks to guard against wastewater infiltration.
Because of the above situation and location at the most upstream of trunk sewers along the Lilongwe River, it may be reasonable to select this Area for development of sewer network.

b) Area 2 is located in the center of the old town. It consists of a commercial area containing a market and shops owned by Indians, a medium-density residential area, and a hospital. Sewerage facilities are already in use at the hospital and around the market. Though a public lavatory with a septic tank is provided in this Area, it requires frequent sludge cleaning

due to its poor infiltration capacity. The commercial area, which lacks sewerage facilities, is considered suitable for sewer development. The F/S called for the residential area to be developed by 2005, but it will be easy to discharge the sewage from this area into the trunk sewers along the Lilongwe River, and it generates a large amount of sewage. For these reasons, it is considered suitable for inclusion in the areas to be developed by the Project.

c) A connection sewer pipeline will be provided in Area 6 to link the inflow sewer of the existing Area 6 Sewage Treatment Plant with the proposed No.2 trunk sewer. No additional sewer network will be provided in Area 6 by the Project.

As a consequence of the above decisions, the sewer network will be provided in 2 areas: Areas 1 and 2. A connection sewer will also be provided for Area 6 by the Project. The following table indicates the length of the sewers to be installed in each area.

Area	Pipe Diameter	Pipe Length
Area 1	150 to 450mm	Approx. 14.8km
Area 2	150 to 200mm	Approx. 9.3km
Area 6	250mm	Approx. 1.2km
Total	150 to 450mm	Approx. 25.3km

(4) Maintenance Equipment

These were not mentioned in the initial request, but the following equipment, instruments, tools and vehicles are needed for the maintenance of facilities, and at the time of the field survey the Malawi side requested that they be included in the grant aid assistance.

1) Water Analysis Instruments

The instruments to conduct a minimum level of water quality analysis required for maintenance of treatment plant.

2) Sewer Cleaning Equipment

Equipment and vehicles needed for prevention and restoration of sewer blockage, particularly on the sewer network.

3) Treatment Plant Maintenance Vehicles, etc.

Dump trucks and boats to remove sludge.

The study team studied the suitability of the above request and reached the following conclusions.

1) Water Quality Analysis Instruments

The water quality analysis is now performed by three persons at the Area 13 treatment plant, but many of the apparatuses they are using were purchased more than 5 years ago, and as a consequence of their aging and breakdowns, a shortage of chemicals, and a lack of vehicles to transport the samples, the BOD and SS of the treated sewage from each treatment plant are analyzed irregularly. Table 3.5 presents the state of existing water quality analysis instruments in use at the Area 13 sewage treatment plant.

Table 3.5 State of Water Quality Analysis Apparatuses at the Area 13 Sewage Treatment Plant

Apparatuses	Age	Condition
BOD Analyzer	3 yrs	in use
Analytical Balance	3 yrs	in use
Incubator	over 5 yrs	in use
pH Meter	over 5 yrs	in use
Conductivity Meter	5 yrs	in use
Vacuum Pump	3 yrs	in use
Electronic Balance	over 5 yrs	in use
DO Meter	1 yrs	in use
Water Bath	over 5 yrs	broken
Water Bath	2 yrs	in use
Electric Oven	5 yrs	in use
Colony Counter	5 yrs	in use
Magnetic Stirrer	5 yrs	broken
Sterilizer	4 yrs	in use
Distiller	over 5 yrs	broken
Spectrophotometer	3 yrs	in use
Desiccator	3 yrs	in use
Measuring Scale	over 5 yrs	in use
Oven	over 5 yrs	in use
pH Meter	over 5 yrs	in use

In order to maintain a sewage treatment plant in good condition, it is essential that the minimum necessary level of water quality analysis be performed continuously and that the results be utilized as information to be applied in the maintenance of the system. In this regard, the request is appropriate, and considering the number of years that the instruments now in use have been operating, it is considered suitable to provide water quality analysis instruments as a part of the Project. Because the treatment method to be used is the stabilization pond process, it will be sufficient to provide a set of instruments and tools that can analyze the air temperature, water temperature, transparency, pH, BOD, COD, SS, DO, ORP, coliform bacteria, and sludge accumulation levels. In principle, because the instruments now in use will be at an advanced stage of aging when the Project will be completed, all the instruments and tools required will be provided.

2) Sewer Cleaning Equipment

In the sewerage service area, particularly in Area 18, many blockages occur in the existing sewer network because of obstacles resulting the lack of covers on the manholes, inappropriate design and the poor construction work. Due to a lack of suitable cleaning equipment and tools, it takes a long time to remove the obstacles, and in some cases blocked sewers have to be removed and replaced. Considering this situation, it would be advisable to provide a set of cleaning tools primarily used for the manual work such as winches, buckets, etc., and a light truck to carry these tools and the personnel who will use it. A high-pressure cleaning truck and sludge vacuum truck should also be provided, so that the maintenance staff can easily, effectively, and quickly clean the sewers at regular intervals to prevent blockages. Care should be taken in preparing the specifications for this equipment so that it will not be larger than necessary. An operating system for this equipment is also required. The sludge vacuum trucks could also be used to reinforce the efforts of the septage collection trucks, as there are only two (one is broken down) operated by the City Council at this time.

3) Sewage Treatment Plant Maintenance Vehicles Etc.

When the sewage treatment plant is in operation, the sludge will have to be removed regularly. A dump truck will have to be provided for this task. It is possible to discharge some of the water in the ponds of the treatment plant by taking advantage of differences between the water levels of two ponds, but in order to drop the water level enough to dry the accumulated sludge in the sun, pumps will have to be used for drainage. For this reason engine-driven pumps should also be provided.

Due to the large water surface area of each pond, a boat should be included so that the water plants can be removed. During the field survey, army soldiers helped oy using a rubber boat to remove water plants at the Area 35 sewage treatment plant.

3.2.6 Need for Technical Assistance

At this point the Malawi side has not made a formal request for technical assistance with the Project, but according to the request for the Project, if a decision will be made to implement it as grant aid, the Malawi side will make a formal request for one each JICA medium-term (3months) expert for civil, mechanical and electrical engineering, for one JICA long-term (2years) expert for project management, and for one each Japan Overseas Cooperation Volunteer for civil, mechanical and electrical engineering, to be sent as well as the request for the participation of two local engineers in the training course conducted by JICA. However, the treatment plant to be constructed in the Project will not involve any complex mechanical equipment, there is no need for JICA mechanical and electrical experts to be dispatched.

When the Project is completed, the contractor is expected to offer sufficient on-the-job training for plant operation, equipment handling and so on. The treatment process to be adopted in the Project has been used successfully in Lilongwe and features easy plant operation and control, therefore, although technical guidance by the sanitary engineer as a part of technical assistance will be hopefully provided, there is less necessity for it at this time. However, as an engineer who can manage plant operations is not deployed with the City Council,

it is hoped that engineers who will be responsible for plant operation and control will participate in the training course conducted by JICA beforehand to study the following subjects:

a) Basic theory of sewage treatment
b) Water quality analysis necessary for plant operation and maintenance
c) Determination of the appropriate number of ponds in use
d) Judgment on whether a treatment plant is satisfactorily operated
e) Removal of accumulated sludge and pond cleaning
f) Other aspects of operation and maintenance
g) Recording of operation and maintenance data

The stabilization pond process is in general easily operated and controlled, but its treatment effectiveness is apt to be influenced by the incoming sewage flow, water temperature, climate (sunlight duration time and air temperature), etc., therefore, the necessity for the JICA expert ought to be examined through the long-term observation of the actual treatment condition at the new treatment plant

3.2.7 Basic Policies on Cooperative Implementation

The results of the study on the details of the request are described above. A summary of the results is as follows:

Purpose of the Project

The project will improve the living and hygienic environment of the people living in the Lilongwe and Lingadzi River basins by purifying the water in these rivers through the expansion of the sewerage facilities in the City of Lilongwe.

Effects of the Project

The implementation of the Project will remarkably improve the water quality of the treated sewage presently discharged from the existing treatment plants, reduce the pollutant load in terms of BOD by 64 g/day, and including that from the people who will switch treatment methods from septic tanks to the sewerage system, will permit an over-

all reduction in the pollutant load discharged into the rivers by 104kg/day. This will improve the water quality of the rivers and the hygienic environment in the surrounding river basins. The number of residents served by sewage treatment will increase by 9,000 in the Lilongwe River basin in the city, guaranteeing a pleasant living environment to approximately 22,000 people. Furthermore, the implementation of the Project will create a framework for a sewerage system within Lilongwe, simplifying future sewerage system improvement work. The Project can also be expected to improve the hygienic environment of the residents indirectly by enabling the Lilongwe Water Board to start work on the third water supply system expansion project that cannot receive funding without improvements to the sewerage system.

Project Implementation Capability

The Lilongwe City Council is the agency that will implement the Project. Because of its financial weakness, the City Council cannot provide sufficient funds for the needed sewerage system improvement work. In order to carry out the Project, the Government of Malawi will have to assist in funding the work to be undertaken by the Malawi side. A project team ought to be formed to carry out the Project. When completed, the Project can be counted upon to increase the sewerage service population, which will in turn produce more income from sewage charges and reduce the costs of operation and maintenance. The Project will, therefore, improve the city's financial condition in relation to a sewerage system.

It is appropriate for the Government of Japan to provide grant aid for this Project. The central government of Malawi will have to provide financial assistance regarding the promotion of the Project and the maintenance of the system, and the City Council will have to strengthen its management system when the Project is implemented. As stated above, the effectiveness of the Project has been confirmed, and effects of the Project conform to the goals and the operating system of the Japanese grant aid. Accordingly, on the premise that the Government of Japan will provide grant aid, the outline of the Project is studied and the basic design is shown as described in the following text.

3.3 Summary of the Project

3.3.1 Organization Implementing the Project and the Operation System

The executing agency of the Project is the Lilongwe City Council, which is under the jurisdiction of the Ministry of Local Government. The Town Clerk administers seven departments and provides municipal administrative services. The sewerage system is overseen by the Sewerage Section of the City Engineer's Department, and this Section will manage the system after the completion of the Project (See Figures 2.11 and 2.12).

Four of the city's existing treatment plants will be abandoned after construction of the new sewage treatment plant. The City Council will also have to form a group for cleaning the sewers. This will nrequire the reassignment of personnel now deployed to the Sewerage Section. Figure 3.1 presents a personnel reassignment plan prepared to meet this need. The number of staff nneedsnot to be increased for the time being. However, it bwill e necessary to increase when the treatment plant in Area 52 is handed over to the City Council by the Ministry of Works, and new treatment plants will be constructed in Areas 46 and 51 (these plants are located ooutside the project area).

3.3.2 Project Planning

The Project will be a radical improvement of the sewerage system for the city. It will include the construction of all-new facilities, except for the existing sewer network, and the closing of some of the existing sewage treatment plants. The existing sewer network will be connected to the trunk sewers of the new sewerage system for system integration.

The following are the facilities to be constructed and the equipment to be provided under the terms of the Project.

(1) Sewage Treatment Plant (Including Civil and Architectural Structures and Mechanical Equipment)

a) Screen
b) Grit Chamber
c) Parshall Flume (Flow Meter)