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Urban and industrial growth in developing countries has increased the demand for water and the related need for more information on water and sewage treatment. This project, conducted by the University of Oklahoma, focuses on that need by developing a global network of adaptive and innovative technologies based on economic, social, political and cultural factors. A series of detailed reports have been produced that are designed to assist planners in their selection of suitable water and wastewater treatment processes appropriate to the material and manpower resource capabilities of particular countries at particular times.

"Prediction Methodology for Suitable Water and Wastewater Processes," George W. Reid and Richard Discenza.
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PN-AAD-293

"Data Requirement," University of Oklahoma Bureau of Water and Environmental Resources Research.
PN-AAD-295

"A Mathematical Model for Predicting Water Demand, Wastewater Disposal and Cost of Water and Wastewater Treatment Systems in Developing Countries," George W. Reid and Michael I. Muiga.
PN-AAD-294

"Treatment Methods for Water Supplies in Rural Areas of Developing Countries," Ir. L. Huisman.
PN-AAD-284
PN-AAD-285

"Sewage Treatment in Developing Countries," L.W. Canter and J.F. Malina.
PN-AAD-286

"Contributions to a Mail Survey on Practical Solutions in Drinking Water Supply and Wastes Disposal for Developing Countries," International Reference Centre for Community Water Supplies, The Hague.
PN-AAD-287

"A Catalog of Water Supply and Waste Disposal Methods for Individual Units," George W. Reid.
PN-AAD-283

"Historic Implication for Developing Countries of Developed Countries' Water and Wastewater Technology," George W. Reid and Kay Coffey.
PN-AAD-288

"Evaluation of Lower Cost Methods of Water Treatment in Latin America," Odyer A. Sperandio and Jose Perez C.
PN-AAD-289

"Socio-Economic Conditions which Pertain to Cost of Construction and Operation of Water and Sewage Treatment Facilities and Quality of Water Consumption in Kenya," Erasto Muga.
PN-AAD-290

"A Water Sterilization Study in the Philippines," Reynaldo M. Lesaca.
PN-AAD-282

"The Study of Microbial Treatment of Nightsoil," Taiwan Institute of Environmental Sanitation.
PN-AAD-281

"Study of an Existing Water Treatment Plant on Simple Design and Operating System for Supplying Drinking Water to Rural Communities in the Lower Mekong Basin Countries," Thailand Ministry of Public Health, Department of Health, Rural Water Supply Division.
PN-AAD-280

SOCIO-ECONOMIC CONDITIONS WHICH RELATE TO COST OF CONSTRUCTION AND OPERATION OF WATER AND SEWAGE TREATMENT FACILITIES AND QUANTITY OF WATER RESOURCES IN KENYA

Under Contract No.
The University of Oklahoma Project
on
Lower Cost Methods of Water and Waste Treatment in Developing Countries
(USAID Contract Number: AID/CM-ta-C-73-13)

F I N A L R E P O R T

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October 1976

SOCIO-ECONOMIC CONDITIONS WHICH PERTAIN TO COST OF CONSTRUCTION AND OPERATION OF WATER AND SEWAGE TREATMENT FACILITIES AND QUANTITY OF WATER CONSUMPTION IN KENYA

by

Dr. Erasto Muga

A Report Submitted to
The University of Oklahoma
Bureau of
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October 1976

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CHAPTER ONE

INTRODUCTION

The Republic of Kenya covers an area of 224,960 square miles (582,646.4 square kilometres). Of this area 5,171 square miles (13,393 sq. km.) is water or swamp covered.[1] According to records kept of rainfall reliability in Kenya,

> "only 15% of the country can expect to receive at least 30 inches (760 mm.) of rainfall in every four out of five years".(2)

This shows that Kenya lacks water sufficient for domestic and livestock requirements for its approximate current population of 13 million. Kenya's population was growing at the rate of 3.3% per year between 1962 and 1969 according to the calculations at the 1969 census. At present its population is growing at the rate of approximately 3.5% per year. Consequently the Kenya government has initiated through the Ministry of Water Development, a programme whose aim is to provide enough water to cater for domestic and livestock consumption through the systematic application of water conservation measures for the whole country. This can be done by conservation of water catchment areas and the development of groundwater resources, so that the requirements of the rapidly expanding populations of municipalities, towns, and rural centres can be met by developing water supplies and sewage disposal systems.

In Kenya, the current average per capita rate of daily water use is approximately 40 litres. It is estimate

that this daily per capita consumption will probably increase to 160 litres by the year 2000. These estimates are derived from calculations based on water conservation experience in the different types of schemes operating in Kenya.[3] These schemes embrace large towns and other major municipalities, smaller urban centres, rural centres and market centres. There are twenty two (22) major towns and smaller urban centres and rural and market centres served by an organised water supply.

The following class of water supply schemes in Kenya show the per capita consumption in liters per day:[4]

Class of Schemes	Per capita Consumption in Litres per day
Nairobi, Mombasa, and other major municipalities	126
Smaller urban centres	108 (for schemes operated by the Water Department)
Rural Centres	67 "
Market Centres	36 "

At present in Kenya, "a total of 932,500 of rural and 1,337,500 of the urban population is served by a water supply of one kind and another".[5] These estimates include: "the population in low potential areas, that is, within 4 kilometres of an improved water source"[6] as the estimates for 1972 show. The following table shows the population served by a water supply in 1972 by province, urban, and rural areas:[7]

Table 1: Population Served by a Water Supply-1972

Province	URBAN			RURAL		
	Major Centre	Urban Centre	Rural Centre	High Potential	Medium Potential	Low Potential
Central (including Nairobi)	60,000	105,400	41,000	193,500	18,000	8,000
Nyanza	-	45,700	7,500	15,000	87,500	25,000
Eastern	-	19,000	24,000	38,500	19,500	112,000
North-Eastern	-	-	10,000	-	-	21,000
Rift Valley	-	122,400	32,000	137,000	46,500	43,500
Coast (including Mombasa)	286,000	-	30,000	27,500	28,000	36,000
Western	-	12,500	2,000	73,500	2,500	-
Totals	886,000	305,000	146,500	485,000	202,000	245,500

About 10 per cent of the people of Kenya live in urban areas and all of them have access to safe water supply, and of the 90 per cent of the rural population 9 per cent (i.e. 932,500 people) of them have access to piped water.[8] There are about 10 million people in Kenya's rural areas who have to draw their water from natural supply points as they have no piped water.

Under the 1974-78 Development Plan the Kenya government hopes to spend more than £ 18.6 million to cover new water projects for the whole country.[9] The government hopes to spend £ 15.6 million to supply all families in Kenya with piped water by A.D. 2000. This is only a partial attempt to control rural-urban migration of young people as there are many reasons for rural-urban migration.

By the end of 1976 the government will serve a total of 3 million families in Kenya with piped water. The water development programme which will be carried out in three phases to cover the entire country will comprise 83 new water projects to be built at a cost of £ 2.1 million for the first phase, 34 water projects to be built at a cost of more than £ 4 million for the second phase and 75 projects to be built at a cost of £ 12.8 million for the third phase.

It was estimated that between July 1975 and 1978 two million families will be supplied with piped water and that this number will increase the total of families supplied with water to 3 million by the year 1978. A total of £ 3.4 million would be spent on rural water supply alone and a total of more than £ 1.3 million would be spent in developing water supplies for livestock throughout the country.[10] It is estimated that a total of £ 145,000 would be spent on "Harambee" ("pull together" self-help) water projects, and that a similar amount would be spent in maintaining water supplies run by various local authorities according to the Ministry of Water Development. Als the Tana River Water Project will need a 1000 gallon reservoir which will be built at a cost of £ 20,000. The Kandara "Harambee" Water Scheme which is due to be completed this year (1976) will cost K.£. 1.6 million and will supply about 140,000 people in the Kandara Division.[11]

The Sabaki River Water Project for Mombasa town in the Coast Province, now under way will cost the government

K.£. 28.5 million. This new project will ease the recurrent water shortage experienced in Mombasa town when it is completed to serve approximately 335,000 people in Mombasa Municipality.

The current Development Plan by the Ministry of Water Development also plans to start a sewage disposal scheme in the urban areas in which it hopes to spend slightly over £7.5 million on behalf of Local Authorities during the current 1974-78 Development Plan.[12]

There is also need in Kenya to conserve water through dams and low water catchment particularly in dry areas in order to beat frequent droughts, and the government has earmarked £ 2.5 million for this purpose. The Ministry of Water Development is also going to spend £6 million to develop ranches in arid and semi-arid areas for livestock development.[13] This is only a partial attempt to control rural-urban migration of young people as there are many reasons for rural-urban migration.

In Kenya, rural-urban migration of young school-leavers is creating many problems in urban areas. These young people go to the urban areas for a better life. This creates need for more water supply in the urban areas. Consequently the Ministry of Water Development intends to spend £16 million to develop water supply in the rural areas to curb rural-urban migration of young school-leavers.

As a result of the great need for water supply all over the Republic of Kenya there are many self-help water projects going on in various parts of the country, and the

Ministry of Water Development is giving them free technical advice. Thus the "Harambee" ("pull together") self-help water projects together with government assistance will make it possible for everyone to get piped water by the year A.D. 2000.

However, some of the self-help water projects are not successful because the people concerned do not have the technical know-how to manage their projects. Lack of trained personnel to operate water supplies and sewerage in the existing treatment plants is a problem facing the nation. Lack of trained personnel is now more serious as the government tries to expand water supply and sewage schemes to cover the entire country. For example by the end of 1975 there were only 35 qualified African engineers and consequently the government is still relying on a handful of expatriates in supervisory positions. There is need for more industrial science subjects in schools rather than industrial art subjects. For example in the field of water and sewage development, operation and maintenance there is need for more engineers, geomorphologists, hydrologists, climatologists, geologists, chemists, biologists, physicists and other scientists in order that work pertaining to operation and maintenance may be carried out efficiently.

It is important to note here that in order that a country may realize its national goal of supplying its entire population with adequate supply of piped water it is not necessary only to have adequate funds for this purpose, but more important is the fact that the country must have

a certain amount of natural water resources to supply the entire population with water. Also of course, materials and equipment necessary for operation and maintenance, and processing water must be available along with the technical know-how which goes with the entire process of operation and maintenance of water and sewage plants.

It is therefore necessary that Kenya's natural water resources be shown in this report so that future programmes of water development and supply may utilize these resources in the best way possible to supply the population with the needed piped water. I now turn to Chapter two to show the existing water resources in Kenya.

Footnotes to Chapter One

1. Francis F. Ojany, "The Status of Kenya's Water Resources and their Development" in Water for the Human Environment - Proceedings of the First World Congress on Water Resources Vol. II, Country Reports, International Water Resources Association, Business Office, 425, Illinois Building, 113 N. Neil St., Champaign, Illinois, 61820 U.S.A., p. 19.

2. Ibid., p. 19.

3. Republic of Kenya: Development Plan 1974-1978, p. 326.

4. Ibid., p. 326.

5. Ibid., p. 326.

6. Ibid., p. 326.

7. Ibid., p. 327.

8. Francis F. Ojany, op.cit., p. 30.

9. The Standard of July 9, 1975. Report by the Minister for Water Development, Government of Kenya.

10. The Standard of July 9, 1975, ibid.

11. Francis F. Ojany, op.cit., p. 31.

12. The Standard of Friday, November 29, 1974. Report by the Minister of Water Development, Government of Kenya.

13. Ibid.

CHAPTER TWO

NATURAL WATER RESOURCES

As I pointed out in Chapter one, water covers about 2.3 % of Kenya total surface area. Thus 5,171 square miles (13,393 square kilometres) of land is water or swamp covered. Kenya, therefore, has 219,789 square miles (569,253.5 square kilometres) of dry land, and 2/3 of this dry land is either semi-desert or desert.[1]

Climate

The source of all water in Kenya is precipitation which is made possible by Lake Victoria, Indian Ocean and Relief.[2] Ojany points out that:

> "the Highlands, Western Kenya, and the Southern coastal belt are the wettest parts of Kenya, whereas the Rift Valley floor and the vast northern plainlands between the Kenya Highlands and the Ethiopian massif are relatively dry". (3)

Kenya has an average annual rainfall of 380 mm. as compared to the world mean annual average of 650 mm.[4] The following table shows the aerial distribution of rainfall over Kenya:[5]

Table 2: Aerial Distribution of Rainfall over Kenya

Rainfall in millimetres	Area in Sq.Km.	Percentage of Total Area	Accumulated Percentages
Less than 255	157,600	27.0	27.0
255 - 510	209,000	35.9	62.9
510 - 760	105,800	18.1	81.0
760 -1015	48,700	8.4	89.4
1015 -1270	28,500	4.9	94.3
1270 -1525	19,400	3.3	97.6
1525 -1780	9,600	1.6	99.2
1780 -2030	3,900	0.7	99.9
Over 2030	500	0.1	100.0

Kenya's temperatures are low in many places due to altitude. Above 3000 metres night frost is found and there is snow in altitudes, above 5000 metres. Arid and semi-arid low lying plains are the hottest areas with temperatures of about 38°C during the day and 20°C during the night. The Rift Valley has the greatest diurnal ranges (16°C).[6]

Some recorded data on evaporation in some 49 stations in Kenya show that the Rift Valley has the highest losses of water through evaporation as noted by Ojany. The record shows this to be 4060 mm in some places in the Rift Valley and in the dry northern plainlands the loss through evaporation is between 2790 and 4060 mm.[7] The coastal areas of Kenya which have a high humidity of 80% have low evaporation. The International Standard "Class A" pans are used by the stations that record evaporation.

The annual rainfall over some selected stations in Kenya shows that: Nairobi has a maximum of 62 inches (1570 mm.), a minimum of 17 inches (437 mm.), and a mean of 35 inches (879 mm.); Mombasa has a maximum of 74 inches (1887 mm.), a minimum of 28 inches (709 mm.), and a mean of 47 inches (1204 mm.); Nyeri has a maximum of 52 inches (1321 mm.), a minimum of 18 inches (460 mm.), and a mean of 36 inches (922 mm.); Kisumu has a maximum of 74 inches (1884 mm.), a minimum of 37 inches (942 mm.), and a mean of 50 inches (1278 mm.).[8] The average number of rainy days in Nairobi, Mombasa, Nyeri and Kisumu are 120, 145, 100 and 139 per year respectively.

Annual temperatures over some selected stations in Degrees Centigrade show the following:[9]

Table 3:

Station	Height in Metres	Absolute Maximum	Mean Maximum	Mean Minimum	Absolute Minimum
Mombasa	16	35.6	30.1	23.4	18.9
Kisumu	1146	36.9	29.4	17.1	11.0
Nairobi (Meteoro-logical Hqs.)	1798	29.7	23.4	11.6	2.5

Also the mean annual rainfall and the mean annual evaporation for some selected stations show the following:[10]

Station	Latitude	Longitude	Altitude		Mean Annual Rainfall		Mean Annual Evaporation	
			Ft.	m	inch.	mm.	inch.	mm
Mombasa Airport	4°02'S	39°37'E	180	55	41.5	1053.7	86.7	2205
Kisumu (met.)	0°06'S	34°45'E	1254	382	50.8	1288.6	83.1	2018

Source: Water Development Department, 1968

Main Kenya Rivers [11]

Rivers	Length	Basin Area	Remarks
Tana	440 miles (708 km.)	24,000 sq.miles (62,160 Km.^{2})	
Athi-Galana-Sabaki	340 miles (547 Km.)	17,000 sq.miles (44,029 Km.^{2})	
Mara	180 miles (290 Km.)	3,000 sq.miles (7,770 Km.^{2})	Half of it is in Tanzania
Nzoia	160 miles (258 Km.)	5,000 sq.miles (12,950 Km.^{2})	
Suam-Turkwell	220 miles (354 Km.)	8,000 sq.miles (20,720 Km.^{2})	90 miles (145 Km) perennial
Ewaso-Ngiro (North)	330 miles (531 Km.)	22,000 sq.miles (56,980 Km.^{2})	180 miles (290 Km.) perennial
Ewaso-Ngiro (South)	85 miles (137 Km.)	2,000 sq.miles (5,180 Km.^{2})	60 miles (97 Km.) perennial
Kerio	220 miles (354 Km.)	2,500 sq.miles (6,475 Km.^{2})	70 miles (113 Km.) perennial
Yala	110 miles (177 Km.)	1,000 sq.miles (2,590 Km.^{2})	
Sondu/Miriu	68 miles (109 Km.)	2,000 sq.miles (5,180 Km.^{2})	called Sondu/miriu by the Luo, Kipsonoi by the Kipsigis
Kuja	55 miles (89 Km.)	2,000 sq.miles (5,180 Km.^{2})	
Melawa	67 miles (108 Km.)	3,000 sq.miles (778 Km.^{2})	
Voi	130 miles (209 Km.)	2,100 sq.miles (5,439 Km.^{2})	50 miles (80 Km.) perennial

Table 4:

Kenya Lakes[12]

Lake	Area		Length		Width		Average Depth		Height over MSL	
	Sq.miles	Km.^{2}	Miles	Km.	Miles	Km.	Feet	M	Feet	M
Victoria (Kenya portion)	26418	67493 3785	175	282	140	225	150	46	3720	1134
Rudolf	2473	6405	154	247	20	32	-	-	1230	372
Baringo	50	129	11	18	4.5	6.8	17	5	3200	975
Magadi	40	104	16	26	2.5	4	-	-	1900	579
Naivasha	44-74	114-191	10	16	5	8	11	3	6150	1875
Amboseli (seasonal)	0-44	0-114	0-13	0-21	0-6	0-10	0-2	0-0.6	3900	1188
Jipe	15	39	7.5	11.8	2	[illegible]	-	-	2300	701
Hannington	13	34	12	19	1.25	[illegible]	-	-	3200	975
Nakuru (seasonal)	2-12	5-31	1-5	2-8	1-2.5	1.6-2	2	0.6	5765	1757
Ximenteita (on Mt. Kenya)	7	18	4.5	6.8	1.5	2.4	-	-	5850	1783
Hohnel	0.03	0.08	0.25	0.4	0.12	0.[illegible]	-	-	13760	4194
Michaelson	0.05	0.13	0.25	0.4	0.19	0.[illegible]	-	-	13010	3965

* Except Lake Victoria, the above lakes are found in the floor of the Rift Valley. Also in the floor of the Rift Valley are lakes Logibi and Kwenia.

The following are the total surface water resources of Kenya:[13]

Drainage Area	River	Mean Annual Run-off Cubic yards (millions)	Mean Annual Run-off M^3 (millions)
Lake Victoria	Nzoia	2511	1920
	Yala	1263	966
	Nyando	654	500
	Sondu	1616	1236
	Kuja-Migori	1138	870
	Others	2354	1800
	Sub-total	9536	7292
Rift Valley	Melawa	242	185
	Gilgil	36	28
	Molo	51	39
	Per Kerra	165	126
	Others	565	432
	Sub-total	1059	810
Athi River	Athi	980	749
	Tsavo	180	138
	Njoro-Lumi Springs	383	293
	Others	150	115
	Sub-total	1713	1295
Tana River	Tana-Garissa	6148	4700
Ewaso Ngiro	Ewaso-Ngiro (Archers Post)	967	739
KENYA	GRAND TOTAL	19423	14836

Source: Director of Water Development, 1968.

In Kenya, windspeeds average about 160 km/day at ground level, but at higher elevations the windspeeds may reach 300-350 km.

It is important to note that more than 80% of Kenya's streams are seasonal in their flow. Lake Victoria is the best reservoir in East Africa, and "its immediate adjoining areas in Kenya receive regular and ample rainfall".[14] Thus it is this lake shore area which has perennial streams and its dry season flow is about 10 cusecs. The waters of Kenyan lakes are too saline for domestic use. The exception to this are Lakes Baringo and Naivasha.

The Tana river is also an important surface water resource, next to Lake Victoria, but it has a very high evaporation rate which reduces its value as a water resource. It should be pointed out here that Kenya is not rich in surface water resources according to what has been stated above.

Rate of Evaporation

In Kenya, evaporation from open water surfaces is nearly half of the total rainfall in some places. The Water Department estimates that below 1000 feet (300 m.) it is more than 100 inches (2540 mm) and that above 10,000 feet (3000 m.) it is about 50 inches (1270 mm).[15]

Groundwater Resources

Kenya has a considerable amount of ground water which makes up for the deficiency in its surface water. However, much of this ground water is undeveloped except in some areas "around Nairobi where some conservation measures have been taken".[16] This ground water originates primarily from rainfall which gets into the ground and which can be recovered from boreholes.

From studies done in Kenya it is recorded that the first borehold drillings were done in 1928 and that today there are some 4000 boreholes.[17] Ojany points out that outside the Rift Valley,

> "Triassic, Jurassic, and the Cretaceous zones form areas in which the parameters are suitable for plenty of ground water storage.

He points out that:

> "aquifers are numerous and water quality is good". (18)

In Kenya the water table which is deeper than in other parts of Africa is reached at an average depth of 260 feet (80 m.) below the surface. This groundwater is what Kenya's rural water supply depends on and as such the first borehole was drilled in 1927-28, and in 1967, 410 wells and protected springs were built. By the end of 1967 there were 3627 boreholes in Kenya.

Groundwater Quality

According to studies based on 1000 boreholes and wells, and 7,000 water chemistry analyses in Kenya, on the whole it has been shown that Kenya's groundwater resources are of good quality.[19]

Groundwater quality in Kenya depends upon hydro-geochemical factors which affect the chemical quality of the water. Four broad groundwater zones have been demarcated in Kenya for the purpose of planning and development of water resources. Zone 1 has Bicarbonate, Carbonate, and Silica as the more important solids in the water and the total dissolved solids range to 1,000 ppm.[20] It is noted that except for the high fluoride and silica content the groundwater resources in this zone are of good quality and suitable for most domestic and industrial purposes. Zone II has high concentrations of Magnesium, Calcium and bicarbonate in the groundwater, and this gives rise to hard water with a total dissolved solids concentration of up to 5,000 ppm. It is noted that the total dissolved solids in this zone may be quite acceptable for stock rearing and other uses, although it is desirable to reduce the concentrations of salts and silica in this water.

Zone III has groundwater with high salt content, with total dissolved solids ranging to 8,000 ppm. This is due to the high chloride content (and possibly sodium and potassium). In this zone, pockets of good quality water are available, but for most uses this water is unsuitable.

Zone IV has groundwater which is quite hard and saline in nature due to the influence of some of the marine sediments in which this water occurs as well as the adjoining sea water (Indian Ocean). In this zone there are high concentrations of chlorides (possibly Sodium and Potassium) Magnesium, Calcium, Bicarbonate and Sulphate. It is noted that these concentrations may be acceptable for some stock rearing purposes. The total dissolved solids concentration of water in this zone is well above 8,000 ppm.

Kenya Rivers as Power Potentials

Kenya rivers are a great potential as a source for hydroelectric power, and at present they are Kenya's best source for power. There are a number of hydroelectric power schemes in Kenya, and the following table shows the river sources and the localities of the schemes:[21]

Table 5: Summary of Existing Hydro-Electric Power Stations

River	Locality of Scheme	Available Head (metres)	Minimum Flow (cusecs)	Output (Kws.)
Maragua	Mesco.	40	1.4	380
Maragua	Wanjii	68	1.7	2,000
Mathioya	Wanjii	110	2.5	5,400
Maragua	Tana	73	1.7	6,400
Tana	Tana	54	4.5	8,000
Sagana	Sagana Falls	37	1.1	1,500
Thika	Ndula	29	2.0	2,250
Liki	Nanyuki	26	0.1	100
Sosiani	Selby Falls	43	0.04	360
Kuja	Macalder Mines	24	0.8	900
Tana	Kindaruma	36	15	40,000

The above hydroelectric power sources will be very useful in the construction of water supply and sewage plants and also in their operation and maintenance wherever they will be built in Kenya.

Kenya's Forests

Afforestation is very useful for water conservation. Unfortunately Kenya's forests cover only 5.2% of the total land surface. As such there is need for afforestation, and the Kenya government at present has a policy of increasing this forest area by an additional 60 sq. km. of exotic trees per year in order to realize this objective.

Footnotes to Chapter Two

1. F.F. Ojany and R.B. Ogendo: A Study in Physical and Human Geography, Longman Kenya Limited, 1973, p. 1.

2. Francis F. Ojany, op.cit., p. 20.

3. Ibid., p. 20.

4. Ibid., p. 21.

5. Ibid., p. 21.

6. Ibid., p. 22.

7. Ibid., p. 23.

8. F.F. Ojany and R.B. Ogendo, op.cit., p. 61.

9. Ibid., p. 67.

10. Ibid., p. 71.

11. Ibid., p. 51.

12. Ibid., p. 55

13. Ibid., p. 71.

14. Francis F. Ojany, op.cit., p. 23

15. F.F. Ojany and R.B. Ogendo, op.cit., pp. 70-72.

16. Ibid.

17. Francis F. Ojany, op.cit., p. 26.

18. Ibid., p. 26.

19. Ibid., pp. 27-28. This observation is based on a paper written by G.S.O. Ongweny, a former post-graduate student in the Department of Geography, University of Nairobi.

20. Ibid., p. 27.

21. Ibid., p. 25.

CHAPTER THREE

POLITICAL LEADERSHIP

Political ideology of a country is crucial in matters pertaining to development of all types at national as well as at the community or local level. Although this report is concerned only with the aspect of development which pertains to "socio-economic conditions which pertain to cost of construction and operation of water and sewage treatment facilities and quantity of water consumption in Kenya", with a view to determine the most appropriate and cost effective water supply and waste water facilities for developing countries, the political ideology of a country is an all embracing factor for all types of development, because it is the driving force behind all development, especially at the national level. Hence a word about the political ideology of Kenya as it affects social, political and economic development of Kenya is appropriate.

The Kenyan political ideology in the arena of economic development is that of "mixed economy" as is stated in the Republic of Kenya Sessional Paper No. 10 on "African Socialism". By "mixed economy" is meant that the government collaborates with individual entrepreneurs in bringing about some kind of economic development. For example the government can give loans to individuals who want to establish some business of their own choosing or who want to buy and develop some farm, or who want to form a cooperative of some commercial nature. This "mixed economy" is encouraged within the framework of a capitalist mode of development. This idea of

mixed economy has been extended to embrace "self-help" or "Harambee" (pull-to-gether) activities which people engage in especially in the rural areas to facilitiate social and economic development in areas of Kenya where individual effort and initiative are not enough to create the desired objectives. When individuals in a particular community in Kenya initiate a "self-help" development project which is of social and economic value to the entire community using their own meagre resources it is possible for the government to come in at a later stage to assist such individuals financially so that the project may be completed. When this is done the total cost pertaining to the individual toward the total cost of the project under consideration is appreciably reduced. The government also does not spend the money on the project doing it alone without the collaboration of the community. Thus costs are reduced both for the community and the government.

Community Activities

It should be noted here that due to "Harambee" self-help spirit stated above, encouraged by the government, in 1967 alone over 3,600 community facilities were completed among which were 119 piped water supplies which were installed and 410 wells and protected springs which were built.[1] It is significant also to note that during 1967 alone "people's contribution to self-help activities in terms of labour, cash and materials" was approximately K.£ 2 million and in 1970 the amount had risen to £ 8,500,000.[2] The Kandara "Harambee" Water Scheme which will be completed this year (1976) and which will cost K.£ 1.6 million and supply about

140,000 people in Kandara Division also has been mentioned elsewhere in this report. It is estimated that the "Harambee self-help projects which included Kenya's Institutes of Technology, water projects and business activities in rural areas amounted to over K.shs. 300 million by 1975.

More important is to note the fact that in 1967 in collaboration between the government and the local people, in self-help projects the government assisted in supplying only 6% of the capital. The remaining 94% of the total effort was contributed by the local people.[3] Thus the "Harambee" self-help programmes in Kenya are very significant in creating facilities of all types including water and sewage for people's use.

The "Harambee" self-help programmes in Kenya are the analogue of socialist mode of development in Tanzania where rural development based on "ujamaa" ("Familyhood") villages is encouraged so that through self-help reliance people engage in agricultural activities, build roads, health centres, and primary and secondary schools and also participate in rural water supply programmes. But even in Tanzania where a strict communal mode of development based on self-reliance is followed it is necessary for the government to assist local people in their social and economic development by supplying them with the necessary capital and money. For example it is estimated that in Tanzania from the year 1969 to 1974 the government spent half a billion shillings in the development of "ujamaa" villages.[4] For example the Upper Kitete ujamaa village received shillings 800,000

in 1973 in order to help it overcome a serious financial crisis.[5]

It is important to point out here that a political ideology which engourages self-help programmes of development in the social and economic fields, coupled with government subsidy and technical advice and help can do a lot to reduce the costs involved in such developments. Also a stable political leadership is necessary for such programmes to succeed. If political leadership at national and local level is unstable and if as such it does not attract the allegiance of the populace a government would find it extremely difficult to marshall both the natural and human resources necessary for development in all fields. At present Kenya and Tanzania are lucky as they are politically stable. But they still have obstacles to development in little capital and inadequate trained manpower to develop the existing natural resources and thus bring about desired social and economic development. There are also many other socio-economic conditions in a developing country such as Kenya, which despite a favourable political ideology and a stable government and political leadership, make it difficult for the country to supply its populace with adequate and necessary facilities for development such as water supply and sewage and waste water disposal.

In view of what has been stated above, it is now in order to discuss the demographic and socio-economic and socio-cultural factors which pertain to cost of construction and operation of water and sewage treatment facilities and

quantity of water consumption in Kenya. These demographic and socio-economic and socio-cultural factors are analysed in Chapter four within the framework of demographic and technological, socio-economic, process, operational and facility construction cost factors at both national and local (community) level. Kisumu, Mombasa and Nyeri towns are the local communities studied where water supply and sewage treatment facilities are found. This report shows how the various factors enumerated above are interrelated in the management of water supply and sewage treatment facilities in order to serve the communities which use such facilities.

Footnotes to Chapter Three

1. Philip M. Mbithi, Rural Sociology and Rural Development: Its Application in Kenya, East African Literature Bureau, 1974, p. 138.

2. Ibid., p. 138.

3. Ibid., p. 139.

4. Goran Hyden, Ujamaa, Villagization and Rural Development in Tanzania, the University of Dar es Salaam, Department of Political Science, 1974, p. 16.

5. Ibid., p. 16.

CHAPTER FOUR

THE DEMOGRAPHIC AND SOCIO-ECONOMIC AND SOCIO-CULTURAL FACTORS

Demographic and Technological Factors (see Appendix A)

Any organized plan for the establishment of water supply and sewage for a community must consider estimates for the demand and for water supply and sewerage to include future projections of annual population growth rate, life expectancy of the population in years, birth rate of the population and infant mortality rate per 1,000 population, survival rate, that is, the percentage of inhabitants expected to survive during any given year, the percentage of emigrants or the percentage of the total population that leave the area and begin to live in another community or country each year, percentage of immigrants, or the percentage of the total population that have just arrived to live in the community or country on a permanent basis each year, calories intake per day per person, and the level of water and sewage treatment technology development in the country.

The above factors are necessary for a reasonable estimate of the amount of water supply needed and the amount of sewage treatment facilities necessary.

DEMOGRAPHIC FACTORS

Population

At present Kenya's population is approximately 13 million. Of this number approximately 1.3 million live

in urban areas and have access to piped water and sewage treatment facilities. Approximately 11.7 million people live in the rural areas and of this number only 1 million (approximately) people have access to piped water.

Annual Population Growth Rate

The annual population growth rate in Kenya according to the last census in 1969 is 3.3%. It is believed that the annual growth rate since 1969 to the present may be higher probably 3.5%. This factor of growth rate must be considered seriously in planning for adequate per capita daily water demand especially in towns where there are populations which depend on piped water supply. The average annual rate of growth of some ten main Kenya towns is 3.89% between 1962 and 1969.[1]

Life Expectancy of Population

At the time of the 1962 Census, Kenya had a life expectancy at birth of 40 to 45 years and at the 1969 census the life expectancy had risen to 47 years for males and 51 for females.[2] In 1972 life expectancy in Kenya was 57.2 years. It is significant to note that life expectancy depends on the incidence of death or mortality rate which differs from one ecological area or condition to another. Thus since Kenya has a variety of ecological areas it is reasonable to state that death rates would vary from region to region and as such infant mortality rates would also differ from region to region, and life expectancy would also differ from region to region. However, the figures given above

are the average for the whole country.

Kenya has 8 provinces each of which shows a slightly different mortality and life expectancy levels from the others as follows:[3]

Table 6

Province	1969		1972	
	Mortality Levels	Life Expectancy	Mortality Levels	Life Expectancy
Coast	16	55.7	17.5	61.5
Eastern	13	48.6	14.5	54.4
North Eastern	11.5	45.0	14.9	50.8
Nairobi	18.5	61.8	20.0	68.3
Central	15.5	54.6	17.0	60.3
Rift Valley	12.0	46.3	13.5	52.9
Western	13.0	50.0	14.5	54.4
Nyanza	14.0	51.0	15.5	56.7
Kenya		51.5		57.2

Birth Rate

According to the 1969 census the average number of new born per year per 1000 population in Kenya was 50. Again, the differential crude birth rates by Kenya's provinces were as follows:[4]

Table 7:

Province	Crude Birth Rate
Nairobi	40.8
Central	51.0
Coast	42.2
Eastern	44.4
North-Eastern	41.0
Nyanza	52.5
Rift Valley	44.2
Western	54.2

Infant Mortality

Estimates of infant mortality rates per 1000 population each year show according to the 1969 census that infant mortality rate in Kenya for males was 126 and for females it was 112. Therefore for both male and female the infant mortality rate was 238 for Kenya as a whole. Infant mortality rates for the different provinces in Kenya were as follows:[5]

Table 8:

Province	Infant Mortality	
	Males	Females
Nairobi	79	62
Central	81	66
Coast	152	136
Eastern	115	100
North Eastern	121	107
Nyanza	183	168
Rift Valley	94	77
Western	150	131

Survival Rate

According to the 1969 census Kenya's death rate was 17 per thousand population per year for the period immediately preceding the census. This is believed to be the current death rate in Kenya. Therefore, the survival rate per thousand population per year in Kenya is 983 persons. This gives a percentage of 98.3.

The mortality indicated here is high but it is declining in Kenya. Medical science and general health measures have helped a lot in the prevention and treatment of diseases which are responsible for killing people. Improved social and economic conditions which have resulted in appreciable economic development also account for the declining death rate.

Migration

Recorded figures on arrivals and departures in and out of Kenya on a permanent basis, show the following from 1968 to 1975. (It is regretted that local figures on such permanent arrivals and departures are not available for nearly all places except the few major towns such as Nairobi and Mombasa):[6]

Table 9:

Year	Permanent Immigrants	Percentage of Total Population	Permanent Emigrants	Percentage of Total Population
1968	16,973	0.15	11,497	0.01
1969	19,082	0.17	13,526	0.01
1970	19,879	0.18	14,020	0.13
1971	1,421	0.01	15,840	0.14
1972	600	0.005	12,100	0.11
1973	4,600	0.04	14,000	0.13
1974	6,000	0.05	13,600	0.12
1975	4,800	0.04	20,900	0.16

The average annual growth rate of Kenyan towns (3.89%) has already been stated elsewhere in this report. This growth rate is due to natural increase as well as migration into these towns.

Calories Intake Per Person Per Day

The ideal calorie intake per person per day depends upon the type of work or activity that an individual engages in. Of course, the amount and type of food that a person eats must be taken account of if he has to satisfy the minimum requirements of calorie intake for the type of work he does or the kind of activity he normally engages in everyday.

The normal (scientific) energy requirements during various activities as pertain to individuals per minute are as follows:[7]

Light Work	Moderately Heavy Work	Heavy Work	Very Heavy Work
Kilo-calories per minute	Kilo-calories per minute	Kilo-calories per minute	Kilo-calories per minute
2.5 - 4.9	5.0 - 7.4	7.5 - 9.9	Over 10
Examples:	Examples:	Examples:	Examples:
Light industrial and domestic work	1. Farm work	1. Mine working	1. Felling trees
Gymnastics	2. Marching with pack	2. Playing football	2. Steel making
Tile laying	3. Balroom dancing		3. Swimming (crawl)
Painting	4. Playing tennis		4. Climbing
Tending agricultural machines	5. Cycling		
Driving goods vehicles			
Playing golf			
Bowling			

According to the above international standards a person doing light work needs a minimum of 3600 calories per day, for moderately heavy work he needs a minimum of 7200 calories per day; for heavy work he needs a minimum of 10,800 calories per day; and for very heavy work he needs a minimum of 14,400 calories per day. The average per capita calorie intake per day for Kenyans is 2200 calories, according to the United Nations Food and Agriculture Organisation. In 1962 and in 1965 and 1966, studies of consumption of calories were done in Kenya in 8 different areas. The per capita calorie consumption per day in each place was as follows: Ngamwa 1727, Gitugi 1933, Ihururu 1558, West Koguta 1487, Masumbi 2485, Ithiumi 1426, Nyaami 2265, Bundeni 1790.[8] These figures give an average per capita calorie intake of 1834. This is an average of 8 different localities only. It seems to the author that the work that Kenyans do which has to do with construction and operation and maintenance of water supply and sewage treatment facilities and all other relevant duties connected with this type of work would require more per capita calorie intake per day than the average daily per capita calorie intake of Kenyans as stated above. The average per capita daily calorie intake for Kenyans is 2200, yet all those activities and types of work shown above (which fall within the spheres of activities of many Kenyans) require between 3600-14,400 calorie consumption per day per person.

Level of Water and Sewage Treatment Technology Development in Kenya

In Kenya approximately 2.4 million people today (1976) have access to piped water supply to their houses. Of these people approximately 1.3 million live in urban areas where they definitely have piped water supply to their houses. The rest of the people who have piped water supply live in rural areas and they number approximately 1.053 million, that is 9 per cent of the total rural population. Of these people in the rural areas who have piped water supply the majority have central village or street pump.

According to the above figures, 18.5 per cent of Kenya's population have access to piped water supply which includes piped water supply to houses and central village or street pump.

The central village or street pump type of water is utilized by approximately 8.1 per cent of the total population and piped water to houses is used by about 10 per cent of the total population who also use sewage treatment facilities.

About 77% of Kenya's population(10 million people) draw their water from natural supply points since they have no piped water supply. These people also have no sewage treatment facilities. It is very difficult to estimate the percentage of people using the sewage collection system which is found mainly in the urban areas. The percentage is very small, almost negligible.

I visited three different sites in Kenya to see the level of water and sewage treatment technology development in these sites. According to the respondents in all these three sites, the level of technology advancement of water and sewage treatment facilities was simply a transfer of a process that had been successful elsewhere. This observation was true of Mombasa, Kisumu and Nyeri water and sewage treatment plants. For the Kisumu plant it was also stated that it is a unique process developed especially for the characteristics of this site (to be explained further below). For the Nyeri plant it was also noted that it is an adaptation of another process but altered to be more suited to local characteristics (to be explained further below).

Concerning quality of project for research the Kisumu water and sewage treatment plant respondent noted that the plant treatment is an important feature for the local people but not significant to overall development of the country (to be explained further below). The Nyeri water and sewage treatment plant respondent also noted the same thing as the Kisumu respondent. The Mombasa water and sewage plant noted that it is a breakthrough for enhancing the development of Kenya (to be explained further below).

Population Projection for Kenya

At the 1969 census when people were enumerated since the last census of 1962, it was noted that the crude birth rate was 50 per thousand, and the crude death rate

of 33 per thousand which is 3.3 per cent per annum.

The present population projection for Kenya assumes that there will be "no change from 1969 fertility up to 1975" and that there will be "no change in age specific fertility rates through 1980"; and secondly, that there will be "a steady decline in mortality leading to a rise in life expectancy at birth for both sexes from 49 years in 1969 to 53 years in 1980" and that there will be a "decline in age specific fertility rates leading to a fall in total fertility rate from 7.6 in 1969 to 6.9 in 1980 and 4.0 in the year 2000".[9]

According to the above assumptions regarding fertility trend it is estimated that Kenya's population will "rise from approximately 11 million in 1970 to 34 million in the year 2000".[10] If total fertility is reduced to half the 1969 level Kenya's population will exceed 28 million by the year 2000.

If a low growth projection is assumed, it is estimated that "population aged 15 to 59 will increase from about 3.8 million in 1960 to 10.7 million" by the year 2000.[11]

Using the two assumptions above regarding no change in fertility, and a decline in mortality and age specific fertility, Kenya's population projection for the years 1970 to 1980 shows the following:[12]

Year	Population
1970	11,247,000
1974	13,413,000
1980	16,053,000
*2000	28,000,000

Similarly Kenya population projection using the assumptions cited above show the following in 5 year intervals:[13]

Table 10

Year	Total Fertility Rate		Total Population	
	No change in fertility rate	Decline in age specific fertility rate	No change in fertility rate	Decline in age specific fertility rate
1970	-	-	11,247,000	11,247,000
1975	-	-	13,413,000	13,413,000
1980	-	6.9	16,053,000	15,877,000
1985	-	6.2	19,310,000	18,635,000
1990	-	5.4	23,302,000	21,617,000
1995	-	4.7	28,213,000	24,795,000
2000	-	4.0	34,286,000	28,131,000

Using the above population projection figures and assuming that the current average daily per capita water consumption is a maximum of 20 gallons (90 litres) - a figure which is calculated to be the maximum average daily per capita water consumption in Kenya by the Water Apportionment Board - then the following is the total daily water consumption demand for the years stated above

for the population that has access to piped water supply, assuming no change in fertility and mortality rates (see next page).

It should be noted in Table 11 that the total daily water consumption in every respective year is based on the assumption that 9 per cent of the total rural population will have access to piped water supply and that 10 per cent of Kenya's population in each respective year will live in urban areas and that all of them will have access to piped water. (Note that this is the current proportion of rural to urban population in Kenya: 10% urban and 90% rural).

Another important aspect of water consumption in Kenya's ten year plan and thereafter is to provide everybody (both rural and urban) with water by the year 2000. Note from Table 10 that by that year Kenya's population will be approximately 34,286,000. Assuming that the per capita daily water consumption will be 160 litres as estimated by the Ministry of Water Development then the total daily water consumption demand by the year 2000 for human beings alone will be 5,485,700 litres - approximately 5.5 billion litres per day.

The daily water consumption demand noted above does not include Kenya's livestock. By the year 2000 every Kenya farmer will probably have to water his livestock from piped water. If this is assumed to be so then more water for livestock will be required at the rate estimated by the

Table 11: Population Using Water at the Rate of 90 Litres per person per day

Year	Rural Population	Daily Consumption in Litres	Urban Population	Daily Consumption in Litres	Total Population Rural + Urban	Total Consumption per day in Litres
1975	1,086,453	97,780,770	1,341,300	120,717,000	2,427,753	218,497,770
1980	1,300,293	117,026,370	1,605,300	144,477,000	2,905,593	261,503,370
1985	1,564,110	140,769,900	1,931,000	173,790,000	3,495,110	314,559,900
1990	1,887,462	169,871,580	2,330,200	209,718,000	4,217,662	379,589,580
1995	2,885,253	259,672,770	2,821,300	253,917,000	5,106,553	513,589,770
2000	2,777,166	249,944,940	3,428,600	308,574,000	6,205,766	558,518,940

Water Approtionment Board, which is 10 gallons per day per animal for big animals (e.g. cattle), 2 gallons per day per animal for small animals (e.g. sheep and goats and pigs). Currently Kenya has 7,242,000 cattle, 6,400,000 goats; 5,400,000 sheep; and 31,000 pigs (figures for 1970, 1966, 1966, 1966 respectively).* Assuming that the number of livestock will remain the same in the years to come Kenya will need (as it does now) the following daily amounts of water for livestock consumption:

Animal		Consumption per day per animal	Total Daily consumption
Cattle	7,242,000	45 litres	325,890,000 litres
Goats	6,400,000	9 litres	57,600,000 litres
Sheep	5,400,000	9 litres	48,600,000 litres
Pigs	31,000	9 litres	279,000 litres
		Total	432,369,000 litres

If the daily water consumption for livestock is added to the total daily water consumption demand for human beings as stated in Table 11 above, we get the following daily water demand for the respective years:

* See Jacques M. May, M.D., The Ecology of Malnutrition in Eastern Africa and Four Countries of Western Africa - Studies in Medical Geography, Vol. IX, p. 310.

Year	Total Daily Water Consumption in Litres
1975	650,866,770
1980	694,370,140
1985	746,928,900
1990	811,958,580
1995	945,958,770
2000	990,887,940

Socio-economic Factors (see Appendix B)

Average Level of Education Obtained in Kenya

The average level of education obtained by persons of various levels of educational standard were as follows for the years 1969 and 1972 to 1975 when the total Kenyan population in the various years is considered [14] (see next page).

In the analysis below the author has assumed that the portion of the population that has no formal education at all has remained unchanged since the 1969 census when this portion of the population was actually counted. The "None" column below contains persons who stated that they did not have any formal education as well as those who did not state anything concerning their educational attainment. Also in the analysis it should be noted that the percentage of the population that attained University standard is not shown for the year 1969 because the total number of persons in the Universities

able 12: Level of Education

Year	Population (approx.)	None	%	Primary school	%	High or Secondary	%	Technical school	%	University	%
1969	10,942,705	7,979,287	72.9	1,282,298	11.7	115.246	1.1	2,344	0.02	1,877	-
1972	11,247,000	7,979,287	70.9	1,675,900	14.9	161.900	1.4	7,236	0.06	7,066	0.06
1973	11,247,000	7,979,287	70.9	1,816,000	16.1	174.800	1.6	7,236	0.06	9,166	0.08
1974	12,000,000	7,979,287	66.5	2,734,400	22.8	195.800	1.6	8,149	0.07	8,593	0.07
1975	13,413,000	7,979,287	59.5	2,881,100	21.5	225 100	1.7	8,266	0.06	8,492	0.06

was not known. 1877 was the total number of Kenya students studying in the East African Universities only, excluding those studying overseas.

It can be noted from the above analysis that all levels of education obtained have shown a steady increase every year when total numbers of persons enrolled at all levels are considered. The percentage of persons enrolled in the same level in some cases are the same for two consecutive years simply because the national population of school age also increases every year. This gives the impression that the total numbers attending school every new year are the same when in actual fact the total numbers are increasing as can be noted above.

The increase in school enrolment at all levels also necessitates additional schools to cater for the additional numbers enrolled. Over the past few years the increase in the total number of schools is as follows:[15]

Primary School	1972	1973	1974	1975
Number of schools	6657	6932	7668	8054
Increase of schools over previous year	-	275	736	386
Secondary School	**1972**	**1973**	**1974**	**1975**
Number of schools	949	964	971	1175
Increase of schools over previous year	-	15	7	204

According to 1976 figures there are 8500 fully maintained government primary schools as opposed to 35 government assisted primary schools, unaided "Harambee" primary schools, unaided church primary schools, and unaided purely private primary schools.

By the end of 1975 there were 379 fully maintained government secondary schools, 43 government assisted secondary schools, 568 unaided "Harambee" (self-help) secondary schools, 61 unaided church secondary schools, and 109 purely unaided and private secondary schools. It should be noted that some of the goverment assisted schools are under church management.

Before 1963, 80 per cent of the primary and secondary schools were run by missionary or church organisations. Since 1963, when Kenya became independent, many voluntary organisations such as "Harambee" or self-help began to establish many primary and secondary schools which began to compete with church schools and schools run by the Central government. For types of secondary schools by districts see Appendix G.

Most local schools offer education up to the end of seventh grade. But now there are many secondary schools established within the local communities although they are not even half as many as the primary schools in many local areas in Kenya. Thus it is reasonable to say that many local communities in Kenya have at least a secondary school.

A local community here is defined as an urban area or a rural centre with a population of not less than 2000. Many rural areas which as communities do not have a secondary school are within an average of about 10 to 30 miles (16-48 kilometres) from a secondary school.

For the last three years since 1974, Kenya has allowed free primary education up to the fourth grade. This free primary education up to the fourth grade caused an incraase of 51 per cent in the enrolment of primary education in 1974, and "from 1974 to 1975 primary and secondary school enrolments rose by 5.4 per cent and 15.0 per cent while the number of schools increased from 7,668 and 971 to 8,054 and 1,175 respectively".[16]

Technical Schools

Kenya has two large polytechnics - Kenya Polytechnic and Mombasa Polytechnic. In addition to these there are 13 others that have been operating, and 3 others that have recently been opened to train post-secondary school leavers.[17] Among those technical institutes of technology that will train post-secondary school leavers, there are 10 others that will soon open. The full list of all technical schools in Kenya is as follows:

1. Kabete Secondary Technical School: trains people in basic engineering courses - mechanical, electrical motor vehicle, basic building courses e.g. carpentry/ joinery, masonry, plumbing.

2. Machakos Secondary Technical School: trains people in basic engineering - mechanical, electrical, motor vehicle.

3. Thika Secondary Technical School: trains people in basic engineering - mechanical, electrical, motor vehicle, agricultural mechanics.

4. Meru Secondary Technical School: trains people in basic carpentry/joinery, plumbing, masonry.

5. Rift Valley Secondary Technical School: trains people in basic engineering - mechanical, electrical, motor vehicle.

6. Kisumu Secondary Technical School: trains people in basic engineering - mechanical, electrical, motor vehicle.

7. Mawego Secondary Technical School: trains people in masonry, carpentry/joinery.

The following train people only up to Form 3 level:

8. Kaiboi Secondary Technical School: trains people in basic engieering - mechanical, motor vehicle, agricultural mechanics, and later will train people in electrical engineering.

9. Sigalagala Secondary Technical School: trains people in basic building courses. Has been conducting basic engineering courses.

10. Technical High School, Mombasa: will now train people in basic building trade courses at Form 3 level. Has been teaching basic engineering courses.

11. Nakuru High School: has been teaching basic engineering courses. Will now teach engineering courses at Form 1 level.

12. Technical High School, Nairobi: has been teaching basic engineering courses. Will now teach industrial education.

13. Nyeri Technical Secondary School: trains people in basic engineering courses. It will start training people at Form 3 level in January 1977. The engineering courses will be in mechanical, electrical, motor vehicle, agricultural mechanics. Girls will be taught business studies, and home economics dealing with textile and industrial tailoring courses.

Nyeri Technical Secondary School will start welding courses soon during 1977, and the government has plans to start other courses in Kitale and Mombasa, where basic engineering courses such as agricultural engineering and mechanics will be taught.

There are 13 new Institutes of Technology in Kenya in addition to the technical schools enumerated above. These, as has already been stated, will train post-secondary school leavers. Three of them, namely Kiambu, Murang'a and Kaimosi have opened.

There are other assisted and private technical schools in Kenya. These are Kajiado, Starehe, Sagana, Christian Industrial Training Centre in Mombasa and Nairobi which cater for mixed levels of training.

Universities

There is only one university in Kenya - The University of Nairobi, which since 1972 incorporated the Kenyatta University College as its constituent college.

As noted in Table above, rapid growth of secondary education will supply middle level entrants to the labour force, and some secondary school graduates will continue their education to the University and it is from among them that high level manpower will be obtained to replace expatriate high level manpower.

As shown above, the total enrolment in secondary schools rose by 29,300 from 195,800 in 1974 to 225,100 in 1975, and the number of secondary schools increased from 971 in 1974 to 1,175 in 1975.

The total enrolment in the primary schools rose from 2,734,400 in 1974 to 2,881,100 in 1975. It is noted that this primary school enrolment increase of 5.5% would make enrolment in primary schools in 1976 more than 3 million.[18]

Primary school expansion will necessitate secondary school expansion as is already evident in Kenya, from now on. Secondary school expansion also necessitates University expansion. At present there is great need for additional universities in Kenya as only less than half the total number of qualified entrants can find places at the University of Nairobi and at Kenyatta University College. In fact the enrolments of Kenyan students in the University of Nairobi declined by 2.3 per cent in the 1975/76 academic year over the previous academic year, as compared with a decline of 1.2 per cent in total enrolments. This decline which has been observed for the first time over the past few years is due to lack of accommodation and financial constraints.

There was also a decline in enrolment at the Kenyatta University College in 1975 from 1,267 to 1,219. This enrolment declined by 3.8 per cent.[19]

From the point of view of qualified personnel who can be engaged in water development successfully, University graduates who have science degrees in Chemistry, Biology, Physics, Botany and Mathematics and in Mechanical and Civil Engineering are very much needed. Both the University of Nairobi and the Kenyatta University College have science departments and engineering departments (in the University of Nairobi) and laboratories which can train persons needed in the fields enumerated here. For example, during the 1973/74 academic year there were 482 Kenyan students in the East African Universities and overseas studying science (Mathematics, Biology, Physics, Botany and Chemistry, etc.).[20] During the same academic year, there were 661 Kenyan students studying Engineering of different types (Civil, Mechanical, Design, etc.).[21]

Of the 9,166 Kenyan students studying in the various universities in East Africa and overseas in 1973, 455 of them or 4.96 per cent were studying in the neighbouring countries of Uganda and Tanzania, and 4,014 of them or 43.8 per cent were studying in foreign overseas universities. There was a total of 4,469 Kenyan students studying outside Kenya and 4,697 Kenyan students studying in Kenya. The percentage of those studying outside Kenya in neighbouring and overseas foreign countries on the one hand and in the home university on the other, were 48.76 and 51.24 respectively. It can be noted that there was almost an equal number of Kenyan university students in foreign countries as compared with that in the home university.

Agricultural Education and Training

An important aspect of education in Kenya is that pertaining to agricultural education and training. This aspect of education is very important since Kenya is primarily an agricultural country. Farmers need plenty of water supply for their livestock as well as for their crops and domestic use. Consequently, Kenya offers education and training in agriculture at degree, diploma and certificate levels, and there are short-term vocational courses as well.

Degrees in agriculture are obtained in the University of Nairobi in the Faculties of Agriculture and Veterinary Medicine and in 1975 there were 185 and 312 students enrolled in these faculties respectively.[22] Egerton College offers Diploma courses in Agriculture and in 1975 total enrolment at Egerton was 643.[23] Embu Institute of Agriculture offers courses in general agriculture at Certificate level and in 1975 there were 161 students enrolled.[24] The Animal Health and Industry Training Institute at Kabete offers courses in animal husbandry and in 1975 there were 215 students enrolled in this Institute. The last two institutions conduct two-year training courses. Bukura Institute of Agriculture also conducts courses in general agriculture.

The short-term vocational courses are conducted by Narosura Farm Mechanization Training Institute at Baringo and at Naivasha Dairy Training School, where the enrolments

in 1975 were 100 and 454 respectively. In the former Institute courses are conducted for one or two weeks and in the latter school short course seminars are conducted.[25]

The enrolments in the above institutions have shown a steady increase since 1971 up to date. These institutions produce knowledgeable persons who in many cases are employed as extension workers to advice farmers in the necessary skills for crop production and animal husbandry. In addition there are Farmers Training Centres which train farmers and equip them with the necessary knowledge aimed at upgrading their farming skills. These Farmers Training Centres are at Kikuyu, Nyeri, Embu, Matuga in Kwale and Murang'a.

Formal In-service Training Programmes for Employees

Government Employees[26]

Government employees who have acquired certain basic practical skills in their places of employment, have opportunities to improve on their skills through formal in-service training programmes offered them by their employers. The level of training depends upon educational attainment or background of the employee to be trained. Formal in-service training programmes are established for various government employees and the type of persons to be trained depends upon where there is need for training.

The following are the institutions in Kenya which conduct formal in-service training courses for government employees in the various ministries: (see pages 54 and 55).

Institution	Courses offered	Duration of the courses
University of Nairobi	Post-graduate and Diploma courses in the following:	
	Agriculture - Master of Science	2 years
	Medicine - e.g. Diploma in Advanced Nursing	2 years
	Land Economics - Bachelor of Arts	3 years
	Diploma in International Relations	1 year
	Diploma in Journalism	2 years
	Post-graduate Diploma in Education	1 year
	Diploma in Adult Education	-
Kenya Institute of Administration	Public Administration	Between 3-9 months
	Management Development	Bet. 3-9 months
	Courses e.g. Accountancy	Bet. 3-9 months
	Social Studies & Cooperatives	2 years
	Training for Income Tax	3-9 months
	Probation	3-9 months
	Training of Personnel Officers	3-9 months
	Store keeping	3-9 months
	Any other courses necessary for particular needs	
Government Training Institute - Kabete	Personnel work	
	Accountancy	
	Clerical training	
	Courses for chiefs	
	Training persons who train clerks in the various ministries	
Medical Training Schools in Nairobi and Nakuru	These schools train paramedicals at different levels	
Kenya Polytechnic (Nairobi)	Mechanical Engineering	
	Electrical Engineering	
	Automobile Engineering	
	General course in Engineering	
	Aeronoutical	
	Telecommunication	
	*Building & Civil Engineering courses	
	Public Health Inspector	
	Science:	
	General Certificate of Education-Ordinary level	
	General Certificate of Education-Advanced level	
	Laboratory & other technicians	
	Secretarial courses	
	Commerce courses	
	Professional courses	
	Printing	
	Institutional Management e.g. catering & hotel management	
	Technical teacher training	
	Special courses	

Institution	Courses offered	Duration of the courses
Mombasa Polytechnic	Pre-technician Mechanical Engineering Technician Electrical Engineering Technician A.C.C.A. and A.C.L. (Accounts Parts I & II) Business Administration (Diploma and Certificate) Mechanical Craft Practice Building and Construction Book-keeping E.A.E.C. Secondary Certificate Higher School Certificate-Advanced Level Ordinary Technical Diploma Motor Vehicle Mechanic Welding Technical Teacher Training Statistics and unspecified evening courses	
East African Staff College	This institution trains senior management staff	
Kenya Government Secretarial Colleges in Nairobi and Mombasa	These colleges train secretarial staff for the government and private sectors.	
Ministry of Works Training Centre in Nairobi	This centre trains technicians and supervisors for various jobs they do for the government.	
Ministry of Water Development	This Ministry trains their technicians for water development	
Prisons Training College, Langata	Trains people to work in prisons at all levels.	
The Police Training College at Kiganjo	This college trains policemen at all levels.	
Criminal Investigation Department Training School in Nairobi	This school trains people specifically for criminal investigation work.	
Egerton College	This college teaches basic agriculture, extension work, farm management, agricultural engineering, home economics and animal husbandry.	
Agriculture Training Institute at Embu and Bukura	These institutes offer the same courses as Egerton college but at a lower level.	
Animal Health and Industry Training Institute at Kabete	This institute offers courses in animal husbandry.	
Institute of Mass Communication in Nairobi.	This institute trains technicians for radio and television and it also teaches newswriting.	

In addition to the above types of training, there are courses which cannot be conducted in Kenya at the same or higher levels in the same fields and consequently the government of Kenya sends its employees overseas to train in such courses.

Employees in the Industrial and Private Sector[27]

Employees who are not strictly government employees also have opportunity to train and up-grade their skills on-the-job. Thus there is also formal in-service training programmes for people employed in different industries and businesses in the private sector. The following are at present in Kenya the registered private industrial business and institutional organisations which offer formal in-service training courses for their employees: (see pages 57-58).

It is to be noted here that there are other firms in Kenya which train their employees but they (the firms) are not yet recognized by the government. The eleven firms named below under private sector, however, are registered and recognized by the government.

The eleven firms named below train their employees for 3-5 years. About 350 people a year are trained by these private firms. The East African Community organizations, analyzed below, also train about 200 people every year.

The East African Community[28]

Business Concern	Type of Training Offered
East African Posts and Telecommunications at Mbagathi Training School	This school trains people in telephony and general telecommunication.
East African Civil Aviation at Wilson Airport and Embakasi in Nairobi	This organisation trains people in engineering fields and offers courses for secretaries.
East African Forest Research Organisation at Muguga	This organisation trains scientists for research work in Botany, Chemistry. and other branches of science.
The East African Meteorological Department	This organisation trains its employees in the field of meteorology and other related fields.
Private Sector: Business Concern:	
D.T. Dobie	This business concern trains electricians and motor vehicle mechanics.
Hughes Limited	Motor vehicle mechanics and electricians.
Westlands Motors	It trains motor vehicle mechanics and electricians.
Marshalls Limited (East Africa)	It trains motor vehicle mechanics and electricians.
Construction Equipment Limited	This business concern trains motor vehicle electricians, diesel engine mechanics and plant mechanics.
Cooper Motor Corporation Limited	This business concern trains motor vehicle mechanics, electricians and it teaches welding and fabrication of motor vehicles.
Kenya Canners Limited	This business concern trains motor vehicle mechanics, agricultural mechanics and electricians.
Metal Box Company	This company trains people in tool and dye making, and precision mechanics.
East African Power and Lighting Company	This company trains people in electrical and mechanical trades.

Business Concern	Type of Training Offered
East African Oxygen Limited	This company trains technicians in the preparation, production, and packing of oxygen or gas.
Craelius Terratest Company	This company trains people in drilling water holes or bore holes.

For the purpose of this report, which is concerned with the socio-economic conditions which pertain to cost of construction and operation of water and sewage treatment facilities in Kenya, we are concerned with the availability of qualified personnel who can deal efficiently and successfully with the entire process of piped water supply that is needed for the Kenyan population at present and in the future. From this point of view, it is reasonable to note that certain types of training offered by both the government and private firms in Kenya as indicated above would be useful in the area of water supply and development, and for the operation of water and sewage treatment facilities. Thus, courses in the fields of Mechanical, Electrical, and Civil engineering and in Building are very useful in this respect. Similarly, courses in general science such as Chemistry and Physical Science are also useful for operators of water and sewage treatment facilities. Kenya needs skilled people in all the various fields stated above, and the related fields, in order that some qualified technicians in these fields may be able to operate water and sewage treatment facilities. Other qualified technicians in these fields will be able to do many other kindred jobs which need their skills, in other words these technicians are needed not only to do jobs which pertain to operation of water and sewage treatment facilities, which is the concern of this report, but also to do other jobs which need their skills.

Supply of Technicians in Kenya

A survey of training institutions in Kenya carried out between June 20, and August 9, 1975, and the report on the survey of industrial training institutions by the UNDP and ILO in 1975, and the report on the survey of in-service training programme by the Ministry of Labour, Kenya in 1975 show the status of available trained technicians in Kenya who are semi-professional and skilled. These surveys made it possible for Mr. Martin Godfrey, ILO Consultant, to write a report on a long-term plan for industrial training in Kenya in December 1975. Among other things this report estimates the rate of increase in output of qualified Kenyans in various occupational categories over the period 1972-78. The report is the result of the work of Mr. Martin Godfrey together with the organizations referred to above. These qualified technicians in the various occupational categories include technicians in the field of water engineering and their specialities are included in this report.

The following Table 13 is the status of Kenya pertaining to semi-professional and skilled technicians in the various stated fields during 1972 and 1972-78 projections of output in selected occupation categories. The table, therefore, shows the supply of qualified Kenyans in the various occupational categories shown.[29]

Table 13: 1972 Stock and 1972-1978 Projections of Output in Selected Occupation Categories

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	January 1972 stock	Of which non-citizens number	Percentage	Plus 1978-78 additions from: Surveyed general purpose institutions	Surveyed in-service institutions	Other sources	Less wastage	January 1979 stock if zero Kenyanization (1+4+5-6-7)	Implied annual average growth rate (% p.a.)	January 1979 stock if 100% Kenyanization (8-2)	Implied annual average growth rate (% p.a.)
Semi-professional (Technicians)											
Physical Science Technicians[b]	535	124	23	20[illegible]	-	-	-2	740	4.7	616	2.0
Draughtsmen and Engineering Technicians (a,b)	3976	1297	51	302[illegible]	783	-	-267	7517	9.5	6220	6.6
Statistical and Mathematical Technicians (a)	100	22	22	-	-	-	-	100	-	78	fall
Secondary Teachers, Technical	376	142	38	24[illegible]	-	-	-12	612	7.2	470	2.8
Total, Semi-Professional	4987	1585	32	348[illegible]	783	-	-281	8969	8.7	7384	5.8
Skilled											
Production supervisors/foremen	3152	744	24	60[illegible]	-	-	-264	3491	1.5	2747	fall
Tailors, dressmakers, patternmakers, etc.	2940	950	32	127[illegible]	-	70	-139	4145	5.0	3195	1.2
Blacksmiths	225	9	4	8[illegible]	12	16	-9	333	5.8	324	5.3
Machinists/Fitters etc.	2178	167	8	41[illegible]	169	451	-94	3117	5.3	2950	4.4
Motor Vehicle Mechanics[c]	3050	260	9	358	-	483	-143	3748	3.0	3488	1.9
Mechanics/Repairmen[c]	1057	171	16	38[illegible]	16	24	-49	1430	4.4	1259	2.5
Electrical/Electronics Worker	1720	280	16	429	279	375	-25	2778	7.1	2498	5.5
Plumbers and Pipefitters	246	60	24	210	11	21	-19	469	9.7	409	7.5
Sheetmetal & Structural Metal Workers (c)	410	79	19	39	-	2	-35	416	0.2	337	fall
Millers and Flamecutters[c]	642	50	8	183	11	164	-55	946	5.7	896	4.9
Compositors and Typesetters (a,c)	518	72	14	48	-	-	-10	556	1.0	484	fall
Letterpress Minders[ac]	410	23	6	23	-	-	-8	425	0.6	402	fall
Other Printers etc.[ac]	539	16	3	81	-	-	-11	609	1.8	593	1.6
Painters/Signwriters[b]	269	23	9	-	-	43	-21	291	1.1	268	fall
Carpenters and Joiners[b]	1488	304	20	332	22	270	-116	1996	4.2	1692	1.8
Stonemasons, bricklayers, etc. (b)	1610	256	16	210	68	82	-126	1844	2.0	1588	fall
Total Skilled	20,621	3,543	17	4,674	588	2,001	-1,124	26,594	[illegible]	23,130	1.7
TOTAL	25,608	5,128	20	5,154	1,371	2,001	-1,405	35,563	4.2	30,514	2.5

Key:
a. Categories for which overseas training has been important
b. January 1972 vacancy rate above average
c. January 1972 vacancy rate below average

In Table 13 above "Column 1 shows the stock of manpower in each occupational category as estimated in the 1972 manpower survey".[30] Skilled worker in this survey was defined as a person who "must have passed at least trade test grade 1 or have equivalent qualifications".[31]

Columns 4 and 5 contain the estimated additional technicians during the period 1972-78 from the training institutions covered by the manpower survey of 1972. Column 6 contains the estimated supply of technicians from sources other than the surveyed institutions. This column contains some skilled workers who belonged to large firms which do not send their apprentices to the industrial training centres.

Column 7 contains the estimated wastage from the stock due to retirement and death. According to the above table, the average wastage rate is 5½ per cent over the seven years considered.

It should be noted here that the output figures in columns 4-6 are net in the sense that "if a skilled worker completes a course at technician level he is added to the stock of technicians but deducted from the stock of skilled workers".[32]

On the assumption of zero Kenyanization we get in column 8 a figure for total stock in 1979, and in Column 9 we get an implied annual average rate of growth between

January 1972 and January 1979.[33]

In Column 10 we subtract the number of non-citizens shown in Column 2 to obtain stock in January 1979, and annual average rate of growth on the assumption of 100 per cent Kenyanisation in Column 11.

According to the figures in Table 13 above, "the average annual rate of increase in the stock of all those in occupational categories shown in Table 13 will range between 2.5 per cent and 4.2 per cent depending on the degree of Kenyanisation achieved".[34] This is the experience according to the expectations of output from training institutions and estimates of output from other sources. For example, in the case of plumbers and pipefitters the rate of increase is between 7.5 and 9.7 per cent per annum.

Annual average rates of increase as shown in the supply projections in Table 13 above are useful in identifying categories of skilled workers and technicians which show an exceptionally high rate of growth in supply vis a vis those which show an exceptionally low rate.[35] For example, as can be seen in the Table, plumbers and pipefitters show a high rate of increase whereas production supervisors/ foremen show exceptionally low rate of increase. Such comparisons show where there is need for future training and the nature of demand for skilled workers and technicians.

In Kenya, the Ministry of Water Dvvelopment in conjunction with the Kenya Polytechnic and Mombasa Polytechnic train water engineering technicians for Ordinary Diploma in Water Engineering. At the Kenya Polytechnic in Nairobi this training takes 2¼ years. The enrolment at the Kenya Polytechnic in Nairobi, from 1972-1976 was as follows:[36]

Year	Enrolment
1972	17
1973	23
1974	18
1975	16
1976	21

The figures for the Mombasa Polytechnic for the above respective years were not available at the time of writing, but the total enrolment there for the Ordinary Diploma in Water Engineering were not expected to be higher than in the Kenya Polytechnic in Nairobi.

The courses taught for the Ordinary Diploma in Water Engineering at the Kenya Polytechnic are as follows:

Building services and water supply

Civil engineering construction

Hydraulics

Hydrology

Geology and soil mechanics

Electrical installation

Carpentry and joinery

Masonry

Mechanical workshop practice

Elementary quantity surveying

General studies

Mathematics and statistics

Land surveying

Concrete technology

Properties of materials

Structures.

If all students pass, it is expected that 21 water engineering technicians will be graduated from the Kenya Polytechnic at the end of 1976.

Table 13 above gives us an idea of the output of skilled workers and technicians in some branch of water engineering. Examples from the Table show January 1972 stock, January 1979 stock if zero Kenyanisation, January 1979 stock if 100% Kenyanisation and implied annual average growth rate of persons trained in some branch of water engineering and in the respective areas as shown below:

Table 14:

Semi-professional (technician)	January 1972 Stock	January 1979 stock if zero Kenyanization	Implied annual average growth rate	January 1979 stock if 100% Kenyanization	Implied annual average growth rate
			(% p.a.)		(% p.a.)
Draughtsmen and engineering technicians	3976	7517		6220	
Physical science technicians	535	740	4.7	616	2.0
Statistical & mathematical technicians	100	100	-	78	fall
Skilled					
Production supervisors/foremen	3152	3491	1.5	2747	fall
Machinist/fitters, etc.	2178	3117	5.3	2950	4.4.
Mechanics/repairmen	1057	1430	4.4	1259	2.5
Electrical/electronics worker	1720	2778	7.1	2498	5.5
Carpenters and Joiners	1488	1996	4.2	1692	1.8
Stonemasons, bricklayers, etc.	1610	1844	2.0	1588	fall
Plumbers and pipefitters	246	469	9.7	409	7.5
Sheet metal and structural metal workers	410	416	0.2	337	fall
Total	16472	23898	6.4	20394	3.4

The analysis in Table 14 above shows that the implied annual average growth rate of skilled workers and technicians in some branch of water engineering from 1972-1978 is between 3.4 and 6.4 per cent depending on the degree of Kenyanisation achieved.

Demand for Technicians for Construction, Operation and Maintenance of Water and Sewage Treatment Facilities: General Observation

Generally speaking, there is great manpower shortage in Kenya in the field of construction, operation and maintenance of water and sewage treatment facilities. Naturally, in the future, as it is now, there will be an increasing demand for technicians in each job category pertaining to construction, operation and maintenance and other related duties, of water and sewage treatment facilities.

In a survey carried out in 1975 by Martin Godfrey he "assumed that the demand for middle-level technical manpower in each sector will increase at the same rate as net output in that sector, based on the further assumptions of no significant movements in real wages relative to other costs and no significant changes in wage differentials between different occupations".[37]

Using the above assumptions it was noted in 1975 that demand projections for certain selected occupational

categories including those required for construction, operation and maintenance of water and sewage facilities would show the following:[38]

Table 15: Demand: Projections of Growth Rate for Selected Occupational Categories January 1972-January 1979

	% per annum
Physical science technicians	8.1
Draughtsmen & engineering technicians	7.2
Statistical and mathematical technicians	6.3
Secondary teachers, technical	7.0
Production supervisors/foremen	6.4
Tailors, dressmakers, patternmakers, etc.	6.5
Blacksmiths	8.6
Motor-vehicle mechanics	6.9
Mechanics/repairmen	7.0
Electrical/electronics workers	7.1
Plumbers and pipefitters	5.4
Welders and flame cutters	7.1
Sheetmetal and structural metal workers	7.1
Compositors and typesetters	7.6
Letterpress minders	7.6
Other printers etc.	7.6
Painters/signwriters	6.1
Carpenters/joiners	6.1
Stonemason/bricklayers, etc.	6.1

The reader should note the occupational categories above which pertain to skills and technical knowledge which are required for construction, operation and maintenance of water and sewage treatment facilities, and what projections of their growth rates are. Those occupations pertinent to

this category as shown above are: physical science technicians, draughtsmen and engineering technicians, statistical and mathematical technicians, secondary teachers, technical, production supervisors/foremen, machinists/fitters etc., motor-vehicle mechanics, mechanics repairmen electrical/electronics workers, plumbers and pipe fitters, welders and flamecutters, sheetmetal and structural metal workers, carpenters/joiners, stonemasons/bricklayers, etc.

From the above Table 15 it can be noted that the demand growth rates differ from one occupational category to another. For example, at one extreme the demand for machinist/fitters is projected as growing at 8.6 per cent per year, while at the other the growth rate for plumbers and pipefitters is projected at only 5.4 per cent.[39] It should be noted that for the economy of Kenya, as a whole the growth rate for all categories is expected to be higher than 5 per cent per annum as the following original and revised projections of output growth rates for 1972-1978 shows.[40]

Table 16:

Original and Revised Projections of Output Growth Rates 1972 - 1978

1972-1978 Growth Rate of Output at Constant Prices

	As projected in Development Plan % per annum	As implied by November 1975 Revision % per annum
Agriculture, forestry and fishing	5.5	4.5
Mining	15.7	14.0
Manufacture and repair	10.1	7.7
Construction	6.9	4.6
Electricity	8.6	6.1
Transport	7.2	4.7
Trade	7.1	4.7
Other enterprises	7.1	4.8
Government	10.0	7.5
Gross Domestic Product (at factor prices)	7.4	5.0

Supply and Demand

It is necessary to compare the projected growth rates of supply and demand for the various occupations in order to "get a rough idea of the occupations for which planned local training provision appears to be adequate and those for which it appears particularly inadequate".[41] In order to do this we compare the output as shown in Column 1 of Table 13 above (which shows January 1972 stock) with the growth rates in demand of Table 15 above (which shows the projected growth rates for various selected

occupational categories). In doing this it should be noted that "the larger the extent by which the growth rate in demand exceeds that of supply the higher the ranking for the occupation",[42] which means that the occupation would need more personnel as according to projections its supply is inadequate.

Thus according to the above analysis we derive the following ranking of occupational categories in order of severity of projected shortage:[43]

Table 17:

Occupational Categories in Order of Severity of Projected "Shortage"

1.	Compositors and typesetters
2.	Letterpress minders
3.	Sheetmetal and structural metal workers
4.	Production supervisors/foremen
5.	Statistical and mathematical technicians
6.	Painters/signwriters
7.	Stonemasons, bricklayers, etc.
8.	Physical science technicians
9.	Other printers, etc.
10.	Carpenters and joiners
11.	Tailors, dressmakers, patternmakers, etc.
12.	Motor vehicle mechanics
13.	Mechanics/repairmen
14.	Secondary teachers technical
15.	Welders and flamecutters
16.	Blacksmiths
17.	Electrical/electronics workers
18.	Draughtsmen and engineering technicians
19.	Plumbers and pipefitters

It should be noted that the above analysis is a macro-level analysis which attempts to identify training priorities. It does not take into consideration individual occupations which may be subject to particular influences not taken account of in the projections.[44] Consequently such analysis should be supplemented by a detailed investigation of the market for individual occupations. With regard to occupations which pertain to construction, operation and maintenance of water and sewage treatment facilities some detailed (but not exhaustive) analysis concerning some shortage and present status of established posts, and jobs which are temporary and outside establishment is shown on pages 73 - 76).[45]

Personnel in the Ministry of Water Development Established Posts - August 1966 (For Kenya as a whole)

Technical Branch

Post Designation	No. in post (authorized establishment)	Vacancies
Chief Engineer (water)	2	
Deputy Chief Engineer (water)	2	
Senior Superintending Engineer	1	
Senior Superintending Hydrologist	1	
Superintending Water Engineer (technical)	9	
Superintending Engineer (mechanical)	0	1
Senior Chemist (water)	1	
Superintending Geologist	2	
Superintending Hydrologist	1	
Engineers (water)	8	
Electrical Engineer	0	1
Senior Superintendent (electrical)	0	1
Engineer (water)	27	
Engineer (mechanical)	1	
Chemist	0	1
Chemist (water)	7	
Geologist I	2	
Engineer (Drilling)	0	1
Geologist II	9	
Superintendent (Drilling)	0	1
Hydrologist I	2	
Hydrologist II	9	
Staff Surveyor I	1	
Senior Water Bailiff	1	
Water Bailiff I	1	
Water Bailiff II	5	
Water Bailiff III	14	
Senior Superintendent (water)	8	
Superintendent (water)	12	
Senior inspector (water)	27	
Inspector (water)	85	
Inspector (ground water)	7	
Assistant Hydrologist II	4	
Assistant Hydrologist III	12	
Computing Assistant Hydrologist	2	
Hydrology Assistants	14	
Senior Assistant Hydrologists	3	
Senior Superintendent (mechanical)	1	
Superintendent (mechanical)	3	
Senior Inspector (mechanical)	3	

Post Designation	No.in post (authorized establishment)
Senior Inspector (electrical)	1
Inspector (mechanical)	6
Mechanics	20
Senior Draughtsman	1
Draughtsman I	2
Draughtsman II	2
Draughtsman III	7
Assistant Draughtsman I	1
Assistant Draughtsman II & III	5
Drilling Inspector	1
Photoprinter	1
Inspector (mechanical) (drilling)	1
Inspector (building)	2
Surveyor Assistant I	1
Surveyor Assistant II	4
Surveyor Assistant III	4
Junior Survey Assistant I	1
Junior Survey Assistant II and III	10
Plant Operators, I, II & III	11
Drivers	131
Hydrology Assistants	72
Artisans (building)	12
Painters, masons, plumbers, pipe fitters etc.	65
Technical Assistants (water) operators	107
Technical Assistants (water)	44
Water bailiff Assistants	1
Water bailiff Assistants II	8
Water bailiff Assistants III	37
Instructors III	0
Total	838

2

Administration

Ministry of Water Development	1
Assistant Ministers of Water Development	2
Permanent Secretary	1
Deputy Permanent Secretary	1
Under Secretary	1
Senior Assistant Secretary	1
Assistant Secretaries	2
Executive Officer II	4
Executive Assistants	4
Bursar	1
Accountant I	1
Accountant II	1
Accounts Assistants	4

Post Designation	No.in post (authorized establishment)	Vacancies
Supplies Officer	0	1
Supplies Officer II	1	
Supplies Assistant	1	
Personal Secretary	4	
Short hand typists	16	
Copy typists	18	
Clerical Officer (salary scale D)	1	
Senior Clerical Officers	2	
Clerical officers (salary C-E)	40	
Storemen	9	
Telephone Operators	3	
Housekeeper II	1	
Cooks	2	
Subordinate staff	303	
Total	426	

Mombasa

Chief Engineer (water)	1	
Deputy Chief Engineer	0	1
Superintending Engineer	0	1
Engineer (water) I	0	1
Superintendent (mechanical)	0	1
Senior Assistant Telecommunication Engineer	0	1
Engineer (water) II	0	1
Water Bailiff II	1	
Water Bailiff III	1	
Senior Superintendent (water)	0	1
Superintendent (water)	1	
Senior Inspector (water)	2	
Inspector (water)	6	
Artisan (building)	2	
Water supply operators	5	
Hydrology Assistants	5	
Meter readers	10	
Mechanics	1	
Drivers	23	
Subordinate staff	90	
Total	155	

Post Designation	No.in post (authorized establishment)	Vacancies
Administration		
Administrative Manager	0	1
Chief Accountant	1	
Senior Accountant	0	1
Senior Supplies Officer	0	1
Executive Officer I	0	1
Supplies Officer II	2	
Supplies Officer I	0	1
Personnel Officer I	0	1
Finance Officer I	0	1
Accountant (Grade I)	2	
Accounts Assistant	4	
Executive Officer II	1	
Personal Secretary	1	
Shorthand Typists	2	
Copy Typists	1	
Clerical Staff	10	
Total	31	

Jobs Outside Establishment - August 1976

In addition to the established posts indicated above, existing in the Ministry of Water Development there are jobs existing outside the establishment. The following are the jobs with the total number of employees in each category (see pages 77 - 79).

Nairobi Headquarters

Job Description	Number Employed
Clerical officers	31
Junior clerical officers	8
Charge Hand	1
Storemen	10
Copy typists I, II & III	8
Drivers (grade 3)	95
Subordinate staff	322
Mechanics	34
Water Bailiff Assistants	18
Hydrology Assistants (grade III)	4
Laboratory Assistants	2
Drillers	11
Artisans (masons, carpenters, plumbers, pipe fitters etc.)	103
Plant operators	31
Total	678

Coast Province (Mombasa)

Drivers	15
Clerks	44
Shorthand typists	1
Pipe fitters	29
Field Assistants	6
Charge hand	1
Draughtsmen	2
Copy typists	7
Artisans	25
Water supply operators	45
Telephone operators	2
Mechanics	10
Storemen	4
Meter Readers	3
Subordinate staff	524
Total	718

Rift Valley Province

Telephone Operators	1
Motor vehicle inspector (mechanic)	1
Motor vehicle mechanic (grades I & II)	9
Drivers I & II	14
Copy typists (grades 1-3)	4
Subordinate staff	159
Clerical staff	10
Storemen	4
Water supply operators	23
Field Assistants	1
Meter reader	2
Water Bailiff assistant	1

	Number Employed
Western Province	
Subordinate staff	142
Drivers	10
Motor vehicle mechanics	2
Copy typists	3
Artisans	9
Clerical staff	5
Storemen	1
Water supply operators	9
Pump Attendants	1
Total	182
Eastern Province	
Clerical staff	9
Water supply operators	21
Copy typists	2
Water bailiff assistants	1
Artisans	11
Drivers	5
Storemen	1
Subordinate staff	145
Total	195
North-Eastern Province	
Clerical staff	2
Drivers	6
Artisans	5
Water supply operators	4
Storemen	1
Motor vehicle mechanics	2
Subordinate staff	49
Total	69
Nyanza Province	
Clerical staff	12
Hydrology assistants	22
Copy typists	4
Storemen	4
Water supply operators	19
Drivers	9
Motor vehicle mechanic inspector	1
Motor vehicle mechanics (grades 1-3)	3
Artisans	16
Telephone operators	2
Subordinate staff	226
Pump attendants	27
Total	345

Central Province		Number Employed
Clerical Staff		3
Motor vehicle mechanics		2
Artisans		9
Water supply operators		14
Copy typists		4
Drivers		1
Storemen		1
Subordinate staff		149
	Total	183

The above totals show that there are 1,450 established posts and 2,611 jobs which are currently filled and performed by persons who are outside the established posts, in the Ministry of Water Development.

An analysis of some 1,046 authorized posts in the establishment in the Ministry of Water Development shows that for the year 1975-1976 there were 756 persons employed in these posts and that there were 290 vacancies to be filled. The Ministry of Water Development has been able to fill 100 of these vacant positions. But the remaining 190 vacant positions have been frozen for lack of money. This is a problem that has affected the whole Republic of Kenya. All vacant positions in the different ministries in the government have been frozen due to inflationary trends in the country. An example from the Ministry of Water Development showing vacant positions in the establishment which cannot be filled because of lack of money is analysed below to indicate the various posts affected and the amount of money lacking to make recruitment possible:[46] (see page 81).

With respect to scarcity of funds necessary for recruitment of the needed staff it should be observed that the salary scales for the above named posts are as follows in Kenya pounds per year (see page 83).

Table 18:

Ministry of Water Development
Vacant Posts for the Year 1975-1976

Post Designation	Job Group	Auth. Estab.	In-post	Vacancies	Money needed K.£
Deputy Chief Engineer	N	3	2	1	2,928
Senior Superintendent Engineer	N	3	1	2	5,023
Senior Superintendent Hydrologist	M	1	-	1	2,514
Superintending Engineer	L	16	7	10	20,100
Superintending Engineer (mechanical)	L	1	-	1	2,010
Superintending Geologist	L	2	1	1	2,010
Engineer Water I	K	27	7	20	32,280
Engineer Water II	J	27	-	-	-
Electrical Engineer	K	1	-	1	2,010
Senior Superintendent Engineer	K	1	-	1	1,614
Chemist (water)	K	1	-	1	1,614
Drilling Engineer	K	1	-	1	1,614
Geologist II	J	11	9	1	1,350
Superintendent Drilling	J	1	-	1	1,350
Water Bailiff I	J	2	1	1	1,350
Water Bailiff II	H	13	8	5	4,530
Water Bailiff III	G	15	14	1	804
Inspector Building	G	3	2	1	804
Senior Superintendent (water)	K	28	8	5	8,070
Superintendent (water)	J		13	19	17,550
Senior Inspectors (water)	H	193	27	16	17,376
Inspectors (water)	G		85	45	
Senior Inspector (mechanical)	H	4	3	2	2,172
Inspector (mechanical)	G	8	5	3	
Drilling Inspector	G	8	1	5	
Assistant Hydrologist I	H	5	6	1	
Assistant Hydrologist II	G	25	12	13	
Survey Assistant II	H-J	6	4	1	1,086
Survey Assistant III	G	9	4	5	
Economist/Statistician	J	2	-	2	2,700
Executive Assistant	G	6	4	2	
Accountant I	J	23	1	1	
Accountant II	H		2	2	
Accountant Assistant	G		2	1	
Supplies Assistant	G	2	1	1	
Personal Secretary	H	7	4	3	4,344

Post Designation	Job Group	Auth. Estab.	In-post	Vacancies	Money needed K.£
Senior Clerical Officer	F	11	-	2	
Storeman III	D	1	-	1	
Laundryman	D	1	-	1	
Senior Inspector	H	2	-	2	2,172
Cook grade I	C-D	3	-	1	
Artisan (Building)	C-E	26	23	3	1,097
Technical Assistant (Water)	C-F	336	334	2	
Driller I (Mechanic)	F	-	-	1	
Assistant V. Mechanic	C-F	29	20	10	
Assistant Draughtsman I	F	6	1	5	
Assistant Draughtsman II	D)	10	5	1	
Assistant Draughtsman III	C)		-	4	
Drivers	C-E	164	138	31	2,970
Total		1046	756	290	147,228

Job Group	
M	K.£2514x90 - K.£2604x108 - K.£3036 p.a.
N	K.£2928x108 - K.£3144x132 - K.£3540 p.a.
L	K.£2010x72 - K.£2154x90 - K.£2514 p.a.
K	K.£1614x60 - K.£1794x72 - K.£2082 p.a.
J	K.£1350x48 - K.£1494x60 - K.£1794 p.a.
H	K.£1086x42 - K.£1254x48 - K.£1446 p.a.
G	K.£804x30 - K.£864x36 - K.£1044x42 - K.£1086 p.a.
F	K.£594x24 - K.£714x30 - K.£834 p.a.
E	K.£489x21 - K.£594x24 - K.£690 p.a.
D	K.£369x15 - K.£399x18 - K.£489x21 - K.£531 p.a.
C	K.£276x12 - K.£324x15 - K.£399 p.a.

According to Table 18 above K.£ 147,228 is needed to employ persons in the designated established posts which are now vacant and which cannot be filled because of lack of funds. This amount of money which shows a "reduced" estimate of the total anount needed to employ enough skilled staff to operate and maintain water supply is an indication that the smooth operation and maintenance of water supply is seriously interfered with without the services which should be rendered by this lacking number of staff (a total of 290) as indicated by this sample analysed here.

Financing Water Supply Administration, Operation and Maintenance

Mr. Farrant, whose work in the Ministry of Water Development is concerned with operation and maintenance of water supply treatment facilities, has shown that there will be national cessation of water supply service in Kenya

within 13 months from May 1976, if no action is taken to correct the present policy.[47] This prediction emanates from the long term objective, the development programme, the population served and the recurrent funding need.

There is a crisis in water supply in Kenya today because "the actual provisions fall below the desirable levels".[48] Farrant attributes this situation to absence of policy for water supply management appropriate to its unique nature of a commercial enterprise of producing and selling.[49] He adds that a change of policy is necessary and that that change of policy must be given practical effect.

The reason for the crisis in water supply according to the Water Department is the serious inadequacy of funds offered for administration, operation and maintenance of water supply facilities. A change in the recurrent funding policy for water supply is necessary in order to make water development drive possible.

The Kenya Treasury has provided an estimate of between some £ 250,000 to £ 300,000 for water supply administration, operation and maintenance for the financial year 1976-77. The Water Department estimates that this amount is about 20% short of the satisfactory amount.

It is to be noted here as observed by concerned personnel in Water Department in Nairobi that "a given level of water supply service requires adequate annual provision of labour -

skilled and semi-skilled, fuels, chemicals, transport, miscellaneous materials and equipment, supervision and administrative services".[50] Thus if a good service is required there must be a minimum funding level. Below this level proper services will be interferrd with. Each water supply development entails an additional running cost embracing more men, fuels, chemicals, etc. which in turn need adequate recurrent funding.

Where the Kenya government has contracted with foreign governments for obtaining aid for water development programmes, one of the conditions is that the Kenya government shall be solely responsible for the funds required for operation of such water development programmes.

From the point of view of the government, which provides water for public consumption, in order that the cost of provision of water may be economic, "the price of water is fixed at a level which produces an income sufficient to cover a predetermined portion of total cost, including development".[51] Ideally, the price should be governed "partly by the need for the lowest income groups to benefit from the supply",[52] and consequently the price may not be made too high.

The personnel in the Water Department observe that "restriction of water production by limitation of funding will reduce water revenue and will often actually increase net expenditure - which is surely the quantity which we should be most concerned to reduce".[53] It is further observed

that as more people are served, more of each of the several inputs, such as labour - skilled and semi-skilled, fuels, chemicals, transport, miscellaneous materials and equipment, and supervision and administrative services, is needed, and this would increase the actual expenditure, but it would also produce more income.

Experience in the Water Department shows that increases in personnel for water supply and related services can be made possible only by increases in fund estimates made for personnel outside the established posts in the Ministry of Water Development, as the personnel in this portion constitute 60 per cent of the total. The provision of these fund estimates for the personnel outside the established posts is necessary for the water works to be run effectively.

The Effect of Water Supply Development on Recurrent Expenditure Need

An attempt has been made to show approximately a statistical relationship between the capital value of water supply installations and the running expenses. It is possible to show this relationship in a situation where there are "a large number of supplies of the various kinds where the 'average' supply does not vary greatly.[54] (It is important to note that "there is no inherent relationship between the capital value of the installations and the running expenses because supplies vary widely".[55]

One method, used by A.E. Farrant, to show the relationship referred to above is the multiplication by a certain factor of the installation "asset value". "As the asset value grows over the years through development carried out and completed, so does the recurrent cost. From the Development Estimates year by year are thus derived the desirable operation funds. The factor selected 0.04 is a rounded figure based on the relationships between asset values and recurrent funds when the latter were relatively satisfactory".[56]

Farrant also observes that although there is no inherent relationship, a formula may be used to connect population-served with the recurrent fund need. A statistical formula in this respect may be shown when the number of supplies of the several types and sizes is large enough as it is in Kenya. The method referred to here "was adopted by the W.H.O. Sectoral Study on Community Water Supplies in 1972 as a means of projecting recurrent finance needs up to the year 2,000. Population-served projections by year are made on the basis of development programme designed to reach the century-end target of water for everyone. These are multiplied by a per capita annual cost to give the required recurrent funding. The unit cost calculated by the Sectoral Study in 1972 was shs. 15/- but longer experience has indicated that this is a high figure and that one of shs. 15/- at that time, corresponding to shs. 9/- today is sufficient".[57]

"A third instrument is to derive as accurate figures as possible for actual fund issues plus those used to counter the shortages (in earlier years shortages were insignificant). Owing to lack of cost analysis it is impossible to be precise in this", ...nevertheless "approximate allocation of administration/supervision and personnel costs based on "weighing" of activity levels has therefore been used".[58]

Thus the above three methods have resulted in the following forecasts of population, installed water supply assets and recurrent water supply costs in Kenya (excluding the Coast Province) between the year 1970 to 2000[59] (see Table 19).

The Effect of Inflation

It is to be noted here that "since the escalation of oil prices commenced in late 1973, there have been accelerating decreases in the purchasing power of the currency relative to world water supply materials and equipment prices as well as corresponding increases in local salaries and material costs".[60] This inflationary trend shows that today there must be substantial increases in the funds required to operate and maintain a specific water supply. It is noted that for the future years it is assumed that there will be a constant overall rate of inflation of 10% per annum.

Table 19: Forecasts of Population, Installed Water Supply Assets, Recurrent Water Supply Costs (Excluding Coast) - 1970 - 2000

At 1976 Monetary Value

Year	Total Population (millions)	Population served by water department (millions)	Installed water supply Assets (£ millions)	Rough Number of Supplies	Estimated Recurrent Cost: Population X factor (£ millions)		Estimated Recurrent Cost: Assets X factor (£ millions)		Actual Allocation (£ millions)
1969-70	11.0	1.0	20	72	15/-	0.75	.04	0.79	0.78
1970-71	11.40	1.05	21.05	76		0.79		0.80	0.83
1971-72	11.80	1.15	22.75	92		0.86		0.86	0.91
1972-73	12.20	1.25	25.00	112		0.94		0.91	0.99
1973-74	12.65	1.40	26.90	132		1.05		1.00	0.94
1974-75	13.10	1.60	30.15	147		1.15		1.07	0.96
1975-76	13.55	1.80	34.75	185	14.00	1.26		1.20	1.04
1976-77	14.05	2.10	39.90	220		1.47		1.39	1.12
1977-78	14.55	2.50	46.30	255		1.75		1.60	-
1978-79	15.05	3.00	53.50	300		2.10		1.85	-
1979-80	15.60	3.60	63.50	360		2.50		2.14	-
1980-81	16.15	4.20	80.00	430	14.00	2.90	.038	2.42	-
1981-82	16.70	4.90	100.00	510		3.40		3.04	-
1982-83	17.30	5.70	120.00	600		4.00		3.80	-
1983-84	17.90	6.60	140.00	700		4.60		4.60	-
1984-85	18.50	7.50	160.00	800		5.30		5.30	-
1985-86	19.15	8.40	180.00	900		5.90	0.36	5.80	-
1986-87	19.80	9.30	200.00	1000		6.50		6.50	-
1987-88	20.45	10.20	220.00	1100		7.20		7.20	-
1988-89	21.15	11.10	240.00	1200		7.80		7.90	-
1989-90	21.85	12.00	260.00	1300		8.40		8.60	-
1990-91	22.55	12.90	280.00	1400		9.00		9.30	-
1991-92	23.30	13.80	300.00	1500		9.70		10.10	-
1992-93	24.05	14.70	320.00	1600		10.40		10.80	-
1993-94	24.80	15.60	340.00	1700		11.00		11.50	-
1994-95	25.55	16.50	360.00	1800		11.60		12.20	-
1995-96	26.35	17.40	380.00	1900		12.20		13.00	-
1996-97	27.15	18.30	400.00	2000		12.80		13.70	-
1997-98	27.95	19.20	420.00	2100		13.50		14.40	-
1998-99	28.80	20.10	440.00	2200		14.10		15.10	-
1999-2000	29.65	21.00	460.00	2300		14.70		15.80	-

Asset values of installations shown in Table 19 "are given in terms of present day cost of constructing all the existing installations, as they stand, without depreciation".[61] It is here, assumed that a supply is in good working order as it is being maintained day by day,

Population figures shown in Table 19 are reasonably reliable up to the year 1980, according to the Sectoral Study findings. The overall population increases in Kenya is taken as averaging about 3.5% per year and local variations are ignored because these are not known from year to year. Thus the figures for population served in any year are regarded as reasonable approximations guided by round figures produced by project investigations.[62]

Table 20 below shows "the rises since 1970 in prices of some typical materials and equipment, in electricity and in salaries".[63] From these rises in prices "a water supply cost inflation index has been derived which is used to refer all figures of development and current cost to a single currency value as at January 1976 representing the year 1975-76".[64]

Table 20: Inflationary Trend in Water Supply Operation and Maintenance

(1) Indices for Various Cost kinds by Years

	69-70	70-71	71-72	72-73	73-74	74-75	75-76	Percentage of whole
Labour (average)	100	100	112	112	130	130	152	30
Diesel	100	100	100	112.5	171	197.5	226	18
Electricity (tariff 3)	100	100	117	125	175	206	206	12
Chemicals	100	101.5	101.5	101.5	144	216	216	7
Meters	100	102	105	108	156	173	199	10
Piping (steel)	100	106	114	124	135	149	162	
Piping (P.V.C.)	100	100	122.5	160	234	234	234	
Engines	100	116	135	142	153	171	225	
Pumps	100	112	143	148	150	248	270	
Timber	100	116	121	121	141	165	183	
Cement	100	107	119	132	145	156	172	
Average	100	110	125	137	160	185	208	10
Miscellaneous purchase of uniforms etc.	100	100	130	130	130	150	180	10

(2) Computation of Average for Water Supply by Operation and Maintenance Change only

Labour x .3	-	-	3.6	3.6	9.0	9.0	15.6	
Diesel x .18	-	-	-	2.2	12.8	17.5	22.7	
Electricity x .12	-	-	2.0	3.0	9.0	12.7	12.7	
Chemicals x .07	-	0.1	-	-	3.1	8.1	8.1	
Meters x .10	-	0.2	0.5	0.8	5.6	7.3	9.9	
Equipment x .13	-	1.3	3.2	4.8	7.8	11.0	14.0	
Miscellaneous x .10	-	-	3.0	3.0	3.0	5.0	8.0	
Average	100	101.6	112.3	117.4	150.3	170.6	191.0	
Year	69-70	70-71	71-72	72-73	73-74	74-75	75-76	
Present value of currency	191	187	170	162	127	112	110	Computed
	190	185	170	160	130	112	100	Rounded

It should be noted from Table 20 above that when the overall cost of operation and maintenance of water supply is considered on the average, the following distribution shows the share that goes to each of the factors involved in operation and maintenance of water supply:

Labour	30 per cent
Diesel	18 per cent
Electricity	12 per cent
Chemicals	7 per cent
Meters	10 per cent
Equipment	13 per cent
Miscellaneous	10 per cent

Considering the inflationary trend noted above together with other factors pertaining to water supply assets, management, operation and maintenance, projections of development costs and consequently of funds needed for water supply services in Kenya, taking account of the present monetary values in Kenya pounds as per January 1, 1976, show the following from 1970 to 1980:[65] (see next page).

It should be noted that the actually provided management, operation and maintenance funds shown in Table 21 "are based on discussions with the Treasury", and it is observed that "unless there is a change in policy the increases appear only likely to cover inflation and hence unable to cater for any growth at all".[66]

Table 21: Water Supply Development Funds, Assets and Management, Operation and Maintenance Funds (Gross) 1970-80 in January 1, 1976 Monetary Values in Kenya Pounds

Year	Inflation Factor	Urban Development Funds	Rural Development Funds	Net Assets taken over	Total Assets (estimated)	1975 Assets x .04	Actually provided (inflation corrected) Management, Operation and Maintenance Funds			
							Urban	Rural	Management Estimated	Total
1969-70	1.90	200,000	200,000		20,000,000	790,000	620,000		160,000	780,000
1970-71	1.85	300,000	1,200,000	-	21,500,000	800,000	670,000	-	160,000	830,000
1971-72	1.70	130,000	1,120,000	-	22,750,000	860,000	580,000	160,000	170,000	910,000
1972-73	1.60	150,000	2,100,000	-	25,000,000	910,000	620,000	190,000	180,000	990,000
1973-74	1.30	200,000	1,500,000	200,000	26,900,000	1,000,000	550,000	190,000	200,000	940,000
1974-75	1.12	600,000	2,550,000	100,000	30,150,000	1,070,000	520,000	220,000	220,000	960,000
1975-76	1.0	1,200,000	3,400,000	80,000	34,750,000	1,200,000	530,000	270,000	240,000	1,040,000
1976-77	0.9	1,200,000	3,750,000	200,000	39,900,000	1,390,000	565,000	297,000	260,000	1,122,000
1977-78	0.8	1,400,000	4,800,000	200,000	46,300,000	1,600,000				
1978-79	0.72	1,500,000	5,500,000	200,000	53,500,000	1,850,000				
1979-80	0.64	1,800,000	6,000,000	200,000	63,500,000	2,140,000				

The development costs for rural and urban water supplies as shown in Table 21 above are based on the Sectoral Study predictions "but corrected for intervening inflation (X 1.7) plus project sophistication increase which has become standard since those times, say 20% average".[67] The original figure was £. 220 million, but when a factor of approximately 2.0 is applied to cover intervening inflation plus project sophistication increase we get £ 440 million (+£ 20 million baseline 1970) as the total investment (1976 values) for all Water Department areas in Kenya other than Coast.[68] Farrant, of the Water Department in Nairobi observes that the actual magnitude of the funds required for water development may be up or down 25% from the amount indicated above (£. 440 million + £. 20 million baseline 1970) without invalidating any of the arguments for the needed funds for development, especially for the years immediately ahead.

It should also be noted here that as the number of water supplies per unit area increases overheads and servicing of various kinds per unit installation will decrease. It is estimated that the amount of reduction in cost in this respect may be up to 10%, and this reduction has been incorporated in the long-term recurrent costings.

Sewerage and "Miscellaneous" Costs

Cost heads of sewerage and "miscellaneous" are at present minor. Sewerage and miscellaneous costs have thus far not yet experienced serious difficulties. "Sewerage in particular has yet to establish a firm pattern of growth and operation and maintenance responsibilities are yet to be clearly determined", according to A.E. Farrant of the Water Department, Nairobi.

However, as opposed to a few years ago, sewage works are now overloaded in urban areas because of too many people who now reside in Kenya's urban areas. Sewage treatment facilities in urban areas originally were not provided for as many people as now need these facilities.

Specific Problems Pertaining to Construction, Operation, and Maintenance of Water Supply and Sewage Treatment Facilities

As has been pointed out above, due to a rapid increase of population in urban areas, sewage works are now overloaded. It is also observed that the designs of sewage works are not very good to begin with, but that now sewage conditions are better designed than before. Observation and a recent study by the author pertaining to sewerage shows that water closet is suitable for large towns and pit latrines are recommended for smaller towns and rural areas. The author observed that in towns persons of different socio-economic class use different types of sewage or waste water facilities. A larger proportion of persons of a high socio-economic class vis a vis those of a lower socio-economic

class use water closet and a larger proportion of persons of a lower socio-economic level use pit latrines. A study of water usage in the towns of Mombasa, Kisumu, and Nyeri analysed in chapter 5 corroborates this observation of differing usage of water facilities by persons of different socio-economic levels.

In rural areas water payment rates are subeconomic because they only cover the cost of operation and maintenance. Eventually these rates cannot cover the value of assets used in installing water treatment facilities, and other recurrent costs. Only in urban areas do we find economic water payment. This means that if treated water is provided to the entire population of Kenya by the year 2000, the majority of Kenyans who are poor and who live in rural areas (at present these account for 90% of the population) will be paying water at subeconomic rates.

Construction of Facilities for Water Supply and Sewage

In the initial stages of project preparation for water supply and sewage treatment facilities there is manpower shortage in Kenya for this type of work. Consequently, in these initial stages of project preparation the country resorts to expatriate advice and know how. But Kenya has the capacity to construct the facilities for water supply and sewage.

Financial Problem

Generally speaking, there is inadequacy of manpower in both water supply and sewage works. At some stage of water development in Kenya there may be financial problem as the foregoing analysis pertaining to shortage of manpower due to lack of funds has shown (see Table 17). The cost of water supply compared with the capacity to finance them is too great in Kenya today as personnel in the Water Department observe. The bigger the per capita consumption the more money is required to run the water supply and sewerage.

Operation and maintenance of water supply and sewerage cost a lot of money. The money for operation and maintenance comes from Kenya, not from outside donors.

The cost of construction of water and sewage treatment facilities is met by Kenya and also by loans and grants from external bilateral and international organisations. The proportion contributed by both varies with different cases.

Another aspect of the financial problem facing the Ministry of Water Development is that concerning recruitment and retention of staff for the work pertaining to water supply and sewage operation, maintenance and administration. Government salary scales are not attractive enough to recruit and retain staff in the higher as well as in the lower echelons.

It should be noted here that since 1970 when a definite plan for water development was launched, until 1973 the funding for water development approximately coincided with the computed needs.[69] The computed needs were approximately met until 1975. But the beginning of 1976 saw deficiency problems which have embraced major laying off of labour, re-allocation and recharging of recurrent costs to suitable development needs (e.g. Minor Augmentations).[70] This trend is continuing unless adequate revenue is allocated for administration, operation, maintenance, and construction of water supply and sewage works.

Revenue

Farrant in his paper on Water Supply Administration, Operation and Maintenance has advised the Kenya government that by increasing revenue (reasonably) the recurrent cost is decreased. This must be done if the present water development plan envisaged by the government from now until the year 2000 is to be carried out to completion. If this is not done, then the development programme must be adjusted to suit the recurrent fund allocation decisions, and if this adjustment is made then it means that the government's desire to provide piped water to everybody in Kenya by the year 2000 must be abandoned.

Repayment of Loans.

Any loans that the Kenya government has received from external bilateral and international organisations

beginning 1970 for water development should be repaid from the beginning of the year 1980. Thus ten year period of grace has been given. Beginning 1980 repayment of loans and interest charges will have to be met within a period of 25 years. The calculations which embrace a 25 year repayment period and soft-loan terms of 2½ per cent have been used and shown in Chart 1 in this report.[71] The calculations show that the interest charges would reach "an annual level of £ 20 million at the year 2000 if the development costs suggested in the 10 year period prove realistic".[72]

Expenditures

The following is the total expenditure on water development and related services by the Central government and other public authorities since 1971 to 1976.[73] These expenditures include the Coast Province of Kenya hitherto not included as in Tables 19 and 20 above:

Table 22: Central Government and Other Public Authority Development Expenditures on Water Supplies and Related Services 1971/72-1975/76

	1971/72	1972/73	1973/74	1974/75	1975/76
Ministry of Water Development	£1,402,000	£2,375,000	£2,912,000	£4,579,000	£8,759,000
Mombasa Pipeline Board	£ 123,000	£ 264,000	£ 333,000	£ 474,000	£ 840,000
Other Ministries	£ 102,000	£ 89,000	£ 191,000	£ 155,000	£ 123,000
Local Authorities	£1,652,000	£2,086,000	£2,482,000	£1,831,000	£2,188,000
Total	£3,279,000	£4,814,000	£5,918,000	£7,039,000	£11,910,000

The above figures show a substantial increase in public expenditures on water development from K.£ 7.9 million in 1974/75 to K.£ 11.9 million in 1975/76. This increase shows the government's determination to provide water for the whole nation as soon as possible. "Of the 183 water schemes under the control of Ministry of Water Development, 80 are located in rural areas and this number is expected to increase in future years".[74] (see next page for Table 23).

The figures in Table 23 show that the total outlay of development expenditure undertaken by the Ministry of Water Development rose by 91.3 per cent from K.£ 4.58 million in 1974/75 to K.£ 8.76 million in 1975/76.[75]

Almost 50 per cent of the Ministry of Water Development's expenditure is earmarked for specific provision of water supply in the rural areas.[76]

Table 24 is the provincial distribution of rural water supply projects being undertaken by the Ministry of Water Development.[77] (see page).

Table 23: Development Expenditures for Water Supplies and Relates Services by the Ministry of Water Development, 1971/72-1975/76 (in Kenya £)

	1971/72 K.£	1972/73 K.£	1973/74 K.£	1974/75 K.£	1975/76 K.£
Urban Water Supplies	208,000	180,000	45,000	452,000	1,495,000
Rural Water Supplies	654,000	1,292,000	1,141,000	2,300,000	4,192,000
Water Resources Surveys	11,000	80,000	138,000	267,000	578,000
Lake Victoria Hydro-meteorological Survey	46,000	50,000	52,000	57,000	342,000
Dam and Borehole Subsidies	8,000	8,000	105,000	174,000	290,000
Livestock Development Project Range Water	392,000	282,000	450,000	779,000	976,000
Miscellaneous Programmes	83,000	483,000	981,000	550,000	886,000
Total	1,402,000	2,375,000	2,912,000	4,579,000	8,759,000

Table 24:

Rural Water Supply Project Schemes Operational or Expected to be Operational at June 1974, 1975 and 1976

Province	June 1974		June 1975		June 1976	
	No.	Cost K.£	No.	Cost K.£	No.	Cost K.£
Central	5	606,000	7	998,000	8	1,080,000
Coast	8	202,000	11	345,000	10	381,000
Eastern	12	203,000	12	203,000	16	532,000
North Eastern	7	37,000	11	84,000	10	136,000
Nyanza	7	292,000	12	605,000	12	605,000
Rift Valley	21	245,000	26	363,000	31	674,000
Western	3	115,000	5	339,000	6	575,000
Total	63	1,700,000	84	2,937,000	93	3,983,000

The figures in Table 24 above show that the number of rural schemes completed or currently nearing completion under various programmes increased from 63 in 1974 to 93 in 1976. It is expected that rates of increase for the number and value of projects as indicated here are likely to continue in the years to come.

In the rural areas the government is encouraging water supply schemes to be developed by community self-help efforts. "The value of self-help water schemes initiated since 1971 and the proportion of the costs of such schemes contributed by local participants were as follows:[78]

Year	Value of Schemes	Proportion from Beneficiaries
1971	K.£ 233,000	64.4 per cent
1972	K.£ 205,000	79.5 per cent
1973	K.£ 260,000	81.2 per cent
1974	K.£ 226,000	83.6 per cent
1975	K.£ 229,000	82.1 per cent

The above figures which show the contributions of the beneficiaries in rural areas to their self-help water supplies show very high proportions as compared with what the government contributed in each of the respective years shown above. As was pointed our in Chapter 1, this joint undertaking by the government and the people themselves reduces government expenditure a great deal in an affort to provide the populace with water supply in the rural areas.

Development Expenditures for Water Supplies and Related Services by the Ministry of Water Development Compared with Revenue Received from Sale of Water and Sewerage and Refuse Removal Charges by Municipalities in Kenya

Perhaps a comparison of development expenditures for water supplies and related services and the revenue received from people who utilize such services by paying for them may show whether Kenya's urban population which uses water and sewage is able to repay for the services rendered it by the Water Department. This comparison is shown below for the years 1971 to 1975:[79]

Year	Revenue from Sale of Water and Sewerage and Refuse Removal Charges in Urban Areas (Municipalities) K.£	Development Expenditures for Water Supplies and Related Services by the Ministry of Water Development K.£
1971	2,804,000	208,000
1972	3,351,000	180,000
1973	3,219,000	45,000
1974	3,816,000	452,000
1975	4,792,000	1,495,000

The above comparative figures have not taken into account the pecularities and differing conditions of different urban areas in Kenya. Also it should be noted that the development expenditures shown above may not have included certain expenditures concerning salaries and wages and other important incidental items in operation and maintenance of water supplies and sewerage. Nevertheless, it can be observed from the above figures that urban areas are in a good position to repay for the services rendered to their populations by water supply and sewerage works. Conversely, the rural populations at this time cannot meet the recurrent expenditures that go into their water supplies because their incomes are not high enough.

Lack of Trained Skilled and Technical Workers

As pointed out earlier in this report, Kenya lacks trained skilled and technical workers in many fields such as automotive, mechanical, electrical and building trades to mention a few outstanding examples. It has also been pointed out that the Kenya government and a number of private firms have instituted formal in-service training programmes which cater for people who want to undergo some type of technical or craft training. The number of persons who enter such type of training depends upon minimum entrance qualifications, the number of places available in training institutions, and the prospects for employment which are usually dictated by the salary scales offered by private firms.

There are about 6 government training institutions and about 9 training institutions (or employers) belonging to private firms which offer formal in-service training programmes for craftsmen and technicians in the fields of electrical, mechanical, civil engineering, automotive, and other trades (see the list of training institutions under the title "Formal In-service Training Programmes for Employees" in this report).

Lack of trained skilled and technical workers may be accounted for by the fact that the Directorate of Industrial Training (a Kenya government body) and the employers, be they the government or the private sector (firms and industries) regulate and control how many persons may be

trained at a time and for what trade.

"The Directorate of Industrial Training has stated that the apprenticeship scheme has priority over other forms of training at present".[80] There is also educational requirement for entry to training: the entry requirement for a three year craft apprenticeship "is completion of secondary academic school Form IV and the East African Certificate of Education (technical), and "for the technician apprenticeship scheme the entry requirement is completion of secondary academic school Form IV and the East African certificate of Education with credits in English, Mathematics and a suitable science subject".[81]

The procedure for recruitment is as follows: "the employers tell the Directorate of Industrial Training the number of apprentices and trades that they would like to recruit and the Directorate sends the appropriate number of candidates along for interview".[82]

Wage-scales for craft apprentices grade 1 differ between industries but are standardised for all firms within an industry, irrespective of size. But all wage-scales for craft apprentices are laid down relative to those for grade 1 craftsmen.[83] Firms which want to train their employees must reach a certain standard of facilities as a condition for their training to be recognised by the government and thus qualify for a grant under the Act.

There is a standardised procedure for testing, based on proficiency tests and City and Guilds examinations.

It is to be noted here that in accordance with the apprenticeship scheme described above the smaller firms lack interest in the apprenticeship scheme because, as summarised by Godfrey:

> "in many cases their facilities do not reach the required standard, the scale of wages for apprentices is often much higher than they can afford to pay..... (the effect on the internal wage structure and industrial relations of a small firm of taking on a young school-leaver who is known by the older "unqualified" craftsmen to be getting considerably more than they can well be imagined). And, after the apprentice has completed his training the full cost of his wage, now equivalent to that of a grade 1 craftsman, falls on the employer. Secondary school leavers do not want to work for smaller firms".

King (1975, p. 90)[84] points out that the secondary technical schools are rapidly academicing themselves and 'have for the first time in their rather chequered history captured some of the best qualified candidates from the quarter of a million odd primary school leavers".[85]

King suggests that such a group "will be unwilling to settle for the role of 'skilled journeyman' and will tend to 'gravitate towards that minority of institutions that recognise formal qualifications and offer avenues of upward mobility'.[86] Godfrey also observes that it seems as if different types of skills are appropriate to larger capital-intensive and to smaller labour intensive firms,

implying a need for different modes of training. "Thus the sort of training offered to apprentices at the industrial training centres is not seen as relevant by small firms, where, solutions to a wide range of technical problems have to be improvised with few resources".[87]

It is also to be noted that the larger firms also are not happy with the centralised method of recruitment. They would welcome more flexibility. For example, although they are happier with the apprenticeship scheme, some of them find the ambitions for upward mobility of secondary-school leavers a problem,despite the fact that others among them at the same time see the advantage of having a more educated higher paid, skilled workforce. Those large firms which are unnappy with upward mobility of secondary school leavers argue that less educated workers have no difficulty in acquiring the necessary skills and so they see no reason why they should be forced to recruit direct from secondary technical schools.

Thus, the conditions described above have accounted for only private firms employing more than 1,000 people and government, parastatal and East African Community (government body), in the final analysis, employing skilled persons and technicians, using the apprenticeship scheme whereas the smaller indigenous and Asian owned firms in Kenya have employed a negligible number. The following table 25 illustrates this phenomenon clearly:[88]

Table 25: 1975 Directorate of Industrial Training Apprentices Recruitment

Trade and Type of Employer

	Private firms employing more than 1.000		Government parastatal and East African Community		Other		Total	
	No.	%	No	%	No.	%	No.	%
Automotive Trades	54	78	11	16	4	6	69	100
Mechanical Trades	55	44	16	13	54	43	125	100
Electrical Trades	27	45	27	45	6	10	60	100
Building Trades	1	2	35	65	18	33	54	100
Total	137	44	89	29	82	27	308	100

Note that in Table above the "Other" category consisted of large and medium-sized international companies, with a negligible representation of the smaller indigenous and Asian owned firms.[89] Private firms employing more than 1,000 persons in the context of Kenyan industry are considered to be giants.

It is to be noted here that due to economic recession in Kenya (which is worsening) and other factors which have been discussed above, there was a significant drop in recruitment of apprentices during 1975 which manifested itself in a severe problem of unemployment of secondary technical school leavers.[90] "A survey carried out by the Ministry of Education and published in August 1975 found that even after the Directorate intake of craft apprentices had been completed, over 58 per cent of the December 1974 leavers were still 'looking for work'". The following table 26 gives the full picture of their status at this time":[91]

Table 26: Technical Secondary School Graduate Status After Directorate of Industrial Training Intake

	Student	Working and Going to School	Military	Employed or Self-employed	Looking for Work	Other	Total
Mechanical	8	39	2	10	39	2	100
Electrical	15	18	-	2	63	2	100
Motor Vehicle	-	38	4	9	48	2	100
Building	-	22	-	2	74	2	100
Total	4	28	2	6	58	2	100

This recruitment and unemployment status such as the one illustrated here affects different kinds of social and economic development in Kenya because it affects the availability of manpower in the government and private firms alike. For example, skilled workers and technicians capable of operating, maintaining, and constructing water supply and sewage treatment facilities are lacking.

It should be pointed out here that in the future "most formal training will be young sponsored students already in employment". This means that access to such training will be closed "to several neglected groups, particularly older workers, the unemployed and those with insufficient educational qualifications for entry to the scheme".[92]

To summarize this section on 'lack of skilled and technical workers with a view to recommending ways and means of encouraging formal in-service training for more skilled and technical workers for recruitment in the various fields for social and economic development, the following procedure should be followed. (Note that this summary is adopted from Godfrey's work, op.cit., p. 27-28):[93]

1. It is recommended that a more decentralised apprentice recruitment procedure should be followed, and the Directorate of Industrial Training centralised recruitment facilities should be available to those firms who wish to use them.

2. The minimum entry standards for a three-year craft apprenticeship should be reduced to Certificate of Primary Education (Standard VII), although the normal entry standard might remain East African Certificate of Education (Form IV Technical).

3. Smaller firms with inadequate facilities should be encouraged to seek attachment of their apprentices to larger firms.

4. A review of wage-scales for apprentices should be undertaken, considering in particular the question of the uniform wage-scale within an industry regardless of size of firm.

5. Skill improvement courses should be reviewed with Table 27 below serving as a tentative check-list of priorities and should be available to others than merely the sponsored employees of firms covered by the levy schemes. The Directorate of Industrial Training should respond to training committee initiatives on this but should also consider the use of government funds to subsidise a wider range of "open" skill improvement courses.

6. Public funds should be used to subsidise wages of learners in firms too small to be covered by the levy-grant scheme.

7. The above recommendations imply a crucial role for the new curriculum development and technical support section of the Directorate of Industrial Training, particularly in developing skill profiles and training syllabi and in planning in terms of long-term projections but of continuously monitoring the changing training needs of the national economy.

During 1975, the in-service training survey carried out in Kenya wanted to know the training requirements for existing staff in the firms covered by the survey. The following Table 27 gives "some idea of where the priorities for skill improvement might be seen to lie by different types of firms".[94]

Table 27: Training Requirements Reported in In-service Training Survey

(Number of workers requiring training as % of total employed in each occupational category)

	Large Firms	Levied firms	Non-levied firms
Production/supervisors/ foremen	43	4	2
Blacksmiths	–	6	–
Machine-tool setter operators	–	13	–
Machine tool operators etc.	–	33	100
Machinery fitters/ assemblers	–	31	100
Motor vehicle mechanics	62	82	–
Aircraft engine mechanics	–	–	100
Mechanics/repairmen	60	–	4
Autoelectricians	9	10	100
Plumbers and pipefitters	51	–	100
Welders and flamecutters	–	16	–
Sheetmetal and structural metal workers	4	53	–
Compositors and typesetters	–	35	–
Pressmen	–	16	–
Painters	–	43	80
Stonemasons and bricklayers	–	4	–
Carpenters and joiners	–	12	100
Metal platers and coaters	–	50	–
Wood processing workers	–	–	100
Knitters	–	–	100
All skilled manual and supervisory workers	15	23	10

The above Table 27 may be interpreted by giving a few examples: "Large firms (employing more than 1,000) felt that 15 per cent of their skilled manual and supervisory workers required further training, levied firms 23 per cent and non-levied firms 10 per cent".[95] In the case of plumbers and pipefitters large firms saw the need for training 31 per cent of their plumbers and pipefitters, the levied firms saw no need of training further any of their plumbers and pipefitters, and the non-levied firms felt that all of their plumbers and pipefitters needed further training.

Average Distribution of Labour Force in Kenya

Kenya official statistics assume that "the labour force is made up of 95 per cent of the population of males and 45 per cent of the females between the ages of 15-59".[96] In 1969 the total labourforce in Kenya was approximately 3.5 million. It is estimated that in 1975 the total labour force was 5,010,000 (5 million).[97]

If labour force is defined in terms of wage employment (note that wage employment is not the only component of labour force) then the following was the distribution of labour force in Kenya during 1973 and 1974:[98]

Year	Unskilled Labourers in wage Employment	Total Labour Force	% of Unskilled over total Labour Force	Semi-skilled Workers in Wage Employment	% of Semi-skilled over total labour force	Skilled Workers	% of Skilled over total Labour Force	Professional	% of Professional over Total Labour Force
1973	259,868	5,010,000	5.17	96,153	1.92	106,546	2.13	9,095	0.18
1974	321,152	5,010,000	6.41	90,144	1.80	74,144	1.08	8,597	0.17

The annual rate of growth of the labour force between 1970-1975 is 2.85 per cent.[99] Note that there are other persons in the labour force who are not included in wage employment and who therefore are not included in the above calculations and categories (for example self-employed persons).

Among the highly skillful and technical workers such as engineers, chemists, and others, according to Manpower Survey carried out in 1972 there were 74,261 Kenya citizens as compared with 25,560 non-citizens. Therefore the percentage of non-local highly skillful and technical workers over the total was 25.5, according to the author's calculation from these figures.[100]

Unemployment

In 1975 there were 6.4 million people in Kenya who were economically active. Of this number only 937,700 or 15 per cent were engaged or employed in the modern sector of the economy and some 247,000 persons were receiving secondary or higher education. The remainder, that is, over 80 per cent of this economically active population "were either in rural areas engaged mainly in small holding agriculture and other informal preoccupations, or in the urban areas seeking gainful employment".[101] This is the portion of the labour force in Kenya which may be said to be unemployed, although the precise proportion of the total labour force unemployed is not known.

"Wage employment in the formal sector is not at present a large proportion of the total labour force" as the following analysis shows.[102]

Persons Engaged: Recorded Totals, 1972-1975

	1972	1973	1974	1975
Modern Establishments - Urban and Rural Areas - Wage Employees	719,800	761,400	826,300	809,400
Self employed and Unpaid family workers	50,000	54,000	55,900	54,200
Informal Establishments - Urban areas	33,900	41,400	76,200	74,100
Total	803,700	856,300	958,400	937,700

It is important to note that the percentage of Kenya's total labour force over the whole population as it is today (1976) is approximately 37.4 It is assumed that Kenya's total labour force is 5,010,000 and the total population is 13,413,000.

Public Versus Private Sector in Wage Employment

When we compare public or the government and the private sectors as employers, present statistics show that the private sector is the bigger employer as the following analysis shows:[103]

Wage Employment by Major Sector. 1972 - 1975

Private Sector	1972	1973	1974	1975	Annual Percentage Change 1973/1974	1974/75
Agriculture and Forestry	197,900	220,600	213,700	195,300	-3.1	-8.6
Rest of Private Sector	234,900	241,800	282,500	273,400	16.8	-3.2
Total Private Sector	432,800	462,400	496,200	468,700	7.3	-5.5
Public Sector	287,000	298,900	330,100	340,600	10.4	3.2
Total	719,800	761,300	826,300	809,300	8.5	-2.0

The above analysis shows that since 1972 up to 1975 the private sector has been the bigger employer. Thus the government does not dominate the labour market. Public employment services are readily available but they are not fully developed to serve the public efficiently. The services are nevertheless being improved by assistance from the Swedish government.

Annual Average Income per Family in Kenya

The following was the distribution of income according to wages earned per month and the total number of persons who earned a certain equal amount of money per month in 1974:[104]

Wage per month (shs.)	Total Number of Persons
Under 100	47,069
100 - 149	102,631
150 - 199	66,741
200 - 399	179,790
400 - 599	121,929
600 - 799	59,869
800 - 999	38,731
1000 -1499	36,167
1500 -1999	19,150
2000 -2999	15,177
3000 and over	14,297

(Note that casual employees were excluded from the above abalysis)

Calculations from the above figures show that the approximate annual average income per family is K.£ 300 (shillings 6,000).

Average wage earnings per employee in Kenya during 1972, 1973, 1974 and 1975 were K.£ 287.3, K.£ 303.7, K.£ 332 and K.£ 384.2 respectively. Taking the most recent figure the average wage earnings per family in Kenya is K.£ 384.2.[105]

Similarly the estimated real average wage earnings per employee in Kenya in 1972, 1973, 1974 and 1975 were K.£ 279.5, K.£ 271.2, K.£ 255.0 and K.£ 247.6. It can be said that the annual average income per family in Kenya is between K.£ 247.6 and K.£ 384.2.[106]

The Role of Family Planning Programme in Kenya

Any water development plan aimed at supplying future population must consider the rate of population growth in order to give accurate projections of water demand. Kenya's population at present is growing at the rate of 3.5 per cent per year. It is noted that if this rate of population growth is not checked, Kenya will have a population of about 34 million by the year 2000. Kenya hopes to provide piped water supply to everybody by the year 2000. The work of construction, operation and maintenance of all water supplies and cost of sewerage will be too much if the whole population is supplied with water. The country may not be able to

provide the money for the recurrent costs of maintenance operation and administration of water supplies and sewerage. In the light of this observation it is necessary to find a way of curbing high birth rates in order to control a rapid increase of population so that the country can provide its population with adequate and necessary facilities for livelihood.

Kenya's five-year (1974-1978) family planning programme will cost K.shs. 271,600,000 (K.£ 13,580,000) and will reach 640,000 women and prevent 150,000 births by 1978.[107] If the number of births stated here are prevented, the 3.5 per cent per annum birth rate in Kenya will be reduced by the year 1978. Furthermore, the aim of family planning programme is to give opportunity for mothers to take care of their children well and thus reduce infant mortality rate. Mrs. F. Otete, the Deputy Director of the National Family Planning Welfare Centre has observed that family planning programme,

> "would also reduce the cost of schooling, reduce pressure on housing and water supplies thereby permitting improved standards of living". (108)

Family planning programme in Kenya is expanding. At present 400 service centres for mother and child health programmes are being established all over the country so that the programme may be more effective.

Footnotes to Chapter Four

1. Simeon Ominde, The Population of Kenya, Tanzania and Uganda, Heineman, Nairobi, 1975, p. 94. This percentage is based on figures of annual rate of growth of the ten towns cited in this book.

2. Ibid., p. 36-37.

3. Adopted and modified from Simeon Ominde, op.cit. p. 38.

4. Ibid., p. 30.

5. Ibid., p. 37.

6. Ibid., p. 50, and Central Bureau of Statistics, Ministry of Finance and Planning, Kenya Statistical Digest, March 1976, Vol. XIV-No 1, p. 5. A total population of 11,000,000 million is used for calculating percentages for the years 1968-1974 and 13,000,000 for the year 1975.

7. K. Diem and C. Lentner (ed.), Scientific Tables, 7th edition, Ciba-Geigy Limited, Basle, Switzerland, p. 495.

8. Jacques M. May, M.D. The Ecology of Malnutrition in Eastern Africa and Four Countries of Western Africa - Studies in Medical Geography, Vol. IX, p. 341. Also in M. Bohdal, et.al. Nutrition Survey and Campaign Against Malnutrition in Kenya, 1964-1968.

9. Simeon Ominde, op.cit., p. 111.

10. Ibid., p. 111.

11. Ibid., p. 111.

12. Ibid., p. 113. *Not indicated in the same Table.

13. Ibid., p. 112. Only a portion of the Table is cited here.

14. The analysis is done by the author using the following references:

    Republic of Kenya, Economic Survey, 1976, pp.155-56, 158.
    Republic of Kenya, Statistical Abstract, 1975, pp. 16, 190, 194, 195.
    Simeon Ominde, op.cit., p. 112.

15. Republic of Kenya, Economic Survey, 1976, pp. 155-56.

16. Republic of Kenya, Economic Survey, 1976, p. 152.

17. Communication by E.A. Wangai, Senior Education Officer (Technical Education), Ministry of Education, Nairobi.

18. Republic of Kenya, Economic Survey, 1976, p. 152.

19. Ibid., p. 158.

20. Republic of Kenya, Statistical Abstract, 1975, p. 194.

21. Ibid., p. 194.

22. Republic of Kenya, Economic Survey, 1976, p. 92.

23. Ibid., p. 92.

24. Republic of Kenya, Economic Survey, 1976, p. 92.

25. Ibid., p. 92.

26. F. Munge, Deputy Secretary, Directorate of Personnel, Kenya Government.

27. Communication by Mr. George I. Wafula, Assistant Director (Technical), Directorate of Industrial Training, Ministry of Labour, Kenya Government.

28. Ibid.

29. Martin Godfrey, "Towards a Long-term Plan for Industrial Training in Kenya", A Report prepared under the auspices of the United Nations Development Programme and International Labour Organisation. December 1975, p. 4. Some of the statistics included here can be found in Republic of Kenya, Statistical Abstract, 1975, pp. 244-45.

30. Ibid.. p. 3.

31. Ibid., p. 3.

32. Ibid., p. 6.

33. Ibid., p. 6.

34. Ibid., p. 6

35. Ibid., p. 6.

36. M.M. Ng'an'ga, Head of Department, Building and Civil Engineering, Kenya Polytechnic, Nairobi.

37. Martin Godfrey, op.cit., p.9.

38. Ibid., p. 10.

39. Ibid., p. 9.

40. Ibid., p. 8.

41. Ibid., p. 11.

42. Ibid., p. 11.

43. Ibid., p. 12.

44. Martin Godfrey, op.cit., p. 11.

45. Source: Water Department, Nairobi: the data is analysed by the author.

46. Mr. A.E. Farrant, Ministry of Water Development, Nairobi. A communication from Mr. Farrant, Head of Operation and Maintenance of Water Supply, Nairobi.

47. A.E. Farrant, Financing Water Administration, Operation and Maintenance, Preface (Summary of Argument).

48. Ibid., Preface

49. Ibid., Preface

50. Ibid., p. 2.

51. Ibid., p. 2.

52. Ibid., p. 3.

53. Ibid., p. 3.

54. Ibid., p. 4.

55. Ibid., p. 4

56. Ibid., p. 4

57. Ibid., p. 4.

58. Ibid., pp. 4-5

59. Ibid., p. 89.

60. Ibid., p. 5.

61. Ibid., p. 5.

62. Ibid., p. 6

63. Ibid., p. 5.

64. Ibid., p. 5. and Appendix 1.

65. Ibid., Appendix 3.

66. Ibid., p. 8.

67. Ibid., p. 6. The Sectoral Study was carried out in 1972.

68. Ibid., p. 7.

69. Ibid., p. 8.

70. Ibid., p. 8.

71. Ibid., Chart 1, (Appendix 1).

72. Ibid., p.7.

73. Republic of Kenya, Economic Survey, 1976, p. 98.

74. Ibid., p. 98.

75. Ibid., p. 98.

76. Ibid., p. 98.

77. Ibid., p. 99

78. Ibid., p. 100

79. Source: Table 23 in this report and Republic of Kenya, Economic Survey, 1976, p. 62. Note that details of the different urban areas are not analysed here.

80. Martin Godfrey, op.cit., p. 14.

81. Ibid., p. 14.

82. Ibid., p. 14.

83. Ibid., p. 14.

84. Not in the original quotation. The author has noted this from a footnote in Godfrey, op.cit., p. 15, who also quoted it from Kenneth King, The African Artisan, Centre of African Studies, University of Edinburgh, March, 1975.

85. Godfrey, op.cit., p. 15.

86. Ibid., p. 16.

87. Ibid., p. 16.

88. Ibid., p. 15. Source: Directorate of Industrial Training.

89. Ibid., p. 15.

90. Ibid., p. 17.

91. Ibid., p. 17. Source: Technical Education Section, Ministry of Education (1975).

92. Ibid., p. 18.

93. Ibid., p. 27-28.

94. Ibid., p. 21.

95. Ibid., p. 23.

96. Simeon Ominde, op.cit., p. 102

97. Ibid., p. 103. This was an estimate by the IL

98. The figures from which the percentages have been calculated by the author are found in Republic of Kenya, Statistical Abstract, 1975, p. 241, and Simeon Ominde, op.cit., p. 103.

99. Simeon Ominde, op.cit. p. 103. This is an estimate by the International Labour Organisation in 1971.

100. Republic of Kenya, Statistical Abstract, 1975, p. 242-3.

101. Republic of Kenya, Economic Survey, 1976, p. 39.

102. Ibid., p. 39.

103. Ibid., p. 40.

104. Republic of Kenya, Statistical Abstract, 1975, p. 259.

105. Republic of Kenya, Economic Survey, 1976, p. 46.

106. Ibid., p. 47.

107. F. Otete, Deputy Director, National Family Planning Welfare Centre, Nairobi, East African Standard, 1975.

108. The East African Standard, 1975.

CHAPTER FIVE

ANALYSIS OF SELECTED WATER SUPPLY SITES

Chapter five is a continuation of the analysis of socio-economic data (see Appendix B) pertaining to actual sites where water supplies and sewage have been established. In other words, Chapter five is a continuation of chapter four with special emphasis on the characteristics of the selected water supply sites.

The Level of Technology Available in Kenya

Mechanical Equipment in Farms

Since Kenya is mainly an agricultural country one would expect to find mechanical tools used in farming by the majority of farmers. Unfortunately this is not the case. Although 90 per cent of Kenya's population lives in rural areas where farming is the major economic activity, only the large farm holdings are mechanized. Such large farm holdings have some mechanical equipment. For example, in 1967 there were 812 crawler tractors, 5,420 wheel tractors, and 1,049 harvester threshers.[1] Subsistence farmers, by far still the majority in the country, still use hoes and other hand tools.

"The use of mechanical equipment decreased between 1963" (when Kenya became independent of British rule) "and 1966 presumably because of the purchase and redistribution of many formerly European-owned large farms under the Million

Acre Scheme".[2] By this Scheme formerly European-owned farms were to be bought by the government and eventually redistributed and bought by African farmers. Thus since 1963 "the equipment of these farms may have been sold elsewhere or may have merely fallen into disuse until the transfer of ownership and skills could be accomplished".[3]

Mechanical Tools (other than those used in farms)

In Kenya, apart from the mechanical tools found in large farms, mechanical tools are mainly concentrated in large towns such as Nairobi, Mombasa, Kisumu, Nakuru and in formerly European farming towns such as Eldoret. In these large towns mechanical tools are mainly found in institutional places such as Polytechnics, the University and large firms and industries where they are either used for teaching and demonstration, or for the manufacture and processing of goods. In such large towns the portion of population utilising these mechanical tools which are gasoline, diesel, or electrically powered is very small compared with the whole population of any such town. Mechanical tools are rarely found in the rural areas.

Electronic Technology

Electronic technology is developed only in the two largest towns of Nairobi and Mombasa in the main. Other large towns in Kenya have very little electronic technology, if any.

Chemical Products

Chemical products used for water supply and sewage treatment facilities are nearly all imported from foreign countries abroad. For example, Chlorine is imported from Britain and Aluminium Sulphate from India. But Soda Ash is obtained locally from Lake Magadi. Once the chemicals are imported from abroad they are available in the local communities which need them. But there are variations in the local communities where water supplies are established since the chemical nature of water dictates what type of chemicals are needed. Sometimes water supply and sewerage works are delayed because of delay in obtaining ordered chemicals from abroad.

KISUMU TOWN
WATER SUPPLY AND SEWAGE TREATMENT WORKS

WATER SUPPLY

Sources of Water Supply

Kisumu town gets its water supply from Lake Victoria. The new extensions of the water supply will receive their water from Kibos river. There is also underground water, that is, "there are a number of boreholes in the area utilised by industrial and public institutions, but the yields are very small, the maximum being 2.4 litres per second (2000 gallons per hour)".[4]

At present approximate average per capita daily water demand for Kisumu Town as well as for the rest of

Kenya is 20 gallons (90 litres). Ten year projection shows that the average per capita daily demand will be 45 gallons (202.5 litres). These are maximum figures, and as such lower per capita daily water demands are possible depending on economic conditions of individuals wherever they may be.

The total individual water connections in Kisumu Municipality is between 50,000 and 70,000 persons. This accounts for between 50-75 per cent.

Kisumu Municipality plus the peri-urban areas which are to be served by water supply has a total population of approximately between 72,400-91,600 according to 1976 estimates.[5] The current daily water demand for Kisumu town and its peri-urban areas is between 2,300,000-3,034,800 gallons. Ten years from now (1986) the approximate daily demand will most likely be at the maximum figure which is 3,034,800 gallons.

Sewerage

During 1974 an average of 519,500 gallons of raw sewage was treated at the Sewage Disposal Works in the Kisumu Municipality.[6] Kisumu Town has a central wastewater collection system. At present the total private properties connected to sewer is 1,214, and apart from these many properties are still on septic tanks and the bucket system, and pit latrines which are emptied by night collection. It

is difficult to say what quantity of wastewater is used by industrial and commercial concerns as compared with individual private persons in Kisumu Town. But more than half of the area contained within the 1971 boundary of Kisumu Town is served by water borne sanitation. This area includes industrial and commercial concerns.

The sewage treatment works has recently been extended to treat a dry weather flow (D.W.F.) of 6,800 m^3 per day (1.5 million gallons per day).[7] "Records made by an automatic recorder at the inlet to the treatment works indicate that dry weather flow (D.W.F.) at present is of the order of 2,960 m^3 per day (650,000 gallons per day), less than half of the design capacity".[8]

It is difficult to predict how many people will be connected to the wastewater system in Kisumu Town 5 or 10 years from now, but indications are that there will be many more people connneted than there are at present. At present the percentage of people connected to wastewater system is 2.6 of the total Municipal population (1976 figures). Sewage treatment is available for between 50-75 per cent of Kisumu Municipality's population.

<u>Projections of Water Demand in the Kisumu Municipality Calculated at the Rate of 45 Gallons (203 litres) per Capita per Day</u>

The sources for the Kisumu Town water supply have been stated. Here it should also be noted that since 1966 up to 1974 Kisumu Town and its environs has been receiving an

annual mean (average) rainfall of 1306.3 millimetres. Kisumu also has since 1972-1974 a mean annual maximum temperature of 29.9 centigrade and a mean annual minimum temperature of 17.2° centigrade. Its mean annual relative humidity for the years 1971-1974 at 1500 hours is 45 per cent.[9] All these facts together with the total population that a water supply serves or is going to serve are necessary components for projections of the future needs in terms of quantity of water needed and the capacity of the water source to supply the needs.

Taking the above factors into consideration the Water Apportionment Board has specified the amount of water that should be made available to the Kisumu Municipality per day in order to meet the demand for consumption by various categories of consumers."Kisumu water is sold to consumers via individual meters or from metered kiosks and from the meter reading records it has been possible to obtain some indication of the pattern of consumption".[10]

From consumer meter readings it was found that domestic consumption accounted for 61% of the total, industrial consumption for 11%, and commercial and institutional (offices, clubs, shops, hotel, schools, etc.) the remaining 28%. The water sold at public kiosks accounted for only 2 per cent of the domestic consumption.

In accordance with the foregoing observations the Water Apportionment Board has specified that the Kisumu Municipality shall receive the following amount of water per day from the existing sources:

From Lake Victoria	5.000	Cusecs
From a tributary of the Kibos river	0.056	Cusecs
From the main Kibos river	0.56	Cusecs
Total	5.616	Cusecs

Thus the total maximum demand per day for Kisumu Municipality = (5.616 x 540,000) gallons (1 Cusec=540,000 gallons per day) = 3,034,800 gallons per day. This is the amount that Kisumu Municipality at the moment cannot exceed.

Projections for water demand per day for the Kisumu Municipality have been estimated from 1972 to 2000 on the basis of daily per capita consumption of 45 gallons (203 litres). The following Table 28 shows the estimated daily demands of water:[11] (see next page)

Table 28: Estimated Daily Demand of Water

Year	Population (within 1971 Municipal Boundary)	Demand at Million Gallons per Day (at the rate of 45 galls. per capita per day)		Population of Nyalenda and Manyatta Peri-urban Areas		
		Cubic Metres per day	Million Gallons per day	Population	Demand in million gallons per day	
					Cubic metres per day	Million Galls. Day
1972	38,100	7,800	1.72	25,200	800	0.18
1973	40,200	8,200	1.81	25,200	800	0.18
1974	42,400	8,700	1.91	25,200	800	0.18
1975	44,700	9,100	2.01	"	"	"
1976	47,200	9,600	2.12	"	"	"
1977	49,800	10,200	2.24	"	"	"
1978	51,900	10,600	2.34	"	"	"
1979	51,900	"	"	"	"	"
1980	51,900	"	"	"	"	"
1981	"	"	"	"	"	"
1982	"	"	"	"	"	"
1983	"	"	"	"	"	"
1984	"	"	"	"	"	"
1985	"	"	"	"	"	"
1986	"	"	"	"	"	"
1987	"	"	"	"	"	"
1988	"	"	"	"	"	"
1989	"	"	"	"	"	"
1990	"	"	"	"	"	"
1991	"	"	"	"	"	"
1992	"	"	"	"	"	"
1993	"	"	"	"	"	"
1994	"	"	"	"	"	"
1995	"	"	"	"	"	"
1996	"	"	"	"	"	"
1997	"	"	"	"	"	"
1998	"	"	"	"	"	"
1999	"	"	"	"	"	"
2000	51,900	10,600	2.34	25,200	800	0.18

The annual water demands are shown in Table 28 above. These are annual demands based on the per capita daily demands of 45 gallons (203 litres) inside the old town or municipal boundary, and 31.5 gallons per day (142 litres per day) in the new development areas and 7 gallons per day (32 litres per day) in the Manyatta and Nyalenda periurban areas.

It is estimated that between 1972 and 1982 the population growth rate of Municipality of Kisumu will be 6.9 per cent per annum, and between 1982 and 2000 it will be 7.3 per cent.[12]

It should be noted that as the town grows and the population becomes larger so will there be a greater consumption of water. The town, as many others in Kenya, is becoming more and more attractive for the rural dwellers and as the amenities and living standards in the town increase more and more rural dwellers will gravitate toward the town and thus its population will increase.

Water Supply and Sewage Treatment Process (See Appendix C)

Water Supply

Treatment of raw water for drinking and other purposes depends on the source of water to be treated. From the point of view of sources of raw water there are three major categories: surface water, for example rivers, and lakes; sub-surface water, for example springs; and groundwater or boreholes for example dug out wells.

Treatment of Surface Water

Surface water is usually coloured and contains suspended matter and germs. Therefore, the process is full treatment which is conventional and which involves coagulation, sedimentation filtration and disinfection (use of chlorine). Sedimentation removes most of the sediments or suspended matter and germs. In filtration rapid sand filter is used to remove the rest of the solids and assist in the removal of germs. Then a disinfectant such as chlorine is added in sufficient amount so that there is residual chlorine in the tap to kill any remaining germs in the water before consumption. This treatment of water as described here briefly is the one used in the Kisumu Municipality water supply and Nyeri Town water supply.

Treatment of Sub-surface Water

Water from springs does not contain any foreign matter such as germs or suspended solids or organic matter. Consequently the treatment of such water is chlorination only to kill any possible germs present in the pipes that carry water or in any other container or reservoir in which water is stored. The Mombasa water supply (another water supply site to be analysed below) which comes from the Mzima Springs is treated as has been described here.

Treatment of Ground Water

Water from boreholes such as is used by people in Kiambu town may have dissolved salts such as fluorine, sulphate, sodium chloride and others. If these salt contents are high they must be dealt with by dilution with water from another borehole which does not have high salt content. This helps to neutralize the water with high salt content. Finally, chlorination is used to treat this water.

Sewage (Wastewater) Treatment

In Kenya it is now proposed that waste stabilization ponds be utilized for the treatment of sewage rather than conventional works with biological filters. Consequently, Kenya is now using waste stabilization ponds as a new type of sewage treatment process. This new type of sewage treatment is now being used in the following towns in Kenya: Kisumu (the new sewage treatment works but the old one is still using the conventional works with biological filters), Nakuru, Thika, Embu, Meru, Murang'a, Karatina, Nanyuki Gilgil, Athi River, and it is also planned for Eldoret.

The two methods are briefly described below:

The Conventional Biological Filtration Process

The conventional biological filtration process comprises screening and grit removal, primary sedimentation or settlement, biological filtration and final settlement of filter humus.

Screening and grit removal removes all sorts of solids. During sedimentation organic matter and solids are separated. Sedimentation removes humus or dead cell particles. In biological filtration organic material is converted into cell tissues and thus a medium for fungus culture is created. This causes aerobic process so that oxygen is available for the process. "The sludge produced is conditioned in cold digestion tanks and dried in sludge drying beds before disposal to the land. It is possible to recirculate filter effluent".[13] Purified water or final effluent is discharged into a river or any body of water that can absorb it. In the case of Kisumu town, which still uses this process in addition to the new waste stabilization ponds, the "effluent is discharged into the Kasat River which then flows through the golf course and into Lake Victoria".

It is noted here that this process in the case of Kisumu sewage treatment as indeed it is in the case of other towns in Kenya, requires constant supervision and chemical analysis of the effluents from various parts of the process. If the flows to be treated such as those expected by the year 2000 are big, then the control required and the difficulties to be overcome would be increased relative to the present works which is small. Hence the decision to use the alternative methods of treatment such as waste stabilization ponds discussed below.

Waste Stabilization Ponds

The advantage of waste stabilization ponds is that they are capable of treating any sewage which can be treated by conventional means. In Kenya, this method of sewage treatment is very suitable because there is plenty of sunshine which is required for this type of treatment.

The process of treatment is as follows: The first step is preliminary treatment which involves screening and grit removal. Sedimentation and biological treatment are combined in one lagoon. Sludge settles to the bottom of the lagoon where it is broken down by bacteria and in doing so they release carbon dioxide and other nutrients. The mechanism of treatment depends on the interactions of bacteria and algae. These lagoons are 1½ metres in depth. Where the sludge is at the bottom there is no oxygen. But in the upper layers there is oxygen which is produced by small green plants or algae. Thus in the upper layers of the lagoon there is aerobic treatment and at the bottom there is anaerobic treatment, both of which are combined in a single lagoon.

Anaerobic part of the treatment if done separately from the aerobic "induces a smell nuisance which would not be tolerated if the works were situated in close proximity of residential areas".[14] In the case of Kisumu town the sites are located at a reasonable distance from residential areas and as such it is considered that a combination of an

anaerobic and aerobic treatment would be suitable for Kisumu.

Waste stabilization ponds have advantages over other methods of sewage treatment for Kenya: they are cheaper and simple to construct; very little mechanical devices are used; they are easy to operate; the ponds are capable of retaining sewage for about 40 days; very little supervision is required, the ponds remove germs better; and they require no energy since they get natural energy from the sun; and also there is land available for this kind of treatment.

Due to the above advantages, waste stabilization ponds are now planned for all sewage treatment in Kenya. However, the following towns are still using the old method of treatment, namely the conventional biological filtration process: Nyeri, Nakuru, Eldoret, Molo, Kitale, Kericho, Thomsons Falls (Nyahururu), and Kariobangi and Eastleigh in Nairobi.

Operation of Water Supply and Sewage Treatment Plants (see Appendix E)[15]

Kisumu town has both water and sewage treatment plants. The processes of treatment used in these two types of plants have been described above.

Operators

Trained or skilled operators, according to the study of the problems of the site by the author, are difficult

to find. These types of operators have to be trained for at least two years after passing the East African Certificate of Education and School Certificate (Form IV). These trained operators have to pass water operators' examination after training in the field and in the classroom. As explained before, the operators have to pass a standardized trade examination as such a standard or system exists in Kenya. There are short courses and training programmes which last longer for water engineers. Such courses are conducted as the author explained in Chapter four by the various institutions and firms stated there.

Experience at the Kisumu Water Supply and Sewage Plants shows that operators leave their employment because of little pay and when they get better jobs elsewhere. They may also be discharged when they abscond their work.

The average age of operators in the Kisumu plants is between 20-30 years. Their quality is good, in other words they are good operators.

Chemicals

For the purposes of the operation and maintenance of water supplies and sewage treatment facilities, it is only soda ash which is obtained locally from Lake Magadi. Other necessary chemicals have to be ordered from out of Kenya. For example, chlorine is ordered from Britain and Alum from India. Chemicals are difficult to obtain locally in the Kisumu plants and there is some delay in obtaining ordered

chemicals from aborad.

Machinery Parts

At the Kisumu plants lack of spare parts is the main cause of machinery breakdown, and the replacement of machinery parts is routine. It is observed here that sometimes machinery parts are not available and have to be made or fabricated locally.

If machinery parts are ordered from abroad it takes more than one year for such parts to be delivered, and sometimes wrong parts are sent. Parts to be replaced are usually ordered specially and machinery is repaired locally.

Technical Operational Failure

The Kisumu Water and Sewage Plants have nuisance from floating islands which obstruct filter and cause difficulty in coagulation. Technical operational failure is due to pumps which burst in the distribution. No failure due to the designed process has been experienced.

Supervisory Control

There is regular active local inspection of the water supply and sewage treatment facilities at the Kisumu town plants. The laboratory is located at the plant.

Problems not Solved by Present Facility

The effluent has an odor from the sewage treatment plant. The water is coloured because the effluent is discharged from the textile industry.

The present facility experiences extreme difficulty in financing. The water supply has a capacity of 2.3 million gallons (10,400 m^3) per day (1976 figures). It is estimated that the demand in 1977 will be 3.25 million gallons per day (14,700 m^3 per day). Also it is estimated that by the year 2000 the water demand in Kisumu town may be in the region of 15.38 million gallons per day (69,800 m^3 per day).

The total annual operational cost of the water supply from 1972 to 1977 is K.£ 63,985.7 (K.shs. 1,279,714.30).[16] The estimated cost at present day prices, of the water works required between 1977 and the year 2000 is K.shs. 64,967,000".[17]. The estimated annual cost of sewerage work required from 1972 to 1977 is K.shs. 3,752,857.15 (K.£. 187,642.9).[18]

It is estimated that "to supply the individual properties with piped water supply and waterborne sanitation systems would be physically difficult and financially expensive. The cost being approximately shs. 290 and shs. 1000 per capita for water supply and sewerage respectively".[19]

From the above figures it can be calculated that the total annual costs per water supply and sewerage in Kisumu

town from 1972 to 1977 is K.£ 251,628.6 (K.shs. 5,032,571.45). Of this amount K.shs. 240,000 (K.£ 12,000) is the annual operational cost of water supply for personnel (payroll) and K.shs. 136,000 is the annual operational cost of sewerage for personnel (payroll).[20]

There are also administrative problems concerning lack of manpower in personnel and sewage plant operators. However, the population of Kisumu Municipality has some limited ability to repay for the costs of operation and maintenance of water supply. One might say that the social benefits exceed the social costs.

Technology

Level of Water Treatment Technology Development in Kisumu Town

Kisumu town is served both by central village or street pump, and piped water supply to houses. Approximately, between 0 -25 per cent of Kisumu's population is served by central village or street pump, and between 50-75 per cent of the town's population has piped water supply to houses.

Level of Sewage Treatment Technology Development in Kisumu Town

Kisumu town has sewage treatment and sewage collection system. The former serves between 50-75 per cent of Kisumu's population and the latter serves between 0-25 per cent of the town's population.

Technology advancement pertaining to water supply is simply transfer of a process that had been successful elsewhere. But the new sewage treatment process, namely waste stabilization pond or lagoon is a unique process developed and designed especially to suit local climatic conditions as the author has explained above in the case of sewage treatment process. The sewage treatment process is an important feature for the local people (Kisumu townsmen) but not significant to overall development of the country.

Facility Construction Cost

The Kisumu town water supply and sewage treatment facilities were built from 1948 to 1950 when the work was completed. Currently the population served by the facility is about 80,000-120,000. When the facility was first built it cost a total amount of K.£ 41,474 (K.shs. 829,480) and it served a population of 10,899.[21] Since then extensions to the Kisumu water supply and sewage works have been done. Most recent extension work started early in 1975.

Extensions pertaining to water supply facilities will cost K.£ 700,000 (K.shs. 14,000,000),[22] and those for sewage will cost K.£ 274,620.2 (K.shs. 5,492,404.50).[23] For sewage the cost stated here is for the work done from January 1975 to August 1976.

The extension for water supply is designed to treat at least 1.25 million gallons a day.

Sewage Treatment Facility Construction Cost

The total cost for sewage works extensions is K.shs. 5,492,404.50. Of this amount K.shs. 800,000.00 was spent for labour. Percentage of total cost for labour, therefore was 14.5, and that for material was 27.3 (K.shs. 1,500,000).[24] Of the total cost spent for material only 1.4 per cent (K. shs. 75,000) was imported from outside Kenya. The rest of the material, amounting to a total cost of K.shs. 1,425,000 (98.6 per cent) was found in Kenya.

A total of K.shs. 400,000 was spent for skilled labour. This was an equivalent of 13.65 per cent of the total amount spent for labour. The other 13.65 per cent was spent for unskilled labour.

The approximate daily wage for unskilled labour in Kenya is K.shs. 11.20, and that for skilled labour is K.shs. 32.00 per day.

Unfortunately, the percentage figure of total cost for engineering fee, pertaining to construction of sewage treatment facilities for Kisumu town extension work is not available.

Water Supply Treatment Facility Construction Cost

The cost analysis of Kisumu town water supply extensions carried out in two phases during December 1969-June 1970 and June 1970-August 1971 show the following construction costs for various items:[25]

December 1969-June 1970: Items	Cost K.shs.	% of Total Cost
Labour	268,506.39	21.1
Material (local)	385,177.10	47.3 (76.2 (not on total cost but on materia only)
Material (imported)	120,096.73	(23.8
Freight and transport	176,369.84	-
Electrical works	26,128.00	-
Consultants fees	92,612.00	8.7
Total	1,068,890.06	
June 1970-August 1971:		
Labour	60,867.60	13.7
Material (local)	181,333.95	72.4 (56.4 (not on total cost but on materia only)
Material (imported)	140,373.85	(43.6
Freight and transport	13,137.00	-
Equipment and instruments	6,292.80	-
Consultants fees	42,500.00	9.6
Total K.shs.	444,505.20	

The above cost analysis shows that between December 1969-June 1970 per cent of total cost for labour was 21.1, that for material was 47.3, and that for engineering fee was 8.7. Of the total cost for material, 76.2 per cent accounted for material found in Kenya and the rest 23.8 per cent accounted

for material obtained from outside Kenya.

Between June 1970 and August 1971 the breakdown based on the total cost of all items was as follows:

Labour	13.7%
Material	72.4%
Material (local)	56.4%
Material (imported)	43.6%
Engineering fee	9.6%

The above cost analysis does not show what per cent of total labour cost was spent for skilled labour vis a vis unskilled labour because the figures were unavailable.

Construction of water supply the cost analysis of which is shown above, included the following:[26]

1. Extensions of the treatment works, alterations to filter gallery and alum house, also the laying and fixing pipeworks, valves etc. together with other auxilliary works.

2. The construction of a reservoir ½ million gallon capacity with associated pipework. The laying of 1,000 yards of 12 inches in diameter water main and the installation of pipework and fittings at two pumping stations.

3. The supply of switchboard equipment and the electrical installation of 2 No. 70 H.P. electric motors and 2 No. 25 H.P. electric motors including alterations to the existing installations e.g. pumps, etc.

Construction Resources Available in Kisumu Water Supply and Sewage Plants

Construction

As was stated in Chapter four, Kenya has both skilled and unskilled people who can do construction work pertaining to water supply and sewage treatment facilities. But there are not enough of them. For example, design engineers, surveyors and construction engineers are very few. but there are enough labourers. There are also skilled equipment operators, carpenters, masons, cement finishers, plumbers, welders, pipe fitters, electricians, painters, steel workers, and unskilled workers.

Operation

In the Kisumu plant a pile driver is not available. But the type of equipment available include meters, lawn mowers, blowers, recording devices, laboratory equipment, portable power plant, motors, pumps, backhoe, crawler tractor, trencher, crane, cement mixer or trucks, grader scraper, welders and power saws.

Operation and Maintenance

Material available for operation and maintenance include silica sand, graded gravel, clean water, gasoline, cement, blasting material, reinforcing steel, wire mesh, and structural material such as wood, plywood, steel and native bamboo.

Process

Process material which are available include pipe (clay, steel, cement, plastic, wood, galvanized) and pipe fittings, paint, valves, wood, tanks, gauges. But heat exchangers are not available - they are rare and may be found only in hospitals and hotels, and a few institutional places.

Chemical Supplies

Chemical supplies which are available include chlorine, Al_2So_4 (aluminium sulphate), F_eCl_2 (ferric chloride), Activated charcoal is available but rarely used, lime, soda ash, ozone, and laboratory chemicals.

MOMBASA TOWN
WATER SUPPLY AND SEWAGE TREATMENT WORKS

WATER SUPPLY

Source of Water Supply

Mombasa town gets its water supply from Mzima Springs 156 miles from Mombasa. There is groundwater but it is not used for any purposes. Wells are already drilled and the water from them is used for agricultural purposes only. Approximately 10 per cent of water receives treatment at Pemba river treatment plant. There is also the Indian Ocean but Mombasa town does not get its water from the Ocean. Apart from the Mzima Springs, Mombasa also obtains its water from Mrere river and its tributaries, Mrere, Marume and their tributaries, Madabara river, and Kitanzi river. From all these sources Mombasa has a capacity of 36.63 Cusecs per day (19,780,200 gallons per day). But the average water consumption per day is between 5-7 million gallons.

Mombasa has an annual mean rainfall of 1083.2 millimetres (between 1966-1974), and an annual absolute mean maximum temperature of 34.2^{o} Centigrade, and absolute mean minimum of 20.0^{o} Centigrade. It has a relative average humidity of 76 per cent at 9 a.m. and 70 per cent at 3 p.m.

Mombasa town population grows at an annual rate of 4.7 per cent.[27] At the 1969 census its population was 247,073. At an annual growth rate of 4.7 per cent Mombasa's population is now approximately 328,357 assuming no drastic

changes in fertility and mortality.

The Mombasa town water supply was built between the year 1955-1956. At present the total population served by the water supply is 200,000 and the total number of connections on the island (Mombasa is a town on an island) is 17,000.[28]

Currently, the domestic per capita water consumption per day is approximately 25 gallons (112.5 litres) and in five years time the per capita daily consumption will be approximately 40 gallons (180 litres). These figures represent consumptions for the years 1976 and 1981 respectively. In ten years' time (1986), the per capita daily water consumption is estimated to be 60 gallons (270 litres).

The percentage of population of Mombasa town served with either piped water to houses or central village or street pump is 67. There are many people who use water from kiosks.

Projections of Water Demand in the Mombasa Municipality Calculated at the Rate of 25, 40 and 60 gallons per capita per day. (Mombasa's population grows at an annual rate of 4.7%)

Year	Population	Per Capita Water Consumption per day (gallons)	Total Water Demand per day (million gallons)
1976	328,357	25	8,208,925
1977	339,969	25	8,499,225
1978	351,581	25	8,789,525
1979	363,193	25	9,079,825
1980	374,805	25	9,370,125
1981	386,417	25	9,660,425
1982	398,029	40	15,921,160
1983	409,641	40	16,385,640
1984	421,253	40	16,850,120
1985	432,865	40	17,314,600
1986	444,477	40	17,779,080
2000	607,045	60	36,422,700

The above projection demand for water consumption shows that as the years go by the population of the town increases and thus the daily per capita water consumption also increases. This amounts to a big increase in the total daily water consumption for the whole town as the years go by.

By the year 2000 the per capita daily water consumption will be between 36 gallons (160 litres) and 60 gallons

(270 litres).

Sewage

The Mombasa town sewage treatment facility was built in 1963. It is now serving a population of 30,000.[29] The town has a central wastewater collection system. The percentage of population being served by sewage treatment is 10 (or 0-25 per cent). Percentage of people to be connected to the sewage treatment facility in five and ten years' time will be 50 and 90 respectively.

Water Supply and Sewage Treatment Process

Water Supply

As has been stated before, Mombasa town gets its water mainly from Mzima Springs. Due to the nature of the water from the springs, there is no need for treatment. Only chlorine (which is imported) is used.

Sewerage

Sewage treatment at the Mombasa plant involves screening and then sedimentation of sludge which is released at ebb tide into the Indian Ocean. Sewage treatment thus involves partial treatment which is preliminary.[30]

Technology of Water and Sewage Treatment Facilities

The Level of Water Treatment Technology Development

As was stated above, the Mombasa water supply serves about 50-75 per cent of its population. The technology

advancement of the water supply plant can be described as simply transfer of a process that had been successful elsewhere. Its quality for research can be described as a breakthrough for enhancing the development of Kenya.[31]

The Level of Sewage Treatment Technology Development

The Mombasa sewage treatment plant serves 30,000 people (10 per cent of the total municipal population). Its level of treatment technology developmnnt can be described as in the case of water supply stated above.

Operation of Water Supply and Sewage Treatment Plants

(See Appendix E for Mombasa Municipality)

Water Supply Treatment

As was stated earlier, approximately 10 per cent of water for Mombasa town receives treatment at Pemba River Treatment Plant. The town receives most of its water from the Mzima Springs. There is no water treatment. Only chlorination is used because the water comes from the Mzima Springs.

Operators

All the operators at the Mombasa water supply treatment plant are trained there and in a training school in Nairobi. Trained operators are difficult to find. These operators have standardized tests they have to pass in order to be operators grade 1, 2 and 3. There are short courses and other training programmes for operators.

Operators may be discharged for breach of discipline. Also very frequently, they leave their employment for better jobs elsewhere.

The average age of operators is between 25-40 years. The performance of most operators is fair but the operator in-charge is good.

Chemicals

Soda ash is the only chemical obtained locally. All others are imported from countries outside Kenya. For treatment of the water supply at Mombasa there is no need for chemicals. Only chlorine which is imported is used.

Chemicals are easy to obtain locally but initially they are imported from abroad.

Machinery and Parts, etc.

General wear and tear is the cause of machinery breakdown if the machine is used for between 18-20 hours a day. There is routine replacement of machinery or parts of the machine.

Parts of the machinery which are usually ordered from England and which come by ship take between 1-6 months. If ordered locally the parts take a much shorter time. Some parts replaced have to be ordered especially. Some suppliers have good supply of spare parts.

Technical Operational Failure

Turbidity during flood period may cause difficulty during treatment. This is more of a problem of Sabaki river than Pemba river.

No water in river Pemba may cause operational failure. Sometimes there is lack of water in Mombasa due to bursts of pipes.

Due to heavy tourist season, now the capacity in Mzima pipeline is too small. Consequently, currently a new water treatment plant is being built at Sabaki river with water piped to Mombasa.

Supervisory Control

There is active regular local inspection of the water supply plant.

Daily laboratory tests of turbidity and alkalinity of water are taken at Pemba river and chlorine residual tests are also taken at Pemba and Changamwe. Chemical and bacteriological analysis is done by General Superintendance Company (general commercial chemists in Mombasa town).

Problems not Solved by Present Facility

Water from Mrere Spring has colour in the rainy season.

At present the government is supplying the money for operating the water supply. However, the Coast Province Water Branch is in the process of making the whole operation self-supporting.

The daily water consumption in Mombasa town is between 5-7 million gallons.

The total annual operation cost of water supply is K.£. 662,300.0. The total annual operational cost for personnel (payroll) is K.shs. 600,000.

There are administrative problems pertaining to personnel relations with people working in the field. The relationship is not very cordial. People working in the field worry personnel about night allowance. Personnel are not willing to pay them. Again personnel are not willing to promote those who show that they deserve promotion. There is also shortage of qualified supervisory staff.

SEWAGE

Type of Treatment

Type of treatment of the sewage includes screening followed by sedimentation of sludge which is released at ebb tide into the Indian Ocean. This is simply preliminary partial treatment.

Operators

Trained or skilled operators are difficult to obtain. There is a standard for evaluating the qualifications of operators and there are course or training programmes for operators (see chapter four).

It is observed in the case of the Mombasa plant that operators do not move very freely because they are used to the type of work they are doing and cannot get a better suitable job elsewhere.

The average age of operators is between 30-40 years. The quality of operators can be described as fair.

Chemicals

In the sewage plant at Mombasa, there is no need for use of chemicals and as such the availability or non-availability of chemicals do not apply here.

Machinery Parts

The cause of machinery breakdown is general wear and tear. There is routine replacement of machinery or parts. The machinery or parts to be replaced are ordered from England and they take between 6 months and a year to arrive by ship. The parts are usually ordered specially. The machinery is repaired locally.

Operational Failure (Technical)

Technical failure due to any characteristics of raw water causing difficulty in treatment does not apply to the Mombasa Sewage Plant. There is no difficulty due to turbidity, algae or any other source. Also operational failure due to storage, pumps, lack of water or any other reason is very rare.

Although there is a need for extension, the sewage treatment process has been running satisfactorily to the maximum load design.

Supervisory Control

There is regular active local inspection of the plant. Laboratory sample tests for effluent are done by General Superintendance Company of commercial chemists who work in the town of Mombasa.

Problems not Solved by Present Facility

There are no technical problems of effluent due to odor, taste or colour of water, but there is a tendency to use sand to wash dishes, which makes the sewage septic before it reaches treatment plant.

There is no monetary problem in operating the sewage plant because there is a sewage levy for the facility provided which makes the operation self-supporting.

The sewage plant has a capacity for 1 million gallons per day. The total annual operational cost is K.shs.400,000 (K.£ 20,000). The total annual operational cost for personnel (payroll) is K.shs. 260,000.00 (K.£ 13,000).

There are administrative problems experienced in operating the sewage plant because there is lack of qualified personnel or people with managerial and supervisory ability. Generally speaking, there is a lack of suitable people to do the job pertaining to sanitary engineering.

Facility Construction Cost

Water Supply Treatment Facility Construction Cost

The type of process for the water supply involves chlorination only. This water supply was built between 1955-1956. At present the facility is serving a population of 200,000. It was constructed at a cost of K.£ 6,000,000 (approximately U.S.$ 17,400,000). The distribution of this cost according to the various items was as follows in percentages:

Percent of total cost for labour	25-50
Percent of total cost for material	50-75
Percent of total cost for engineering fee	6-10
Percent of total cost for skilled labour	50-75

Of the total cost spent on material the per cent of the material found in Kenya was between 10-25.

The approximate daily wage for unskilled labour in Kenya is K.shs. 15.00 and for skilled labour it is between K.shs. 25-100 (depending upon the level of skill).

At present the Sabaki River water project for Mombasa Municipality is underway and when completed will cost an estimated K.£ 28.5 million.[32] How the money is going to be spent for the various item categories as shown above is not yet worked out and consequently the figures are not available.

Sewage Treatment Facility Construction Cost

Sewage treatment plant in Mombasa was built in 1963. The treatment process is partial treatment which involves screening followed by sedimentation of sludge which is only released at ebb tide into the Indian Ocean.

The sewage treatment plant was built at the cost of U.S.$ 7,000,000 (K.£ 1,050,000). The distribution of this cost of construction according to the various items was as follows in percentages:

Item	Percent of Total Cost
Labour	25-30
Material	40
Engineering fee	6
Skilled labour	25

The approximate daily wage for unskilled labour in Kenya for this type of work is K.shs. 14.50 and that for skilled labour is K.shs. 25.00.

Of the total cost spent for material 65% was found in Kenya. The material found in Kenya includes ballast, sand, cement reinforcement, p.c.c. pipes and timber.

The cost of construction included treatment works, pumping stations, machinery, trunk sewers and reticulations. The cost of material here does not include any machinery - mechanical plant. Engineering fee included survey, design, execution of tender documents and supervision. Skilled labour entails mchanical plant operators, electricians and mechanics.

Construction Resources Available

CONSTRUCTION

Labour Force Availability

As in the case of Kisumu Municipality, Mombasa Municipality has design engineers, surveyors, construction engineers, and labourers. The first three types of manpower are not available in adequate numbers. Skilled workers are available. These include equipment operators (not enough) carpenters, masons, cement finishers, plumbers, welders, pipe fitters, electricians, painters, and steel workers. Unskilled workers are also available.

Operation

Equipment Availability

Equipment available for operation include back hoe, crawler tractor, trencher, crane, pile driver, cement mixer or trucks, grader, scraper, welders, power saws, meters, lawn mowers, blowers, recording devices, laboratory equipment, portable power plant, motors, and pumps.

Operation and Maintenance

Material Availability

Material available include silica sand, graded gravel (ballast), cement, clean water, gasoline, blasting material, reinforcing steel, wire mesh, and structural material like wood, plywood, steel, native bamboo and mangrove poles.

Pertaining to pipe and fittings material available include galvanized, iron, steel, cement, plastic, clay, wood, asbestos, cement pipes, and pitch fibre. Paint is also available.

There are skilled mechanics, but skilled chemists and biologists are rare.

Chemical Supplies

Chemical supplies available include chlorine. Also (Aluminium Sulphate) soda ash and laboratory chemicals. Ferric chloride, activated charcoal, lime, and ozone are not available in Mombasa.

NYERI TOWN
WATER SUPPLY AND SEWAGE TREATMENT WORKS

Nyeri town is located at an altitude of between 6,000 ft. (State Lodge) - 7,800 ft. (Kiandongoro). During 1974 it had an average temperature of 20.8° Centigrade (maximum) and 7.0° Centigrade (minimum). It has an annual mean rainfall of 966.5 millimetres (between 1966-1974).[33] At the 1969 Census Nyeri town had a population of 10,004. Its annual rate of growth was 7.9 per cent per annum between 1962-1969.[34] It is assumed that its annual rate of growth today is still 3.5 per cent per annum.

Growing at the rate of 3.5 per cent per annum, Nyeri town's population is now (1976) approximately 12,454.

WATER SUPPLY

Sources of Water Supply

Nyeri town gets its water from Chania river. Ground water is available and there are no wells drilled.

The water supply plant was built in 1959. The approximate quantity of water consumption per day in Nyeri Municipality is 517,000 gallons (2,350 cubic metres). The water supply serves a total population of 1,393 persons who have meter connections, and it is estimated that the current demands are 1.5 cubic meters per day per household.[35]

It is also observed that every year there is an increased demand of 50,000 gallons in Nyeri town because of population increase. The average daily per capita water consumption for Nyeri town is 40 gallons.

The following is the projection demands for water for Nyeri Municipality for the next ten years beginning 1976, assuming a population growth rate of Nyeri town to be 3.5 per cent per annum, and per capita daily water consumption of 40 gallons and that there are no changes in fertility and mortality.

Year	Population	Per Capita Daily Consumption (Gallons)	Total Daily Consumption (Gallons)
1976	12,454	40	498,160
1977	12,804	40	512,160
1978	13,154	40	526,160
1979	13,504	40	540,160
1980	13,854	40	554,160
1981	14,204	40	568,160
1982	14,554	40	582,160
1983	14,904	40	596,160
1984	15,254	40	610,160
1985	15,604	40	624,160
1986	15,954	40	638,160
2000	20,854	40	834,160

The above projection demands have not taken into account the effect of a possible rise in the standard of living which may increase or decrease the demand for water consumption.

Sewage

The Nyeri sewage treatment facility was built in 1959. At present the sewage collection system is serving 25 per cent of the population of the Municipality, and sewage treatment also 25 per cent of the town's population.

In five years' time the Municipality hopes to connect 100 per cent of the population of Nyeri town to sewage treatment facility. Similarly in ten years' time 100 per cent of the town's population will be connected to sewage treatment facility.

Water Supply and Sewage Treatment Process

Water Supply Treatment

Nyeri town receives its water from the Chania River. Therefore the water receives full treatment (as in the case of the Kisumu Municipality water supply) which includes coagulation, sedimentation, filtration, and finally sterilization or chlorination.

Sewage Treatment

Nyeri Municipality uses bio-filter and sedimentation tank in the treatment of its sewage. The sewage treatment system was not properly designed for Nyeri town. It now needs the new system of waste water disposal, namely, the waste stabilization pond or oxidation pond which is now planned for many towns in Kenya. At present Nyeri is using pumped recirculation system which should now be avoided.

Technology of Water and Sewage Treatment Facilities

The Level of Water Treatment Technology Development

About 11 per cent of the population of Nyeri town (1,393 persons) have piped water supply to their houses. Technology advancement here is simply transfer of a process that had been successful elsewhere. Its quality for research can be described as an important feature for the local people but not significant to overall development of the country.

The Level of Sewage Treatment Technology Development

Sewage treatment facility is serving 25 per cent of Nyeri town's population. Its technology advancement is simply transfer of a process that had been successful elsewhere. Its quality for research can be described as an important feature for the local people but not significant to overall development of the country.

Operation of Water Supply and Sewage Treatment Plants

WATER SUPPLY TREATMENT

Operators

Water supply operators in Nyeri town are difficult to find. If they are not trained by the Ministry of Water Development, recruits come from primary and secondary schools. Operators take government trade tests which are standardized. Short courses or other training programmes are available for operators.

Operators leave employment at the Nyeri treatment plant because there is too much work but not enough emoluments. Workers must always be available like doctors and sisters in hospitals. They leave work for better employment elsewhere.

The average age of operators is between 30-40 years. Quality of operators can be described as good.

Chemicals

Chemicals are obtained locally and they are easy to obtain both locally and non-locally.

Machinery and Parts, etc.

Normal wear and tear is the cause of machinery breakdown. Time interval for replacement of machinery or

parts is observed to be not as often as compared to the expected life of the item. There is routine replacement of pipe fittings and bearings.

Delivery time of ordered bearings sometimes is between 1 and 6 months and sometimes between 6 months and a year. For other parts delivery time is between 1 and 4 weeks. The parts which are replaced are ordered specially.

Repair of machinery is done locally, but there are some parts which have to be replaced by new ones: these include bearings, gaskets, cupleathers, etc.

Technical Operational Failure

Nyeri water supply has not experienced any technical failure due to turbidity, algae, or any other cause.

Supervisory Control

There is regular local inspection of the water plant by local personnel. In addition there is regional inspection by provincial personnel, and national supervision by personnel from the Ministry of Water Development in Nairobi.

At the time of research during 1975 there was active supervision of the water supply plant.

The water supply laboratory is at the plant and also is central in Nairobi about 90 miles away from Nyeri town.

Problems not Solved by Present Facility

The water supply in Nyeri town has no physical or chemical problems, and it does not have any difficulty in financing.

The Nyeri town water supply has a capacity of 650,000 gallons (2,954 cubic metres) per day. Its daily operational cost is K.shs. 12,500 and its total annual operational cost is K.shs. 150,000. The annual operational cost for personnel (payroll) is K.shs. 60,000.00 which is the total annual salary for 15 people.

The water supply does not experience any administrative problems at the moment.

SEWAGE TREATMENT

Operators

As in the case of water supply, operators for sewage treatment are difficult to find. The people responsible for employing operators at the plant do not have standard or system for evaluating the qualifications of operators. There are short courses or other training programmes for operators.

The experience of engineer in-charge of sewerage in Nyeri is that operators tend to stay on the job.

The average age of operators is between 30-40 years. Their quality on the job can be described as excellent.

Chemicals

Chemicals are obtained locally and are easy to obtain locally and non-locally.

Machinery and Parts, etc.

Product failure and normal wear and tear are the causes of machinery breakdown.

Time interval for replacement of machinery or parts is too often as compared to the expected life of the item. There is also routine replacement of parts. Delivery time of ordered parts is sometimes between 1 and 6 months and sometimes between 6 months and a year. The parts replaced are usually ordered specially, and common parts are taken off the shelf.

The machinery is repaired in Kenya, in Nairobi, 90 miles away from Nyeri. Some parts such as bearings and broken parts are not repaired but replaced by new ones.

Technical Operational Failure

The sewage plant has experienced technical failure due to breakdown of pumps and lack of proper maintenance due to unskilled labour. There is also failure due to improper design of the plant. As has already been stated the present system of treatment is bio-filter and sedimentation tank which uses pumped recirculation which could have been avoided in favour of waste stabilization pond.

Supervisory Control

There is regular local mechanical inspection of plant. In addition there is national inspection for efficiency.

Supervision was not active at the time of the research (during early 1975) but it was expected that supervision would be active as soon as a qualified person was available in May 1975.

Laboratory is located in Nairobi, 90 miles away from Nyeri.

Problems not Solved by Present Facility

The sewage plant is inefficient. Dissolved Oxygen is too low and Biological Oxygen demand is too high. The sewage plant does not experience any difficulty in financing.

The total annual operational cost of the sewage plant is K.£ 8,000 (K.shs. 160,000). Annual operational cost for personnel (payroll) is K.£ 2,000 (K.shs. 40,000).

Administrative problem experienced is lack of technically qualified supervisors.

Facility Construction Cost

Water Supply Treatment Facility Construction Cost

The Nyeri water supply was built in 1959. It is serving 1,393 persons who have piped water supply to their houses. The rest use central village or street pump. The water supply plant was built at a cost of K.£ 123,055 (K shs. 2,461,100)

The above cost of construction was distributed among the various items as follows:

Item	Actual Cost £	Percentage of item over total cost
Labour	36,886.50	30
Material	79,920.75	65
Engineering fee	6,147.75	5
Total	123,055.00	100

Of the total cost spent for material, about 75-100 per cent of the material was found in Kenya.

The per cent of the total cost spent for skilled labour was 20 per cent (K.s 7,377.30). Approximate daily wage for unskilled labour in Kenya doing this type of work is K.shs. 9.30 and that for skilled labour is K.shs. 15.00 in Nyeri.

Facility construction cost for sewage treatment for Nyeri town was not available at the time of research, and as such this analysis is not included here.

Construction Resources Available

CONSTRUCTION

Labour Force Availability

Design engineers, surveyors, construction engineers, labourers are available.

Of the necessary skilled workers, electricians are not available and steel workers are not fully skilled. The available skilled workers include equipment operators, carpenters, masons, cement finishers, plumbers, welders, pipe fitters and painters. Unskilled workers are also available.

OPERATION

Equipment Availability

The unavailable equipment in the Nyeri plant include back hoe, crawler tractor, trencher, crane, pile driver, cement mixer, grader, scraper, brushhog, power saws, portable

plant is partly available and partly not available.

Operation equipment available include trucks, welders, meters, lawn mowers, blowers, recording devices, laboratory equipment, motors, and pumps.

Operation and Maintenance

Material Availability

Of the materials necessary for operation and maintenance, materials not available include blasting material and clay and wood pipe and fittings. Materials available include silica sand, graded gravel, cement, clean water, gasoline, reinforcing steel, wire mesh and structural material such as wood, plywood, steel, native bamboo, and also pipe and fittings, e.g. galvanized, iron, steel, cement, plastic, and asbestos cement. Paint is also available.

Concerning labour, skilled labour which is not available include chemists and biologists. Skilled mechanics are available. Unskilled labour are also available.

Chemical supplies which are not available because they are not needed because of the chemical nature of water include: Ferric chloride ($FeCl_2$), activated charcoal, lime, and ozone. Chemical supplies available include chlorine, Al_2So_4(Aluminium Sulphate), soda ash, and laboratory chemicals.

THIKA TOWN
WATER SUPPLY AND SEWAGE TREATMENT WORKS

An analysis of Thika town water supply and sewage treatment works was out of scope of the author's research for purposes of this report. However, Thika is a very interesting town from the point of view of its rapid expansion as an industrial town of Kenya. Of interest to the author is the fact that Thika's sewage and water supply facility was constructed by the middle of 1974. From the point of view of the nature of research undertaken by the author, which pertains to the socio-economic conditions which pertain to cost of construction and operation of water and sewage treatment facilities and quantity of water consumption, Thika today would be an ideal town for study. Its population at the 1969 census was 18,387. Its population is growing at an estimated rate of 4 per cent per annum, according to the estimates for the years 1962-1969.[36] Using this assumption of population growth rate, Thika today (1976) has an estimated population of 23,532.

The author, because of interest, was able to have access to the figures showing the cost of construction of sewage treatment facility in Thika town, because these figures reflect more or less accurately the current cost of various items in Kenya which is experiencing an upward trend in inflation. The cost which reflects 1974 economic conditions in Kenya was as follows according to various items:

Cost of Building Sewage Treatment Works - 1974

Item	Cost in K.shs.
Preliminary - insurance, bond, construction establishment	474,000
Excavation of sewage	4,255,000
Sewers and pipes	2,700,000
Manholes	400,000
Concrete structures	450,000
Mechanical equipment	270,000
Others (unspecified)	751,000
Total	9,300,000

*The total amount of money used was K.£ 465,000 (K.shs. 9,300,000).

Footnotes to Chapter Five

1. Jacques M. May, M.D. The Ecology of Malnutrition in Eastern Africa and Four Countries of Western Africa - Studies in Medical Geography, Vol. IX, p. 304.

2. Ibid., pp. 303-304.

3. Ibid., p. 304.

4. Municipality of Kisumu, Future Water Supply and Sewerage Report, September, 1972, p. 27. Howard Humphreys and Sons (E.A.) Consulting Engineers, Nairobi, Kenya.

5. Ibid., p. 19.

6. Municipality of Kisumu - Annual Report 1974, p. 6.

7. Ibid., p. 65.

8. Ibid., p. 67.

9. Republic of Kenya, Statistical Abstract, 1975, pp. 8-9.

10. Municipality of Kisumu - Future Water Supply and Sewerage Report 1972, p. 11.

11. Ibid., p. 19.

12. Ibid., p. 10.

13. Ibid., p. 67.

14. Ibid., p. 70.

15. Joshua Oiro, B.Sc. (Civil Engineering), M.Sc (S.E.), M.I.E.K., Acting Town Engineer, Kisumu Municipality.

16. Municipality of Kisumu, op.cit., p. 2.

17. Ibid., p. 2.

18. Ibid., p. 2.

19. Ibid., p. 6

20. Ibid., pp. 54 and 73.

21. Communication from Richard Nyamao Mbeche, Town Treasurer, Kisumu Municipality, 1975.

22. Communication by J.H. Greenlees, Principal Engineer, Howard Humphreys and Sons (East Africa), Consulting Engineers, Nairobi, Kenya.

23. Communication by S.S. Mehta and Sons, Consulting Engineers, Nairobi.

24. Communication by S.S. Mehta, op.cit.

25. Communication by Joshua Oiro, op.cit.

26. Ibid.

27. Simeon Ominde, op.cit., p. 94.

28. Communication by Peter Ouma and a Danish hydraulic engineer, Mombasa Municipality.

29. Communication by P.C. Patel, Principal Assistant Engineer (Design and Development), Mombasa Municipality.

30. Ibid.

31. Communication from the Town Engineer, Mombasa Municipality.

32. Republic of Kenya, Economic Survey 1976, p. 100.

33. Republic of Kenya, Statistical Abstract, 1975, p. 7.

34. Simeon Ominde, op.cit., p. 94.

35. P.C. Shelat, B.Sc., B.E. (Civil), Water Engineer, Nyeri Municipality.

CHAPTER SIX

NATURE OF WATER USAGE AND LEVEL OF WATER CONSUMPTION

In order to see how water is used by people who have water and wastewater facilities and whether there are any socio-economic and cultural factors which determine how water and wastewater is used, the author studied three samples of water users drawn from Mombasa, Kisumu and Nyeri towns. A total of 95 persons were studied from Mombasa (33), Kisumu (31) and Nyeri (31).

The water users studied were chosen from three educational levels as follows:

Level of Education	Number of Persons
Primary education (Std. 1-7)	17
Secondary education (Forms 1-6)	44
Technical Training (Diplomas and Certificates)	14
University (Bachelor, Master, Ph.D degrees)	17
Others (unspecified)	3
Total	95

Water Facilities

The following analysis shows the total number of people who had the same kind of water and wastewater facilities and those who did not have the same kind of water and wastewater facilities in their homes.

Facility	No. of People having the Facility			
	Kisumu	Mombasa	Nyeri	Total
Bath tub or shower	31	21	18	90
Water closet	28	20	15	63
Wash basin	20	18	12	50
Kitchen sink	29	18	13	60
Tap (outside house)	16	7	30	53
Pit latrine	3	4	24	31

Facility	No. of People who do not have the facility			
	Kisumu	Mombasa	Nyeri	Total
Bath tub or shower	0	12	13	25
Water closet	3	13	16	32
Wash basin	11	15	19	45
Kitchen sink	2	15	18	35
Tap (outside house)	15	24	1	40
Pit latrine	28	29	7	64

The above analysis concerning water supply facilities in the house shows in addition to the availability or non-availability of the facilities shown for some individuals that all the people with primary education did not have a wash

basin, water closet, and bath tub as compared with people with University education who had all these stated facilities in their houses.

Concerning people with secondary and technical education, those without the three facilities were as follows: secondary (34), technical (6).

From the above observation it may be stated that the higher or the better the education the more likely that a person will have better water and wastewater facility in his house. This is a function of better job opportunity for such better educated people. This is also an indication of what kind of rent they can afford. Houses whose rents are high also tend to have better water and wastewater facilities in them. People with a good education can afford to pay rents which warrant the usage of such facilities.

It was also observed that the majority of primary school graduates as compared with those who had higher qualifications used tap water outside their houses since they do not have water facilities inside their houses. The majority of them also, as compared with those with higher educational qualifications, used pit latrines instead of water closets. In fact all University graduates did not use any pit latrines.

Usage of Water

Water usage as usual includes washing eating utensils, clothes, food, floors (cemented floors), cars, and bathing and also watering gardens and flowers.

It is to be noted here that water is used much less by individuals for watering gardens and flowers and also for washing cars because not many people own cars. This was the author's observation according to the sample of people studied in Mombasa, Kisumu and Nyeri.

WATER CONSUMPTION

Methodology used in Studying Level of Water Consumption

The author studied the amount of water consumption per family in all the three towns by studying individual families that had meter connections in their homes. Data concerning their monthly expenditure on water was collected. Using the average amount of money they paid per month for water, the author got the following distribution of the amount of water consumption, using the current cost of water, which is Kenya shillings 2.60 per 1000 litres and also using the maximum amount of money paid for water per month.

Number of Families	Average amount of Money paid per month by each family	Average amount of water consumption per month by each family	Average amount of water consumption per day by each family	
	K.shs.	Litres	Litres	Gallons
11	10.00	3,846.2	128.2	28.5
25	11.00-20.00	7,692.4	256.4	57.0
28	21.00-30.00	11,538.6	384.6	85.5
3	31.00-40.00	15,384.8	512.8	114.0
3	41.00-50.00	19.231.0	641.0	142.4
11	51.00-60.00	23,077.2	769.2	170.9
81				

The above figures show that the average amount of water consumption per day per family is between 128.2 litres (28.5 gallons) - 769.2 litres (170.9 gallons).

Marital Status of the Families

The marital status of the families studied was as follows:

Marital Status	No. of Households
Single	18
Married	75
Unspecified	2
Total	95

An analysis of the number of wives married to each individual and the total number of children in each family was as follows:

Number of Wives

Number of Families	Number of Wives in each family
75	1
15	2
3	3
1	4
1	6
Total 95	

Number of Children

Number of Families	Number of Children in each family	Total
5	0	0
9	1	9
13	2	26
12	3	36
13	4	52
4	5	20
5	6	30
3	7	21
5	8	40
3	9	27
1	13	13
1	15	15
1	19	19
Total 75		308

According to the above figures pertaining to children it can be calculated that the average number of children per family is 4. Therefore for the majority of families (75 in number) where the spouse is married to one wife it can be said that the total number of persons in each family is 6. On the average, therefore, the number of persons in each family studied was 6 (this approximation exempts families where persons are not married).

The total number of persons in a family can now be related to the daily water consumption per family as stated above We get the following figures which show the per capita daily consumption based on the above categories of consumers:

No. of Families	Average amount of money paid per month by each family	Average consumption per month per family	Average consumption per day per family		Average per capita consumption per day	
	K.shs.	Litres	Lits.	Galls.	Lits.	Galls.
11	10.00	3,846.2	128.2	28.5	21.37	4.75
25	11.00-20.00	7,692.4	256.4	59.0	44.1	9.5
28	21.00-30.00	11,538.6	384.6	85.5	64.1	14.25
3	31.00-40.00	15,384.8	512.8	114.0	85.45	19.0
3	41.00-50.00	19,231.0	641.0	142.4	106.8	23.7
11	51.00-60.00	23,077.2	769.2	170.9	128.2	28.5
81						

The sample studied shows that the average per capita daily demand as shown by the study of 81 families is between 21.37 litres (4.75 gallons) - 128.2 (28.5 gallons). These

figures are approximately the same as those worked out by the Kenya Water Apportionment Board which has the following specifications concerning per capita daily water consumption for Kenya as a whole:

	Per capita daily water consumption
For persons	20 gallons (90 litres)
For big animals (eg. cattle)	10 gallons (45 litres)
For small animals (e.g. sheep and goats)	2 gallons (9 litres)
For irrigation per acre (to provide 3 inches of rainfall equivalent per month)	2269 gallons (10210.5 litres)

From the sample study of water consumers the author noted that a higher standard of living for an individual was concomitant with more money paid for water consumption when this standard of living was compared with a lower one. Thus persons who had cars spent a little more money on water than those who had none. Of course also the total number of people living in a household having water facilities also had a great effect on the total amount of water used per day. For example single persons in the sample studied (constituting 18 households) formed the entire number of families (11 altogether) who spent the least amount of money per month (K.shs. 10.00) for their water bills. This shows that the most important single factor in determining the amount of

water used is the number of people using that water. Another factor which comes close to the total number of persons using water in determining more usage of water is the level or standard of living of different individuals.

Income of the Sample Using Water Facilities

The following was the distribution of income of the sample of people who used the water facilities:

Income per year	No. of persons earning the money
Not stated	40
K.£ 100-200 (K.shs.166.65-333.30)	1
" 201-300 (" 333.30-499.95)	1
" 301-400 (" 499.95-666.60)	14
" 401-500 (" 666.60-833.25	4
" 501-600 (" 833.25-999.90)	1
" 601-700 (" 999.90-1166.55)	2
" 701-800 (" 1166.55-1333.20)	9
" 801-900 (" 1333.20-1499.85)	4
" 901-1000(" 1499.85-1666.50)	4
" 1001-2000(" 1666.50-3333.00)	12
" 2001-3000(" 3333.00-4999.50)	2
Total	95

It should be noted here that the amount of one's income per month or per year determines where a person will live in a town and consequently the type of water facilities available to him. This income also determines the level of living of an individual which in turn will control how much

water he uses every day. As has been stated above, a higher standard of living demands more water usage. This higher standard of living is experienced mainly in urban areas where the more and better educated Kenyans are now living because they have better job opportunities there.

Nature of Water Usage

There are cultural and religious reasons which hinder the sharing of water and wastewater facilities among Africans living in urban areas. For example there are certain relatives who cannot share bathrooms and water closets with other relatives. This depends upon taboos and religious beliefs which pertain to certain tribes in Kenya, as it is in other parts of Africa.

The families studied in Kisumu, Mombasa and Nyeri towns showed the following negative attitude toward sharing water and wastewater facilities in their houses with certain types of relatives or other persons of some specific type:

Families that Cannot Share Bathroom (Bath tub and Shower) with Certain Relatives

Type of Relative	No. of Families that cannot share bathroom (bath tub and shower) with that relative
Strangers or visitors I do not know	39
Parents-in-law	30
Adult uncles and aunts	19
My parents (when children are fully grown)	12
Adult nephews and nieces	9
Sisters and brothers-in-law	9
My grown up children	4
Persons who do not share my religious belief	4

Similarly the following negative attitude was shown regarding sharing water closets in the houses.

Type of Relative	No. of Families that cannot share water closets with that relative
Strangers or visitors I do not know	29
Parents-in-law	23
Adult uncles and aunts	20
My parents	10
Adult nephews and nieces	9
My adult children	4
My brothers and sisters-in-law	3
Persons who do not share my religious belief	1

The heads of the households studied gave a number of reasons for not making their water and wastewater facilities available for the type of relatives and people stated above. These reasons were as follows:

Reasons for not Sharing Bathroom (bathtub and shower) and Water Closet with the Stated Persons

Reason	No. of Families stating the reason
Customs and taboos of my tribe do not allow	25
I am not aware of their cleanliness (medical reasons, health reasons)	15
They give no assistance in household duties	5
Personal conscience and respect	4
Psychological reasons (e.g. attitude towards other people)	4
Inconvenience	2
Religious reasons (e.g. people who belong to different religions)	1
Strangers may be thieves	1
To segregate youth from the old	1
To relieve family of the burden of living expenses	1
These people are not used to me	1

African way of life entails so much communalism, especially that pertaining to relatives that it is often too difficult for anyone living in an urban area to detach himself completely from relatives and friends. Africans who live in urban areas find that they have to accommodate relatives and friends from rural areas who have gone to the urban areas in search of a job. But there are taboos as noted above which forbid intimate mixing with certain types of relatives or people. Furthermore, economic difficulties of a financial nature now make it too difficult for people to

help and accommodate friends and relatives who go to them in the congested urban areas. Even in the rural areas these customs and taboos exist even more strictly than they are observed in the urban areas. Consequently because of an earlier socialization received in rural milieu x it is difficult to eradicate these attitudes among urbanites in Africa today. Hence the attitude of these urbanites recorded above.

One may now ask what alternative arrangements may be made to meet the water and wastewater needs of persons who find in an urban situation that they have to share these facilities with their relatives. The following are the suggestions made by the various families studied as to what alternative arrangements can be made for their relatives, if there are any alternatives which are feasible:

The alternative arrangement	No. of families in favour of that alternative
Have a separate building (house) for the relatives	12
Consult authorities (e.g. the government) to build extra houses for them in urban areas	11
Place them in a friends house which is distant from your house	6
Have common public baths etc.	4
Encourage these people to have their own facilities	3
Have a bigger house	1

It should be noted that one of the suggestions stated above as an alternative arrangement is the establishment of public baths, water closets, and other types of lavatories. This type of alternative is not acceptable to all the families that the author studied. 26 families were opposed to public utilities, and 47 families accepted the use of public utilities. The following were the reasons given by the families not in favour of public water and wastewater facilities:

Reason for objection to use of public utilities	No. of families in favour of that reason
Spread of diseases	15
People will fail to pay for these facilities	4
These facilities will be misused by people	2
Money spent for building the facilities could be better used for building a water supply	2
I would meet relatives whom I would not traditionally like to meet	1
One should use his own facility for privacy	1
There may be sudden deaths in such public places	1

The religious affiliations of the families studied were as follows:

Religion	No. of adherents
Protestants	55
Roman Catholic	22
Mohammedans	16
Unspecified	2

The above attitude of the people toward utilising public water and wastewater facilities is important in view of the government's wish to provide water to everybody in Kenya. In the rural areas, people are poor and may not be able to afford individual meter connections. Public utilities could only be used if people were willing to pay for them jointly. This will depend upon raising the level of living of people in the rural areas so that they can afford to pay for their water, either individually or on a communal basis. Communal use of water depends upon changing people's attitudes and as has been pointed out above this will take a long time. The Kenya government will have to think carefully how to introduce rural water supply usage in such a way that even the very poor will have access to water for all types of use. What makes things more difficult is the fact that rural life is not stable. People are reluctant to build permanent houses because of the African way of life. This makes building permanent water sources difficult for a given community or population in a rural area. Young men and women now move to urban areas to work and few are reluctant to stay in the rural areas permanently.

CHAPTER SEVEN

SUMMARY

This report has entailed a detailed analysis of the socio-economic conditions which pertain to cost of construction and operation of water and sewage treatment facilities and quantity of water consumption in Kenya. The socio-economic conditions which have been analysed must be considered in any situation which requires rational planning for the supply of adequate water and wastewater facilities, their operation, and maintenance, and the total cost of construction of such facilities and the total recurrent cost of administration, operation and maintenance of such facilities for a given population.

Rational planning for water development aimed at serving a given population adequately at a given time at present and in the future must consider the following factors:

1. Size of Population Served

The population growth rate per year of a given country or community to be served with water and wastewater facilities must be known in addition to a knowledge of the present size of that population. The mortality rate per thousand population must be known. Thus both the fertility rate per thousand population and the mortality rate per 1000 population must known in order that the survival rate of the given population can be known.

Along with the population growth rate the life expectancy of the population should also be known. This factor is important so that planners for water development may have a rough idea as to how long a given population is expected to utilize certain amenities. The average life expectancy in Kenya is 57.2 years.

2. Migration

Closely connected with population rate of growth is rate of growth which is not due to natural increase but which is due to internal or external migration into a given population every year. Also emigration out of this given population should be known. This knowledge of permanent in-migration and permanent out migration of population is necessary so that the total size of permanently settled population should be known. This is the population to be served with the amount of water available for their use.

In a developing country like Kenya, rural-urban migration is a great problem. There is gravitation of population from rural areas to urban areas. At present the average annual rate of growth of Kenya's main towns is 3.89 per cent (which is nearly 4 per cent). This rate of growth of towns is due partly to natural increase and partly to in-migration. The problem of water supply and wastewater facilities is concentrated in Kenya's towns where the population is increasing rapidly. A water development plan must take account of this fact, especially as it relates

to the portion of Kenya's population that is receiving formal education and whose ultimate area of abode is urban areas where the young educated persons hope to find employment. Whether they find employment or not in urban areas, they still go to the urban areas to live. Hence educational levels and the nature of this education must be considered in planning for water demands in urban areas.

3. Educational Levels

Kenya's primary, secondary, technical and university education has increased rapidly over the years since independence. More schools of all categories have been built and enrolment in them is ever increasing. The effect of this as has been stated is that all the graduates from these schools will be going to the urban areas to work and live there. This in turn necessitates a rational master plan for adequate provision of water and wastewater facilities in urban areas. This in turn costs more money to construct, operate and maintain water and wastewater treatment facilities, not only in urban areas but also in rural areas where these people will have to work as it is the Kenya government's plan to develop the rural areas as well.

As was pointed out earlier in Chapter six the more people get higher education the more necessary it is that they will need more sophisticated facilities for water and wastewater usage. This in turn will cost more money to construct such facilities and there will be need for more water usage for the people who utilize such facilities and

thus there will be greater water demand.

4. Role of Family Planning Programmes

A community or country whose population is increasing very rapidly, such as Kenya's will lack the necessary amenities of life (e.g. water, food, clothing and shelter and many other necessities of modern life) if the country is not rich in resources and if nothing is done to curtail the population growth. Kenya has realised this, and as such it has a family planning programme aimed at reducing the population growth rate. If such a programme is successful it may help to reduce the expenses toward the construction of sewage and water supply treatment facilities as well as the amount of water needed to satisfy the demands of people in a household (at family level) and in a whole nation or community. Kenya's five year plan (1974-1978) in the area of family planning hopes to prevent 150,000 births by 1978. A successful family planning programme thus may eventually help to reduce family and national expenditures on water demand.

5. Sources of Water Supply

A country that is endowed with plenty of natural water resources from rivers, lakes and groundwater which are supplemented by good climate which causes the necessary precipitation is lucky because its population can have access to adequate water supply. The opposite is the case in a country that is not so very well endowed with natural water resources. In fact the natural water resources are

the limiting factor since if there are none a population cannot be served with water. Therefore planners in water development should know the sources of water supply and the quantity of water likely to be derived from such sources for human and livestock use. Water from such sources moreover, must be of good quality for human use. If not, the water must be treated specially to make it useful for humans. This costs a lot of money. When qnantities of water derived from such sources are known, then it is possible to plan for water supply for a known population. Kenya has lake, river and ground water sources. The river resources are the best source for Kenya's water supply. To develop such water source in Kenya for human consumption is a costly affair as it requires a lot of money and capital. Once a water supply has been built, the water requires treatment. Excepting supplies from springs which need only chlorination, supplies from river sources require full treatment - coagulation, sedimentation, filtration and disinfection. This kind of treatment is much more expensive than the treatment of water from springs (sub-surface water). Kenya gets its water supply from springs (in some places like Mombasa), rivers (or surface water), and also from groundwater or boreholes.

Treatment of water from boreholes is not as expensive as the treatment of water from rivers. It needs only dilution with fresh water from another borehole if it has high salt content and then it is treated with chlorine.

6. Availability of Technicians for Water Supply and Sewage Treatment Works

As stated before, there are not enough skilled technicians of a high level such as design engineers, surveyors and construction engineers. Those that are available can do a good job but there are not enough of them. Skilled supervisors are not available in adequate numbers.

There are a number of reasons for dearth of trained personnel and skilled workers for water supply and sewage treatment works. Firstly, there are not enough places available for training such persons relative to the present demand for training. Since training of such people is based on apprenticeship there are some employers that do not have adequate facilities for training their employees and as such they are not licensed by the government to train them. Secondly, there are employers (private) who are not in favour of employing High School Graduates who are so skillfully trained as they will demand high wages or salaries which the employers cannot afford. Thirdly, High School Graduates who are academically oriented do not want to undertake such technical training as would qualify them to do the jobs which require their training for private firms, industries or the government because the wages or salaries offered by these bodies are not attractive enough. Closely related to this phenomenon is the fact that people who are qualified to train such people also do not want to accept jobs offered them by the government or firms because the salaries are not attractive enough for them.

This is especially so in the case of expatriates who form the bulk of the best qualified persons to train other people. When better salaries are offered and more training opportunities are offered, Kenya will not suffer from lack of personnel and skilled workers for the job of construction, operation, and maintenance of water supply and sewage treatment works.

7. Cost of Construction of Water Supply and Sewage Treatment Facilities

As has been pointed out, Kenya has the capacity for the construction of the above facilities using both local and expatriate knowhow. However, problems are experienced when it comes to the cost of operation and maintenance of such facilities because of lack of qualified personnel for such jobs and for general supervision.

It was stated earlier that Kenya gets money for construction of the above facilities from local sources coupled with external loans and grants from bilateral and international organisations. However Kenya has to get enough money for operation and maintenance of water supply and sewage treatment facilities which also include recurrent expenditure for administration. This is the aspect of water development for which Kenya cannot find enough money. Watersupplies built by different communities on a self-help basis have reduced appreciably government expenditure on construction of water supplies.

8. Financing Water Supply Administration, Operation and Maintenance

There is shortage of funds provided by the government for recurrent expenditure on water supply, operation and maintenance. Currently the government has allocated £ 250,000 - £ 300,000 for water supply administration, operation and maintenance. This amount is about 20 per cent short of the satisfactory amount required to provide the population served with water and sewage facilities. The amount needed should cover provisions for skilled and semi-skilled labour, fuels, chemicals, transport, miscellaneous material and equipment, supervision and administrative services.

It is to be noted that each water supply development entails an additional running cost embracing more men, fuels, chemicals, etc. which in turn need adequate recurrent funding. The funds must be provided in order to make water available for the population.

In view of the above observations, it is not economical to restrict water production because this will reduce water revenue from consumers and it is the government that will suffer since it will not get enough money to take care of recurrent expenditure on water. The best thing to do under these circumstances is to fix the price of water at a level which can be afforded by both the poor and the richer segments of the population, but a price level which will produce enough income to cover a predetermined portion of total cost,

including development. In urban areas sewage treatment facilities are now overloaded due to rapid population growth in the urban areas. This causes more expenditure on the operation of wastewater facilities.

9. The Relationship between the Capital Value of Water Supply Installations and the Running Expenses

It has been noted (in the case of Kenya where there are a large number of water supplies of various kinds where the "average" supply does not vary greatly) that as the installation asset value grows over the years through development carried out and completed, so does the recurrent cost.

It should be noted that Kenya imports all chemicals used in the treatment of water except soda ash which is obtained locally. If all the chemicals used in the treatment of water were obtained locally, the running expenses of water supplies would be reduced greatly.

10. The Effect of Inflation on Prices of Materials

Inflationary trends which are world wide have had the effect of raising the prices of things as well as the price of food. Consequently for Kenya the prices of materials needed for the construction, operation and maintenance of water supply and sewage treatment facilities have also increased. This increase has also affected the cost for labour, since because of inflation, salaries and wages have also increased. The average increase of cost of

materials and labour today is estimated to be approximately 10 per cent per annum and this increase due to inflation is expected to continue for the future years.

11. Labour Force

It has been noted that among the highly skillful and technical workers, such as engineers, chemists, and others, the non-local (expatriate) portion makes up 25.5 per cent - a rather high percentage considering that the expatriates earn a higher salary than that of the local experts. Consequently, as pointed out before, there is lack of expertise in important areas of work pertaining to construction, operation and maintenance of water supply and sewage treatment facilities because it is the expatriates who form the bulk of the experts at the top. If Kenya could train its own local highly qualified staff in these areas which need their skill, it might reduce the expenditure pertaining to salaries which are now paid to expatriates who earn more than local staff with the same qualifications.

12. Effect of Unemployment

As has already been stated, about 80 per cent of Kenya's labour force is unemployed. This has an effect on the total water consumption which would be higher if this section of the population had wage employment. The rationale here is that with employment these unemployed people now numbering 5,215,300, would be in a position to pay for their water consumption. This naturally would increase the

amount of water demand and at the same time would increase revenue from water.

13. Effect of Public versus Private Sector in Wage Employment

At present because the private sector (private firms and industries) offer higher salaries than the public sector (the government), there are more people employed by the private sector than by the public sector. There are 468,700 people employed by private sector as compared with 340,600 people employed by the public sector. Thus the private sector has employed 128,000 more people than the public sector. The effect of this is that the government is short of employees who otherwise would be employed on the jobs which, for example, pertain to construction, operation and maintenance of water supply and sewage treatment facilities. More employees in this area would result in more water supplies constructed which would probably mean that more people would use water and thus there would be more revenue received from water consumption although this also has the effect of creating more recurrent expenditure to operate and maintain additional water supplies.

14. The Effect of the Average Income per Family

The average income per year per family in Kenya is only K.£ 300 (K.shs. 6,000). This income is too low for people to want to make full use of piped water which must be paid for. Consequently many employed people in Kenya cannot afford living in homes where they have to pay a

substantial amount of money for their water. This has the effect of reducing the amount of income or revenue that the government could derive from water charges as it also has the effect of discouraging plans for expansion of the number of water supplies needed by the population.

If wages are increased adequately to take care of such expenses as water, it is likely that the government may collect a little more revenue from water than it is doing at the moment. But raising the incomes of individuals also entails educating the population and giving people skills and knowledge necessary for work and expertise required in many fields. Hence this also has the effect of extra expenditure by the government on educational expansion.

15. Expanding Rural Water Supplies and Wastewater Facilities

Rural population is still poor. Customs and the concomitant taboos still control people's behaviour. Research by the author, reported here shows that because of the African traditional way of life many people are not in favour of shared water and wastewater facilities in their homes or in their communities because of certain taboos which restrict such sharing of water with certain individuals and relatives. This attitude is observed both in rural and urban areas. Public water facilities in rural and urban areas for the purposes of bathing and wastewater disposal are not very welcome by people. Therefore plans

to establish water supplies in rural areas must consider people's attitudes toward water usage. Individual water connections would be ideal but rural population is poor and many people cannot afford to pay for their water. For those who cannot pay for their water it seems that the only alternative possible is the establishment of communal water points whose supply can only be used for drinking, cooking and bathing at home (not in the actual communal water spots from where individuals will have to draw water and carry it home).

The spirit of "self-help" (Harambee) in rural areas has made it possible for people in different communities in Kenya to construct their own water supplies using their own resources. This has greatly reduced government expenditure on construction of water supplies in rural areas. Due to poverty which makes it impossible for rural people to construct more sophisticated water supply and wastewater facilities whose cost of operation and maintenance they cannot meet, it would be worthwhile to advise rural people to use pit latrines which are cheaper to construct and maintain.

APPENDIX A

DEMOGRAPHIC AND TECHNOLOGY DATA

Please check the appropriate category in each question. If exact figures are not available, give the closest estimate.

POPULATION

1. Present Population - The figure or estimate of the present population should reflect the number of inhabitants that the proposed water or wastewater treatment facility is going to serve.

____ (1) Between 500 and 2,500 people

____ (2) 2,500 - 15,000

____ (3) 15,000 - 50,000

____ (4) 50,000 - 100,000

x (5) Other (specify)

Mombasa	Kisumu	Nyeri	Kenya
328,357	47,200	12,454	13,413,000

For each question from number 2 to number 9, if local or site figure is not available, please use national figure and also indicate whether it is national or local figure.

2. Annual population growth rate

[X] National [ ] Local

____ (1) Less than 1%

____ (2) 1% - 3%

x (3) 3% - 5% 3.5%

____ (4) 5% - 10%

____ (5) 10% - 20%

____ (6) Greater than 20%

3. Life expectancy of population in years

[X] National [ ] Local

____ (1) Less than 40 years old

____ (2) 40 - 50

_x_ (3) 50 - 60 57.2

____ (4) 60+

4. Birth Rate: The average number of newborn each year per 1,000 population.

[X] National [ ] Local

____ (1) Less than 10

____ (2) 10 - 30

____ (3) 30 - 50

_x_ (4) 50 - 100 50

____ (5) 100 - 200

____ (6) More than 200

5. Infant (under one year of age) mortality rate per 1,000 population each year.

[X] National [ ] Local

____ (1) Greater than 100

____ (2) 50 - 100

____ (3) 30 - 50

_x_ (4) 10 - 30 17

____ (5) Less than 10

6. Survival Rate: The percentage of inhabitants expected to survive during any given year.

[X] National [ ] Local

____ (1) Less than 80%

____ (2) 80% - 90%

____ (3) 90% - 95%

____ (4) 95% - 97%

x (5) 97% - 99% 98.4%

____ (6) More than 99%

7. % of Emigrants: The percentages of the total population that leave the area and begin to live in another community each year.

[X] National [ ] Local

x (1) Less than 1%

____ (2) 1% - 3%

____ (3) 3% - 5%

____ (4) 5% - 10%

____ (5) 10% - 20%

____ (6) Greater than 20%

8. % of Immigrants: The percentages of the total population that have just arrived to live in the community on a permanent basis each year.

[X] National [ ] Local

x (1) Less than 1%

____ (2) 1% - 3%

____ (3) 3% - 5%

____ (4) 5% - 10%

____ (5) 10% - 20%

____ (6) Greater than 20%

9. Calories intake per day per person

[X] National [ ] Local

____ (1) Less than 1,000

____ (2) 1,000 - 1,500

____ (3) 1,500 - 2,000

x (4) Greater than 2,000 2200

TECHNOLOGY

10. Level of water treatment technology development in the local comm

Type of Water Supply System	% of Population Being Served			
	0-25%	25-50%	50-75%	75-100%
(1) Central village or street pump	K			
(2) Piped water supply to houses	N		K M	

11. Level of sewage treatment technology development in the local com

Type of System	% of Population Being Served			
	0-25%	25-50%	50-75%	75-100%
(1) Sewage collectic system	K N*			N**
(2) Sewage treatment	M N		K	

Key: M - Mombasa
K - Kisumu
N - Nyeri

* Main town sewerage
** Town plus separate systems

In the judgement of the respondent, which of the following most appropriately describes this project.

12. Technology Advancement

x M,K,N (1) Simply transfer of a process that had been successful elsewhere.

x N (2) An adaptation of another process but altered to be more suited to local characteristics.

x K (3) A unique process developed especially for the characteristics of this site.

13. Quality of Project for Research

x M (1) A breakthrough for enhancing the development of this country.

x K,N (2) An important feature for the local people but not significant to overall development of the country.

____ (3) Redundant, of little use to the people.

Key: M - Mombasa
K - Kisumu
N - Nyeri

APPENDIX B

SOCIO-ECONOMIC DATA

Check the appropriate category for the following.

1. Average level of education obtained for the community.

	Level	None	Primary	High School	Technical Institute	College
____	(1)	95%	4%	1%	0%	0%
____	(2)	70%	19%	7%	3%	1%
____	(3)	55%	x 22%	14%	6%	3%
____	(4)	9%	34%	42%	8%	7%
x		60%		1.7%	0.06%	0.06%

2. Average distribution of Labor Force in the community.

	Level	Unskilled	Semi-Skilled	Professional
____	(1)	97%	2%	1%
____	(2)	80%	16%	4%
____	(3)	61%	27%	12%
____	(4)	45%	30%	25%
x	(5)	6.41%	1.80%	0.17%

3. Annual average income per family in your country currency.

300	Kenya pounds
amount	unit

If available, also check the approximated U. S. dollars equivalency of this amount shown in the following

____ (1) Less than $100

x (2) $100 - $1,000 $ 750

____ (3) $1,000 - $3,000

____ (4) Greater than $3,000

4. Among the highly skillful and technical workers (for example, engineer, chemist, etc.) what percentages of these are non-local or non-native people.

____ (1) Less than 10%
____ (2) 10% - 25%
x (3) 25% - 50% 25.5%
____ (4) 50% - 75%
____ (5) 75% - 100%

5. Are the primary and secondary schools operated by voluntary or missionary organizations?

x (1) Yes But not all of them ____ (2) No

6. What is the highest grade offered by local schools on a regular basis? (Circle one)

1 2 3 4 5 6 7 8 9 10 11 x 12 xx 12+ Not man

7. If the number selected in #6 above is less than 12, how far away is the nearest high school offering the 12th grade?

____ (1) Less than 10 miles (or less than 16 kilometers) Not applicable
____ (2) 10 - 30 miles (or 16 - 48 kilometers)
____ (3) 30 - 50 miles (or 48 - 60 kilometers)
____ (4) Greater than 50 miles. (greater than 60 kilometers)
____ (5) Other (specify) _____

8. Are there any technical or vocational schools in the community?

x (1) Yes ____ (2) No

9. Has the community achieved compulsory primary education of at least six years?

____ (1) Yes x (2) No

10. Are there any formal in-service training programs by either the government or local industry for their employees?

x (1) Yes ____ (2) No

11. Is there a college or university in the community?

x (1) Yes ____ (2) No

12. Does the university have a chemistry department or laboratory?

x (1) Yes ____ (2) No

13. How do you rate the ability of the community to finance a water and sewage treatment project?

____ (1) Unable to repay; the project is a pure charity scheme because the beneficiaries are poor.

x (2) Limited ability to repay; however, the social benefits exceed the social costs. - For Mombasa, Kisumu and Nyeri

____ (3) Repayment prospects are good; the beneficiaries have comparatively high incomes.

14. Is unemployment widespread?

x (1) Yes - ____ (2) No

If available, give the percentage of unemployment among the total population.

92.8 % of unemployment

15. Are advisory services widely available to farmers for community development or for other programs designed to upgrade the skills and enlist the participation of the masses?

x (1) Yes ____ (2) No

16. Do most college or university students of the community receive their education in neighboring communities, neighboring countries, or other foreign countries?

____ (2) Yes x (2) No

17. The level of technology available can generally be classified as

x (1) Hand tools only
x (2) Mechanical tools (i.e., gasoline powered equipment)) Hand tools and some mechanical tools
____ (3) Chemical products (fertilizers, chlorine)
____ (4) Electronic technology

18. Does the government dominate the labor market?

____ (1) Yes x (2) No

19. Are public employment services readily available?

x (1) Yes - But they are not very efficient (2) No

Questions 20 - 23 relate to the availability of materials and equipment. Check those items that are never available in the Community.

20. Operation: Which of the following are never available in the local community.

____ (1) Meters
____ (2) Lawn mowers
____ (3) Blowers
____ (4) Recording devices
____ (5) Laboratory equipment
____ (6) Portable power plant
____ (7) Motors
____ (8) Pumps

Not applicable

21. Process: Which of the following are never available in the local community.

____ (1) Pipe (clay, steel, cement, plastic, copper, etc.)
____ (2) Pipe fittings
____ (3) Paint
____ (4) Valves
____ (5) Tanks
____ (6) Gauges
X (7) Heat exchangers

22. Operation and Maintenance: Which of the following are never available in the local community.

____ (1) Silica sand
____ (2) Graded gravel
____ (3) Clean water
____ (4) Gasoline

Not applicable

23. Chemicals: Which of the following are never available in the local community.

____ (1) Al_2SO_4 (aluminum sulfate)
____ (2) $FeCl_2$ (ferric chloride)
____ (3) Activated charcoal
____ (4) Lime
____ (5) Soda ash
____ (6) Chlorine
____ (7) Ozone
____ (8) Laboratory chemicals

Not applicable

24. Major Water Source (check appropriate category).

X (1) River or stream
____ (2) Lake or impoundment
____ (3) Wells
____ (4) Sea or brackish

25. Approximate per capita water demand (daily)

(1) Current demands _____ in _____ (units)

(2) 10 year projection: _____

(see next page)

26. Is groundwater available?

_x_ (1) Yes ____ (2) No

27. Are wells already drilled?

_x_ (1) Yes ____ (2) No

28. Is a central wastewater collection system in existence?

_x_ (1) Yes ____ (2) No

29. Is the following wastewater data available? Please fill in the percentage of people in the community that are:

(1) Currently connected to the system _____ %

(2) To be connected within 5 years of the start of the project _____ %

(3) To be connected within 10 years _____ %

(See next page)

30. Are industrial and commercial concerns using the waste water system and if so, in what quantity? (in thousands of gallons)

(1) Currently _____

(2) Within 5 years _____

(3) Within 10 years _____

Figures for Kisumu, Mombasa and Nyeri towns are not available.

25. (1) 5-7 million gallons for Mombasa Town
(2) 17,779,080 million gallons for Mombasa Town.

(1) 517,000 gallons for Nyeri Town
(2) 638,160 gallons for Nyeri Town

(1) 2,300,000 gallons for Kisumu Town
(2) 2,340,000 gallons for Kisumu Town

29. (1) 2.6% for Kisumu
(1) 10% for Mombasa
(2) 50% for Mombasa
(3) 90% for Mombasa

(1) 25% for Nyeri
(2) 100% for Nyeri
(3) 100% for Nyeri

APPENDIX C

PROCESS DATA

Please supply the following data related to the treatment process of the project. If there are more than one treatment plant, please fill in ONE data sheet FOR EACH PLANT.

For Water treatment process, please fill in PART I; and for Sewage treatment, fill in PART II. Indicate the data either in metric unit or in British unit.

PART I: WATER TREATMENT PROCESS - Kisumu Town

1. Type of Process: Lake supply-coagulation, upward flow, sedimentation, rapid gravity filtration, disinfection and PH correction.
2. Please check the appropriate water treatment process or processes in the following which fit the one(s) used at your treatment plant.

____ (1) PW1* Drilled Well

_x_ (2) PW2 Pre-Treatment

____ (3) PW3 Slow Sand Filtration

_x_ (4) PW4 Rapid Sand Filter - Conventional

____ (5) PW5 Rapid Sand Filter - Advanced

____ (6) PW6 Softening

_x_ (7) PW7 Disinfection

____ (8) PW8 Taste-Odor - Fe, Mn

____ (9) PW9 Desalting - Salt (Sea water)

____ (10) PW10 Desalting - Brackish

____ (11) PW11 Coagulation Pressure Filtration

---

* PW1, PW2, PW3, etc., are process codes used in the OU/USAID project.

3. Source

____ (1) River or stream

_x_ (2) Lake or impoundment

____ (3) Wells

____ (4) Sea or brackish

Sub-treatment methods used

4. Settling

____ (1) Plain sedimentation

_x_ (2) Coagulation

____ (3) Tube or plate

_x_ (4) Upflow

_x_ (5) Coagulation material

_x_ a. Al_2SO_4

____ b. $FeCl_3$

____ c. Polymer

____ d. Other

____ (6) Approximate design criteria used

British Unit		Metric Unit	
a. Loading rate (Q/A)			
____ (a) Less than 500 gpd/ft^2	or	____ (a) Less than 20 m/day	
____ (b) 500 - 1,000	or	_x_ (b) 20 - 40	
____ (c) Greater than 1,000	or	____ (c) Greater than 40	

b. Detention time in hours

____ (a) ½ - 1

____ (b) 1 - 2

_x_ (c) 2 - 4

____ (d) Greater than 4

c. Mixing: Mean velocity gradient, G (= $\frac{1}{T}$, when T=detention time).

____ (a) 10 - 25)
____ (b) 25 - 50) Not applicable
____ (c) 50 - 75)

d. Design capacity

British Unit			Metric Unit		
____	(a) Less than 0.5 MGD	or	____	(a) Less than 0.025 m^3/se	
____	(b) 0.5 - 5	or	X	(b) 0.025 - 0.25	
____	(c) 5 - 20	or	____	(c) 0.25 - 1.0	
____	(d) Greater than 20	or	____	(d) Greater than 1.0	

e. Stirring and/or mixing devices.

____ (a) Baffle)
____ (b) Paddle) Not applicable
____ (c) Air)

5. Filters

(1) Rate of flow

____a. Slow (0.05 to 0.10 gpm/ft^2 or 0.002 to 0.004 M/min)

X b. Rapid (approximately 2 gpm/ft^2 or 0.08 M/min)

____c. Greater than 2 gpm/ft^2 or 0.08 M/min

(2) Filter media

X a. Sand

____b. Multi-media

____c. Other

(3) Hydraulic mean size (10% by weight on sieve analysis)

____a. 0.2 mm

_x_b. 0.6 mm

____c. 1.0 mm

(4) Depth of media

British Unit		Metric Unit
____a. Less than 40 inches	or	_x_a. Less than 100 cm
____b. 40 - 50	or	____b. 100 -. 125
____c. Greater than 50	or	____c. Greater than 125

(5) Controls for backwash

____a. Mechanical or hydraulic

_x_b. Simplified or operator controlled

(6) Direction of flow through filter

____a. Upward

_x_b. Down flow

____c. Both

(7) Control of Filtration rate

____a. Rate controller

_x_b. Declining head

____c. Siphon head

____d. Other (specify)

6. Disinfection Method

_x_ (1) Cl_2

____ (2) Lime

____ (3) Ultra-violet

____ (4) Ozone

____ (5) Other

PART II: SEWAGE TREATMENT PROCESS - Kisumu Existing Sewage Treatment Works

1. Type of Process: Conventional-primary sedimentation, biofilters, humus recirculation

2. Please check the appropriate treatment process or processes in the following which fit the one(s) used at your treatment plant.

x (1) PS1 Primary - Conventional (e.g., settling and discharge)

___ (2) PS2 Primary - Stabilization Pond

x (3) PS3 Sludge - Conventional (e.g., anaerobic digesters)

___ (4) PS4 Sludge - Advanced (using commercial filters)

___ (5) PS5 Sludge - Combined Imhoff

x (6) PS6 Secondary - Standard Filter (e.g., slow-sand or trickling filter)

___ (7) PS7 Secondary - High Rate Filter (e.g., high rate trickling filter)

___ (8) PS8 Secondary - Activated Sludge

___ (9) PS9 Secondary - Extended Aeration (e.g., aerated lagoon, Dutch ditch)

___ (10) PS10 Disinfection (e.g., chlorination)

x (11) -- Irrigation, dilution - Humus tanks and recirculation

3. Type of separate sludge treatment

x (1) Anaerobic

___ (2) Heated

___ (3) Vacuum filter

x (4) Aerobic

___ (5) Mixing

4. Sludge disposal

____ (1) Incineration
x (2) Fertilizer
____ (3) Others (specify) _____

5. Design capacity

	British Unit			Metric Unit
____	(1) Less than 0.1 MGD	or	____	(1) Less than 0.004 m^3/sec
____	(2) 0.1 - 1	or	____	(2) 0.004 - 0.05
x	(3) 1 - 5	or	x	(3) 0.05 - 0.25
____	(4) 5 - 10	or	____	(4) 0.25 - 0.5
____	(5) Greater than 10	or	____	(5) Greater than 0.5

6. Type of screens

x (1) Manual
x (2) Mechanical
x (3) For grit removal
____ (4) For grease or floating wastes removal

7. Primary treatment design

(1) Loading rate in clarifier, (Q/A)

	British Unit			Metric Unit
x	a. Less than 750 gpd/ft^2	or	____	a. Less than 30 m/day
____	b. 750 - 1000	or	____	b. 30 - 40
____	c. Greater than 1000	or	____	c. Greater than 40

(2) Dentention time (t)

____ a. Less than 1 hour
____ b. 1 - 2 hours
x c. More than 2 hours

8. Secondary treatment design

(1) Trickling filter

	British Unit			Metric Unit
x	a. 0.1 - 1.0 lb-BOD/yd^3/day	or	x	a. 0.06 - 0.6 Kg-BOD/m^3/day
____	b. 1.0 - 4.5	or	____	b. 0.6 - 2.6
____	c. 4.5 - 6.0	or	____	c. 2.6 - 3.5
____	d. 6.0 - 25	or	____	d. 3.5 - 15
____	e. Greater than 25	or	____	e. Greater than 15

(2) Sand filter loading (N/A)

	British Unit			Metric Unit
____	a. Less than 50 lb-BOD/acre/day		____	a. Less than 5.0 g-BOD/m^2/day
____	b. 50 - 100	or	____	b. 5 - 10
____	c. 100 - 250	or	____	c. 10 - 28
____	d. 250 - 500	or	____	d. 28 - 56
____	e. Greater than 500	or	____	e. Greater than 56

(3) Activated sludge loading by MLSS (mixed liquor suspended solids #BOD/#SS)

____ a. 1/1 or less (N/A)

____ b. 2/1 to 5/1

____ c. 10/1 to 20/1

or by Aeration (N/A)

	British Unit			Metric Unit
____	a. 0 - 30 lb-BOD/1000 CF	or	____	a. 0 - 0.50 Kg-BOD/m^3
____	b. 30 - 60	or	____	b. 0.50 - 1.0
____	c. 60 - 300	or	____	c. 1.0 - 5.0

(4) Aeration devices

____ a. Compressed air

____ b. Brushed N/A

____ c. Surface aerator

____ d. Paddles

____ e. Other

(5) Oxidation pond loading N/A

British Unit			Metric Unit
____	a. Less than 20 lb-BOD/acre/day		____ a. Less than 2.2 g-BOD/m^2/day
____	b. 20 - 50	or	____ b. 2.2 - 5.5
____	c. 50 - 150	or	____ c. 5.5 - 17
____	d. Greater than 150	or	____ d. Greater than 17

(6) Aerated lagoon N/A

British Unit			Metric Unit
____	a. Less than 100 lb-BOD/acre/day		____ a. Less than 10 g-BOD/m^2/day
____	b. 100 - 250	or	____ b. 10 - 28
____	c. 250 - 500	or	____ c. 28 - 56
____	d. Greater than 500	or	____ d. Greater than 56

PART II: SEWAGE TREATMENT PROCESS - Kisumu - New Sewage Treatment Works

1. Type of Process: Waste stabilization Ponds-Facultative + 2 Maturation

2. Please check the appropriate treatment process or processes in the following which fit the one(s) used at your treatment plant.

____ (1) PS1 Primary - Conventional (e.g., settling and discharge)

X (2) PS2 Primary - Stabilization Pond

____ (3) PS3 Sludge - Conventional (e.g., anaerobic digesters)

____ (4) PS4 Sludge - Advanced (using commercial filters)

____ (5) PS5 Sludge - Combined Imhoff

____ (6) PS6 Secondary - Standard Filter (e.g., slow-sand or trickling filter)

____ (7) PS7 Secondary - High Rate Filter (e.g., high rate trickling filter)

____ (8) PS8 Secondary - Activated Sludge

X (9) PS9 Secondary - Extended Aeration (e.g., aerated lagoon, Dutch ditch) - Maturation (Aerobic)

____ (10) PS10 Disinfection (e.g., chlorination)

____ (11) -- Irrigation, dilution

3. Type of separate sludge treatment N/A

____ (1) Anaerobic

____ (2) Heated

____ (3) Vacuum filter

____ (4) Aerobic

____ (5) Mixing

4. Sludge disposal

____ (1) Incineration
x (2) Fertilizer
____ (3) Others (specify) _____

5. Design capacity

British Unit			Metric Unit	
____ (1) Less than 0.1 MGD	or		____ (1) Less than 0.004 m^3/sec	
____ (2) 0.1 - 1	or		____ (2) 0.004 - 0.05	
x (3) 1 - 5	or		x (3) 0.05 - 0.25	
____ (4) 5 - 10	or		____ (4) 0.25 - 0.5	
____ (5) Greater than 10	or		____ (5) Greater than 0.5	

6. Type of screens

x (1) Manual
____ (2) Mechanical
x (3) For grit removal
____ (4) For grease or floating wastes removal

7. Primary treatment design

(1) Loading rate in clarifier, (Q/A)

British Unit		Metric Unit
____ a. Less than 750 gpd/ft^2	or	____ a. Less than 30 m/day
____ b. 750 - 1000	or	____ b. 30 - 40
____ c. Greater than 1000	or	____ c. Greater than 40

(2) Dentention time (t) N/A

____ a. Less than 1 hour
____ b. 1 - 2 hours
____ c. More than 2 hours

8. Secondary treatment design

(1) Trickling filter N/A

British Unit			Metric Unit	
____	a. 0.1 - 1.0 lb-BOD/yd^3/day	or	____	a. 0.06 - 0.6 Kg-BOD/m^3/day
____	b. 1.0 - 4.5	or	____	b. 0.6 - 2.6
____	c. 4.5 - 6.0	or	____	c. 2.6 - 3.5
____	d. 6.0 - 25	or	____	d. 3.5 - 15
____	e. Greater than 25	or	____	e. Greater than 15

(2) Sand filter loading N/A

British Unit			Metric Unit	
____	a. Less than 50 lb-BOD/acre/day		____	a. Less than 5.0 g-BOD/m^2/day
____	b. 50 - 100	or	____	b. 5 - 10
____	c. 100 - 250	or	____	c. 10 - 28
____	d. 250 - 500	or	____	d. 28 - 56
____	e. Greater than 500	or	____	e. Greater than 56

(3) Activated sludge loading by MLSS (mixed liquor suspended solids #BOD/#SS) N/A

____ a. 1/1 or less

____ b. 2/1 to 5/1

____ c. 10/1 to 20/1

or by Aeration N/A

British Unit			Metric Unit	
____	a. 0 - 30 lb-BOD/1000 CF	or	____	a. 0 - 0.50 Kg-BOD/m^3
____	b. 30 - 60	or	____	b. 0.50 - 1.0
____	c. 60 - 300	or	____	c. 1.0 - 5.0

(4) Aeration devices

____ a. Compressed air

____ b. Brushed

____ c. Surface aerator

____ d. Paddles

____ e. Other

(5) Oxidation pond loading

	British Unit			Metric Unit
____	a. Less than 20 lb-BOD/acre/day		____	a. Less than 2.2 g-BOD/m^2/day
____	b. 20 - 50	or	____	b. 2.2 - 5.5
x	c. 50 - 150	or	x	c. 5.5 - 17
____	d. Greater than 150	or	____	d. Greater than 17

(6) Aerated lagoon N/A

	British Unit			Metric Unit
____	a. Less than 100 lb-BOD/acre/day		____	a. Less than 10 g-BOD/m^2/day
____	b. 100 - 250	or	____	b. 10 - 28
____	c. 250 - 500	or	____	c. 28 - 56
____	d. Greater than 500	or	____	d. Greater than 56

APPENDIX D

DATA IDENTIFICATION

FACILITY TITLE:

Kisumu Town Water Supply and Sewage Treatment Facilities

RESPONDENT:

Name: Mr. Joshua Oiro, B.Sc.(Civ. Eng.), M.Sc., (S.E.), M.I.E.K.

Title: Acting Town Engineer

Address: Municipality of Kisumu, Town Hall. P.O. Box 105, Kisumu, Kenya.

OWNERSHIP OF THE FACILITY:

Municipality of Kisumu

Owner's Address: Municipality of Kisumu, Town Hall, P.O. Box 105, Kisumu, Kenya.

NAME OF COMMUNITY TO BE SERVED BY THE FACILITY:

Town or City: Kisumu Town

State or Province: Nyanza Province

Country: Kenya

APPENDIX D

DATA IDENTIFICATION

FACILITY TITLE:

Nyeri Town Water Supply and Sewage Treatment Facilities

RESPONDENT:

Name: Mr. P.C. Shelat, B.Sc., B.E.(Civil)

Title: Town Water Engineer

Address: Provincial Water Engineer's Office, Nyeri Town, P.O. Box 1343, Nyeri, Central Province, Kenya.

OWNERSHIP OF THE FACILITY:

Nyeri Municipality

Owner's Address: Nyeri Town, P.O. Box 1343, Nyeri, Central Province, Kenya

NAME OF COMMUNITY TO BE SERVED BY THE FACILITY:

Town or City: Nyeri Town

State or Province: Central Province

Country: Kenya

APPENDIX D

DATA IDENTIFICATION

FACILITY TITLE:

Mombasa Town Water and Sewage Treatment Facilities

RESPONDENT:

Name: a. Mr. P.C. Patel, C.Eng., M.I.C.E. (Sewage)
b. Mr. Peter Ouma (Water Supply)

Title: Mr. Patel, Principal Assistant Engineer, Design and Development, Mombasa Municipal Council
Mr. Ouma, Water Supply Assistant

Address: * For Water Supply) see below
** For Sewerage)

OWNERSHIP OF THE FACILITY:

Mombasa Municipality

Owner's Address: Mombasa Municipal Council
P.O. Box 90440, Mombasa, Kenya

NAME OF COMMUNITY TO BE SERVED BY THE FACILITY:

Town or City: Mombasa Town

State or Province: Coast Province

Country: Kenya

* For Water Supply: Water Development Division, Mombasa Provincial Headquarters, P.O. Box 82276, Mombasa, Kenya.

** For Sewerage: Principal Assistant Engineer-Design and Development Mombasa Municipal Council, P.O. Box 81861, Mombasa, Kenya.

APPENDIX E

OPERATIONAL DATA ~~XXXXXXXX~~ (WATER)

KISUMU TOWN

Please check the appropriate category related to the operation of the treatment plant.

1. Type of treatment plant.

x (1) Water treatment

____ (2) Sewage treatment

OPERATORS

2. Availability of trained or skilled operators

____ (1) Easy to find

x (2) Difficult to find

3. Existence of a standard or system for evaluating the qualifications of operators

x (1) Yes

____ (2) No

4. Short courses or other training programs for operators available

x (1) Yes

____ (2) No

5. Reason for leaving employment at the treatment plant

x (1) Better job

____ (2) Discharged

x (3) Others (specify) some may choose to leave the work if they abscond work and they are to be disciplined for it.

6. Average age of operators

____ (1) Less than 20 years old

x (2) 20-30

____ (3) 30-40

____ (4) Older than 40

7. Qualify of operators

_____ (1) Not dependable

_____ (2) Fair

x (3) Good

_____ (4) Excellent

CHEMICALS

8. Location (distance) for obtaining chemicals

x (1) Local Soda ash from Lake Magadi

_____ (2) In-country

x (3) Out-of-country from Britain (chlorine gas) India (Alum)

9. Availability of chemicals

_____ (1) Easy to obtain locally

x (2) Difficult to obtain locally

_____ (3) Easy to obtain non-locally

_____ (4) Difficult to obtain non-locally

MACHINERY, PARTS, ETC.

10 Causes of machinery breakdown

_____ (1) Operator error

_____ (2) Product failure

x (3) Others (specify) Lack of spare parts.

11. Time interval for replacement of machinery or parts

_____ (1) Too often as compared to the expected life of the item

_____ (2) Not as often as compared to the expected life of the item

x (3) Routine replacement

12. Delivery time of ordered parts

_____ (1) Less than 1 week

(2) Between 1 and 4 weeks

x (5) More than one year

If ordered from abroad, and sometim

13. Parts replaced are usually

x (1) ordered specially

____ (2) Off the shelf (common parts)

____ (3) Other (specify) _____ water

_____ sewage

14. Repair of machinery

____ (1) Repaired locally

x (2) Repaired in-country

____ (3) Repaired out-of-country

____ (4) No repair, replaced by new one

OPERATIONAL FAILURE (TECHNICAL)

15. Characteristic of raw water causing difficulty in treatment

____ (1) Turbidity

____ (2) Algae

x (3) Other (specify) Floating islands cause difficulty in the coagulation process water

_____ sewage

16. Operational failure due to the following

____ (1) Storage

x (2) Pumps bursts in the distribution

____ (3) Lack of water

____ (4) Other (specify) _____ water

_____ sewage

17. Failure due to the designed process

____ (1) Under-designed

____ (2) Improper design

____ (3) Adequate design

____ (4) Over-loading

x (5) Other (specify) No failure due to the design water

_____ sewage

SUPERVISORY CONTROL

18 Inspection of plant

x (1) Regular inspection

x a. Local

____ b. Regional

____ c. National

____ d. Other (specify) _____ water

_____ sewage

____ (2) Active supervision at the plant

____ (3) Other (specify) _____ water

_____ sewage

19. Laboratory location

x (1) At plant

____ (2) Regional

____ (3) Central

____ (4) Mobile

____ (5) Non-existant

PROBLEMS NOT SOLVED BY PRESENT FACILITY

20. Technical problems of effluent

x (1) Odor of water From sewage treatment plant

____ (2) Taste of water

x (3) Color of water Effluent discharged from textile industry colours the water

____ (4) None

____ (5) Other (specify) _____ water

_____ sewage

21. Monetary problems in operations

x (1) Extreme difficulty in financing

____ (2) Moderate difficulty in financing

____ (3) No difficulty in financing

APPENDIX E

OPERATIONAL DATA (SEWAGE)

KISUMU TOWN

Please check the appropriate category related to the operation of the treatment plant.

1. Type of treatment plant.

____ (1) Water treatment

_x_ (2) Sewage treatment

OPERATORS

2. Availability of trained or skilled operators

____ (1) Easy to find

_x_ (2) Difficult to find

3. Existence of a standard or system for evaluating the qualifications of operators

_x_ (1) Yes

____ (2) No

4. Short courses or other training programs for operators available

_x_ (1) Yes

____ (2) No

5. Reason for leaving employment at the treatment plant

_x_ (1) Better job

____ (2) Discharged

____ (3) Others (specify)

6. Average age of operators

____ (1) Less than 20 years old

_x_ (2) 20-30

____ (3) 30-40

____ (4) Older than 40

7. Qualify of operators

_____ (1) Not dependable

_____ (2) Fair

__x__ (3) Good

_____ (4) Excellent

CHEMICALS

8. Location (distance) for obtaining chemicals

__x__ (1) Local

_____ (2) In-country

__x__ (3) Out-of-country

9. Availability of chemicals

_____ (1) Easy to obtain locally

__x__ (2) Difficult to obtain locally

_____ (3) Easy to obtain non-locally

_____ (4) Difficult to obtain non-locally

MACHINERY, PARTS, ETC.

10 Causes of machinery breakdown

_____ (1) Operator error

_____ (2) Product failure

__x__ (3) Others (specify) Lack of spare parts

11. Time interval for replacement of machinery or parts

_____ (1) Too often as compared to the expected life of the item

_____ (2) Not as often as compared to the expected life of the item

__x__ (3) Routine replacement

12. Delivery time of ordered parts

_____ (1) Less than 1 week

_____ (2) Between 1 and 4 weeks

(3) Between 1 and 6 months

13. Parts replaced are usually

x (1) ordered specially

____ (2) Off the shelf (common parts)

____ (3) Other (specify) _____ water

_____ sewage

14. Repair of machinery

____ (1) Repaired locally

x (2) Repaired in-country

____ (3) Repaired out-of-country

____ (4) No repair, replaced by new one

OPERATIONAL FAILURE (TECHNICAL)

15. Characteristic of raw water causing difficulty in treatment

____ (1) Turbidity

____ (2) Algae

x (3) Other (specify) _____ water

Floating islands cause difficulty in the coagulation process sewage

16. Operational failure due to the following

____ (1) Storage

x (2) Pumps · Pump bursts

____ (3) Lack of water

____ (4) Other (specify) _____ water

_____ sewage

17. Failure due to the designed process

____ (1) Under-designed

____ (2) Improper design

____ (3) Adequate design

____ (4) Over loading

x (5) Other (specify) _____ water

No failure due to the design sewage

SUPERVISORY CONTROL

18 Inspection of plant

x (1) Regular inspection

x a. Local

____ b. Regional

____ c. National

____ d. Other (specify) _____ water

_____ sewage

____ (2) Active supervision at the plant

____ (3) Other (specify) _____ water

_____ sewage

19. Laboratory location

x (1) At plant

____ (2) Regional

____ (3) Central

____ (4) Mobile

____ (5) Non-existant

PROBLEMS NOT SOLVED BY PRESENT FACILITY

20. Technical problems of effluent

x (1) Odor of water — From sewage treatment plant

____ (2) Taste of water

x (3) Color of water — Effluent discharged from textile industry colours the water

____ (4) None

____ (5) Other (specify) _____ water

_____ sewage

21. Monetary problems in operations

x (1) Extreme difficulty in financing

____ (2) Moderate difficulty in financing

____ (3) No difficulty in financing

22. Operational cost and capacity

(1) Capacity in million gallon/day or in m^3/day

____	2,0. .,000 (Amount)	Gallons (Unit)

(2) Total annual operational cost

____	3.752.857.15 (Amount)	Kenya shillings (Unit)

(3) Annual operational cost for personnel (payroll)

____	____ (Amount)	____ (Currency unit)

23. Administrative problems

x (1) Personnel

____ (2) Managerial

____ (3) Supervisory

x (4) Operators Lack of qualified operators

____ (5) None

____ (6) Others (specify) ____ (water)

____ (sewage)

APPENDIX E

OPERATIONAL DATA (XXXXXXX) (WATER)

NYERI TOWN

Please check the appropriate category related to the operation of the treatment plant.

1. Type of treatment plant.

_x_ (1) Water treatment

____ (2) Sewage treatment

OPERATORS

2. Availability of trained or skilled operators

____ (1) Easy to find

_x_ (2) Difficult to find

3. Existence of a standard or system for evaluating the qualifications of operators

_x_ (1) Yes

____ (2) No

4. Short courses or other training programs for operators availab

_x_ (1) Yes

____ (2) No

5. Reason for leaving employment at the treatment plant

_x_ (1) Better job

____ (2) Discharged

____ (3) Others (specify)

6. Average age of operators

____ (1) Less than 20 years old

____ (2) 20-30

_x_ (3) 30-40

____ (4) Older than 40

7. Qualify of operators

_____ (1) Not dependable

_____ (2) Fair

_x_ (3) Good

_____ (4) Excellent

CHEMICALS

8. Location (distance) for obtaining chemicals

_x_ (1) Local

_____ (2) In-country

_____ (3) Out-of-country

9. Availability of chemicals

_x_ (1) Easy to obtain locally

_____ (2) Difficult to obtain locally

_x_ (3) Easy to obtain non-locally

_____ (4) Difficult to obtain non-locally

MACHINERY, PARTS, ETC.

10 Causes of machinery breakdown

_____ (1) Operator error

_____ (2) Product failure

_x_ (3) Others (specify) normal wear and tear

11. Time interval for replacement of machinery or parts

_____ (1) Too often as compared to the expected life of the item

_x_ (2) Not as often as compared to the expected life of the item

_x_ (3) Routine replacement

12. Delivery time of ordered parts

_____ (1) Less than 1 week

_x_ (2) Between 1 and 4 weeks

13. Parts replaced are usually

x (1) ordered specially

____ (2) Off the shelf (common parts)

____ (3) Other (specify) _____ water

_____ sewage

14. Repair of machinery

x (1) Repaired locally

____ (2) Repaired in-country

____ (3) Repaired out-of-country

x (4) No repair, replaced by new one — this involves some parts e.g. bearings, gaskets, cupleathers, etc.

OPERATIONAL FAILURE (TECHNICAL)

15. Characteristic of raw water causing difficulty in treatment

____ (1) Turbidity

____ (2) Algae

x (3) Other (specify) No failure _____ water

_____ sewage

16. Operational failure due to the following

____ (1) Storage

____ (2) Pumps

____ (3) Lack of water

x (4) Other (specify) No failure _____ water

_____ sewage

17. Failure due to the designed process

____ (1) Under-designed

____ (2) Improper design

____ (3) Adequate design

____ (4) Over-loading

x (5) Other (specify) No failure _____ water

_____ sewage

SUPERVISORY CONTROL

18 Inspection of plant

x (1) Regular inspection

x a. Local

x b. Regional

x c. National

____ d. Other (specify) _____ water

_____ sewage

x (2) Active supervision at the plant

x (3) Other (specify) not active at the time of research because of lack of a qualified person who was not available at that time. water

_____ sewage

19. Laboratory location

x (1) At plant

____ (2) Regional

x (3) Central

____ (4) Mobile

____ (5) Non-existant

PROBLEMS NOT SOLVED BY PRESENT FACILITY

20. Technical problems of effluent

____ (1) Odor of water

____ (2) Taste of water

____ (3) Color of water

____ (4) None

x (5) Other (specify) no physical or chemical problems water

_____ sewage

21. Monetary problems in operations

____ (1) Extreme difficulty in financing

____ (2) Moderate difficulty in financing

x (3) No difficulty in financing

NYERI TOWN 204

22. Operational cost and capacity

(1) Capacity in million gallon/day or in m^3/day

_____	0.65 million (Amount)	Gallons (Unit)

(2) Total annual operational cost

_____	150,000 (Amount)	Kenya shillings (Currency unit)

(3) Annual operational cost for personnel (payroll)

_____	60,000 (Amount)	Kenya shillings (Currency unit)

23. Administrative problems

_____ (1) Personnel

_____ (2) Managerial

_____ (3) Supervisory

_____ (4) Operators

__x__ (5) None

_____ (6) Others (specify) _____(water)

_____(sewage)

APPENDIX E

OPERATIONAL DATA (SEWAGE) ~~XXXXXX~~

NYERI TOWN

Please check the appropriate category related to the operation of the treatment plant.

1. Type of treatment plant.

____ (1) Water treatment

x (2) Sewage treatment

OPERATORS

2. Availability of trained or skilled operators

____ (1) Easy to find

x (2) Difficult to find

3. Existence of a standard or system for evaluating the qualifications of operators

____ (1) Yes

x (2) No

4. Short courses or other training programs for operators available

x (1) Yes

____ (2) No

5. Reason for leaving employment at the treatment plant

____ (1) Better job

____ (2) Discharged

x (3) Others (specify) people tend to stay on the job

6. Average age of operators

____ (1) Less than 20 years old

x (2) 20-30

____ (3) 30-40

x (4) Older than 40 Many people are older than 40

7. Qualify of operators

____ (1) Not dependable

____ (2) Fair

____ (3) Good

x (4) Excellent

CHEMICALS

8. Location (distance) for obtaining chemicals

x (1) Local

____ (2) In-country

____ (3) Out-of-country

9. Availability of chemicals

x (1) Easy to obtain locally

____ (2) Difficult to obtain locally

____ (3) Easy to obtain non-locally

____ (4) Difficult to obtain non-locally

MACHINERY, PARTS, ETC.

10 Causes of machinery breakdown

____ (1) Operator error

x (2) Product failure

x (3) Others (specify) Normal wear and tear

11. Time interval for replacement of machinery or parts

x (1) Too often as compared to the expected life of the item

____ (2) Not as often as compared to the expected life of the item

x (3) Routine replacement

12. Delivery time of ordered parts

____ (1) Less than 1 week

____ (2) Between 1 and 4 weeks

x (3) Between 1 and 6 months

13. Parts replaced are usually

x (1) ordered specially

x (2) Off the shelf (common parts)

____ (3) Other (specify) _____ water

_____ sewage

14. Repair of machinery

____ (1) Repaired locally

x (2) Repaired in-country

____ (3) Repaired out-of-country

x (4) No repair, Parts replaced by new one are bearings and broken parts

OPERATIONAL FAILURE (TECHNICAL)

15. Characteristic of raw water causing difficulty in treatment

____ (1) Turbidity

____ (2) Algae

____ (3) Other (specify) _____ water

N/A no failure sewage

16. Operational failure due to the following

____ (1) Storage

x (2) Pumps Pumps break down

x (3) Lack of water Lack of proper maintenance due to unskilled labour may bring about operational failure

____ (4) Other (specify) _____ water

_____ sewage

17. Failure due to the designed process

____ (1) Under-designed

x (2) Improper design

____ (3) Adequate design

____ (4) Over loading

____ (5) Other (specify) _____ water

_____ sewage

NYERI TOWN

SUPERVISORY CONTROL

18 Inspection of plant

x (1) Regular inspection

x a. Local - for mechanical problems

____ b. Regional

x c. National - for efficiency

____ d. Other (specify) _____ water

_____ sewage

____ (2) Active supervision at the plant

____ (3) Other (specify) _____ water

_____ sewage

19. Laboratory location

____ (1) At plant

____ (2) Regional

x (3) Central

____ (4) Mobile

____ (5) Non-existant

PROBLEMS NOT SOLVED BY PRESENT FACILITY

20. Technical problems of effluent

____ (1) Odor of water

____ (2) Taste of water

____ (3) Color of water

____ (4) None

x (5) Other (specify) _____ water

Dissolved oxygen is too low and _____ sewage

biological oxygen. Demand is too high.

21. Monetary problems in operations

____ (1) Extreme difficulty in financing

____ (2) Moderate difficulty in financing

x (3) No difficulty in financing

NYERI TOWN 207

22. Operational cost and capacity

(1) Capacity in million gallon/day or in m^3/day

	Amount	Unit

(2) Total annual operational cost

	Amount	Unit
	8,000	Kenya £

(3) Annual operational cost for personnel (payroll)

	Amount	Currency unit
	2,000	Kenya £

23. Administrative problems

____ (1) Personnel

____ (2) Managerial

____ (3) Supervisory

____ (4) Operators

____ (5) None

x (6) Others (specify) _____ (water)

Lack of technically qualified supervision. (sewage)

APPENDIX E

OPERATIONAL DATA ~~(SUMMARY)~~ (WATER)

MOMBASA TOWN (ISLAND)

Please check the appropriate category related to the operation of the treatment plant.

1. Type of treatment plant.

x (1) Water treatment

____ (2) Sewage treatment

OPERATORS

2. Availability of trained or skilled operators

____ (1) Easy to find

x (2) Difficult to find

3. Existence of a standard or system for evaluating the qualifications of operators

x (1) Yes

____ (2) No

4. Short courses or other training programs for operators availab

x (1) Yes

____ (2) No

5. Reason for leaving employment at the treatment plant

____ (1) Better job

x (2) Discharged They may be discharged for disciplinary reasons

x (3) Others (specify) They may be transferred to other places

6. Average age of operators

____ (1) Less than 20 years old

x (2) 20-30 } 25-40

x (3) 30-40 }

____ (4) Older than 40

MOMBASA TOWN ALI

7. Qualify of operators

____ (1) Not dependable

__x__ (2) Fair

____ (3) Good

____ (4) Excellent

CHEMICALS

8. Location (distance) for obtaining chemicals

____ (1) Local

____ (2) In-country

__x__ (3) Out-of-country Soda ash is available locally

9. Availability of chemicals

__x__ (1) Easy to obtain locally

____ (2) Difficult to obtain locally

____ (3) Easy to obtain non-locally

____ (4) Difficult to obtain non-locally

MACHINERY, PARTS, ETC.

10 Causes of machinery breakdown

____ (1) Operator error

____ (2) Product failure

__x__ (3) Others (specify) General wear and tear

11. Time interval for replacement of machinery or parts

____ (1) Too often as compared to the expected life of the item

____ (2) Not as often as compared to the expected life of the item

__x__ (3) Routine replacement

12. Delivery time of ordered parts

____ (1) Less than 1 week

____ (2) Between 1 and 4 weeks

13. Parts replaced are usually

_____ (1) ordered specially

_____ (2) Off the shelf (common parts)

x (3) Other (specify) Some suppliers have good supply of spare parts but some have to be ordered specially _____ water

_____ sewage

14. Repair of machinery

x (1) Repaired locally

_____ (2) Repaired in-country

_____ (3) Repaired out-of-country

_____ (4) No repair, replaced by new one

OPERATIONAL FAILURE (TECHNICAL)

15. Characteristic of raw water causing difficulty in treatment

x (1) Turbidity

_____ (2) Algae

_____ (3) Other (specify) _____ water

_____ sewage

16. Operational failure due to the following

_____ (1) Storage

x (2) Pumps

_____ (3) Lack of water

_____ (4) Other (specify) _____ water

_____ sewage

17. Failure due to the designed process

x (1) Under-designed

_____ (2) Improper design

_____ (3) Adequate design

_____ (4) Over-loading

_____ (5) Other (specify) _____ water

_____ sewage

SUPERVISORY CONTROL

18 Inspection of plant

x (1) Regular inspection

x a. Local

____ b. Regional

____ c. National

____ d. Other (specify) _____ water

_____ sewage

____ (2) Active supervision at the plant

____ (3) Other (specify) _____ water

_____ sewage

19. Laboratory location

x (1) At plant

x (2) Regional Chemical and bacteriological analysis are done by the General Superintendance Company in Mombasa town.

____ (3) Central

____ (4) Mobile

____ (5) Non-existant

PROBLEMS NOT SOLVED BY PRESENT FACILITY

20. Technical problems of effluent

____ (1) Odor of water

____ (2) Taste of water

x (3) Color of water Water from Mrere Spring has colour in the rainy season.

____ (4) None

____ (5) Other (specify) _____ water

_____ sewage

21. Monetary problems in operations

____ (1) Extreme difficulty in financing

____ (2) Moderate difficulty in financing

x (3) No difficulty in financing

22. Operational cost and capacity

(1) Capacity in million gallon/day or in m^3/day

x	5 - 7 million	Gallons
	Amount	Unit

(2) Total annual operational cost

	662,300	Kenya pound
	Amount	Currency unit

(3) Annual operational cost for personnel (payroll)

	K.shs. 600,000	Kenya shillings
	Amount	Currency unit

23. Administrative problems

x	(1) Personnel	Personnel relations with people working in the field are not very cordial. For example personnel are not willing to pay field workers who want night.....
	(2) Managerial	
x	(3) Supervisory	There is shortage of qualified supervisory staff
	(4) Operators	
	(5) None	
	(6) Others (specify)	_____ (water)
		_____ (sewage)

..... allowance. Also personnel are not willing to promote those who show that they deserve promotion.

APPENDIX E

OPERATIONAL DATA (SEWAGE) (XXXXXX)

MOMBASA ISLAND (MOMBASA TOWN)

Please check the appropriate category related to the operation of the treatment plant.

1. Type of treatment plant.

_____ (1) Water treatment

__x__ (2) Sewage treatment — Preliminary (partial)

OPERATORS

2. Availability of trained or skilled operators

_____ (1) Easy to find

__x__ (2) Difficult to find

3. Existence of a standard or system for evaluating the qualifications of operators

__x__ (1) Yes

_____ (2) No

4. Short courses or other training programs for operators available

__x__ (1) Yes

_____ (2) No

5. Reason for leaving employment at the treatment plant

_____ (1) Better job

_____ (2) Discharged

__x__ (3) Others (specify) — The people do not move very freely because they are used to the type of work and cannot get a better suitable job elsewhere

6. Average age of operators

_____ (1) Less than 20 years old

_____ (2) 20-30

__x__ (3) 30-40

_____ (4) Older than 40

7. Qualify of operators

_____ (1) Not dependable

__x__ (2) Fair

_____ (3) Good

_____ (4) Excellent

CHEMICALS

8. Location (distance) for obtaining chemicals

_____ (1) Local

_____ (2) In-country

_____ (3) Out-of-country

N/A: No need for chemicals

9. Availability of chemicals

_____ (1) Easy to obtain locally

_____ (2) Difficult to obtain locally

_____ (3) Easy to obtain non-locally

_____ (4) Difficult to

N/A

MACHINERY, PARTS, ETC.

10 Causes of machinery breakdown

_____ (1) Operator error

_____ (2) Product failure

__x__ (3) Others (specify) General wear and tear

11. Time interval for replacement of machinery or parts

_____ (1) Too often as compared to the expected life of the item

_____ (2) Not as often as compared to the expected life of the item

__x__ (3) Routine replacement

12. Delivery time of ordered parts

_____ (1) Less than 1 week

_____ (2) Between 1 and 4 weeks

_____ (3) Between 1 and 6 months

__x__ (4) Between 6 months and a year

_____ (5) More than one year

13. Parts replaced are usually

x (1) ordered specially

____ (2) Off the shelf (common parts)

____ (3) Other (specify) _____ water

_____ sewage

14. Repair of machinery

x (1) Repaired locally

____ (2) Repaired in-country

____ (3) Repaired out-of-country

____ (4) No repair, replaced by new one

OPERATIONAL FAILURE (TECHNICAL)

15. Characteristic of raw water causing difficulty in treatment

____ (1) Turbidity

____ (2) Algae

____ (3) Other (specify) ____ water

N/A _____ sewage

16. Operational failure due to the following

____ (1) Storage

____ (2) Pumps

____ (3) Lack of water

x (4) Other (specify) _____ water

Operational failure is a very rare thing sewage

17. Failure due to the designed process

____ (1) Under-designed

____ (2) Improper design

____ (3) Adequate design

____ (4) Over loading

x (5) Other (specify) _____ water

Treatment up to date is running satisfactorily to the maximum load design. There is a need for extension sewage

SUPERVISORY CONTROL

18 Inspection of plant

x (1) Regular inspection

x a. Local

____ b. Regional

____ c. National

____ d. Other (specify) _____ water

_____ sewage

____ (2) Active supervision at the plant

____ (3) Other (specify) _____ water

_____ sewage

19. Laboratory location

____ (1) At plant

x (2) Regional

____ (3) Central

____ (4) Mobile

____ (5) Non-existant

The sample tests for effluent are being done by commercial chemists in town (General Superintendance)

PROBLEMS NOT SOLVED BY PRESENT FACILITY

20. Technical problems of effluent

____ (1) Odor of water

____ (2) Taste of water

____ (3) Color of water

____ (4) None

x (5) Other (specify) _____ water

sewage

There is a tendency to use sand to wash the dishes which makes the sewage septic before it reaches treatment plant

21. Monetary problems in operations

____ (1) Extreme difficulty in financing

____ (2) Moderate difficulty in financing

x (3) No difficulty in financing There is a sewerage levy for the facility provided which makes the operation self-supporting.

22. Operational cost and capacity

(1) Capacity in million gallon/day or in m^3/day

x 1 million per day (Amount) — Gallons (Unit)

(2) Total annual operational cost

x 400,000 (Amount) — Kenya shillings (Unit)

(3) Annual operational cost for personnel (payroll)

x 260,000 (Amount) — Kenya shillings (Currency unit)

23. Administrative problems

x (1) Personnel)
x (2) Managerial)
x (3) Supervisory)

There is lack of suitable people to do the job in these sections, particularly sanitary engineering.

___ (4) Operators

___ (5) None

___ (6) Others (specify) _____ (water)

_____ (sewage)

APPENDIX F

FACILITY CONSTRUCTION COST DATA ~~XXXXXXX~~ (WATER)

KISUMU TOWN

Please answer the following related to the construction cost of the project. If there are more than one facility involved, please fill in ONE questionnaire FOR EACH

1. Type of the treatment: check whether it is water or sewage treatment.

_x_ Water treatment

Type of Process conventional - coagulation, sedimentation, filtration, disinfection

____ Sewage treatment

Type of the process _____

2. (1) Year the plant was built 1948 - 1950

(2) Population served by the plant 70,000

(3) Construction cost in US.$ _____

or construction cost in your country currency

6,613,312 (Amount (including all phases)) — Kenya shillings (Currency)

First phase cost K. £41,474

3. Percent of total cost for labor

____ (1) Less than 10%

_x_ (2) 10%-25%

____ (3) 25%-50%

____ (4) 50%-75%

____ (5) 75%-90%

____ (6) Greater than 90%

KISUMU TOWN 211

4. Percent of total cost for material

_____ (1) Less than 10%

_____ (2) 10%-25%

_____ (3) 25%-50%

x (4) 50%-75%

_____ (5) 75%-90%

_____ (6) Greater than 90%

5. Percent of total cost for engineering fee

_____ (1) Less than 2%

_____ (2) 2%-4%

_____ (3) 4%-6%

x (4) 6%-10%

_____ (5) Greater than 10%

6. Percent of the total labor cost spent for skilled labor

x (1) Less than 25%

_____ (2) 25%-50%

_____ (3) 50%-75%

_____ (4) Greater than 75%

7. Approximate daily wage for unskilled labor in your country's currency

11.20 (Amount) Kenya shillings (currency unit)

or, if available, please check the category of US $ equivalen shown below

_____ (1) Less than $1/day

x (2) $1-$3/day

_____ (3) $3-$5/day

_____ (4) $4-$10/day

_____ (5) $10-$15/day

_____ (6) More than $15/day

KISUMU TOWN 272

8. Approximate daily wage for skilled labor in your count currency

32.00 (Amount) Kenya shillings (Currency unit)

or, if available, please check the category of US dollar equivalent shown below

____ (1) Less than US $2/day

__x__ (2) $2-$5/day · $4

____ (3) $5-$10/day

____ (4) $10-$15/day

____ (5) $15-$20/day

____ (6) More than $20/day

9. Of the total cost spent for material, what percent of material was found in-country?

____ (1) Less than 10%

____ (2) 10%-25%

____ (3) 25%-50%

__x__ (4) 50%-75%

____ (5) 75%-100%

APPENDIX F

FACILITY CONSTRUCTION COST DATA (SEWAGE)~~XXXXXXX~~

KISUMU TOWN

Please answer the following related to the construction cost of the project. If there are more than one facility involved, please fill in ONE questionnaire FOR EACH

1. Type of the treatment: check whether it is water or sewage treatment.

_____ Water treatment

Type of Process _____

x Sewage treatment

Type of the process Conventional, Biological treatment

2. (1) Year the plant was built 1948-1950

(2) Population served by the plant _____

(3) Construction cost in US.$ _____

or construction cost in your country currency

_____ Amount _____ Currency

3. Percent of total cost for labor

_____ (1) Less than 10%

x (2) 10%-25%

_____ (3) 25%-50%

_____ (4) 50%-75%

_____ (5) 75%-90%

_____ (6) Greater than 90%

4. Percent of total cost for material

____ (1) Less than 10%

____ (2) 10%-25%

x (3) 25%-50%

____ (4) 50%-75%

____ (5) 75%-90%

____ (6) Greater than 90%

5. Percent of total cost for engineering fee

____ (1) Less than 2%

____ (2) 2%-4%

x (3) 4%-6%

____ (4) 6%-10%

____ (5) Greater than 10%

6. Percent of the total labor cost spent for skilled labor

x (1) Less than 25%

____ (2) 25%-50%

____ (3) 50%-75%

____ (4) Greater than 75%

7. Approximate daily wage for unskilled labor in your country's currency

11.20 (Amount) Kenya shillings (currency unit)

or, if available, please check the category of US $ equivalent shown below

____ (1) Less than $1/day

x (2) $1-$3/day

____ (3) $3-$5/day

____ (4) $4-$10/day

____ (5) $10-$15/day

____ (6) More than $15/day

KISUMU TOWN 275

8. Approximate daily wage for skilled labor in your country's currency

32.00 (Amount) — Kenya shillings (Currency unit)

or, if available, please check the category of US dollar equivalent shown below

____ (1) Less than US $2/day

x (2) $2-$5/day $4.00

____ (3) $5-$10/day

____ (4) $10-$15/day

____ (5) $15-$20/day

____ (6) More than $20/day

9. Of the total cost spent for material, what percent of material was found in-country?

____ (1) Less than 10%

____ (2) 10%-25%

____ (3) 25%-50%

____ (4) 50%-75%

x (5) 75%-100%

APPENDIX F

FACILITY CONSTRUCTION COST DATA ~~XXXXXXX~~ (WATER)

NYERI TOWN

Please answer the following related to the construction cost of the project. If there are more than one facility involved, please fill in ONE questionnaire FOR EACH

1. Type of the treatment: check whether it is water or sewage treatment.

__x__ Water treatment

Type of Process full treatment - coagulation, sedimentation, filtration, sterilization

_____ Sewage treatment

Type of the process _____

2. (1) Year the plant was built 1959

(2) Population served by the plant 1,393

(3) Construction cost in US.$ _____

or construction cost in your country currency

122,955 (Amount) Kenya pounds (Currency)

3. Percent of total cost for labor

_____ (1) Less than 10%

_____ (2) 10%-25%

__x__ (3) 25%-50% 30% (K. £36,886.50)

_____ (4) 50%-75%

_____ (5) 75%-90%

_____ (6) Greater than 90%

NYERI TOWN

Percent of total cost for material

_____ (1) Less than 10%

_____ (2) 10%-25%

_____ (3) 25%-50%

x (4) 50%-75% 65% (K.£ 79,920.75)

_____ (5) 75%-90%

_____ (6) Greater than 90%

5. Percent of total cost for engineering fee

_____ (1) Less than 2%

_____ (2) 2%-4%

x (3) 4%-6% 5% (K.£ 6,147.75)

_____ (4) 6%-10%

_____ (5) Greater than 10%

6. Percent of the total labor cost spent for skilled labor

x (1) Less than 25% 20% (K.£ 7,377.30)

_____ (2) 25%-50%

_____ (3) 50%-75%

_____ (4) Greater than 75%

7. Approximate daily wage for unskilled labor in your country's currency

9.30 (Amount) Kenya shillings (currency unit)

or, if available, please check the category of US $ equivalent shown below

_____ (1) Less than $1/day

x (2) $1-$3/day

_____ (3) $3-$5/day

_____ (4) $4-$10/day

_____ (5) $10-$15/day

_____ (6) More than $15/day

NYERI TOWN

8. Approximate daily wage for skilled labor in your country's currency

15.00 (Amount) — Kenya shillings (Currency unit)

or, if available, please check the category of US dollar equivalent shown below

____ (1) Less than US $2/day

x (2) $2-$5/day . $ 2

____ (3) $5-$10/day

____ (4) $10-$15/day

____ (5) $15-$20/day

____ (6) More than $20/day

9. Of the total cost spent for material, what percent of material was found in-country?

____ (1) Less than 10%

____ (2) 10%-25%

____ (3) 25%-50%

____ (4) 50%-75%

x (5) 75%-100%

APPENDIX F

FACILITY CONSTRUCTION COST DATA ~~SEWAGE~~ (WATER)

MOMBASA TOWN (MOMBASA ISLAND)

Please answer the following related to the construction cost of the project. If there are more than one facility involved, please fill in ONE questionnaire FOR EACH

1. Type of the treatment: check whether it is water or sewage treatment.

_x_ Water treatment

Type of Process chlorination only

____ Sewage treatment

Type of the process _____

2. (1) Year the plant was built 1955-1956

(2) Population served by the plant 200,000 (17,000 connections on the island)

(3) Construction cost in US.$ _____

or construction cost in your country currency

6,000,000 (Amount) Kenya pounds (Currency)

3. Percent of total cost for labor

____ (1) Less than 10%

____ (2) 10%-25%

_x_ (3) 25%-50%

____ (4) 50%-75%

____ (5) 75%-90%

____ (6) Greater than 90%

MOMBASA TOWN

4. Percent of total cost for material

____ (1) Less than 10%

____ (2) 10%-25%

____ (3) 25%-50%

x (4) 50%-75%

____ (5) 75%-90%

____ (6) Greater than 90%

5. Percent of total cost for engineering fee

____ (1) Less than 2%

____ (2) 2%-4%

____ (3) 4%-6%

x (4) 6%-10%

____ (5) Greater than 10%

6. Percent of the total labor cost spent for skilled labor

____ (1) Less than 25%

____ (2) 25%-50%

x (3) 50%-75%

____ (4) Greater than 75%

7. Approximate daily wage for unskilled labor in your country's currency

15.00 (Amount) Kenya shillings (currency unit)

or, if available, please check the category of US $ equivalent shown below

____ (1) Less than $1/day

x (2) $1-$3/day $2

____ (3) $3-$5/day

____ (4) $4-$10/day

____ (5) $10-$15/day

____ (6) More than $15/day

MOMBASA TOWN 281

Approximate daily wage for skilled labor in your country' currency

25-100	Kenya shillings
Amount	Currency unit

or, if available, please check the category of US dollar equivalent shown below

____ (1) Less than US $2/day

x (2) $2-$5/day } $3-13

x (3) $5-$10/day }

____ (4) $10-$15/day

____ (5) $15-$20/day

____ (6) More than $20/day

9. Of the total cost spent for material, what percent of material was found in-country?

____ (1) Less than 10%

x (2) 10%-25%

____ (3) 25%-50%

____ (4) 50%-75%

____ (5) 75%-100%

APPENDIX F

FACILITY CONSTRUCTION COST DATA (SEWAGE) (~~WATER~~)

MOMBASA ISLAND (MOMBASA TOWN)

Please answer the following related to the construction cost of the project. If there are more than one facility involved, please fill in ONE questionnaire FOR EACH

1. Type of the treatment: check whether it is water or sewage treatment.

____ Water treatment

Type of Process _____

x Sewage treatment

Type of the process Screening and then sedimentation of sludge which is only released at ebb tide (partial treatment)

2. (1) Year the plant was built 1963

(2) Population served by the plant 30,000

(3) Construction cost in US.$ 7,000,000 (£ 1,000,000)

or construction cost in your country currency

_____ Amount _____ Currency

3. Percent of total cost for labor

____ (1) Less than 10%

____ (2) 10%-25%

x (3) 25%-50% 25% and 30%

____ (4) 50%-75%

____ (5) 75%-90%

____ (6) Greater than 90%

MOMBASA TOWN 263

4. Percent of total cost for material

_____ (1) Less than 10%

_____ (2) 10%-25%

x (3) 25%-50% 40% This does not include any mechanical p (about 20%) - this was imported from overse

_____ (4) 50%-75%

_____ (5) 75%-90%

_____ (6) Greater than 90%

5. Percent of total cost for engineering fee

_____ (1) Less than 2%

_____ (2) 2%-4%

x (3) 4%-6% 6%

_____ (4) 6%-10%

_____ (5) Greater than 10%

6. Percent of the total labor cost spent for skilled labor

_____ (1) Less than 25%

x (2) 25%-50% 25%

_____ (3) 50%-75%

_____ (4) Greater than 75%

7. Approximate daily wage for unskilled labor in your count currency

14.50 (Amount) Kenya shillings (currency unit)

or, if available, please check the category of US $ equi shown below

_____ (1) Less than $1/day

x (2) $1-$3/day $2

_____ (3) $3-$5/day

_____ (4) $4-$10/day

_____ (5) $10-$15/day

_____ (6) More than $15/day

MOMBASA TOWN 284

8. Approximate daily wage for skilled labor in your country's currency

25.00	Kenya shillings
Amount	Currency unit

or, if available, please check the category of US dollar equivalent shown below

____ (1) Less than US $2/day

x (2) $2-$5/day $ 4

____ (3) $5-$10/day

____ (4) $10-$15/day

____ (5) $15-$20/day

____ (6) More than $20/day

9. Of the total cost spent for material, what percent of material was found in-country?

____ (1) Less than 10%

____ (2) 10%-25%

____ (3) 25%-50%

x (4) 50%-75% 65%. This includes ballast, sand, cement reinforcement, p.c.c. pipes, timber.

____ (5) 75%-100%

APPENDIX G

Types of Secondary Schools by District

District	Government Maintained	Government Assisted	Unaided Harambee	Unaided Church	Unaided Private	Total
Taita Taveta	8	-	11	-	-	19
Kilifi	5	-	8	-	-	13
Tana River	2	-	-	-	-	2
Lamu	1	-	1	-	-	2
Kwale	3	-	4	1	-	8
Mombasa	6	3	-	2	11	22
Coast Prov. Total	25	3	24	3	11	66
Kiambu	30	2	39	1	6	72
Nyandarua	7	2	7	-	2	18
Nyeri	21	-	46	7	6	80
Kirinyaga	11	3	21	2	3	40
Murang'a	24	2	63	8	-	97
Thika Municipal	4	-	-	-	2	6
Central Prov Total	97	9	176	18	19	319
Machakos	25	-	63	1	21	110
Kitui	7	5	13	2	1	28
Embu	11	2	6	-	-	19
Meru	20	3	45	1	2	71
Marsabit	1	-	1	-	-	2
Isiolo	2	-	-	1	-	3
Eastern Prov Total	66	10	128	5	24	233
Nairobi	25	4	4	5	22	60
Nairobi Prov Total	25	4	4	5	22	60
Nakuru	10	1	3	2	8	60
Kericho	12	-	19	1	-	32
Nandi	6	1	9	1	-	17
Laikipia	2	-	1	-	1	4
Kajiado	3	-	-	-	1	4
Narok	2	-	2	-	-	4
Baringo	5	1	4	-	-	10
Elgeyo Marakwet	3	1	7	1	-	12
Uasin Gishu	2	1	3	4	-	10
Turkana	1	-	-	-	-	1
Samburu	1	-	1	1	-	3
Trans-Nzoia	2	-	3	1	1	7
West Pokot	2	-	1	-	-	3

District	Government Maintained	Government Assisted	Unaided Harambee	Unaided Church	Unaided Private	Total
Nakuru Municipal	2	-	2	1	4	9
Kitale Municipal	2	-	-	2	1	5
Eldoret Municipal	3	-	2	1	-	6
Rift Valley Prov. Total	55	5	57	15	16	151
Kakamega	25	-	58	3	6	92
Busia	11	1	11	-	-	23
Bungoma	13	2	35	2	2	54
Western Prov. Total	49	3	104	5	8	169
Kisumu	8	-	10	1	-	19
Kisumu Municipal	2	-	1	-	2	5
Gusii	15	8	32	2	6	63
South Nyanza	10	-	22	3	1	47
Siaya	13	1	10	1	-	25
Nyanza Prov. Total	56	9	75	10	9	159
Garissa	2	-	-	-	-	2
Wajir	-	-	-	-	-	(?)
Mandera	1	-	-	-	-	1
North Eastern Prov. Total	3	-	-	-	-	3

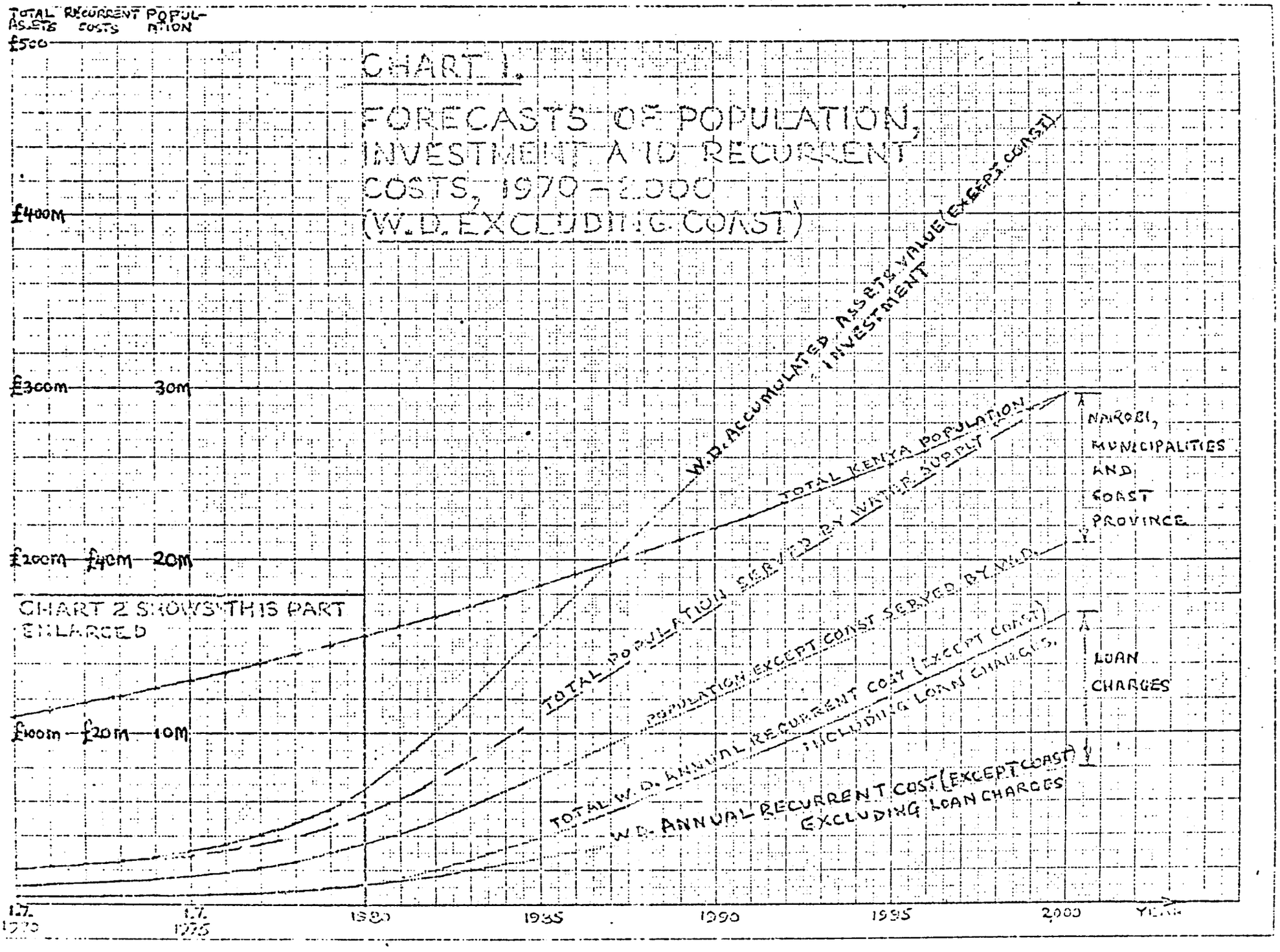
CHART 1.
FORECASTS OF POPULATION, INVESTMENT AND RECURRENT COSTS, 1970 – 2000
(W.D. EXCLUDING COAST)
TOTAL ASSETS
RECURRENT COSTS
POPULATION
£500
£400M
£300m
30m
£200m
£40m
20m
£100m
£20m
10M
CHART 2 SHOWS THIS PART ENLARGED
W.D. ACCUMULATED ASSETS VALUE (EXCEPT CONST) INVESTMENT
TOTAL KENYA POPULATION
TOTAL POPULATION SERVED BY WATER SUPPLY
TOTAL POPULATION EXCEPT CONST SERVED BY W.D.
TOTAL W.D. ANNUAL RECURRENT COST (EXCEPT CONST) INCLUDING LOAN CHARGES
W.D. ANNUAL RECURRENT COST (EXCEPT COAST) EXCLUDING LOAN CHARGES
NAIROBI, MUNICIPALITIES AND COAST PROVINCE
LOAN CHARGES
1.7. 1970
1.7. 1975
1980
1985
1990
1995
2000
YEAR

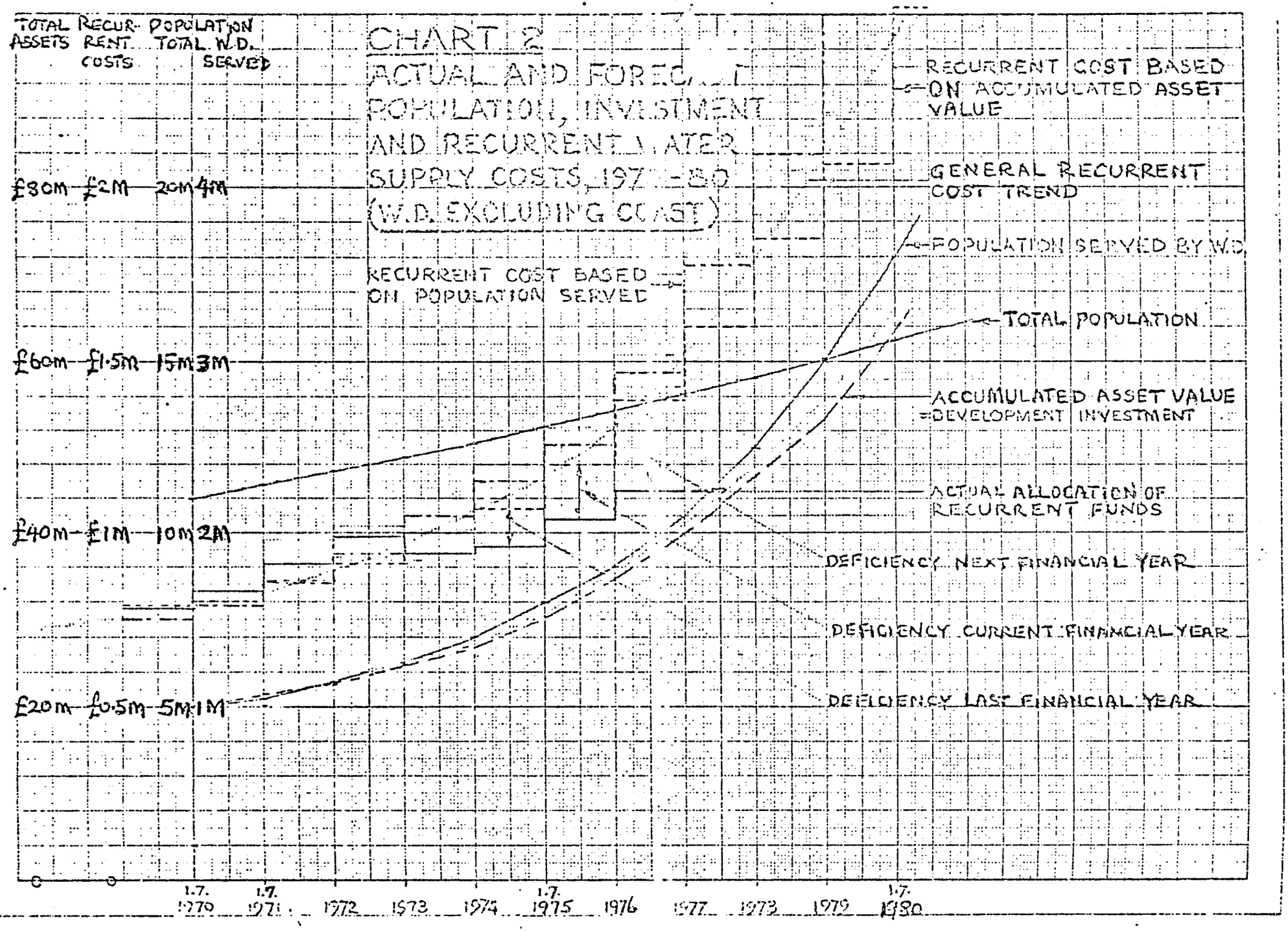

CHART 2
ACTUAL AND FORECAST POPULATION, INVESTMENT AND RECURRENT WATER SUPPLY COSTS, 197 -80
(W.D. EXCLUDING COAST)