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GOVERNMENT OF KENYA

2075

**SECTORIAL STUDY AND NATIONAL PROGRAMMING
FOR
COMMUNITY AND RURAL WATER SUPPLY,
SEWERAGE AND WATER POLLUTION CONTROL**

REPORT No. 17

LIBRARY
International Reference Centre
for Community Water Supply

FINAL REPORT

WORLD HEALTH ORGANIZATION

BRAZZAVILLE

DECEMBER 1974



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1 INTRODUCTION

1.1 Background to the Project

In January 1970, a credit agreement for the development of rural water supplies was signed between the Kenyan and Swedish Governments. In the agreement, a clause was included that the Kenya Government should establish long-term plans for water supply development and a grant for this purpose was attached to the agreement.

During May and June, 1970, negotiations were held in Nairobi between representatives of the Kenya Government, the Swedish International Development Authority (SIDA) and the World Health Organization (WHO), to establish the Plan of Operation for a long-term study with WHO as Executing Agency.

The initial Project proposed by WHO included studies in the three sectors of:

- Community water supplies
- Sewerage
- Water pollution control

The Kenya Government had visualized the Project as including also an analysis of the availability of water resources within the country plus projections of future water requirements for all sectors of water development.

During the negotiations it became clear that, in the first place, the financial resources available for the Project would not be sufficient to carry out a Master Water Plan Study encompassing all water sectors and, secondly, that the area of competence and responsibility of WHO within the UN organization does not include sectors such as irrigation and hydro-power.

A compromise was reached, and it was decided to include a hydrologist and a hydrogeologist on the WHO team. An addition was made to the Plan of Operation to the effect that the Management Study within the Project should include recommendations regarding co-ordination between all agencies involved in water development. During the course of the study, WHO Headquarters instructed the Project team that the Management Study should not go beyond the three main sectors mentioned above.

It was further stated during the negotiations that the WHO Sectorial Study would be a fore-runner to a Master Water Plan Study, which would include studies of water availability and demand from all water sectors, on a national basis.

The Plan of Operation was signed by WHO on 3 December, 1970, and by the Kenya Government on 26 June, 1971.

Field operations for the Project commenced on 18 June, 1971, and ended with the departure of the Project Manager on 7 September, 1973.

1.2 Project Objectives

The Project objectives stated in the Plan of Operation were as follows:--

"1.01 Development Objectives

Study of general community water supply and sewerage problems throughout Kenya and recommendations on general development policies related to the various climatological regions. Recommendations on national programmes for community water supply and sewerage.

Study of general water pollution throughout Kenya and recommendations on policy, national planning and legislation to deal with it and to minimize its incidence in the future.

1.02 Studies on Water Resources

Analysis of available data and preparation of maps indicating monthly rainfall and surface water resources.

1.03 Criteria and Guidelines for Water Supply Development

Formulation of proposed criteria and guidelines for community water supply comprising quantity per capita of human and livestock population. Water quality and treatment policies, distribution systems, types of installation and suggested standards of design and construction.

Development of proposed criteria to be used in the preparation of priority lists of water supply and sewerage development schemes, taking into account social, economic, technical and financial factors.

1.04 Management Aspects

Study of present management practices and proposals for possible improvements regarding maintenance and operation of water schemes.

1.05 Organizational Aspects

Analysis of administrative implications of the proposed water supply development programme with recommendations for a suitable organization structure. Proposals for arrangements for co-ordination between Government agencies responsible for sectors of water resources development, i.e. irrigation, hydro-power, water supply, drinking water quality, sewerage, etc.

1.06 Legal Aspects

Analysis of existing water legislation with a view to making recommendations for modifications or additional legislation to enable national programmes for community water supply, sewerage and water pollution control to be effectively implemented.

1.07 Specific Development Projects

A Proposed programme for planning and construction of community water supply and sewerage projects for the ten year period beginning 1 July, 1972, to fit the needs of the national development plan.

Preparation of a methodology for technical, economic, social and financial feasibility studies, resulting in the estimation of capital investments, financial viability and economic and social benefits.

For an agreed number of urban communities or integrated groups of rural communities selected by mutual agreement between WHO and the Government, studies will be made to include preliminary engineering, economic and financial feasibility studies, investment costs and recurrent costs for operation and maintenance, taking into account social implications.

1.08 Manpower and Training Requirements

Forecast of manpower requirements both professional and sub-professional to meet the needs of the ten year programme mentioned in paragraph 1.07 and recommendations on training programmes to meet these manpower needs.

1.09 National Water Resources Development Plan

Formulation of draft terms of reference and plan of operation for a proposed project to assist the Government in planning a national water resources development programme, policies and enabling legislation for which the present study is an input."

1.3 Project Resources

1.3.1 Funds

The total cost of the Project was estimated at \$ 356 100 in the Plan of Operation. Two-thirds, or \$ 237 000, was supplied as a grant from SIDA. The remaining third, or \$ 118 700, was financed through the credit agreement mentioned in sub-Section 1.1. Towards the end of the Project, it became clear that the funds would not be sufficient and an additional \$ 20 000 was supplied to WHO by the Kenya Government through a second credit agreement with SIDA for development of rural water supplies. At the time of writing this Report, it is not known what the balance of the funds is. Any funds remaining at the end of the Project will be returned to the Kenya Government.

The cost to the Kenya Government for counterpart staff, office accommodation, equipment, air travel, etc., was estimated in the Plan of Operation at \$ 107 250. Details of the actual Government expenditure are not yet available; however, it is likely that the estimate will have been slightly exceeded due to the increased number of counterpart man-months.

1.3.2 Personnel

The WHO staffing schedule prepared for the Plan of Work in August 1971 is presented in Appendix A. The actual duration of the staff members' contracts is indicated on the schedule by dotted lines.

The staff schedule may be summarized as follows:-

<u>Designation</u>	<u>Scheduled Duration</u> Months	<u>Actual Duration</u> Months
Project Manager	23	27
Sanitary Engineer Water	22	22.5
Sanitary Engineer Sewerage	16	18
Economist	15	17
Water Pollution Consultant	5	5
Legal Consultant	3	3
Management Analyst	8	7.5
Hydrologist	12	10
Hydrogeologist	4	4
Administrative Officer	22	26
Secretary*	20	25
	150	165

* In addition to the Project Secretary, secretarial services corresponding to fifteen months were engaged externally.

Actual man-months exceed estimated man-months by ten per cent, as can be seen from the table. The actual cost per man-month was lower than estimated and the over-expenditure on the allocation for personnel was therefore less than 10 per cent.

With international recruitment of staff, it cannot be expected that personnel will arrive exactly as scheduled. As can be seen from the schedule in Appendix A, there were only two cases where staff members - namely, the Sanitary Engineer Sewerage and the Hydrologist - were considerably delayed. In fact, neither of these two became a constraint for the completion of the Project.

The Kenya Government staffing schedule is summarized as follows:-

<u>Designation</u>	<u>Scheduled Duration</u> <u>Months</u>	<u>Actual Duration</u> <u>Months</u>
Project Co-Manager	18	27
Planning Engineer	8	2
Senior Health Inspector	16	20
Legal Officer (Senior State Counsel)	1	1
Planning Economist	8	6
Hydrologist	8	12
Hydrogeologist	4	8
Hydrological Assistants	24	33
Hydrological Trainees	0	36
Draughtsmen	16	26
Engineer (Sewerage)	0	6
Junior Engineers	16	9
Field Survey Staff	12	23
Secretary/Typist	18	21
Drivers	50	78
Messengers	30	27
	<u>229</u>	<u>335</u>

1.3.3 Equipment

In accordance with the Plan of Operation, two long-wheel-base Land Rovers and a Volkswagen Kombi were purchased from WHO Project funds.

During the peak of the Project, the three vehicles were insufficient and the Water Department, Ministry of Agriculture (WD) made additional vehicles available for Project activities. Towards the end, the Project was occasionally able to lend vehicles to WD.

Two field kits for chemical analysis and one for bacteriological analysis were purchased from Project funds and utilized by the Senior Health Inspector throughout the Project's duration.

A dissolved oxygen meter for the water pollution survey was purchased from Kenya Government funds.

Initially, two second-hand manual typewriters on loan from WHO were supplied for the Project. As these machines were clearly not suitable, an electric typewriter was bought from Project funds.

At the end of the Project, some equipment was handed over to the Kenya Government in accordance with the Plan of Operation. The remainder of the equipment was retained for use during the Project extension (see sub-Section 1.8). Details of the handing-over are given in Appendix C.

1.4 Project Reports

In accordance with the Plan of Work, a total of seventeen technical reports were issued by the Project. The Reports are listed in Appendix D.

Each report was issued first in draft and then in final form after review by WHO Headquarters, WHO Regional Office and the Kenya Government.

Sewerage reports Nos 9, 13 and 15 will be issued in final form during the second phase of the Project. There was insufficient time during the Project for Government and WHO to review the revised draft of Report No 10 (Recommendations on Administration and Organizational Structure for Water Supply Development) and so the final version of this Report will also be issued during the Project extension.

In addition to the technical reports, a Plan of Work Report and Quarterly Reports showing work progress in relation to the Plan of Work were issued.

1.5 Project Control by WHO

1.5.1 Funds

Project expenditure from the imprest account was reported monthly to WHO Regional Office. The Regional Office prepared quarterly statements of expenditure, during the Project, and a final statement of account was subsequently issued.

1.5.2 Time

As mentioned above, work progress was reported quarterly against the Work Plan.

1.5.3 Quality

All draft technical reports were submitted to WHO Headquarters and WHO Regional Office, for review.

The review was primarily aimed at checking that due consideration had been given to health aspects in the reports. Experience from projects in other countries guided the preparation of technical comments.

In October 1972, a mid-term review mission with representation from WHO Headquarters and the Regional Office, visited the Project. Draft reports were reviewed and discussions were held with WHO and counterpart staff and Kenya Government officials regarding the progress of the Project.

In April 1973, the same mission team, on this occasion primarily engaged on another assignment, visited the Project for discussions on the work progress.

A final WHO/SIDA Project evaluation mission is planned to visit Kenya during February 1975. Inter alia, this mission will carefully review the quality of the reports.

1.6 Project Control by the Kenya Government

One of the duties of the Project Co-Manager was to report to senior Government officials on the general progress of the Project.

The Plan of Operation required the Project Manager to report to a Steering Committee chaired by the Deputy Permanent Secretary to the Ministry of Agriculture. All Government agencies concerned with water development were to be represented on the Committee.

The Committee met for the first time on 3 September 1971. From that date until December 1972, the Committee met seven times. During the meetings, the WHO team gave verbal and visual presentations of their findings, which were later included in the technical reports.

During the first half of the Project, the Steering Committee was useful in providing contacts within the Ministries concerned. At this stage, the Project activities were on a more general level, dealing with overall problems on community water supplies, sewerage and water pollution control, and in establishing long-term objectives and resource requirements. The Committee members could learn from the Project and provide feedback to the team.

During the second half of the Project, the activities were of a more technical nature and the Committee members could not therefore contribute to the same extent.

Working groups were then established within the Water Department, comprising specialists concerned with the subject of each report, to review the Project draft reports. This worked very well and the reports were considerably improved through these review meetings; hopefully, the degree of implementation of accepted recommendations will be affected by this involvement of the members of the Water Department.

1.7 Project Evaluation

The value of a Project of this nature cannot be measured by the number of reports issued or their volume. The reports in themselves do not result in improvements, but are merely tools which can, if utilized, improve resource allocations to the sectors of community water supply, sewerage and water pollution control, and the optimisation of resources allocated.

The true measure of success is rather the degree of implementation of accepted recommendations and the long-term effects of the reports on progress in the sectors studied.

The primary task of the WHO/SIDA Project evaluation mission, planned for February 1975, will be to assess the success of the Project from these viewpoints.

The report which this mission will issue will therefore be of considerable interest and importance.

1.8 Project Extension

At the request of the Government, the appointment of the Sanitary Engineer (Sewerage) on the Sectorial Study was extended for a period of thirty months so that he could become the Head of a new Sewerage Section (which soon became the Sewerage Division in the MOWD). This WHO expert is provided under an Amendment to the original Plan of Operation for the Sectorial Study; part of this Amendment is, for convenience, reproduced in Appendix B of this Report.

Phase II of the Project - viz the Project extension - commenced on 15 October 1973. The total cost of the Project extension is estimated in the Amendment No 2 to the Plan of Operation as US \$ 119 880.

1.9 Acknowledgement

The co-operation with Kenya Government officials was very good throughout the Project and the assistance they gave was very much appreciated. Assistance from Mr. I. D. Carruthers, Research Economist at the Water Department during the first half of the Project, was specifically helpful.

2 ABSTRACT

Since the preparation of the draft of this Report, and also since the finalization of most of the other study reports, the Government of Kenya has created a Ministry of Water Development.

The establishment of such an authority was the major recommendation of Sectorial Study Report No 10 and also of the draft of this Final Report.

This present version of the Final Report takes the establishment of the Ministry of Water Development as the starting point when discussing proposals and recommendations.

This Study has investigated the stated Government target of adequate water supplies for everyone in Kenya, by the end of this century, plus the parallel target recommended in the sewerage reports prepared under this Study that everyone and every factory in Kenya should have adequate sewage disposal arrangements by the same date.

The findings of this Study are that these targets are ambitious but possible, provided that past constraints to progress are removed.

These constraints can be categorized into:-

- (i) Organizational shortcomings.
- (ii) Manpower shortages in all relevant specialities at almost all levels.
- (iii) Technical deficiencies in planning, design, construction and operation and maintenance.

Detailed recommendations are made in the Study reports, and summarized in this Report, as to how to overcome these constraints. The creation of the Ministry of Water Development is, of course, a major step towards overcoming the organizational problems.

2.1 Management and Organization

The Ministry of Water Development is charged with the overall responsibility for the community water supply sector. The national responsibility for water supplies has changed from the Ministry of Works to the Ministry of Natural Resources to the Ministry of Agriculture to the Ministry of Water Development over the past ten years; in fact, the Ministry of Water Development merely took over the Water Department of the Ministry of Agriculture. The Organization was, before 1964, strictly engaged on urban water supplies development. A major rural water programme was launched in 1969.

Water supply and sewerage in Nairobi are operated by the Water and Sewerage Department of the Nairobi City Council. This Department works rather independently of both the Ministry of Water Development and the Ministry of Local Government; for example, the recent loan agreement with the World Bank for an extension of Nairobi's water supply was signed by the City Council.

The Water and Sewerage Department currently functions as an integral part of the Nairobi City Council and, consequently, in the past procedures have proved to be very cumbersome. The Department should have rather more autonomy in the future, when the Nairobi City Council implement the recommendations made in the current WHO/UNDP Study (see Clause 3.1.4).

The Mombasa Water Supply is operated by the Ministry of Water Development. The water is purchased by the Ministry in bulk from the Mombasa Pipeline Board.

The Ministry of Local Government operates eight major urban water supplies (including Nairobi).

Rural supplies developed through the Ministry of Health WHO/UNICEF Programme are usually operated by County Councils. Rural schemes developed in settlement areas by the Ministry of Lands and Settlement are operated by Co-operatives.

The Ministry of Local Government, the Ministry of Water Development, the Ministry of Works and several other Governmental agencies have all been involved in sewerage development, and in the past it has not been clear which of these had overall national responsibility in this sector. The National Development Plan, 1974-1978, has attempted to resolve this situation by stating that the Ministry of Water Development is responsible technically for all sewerage development and operation and maintenance throughout Kenya. However, the financing of sewerage is still the responsibility of local authorities and the Ministry of Local Government.

National interest in water pollution control was aroused during the preparation of Kenya's contribution to the Conference on Human Environment held in Stockholm during 1972. The Ministry of Water Development has since then set up a Water Pollution Control Section within its Water Resources Branch.

It is recommended that the overall responsibility held by the Ministry of Water Development for the three sectors of community water supply, sewerage and water pollution control should be communicated to all Government agencies, preferably by means of a Cabinet Paper.

The Ministry of Water Development will need adequate financial and manpower resources in order to build up the organization to cope with these responsibilities. Manpower is currently very scarce in both the technical and administrative departments of the Ministry.

2.2 Water Legislation

The Kenya Water Law is basically sound and adequate, although involving a multiplicity of Acts and other statutory instruments. The problem is one of poor enforcement rather than lack of, or defects in the Law.

This lack of enforcement of legislation is particularly serious in the water pollution control sector because the qualities of water resources can only be guaranteed if discharges into them are strictly controlled. The writing of appropriate legislation and discharge agreements is a relatively simple matter; whether these are effective or not depends absolutely upon a national inspectorate properly staffed by trained and experienced personnel.

The Kenya Water Law is currently being amended so as to take into account the recent creation of the Ministry of Water Development. It is recommended that a Bill consolidating and amending as appropriate all the Kenya Law relating to water, sewerage and water pollution control should be prepared and introduced before July 1978, the start of the next five-year National Development Plan period.

2.3 Manpower and Training Requirements

The shortage of skilled manpower is expected to be the biggest constraint on the execution of the planned programmes in community water supply, sewerage and water pollution control during the current National Development Plan period. It is likely to continue to be a major problem even during the next Plan period.

The annual demand from these three sectors for civil engineers is of the same order as the current annual output of Kenyan engineers from the University of Nairobi. Additional engineers are trained at universities abroad but the water and sewerage sectors can only be expected to attract a modest portion of the Kenyan civil engineer graduates, in competition with other sectors of the economy requiring engineering input.

At the present time, there are no plans for expanding the Engineering Faculty of the University of Nairobi. This Study recommends that an ad hoc Civil Engineering Manpower Planning Group should be established between the major users of civil engineers and the teaching and training organizations in Kenya. This Group should be required to study the overall long-term demand and supply situation, and to make recommendations as to how Kenya's needs may be met.

The Ministry of Water Development has established a training school for sub-professional technical officers with a current output of 100 students per year. During a six-month "Pre-selection" course, the students receive a general introduction to engineering. The students who obtain the highest marks on this course (approximately one-third of the total) are sponsored for a two-and-a-half year diploma sandwich course at the Kenya Polytechnic. The remaining students receive in-service training in the various sections of the Ministry of Water Development. The total formal training period for all students is three years.

The current output of the School is quite insufficient to meet the demand for technical officer staff required to execute the current National Development Plan programmes. However, the Ministry could not absorb additional technical trainees with the present professional manpower situation without in-service training becoming ineffective and the development programme suffering.

Expatriate technical assistance personnel will need to be utilized to fill in the gap between the demand for manpower and the availability of Kenyans, if the Plan programmes are to be achieved.

The Ministry of Water Development and the Nairobi City Council have had only moderate success in recruiting expatriates in recent years. The conditions of service offered need to be brought in line with the world market situation. The water and sewerage sectors can, at least for major urban areas, be financially viable if efficiently run. This is an argument which justifies the payment of sufficiently high salaries to attract competent staff.

2.4 Community Water Supplies

The stated long-term objective of the Kenya Government is to provide practically everyone in the country with an adequate water supply by the year 2000.

The majority of the urban population, which constitutes about 10 per cent of the total population, has access to a piped water supply today. Of the rural population, about 10 per cent only are served in this way.

The Kenyan population requiring an urban-type water supply is expected to increase to 9 times the present figure by the year 2000, and the rural population is expected to increase by approximately 80 per cent during the same period.

In fact, the water development programme carried out during 1973/1974 hardly kept up with the population increase.

It is considered that the rural development programme, as described in the current National Development Plan, 1974-1978, is too ambitious. Even if it is possible to obtain the necessary finance for the programme, and also to carry out the development work with the assistance of consultants and contractors, it will be extremely difficult to train sufficient staff to operate and maintain properly the supplies.

This is not to say that the long-term objectives of the Kenya Government are unrealistic. It is considered that they could be met, even if the development programme accelerates at a slower pace than proposed during the current Plan period.

The rural water supplies are designed for an ultimate degree of service of connections to most individual farms. It is recommended that individual connections should be encouraged at the early stage of a supply so as to increase the utilization of the scheme capacity and to maximize the benefits. This will also improve the economy of the rural water supply programme as the revenue provided from individual connections will offset the extra cost.

It is recommended that water from communal water points, which should be of simple construction and few in number in high and medium potential areas, should be delivered free of charge to the people, perhaps not in the long term but certainly during the next several years; this latter recommendation is based upon the practical difficulties involved in collecting charges from those who use communal water points, coupled with the desirability of encouraging people to use these facilities.

The rural water programme will require some subsidy by the Government under any circumstances. It is recommended that a proper Government pricing policy be established. It is important that this programme is tackled with an awareness that there will be a deficit between revenue and cost, to avoid the danger that insufficient resources will be allocated for the operation and maintenance of the supplies in the future.

With some adjustments, it is suggested that the funds available for rural water development should be distributed between the districts in proportion to unserved rural population, over each five year planning period.

2.5 Sewerage

Between the mid-fifties and the mid-sixties, twenty-one Kenyan towns were provided with sewerage. Urban sewerage development then effectively ceased until recently.

The result is that there is today a very considerable back-log in the sewerage sector, when compared with water supply. There are also operation and maintenance difficulties and a high proportion of existing sewage disposal installations of all types are consequently operating at very low efficiencies.

It may reasonably be said that, throughout Kenya outside Nairobi at the present time, there is generally little control over the disposal of sewage, from individual dwellings, villages, towns or factories.

The control of sewage discharges is necessary in order to:-

- a) improve and safeguard public health;
- b) protect Kenya's water resources.

At the present time in most parts of Kenya, the situation is undesirable but not yet dangerous and unacceptable; however, it will tend to become serious rapidly as:-

- i) Kenya's population, especially in urban communities, quickly grow.

- ii) The country becomes much more industrialized;
- iii) Water usage and consequently sewage production increase, due to the foregoing factors but also because of rising living standards.

Now is the time to take positive action, not only to eliminate the current national back-log in sanitary sewage disposal, but also to ensure that the serious and expensive problems which have arisen as a result of poor control over sewage disposal in so many countries are forestalled in Kenya.

The objectives recommended in these Study Reports are to ensure that every dwelling and every business and factory in Kenya, will have adequate sewage disposal arrangements by the year 2000.

The recommended sub-objectives are:-

- i) The provision of sewerage in urban areas should catch up with water supply development before the end of this current decade.
- ii) Every sewage disposal installation constructed in the future should be appropriate to the circumstances and properly designed and constructed.
- iii) Every sewage disposal installation in Kenya should be efficiently operated, maintained and serviced.
- iv) Public latrines should be provided in all towns.

Sewerage development is expensive; the estimated costs of achieving the recommended sub-objective of sewerage in every town with a piped water supply by 1984 are £27.57 millions (based upon 1973 price levels). The public latrine programme would cost an additional £2 millions.

The major constraint is likely to be the national lack of implementation capacity rather than the shortage of funds which overseas agencies are often pleased to provide. As a first, major, step towards eliminating this constraint a Sewerage Division has been set up within the Ministry of Water Development with the assistance of WHO (see sub-Section 1.8). It is most important to the future of sewage disposal in Kenya that the Government fully supports this step so that, at the end of thirty months when this WHO assistance is programmed to end, there will be a strong, effective national sewage disposal organization which can continue to expand.

2.6 Water Pollution Control

Although the control of discharges into the country's water resources has been a neglected sector in the past, Kenya does not generally have a serious water pollution problem at the present time.

However, the problems which currently exist indicate that matters are likely to become much more serious in the future if active measures are not taken soon to control pollution.

The country has a rapidly growing population, which is becoming more urbanized, and an expanding industry. At the same time, the standard of living of the people, and thus their use of water, is improving.

After use, effectively all the dirtied water, or sewage, is discharged into Kenya's water resources; that is, into the sources of Kenya's water supplies. Pollution of Kenya's water resources - which are by no means limitless - can completely ruin them as water supply sources.

The Ministry of Water Development established a Water Quality (viz. water pollution control) Section two years ago. This Section is currently very short of the manpower it needs to set up a competent inspectorate over all sewage discharges, and to monitor and thereby preserve the qualities of Kenya's water resources.

The Water Quality Section is also at the present time unable to look into the financial implications of a national water pollution control programme. In any developing country such as Kenya, in order to avoid communities and vital industry from being crippled by the financial burden of too strict a water pollution control programme, it is necessary to strike a balance between the country's development needs and the anti-pollutional measures which can and must be afforded.

It is far cheaper for the Nation to tackle the problem of water pollution now, when primarily preventive measures are required, than to wait until the emphasis will need to be on curing polluted water resources.

2.7 Water Resources

Studies of the availability of surface water and groundwater resources were included in the Project.

Based upon data from river gauging stations, maps showing mean and low flow run-off were prepared for central Kenya; tabulated data, histograms and flow duration curves for these stations were also published.

Tentative maps on groundwater availability were prepared and computer listings were made of borehole data from approximately 4 000 wells. Most of the work on the borehole data bank had previously been carried out by the Water Department with assistance from the Ministry of Finance and Planning.

Considerable additional work on water resources' data collection, analysis and mapping is required to obtain a complete and satisfactory picture of the country's water resources.

A more efficient data bank for water apportionment should be developed, to ensure that the total abstractions permitted for each particular water resource do not exceed the available flow.

These activities are scheduled to be included in the planned National Master Water Plan Study (see sub-Section 4.17) which should follow this Project as soon as possible.

3 SUMMARY OF PROJECT FINDINGS

3.1 Management and Organization

3.1.1 Existing Organizations

The overall responsibility for water development has shifted between four Ministries over the past decade.

Until 1964, the Hydraulic Branch of the Ministry of Works was responsible for water and sewerage development in the urban areas. Rural water development was one of the responsibilities of the African Land Development Organization (ALDEV) of the Ministry of Agriculture.

The two Organizations were amalgamated as the Water Development Department under the Ministry of Natural Resources in 1964 and transferred to the Ministry of Agriculture in 1968, when the title was changed to the Water Development Division. Responsibility for the provincial organizations of the Division was divided between the Director of WDD and the Provincial Directors of Agriculture. The distribution of authority and responsibility was very vaguely defined and caused considerable unease among the provincial organizations.

In 1972 the status of the Organization was raised to that of Department and the Director again became directly responsible for the provincial organizations.

In November 1974, a Ministry of Water Development (MOWD) was established. It is too early yet to determine the impact of this step. The immediate result was that the Water Department of the Ministry of Agriculture moved, complete, to the MOWD.

The MOWD has overall technical responsibility for water and sewerage development in Kenya. However, certain sectors are the responsibility of specialized agencies; thus, the National Irrigation Board handles all major irrigation developments and the development of hydro-electric power is handled by the Ministry of Power and Communications.

The MOWD is alone responsible for the control of water pollution except that the Ministry of Health is also involved in cases of pollution which specifically endanger public health.

Water permits, which are required for all surface water abstractions, are issued by the Water Apportionment Board, which is responsible to the MOWD. The quantity and quality of water to be supplied, and disposed of, and the means and location of its abstraction, are stipulated in the permits. The MOWD Director of Water Development (who was previously Director of the Water Department) is the Chief Technical Advisor to the Board.

The Water Resources Authority, with advisory functions on all aspects of water use, was established in 1951 and de-gazetted in 1972, after several years of inactivity. The MOWD has taken over the functions of the Water Resources Authority, but the Water Act is only now being amended to this effect.

The Water and Sewerage Department of the Nairobi City Council comes directly under the Ministry of Local Government, but has an autonomous position vis-a-vis the Ministry.

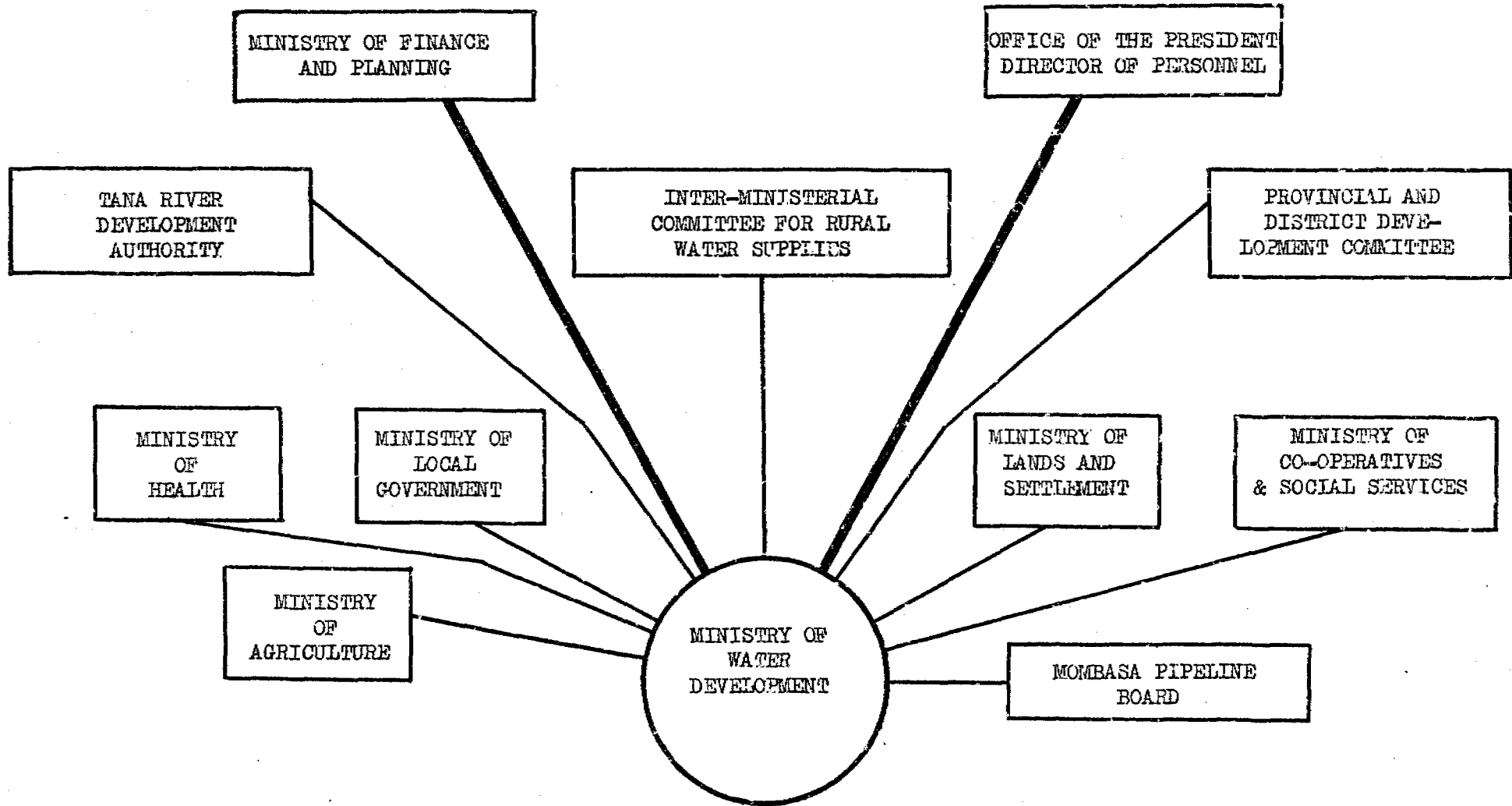
The Ministry of Local Government operates seven other large urban water supplies, all sewerage schemes in urban areas (but under the overall technical control of the MOWD) through town authorities, and a large number of rural water schemes through County Councils. The MOWD is responsible for advising the Ministry of Local Government on all technical matters concerning community water supply and sewerage.

The Mombasa water supply is operated by the MOWD, which buys water in bulk from the Mombasa Pipeline Board, a statutory body created in 1957. The MOWD operates and maintains plant owned by the Board, on an agency basis.

Since 1963, the Ministry of Lands and Settlement, with technical assistance from the MOWD, has been executing a rural water development programme in settlement areas through finance from the World Bank and the British and West German Governments. Most of these water schemes are operated by the co-operatives in the settlement areas; they have problems in obtaining trained operators to run the supplies. Many schemes are under-designed, resulting in lower quantities of water supplied than initially intended. Practically all schemes are based on individual connections and the water charges are high, averaging about shs 25/- per family per month.

Figure 3.1.1

External Organization, Ministry of Water Development



Communications for procurement of resources

Communications for work execution

The Ministry of Health is responsible for water supply quality surveillance in the country. With assistance from WHO and UNICEF, the Ministry carried out a rural water development programme over a ten year period, with the main aim of demonstrating the benefits of rural supplies and creating interest in this development amongst the rural population. This objective has been met and the programme is being phased out, which is logical as the MOWD has launched a massive rural water development programme. Most of the supplies developed through the WHO/UNICEF Programme have been handed over to County Councils, many of which do not have adequate resources properly to maintain the supplies. The problem is aggravated by the fact that many of the schemes are not adequately designed.

An Inter-Ministerial Committee for Rural Water Supply Development was created in 1969. All Government agencies concerned with rural water development are represented on the Committee, which is chaired by the Deputy Secretary to the MOWD. The main function of the Committee is to review the rural water development programmes set up by the MOWD.

Recently, the Tana River Development Authority, a new para-statal body reporting to the Ministry of Finance and Planning, was established. The Authority has an advisory function and has been charged with the task of preparing a Master Plan for all water use, including domestic supply, for the Tana River Basin. The British Government is seconding expatriates to the Authority for a minimum period of three years.

3.1.2 The Ministry of Water Development (MOWD) - External Organization

This is shown diagrammatically on Figure 3.1.1.

The Director of Water Development is responsible to the Permanent Secretary of the MOWD. The principle agencies dealt with by MOWD are the Ministry of Finance and Planning, for allocations of financial resources, and the Director of Personnel in the Office of the President, for manpower establishment.

Tasks to be carried out by the MOWD are based upon an intermediate horizon, established in the five year national development plans. On a short-term basis, the tasks are defined through financial agreements with donor agencies (including, in the case of sewerage development, loans negotiated also by the Ministry of Local Government) and the annual development and recurrent estimates.

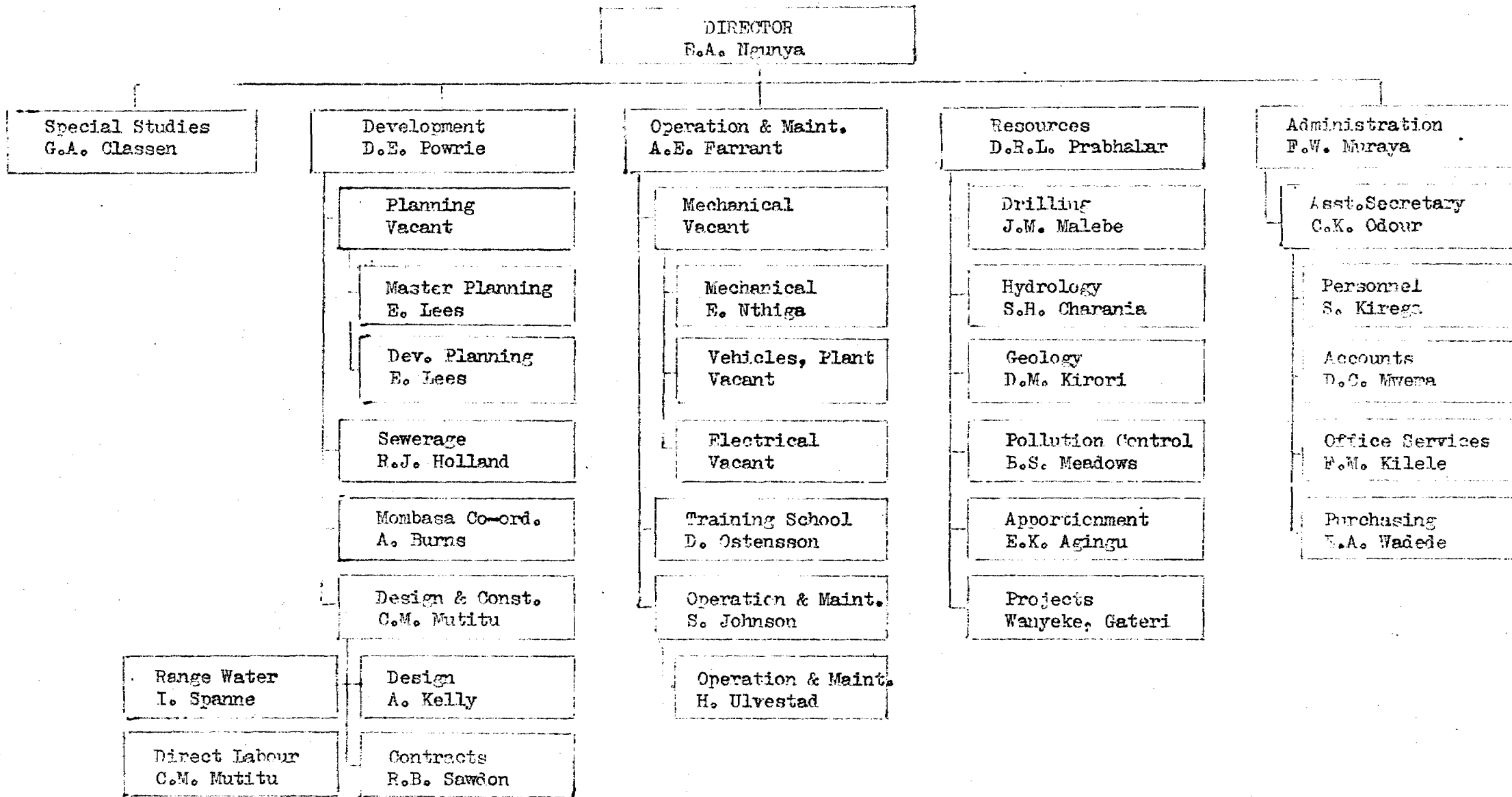
The duties of the MOWD cover many fields and programmes, as can be seen from the list below:-

- Urban Water Supply Programme
- Mombasa Water Supply extension
- Technical assistance to the Ministry of Local Government Urban Water Supply Programme.
- Technical control of the Local Government Urban Sewerage Development Programme
- Rural Water Supply Programme
- Water Supply Programme in settlement areas
- Range Water Development Programme
- Technical assistance for self-help water development
- Technical assistance in the operation and maintenance of sewage disposal systems
- Training programmes for sub-professional sewerage technicians
- Water Pollution Control Programme
- Water Conservation Programme
- Water Resources Studies
- Minor Irrigation Development
- Coast and Flood Protection Programme

The recent establishment of the MOWD is completely justified by the large programmes currently being undertaken by this Ministry, especially when it is realized that this programme is about to be expanded considerably.

FIGURE 3.1.2

MINISTRY OF WATER DEVELOPMENT - WATER DEPARTMENT, ORGANIZATION CHART



Provincial Organization

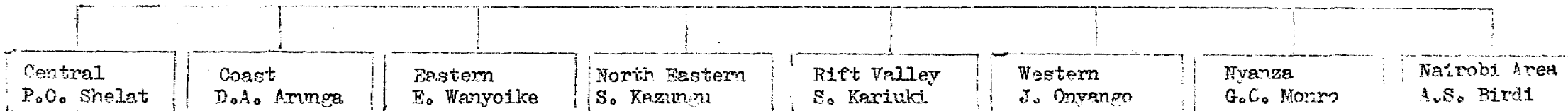


FIGURE 3.1.3

ORGANIZATION CHANGE FOR ALL WATER FUNCTIONS
CARRIED OUT BY THE SAME AUTHORITY

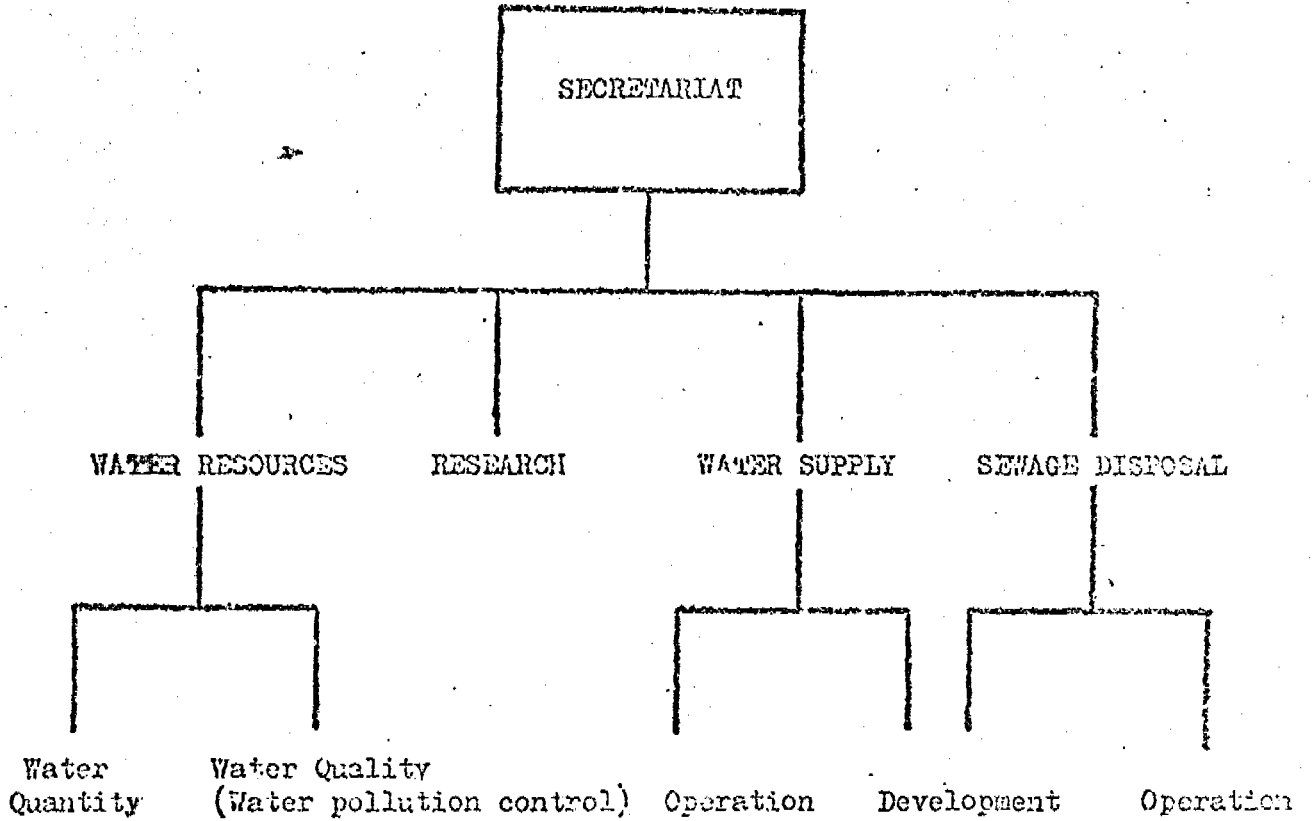
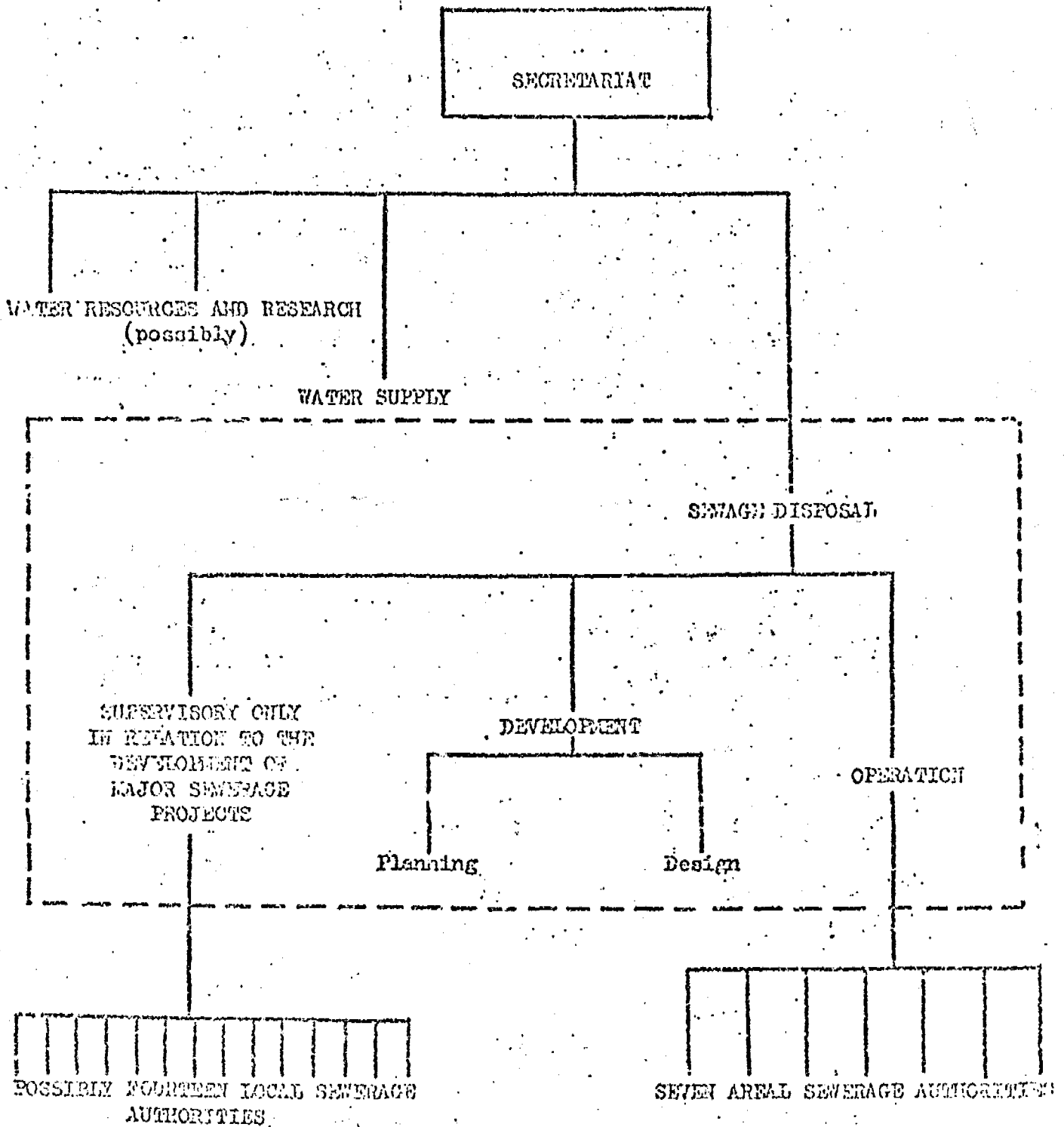


FIGURE 3.1.4

DIAGRAM SHOWING THE EVENTUAL PROPOSED/ANTICIPATED NATIONAL ORGANIZATION FOR SEWAGE DISPOSAL IN KENYA



NOTES:-

1. The agencies within the dotted frame are collectively referred to as the "Central Sewerage Authority".
2. The Areal Sewerage Authorities are responsible for the development of minor projects in their respective areas

However, the MOWD can only function properly if there is an immediate strengthening of the Ministry, on both the technical and administrative sides. Organizational changes as recommended in this Report, and possibly modified after the planned Master Water Plan project, are also required for efficiency.

3.1.3 The Ministry of Water Development (MOWD) - Internal Organization.

The current organization of the technical arm of the MOWD is shown diagrammatically on Figure 3.1.2.

As the Ministry is responsible for so many programmes, each consisting of many individual projects, it has not been practical to organize the work on a project basis. The Ministry is therefore technically organized on a functional basis, the three Branches being Development, Operation and (Water) Resources. In a functional organization, the various programmes and projects within them, compete for the same resources.

So far as water supply is concerned, it is considered that the existing internal technical organization of the MOWD is sound. It is, however, recommended that the existing Sewerage Division be raised to the status of a branch, headed by a Deputy Director, and that the Water Quality Section be promoted to become one of the two major divisions in the (Water) Resources Branch of the MOWD.

These recommendations are shown diagrammatically in Figure 3.1.3.

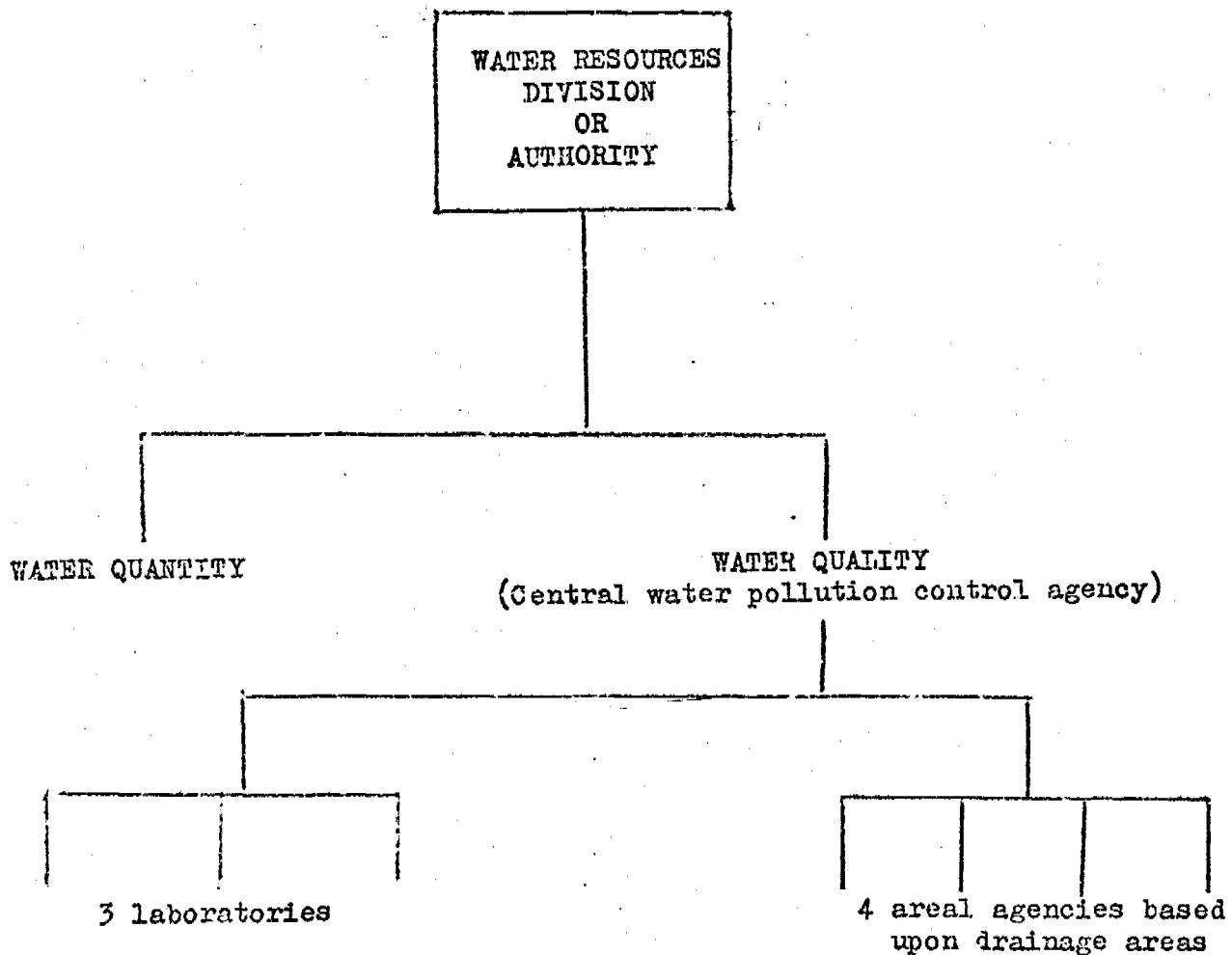
A more detailed recommendation for the future national organization of sewage disposal is shown in Figure 3.1.4. The various elements which comprise the organization are:-

A Secretariat with overall responsibility for all technical and financial matters. It will comprise the Minister for Water Development and his senior advisers.

A Central Sewerage Authority which will be the national organizing agency for sewage disposal, implementing new projects and supervising the running of existing installations.

FIGURE 3.1.5

SUB-DIVISION OF THE WATER QUALITY BRANCH
OF THE WATER RESOURCES DIVISION OR AUTHORITY



Seven areal sewerage authorities, generally based upon Kenya's provinces, to be responsible for the day-to-day operation of sewage disposal throughout the country.

Several local sewerage authorities, which will be municipal and urban councils which, having demonstrated their competence, have been formally authorized to deal with sewage disposal within their own districts.

The recommended national sewage disposal organization cannot be established until the current manpower situation has been greatly improved. Therefore, the organization shown on Figure 3.1.4 should be considered to be an objective rather than an immediate recommendation. In the short-term, it is considered that sewage disposal should be technically controlled centrally by the MOWD. It is envisaged that the replacement of this central organization by that shown on Figure 3.1.4 is unlikely to start before 1979 (except in the case of Nairobi which is already, effectively, a "local sewerage authority").

The recommended future organization of Water Pollution Control in Kenya is shown diagrammatically on Figure 3.1.5. It should comprise:-

The Central Water Pollution Control Agency, which would be the Water Quality Division in the Resources Branch of the MOWD.

Four areal agencies based upon natural drainage areas.

Three laboratories to monitor the qualities of the water resources and to carry out periodic tests on effluent discharged into water courses from stormwater drains and sewage treatment works, including those treating industrial effluents.

It is proposed that the Research Organization shown on Figure 3.1.3 will cover the entire subject of "water"; in fact, its work is likely to be concerned predominantly with the treatment and disposal of sewage and water pollution control.

The orderly execution of the MOWD's programmes requires firm steering of the work by the senior management. Targets and priorities must be established, as must an effective system for feedback on progress, so that targets and priorities can be adjusted with time. In 1970, a system of time distribution reporting was introduced, but it was abandoned after operating for a year and a half. The emphasis was on a cost data bank and the system was operated by the then Water Department Accounting Section. It is recommended that the system be re-introduced, but with the emphasis on man-day statistics; the system should in the future be operated by the Planning Section within the Development Branch. The system will provide data for time-scheduling and resource requirements, and will also provide senior management with information which will enable them to steer the activities of the MOWD.

It is further recommended that a Management Committee, chaired by the Director of Water Development and consisting of Branch Heads and the Head of the Planning Section, should meet regularly to establish objectives and priorities, to report progress and to identify and solve problems.

The biggest constraint to the implementation capacity of the MOWD is the shortage of skilled manpower. Therefore it is important that the scarce manpower available is highly utilized. High work output from employees requires a high morale, and therefore everything possible should be done to boost morale. Staff meetings to give members of the Divisions and Sections an overall view of the activities of the MOWD, and an opportunity to air their problems and express their views, could be a step in that direction.

The provincial organizations of the MOWD need more, and higher qualified, staff to be able to cope with the increased work volume on operation and maintenance.

3.1.4 The Water and Sewerage Department, Nairobi City Council

The Water and Sewerage Department currently functions as an integral part of the Nairobi City Council. As a result, procedures are very cumbersome. Before final approval by the Council, decisions often have to pass through several committees and sub-committees. The Department is dependent upon the centralized administrative functions of the Council. Financial matters are difficult, salaries are low and personnel recruitment procedures are inefficient.

It should be noted that the operations of the Department differ from other activities of the City Council in that this organization is financially viable. It therefore could be run on a commercial basis.

The Nairobi Sewerage and Groundwater Survey Project started in 1971 and is scheduled to be completed in the early part of 1975. The World Health Organization is acting as executing agency for UNDP and the study is being carried out by the Swedish consultants, SWECO.

As part of their duties, SWECO have examined the organizational framework and practices of the Water and Sewerage Department and have prepared recommendations for the modification and strengthening of the managerial and operating practices to meet the future needs of Nairobi. Draft reports from the Nairobi Study were available at the time of preparation of this report and have formed a valuable input.

SWECO, in their draft Organization, Management, Finance and Legislation Report, Part 1, have presented two alternatives for the future organization and management of Nairobi's Water and Sewerage:-

Alternative I - with a Water and Sewerage Department still as part of Nairobi City Council, but with a new organization structure and much more direct control and responsibility for all its functions.

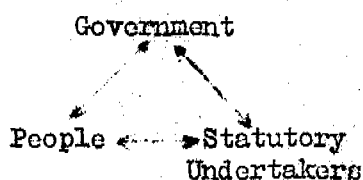
Alternative II - the establishment of the Nairobi Water and Sewerage Authority, which would be an autonomous body created under a new act of legislation. Such an Authority could eventually come under the umbrella of the MOWD.

At the present time, it appears that the Nairobi City Council favours Alternative I.

3.2 Water Legislation

The law is the formal expression of the policy and decisions of the Government, and the means by which it discharges its functions. Water conservation, supply and use, and the collection and disposal of sewage, are included in the domestic functions of the Government.

Water legislation is necessary to implement the Government's policy in these matters, to establish authorities or undertakers to carry out these functions, to provide for control of these authorities and undertakings by the Government and for the management of their affairs by the undertakers. Water legislation, in other words, represents the result of a triangular exchange of views and authority:-



Water management is basically a matter of matching available resources to the demands made on them. Whilst it may well be true that at present there is sufficient water in Kenya to meet demands, it is certain that, as the development of the country proceeds, the pressure on water resources will increase to the point where stricter controls will be needed. This will call for water law that is acceptable, workable and enforceable.

The Kenya water law is basically sound and adequate, although involving a multiplicity of Acts and other statutory instruments. The problem is one of poor enforcement rather than lack of, or defects in, the law.

Acts are the primary instruments by which the legislature expresses its will and exercises its authority. The Bill (or draft) is considered in detail by Parliament before being passed and presented to the President for assent.

The laws with a direct bearing on the conservation and use of water resources, for water supplies, for sewerage, for pollution control and for purposes connected therewith, are:-

i) The Water Act, Chapter 372, revised 1968

The fundamental effect of the Act is to place the control of and the right to use all water in the hands of the Minister responsible for water development (that is currently, the Minister for Water Development).

ii) The Public Health Act, Chapter 242

This Act makes provision for securing and maintaining health. It recognises the importance of water from the health point of view, particularly in the prevention of certain infectious diseases, by including many provisions relating to water and sewerage.

iii) The Irrigation Act, 1966

This Act is mainly concerned with the establishment, constitution and functions of the National Irrigation Board.

iv) The Mombasa Pipeline Board Act

The Act provides for the establishment of the Board, its constitution, powers and functions.

v) The Local Government Regulations, 1963

These regulations set out, for the local government areas, the constitution, powers and duties of local authorities.

Many local authorities are water undertakers but certain provisions of the Water Act and its subsidiary legislation do not apply to local authority undertakers.

The supreme authorities for implementing water law are the Ministers, i.e. the Minister for Water Development for the Water Act; the Minister for Health for the Public Health Act and the Minister for Local Government for the Local Government Regulations. Each Minister has wide powers.

One of the greatest problems in the enforcement of water law in Kenya is the number of agencies involved. The main agencies referred to in the Water Law are as follows:-

i) The Water Resources Authority

The Water Resources Authority is established by Section 19 of the Water Act. The Authority ceased to function and was de-gazetted in 1972. Its duties included investigating the water resources of Kenya and making recommendations thereon to the Minister; to make estimates of supply and demand; to formulate proposals for meeting the demands, and to supply information on water resources to the Minister and others. It was also the appeal body for certain decisions of the Water Apportionment Board.

The functions of the Water Resources Board are said to have been taken over by the MOWD. Only now are amendments to the Water Act to this effect being drafted.

ii) The Water Apportionment Board

The Water Apportionment Board is appointed by the Minister under Section 25 of the Water Act. Whilst its powers and duties as set out in the Act do not so provide, they in effect exercise the Minister's powers to control the right of water use.

The functions of the Board are mainly concerned with the issue, variation and revocation of water permits. The technical advisor to the Board is the Director of Water Development (the technical Director of the MOWD), who also provides the secretariat and the water bailiffs who are the Board's field workers.

iii) Catchment Boards

There are six Catchment Boards appointed by the Minister. Their duties are to advise the Water Apportionment Board on the appointment and use of water supplies and the adjustment, cancellation or alteration of any water permit.

iv) Regional Water Committees

Section 24 of the Water Act provides for the appointment, by the Minister, of a Regional Water Committee for each Province. Their duties were to advise the Minister and the Water Resources Authority on water conservation and development matters. The Regional Water Committees no longer exist.

v) The Ministry of Water Development (MOWD)

Relevant Clauses in the Water Act are currently being amended so as to take into account the recent establishment of this Ministry.

The MOWD is responsible for water supply and conservation work, including general technical services in the field of water, sewerage and water pollution control. In this way, the Ministry is both directly and indirectly involved in the implementation and enforcement of water law.

With the establishment during 1972 of the Water Pollution Control Section in its Resources Branch, the MOWD became more directly engaged in the enforcement of the Water Law.

The creation of the Sewerage Section (subsequently the Sewerage Division) further reinforced the position of the MOWD as the main agency concerned with the enforcement of Kenyan Water Law.

3.3 Manpower and Training Requirements

The MOWD can perform its functions as outlined in the current National Development Plan, plus its future responsibilities, only if it has sufficient trained and experienced personnel.

However, at the present time, there is a severe shortage of such persons and it is concluded that, unless this shortage can be eliminated, the current National Development Plan programme is too ambitious. If the shortage continues, it is considered that the development programme should be reduced to match the availability of competent staff.

There has not been any major increase of staff within the MOWD over the past few years, although the work volume, specifically the rural water and sewerage development programmes, has been rapidly increasing.

Aiming at complete Kenyanization by the year 1983, the annual increase of Kenyan engineers for the water sector should average at least 12 (plus a further 8 for the sewerage sector), bearing in mind that some will change to other employment. To achieve 50 per cent Kenyanization by 1983 would require an annual increase of Kenyan engineers by ten. About 30 expatriates should then be recruited annually by 1983, assuming an average duration of their stay of three years.

The number of graduates from the Civil Engineering Faculty of Nairobi University has over the past few years averaged around 50 and no plans at the present time are in existence for expansion. With the opening of an Engineering Faculty at the University of Dar-es-Salaam it can be expected, however, that the portion of Kenya students will increase from 50 per cent to about 75 per cent. In addition, some Kenyans graduate from Universities abroad; it is difficult, however, to estimate how many.

There is considerable competition for civil engineers from both the public and private sectors. The Ministry of Works alone has an establishment of 186 engineers with 69 vacancies. There are 46 non-citizens holding posts and the remaining 71 are Kenyan engineers, most of whom have been trained abroad, sponsored by the Government of Kenya.

Within the water and sewerage sectors, the MOWD and the Nairobi City Council have the biggest demand for civil engineers.

It is considered most unlikely that the MOWD will be able to attract a total of 20 engineers per year.

The alternatives are:-

- i) Cut the programme so as to match the rate of development to the availability of Kenya engineering staff.
- ii) Increase the output from the Engineering Faculty of the University of Nairobi.
- iii) Continue to rely upon technical assistance from overseas.
- iv) A combination of the above alternatives.

As Alternative ii) is not immediately possible, the short-term solution is to balance, by cutting down as necessary, the targets outlined in the current National Development Plan with the numbers of expatriate staff recruited.

For a proper long-term solution, it is recommended that an ad hoc Civil Engineering Manpower Planning Group should be established between the major users of civil engineers and the teaching and training organizations in Kenya. This Group should be required to study the overall long-term demand and supply situation, and to make recommendations as to how the country's need may be met.

It is necessary for the MOWD to have a more vigorous and less rigid recruitment policy, whether the output of civil engineers from the Nairobi University is increased or not, or they will not be able to recruit their fair share of Kenyan graduates. Many candidates have in the past gone to other employers because the MOWD procedure has been too lengthy.

It is also recommended that the Kenya Government should continue to recruit engineers from overseas. The present practice of taking overseas expatriates on relatively short contracts is inefficient; in the first instance, these experts spend a considerable portion of their contract periods settling in and becoming familiar with local conditions; secondly, Kenya loses much of the knowledge gained by these persons when they leave the country.

Expatriates achieving good performances should be given every encouragement to extend their contracts whereas the contracts of those who are not up to an acceptable standard should be terminated; that is, it is suggested that the Government should be more selective in recommending extensions for expatriates.

This problem of a national shortage of engineers applies similarly to sanitary chemists, required to fill posts in the Sewerage Division and Water Quality Section. The problem is not so acute in other scientific disciplines -- the majority of hydrologists and geologists within the Water Resources Branch of the MOWD are Kenyans.

The present number of sub-professional technical staff (below engineers but above artisans) in the MOWD is about 160. By 1978 about 840 will be required and by 1983 the total should reach about 1 400 if the proposed water supply and sewerage development programmes are to be implemented, and the water pollution control agency is to become effective.

This means a net annual increase of about 200 technician staff members during the next few years. The annual intake of students should be higher to cater for drop-outs, retirements and transfers to other organizations.

The MOWD Training School has an annual intake of about 100. The students attend a six-month pre-selection course at the School during which general engineering subjects are taught. The teaching staff at the Training School consider six months to be too short a period, and would prefer a 12 month course. An alternative, but less desirable possibility, would be to reduce the number of subjects included in the curricula.

The students who obtain the highest marks on the pre-selection course (approximately one-third of the total) are sponsored for a two-and-a-half year diploma sandwich course at the Kenya Polytechnic. The remaining students receive in-service and occasionally formal training in the various Sections of the MOWD. The total formal training period for all students is three years.

Even this output is estimated to be insufficient to meet the demand for technical officer staff required to execute the current National Development Plan programme. However, any attempt by the Ministry to absorb additional technical trainees with the present professional manpower situation would render in-service training ineffective and would cripple the development programmes. Therefore, it is not suggested at the present time that the intake to the Training School should be increased over 100 per year.

This gap between supply and demand for sub-professional officers could be met, as in the past, by the utilization of the services of volunteers from donor organizations. These volunteers receive only nominal emoluments.

A recommended improvement would be to call expatriate volunteers "Junior Experts". If this were done, it is felt that the MOWD could ask for better experienced and qualified volunteers. In this way, not only would the work output of these officers be increased but also they could play a larger part in providing in-service training to Kenyan sub-professionals.

The technical officers within the MOWD can only work efficiently if the quality and quantity of the Ministry's administrative staff increases in parallel with the technical establishment.

Particular administrative deficiencies at the present time concern Personnel (records are not properly kept and the system generally needs a complete overhaul), Purchasing, Stores and Accounts. An important step would be to upgrade the status of the Heads of the administrative sections.

Table 3.7.1

Manpower Requirements for Sewage Disposal, National Totals
(based upon Table C.2C and including the proposed Research Organisation)

POST DESIGNATION	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	Remarks
Senior Sanitary engineer (Engineer A)	0	1	1	1	1	1	1	1	1	1	The Secretariat
Director (Engineer A)	1	1	1	1	1	1	1	1	1	1	The Central Sewerage Authority
Chief engineer (Engineer B)	0	2	4	7	7	7	7	7	7	7	of each areal sewerage authority
Municipal engineer/sanitary engineer (Engineer B)	0	0	0	2	4	6	8	10	12	14	of each local sewerage authority
Director (Chemist A)	1	1	1	1	1	1	1	1	1	1	The Research Organisation
Engineer A	4	5	7	8	8	8	8	8	8	8	
Engineer B	2	3	3	4	6	6	7	7	7	7	
Engineer C	1	5	7	10	10	10	10	10	10	10	
Engineer D	0	2	6	10	14	18	21	23	25	27	
Chemist A	2	4	5	7	7	7	7	7	7	7	
Chemist B	0	3	9	14	17	18	18	18	18	18	
Biologist	0	2	3	3	3	3	3	3	3	3	
Limnologist	0	1	1	1	1	1	1	1	1	1	
Sewage works' manager	1	5	7	13	17	20	22	24	26	28	
Scientific assistant	0	6	10	18	24	30	33	36	38	40	
Deputy Sewage works' manager	0	4	8	16	23	29	33	37	41	45	
Civil engineering inspector	0	2	5	11	17	21	25	29	33	37	
Superintendent	0	9	18	32	35	35	36	37	35	33	of individual-type sewage disposal
Supervisor	0	4	8	12	16	20	20	18	16	14	of public latrines
Engineering design assistant	2	2	3	8	11	13	15	17	19	21	
Senior administrators	2	14	23	23	23	23	23	23	23	23	
Librarian	0	0	2	2	2	2	2	2	2	2	
Draughtsman	2	8	17	28	37	35	37	39	41	43	
Laboratory assistant	0	0	8	18	25	31	36	38	40	42	
Mechanic/plant operator	0	8	18	33	49	56	64	72	80	88	
TOTALS	18	92	175	283	355	402	439	469	495	521	

3.3.1 The Water Supply Sector

The present staff of the Department is insufficient to cope with the water supply development programme. In particular the rural programme is not expanding at the planned rate, in spite of extensive utilization of consultants and contractors. Implementation capacity is the limiting factor rather than availability of finance. The installation of new supplies will require a considerable increase in the establishment, especially of staff for operation and maintenance.

There are, at the present time approximately 45 professionals holding established posts concerned with water supply. In addition, there are three expatriates not holding a post and some 35 US Peace Corps, Scandinavian and British Volunteers, some of whom have duties at a professional level.

It is estimated that by 1978 about 100 professionals, mostly engineers, will be required to implement the then current five year water supply programme, even if two-thirds of design and construction work is carried out by consultants and contractors. The number of professionals would need to be increased to about 125 by 1983. Staff in the Water Resources Branch is not included in these figures.

3.3.2 The Sewerage Sector

Whether the National Organization for Sewage Disposal (see Clause 3.1.3) can ever become a reality depends upon how effectively competent manpower, both professional and sub-professional, can be recruited and trained. The national manpower requirements to staff the growing organization are summarized in Table 3.3.1.

It should be noted that the staff requirements for the proposed Research Organization are included in these estimates, although it is considered that this organization need not necessarily be directly attached to the National Sewage Disposal Organization.

At the present time in Kenya, outside Nairobi, the numbers of citizens sufficiently trained and experienced to fill these posts are negligible. The manpower shortage may be overcome temporarily by employing expatriates in the professional posts and by making maximum use of firms of consulting engineers. However, a crash training programme is the only comprehensive solution to the present difficulties.

The urgency to produce trained citizens is considered to be so great that it is proposed that the training of each person should be restricted to the minimum which he will require to carry out his particular function within the overall organization.

With reference to Table 3.3.1, it is assumed that professional staff (engineers, chemists, biologists and the limnologist) will have received their basic academic training at Nairobi University, or at a similar institution elsewhere. They should be given an introductory course in sewage disposal upon recruitment, if they lack appropriate practical experience.

As there are currently no schools or colleges in Kenya capable of providing the training required by the majority of the sub-professionals in the Sewage Disposal Organization, it is suggested that the MOWD Training School should become the principal training institution, assisted where possible by Polytechnics.

Briefly, the expertise and training required by the various categories of officers listed on Table 3.3.1 are as follows:-

Sewage works' managers

Preferably these should be chemists, although, sub-professionals with suitable experience, aptitude and enthusiasm, could be a satisfactory alternative. It is proposed that the recruitment of sewage works' managers will be sufficiently strict to ensure that those appointed will require only a brief introductory period - about 2 months - of formal training.

Scientific assistants

They will be the major assistants to the chemists, biologists and limnologist. If, as recommended, recruits will already have had a general scientific education, then it is considered that a two-week orientation course only will be required for these officers.

Deputy sewage works' managers

A general scientific education is also desirable for recruits to these positions. However, more important is relevant industrial experience and aptitude. Deputy sewage works' managers should be essentially practical persons, capable of handling labour and of organizing jobs. It is suggested that a short course lasting only one month would be sufficient to introduce deputy sewage works' managers to their duties.

Civil engineering inspectors

A thorough knowledge of practical site work is required to carry out their job, which is the site supervision of civil engineering and building construction. A short course, lasting about six weeks, is recommended in order to introduce already experienced recruits to the standards of workmanship and record-keeping expected.

Superintendents (for individual-type domestic sewage disposal installations)

Enthusiastic, versatile and reliable persons, capable of working with a minimum of supervision, are required. The technical aspects of their work are relatively simple and it is suggested that sufficient guidance could be given to suitable candidates during a course lasting only one month.

Supervisors (of public latrines)

Once again, enthusiasm, versatility and reliability are the main attributes to be looked for in recruits. An introductory course lasting about one month should suffice to introduce good recruits to their work.

Engineering design assistants

They may be considered intermediates between engineers and draughtsmen. They should be sufficiently versatile to work both in design offices and on site. It is suggested that these officers may best be trained at a full-time formal training course at a Polytechnic lasting for at least two years. When their academic course has been supplemented by in-service training, they should be fully capable of carrying out simple designs and of representing their professional seniors on site.

Senior administrators

Their task is generally to assist and support the technical personnel. Persons with varying expertise are required. It is expected that the senior officers will normally be graduates and several should have some relevant specialization such as management, economics, commerce and accountancy. Senior administrators will often be chief officers and as such should be very carefully selected.

Librarians

Recruits should be qualified and experienced librarians. They will be expected to organize and run the national library of technical publications relevant to "water", with particular emphasis on "sewage disposal" and "water pollution control". Their job will also include the dissemination of technical information to those who can make use of it, and therefore an intelligent interest and comprehension of technical matters should be considered a pre-requisite.

Draughtsmen

They should normally be trained on a formal course at a Polytechnic, prior to or soon after recruitment.

Table 3.3.2

Anticipated Total Manpower Requirements, 1973 - 1983
Water Pollution Control Agencies, including Laboratories

POST DESIGNATION	CLASSIFICATION	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
DIRECTOR (CHEMIST A) (Chief Officer)	Professional	-	1	1	1	1	1	1	1	1	1	1
CHEMIST A	Professional	2	3	4	4	4	4	4	4	4	4	4
CHEMIST B	Professional	-	4	5	6	6	8	8	8	8	8	8
BIOLOGIST	Professional	1	1	1	2	2	2	2	2	2	2	2
LIMNOLOGIST	Professional	-	1	1	1	1	1	1	1	1	1	1
ENGINEER	Professional	1	2	2	2	2	2	2	2	2	2	2
SCIENTIFIC ASSISTANTS	Sub-professional	-	3	6	7	7	9	9	9	9	9	9
WATER POLLUTION INSPECTORS - SENIOR	Professional	-	5	5	5	5	5	5	5	5	5	5
WATER POLLUTION INSPECTORS - JUNIOR	Sub-professional	10	10	15	20	20	20	20	20	20	20	20
LABORATORY ASSISTANTS	Sub-professional	-	-	2	4	6	10	10	10	10	10	10
SENIOR ADMINISTRATORS	Professional	1	6	6	6	6	6	6	6	6	6	6
TOTALS		15	36	48	58	60	68	68	68	68	68	68

Laboratory assistants

They will assist chemists and scientific assistants by setting up apparatus and carrying out simpler routine tests and analyses in laboratories. Much of their work will be repetitive and therefore recruits with the proper temperament should be chosen. They will receive in-service training and, in order to comprehend this, they should have had a basic general education with a bias towards scientific subjects.

Mechanics/Plant operators

Their primary task will be to keep systems and equipment working efficiently. They should generally be properly-trained tradesmen, capable of working with their hands and of supervising less-skilled assistants. Regardless of their specific background, it is suggested that all recruits should undergo a two-month course to orient them in sewage disposal.

3.3.3 The Water Pollution Control Sector

The total manpower requirements of the recommended water pollution control agencies and laboratories (see Clause 3.1.3) are shown on Table 3.3.2.

It is considered very important that the water pollution control agencies, and their supporting laboratories, should be established as early as possible and this urgency is reflected in the Table.

The personnel of the water pollution control agencies will work very close to Kenya's water resources and their effectiveness will be proportional to the intimate knowledge that individual staff members gain of particular lakes, or marine waters, or stretches of watercourses. Such knowledge stems from experience acquired over a number of years and it is therefore most desirable that those employed in water pollution control agencies should have career, rather than short-term, appointments.

At the present time, one pollution control officer -- an expatriate on a thirty-month contract -- plus a professional deputy is employed by the Water Department. He is Head of the Water Quality Section and has a small laboratory manned by one chemist and three laboratory assistants.

There are no water pollution control inspectors in Kenya, although some of the functions of such officers are carried out by water bailiffs and health inspectors. However, the training of water bailiffs and health inspectors in water pollution control falls very far short of that which should be given to a water pollution control inspector.

Only 17 of the 29 authorized posts in the MOWD for water bailiffs are filled; however, there are 27 water bailiff assistants.

The inspectors of the Ministry of Health, and their assistants, have a great many duties, including an overall responsibility to safeguard drinking water sources.

At the start of 1970, there were in Kenya 134 health inspectors, supported by 101 less-qualified health assistants; that is, there was only one health inspector to every 80 000 persons, a very low ratio.

With reference to Table 3.3.2, it is assumed that professional staff (chemists, biologists, engineers and the limnologist) will have received adequate academic training before recruitment. A short introductory course on sewage treatment and water pollution control, lasting about four weeks is proposed for them where necessary. The experience and expertise all these professionals gain in service should be supplemented by occasional, relevant refresher courses.

More formal training courses are proposed for scientific assistants and water pollution inspectors.

Scientific assistants

The training of scientific assistants, who should have had a general scientific education will normally be in-service and linked to their particular job. However, it is suggested that on recruitment they attend a short training course, lasting about three weeks, which covers sewage treatment and laboratory techniques and water pollution control.

Water Pollution inspectors

On recruitment, inspectors should be reasonably, but not necessarily technically educated men with good, determined characters and pleasant personalities; at the recruitment stage, the type of person is considered more important than his education. An initial intensive training course lasting about eight weeks is proposed for all recruits, and this should be followed by periodic refresher courses and seminars.

Laboratory assistants

They will assist chemists and scientific assistants by setting up apparatus and carrying out simpler routine tests and analyses in laboratories. Much of their work will be repetitive and therefore recruits with the proper temperament should be chosen. They will receive in-service training and, in order to comprehend this, they should have had a basic general education with a bias towards scientific subjects.

Senior administrators

Their task is generally to assist and support the technical personnel. Persons with varying expertise are required. It is expected that the senior officers will normally be graduates and several should have some relevant specialization such as management, economics, commerce or accountancy. Senior administrators will often be chief officers and as such should be very carefully selected.

Table 3.4.1

Population Served by Community Water Supplies

PROGRAMME	OPERATING AGENCY	TYPE	NUMBER OF SCHEMES	POPULATION SERVED (approximate figures)
NAIROBI				
Local Authority	Nairobi City Council	Urban	1	500 000
Airports plus Kabete	MOWD	Urban	3	40 000
Private Supplies	Private Water Undertakers	Urban	13	40 000
MINISTRY OF LOCAL GOVERNMENT				
Kisumu, Thika, Kitale Nakuru, Eldoret, Nanyuki, Nyahururu	Local Authorities	Urban	7	180 000
MINISTRY OF WATER DEVELOPMENT (MOWD)				
Mombasa and surroundings	MOWD	Urban	1	280 000
Others	MOWD	Urban	94	350 000
TOTAL URBAN			119	1 390 000
Rural Water Supply				
Lands and Settlement	MOWD	Rural	66	220 000
WHO/UNICEF	Co-operatives	Rural	30	350 000
Self-Help	County Councils	Rural	300	330 000
	Self-help Groups	Rural		200 000
TOTAL RURAL				1 100 000

3.4 Community Water Supplies

3.4.1 Inventory of Existing Supplies

In Report No 1, some statistics on existing urban and rural water supplies in Kenya were presented. The Water Department was at that time involved in the preparation of a data bank on existing supplies. Data for the following water supplies has been collected to date.

	<u>Type of Supply</u>	<u>Number of Supplies Recorded</u>
1	<u>MOWD</u>	
	i Urban, gazetted W/S	89
	ii Urban, non-gazetted W/S	5
	iii Institution and other W/S	76
	iv Rural Water Supply I	84
	v Rural Water Supply II	
	vi Range Water Supply	21
2	<u>LOCAL AUTHORITY W/S</u>	840
3	<u>SETTLEMENT SCHEMES W/S</u>	32
4	<u>SELF-HELP W/S</u>	
5	<u>WHO/UNICEF W/S</u>	400
6	<u>EAR W/S</u>	27

The work has been done by a statistician seconded from the Ministry of Finance and Planning, assisted by two clerks. All of the data have been put on punched cards for computer processing. The statistician seconded has been replaced several times, which has delayed the completion of this activity.

There are no available data at present in addition to that which was presented in Appendices E to I in Report No 1. The population served by the various programmes is summarized in Table 3.4.1.

In general, the urban population is well catered for, although many of the supplies are running close to capacity and are in need of augmentations. About 10 per cent of the rural population has access to a community water supply. Most of the rural supplies have no treatment and less than half of the supplies deliver safe water from a bacteriological point of view.

During the financial year 1973-74, the installed capacity of new rural supplies is estimated to reach about 300 000 people, which just about equals the increase of the rural population during the same period.

3.4.2 Current Water Development Programmes

These current programmes are the starting point of the recommended national programme described in sub-section 3.4.3.

Nairobi Water Supply

Until 1974, the total capacity of Nairobi water supply was approximately 87 000 m³/day (19 million gallons/day) composed as follows:

Ruiru	23 000 m ³ /day;
Sasakua	59 000 m ³ /day;
Kikuyu Springs	5 000 m ³ /day.

In addition, private supplies in the Nairobi area provided about 14 000 m³/day. The total capacity during 1973 just exceeded the average demand. During the dry periods of January and February in 1972, 1973, and 1974 water shortages occurred. It was primarily the poorer areas of the City, such as the Mathari Valley, which were affected by the water shortage.

The Nairobi City Council has estimated that about 80 per cent of the City's present population of about 650 000 is connected to their supply. There are three supplies within the City operated by the MOWD and thirteen private supplies. All these supplies should, in the near future, be taken over by the Nairobi City Council.

An extension of the City's water supply from the Chania River has recently been commissioned and has increased the capacity by about 38 000 m³/day (8.3 million gallons/day).

The project, estimated at £5.0 million, has been partially financed through a £3.3 million loan from IBRD to the Nairobi City Council.

Mombasa Water Supply

Mombasa is served by water supplies owned by the Mombasa Pipeline Board. The Board sells water in bulk to the MOWD which distributes the water to the consumers.

The present water supplies consist of 36 000 m³/day (8 million gallons/day) from Mzima Springs 220 km west of Mombasa and 7 000 m³/day (1.5 million gallons/day) from Mrere 30 km south-west of Mombasa. The water is distributed to Mombasa itself and Kilifi and along the beaches north and south of Mombasa.

The Mzima pipeline has not proven wholly successful in operation, due to its susceptibility to water hammer resulting from flow fluctuations.

The water supply barely copes with the demand. On several occasions over the past two years, it has been necessary to close the supply during certain hours of the day to build up the water level in the reservoirs at Hazeras.

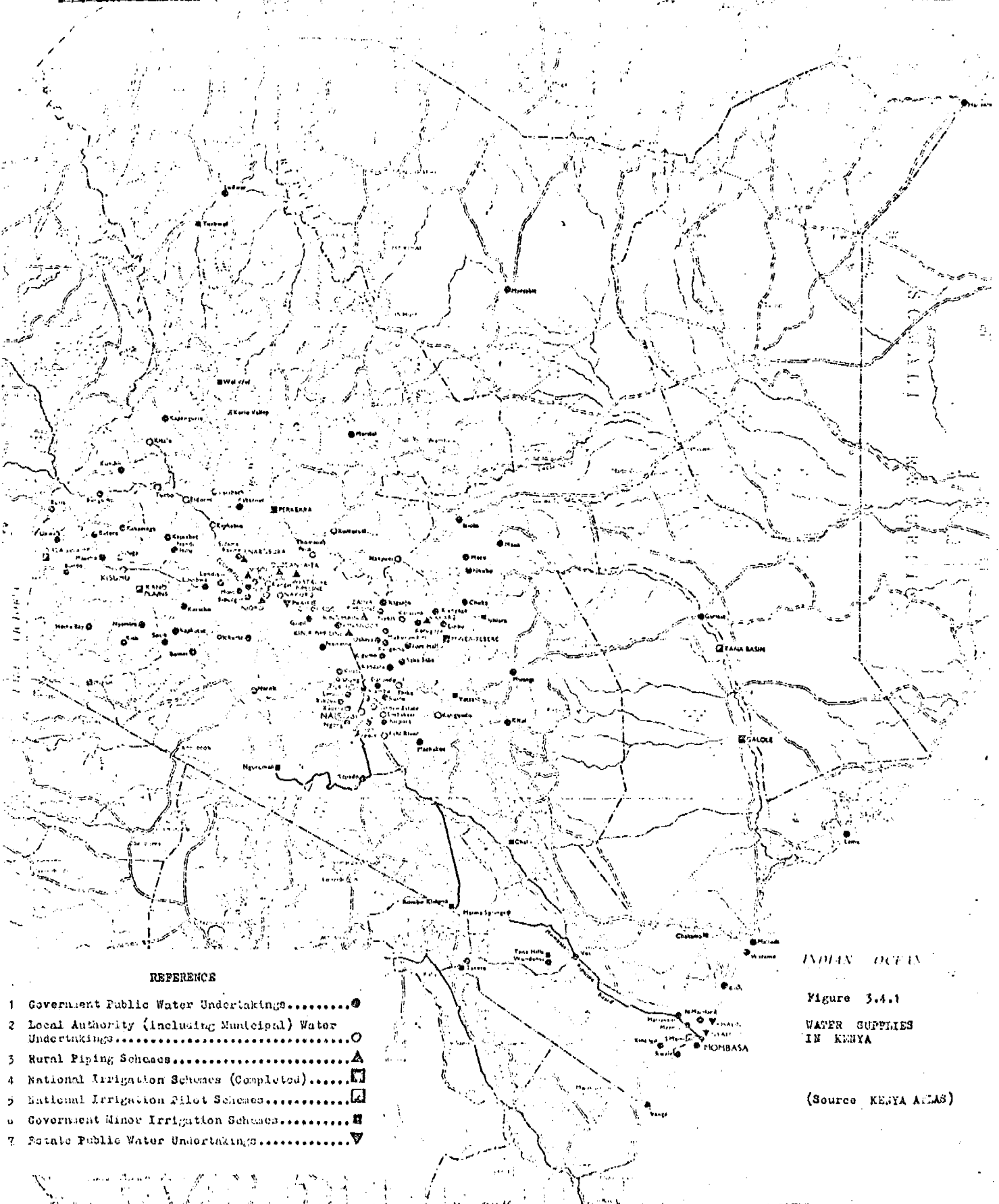
In 1970, the Mombasa Pipeline Board engaged a consulting firm to carry out a feasibility study on how to meet the long-term water needs of Mombasa.

Some immediate measures recommended by the consultants are under implementation. Water from an intake at the Pemba River and from additional boreholes will be directed to the Mrere pipeline. The capacity of this pipeline will be boosted to about 14 000 m³/day (3 million gallons/day) through a pumping station. Funds have been requested from a Japanese loan to carry out urgent work on the Mzima pipeline to replace the weakest sections of the existing reinforced concrete pipe with steel pipe.

The consultants studied four alternatives for the extension of Mombasa water supply, and recommended that the first choice should be either a pipeline from the Sabaki River or a doubling of the pipeline from Mzima Springs.

FIGURE 3.4.1

WATER SUPPLIES



The first alternative, which is estimated at £14.5 million, was approved. It is anticipated that this will cope with the demand for Mombasa to 1985 and will also serve the 300 km coastal belt from Malindi to Mombasa and the rural areas in the coast hinterland.

The IBRD has been successfully approached for financing of the extension.

It is most urgent that the works on the Mombasa extension get underway.

Urban Water Supplies operated by the Ministry of Local Government

The Ministry of Local Government operates the water supplies for the municipalities of Nakuru, Kisumu, Thika, Eldoret and Kitale and for the County Councils of Nanyuki and Nyahururu (Thomson's Falls).

The development estimates for 1973/74 listed the following expenditures:-

<u>Town</u>	<u>Estimates 1973/4</u> £	<u>Total Project Cost</u> £
Nakuru	69 000	268 000
Kisumu	100 000	700 000
Eldoret	2 000	100 000

The extensions of Nakuru and Kisumu water supplies are financed through a loan from West Germany.

Urban Supplies Operated by the MOWD

There are 89 supplies classified as urban operated by the MOWD. (See Figure 3.4.1)

The development expenditures for 1973/74 were estimated at £ 380 000.

Negotiations have been held with the Norwegian Government for a grant for urban water development, and an agreement for a five year programme has been signed. The grant is 50 per cent of a project of 60 million Norwegian Kroner. (£ 3.9 million at the exchange rate of July 1973).

Rural Water Development by the MOWD

In January 1970, a credit agreement was signed with the Swedish Government for a two year rural water development programme.

At the end of the second quarter of 1973, the status of the programme was as follows:-

<u>Phase</u>	<u>Number</u>
Planning	3
Design	0
Construction	32
Operation	43
	—
	<u>TOTAL 78</u>

Actual expenditures amount to £ 1.50 million out of £ 1.75 million.

In April 1972, a second credit agreement was signed with the Swedish Government for a two year rural water development programme. The credit accounts to 20 million Swedish Kroner (£ 1.7 million at the exchange rate of July 1973). Attached to the agreement is a grant of Swedish Kronor 1.62 million (£ 140 000) for training activities and facilities and Swedish Kroner 350 000 (£ 28 000) for implementation of a research programme.

The credit is distributed as follows:-

<u>Category of Cost</u>	<u>Estimated Cost</u>	<u>To be Covered by the Credit</u>
i Construction		
a) Direct Costs	18 661 000	12 130 000
b) Overhead Costs	3 632 200	2 426 000
ii Water Conservation Programme, etc	1 015 380	660 000
iii Vehicles, Plant and Equipment	1 338 460	870 000
iv Storage, Workshop & Office Facilities	746 150	485 000
v Consulting Services (excluding Design & Supervision of Programme Schemes)	1 338 460	870 000
vi Unallocated	3 937 350	2 559 000
	<u>30 769 000</u>	<u>20 000 000</u>

At the end of the second quarter of 1973, the status of the programme was as follows:-

<u>Phase</u>	<u>Number</u>
Planning	2
Design	9
Construction	22
Operation	2

	35

Actual expenditure amounts to £ 0.61 million at the end of the second quarter 1973.

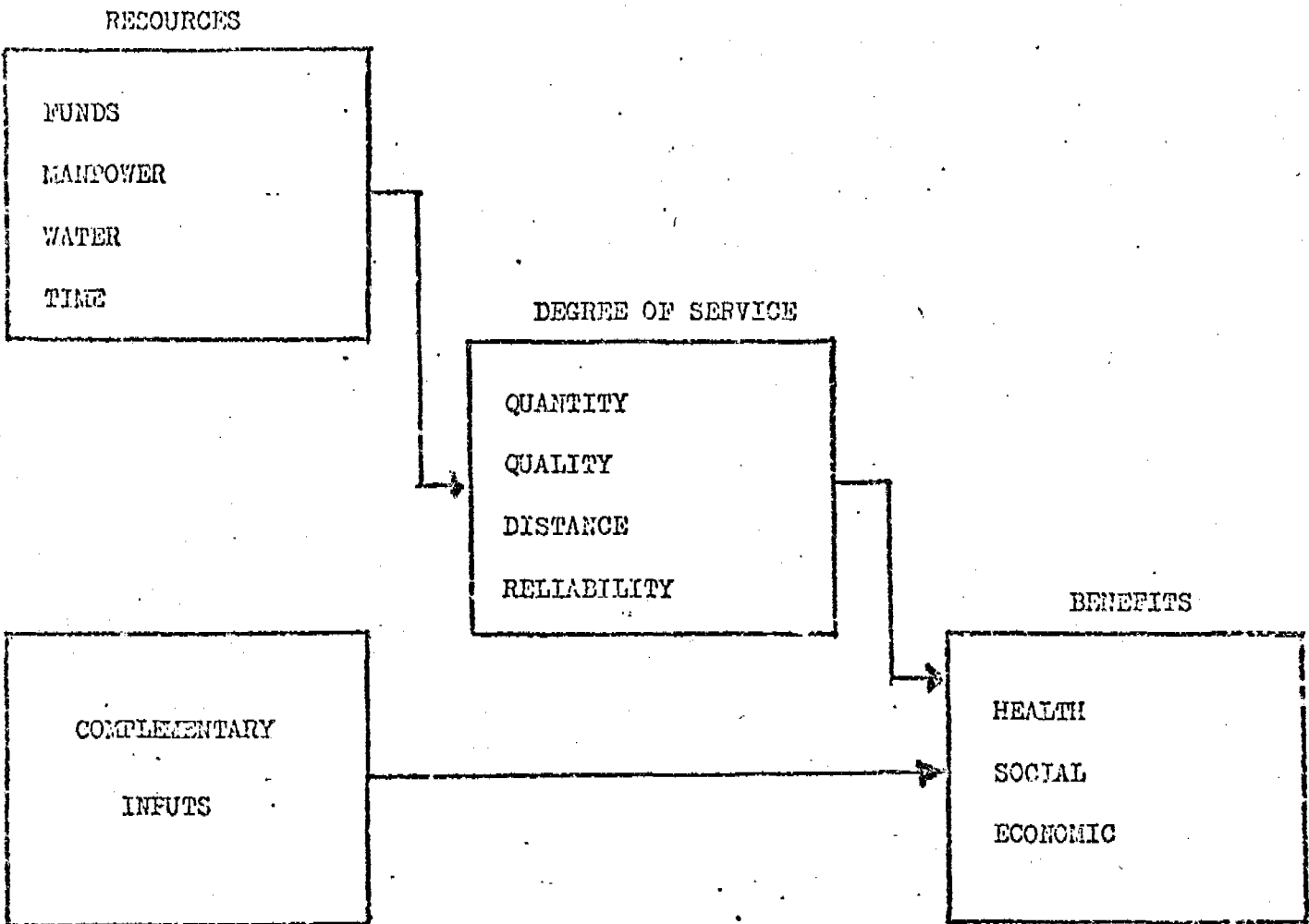
Rural Water Development by the Ministry of Health

In the Development Estimates for the financial year 1973/74, about £ 63 000 was allocated to the environmental sanitation programme carried out by the Ministry of Health.

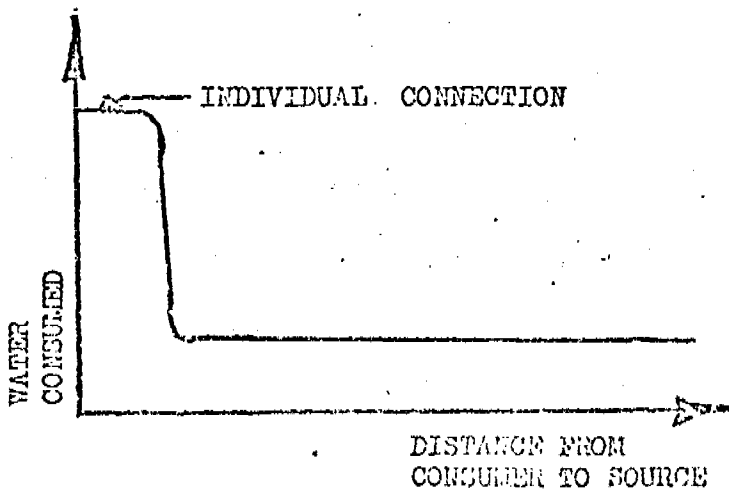
During 1972/73, about 50 per cent of the allocation on environmental sanitation was spent on development of rural water supplies. The demonstration programme on rural water supplies will be phased out and the proportion of available funds spent on water development will be reduced.

It is expected that the funds on water development will be spent mainly on the following items:-

- a) Completion of existing schemes that are not finalized or not in working order. In cases where village participation in the scheme is no longer forthcoming, materials should be diverted to other schemes. Schemes not in working order should be repaired to give an efficiently run water supply.
- b) New schemes which should be limited to providing schools, dispensaries and people in dry areas with rainwater catchments or shallow wells. These installations would be within the capacity of the Public Health Inspectors and local people to design and install.
- c) Installation of more slow sand filters to existing schemes.



QUANTITY vs DISTANCE



Rural Water Development by the Ministry of Lands & Settlement

The Ministry of Lands and Settlement was allocated £ 250 000 for development of water supplies in settlement areas for the financial year 1973/74.

The water development programme in the settlement areas is being carried out by the MOWD on an agency basis.

Self-Help Rural Water Development, the Ministry of Co-operatives and Social Services

The Ministry of Co-operatives and Social Services was allocated £ 150 000 for grants for self-help services in the Development Estimates for 1973/74. In the past, about 30 per cent of the grant has been spent on rural water development.

It is not possible to estimate how much money will be spent on water development by self-help groups. Large self-help water projects are planned in primarily the Central Province but also in the Eastern Province.

Kandara scheme, the largest self-help water project planned, is under construction. The scheme has been designed by a consulting firm from funds in the RWS II Programme. The self-help group has obtained a £ 1 million loan from overseas.

3.4.3 Recommended National Programme

The stated long-term objective of the Kenya Government is to provide practically everyone in the country with an adequate water supply by the end of this century.

The benefits gained from an improved water supply can be categorized as health, social and economic benefits (see also Figure 3.4.2).

The main resources required are funds for development and operation and maintenance; skilled and unskilled manpower to plan, design, construct, operate and maintain the supplies; water and time.

The degree of service varies with quantity of water supplies, quality of the water, distance from the consumer to the water and the reliability of the water supply. There is an important relationship between the quantity of water utilized and the distance between the consumer and the supplied water. Research has indicated that a significant increase in quantity of water used occurs when individual connections (water outlets on the farms) are installed. Water consumption from communal water points is almost constant, seldom exceeding fifteen litres per person per day, whether the distance is only a hundred metres or up to several kilometres.

The importance of increased water consumption is apparent as it is a fact that health benefits from a safe water supply increase with the quantity of water utilized. Hence, there is a marked improvement in health when people have access to individual connections. Water consumption rises, hygiene is improved and incidence of diseases will decline, provided the used water is disposed of hygienically.

A water supply without disinfected water is a health hazard. For instance, in the case of a cholera epidemic, an untreated water supply can be the cause of rapid spreading of the disease.

The source of water should be reliable. If the supply is wholly or partially treated, people tend to lose their immunity to water-borne diseases. An unreliable source would mean that people in case of drought would have to go back to the traditional sources of untreated water, when they are more susceptible to water-borne diseases.

Time and effort saved on obtaining water from a nearby piped water supply rather than from the traditional source is the most important component of the social benefits.

Time saved can be spent on productive work on the farms. Availability of labour is a constraint on the farms during certain periods of the year, for example during harvesting. The quality of the crop is often dependent upon the timing of the harvesting. There are in Kenya more than 500 000 farms where the husband is away from the farm and the wife is responsible for running the farm. For these farms it is particularly true that availability of labour is a constraint during period of peak demand, as the wives and children spend a considerable portion of their time drawing water.

Development of water supplies in rural areas has, until very recently, been carried out on a small scale, and only about 10 per cent of the rural population has access to a piped water supply.

The majority of Kenya's rural population is today drawing its water from natural sources. The degree of service provided by nature varies considerably over the ecological zones.

In high potential rural areas, water is available in large quantities from permanent rivers and springs near to the people. Rivers are often polluted and the pollution will increase with industrial development, increased water consumption and urbanization, unless strict controls are enforced. The quantity of water used is small as people have to carry the water from the bottom of the valleys up to the populated ridges.

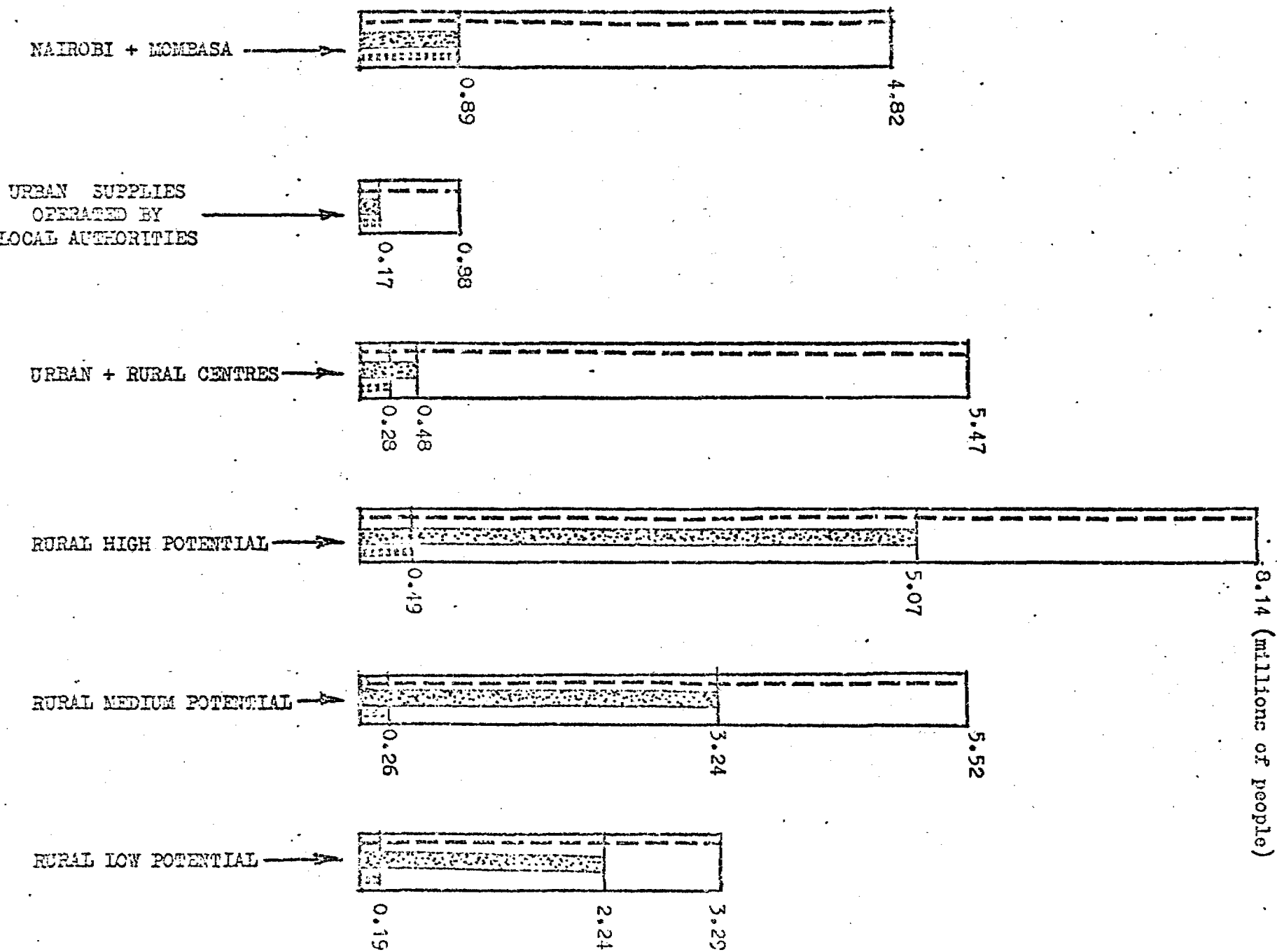
In medium potential areas, the water sources are less reliable and the volume of water is also less. The quantity used is about the same as in high potential areas, although the distance to the water is, on the average, further.

In low potential areas, a high proportion of the population comprise nomadic, pastoral people. The natural water sources are very unreliable. The quantity available is limited and the quality is often very poor with saline or a high fluoride content water and local pollution from people and domestic animals.

In implementing a water development programme within the country, it will not be possible to provide the same degree of service to all the population. The needs, marginal benefits and costs are different in urban and rural areas, and vary between the ecological zones in rural areas. National resources available are limited and water development is one of many sectors demanding public expenditure.

In analysing the feasibility of the Government objective of providing the total population with water supplies by the end of the century, the following assumptions were made for the main case studied:-

POPULATION YEAR 2000
POPULATION YEAR 1972
POPULATION SERVED 1972



Farmers are reluctant to obtain grade cattle unless their farms are connected to a water supply with individual connections, so that the cattle can be grazed and watered on the farm. Furthermore, high quality milk cannot be produced without water supplies in the dairy.

No attempt has been made to carry out formal cost-benefit analysis. This is partly because benefits from an improved water supply cannot readily be separated from benefits from complementary input, and partly because it is almost impossible to quantify the benefits. Whilst water is a contributing factor to development, it is also true that it is a consequence of development.

Kenya's population is expected to increase from to-day's 11 million to about 28 million people by the end of the century. Migration from rural areas is expected to result in an increase of the urban population from one and a half to about 11 million during the same period.

In the analysis, urban water supplies have been defined as those serving "people living in rural centres, urban centres, municipalities and the City of Nairobi".

The rural population has, in the analysis, been distributed on the three ecological zones - high, medium and low potential areas. The present population distribution between these zones is approximately 50, 30 and 20 per cent respectively. Migration between the zones can be expected, but the net result is not likely to significantly change the present distribution.

The present situation and future requirements for community water supplies in urban and rural areas are summarized in Figure 3.4.3.

The degree of water service for the urban population of Kenya is by world standards relatively high, and practically all people in Nairobi, municipalities and urban centres have access to a safe water supply. About half the population in centres designated as rural centres also have access to a piped water supply. Augmentations of urban water supplies, however, are lagging behind.

- i) The total population of Kenya to grow from 12.1 million in 1972 to 28.1 million in 2000. (This is the probable growth according to the demographic analyses made by the Statistics Division of the Ministry of Finance and Planning on the basis of population censuses carried out in 1962 and 1969).
- ii) The urban population to grow from 1.2 million in 1972 to 9.2 million in 2000 (probable growth).
- iii) The majority of the urban population to be served by individual connection service (an exception will be areas occupied by squatters in the outskirts of urban areas which will be provided with communal water and sanitary facilities).
- iv) The proportion of low cost housing to increase in relation to high cost housing areas in major urban areas, resulting in very minor average increases in water demand for the urban population.
- v) Water demand for the rural population in high and medium potential areas is calculated on the basis that about 60 per cent of consumers eventually will have individual connections.
- vi) Water demand for the rural population in low potential areas is calculated on the basis of communal water point type service.
- vii) Unit costs used assumed 1972 constant prices.
- viii) Unit costs per head for development of rural water supplies to be multiplied by factors of 1.3 and 1.5 respectively for schemes developed during the eighties and nineties, as low cost schemes would be given priority and be built first.
- ix) The annual increase of the Gross National Product to be 6.7 per cent from 1972 to 2000.
- x) The Government Development expenditure to be directly proportional to GNP during 1972 to 2000.

FIGURE 3.4.4

CENTRAL GOVERNMENT DEVELOPMENT EXPENDITURE EXCLUDING MOMBASA

£ MILLION

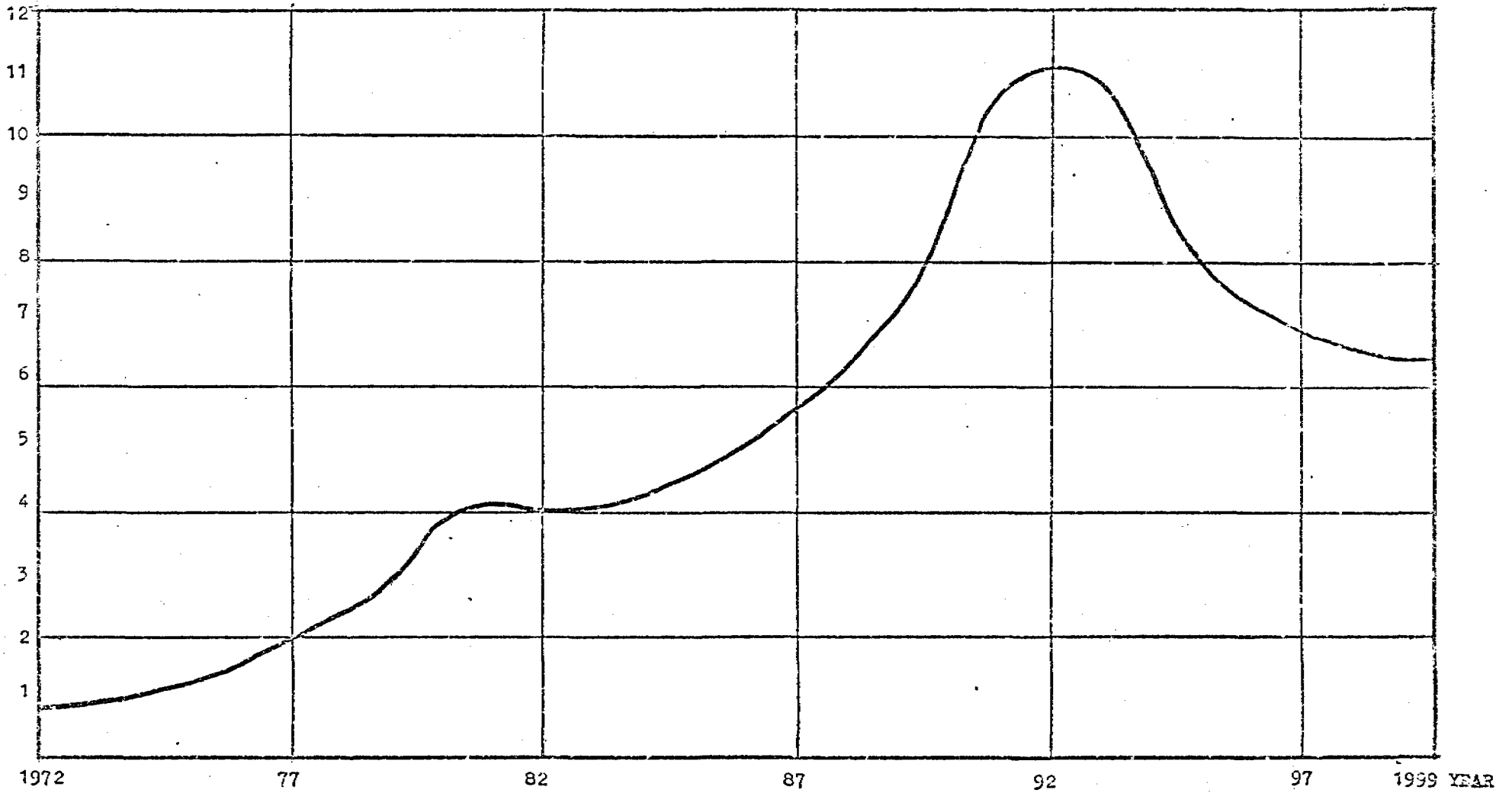
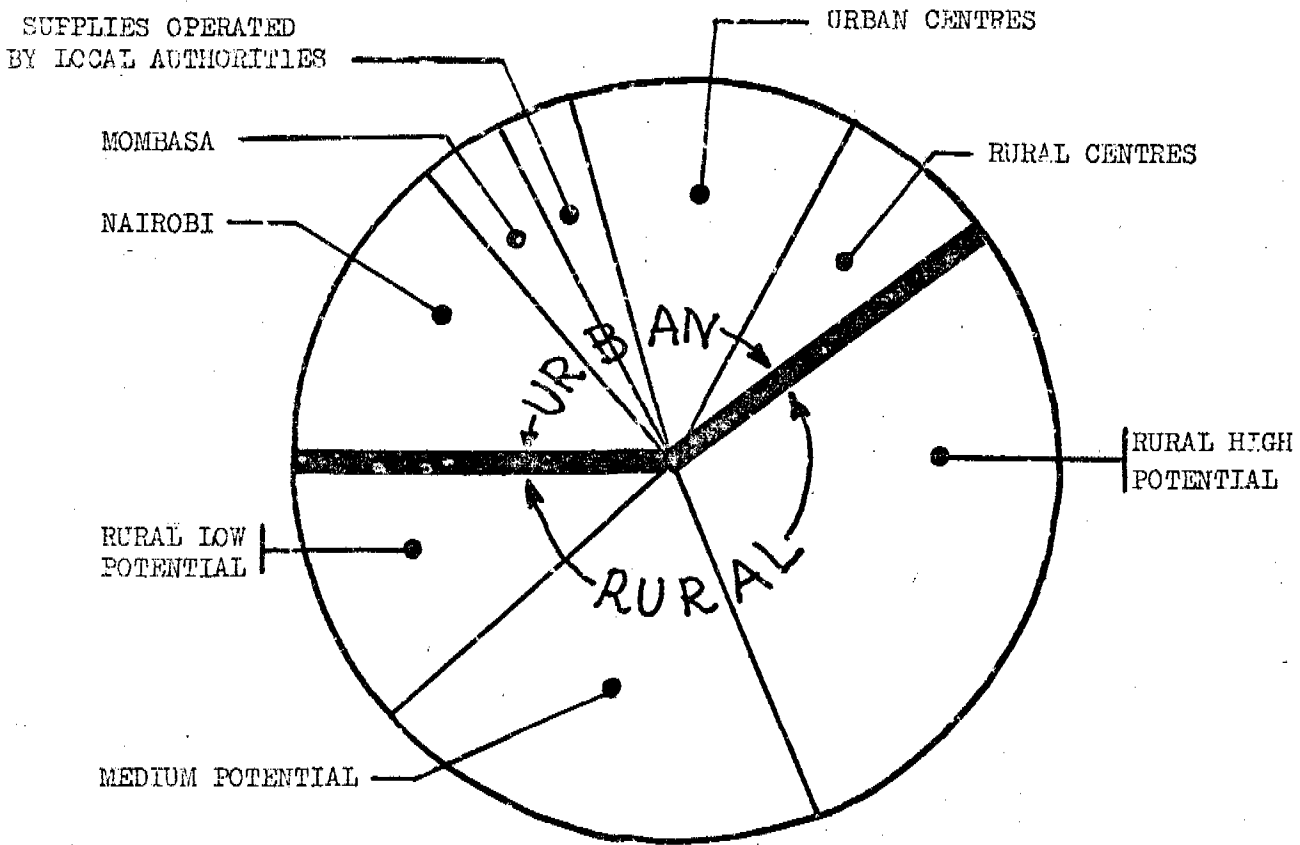
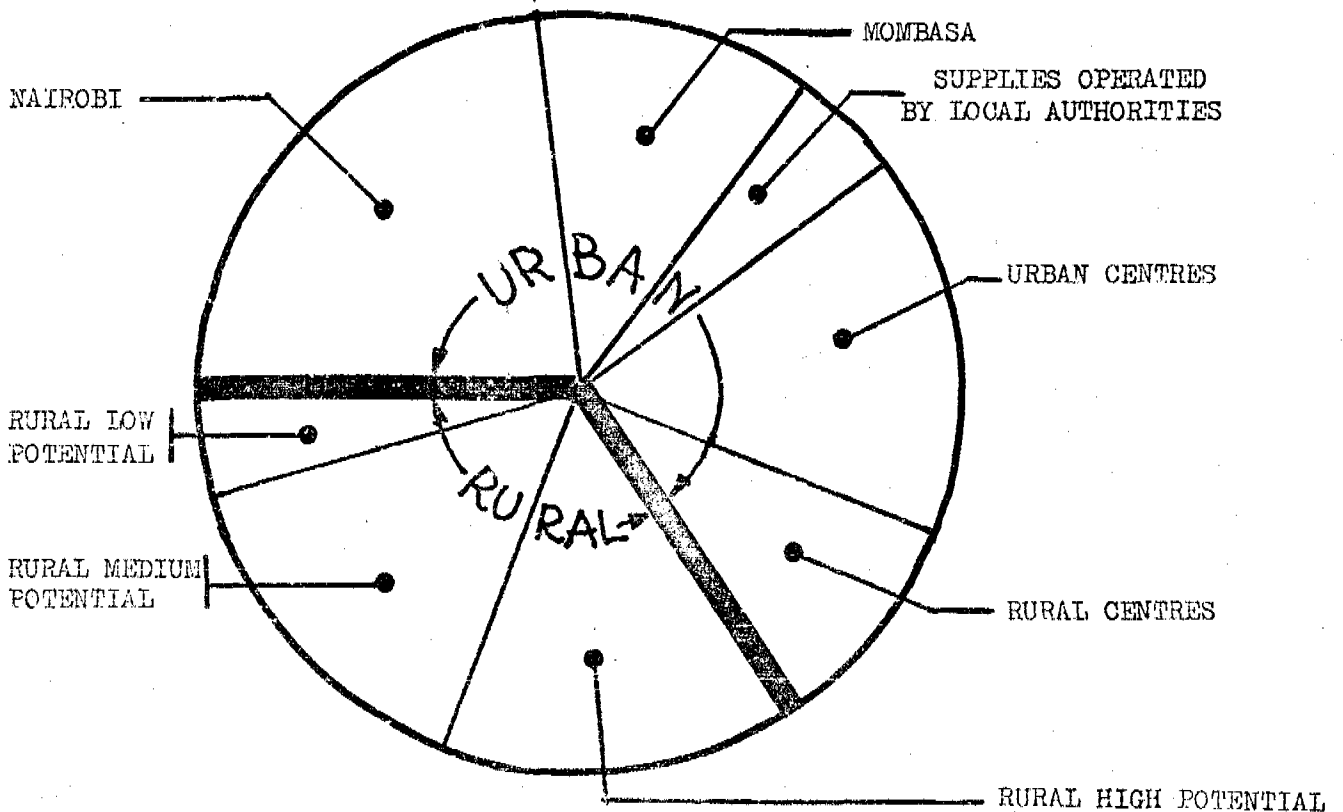


FIGURE 3.4.5

DISTRIBUTION OF POPULATION YEAR 2000



DISTRIBUTION OF DEVELOPMENT FUNDS 1972-2000



The pattern of development expenditure assumed is shown in Figure 3.4.4. The curve includes all Central Government expenditures with the exception of Mombasa. Expenditures by the Ministry of Local Government are thus not included. The pattern is based on a relatively slow acceleration of the development in the early years to allow for a build-up of implementation capacity. The hump on the curve around 1980 represents the development of water supplies in rural centres, which are recommended to be given priority. The curve reaches its peak in 1992 after which the development programme slows down to allow for the transfer of resources from development to operation and maintenance. During the five year period 1990-1994, the MOWD development programme excluding Mombasa would require about 4.5 per cent of the total Public Sector Development Expenditure. For comparison, it may be mentioned that, according to the 1973/74 development estimates, MOWD will spend 2.8 per cent of the total development budget on domestic water supplies.

The anticipated distribution of population in the year 2000 and the accumulated development expenditure from 1972 to 2000 are shown in Figure 3.4.5. The estimated total development expenditure during 1972 to 2000 is distributed as follows:-

<u>Category</u>	<u>Total Funds</u> <u>£ millions</u>
Nairobi	57
Mombasa	29
Supplies operated by Local Government	12
Urban centres	41
Rural centres	<u>23</u>
TOTAL URBAN	162
Rural high potential	38
Rural medium potential	36
Rural low potential	<u>11</u>
TOTAL RURAL	85
<u>OVERALL TOTAL</u>	<u>247</u>

Sensitivity analyses were carried out for the following alternatives:-

i) Lower Degree of Service in High and Medium Potential Rural Areas

High and medium potential rural areas to be served by communal water points. A per caput water consumption of 15 litres per day was assumed; this will not permit any individual connections to be developed.

The accumulated development expenditure for high potential areas would be reduced from 38 to 21 and for medium potential areas from 36 to 17 million pounds. The total accumulated development funds from 1972 to 2000 would be reduced by about 14 per cent.

The reduced capital outlay would be offset by a reduction in water revenue.

ii) Pessimistic Alternative

In this case the high population forecast (34 million people by the year 2000) was combined with an annual growth of development expenditure of only 4 per cent.

On the assumption that the proportion between urban and rural population would be the same as for the probable population forecast, the total expenditure would increase by 21 per cent to £ 300 million.

During the peak five year period of 1990-1994 water development would require 13 per cent of the total public sector development expenditure and MOWD would require 9 per cent of the development budget.

iii) Optimistic Alternative

In this case, the low population forecast (24 million people by the year 2000) was combined with an annual growth of development expenditure of 6.7 per cent.

The total expenditure would be reduced by 14 per cent to £ 210 million.

During the peak five year period of 1990-1994, water development would require 5.5 per cent of the total public sector development expenditure and the MOWD would require 4 per cent of the development budget.

iv) Crash Programme

If the Government objectives were to provide practically everyone in the country access to a water supply by the year 1990, combined with the other assumptions made for the main alternative, the peak period would be 1983-1988.

The urban water development expenditure curve would not be affected by this changed objective as it is assumed that the development would follow the population increase.

The earlier and higher peak of the rural development programme would mean that about 10 per cent of the Central Government Development Expenditure would be required for the MOWD during the period 1983-1988.

Development of community water supplies in rural areas will have to be subsidized from other water sectors or other sectors of the economy.

If communal water point systems are installed, it is impractical and - from a social point of view - undesirable, to collect revenue from the people using the facilities.

If individual connection systems are installed, the total cost would be higher than the rural population can be expected to pay. However, the required total subsidy would be less than if communal water point systems were installed. This conclusion is based on the assumption that 20 per cent of the families obtain individual connections initially and 50 per cent ultimately.

As the benefits are considerably higher for individual connections, it is recommended that individual connection schemes are installed in high and medium potential areas.

For Nairobi, Mombasa and urban water supplies operated by Local Authorities, the cost of planning and designing the supplies has been included in the unit costs for development. For urban centres, rural centres and rural supplies, an additional 20 per cent on top of the development expenditure will be required from the recurrent budget to cover planning, design and overheads.

Costs for operation and maintenance will, by the year 2000, have reached the following levels:-

	<u>£ millions</u>
Nairobi.....	3.8
Mombasa.....	1.0
Municipalities.....	0.6
<u>Total Local Government.....</u>	<u>5.4</u>
Urban centres.....	2.1
Rural centres.....	1.2
Rural supplies.....	10.2
<u>Total KOWD.....</u>	<u>13.5</u>
<u>TOTAL.....</u>	<u>18.9</u>

Theoretically, water rates should in principal be based on marginal costs, in order to maximize the benefits to the country. It is recommended that water rates for Nairobi and the municipalities should be based on actual cost for each supply, and that the full cost for development and operation and maintenance should be recovered.

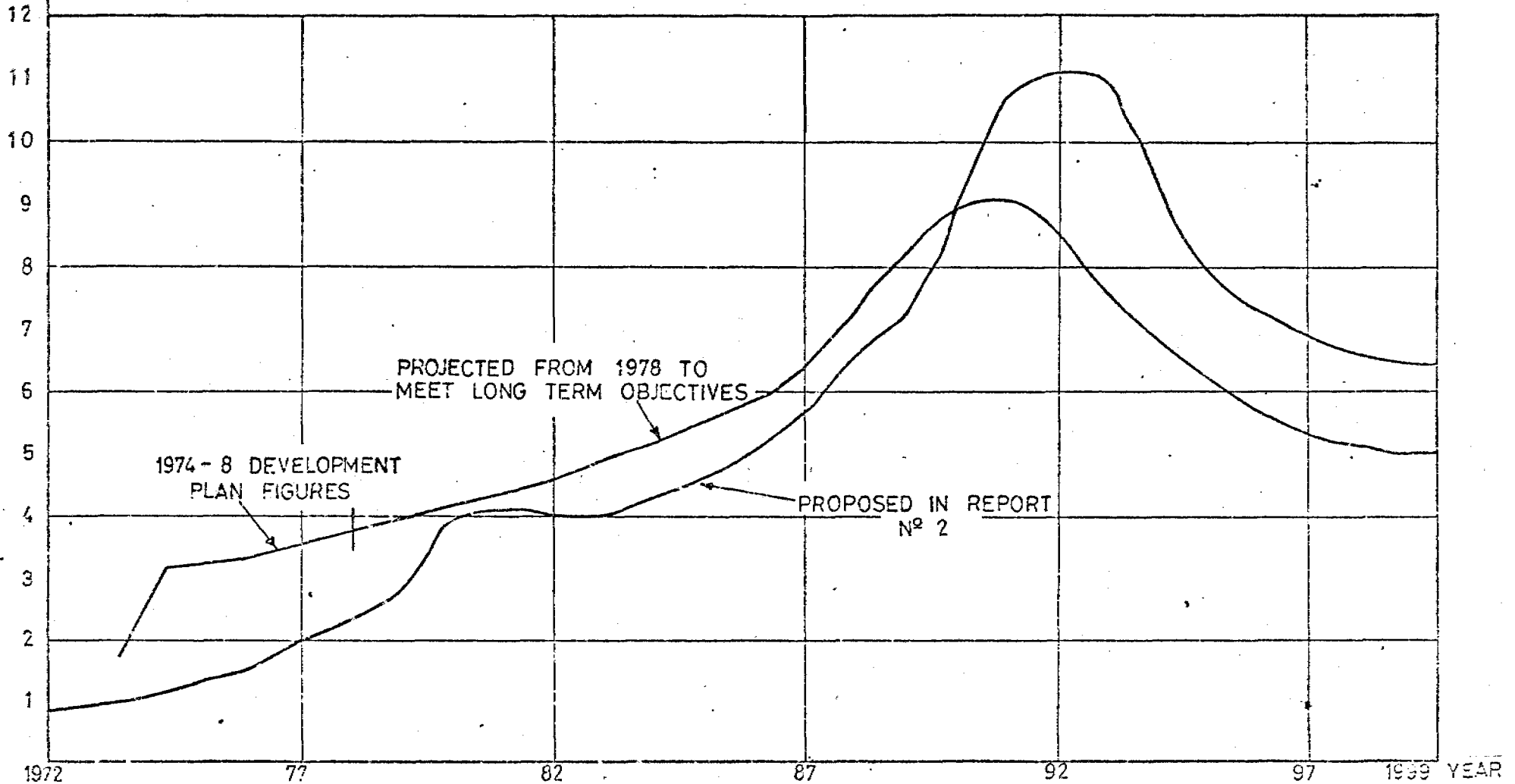
For urban and rural centres, the full cost should also be recovered in total but not based on each individual supply. For rural water supplies with individual connections, the annual revenue should cover the annual operation and maintenance costs by year 20 of the scheme. The capital costs will most likely have to be subsidized. Water from communal water points should be free of charge

FIGURE 3.4.6

COMPARISON OF THE 1974-8 DEVELOPMENT PLAN EXPENDITURES WITH THOSE PROPOSED IN REPORT Nº 2

(Central Government Expenditures excluding Kombasa)

£ MILLION



The Government's objective of supplying water to the total population of Kenya by the turn of the century is feasible provided the Government is prepared to increase its resource allocation to the community water supply sector in accordance with the projected estimates, and that the growth of the economy is of the same order as assumed above. Availability of skilled manpower is likely to be the biggest constraint on implementation for a long time to come.

3.4.4 Objectives during the Next Decade

The major inputs for the 10-Year Programme presented in Report No. 12 were the Report No. 2 on a National Programme and the Government's current 5-Year Development Plan, 1974-78. The 5-Year Development Plan figures are more ambitious than those presented in Report No. 2. For example, Central Government's water expenditure, i.e. excluding Local Government and Mombasa expenditure, is double that proposed in Report No. 2. Report No. 12 assumes that the Government will attain its 1974-78 targets. Hence the long-term development path was redrawn. (See Figure 3.4.6). During 1978-83, expenditure should continue to increase. However, the increase over 1973-78 should be at a reduced rate. 1978-83 should be a period of consolidation unless constraints prevent the targets for the period 1973-78 being achieved.

The major Government water development objectives for the next plan period are that an additional 2 million rural people and an additional $\frac{1}{2}$ million urban people should be served by water supplies.

The real constraints for the execution of the 5-Year Programme will be factors other than finance.

Manpower and training requirements, which are expected to be the biggest constraints, are discussed in Clause 3.3 above.

Table 3.4.2

Water Development Expenditure

Summary (1973-83)

Programme	1973-8			Total	1978-83			Total
	Development	Operation and Maintenance	Head Office Overhead		Development	Operation and Maintenance	Head Office Overhead	
Urban								
Nairobi	16.089	.560	1.229	17.878	15.160	1.906	1.355	18.421
Mombasa	14.420	.609	1.117	16.146	23.000	1.764	1.895	26.659
Townships	6.280	.248	.484	7.012	3.670	.744	.368	4.782
MOWD Urban	2.705	.294	.235	3.234	5.410	1.218	.560	7.188
URBAN TOTAL	34.494	1.711	3.065	44.270	47.240	5.632	4.178	57.050
Rural								
MOWD Rural	10.565	2.27	1.079	13.914	18.480	9.36	2.657	30.497
Settlement	3.227	.65	.323	4.200	-	-	-	-
County Councils	.750	.81	.169	1.729	-	.81	.169	.979
Self-Help	.270	.30	.042	.612	.300	.900	.128	1.328
Water Conservation	1.500	-	.107	1.607	1.500	-	.107	1.607
Range Water	3.450	.20	.275	3.925	3.450	.60	.332	4.382
RURAL TOTAL	19.762	4.23	1.995	25.897	23.730	11.670	3.393	38.793
NATIONAL TOTAL	59.256	5.941	5.060	70.167	70.970	17.302	7.571	95.843

Another constraint that needs to be overcome is the tendency in the past to cut down on the funds requested for operation and maintenance of water supplies. If there are insufficient resources available to implement the planned development programme and to maintain the supplies, resources should be diverted from developmental to operational activities.

The procurement and accounting systems of the MOWD need considerable improvements in order to cope with the planned increase of the workload.

The staff at the MOWD Headquarters can only be marginally increased without new offices being built. If the Department is to remain in the Industrial Area of Nairobi, a multi-storey office building is urgently required. The provincial organizations cannot be expanded without investments in offices and office facilities. The setting-up of District Water Organizations will likewise require new office facilities.

A summary of all expenditures for the Ten Year Programme is presented in Table 3.4.2. The total expenditure for the period 1973-78 is £ 70 million, of which £ 59 million is development expenditure. In the following five year period, total expenditure increases to £ 96 million, of which £ 71 is development expenditure.

Thus, the development proportion of total expenditure drops from 84 per cent to 74 per cent as a result of operation and maintenance cost increasing due to servicing more and more existing supplies. This is a trend which will continue to the end of the century and it is vital that sufficient allocations are made to the water sector in the recurrent budgets to maintain past and present development expenditures.

Another notable feature of the Ten Year Programme is the high percentage of total expenditure that is required for the urban sector and for Nairobi and Mombasa in particular. During 1973-78, the urban sector requires 63 per cent of the total expenditure and Nairobi and Mombasa together require 48.5 per cent of the total expenditure. For 1978-83, the respective figures are 59.5 per cent and 45 per cent. Thus Nairobi and Mombasa require almost half of the total water expenditure.

Table 3.4.3

Total Expenditures and Revenues of the
Water Sector, 1973-83

	1973-78	1978-83	Total
Ten Year Programme Expenditure	70.167	95.843	166.010
Maintenance of Existing Supplies	12.850	12.850	25.700
Total Expenditure	83.017	108.693	191.710
Revenue	25.130	39.270	64.400
Net Expenditure	57.887	69.423	127.310

It is expected that revenue from water supplies will yield £ 25 million during 1973-78, £ 24 million of which will come from urban supplies. During 1978-83, revenue will increase to £ 39 million, of which £ 34 million will come from urban supplies.

In addition to the expenditure on developing and maintaining the supplies proposed in the Ten Year Programme, existing supplies have to be maintained. The cost is estimated at £ 12.85 million for each five-year period. Table 3.4.3 presents all expenditures and revenues for the ten year period. It can be seen that expenditures exceed revenue over the ten year period by £ 127 million. In other words, water supplies would have to be subsidized from other sectors by approximately two thirds of their total costs over the ten year period.

An important aspect of a Water Development Programme is foreign exchange. The requirement represents approximately 55 per cent of the development expenditure at first order level. In addition, between 15 per cent and 20 per cent of organisation, maintenance and overhead costs are also foreign exchange.

3.4.5 Selection Criteria for Community Water Supplies

The function of selection criteria is to assist the decision makers choose which water schemes should be implemented and which areas will have to wait longer for water schemes. This need to choose is necessary due to the limited funds and resources available, and the many proposals for water schemes.

Although poor design can generate higher costs to the economy than poor scheme selection, the importance of intelligent selection should not be under-estimated. Optimum scheme selection is a complex process, because of the large number and the diversity of variables to be considered. It is therefore quite obvious that hard and fast rules are unlikely to be appropriate throughout Kenya. However, one generalization regarding scheme selection is important for policy and it does appear to have empirical backing. This generalization is that an improved water supply, though perhaps necessary for improved health, welfare and economic progress, is not always sufficient to ensure any desirable change within the community.

Water investment should be coupled with complementary investments to ensure success. These complementary investments could be directly productive, for example tea development or dairy development projects, or simply educational such as public health campaigns. The corollary of this conclusion is that water proposals should be linked with existing or proposed development programmes. Water schemes should not be regarded as compensation for an area which did not receive new schools or other forms of public investment. This principle that water is a service to other forms of public investment lies behind the discussion in the Report on Selection Criteria.

It might be felt that the proposals on Selection Criteria are based more on opinions than on facts. Data on the impact of rural water supplies on a community are very scarce. It is extremely difficult to isolate the effects of introducing a safe water supply in a rural area from other inputs.

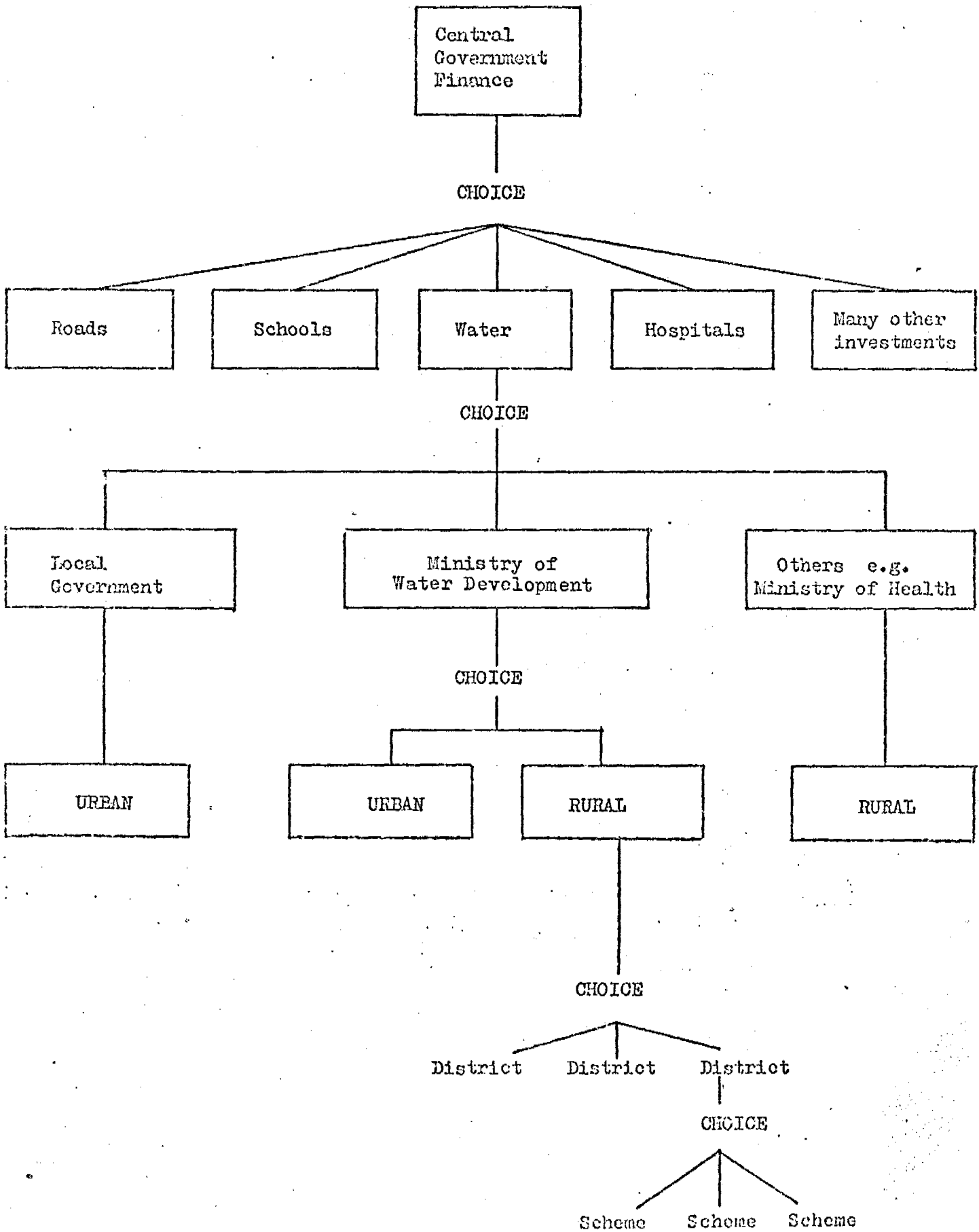
Today, about 90 per cent of the rural population of Kenya does not have access to an improved water supply. The Government objective is that practically all the rural population should be served by the end of this century. The mistake that could be made by using inaccurate Selection Criteria is that rural supplies would not be developed in perfect order. The implications of inadequate design criteria are more far-reaching. Over-design results in unnecessary investments and under-design in poor service and/or augmentations being too closely spaced, resulting in sub-optimal use of resources.

The Selection Criteria proposed are rather unsophisticated. A system based on cost benefit analyses which would require that a money value be assigned to intangible health and social benefits might seem more accurate, but would be false.

It is even very difficult to evaluate the economic benefits to a sufficient standard of accuracy to justify the ranking of proposed schemes in order of potential for economic benefits.

FIGURE 3.4.7

Levels of Government Investment Decisions



The only analysis which can be made with a reasonable degree of accuracy is of a cost-effective nature, that is cost per person served, or cost per unit of water produced. It is suggested, however, that the potential for benefits should be considered in addition to cost criteria, even if the system is bound to be somewhat subjective. In particular, the presence of plans for complementary development inputs should be given weight as mentioned above.

Figure 3.4.7 shows, schematically, the levels of decisions in the Water Development Programme.

The Government has to allocate funds between all Government services, of which water supply is only one.

Funds for development of community water supplies should be distributed between the Ministries concerned.

The Ministry of Local Government requires funds for augmentation of the urban supplies which are operated by the Ministry (Nakuru, Kisumu, Kitale, Eldoret, Thika, Nanyuki, Nyahururu). As all of them are fairly major supplies for concentrated populations, it is essential that they obtain sufficient funds to keep up with the population growth. The recent extension of the Nairobi water supply was financed by IBRD through an agreement with the Nairobi City Council.

The Ministry of Health has been involved in water development programmes in the past, because the ten year demonstration programme supported by WHO and UNICEF is being carried out through this Ministry. If and when the technical and financial support from these agencies is discontinued, it is recommended that the Ministry of Health should no longer concern itself directly with water supply development.

However, the Ministry of Health should retain its responsibility for surveying the quality of drinking water throughout the country.

It is recommended that the water development programme so far undertaken by the Ministry of Lands and Settlement in settlement areas, should be transferred to the MOWD, and be part of their rural water development programme.

The bulk of the funds are allocated to the MOWD, which is involved in both rural and urban water development. If resources available are insufficient to allow urban supplies to be augmented in line with the urbanization process, in parallel with the rural development programme, it is recommended that the urban population is given priority as it is captive of the supply, whereas the rural population normally has access to an alternative water source. With indicated levels of investments in the community water supply sector for the next 5-year plan, development of rural water supplies will increase even if these criteria are applied.

With urban areas, it is proposed that as a rule towns needing urgent augmentations in order to meet the increasing demand from areas already supplied be given preference over towns wanting to expand the area to which they wish to supply water.

It is recommended that funds which are available for rural domestic water supplies should be distributed over districts on a population unserved basis. This is a criterion which is equitable, understandable, easily applicable and difficult to improve upon.

The choice of rural water schemes within districts should be based on a series of selection criteria. A scheme should be justified on either economic or social grounds.

Highest priority should be given to:-

- Schemes with low per caput cost, estimated high potential for development and which have been given high priority by District Development Committees (DDC's).
- Schemes justified on humanitarian grounds which will relieve people from suffering and/or have an obvious potential for improving the health among people.

The proposed procedure for selection of rural schemes emphasizes the important role to be played by DDC's. Training programmes launched for District Planning Officers will eventually strengthen the Committees. The Committees should screen requests for water schemes from villages and submit lists of proposed schemes with some basic information and indicate their priorities based on non-technical information, to the MOWD. The MOWD should carry out preliminary pre-development studies for the proposed schemes and revise the priority list on the basis of technical and cost data. The reports and the revised priority list should be submitted to the DDC's for their comments. The final section should be confirmed by the Inter-Ministerial Committee for Rural Water Supplies. The Committee should arbitrate in cases where the DDC's are in disagreement with the MOWD on the selection of water schemes.

3.4.6 Design Criteria for Community Water Supplies

The function of design appraisal is to ensure that the correct scheme is selected, that the structure fits the objectives, that the elements and processes are appropriate to the resource endowment, and that the procedure for implementation is workable. Hence the technical competence of the proposal must be determined, also it must be confirmed that the design is not excessively complicated, that it is complete, that practices, particularly those established for developed countries, are not slavishly followed, and that new improved materials and methods are utilized where appropriate.

With such a comprehensive set of requirements, it might appear to be simple to break down these into detailed tests. However, this is far from the case. Design criteria are an extremely complex and sensitive area to define. Some engineers would maintain that for water supply, above all other civil engineering works, maximum flexibility and initiative should be left with the design engineer. This is because of the wide variation in type of scheme and local conditions including distance to source, topography, labour supply and so on. At the other extreme there are those engineers who maintain that, in the Kenyan situation, fairly rigid standard designs are the only feasible means of obtaining rapid and efficient design and implementation.

Table 3.4.4 Basic Criteria used by Consultants for Rural Schemes

Scheme	Degree of Service	Provision for Population Growth	Human Consumption Rate	Livestock Consumption Rate	Use of Scheme by Livestock	Peak Flow/Average Flow
Uyoma	Communal points	10 years	5 g.p.h.p.d.	5 gal/cow	Included	3 domestic 2 livestock
Tetu-Thegenge	Communal points	20 years	11 g.p.h.p.d.	20 gal/grade cattle 10 gal/native cattle 4 gal/small livestock	half included	Not used
Gatango	Communal points	Not stated	Plots 2 acres 30 g/day Plots 2-4 acres 60 g/day Plots 4 acres 100 g/day	-	Yes	Not used
Inoi	Communal points	Not stated	"	-	Yes	2.4
Karachuonyo	Communal points	Present population	5 g.p.h.p.d.	-	No	2.0
Ndivisi	Communal points	Present population	10 g.p.h.p.d.	-	Yes	Not used

There are many schemes in Kenya which have been designed and installed by advocates of both these extreme positions. The "flexibility" school results in the neglect of accumulated experience, risk of technically deficient solutions and the pursuit of narrow local optimal solutions. Table 3.4.4 shows key variables and assumptions made by consultants to the MOWD acting independently, before the MOWD guidelines were issued. The "standardization" school suffers from their over-simplified, inflexible approach. There are many schemes in Kenya where designers' lack of skills and judgements have resulted in schemes with uneconomical designs or complete breakdowns.

The approach adopted by the Project on water supply development represents a middle way between these extremes. It is considered that some guidelines are necessary to record experience and to define present standards in an indicative rather than definitive way. As with all planning work, revisions will be required from time to time. To-day's standards, materials and methods will inevitably be in some way inappropriate tomorrow. One of the main dangers is that the proposed criteria may be placed on one side as a finished task. The Pre-development Studies Section of the MOWD has already done much on rural design criteria and use has been made of their work; it is expected that they will continue to improve upon the proposed design criteria.

The design is to a large extent governed by the degree of service offered. Factors affecting the level of service are quantity and quality of water served, distance from point of supply and point of consumption and the reliability of the supply. The following levels of degree of service are recommended:--

Consumer	Quantity l/hd/day	Quality	Proximity	Reliability
<u>URBAN</u>				
High Class housing	300	WHO Standards (safe and pleasant taste)	Individual Connections	Storage for breakdowns
Average urban housing	150		Individual Connections	
Low cost housing	75		Individual Connections	
Squatters	15		Communal Water Points	
<u>RURAL</u>				
High Potential Areas	50*	Safe Water	Individual Connections & Communal Water Points	No storage for breakdowns
Medium Potential Areas	50*		as above	
Low Potential Areas	20		Communal Water Points	

* This is based on the assumption that 60 per cent eventually will have individual connections with a daily consumption of 70 l/head, 30 per cent shared individual connections or communal water points with a daily consumption of 20 l/head and 10 per cent will use the traditional source.

The only area of conflict regarding the degree of service seems to be for high and medium potential rural areas. In Report No.2, it was recommended that individual connections should be encouraged in these areas in order to achieve maximum benefits from the water supplies. The extra cost would be offset by revenue collection.

If the Government is not prepared to encourage individual connections in these areas or does not believe that the ultimate percentage of connections will nearly reach 60, then the quantity of water supplied should be reduced. This should also perhaps have an effect on selection criteria, as it is believed that the benefits from communal water point service, especially in high and maybe even medium potential areas, are very marginal.

The proposed design criteria are separated into two categories, urban and rural. The categories are defined according to the growth centre classifications made by the Town Planning Department of the Ministry of Lands and Settlement.

The criteria recommended cover water consumption rates, population growth, pipe types and diameters, flow formulae, peaking factors, minimum and maximum pressures, optimum design periods, storage capacity, pumping capacity, fire-fighting requirements and standards of water quality.

It is recommended that urban water supplies should be treated to WHO standards. The WHO standards ensure that the water is not only safe, but also pleasant with regard to smell and taste and colour.

For rural water supplies in high and medium potential areas the emphasis should be on safe water, which means that there should be more tolerance, than is the case for urban supplies, on components in the water affecting the aesthetic senses such as smell, taste and colour, but not the safety of the water.

In low potential rural areas, the aim should be to provide safe water. However, it is recognized that it is not always possible to prevent contamination from cattle and people in respect of dams, rock catchments and hafirs without a distribution system.

3.4.7 Preliminary Design of Ngariama Water Supply

The Plan of Operation included preliminary engineering, economic and financial feasibility studies with investment and recurrent costs of water schemes for an agreed number of rural and urban communities. The aim of these studies would be to present bankable projects to financing agencies. As the MOWD had arranged for financing for both urban and rural water development and the major constraint is implementation capacity rather than finance, it was agreed with the Government that a preliminary design of a rural scheme should be carried out instead of the above-mentioned studies. The main object of this was to demonstrate in practice the policies and design criteria outlined in Reports Nos. 2 and 4.

Several criteria were used in selecting a suitable scheme. It was necessary for the scheme to be high in priority, thus warranting construction in the near future. Schemes which relied upon exploratory drilling in the design stages were not considered because of the time element. The scheme should be of reasonable size and present typical design problems for Kenyan conditions. Many possible schemes were inspected and a project for Ngariama location was finally chosen. This project was given top priority for Kirinyaga district by the District Development Committee and £150 000 has been allocated to it from the SIDA funds currently financing the Rural Water Supply Programme. The selection was based on a preliminary feasibility study carried out by the MOWD. Ngariama is representative of a large number of similar schemes in this programme.

The Ngariama location is situated on the southern slopes of Mount Kenya, and has an area of about 90 square kilometres and a present population of 22 000. Out of sixteen self-help water schemes developed in the location, only three are working relatively satisfactorily, although their water quality is doubtful. Some of the piping from the self-help schemes can be used in the major scheme after negotiations with the self-help groups. Practically all the self-help schemes are based on an individual connection service.

The preliminary engineering included analysis of a number of choices, such as:-

Water Source

Six rivers were investigated as possible sources of supply. Intakes on two rivers were finally selected. The ultimate water consumption corresponds to about 15 per cent of the flow (95 per cent duration) of the two rivers.

Limits of Supply

The Marinduko location, south of Ngariamana and at a lower elevation, has also been allocated a high priority for water development by the District Development Committee. Comparative estimates were prepared for supplying Marinduko together with Ngariamana or alternatively as a separate scheme. It was found that the former alternative is more economical. The main pipes going through the Ngariamana location have been designed to cater for the future needs of the Marinduko location.

Gravity versus Pumped Supply

The whole scheme area could be served by gravity from intakes up in the Mount Kenya forest. Alternatively, with an intake at the forest boundary, the upper part of the Ngariamana location could be served by pumping and the remaining parts of the scheme by gravity. It was found that the first alternative would be more economical.

Peak Flow versus Average Flow Design

Due to the likely increase in population and number of individual connections with time, the water consumption during the first years will be considerably less than the ultimate consumption from the scheme. The main pipes have been designed for the ultimate average flow. No storage tanks, with the exception of the nominal storage provided through break pressure tanks, are included in the initial stage of the scheme. Storage tanks on the main lines should be built when they are required, which is expected to be in about ten years' time.

Degree of Service

It is considered that the ultimate aim of a water supply in Ngariama should be to provide safe piped water to each consumer's plot or adjacent to it. The extent of self-help activities on water supplies in the location shows that there exists a real desire for individual connections. The number of individual connections will depend upon the future pricing policy.

Communal water points could be provided in the poorer, lower parts of the location and in areas where there is a large floating population, for example for the Kamotugu market. If communal water points are provided in Ngariama, they are likely to become free individual connections for the immediate neighbourhood and be unused by anyone else.

The estimated cost of the scheme is £ 127 000 based on 1972 prices, of which approximately £ 27 000 can be attributed to supplying water to Marinduko, that is extra pipe capacities in the Ngariama scheme. This gives a unit cost based on the 1974 population of £ 4.2 per head.

3.5 Sewerage

It should be noted that the sewerage reports do not cover Nairobi, as this City is the subject of the current WHO/UNDP-assisted Government study "Sewerage and Groundwater Pilot Project for Nairobi".

3.5.1 The Present Position in Kenya

At the present time, only 2 per cent of the people of Kenya live in buildings which are served by public sewers. 51 per cent of Kenyans have no sanitary facilities whatsoever. Between these two extremes, approximately 4 per cent of the population are served by septic tanks or aqua privies, 3 per cent by bucket lavatories or cesspools and 40 per cent use pit latrines.

In fact, these figures are optimistic as very many of the installations provided do not work properly, sometimes because they have been poorly designed or are quite inappropriate to the conditions but more often because they are badly operated and maintained.

As described in sub-Section 3.6 of this Report, in the past there has been virtually no control over the discharge of industrial effluent into Kenya's water resources. There has similarly been negligible control over the discharge of industrial effluent into public sewers.

As a consequence, public sewerage systems have become choked and community sewage treatment works are often grossly overloaded, to the extent that their efficiencies become very low indeed.

3.5.2 Reasons for the Present Situation

During the past several years, insufficient funds have been invested in providing sewerage facilities for Kenyan towns. The result is that, in communities outside Nairobi, the proportion of dwellings connected to public sewers has been steadily falling. Where public sewerage is not provided, insufficient attention has been paid to the suitability and efficiencies of individual-type sanitary installations. Even where modern sanitation has been provided, the funds allocated towards the operation and maintenance of these facilities have been much too low.

Most of the difficulties with which Kenya is now faced in the sanitary field can be attributed to the poor national organization of sewage disposal in the past. Responsibility for various aspects has been divided between several Government agencies. Co-ordination between these agencies has not been good and the inevitable results have been poor planning, a lack of national procedure and a generally weakened approach to the problem. It is hoped that the recent creation of the Ministry of Water Development will eliminate these past difficulties.

As a result of poor planning and the lack of attention paid to sewage disposal in Kenya in the past, at the present time there is a severe national shortage of personnel trained and experienced in the various aspects of this subject. This is true at every level, from senior professional staff to plant operators and sewer maintenance workers. The consequence is a national inability to supervise and operate sanitary arrangements properly and to enforce the sanitary legislation which does exist.

3.5.3 Recommended National Objectives for Sewage Disposal

The major recommended objective is that there should be adequate sanitary arrangements for the disposal of all Kenya's sewage, from factories as well as from dwellings, as soon as possible and certainly by the end of this century.

In large, densely populated communities, the only feasible way of providing adequate sewage disposal is to construct public sewerage systems which transport the sewage to communal treatment works. At the present time, there is a considerable backlog in urban sewerage development when compared with urban water supply development. A sub-objective of the recommended programme is to eliminate this backlog so that urban sewerage development will have caught up with urban water supply development by the mid-eighties.

3.5.4 The National Sewage Disposal Problem

The recommended objectives are not only to eliminate the present backlog in sanitary sewage disposal but also to keep pace with the rapidly increasing volumes of sewage which will be produced in Kenya during the remainder of this century.

Sewage quantities will increase in the future for the following reasons:-

- (i) The population of Kenya outside Nairobi is expected to increase from the present estimated 11.5 million to 24 million during the remainder of this century.

(ii) Although at the present time Kenya is essentially a rural country, it seems almost certain that in the future there will be increasing migration into towns. As a consequence, it is anticipated that the urban population of Kenya (excluding Nairobi) which is currently 1 million, will grow to 7.5 million by the year 2000.

(iii) If the Government's stated objective of an adequate water supply for everyone by the year 2000 is achieved, this will result in more people than now being served with piped water and consequently much more water being used; at the same time, as the standards of living of the people of Kenya steadily rise, the average amount of water used by each person will also increase. Thus, domestically, more people will each produce more sewage.

(iv) Tremendous industrial expansion will be needed to provide employment for the future urban populations; also, as agricultural production increases, more and more factories for processing crops will need to be established throughout the rural areas. Modern factory processes tend to use increasingly large amounts of water and the industrialization of Kenya is therefore virtually certain to result in a rapid increase in industrial water usage, with parallel increases in the volumes of industrial effluents discharged.

Except in very unusual circumstances, sewage must be disposed of by discharging after treatment into the sources of Kenya's water supplies. There is thus an apparently endless problem of water supplies being drawn from sources polluted by the sewage which results from the water supplies. Strict control over the disposal of all sewage is the only solution to this problem.

3.5.5 Technical Aspects of the Recommended Sewage Disposal Programme

Sewerage, that is a system of public sewers followed by treatment of the collected sewage, is the most convenient, inoffensive and sanitary method of dealing with domestic sewage, but can only be used where there is a piped water supply.

Indeed, sewerage is often the only feasible solution to the disposal of sewage from large and densely-populated communities, especially when they are located on impermeable ground.

It is proposed that, in practice, sewerage will generally be provided in:-

- (i) All urban residential areas where the population density is 124 persons per hectare (50 persons per acre) or more, and also in the business and shopping centres enclosed by these residential areas.
- (ii) The higher density town suburbs located on impermeable ground.
- (iii) The more developed parts of local and market centres located on impermeable ground.

Sewerage is also the only acceptable method of sewage disposal, from the point of view of public health, for communities who take their water supplies from local, shallow wells.

There are several other methods of domestic sewage disposal which are appropriate to areas where sewerage is neither necessary nor economically feasible. Most of these methods are "individual", in that they serve only one family.

Bucket latrines

Pit latrines

Aqua privies

Cesspools

Septic tanks

These methods all have optimum applications and each has some disadvantages. Also, they do not all perform the same functions and so they are not always strictly comparable. A disadvantage common to several of the methods is that they rely upon ground soakage and so are inappropriate where the ground is impermeable or where the local water supply is from shallow wells.

From every point of view, it is most important that, when sewage disposal facilities are provided, they are properly designed and constructed and are appropriate to the circumstances. To achieve these, some form of standardization in sewage disposal is most desirable and is strongly recommended. At the present time, there are no national criteria or specifications and therefore the units selected for a particular project depend almost entirely upon the opinions and prejudices of the responsible engineer or health officer. This inevitably results in completed projects of very variable quality and efficiency.

Whilst it is not suggested that design and construction should be stereotyped patterns, nevertheless some standardization of techniques, design criteria, materials, equipment and spares would doubtless result in increased sanitary efficiency as well as considerable economy. An additional, important benefit of this type of control would be that less qualified persons would be able to carry out projects.

When a town is sewered, there are likely to be existing low-cost houses, perhaps built using temporary materials, which it is not economically feasible to sewer individually. In such areas, it is proposed to provide "communal ablution/latrine blocks". Charging for the use of such facilities is not recommended because charges would tend to discourage people from using them and this would be detrimental to the health of the entire community.

It is proposed to construct "public latrines" at convenient locations in all towns. The purpose of public latrines is to serve travellers and others away from their homes so that everyone at all times has access to sanitary sewage disposal facilities and there is therefore no excuse for indiscriminate excretion, which could endanger the health of all.

If they are truly to safeguard the health of the public, public latrines must be maintained in clean and working conditions. They are likely to require full-time attendance, and this it is recommended should be provided by the local authority.

Table 3.5.1 SUMMARY OF SEWAGE DISPOSAL ANTICIPATED IN KENYA, OUTSIDE NAIROBI, BY THE YEAR 2000

Type of Community or Area	Anticipated Sewage Disposal Method (Thousands of persons)								Projected population for year 2000 (thousands)
	Sewerage	Septic Tanks	Large (1) Cesspools	Small * Cesspools	Aqua Privies	Pit Latrines	Bucket Lavatories	None	
Nomadic	-	-	-	-	-	300	-	700	1 000
Low potential rural	-	60	-	-	60	2 010	60	110	2 300
Medium & high potential rural	20	730	40	350	-	12 560	-	-	13 700
Low density urban	350	360	30	150	170	440	-	-	1 500
High density urban	5 700	180	60	-	60	-	-	-	6 000
Totals	6 070	1 330	130	500	290	15 310	60	810	24 500

(1) That is, dealing with water-borne sanitation

* That is, not dealing with water-borne sanitation.

TABLE 3.5.2

PROPOSED TOTAL NUMBER OF PUBLIC LATRINES IN SERVICE
DURING PARTICULAR YEARS

Type of latrine	Method of drainage	1975	1980	1985	1990	1995	2000
Water closets	Sewerage	60	215	420	550	600	650
	Septic tank	60	305	500	600	700	700
	Cesspool	20	80	110	140	120	70
Aqua privy	-	40	80	140	180	180	180
Pit latrine	-	20	80	100	100	100	100
TOTALS		200	760	1 270	1 570	1 700	1 700

Sewerage systems and sewage treatment facilities require skilled and regular attention if they are efficiently to carry out their tasks. From time to time, it is necessary to remove blockages from sewers. Mechanical equipment requires proper maintenance. Sewage treatment units require competent operation and regular servicing. If these important tasks are neglected, then many of the benefits which may be expected from sewerage will be lost, and effectively a proportion of the capital sum spent on sewerage development will have been wasted.

Similarly, the best individual-type domestic sewage disposal facilities can operate efficiently and in a sanitary manner only if they are serviced regularly and kept clean. If this is not done, by acting as reservoirs of disease, they may cause more nuisance and endanger the health of the community to a greater extent than if they had not been provided in the first place.

It is recommended that sewerage authorities should have the responsibility of servicing all domestic sewage disposal installations throughout the country; this includes emptying bucket latrines, aqua privies, cesspools and septic tanks at appropriate intervals, and disposing of their contents.

If the sewage disposal development programme recommended in the reports from this Study is implemented, then it is anticipated that, by the year 2000, Kenya will dispose of its domestic sewage approximately in accordance with Table 3.5.1.

If the recommendations with regard to the provision of public latrines are carried out, then the numbers of public latrines in service will increase approximately as shown on Table 3.5.2.

3.5.6 Financial Resources required to Implement Recommendations

It is repeated, for emphasis, that the following financial estimates cover the whole of Kenya, but with the exception of Nairobi.

The proposed national programme for the development of urban sewerage will involve a public expenditure of £ 212 million during this century, with a maximum rate of spending exceeding £ 15 million during 1999. In parallel with this public development, it is estimated that the private sector investment in individual-type domestic sewage disposal is likely to total approximately £ 203 million by the year 2000.

The estimated rate of capital expenditure on sewerage required is shown on Figure 3.5.1.

Foreign aid will almost certainly be necessary if the recommended national programme for sewerage is to be implemented. It is believed that, if projects are properly planned and satisfactory pre-investment studies are carried out, the necessary foreign finance will be made available. Assuming that 65 per cent of capital expenditure on sewerage will be financed by foreign loans, the aid requirement of the programme is £ 138 million, to the year 2000.

The anticipated parallel recurrent costs of running existing and proposed sewerage schemes plus servicing individual-types of domestic sewage installations in Kenya, outside Nairobi, is expected to increase to almost £ 9.4 million per annum by the year 2000, as shown on Figure 3.5.2. This diagram estimates the running costs during the year 1972 as £ 2.5 million. This is approximately what it would have cost to run the existing national sanitary facilities, outside Nairobi, properly and efficiently, but sadly the amount spent was considerably less than this, resulting in the consequences described earlier in this Report.

The capital costs of the proposed public latrine programme, which again excludes Nairobi, will total £ 4.7 million by the year 2000. The corresponding recurrent expenditure will increase to a peak of £ 1.85 million per annum in 1985, but will then slowly fall as a higher proportion of public latrines are connected into the public sewers.

Table 3.5.3 Proposed extent of sewerage in Kenya, outside Nairobi, by 1983

Type of Community	Persons Served (in millions)
Medium and high potential rural	0.01
Low density urban communities	0.08
High density urban communities	1.12
TOTAL	1.21

It is of course desirable for all costs associated with sewerage, both capital and recurrent, to be covered by revenue. However, the investments required for sewerage per caput are large. This will frequently mean very high theoretical rates.

Although industries and hotels may be able to absorb these rates, if domestic rates are too high householders may be deterred from connecting to sewerage systems, a most undesirable situation from the national viewpoint.

The rate philosophy suggested is that the rates should be as high as possible, consistent with not deterring too many establishments from connecting to the sewerage systems. This however is likely to mean that subsidies will be required from the Government for smaller and poorer towns.

Where sewerage is provided, it is desirable to have standard rates for similar types of community. In the case of industrial effluent discharges into public sewers, a standard "formula" rather than standard rates would apply. Such a system would result in some communities making a profit and others a loss, and there would therefore need to be some adjustment, directed by the Government, with the more profitable authorities subsidising the poorer.

3.5.7 Recommended sub-Objectives during the next Decade

The 1983 sub-objectives, which are in line with the long term objectives, may be categorized as follows:-

- i) Sewerage: to provide sewerage to serve a total urban population of approximately 1.21 million persons, distributed as shown on Table 3.5.3 (this compares with the approximately 0.2 million who enjoy sewerage at the present time).
- ii) Industrial effluent discharges into sewers or into water resources: factories will be encouraged to discharge industrial effluents into public sewers wherever they are available; however, regardless of where effluents are discharged, national controls will ensure that all industrial effluent discharges will be to acceptable standards, having been pre-treated if necessary.

Table 3.5.4 Recommended cumulative public capital expenditure on sewage disposal in Kenya, outside Nairobi, 1973-1983 (based upon 1973 price levels)

To be spent on:--	Millions of Kenyan pounds	
	by 1978	by 1983
Sewerage	9.80	27.57
Public latrines	1.12	2.06
TOTALS	10.92	29.63

Table 3.5.5 Cumulative anticipated and recommended recurrent expenditure on sewage disposal in Kenya, outside Nairobi, 1973-1983 (based upon 1973 price levels)

To be spent of:--	Millions of Kenya pounds	
	by 1978	by 1983
Existing sewerage projects	0.49	0.85
New projects constructed after 1973	0.81	3.21
Servicing individual-type sewage disposal installations	16.00	28.61
Running public latrines	1.80	6.01
TOTALS	19.10	38.68

Table 3.5.6 Funds allocated for Sewerage in Kenya, outside Nairobi, in the National Development Plan, 1974-1978

To be spent on:--	Millions of Kenyan pounds
Providing sewerage ①	5.25
Operation, Maintenance and Overheads for Sewerage *	2.0373

① excluding Nairobi

* including Nairobi

iii) Individual-type sewage disposal: even by the year 2000, it is expected that the great majority of Kenya's citizens will have individual-type sewage disposal arrangements, such as septic tanks and pit latrines; the future aims should be to ensure that all such installations are appropriate to the circumstances and are properly serviced; it is recommended that guidance in applying standardization models, overall supervision of design and construction, and servicing, should be the responsibilities of sewerage authorities.

iv) Public latrines: these should be provided in all major towns, and in local and market centres, to cater adequately for travellers and other visitors; it is proposed that there will be approximately 1 080 public latrines in service throughout the country, in addition to those in Nairobi, by 1983. Guidance as to standardised designs suitable for particular circumstances should be given by sewerage authorities.

v) Communal ablution/latrine blocks: It is anticipated that all densely-populated urban areas will have piped water supplies by 1983; it is recommended that everyone living there who cannot afford to have running water in their homes should be served by communal ablution/latrine installations, with piped water and water-borne sanitation. Guidance as to standardised designs suitable for particular circumstances should be given by sewerage authorities.

A distinction is made in this and earlier study sewerage reports between "public funds", that is those under the control of sewerage authorities, and spending by others.

The recommended capital expenditures from public funds and also the anticipated and recommended recurrent spending required to achieve the stated sewage disposal objectives are summarized in Tables 3.5.4 and 3.5.5, respectively.

It is suggested that neither the treatment of industrial effluents before discharge nor the construction of communal ablution/latrine blocks should be paid for out of public funds; however, the capital costs of public latrines, which may or may not be so financed, are for convenience and emphasis included in the development estimates given in Table 3.5.4. Tables 3.5.4 and 3.5.5 give cumulative cost estimates for both 1978 and 1983. The former estimates are included because it is considered appropriate to compare the recommended funds with those allocated in the current National Development Plan, the period of which ends in mid-1978. The funds allocated in the Plan for sewerage disposal are summarized in Table 3.5.6.

In fact, many of the headings given in Tables 3.5.4 and 3.5.5 are missing from Table 3.5.6. An added complication is that the funds for "Operation, Maintenance and Overheads for Sewerage" include for Nairobi. (SWECO, Nairobi's Consultants, estimate that the operation and maintenance of Nairobi's sewerage up to the end of 1978 will cost £1.7265 million which, when deducted from £2.0373, leaves only £0.3108 million for the remainder of the country).

Although because of these differences in scope no direct comparisons may be made between the tables as a whole, comments on their details are possible.

The discrepancy between the amounts for "providing sewerage" (£ 9.8 millions recommended) compared with £ 5.25 millions allocated in the Plan) is considered acceptable, especially as the sum allocated represents a tremendous increase in spending on sewage disposal over what has taken place during the past several years; provided that sufficient funds are allocated during the next National Development Plan period, the 1983 targets can undoubtedly be reached.

In this country at the present time, virtually no town sewerage study reports of proper standard nor master sewerage plans exist. The preparation of study reports and master plans is considerably cheaper than the implementation of sewerage projects and the funds allocated in the current Plan will certainly be sufficient to have studies and master plans prepared for the hundred or so larger Kenyan towns. When these have been completed, they will form an excellent foundation for a greatly accelerated urban sewerage implementation programme during the next National Development Plan period.

Bilateral agencies are often willing to give grants for urban sewerage studies; funds donated in this way are considered by the Government as additional to the funds allocated for sewerage development in the National Plans.

It is disappointing that no funds are earmarked in the Plan specifically for the recommended national public latrine construction programme which, it is considered, is long overdue.

The funds allocated for sewerage operation, maintenance and overheads are disappointingly low, when it is considered that they include for Nairobi and also comprise the only funds available to set up the recommended national sewage disposal organization (see Clause 3.1.3) plus the office and laboratory accommodation and the support services which it must have. The Plan does not specifically allocate funds to help the proposed sewerage authorities during their early years, whilst they are building-up their establishments but receiving relatively little financial return.

In fact, if the proposed national sewage disposal organization is to become viable, then funds much greater than those allocated in the Plan will be required. If the new organization is unable to carry out its responsibilities because it is financially crippled, then the sewage disposal objectives and sub-objectives summarized in this Report will become dreams rather than realistic targets.

3.5.8 Selection Criteria for Sewerage Projects

During the foreseeable future, public funds for sewage disposal in Kenya are likely to be limited. They will certainly be insufficient to cover the costs of installing sewerage, the optimum method of community sewage disposal, in any but the more important and populous towns and centres in the country. Elsewhere, the population will have to rely upon "individual-type" domestic sewage disposal arrangements.

As money will be scarce, it is of particular importance that it is utilised in ways which are most advantageous to Kenya, and to its citizens.

With this in mind, it is recommended that the first "slice" of the available money should be used for training personnel so as to ensure that existing sewerage and sewage disposal installations are operated correctly and are properly maintained. Priority should next be given to improving existing community sewerage schemes and in providing public latrines in those market towns and centres where travellers particularly congregate.

Preferably, new sewerage projects, or extensions to existing schemes, should be considered only when these demands have been satisfied.

At this stage, difficult decisions must be made as to which of probably numerous possible sewerage projects should be financed from the remaining limited funds. The function of selection criteria is to assist the decision-makers to choose which schemes to implement.

Generally, more value for money spent will be obtained by sewerage communities with large populations; therefore, it is proposed that the municipalities should be given first priority. Next should come extensions to existing urban sewerage systems, so that they keep pace with development. Finally, new sewerage projects should be financed.

The selection criteria comprise both primary and, less important, secondary considerations.

Primary Criteria

A community qualifies for top priority if it should have sewerage from health considerations, or in order to prevent the pollution of an important water resource. It also has a strong claim for sewerage if a great number of its citizens live or will shortly live at a density of 124 persons per hectare (50 persons per acre) or more, especially if the local ground is impermeable so that "individual-type" sewage disposal is difficult and expensive.

Secondary Criteria

After possible projects have been short-listed in accordance with the primary considerations, secondary criteria become important; these include local enthusiasm for the sewerage project, the stage of development of the local industry and the likely cost per head of providing sewerage. It is strongly suggested that the ability of the community to pay for the project should not be given undue emphasis.

3.5.9 The Design of Sewerage Projects

For design purposes, the strength of domestic sewage in Kenya may be taken to be 55 grammes (0.12 lbs) of BOD and 80 grammes (0.18 lbs) of suspended solids per head per day. Based upon the water supply estimates given in Report No 4, the anticipated per caput sewage flows vary from 65 litres (14 gallons) per day from persons living in low cost developments, to 120 litres (26 gallons) from medium cost dwellings, to a maximum of 220 litres (48 gallons) from high income citizens living in the better class of houses.

From the alternatives of "separate", "combined" or "partially separate" sewerage systems, the latter is selected as more suitable for Kenya.

In a partially separate system, when it rains the sewers take sewage plus the storm-water run-off from selected paved areas; it is proposed that yards so drained should be restricted to those which are normally fouled by animal or vegetable wastes - slaughterhouse and dairy yards and open market places are examples.

In order to spread the available funds for sewerage development as fairly and as evenly as possible throughout Kenya, it is proposed generally that only the more densely populated parts of any town or centre should be sewered.

However, it is also recommended that any sewers constructed should form part of a Master Sewerage Plan for the particular community. This Master Plan should be based upon the best long-range forecast of the community's future development which is available. In Kenya, this is normally the Town Development Plan, which may show development as far ahead as the end of this century but which often covers a shorter period.

It is recommended that sewerage systems should be designed as if the entire area scheduled for development will be saturated by development. Once a Master Sewerage Plan has been prepared, then sewerage implementation should be phased; although every sewer constructed should be to the size and gradient shown on the Master Sewerage Plan, the area of the community to be sewered during each phase should be limited to that already densely-developed, or likely to be so in the relatively near future.

It is suggested that the general rule should be that, when a new sewerage system is constructed, it should not be necessary to extend the main sewers for a period of at least five years after construction is complete (although the construction of housing estate sewers and the like should and is expected to be carried out during this period to serve new development).

Table 3.5.7 Types of Sewage Pumping Plants Recommended for Kenya

Approximate Range of Flows		Type of Pump	Optimum application	Limitations
Litres per Second	Gallons per Minute			
2 to 8	25 to 100	Solids diverter (centrifugal)	Raw sewage	-
8 to 40	100 to 550	Submersible (centrifugal)	Raw sewage	-
40 to 150	550 to 2 000	Centrifugal (dry well station)	Will perform any duty but probably inferior to reciprocating pumps when dealing with sludges	The impeller should be adapted to the particular duty
300 and above	4 000 and above	Mixed flow	Treatment works' effluents	Not raw sewage
75 to 7500	1 000 to 100 000	Axial flow	Treatment works' effluents and digested sludges	Not raw sewage
10 to 1300	130 to 18 000	Archimedean Screw	At inlets to treatment works' and for sludges	Lift Stations only, low heads
4 to 8	50 to 100	Reciprocating (the range given assumes sludge pumping)	Sludges	Screened and digested sludges only
-	-	Air lifts	Activated sludges	Low heads and effluents
-	-	Sludge wheels	Activated sludges	Low heads and capacities

A similar rule should be applied to sewage treatment works. Their construction should also be phased, care being taken to ensure that the volumetric treatment capacity of any treatment works always conforms generally with the total quantity of water supplied to the community.

As public sewerage systems are provided, local industry should be encouraged, by economic considerations rather than by force, to drain factory effluents into the public sewers.

Design Criteria for Sewers

It is proposed that gravity sewers should be designed in accordance with the Crimp and Bruges' adaption of the Manning Formula; this formula is particularly convenient because the results of calculations are available in simple tabular forms.

This formula, if modified, is applicable to the concrete, PVC and pitch fibre sewers available in Kenya.

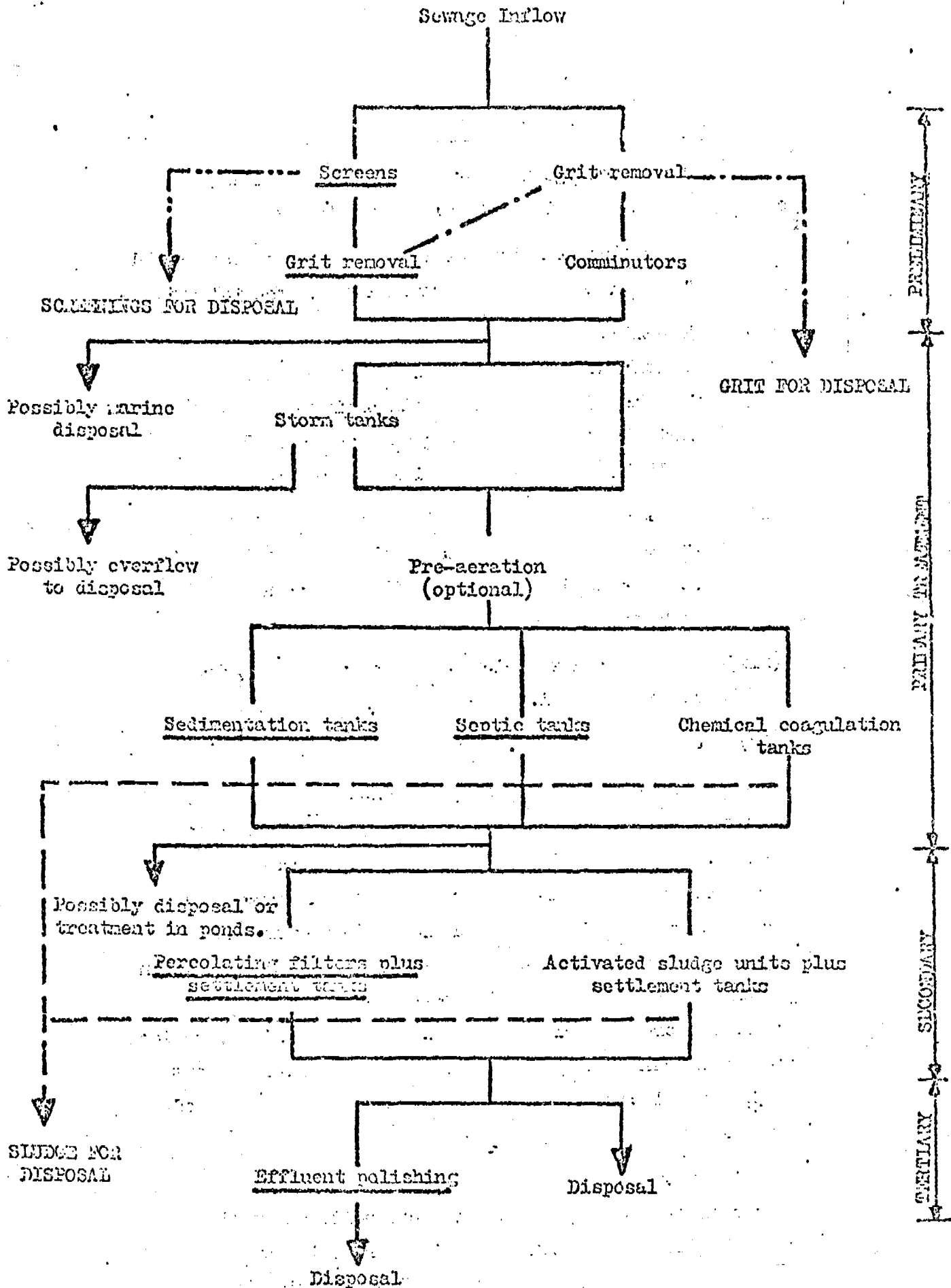
In order to minimize deposition in sewers, and also the corrosion of concrete sewers and manholes, it is recommended that the gradients of sewers should be such as to achieve a velocity of flow of at least one metre (3.25 feet) per second once every day during dry weather.

At the present time in Kenya, sewers are normally constructed using concrete pipes with rigid joints. International research and experimentation have recently shown that flexibly jointed concrete pipes are much more suitable and economical to use than those with rigid joints, and it is strongly recommended that, where concrete pipes are used for sewers in Kenya in the future, these pipes should have flexible joints.

Design Criteria for Sewage Pumping Stations

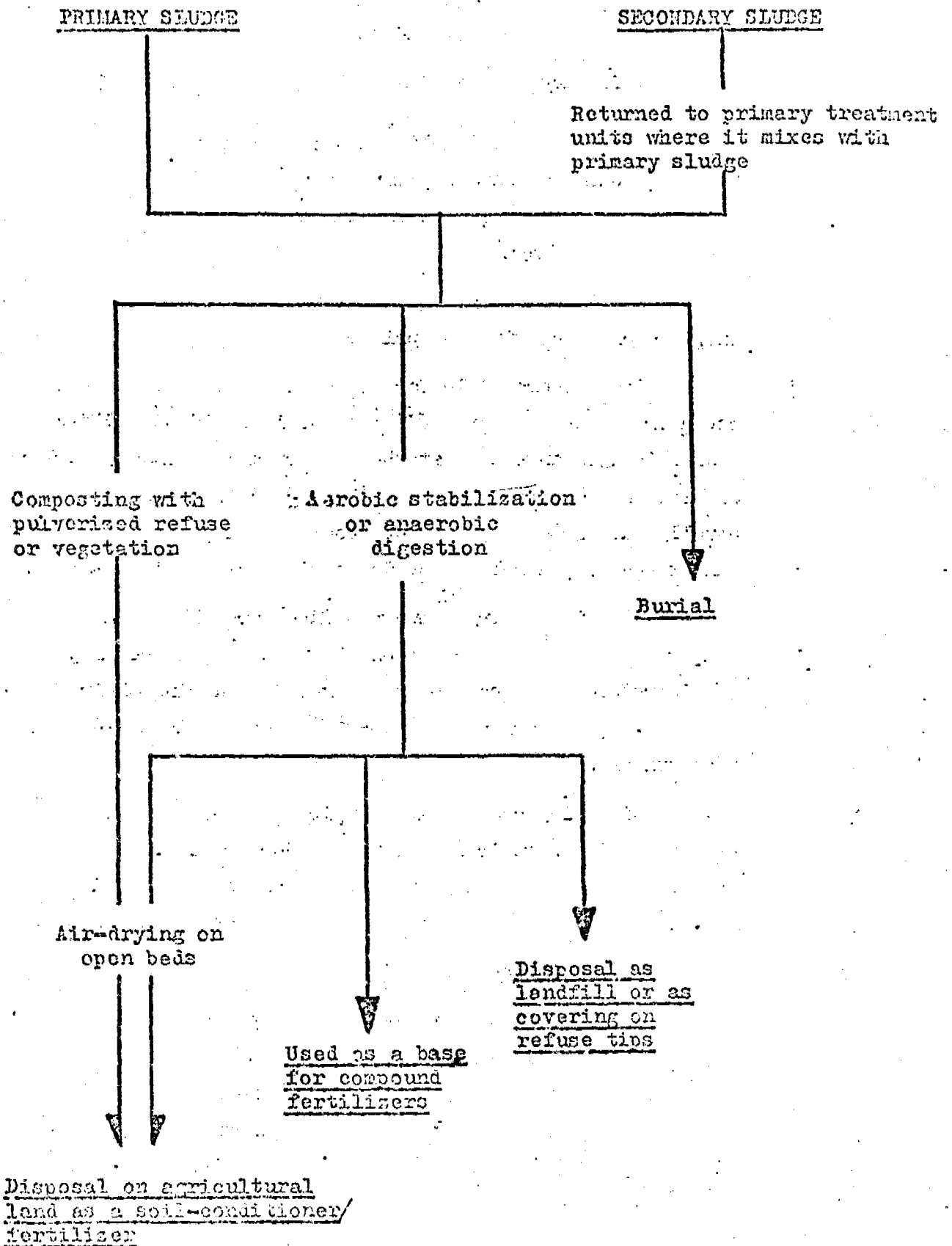
Based upon the magnitudes and qualities of the flows to be dealt with, the types of sewage pumping plant recommended for use in Kenya are summarized in Table 5.5.7.

Wherever electricity is available, it is recommended that pumps be driven by electric motors. The presence of electricity also simplifies pump control, which should be automatic so that sewage pumping stations need not be continuously manned.



Note: Methods shown underlined are considered more suitable for Kenya.

FIGURE 3.5.4 METHODS OF SEWAGE SLUDGE TREATMENT AND DISPOSAL RECOMMENDED FOR KENYA



Communal Sewage Treatment

It is recommended that, during the foreseeable future, sewage treatment in Kenya should be provided by waste stabilization ponds (with artificial aeration, if appropriate) in preference to conventional treatment units, except possibly where a community already has a conventional treatment works which can conveniently and economically be extended.

It is recommended that two facultative waste stabilization ponds in series, followed by maturation ponds where the removal of pathogens is an important requirement, should normally be used. The recommended method of design is in accordance with Gloyna's modifications of Marais' formulae. These have a factor KT which varies with the temperature of the locality, and allows considerable savings in area and thus in costs when ponds are constructed in the hotter parts of Kenya.

Often, because suitable land for facultative waste stabilization ponds is scarce or very expensive, it will not be feasible to provide this form of treatment. The recommended alternatives in such circumstances are either mechanically-aerated ponds or oxidation ditches.

When it is decided that conventional sewage treatment works should be provided or extended, then the types of units should be restricted to those shown underlined on Figure 3.5.3. Effluent "polishing" techniques should be used only in very exceptional circumstances; even then, maturation ponds should normally be used in preference to any polishing process utilizing machinery.

The Treatment and Disposal of Sewage Sludges

As raw sewage sludges are potentially very dangerous to health, their disposal is a difficult problem which must be dealt with carefully, but positively.

The methods of sewage sludge treatment and disposal recommended for Kenya are summarized on Figure 3.5.4.

The pollution problems that now exist and those that may arise in the future could be corrected if the existing laws, with a few minor amendments and additions, were vigorously enforced. To do this, however, technically qualified people must be employed as the "eyes of the law" to investigate and deal with water pollution problems.

In the past, the MOWD, though charged with the responsibility for this activity, has been so under-staffed as to be powerless in doing its job. The creation of the Water Quality Section within the Resources Branch of the MOWD is a positive step in the right direction; however, this Section will only be able to make a real impact on the national problem if it is properly staffed and supported.

As stated in Clause 3.1.3, it is recommended that a network of water pollution control agencies should be set up throughout the country, based upon the natural drainage areas. The role of these agencies will be that of "policemen"; they will have the duty of surveying all discharges into this country's water resources and of pursuing and rectifying any discharge which, being of inferior quality to that required, is causing an unacceptable degree of pollution. The creation and correct functioning of these agencies is urgently required to protect Kenya's water resources.

The water pollution control agencies will take a great number of water samples which will require analysis and it is suggested that the agencies are served by three laboratories spaced conveniently across Kenya.

National water pollution and sewage treatment problems, requiring detailed study and investigation, will arise; it is proposed that such work is dealt with by the recommended Research Organization (see Clause 3.1.3).

The Marine Disposal of Sewage

For the relatively few communities located on Kenya's coast, the discharge of sewage into the sea through submarine pipelines is likely to be the cheapest method of sewage disposal.

However, great care must be taken at the planning stage to ensure that the marine disposal of sewage will neither contaminate nor unduly pollute the inshore bathing waters and beaches. It is also important that it does not adversely affect the marine ecology of the coastal waters, and especially that of the reef, and does not harm the inshore fishing industry.

The only way in which the likely effects of marine sewage discharges may be predicted is to carry out extensive marine investigations. To be valid, these should be continued throughout complete cycles of typical tides, at representative seasons during at least one complete year.

The Re-use of Sewage

It is believed that the re-use of sewage, or more probably treated sewage, would be advantageous for Kenya and it is suggested that it should be encouraged.

Applications considered particularly suitable include the irrigation of agricultural crops or forests, groundwater recharge, fish farming and re-use by industry.

However, sewage is offensive and potentially very dangerous to health and its re-use is only permissible where it is carefully supervised. In particular, great care should be taken to ensure that sewage is not allowed to contaminate underground water resources or crops which are eaten raw.

3.5.10 Preliminary Design of Ngong Sewerage Scheme

Included in the sewerage studies was the preparation of a Master Sewerage Plan for the town of Ngong. The main object of the Ngong Report (Report No 15) was to demonstrate the practical application of the recommendations made in Report No 9, "Selection and Design Criteria for Sewerage Projects".

Ngong was chosen as a typical Kenyan town, with an existing but inadequate public sewerage system, some industry and also with a congested area of temporary dwellings with neither piped water supply nor proper sanitation. An additional attraction was that a contoured Town Development Plan was available for the area.

Ngong is conveniently close to Nairobi and therefore it could become a suitable town in which to give practical training in the survey and design of sewerage projects to students attending Ministry of Water Development training courses.

The existing Ngong sewerage system drains to two waste stabilization ponds, connected in series. The maintenance of these ponds has been neglected over the years and, as a result, they contain banks of sludge rising almost to water level. The secondary pond discharges into a stream which is usually dry. However, the ponds leak to such a degree that very little effluent actually escapes along the outfall pipe.

The twelve-year-old sewerage system is limited in extent and serves mainly the shops and houses around the town centre, including the market area. Some sewers have collapsed in the past and have been replaced. Blockages of the sewerage system are frequent, probably because the untreated wastes from the local abattoir also flow into the sewers. The obvious overloading and unsightliness of the waste stabilization ponds is also due to the abattoir wastes.

The sewerage system required to serve Ngong when it is fully developed in accordance with the Town Development Plan proposals will comprise:-

- 1 300 metres (4 300 feet) of 375 mm (50 inch) diameter sewer,
- 140 metres (450 feet) of 300 mm (12 inch) diameter sewer,
- 6 300 metres (20 600 feet) of 175 mm (9 inch) diameter sewer.

It is recommended that the construction of sewers be phased, in parallel with Ngong's development.

It is further recommended that the existing waste stabilization ponds should be emptied of sludge and renovated. If this is done, they will be able to deal properly with the sewage currently entering the sewerage system.

However, it is proposed that this existing works should be phased out in the long term. It will be replaced by a new sewage treatment works, to be constructed on a different site, of lower elevation than any part of the town, so that gravity sewers only will be required just outside Ngong's northern boundary.

The proposed new sewage treatment works will ultimately comprise:-

- (i) Hand-raked bar-screens.
- (ii) Two oxidation ditches, in parallel with each other, in which screened sewage is mechanically-aerated by means of horizontal rotors.
- (iii) Four secondary settlement tanks, to remove the sludge from the oxidation ditch effluents; there will be provision for returning settled sludge to the oxidation ditches in order to keep the mixed liquor suspended solids in these units at the optimum level.
- (iv) A series of four maturation ponds, provided primarily to reduce the number of pathogens in the works' effluent.

The small stream which today receives the effluent from the existing waste stabilization ponds will also receive the effluent from the proposed future treatment works.

The estimated capital costs of these proposals, based upon 1973 prices, is as follows:-

Sewers and Manholes	shs 1 000 000
New sewage treatment works (excluding cost of land)	shs 3 000 000
Total	<u><u>K shs 4 000 000</u></u>

3.6 Water Pollution Control

Most people in the rural areas of Kenya use untreated water from rivers and streams for drinking and culinary purposes, and probably will continue to depend on these sources for many years to come. These people fill their water containers at nearby watercourses and carry the water to their homes. If local sources of water become polluted by sewage, these people will have to make use of more distant sources of supply or they will suffer from those types of illnesses that can result from consuming contaminated water.

Generally, Kenya does not have a serious water pollution problem at the present time; however, the problems which do currently exist indicate that matters could become much more serious in the future if active measures are not soon taken to control pollution. The country has a rapidly growing population, an expanding industry and is becoming more urbanized. In the face of this, the fact that the country's water resources are not unlimited becomes important.

There is strong evidence that during the 1950's something was being done to control water pollution. Sound legislation had been enacted, up-to-date sewage treatment works were being built and technically qualified personnel were employed in water pollution control activities. The present problems exist largely because the operation, maintenance and improvement of existing systems has been neglected and because the laws which would have remedied these deficiencies have not been enforced.

Nairobi and Mombasa are the most important centres of urban population and industry and will continue to be so in the future. The Government of Kenya, however, is encouraging industries to locate in other towns and areas and, as these new industrial centres grow, water pollution problems can be expected to become more widespread.

There are few perennial rivers of any size in Kenya and few of the towns and centres designated for industrial growth are located on these rivers. Most of the rivers and streams which will be used as receiving waters for the community and industrial sewages are small, and during dry weather periods have little capacity for diluting wastes. This will either lead to periodic water quality problems in these watercourses or make the cost of sewage treatment very expensive.

Coffee processing wastes are currently the most widespread source of pollution in the country. There are about 750 coffee processing factories scattered throughout the southern part of the country and many of these factories are located so close to rivers as to make the treatment of their wastes expensive and difficult. There is an urgent need for the development of an efficient but inexpensive means of treating these and other industrial effluents similarly resulting from the processing of agricultural produce.

Currently, several communities plan to augment existing or construct new sewage treatment works. Potentially this could do much to alleviate problems that now exist where sewage treatment works are overloaded. Building new sewage treatment works will not, however, solve Kenya's future water pollution problems, unless something is done to train the personnel employed to run these facilities correctly. Currently, most of the existing sewage treatment works are so poorly maintained and operated that they are extremely inefficient and in some cases not functioning at all. There is an urgent need for operator training that currently is not being met.

This shortage of trained operators for sewage treatment plants is also apparent in the industrial sector. Few of Kenya's commercial and industrial premises treat their wastes before disposal; even where a factory has gone to the expense of constructing an effluent treatment plant, because of generally poor operation and maintenance the efficiency of treatment is usually so low as to be virtually useless.

3.7 Water Resources

3.7.1 Surface Water

The drainage system of Kenya is determined by the Great Rift Valley, which runs approximately North to South, from the flanks of which waters drain westwards to Lake Victoria and eastwards to the Indian Ocean. The Rift Valley itself has an internal drainage system. There are five main drainage areas in Kenya as shown numbered on Figure 3.7.1 :-

1. Lake Victoria
2. Rift Valley
3. Athi/Sabaki/Tsavo Rivers
4. Tana River
5. Ewaso Ng'iro River

Kenya has a mean annual rainfall of about 500 mm, varying from less than 200 mm in the arid areas to over 1 000 mm over the major mountain ranges. The annual variations are large and the rainfall is often erratic.

Evaporation and transpiration reduce the effectiveness of rainfall and influence the amounts which eventually serve the water resource system of the country. Potential evaporation may be as high as 3 000 mm at altitudes of 300 m. At higher altitudes it is reduced as the temperatures become lower but may still exceed 1 000 mm per annum at an altitude of 3 000 m.

Relative to area and population, Kenya has limited surface water resources, with the perennial rivers concentrated in the central and coastal areas of the country. About 2 per cent of the total area of the country or 13 000 km² is lake area.

Reduction in the ability of over-grazed and eroded soils to absorb and retain the rainfall which they receive, results in water regimes characterized by flashy floods and absence of dry weather flow. The maintenance and conservation of the country's water resources is very closely tied to proper range and forest management.

The Hydrology Section in the Resources Branch of the MOWD is responsible for collecting and evaluating data on surface water resources of Kenya.

The first river gauging station was opened in 1921. A network of stations was successively built up. A major extension of the network was made in the mid-forties. By the early 1960's, there were 500 stations in operation. The number of stations was reduced in 1963. Today there are some 355 stations in operation.

Before 1970, stream flow data were manually computed and records of monthly means and extremes of flow at selected river gauging stations were published at six monthly intervals. In 1970, the Water Department embarked on a computer processing programme to publish the daily values of stream flows in a regular manner.

At the start of this WHO Sectorial Study, computer print-outs were available for 113 stations for the period 1961-1970. Work was in progress to computerize data prior to 1961 for these same stations and to include additional stations in the publication programme.

One of the objectives for Kenya's water development programme stated in the current National Development Plan is "to improve the state of knowledge of the country's water resources and hydrology and to develop adequate long-term master plans for urban and rural water development."

This Study may be seen as one of the links in meeting this objective.

The terms of reference for this Study included the collection and analysis of available hydrological data in respect of surface water resources and river characteristics. The need for hydrological maps giving information on stream run-off was stressed in the Plan of Operation.

The preparation of hydrological run-off maps on a countrywide basis is not a routine task. Few countries have this type of map although they are very useful when planning the utilization of water resources and land use. Hydrological maps published for Norway have served as an input to the study.

Processing of available data from river gauging stations, including flow duration analysis, were carried out by the Study team. Data from the 113 stations mentioned above served as a major input to the study. Minimum, mean and maximum daily discharges had previously been calculated for these stations. The original selection of the stations was not made with the preparation of run-off maps in mind. The geographic distribution of the stations is such that analysis of data from additional stations was necessary to fill information gaps.

Processing of data from 97 additional stations was carried out, including flow duration analysis. For these stations mean monthly discharges were used, while for the other 113 stations daily mean discharges were used.

All the data which served as an input to the preparation of run-off maps is presented in Annexes to Report No 16 (Annex I covers Drainage Area 1, Annex II covers Areas 2 and 3 and Annex III covers Areas 4 and 5). The data include tables showing available records of monthly and annual mean discharges for the period 1956-1972 in m^3/s .

For the stations calculated manually, frequency histograms of the distribution of different discharges are presented. Flow duration curves for 172 stations are included in the Annexes in addition to a schedule showing the duration of records for all stations.

Mean monthly discharges and monthly discharges with 95 per cent duration (low flow) in l/s per km^2 drainage area for 172 stations have been plotted on separate maps (see Maps 6 and 7 in Appendix C to Report No 16).

The mean annual rainfall map was superimposed on the above-mentioned maps, to show specific run-offs in order to guide the drawing of the run-off maps of areas with the same specific run-off.

Nine different intervals ranging from less than 0.15 l/s km² to more than 8 l/s km² were selected for the map showing low flow analysis (95 per cent duration). The map has been printed in colour to facilitate reading. (Map No 4, Appendix C, Report No 16).

On the mean specific run-off map, the intervals vary from less than 1 l/s km² to more than 30 l/s km². (Map No 5, Appendix C, Report No 16).

The maps should serve as guides for water resources planning on a broad scale. Most of the discharge figures refer to relatively large drainage areas, which means that local run-off conditions for smaller streams do not become apparent.

The mean run-off map is more accurate than the low flow map, as longer records are required to obtain reliable extreme values.

For more detailed run-off calculations, it is recommended that the planners utilize the back-up data presented in the Annexes.

The maps together with the discharge data presented in the Annexes should serve as a valuable input to the Water Apportionment Board in their processing of applications for water permits. It is important and urgent, however, that a more efficient data bank of permits issued is developed as knowledge of previous commitments is of equal importance to total water availability when water is allocated.

Approximate domestic water requirements for the year 2000 were calculated for both densely-populated and arid areas.

In Drainage Area No 1 (Lake Victoria Catchment) and in the Upper Tana and Athi River Catchment areas, it is estimated that the domestic water requirements will be of the order of 10 per cent of the 95 per cent duration flow. This means that for high and medium potential areas it should not be necessary to introduce major stream storages and transport of surface water for domestic purposes, except for the larger towns.

Calculations of water demand in areas of the Rift Valley indicated that these semi-arid parts will have to rely on groundwater resources to an even greater extent in the future.

The Kenya Government plans to launch a Master Water Plan Study. The Study should include considerable hydrological work, for example:-

- (i) Evaluating and eliminating the backlog of processing of river gauging data.
- (ii) Reviewing the hydrological network, with special emphasis on expanding the network to semi-arid and arid areas of the country.
- (iii) Analysing the frequency and distribution of floods and droughts.
- (iv) Water balance studies.

The Master Water Plan Study should also include advice on the establishment of an effective data bank for water permits issued, and the setting up of a water quality network.

3.7.2 Groundwater

The time available within this Project for the study of the groundwater resources of Kenya was very limited and did not permit full utilization of data available. Report No 7 gives a very general picture of the quantity, quality and distribution of groundwater in the country and indicates what work should be undertaken in the future to improve the knowledge of Kenya's groundwater resources.

Kenya is a country of wide contrasts, and this also applies to its geology and hydrogeology. Regional maps of hydrogeological parameters can only be indicative and serve as a guide for the planners.

In co-operation with the Statistics Division of the Ministry of Finance and Planning, the MOWD has established a computerized data bank on borehole data. The computer work was finalized during the course of this WBG Sectorial Study, with assistance from the University of Nairobi, and has been a most valuable input to the Study. The data bank will serve as a useful tool in the future analysis of groundwater data and in the siting of boreholes. Computer print-outs with data on some 4 000 boreholes are now available to the MOWD. Information on the location, depth, yield and rock type is indicated for each borehole. Information on water quality and draw-down is given where such data are available. The data are presented in three different formats, based respectively upon:-

- i) Borehole number.
- ii) Longitude.
- iii) Latitude.

The findings of this Study can be summarized as follows:-

Evidence is presented to show the existence of a wide belt of shallow aquifers in the Quaternary sediments of Eastern Kenya. In most parts of Central Kenya, stretching from south-west and south-east and narrowing to the north-east, the depth to the first major aquifer is of the order of 50 to 150 metres. In the north-western parts of the country adjoining Lake Rudolf, the aquifers are also relatively shallow - approximately 50 metres.

Most areas covered by the Quaternary and Basement Complex Systems are typified by unconfined aquifers, whereas groundwater in the older sediments and the volcanic areas are typically confined.

Although yield data are of limited reliability, the expected yield may be simple and appears to be strongly dependent on geology. Thus low yields are recorded for the Basement Complex areas and the highest figures occur in the Quaternary sediments in the east.

The quality of groundwater in most parts of Kenya is generally satisfactory for most purposes. The occurrence of saline water is a problem in the eastern areas (Wajir, Garissa, etc) but the occurrence of good quality waters in shallow wells and boreholes in the east is positive evidence that fresh water abounds in the shallow zones of this area. Because fresh water floats over saline waters in many parts of this area, every drilling and abstraction should be closely watched to prevent irreversible damage to the aquifers through salt water contamination.

The high concentration of fluoride in certain areas may be due to the mixing of waters from different aquifers. Judicious sampling and analysis of waters from different major aquifers should reveal which waters are unsuitable, and these may be sealed off. Defluoridation may be necessary in certain cases to reduce the fluoride content of waters to acceptable levels.

The groundwater resources' potential of Kenya appears promising, but considerably more investigations are required before the resources can be mapped. There is an urgent need to update the existing data and to obtain additional data for a more dependable assessment. Until this is done, the results presented in these Reports are tentative and should be used only as a guide to future groundwater development and management.

4 RECOMMENDATIONS REQUIRING DECISION AT MINISTERIAL LEVEL4.1 Management, Organization and Manpower4.1.1 The Permanent Secretary of the Ministry of Water Development (MOWD) should Establish a Committee to Implement accepted Recommendations made by the Study

In accordance with the Plan of Operation, the Ministry of Agriculture was the co-operating agency for this Project; the MOWD has now taken over the relevant functions from the Ministry of Agriculture.

In order to utilize the output from the Study, a committee should be established to work out an implementation programme of accepted recommendations.

The implementation committee should be appointed by the Permanent Secretary of the MOWD. It is recommended that at least the following Ministries should be represented on the committee:-

The MOWD
 The Ministry of Local Government
 The Ministry of Finance and Planning
 The Ministry of Health

It is suggested that the Committee should have few but senior members.

For each accepted recommendation, an officer (not necessarily a member of the committee) should be made responsible for the implementation and should periodically report progress to the Implementation Committee.

The committee should arrange for the preparation of Cabinet papers for those recommendations requiring Cabinet decisions.

4.1.2 The Duties and the Responsibilities of the Ministry of Water Development (MOWD) should be clearly defined

The terms of reference of this new Ministry are described, but hidden, within the current National Development Plan. It is strongly recommended that these terms of reference should be more precisely re-written and then communicated to all Government and other responsible agencies throughout Kenya, so as to eliminate the doubt and uncertainty which now often exists.

This is particularly true on the cases of sewage disposal and water pollution control. Especially in the latter case, it is not absolutely clear that the MOWD has overall national responsibility in this sector, and it is recommended that a Cabinet paper to establish responsibility should be prepared.

4.1.3 Long-Term Plans for Office Requirements for the Ministry of Water Development (MOWD) should be Established and Implemented

The MOWD Headquarters are divided between borrowed accommodation in the new Ministry of Agriculture building and temporary office buildings in the Nairobi Industrial Area. Conditions are already overcrowded and there are no definite plans as to how the expected additional staff will be accommodated.

The only possibility for expansion within the present Industrial Area site would be to erect a multi-storey office building after demolition of some of the temporary buildings. It is understood that an office building to be constructed in another part of Nairobi is the solution favoured by the MOWD.

The elapsed time between the preparation of plans for new offices and their availability is considerable. Therefore, it is most urgent that the planning for new offices for the MOWD Headquarters gets underway.

Most of the Provincial offices are also congested and inadequate and need to be expanded.

The District Water and Sewerage (and the Water Pollution) Control agencies will all require office buildings in the Provinces, when they are created.

4.1.4 The Nairobi Water and Sewerage Department should be given more autonomy

A decision should be made immediately as to which one of the future organization alternatives described by the Swedish consultants, SWECO, in their reports issued under the Nairobi Sewerage and Groundwater Survey Project, is acceptable, and the alternative decided upon should be implemented immediately.

4.1.5 The Administrative Wing of the MOWD should be strengthened

Inefficient administration has often been the cause of bottlenecks in the past, and it is recommended that an overall review of the present administrative organization of the Ministry should be made with a view to upgrading posts, where appropriate, and to creating new Sections and Divisions with specific responsibilities.

At the same time, it is recommended that specialists should be engaged to develop and install improved administrative systems for specific areas, for example:-

- (i) In personnel record-keeping
- (ii) In accounting
- (iii) In procurement of stores

4.1.6 Positive Action should be taken to overcome as soon as possible the present Technical Manpower problems within the MOWD

A massive recruitment programme should be launched immediately to fill existing vacancies within the technical wing of the MOWD. Particular emphasis should be placed upon obtaining recruits with proper experience and competence. At the same time, the status of all the key positions within the Ministry should be re-considered and posts should be re-graded if appropriate.

4.1.7 The Demand and Supply of Kenya Civil Engineers should be established and action taken to balance the situation in the future

The annual increase in demand for sanitary engineers for water and sewerage within Kenya, taking into account demands from central and local government and from the private sectors, exceeds the present output of Kenyan civil engineers from the Nairobi University.

The demand for civil engineers from other sectors is even greater. It is recommended that an ad hoc Civil Engineering Manpower Planning Group should be established between the major users of civil engineers and the teaching and training organizations in Kenya. The terms of reference of this Group should be to study the overall long-term demand and supply situation, and to make recommendations as to how Kenya's needs may be met.

4.1.8 The need to recruit Expatriate Engineers for the Community Water Supply, Sewerage and Water Pollution Control sectors for several years to come should be recognised.

As implied by the previous recommendation, it will not be possible to recruit Kenyan civil engineers in sufficient numbers for these sectors for several years. Even if the intake to the University is expanded during the next few years, it will take another three or four years before the output increases and more years before these new engineers will have gained sufficient practical experience to take over senior positions.

Both the MOWD and the Nairobi City Council have been rather unsuccessful during recent years in recruiting both Kenyan and expatriate engineers and many established posts remain vacant. The reasons for these failures should be investigated so that a more realistic and sophisticated recruitment policy can be adopted both within Kenya and for expatriates.

An important point is to ensure that the conditions of service for expatriates are competitive with the world market, so that they will attract competent engineers.

4.1.9 A less rigid Recruitment Policy and improved Recruitment Procedures are required

In the past, the MOWD has often failed to recruit the experienced technical manpower it requires because of inefficiencies in its recruiting policy and procedures. In view of the present desperate need to recruit personnel, it is recommended that the present policies and procedures should be carefully reviewed and streamlined wherever possible.

4.1.10 A Personnel Division, headed by a Senior Personnel Officer, should be created in the Ministry of Water Development (MOWD)

The past problems of manpower recruitment and training have often been the result of divided responsibility. It is recommended that a new Division, with the sole responsibility for manpower recruitment, training and personnel matters, should be established within the Ministry as soon as possible.

4.1.11 The Development Programmes of the Ministry of Water Development (MOWD) should be publicised, and the Public should be educated into using correctly the facilities provided

Public support is vital to the success of any national programme. The MOWD water supply and sewerage development programmes should receive sufficient publicity to ensure that the Kenya public fully appreciates the benefits of and wants the facilities which will be provided. At the same time, the people of Kenya should be taught, where necessary, how to use and maintain these facilities properly. They should also learn that it is fair and reasonable that they should have to pay for such services, in proportion to the benefits they personally receive.

4.1.13 A National Research Organization should be established

There is need for investigation and research in the water supply, sewerage and water pollution control sectors. It is recommended that a national Research Organization should be created, to deal with these matters and to handle also the collection and publication of statistics and records and the dissemination of technical information.

4.1.14 A Master Water Plan Study should be carried out

As mentioned in sub-Section 1.2 of this Report, the WHO Sectorial Study was planned to be a fore-runner of a Master Water Plan Study.

This new Study should include:-

- (i) Projections of the long-term demand for water from all sectors depending on water.
- (ii) Further assessments of the country's surface and groundwater resources.
- (iii) Preparation of an efficient system for the processing of data on water permits issued and expected.
- (iv) Recommendations on methods, procedures and organization for water management.
- (v) More detailed recommendations on training programmes in the water resources sector.

4.2. Water Legislation

4.2.1 The Water Act should be Amended

The Water act should be amended to reflect the establishment of the MOWD and the de-gazettement of the Water Resources Authority and Regional Water Committees.

The duties of the Water Apportionment Board should be clarified. The Water Act should further be amended to state that it and its subsidiary legislation also apply to local authority water undertakers.

4.2.2 A New Comprehensive Water Act should be Established by 1978

The Kenya Water Law is basically sound and adequate, although involving a multiplicity of Acts and other statutory instruments. It is recommended that a Bill consolidating all the law relating to water, sewerage and water pollution control should be introduced, to become law by 1978. By then, the Government's policy on the organizational structures of the various sectors should be known and experience of enforcement will have been gained. As drafting of such a Bill is a lengthy process, an early start should be made.

4.3 Water Supply

4.3.1 Recurrent Budgets should be related to the Development Budget

In the water supply sector, recurrent budgets have in the past often been related to the previous year's recurrent budget rather than to the same year's development budget. As a result, recurrent funds have for several years been too low to cover administration and running expenses.

Money will inevitably be wasted if new supplies and services are developed and then insufficient funds are allocated to maintain and operate them.

4.3.2 Government Pricing Policies on Community Water Supplies should be established

In this exercise, urban and rural areas should be dealt with separately.

A viable pricing policy is required for water supplies in urban areas. Rates should be fixed so that the revenue generally covers loan repayments on capital plus operation and maintenance costs, with possibly cross-subsidy between communities.

The Government is currently implementing a massive water development programme in the rural areas. Although a pricing policy is urgently required, it should be at all times realized that this programme must be subsidized from other sectors of the economy, in line with the Government policy of improving conditions for the rural population. An advantage of having a nationally recognized pricing policy on water supplies in rural areas would mean that the extent of subsidy within the sector and from other sectors would be known.

It is recommended that water from individual connections in rural areas should be charged for, the aim being to cover operation and maintenance expenses, in the long-term. Connection fees should be kept low to encourage individual connections.

4.3.3 Water from Communal Water Points should be Free

It is recommended that water from communal water points, which should be of simple construction and few in number in high and medium potential areas, should be delivered free of charge to the people, perhaps not in the long-term but certainly during the next few years.

4.3.4 Communal Water Points which have been Closed for Non-Payment should be Re-opened

Operating staff of the MOWD were instructed to close communal water points on 1 October, 1972, if the user groups had not paid their water rates. Many communal water points were closed and are still not operating. In a few cases, the water fees were paid; there are also instances where water points are operating, although the fees have not been paid.

If a decision is taken that, as recommended in Clause 4.3.3, water from communal water points should be provided free of charge, then it follows that all such facilities now closed should be re-opened.

4.3.5 Water Supplies in Settlement Areas and those operated by County Councils should eventually be taken over by the Ministry of Water Development (MOWD)

It is obvious that many County Councils have insufficient resources to operate their rural water supplies. Water schemes developed in settlement areas are also deteriorating because of poor operation and maintenance.

It is recommended that supplies not properly run should gradually be taken over by the MOWD. This is a major task and requires considerable preparation by the Operations Branch of the MOWD, and reinforcement of manpower, equipment and funds.

A policy on taking-over such schemes should be decided and a programme for implementation should be prepared.

4.3.6 An Equitable Balance should be Kept between Investments in Urban and Rural Water Supply Development

Prior to 1969, virtually all efforts on the development of community water supplies were directed at the urban areas. Early in 1970, a credit agreement was signed with the Swedish Government for rural water supply development, and a massive rural programme was launched. At about the same time, negotiations with the United Kingdom for a credit for urban water supply development failed and, for a period of about four years, funds for the augmentation of urban water supplies operated by the MOWD were very scarce.

With the rapid urbanization taking place in Kenya, it is most important that the urban water supply sector is allocated sufficient funds to maintain an adequate service. The urban population is captive of the community water supplies and an inadequate supply is a major health hazard. Urban areas are also more dependent on water supply for economic development than are rural areas.

The Government should aim at an equitable balance in the allocation of funds between the urban and the rural sectors when negotiating for finance from donor and other financial agencies.

4.3.7 Funds for Rural Water Development should be Distributed In Proportion to Population Unserved

It is recommended that the development funds allocated to rural water development should be distributed over the districts in proportion to population unserved by a community water supply.

Expected benefits from rural water supplies in high and medium potential areas are primarily of economic character, although health and social conditions will also improve. In the low potential areas, the health and social benefits dominate and the schemes are justified primarily on humanitarian grounds. It could be argued that the low potential areas should be given priority and the more well-to-do populations in high and medium potential areas should wait until those living in more arid areas have been catered for. It is most important, on the other hand, that the potential of the more humid areas of the country is utilized for the general growth of the country's economy; otherwise, the nation will not be able to afford to develop and help the poorer areas.

4.3.8 Investigation and Research into Community Water Supplies should be carried out

The research recommended in the water supply sector includes both technical and economic studies.

The technical studies should be aimed at investigating existing systems and facilities with a view to arriving at more efficient design criteria.

The economic research activities, although also concerned with the improvement of the standard of service, should concentrate on such areas as:-

- i) The volume of water consumed from individual connections.
- ii) The demand for individual connections.
- iii) The ability and the willingness of the consumers to pay for water, for different degrees of service.
- iv) The impact of water supplies on and its inter-relationship with other development inputs.

4.4 Sewerage

4.4.1 The Relative Priority nationally of Sewerage and Sanitary Sewage Disposal should be decided and established

The Project reports describe the results of past negligence in this sector, explain the consequent dangers to health and to Kenya's water resources and strongly recommend that sewerage and sewage disposal receive proper priority in the future. Acceptance that sewerage and sanitary sewage disposal are important and should receive priority carries with it the obligation for the Government to provide the necessary trained manpower, resources and support, without which the stated objectives have no hope of being achieved. In particular, the new national organization for sewage disposal, as proposed in the Project reports, is considered an absolute necessity to future success.

4.4.2 Recurrent Budgets should bear a closer relationship to the Services to be provided

At the present time, the operation and maintenance of community sewerage and the servicing of individual-type domestic sewage disposal arrangements are the responsibilities of local authorities. The standard of services provided by these authorities is usually very low indeed.

The major constraint is lack of available finance.

This situation is not caused solely by the lack of a national pricing policy for sewerage; it is more often due to local authorities diverting sewerage revenue into their general funds.

It is recommended that sufficient funds should, in the future, be allocated to these important services.

4.4.3 A National Pricing Policy for Sewerage and Sewage Disposal is required

A national pricing policy to cover not only community sewerage but also the servicing of individual-type domestic sewage treatment facilities, and the acceptance of industrial effluent discharges into public sewers, is urgently required. The general aim of such a policy should be to ensure that revenue, in the long-term, will cover both capital repayments of development funds plus operation and maintenance expenses.

There are several attractions in having a standard rate for urban sewerage, based upon volume only in the case of domestic users, for all towns throughout Kenya, with the possible exceptions of Nairobi and Mombasa, which are both unique. A corollary to a standard domestic sewerage rate would be a standard national formula for determining charges for industrial effluent discharges into public sewers; this formula would take into account not only volume but also the quality of the industrial effluent discharged.

It should be noted that, if it is decided to have standard national rates for sewerage, then some cross-subsidy between urban communities should take place.

4.4.4 The Ministry of Water Development (MOWD) should control all Sewerage Development Funds

At the present time, although the MOWD is technically responsible for sewerage development throughout Kenya, outside Nairobi, development funds are still controlled by the Ministry of Local Government.

This situation has led to difficulties in the past and should be remedied by giving the MOWD complete control over the funds. How this should be done needs careful investigation because the Ministry of Local Government are, at the present time, merely acting as agents for Local Authorities, who have the responsibility of repaying development loans.

4.4.5 Research should be carried out in the Sewerage Sector

Potentially, great economies could be made in Kenya in the future if it could be certain that design criteria and the types of installations provided took complete advantage of Kenya's favourable climate.

Investigations and research are urgently required to establish precisely where existing criteria may be improved and economies made.

4.4.6 The Location of Industries in Towns

The haphazard location in towns of industries which produce highly polluting effluent discharges can result in considerable problems in the treatment of the community sewage.

It is recommended that those Government officers responsible for the efficiency of the treatment and disposal of sewage throughout Kenya should be invited to comment and attend negotiations at the planning stage of any new industry. These officers should also have powers to prevent the location of a new factory in a particular community if this is necessary to protect the community sewerage arrangements and the environment.

4.4.7 Public Latrines should be provided in Important Centres

It is recommended that a programme should be launched to construct public latrines at busy locations in all Kenyan towns, in order to serve travellers and others away from their homes so that everyone at all times has access to sanitary sewage disposal facilities. In this context, towns include also locations where large markets are held and transfer points on the country's transportation systems.

4.5 Water Pollution Control

4.5.1 The National Importance of Water Pollution Control should be recognized

Kenya's water resources are an invaluable and irreplaceable asset to the country. However, some are in danger of becoming so polluted as to become worthless to society. If the Government wishes to eliminate this danger, then it should, as quickly as possible, take steps to build up a competent and effective national water pollution control organization, as described in the Study reports.

4.5.2 Research should be carried out in the field of Water Pollution Control

The aim of water pollution control is to maintain the quality of Kenya's water resources at a satisfactory level. A great deal of local knowledge is required to determine what this level should be for each particular resource. The next stage is to decide upon quality standards for each sewage discharge into a water resource. To decide this, it is necessary to be able to predict the effects of polluting discharges on water in Kenya's varying climatic conditions.

Research studies and investigations would provide the answers to these problems and thus, by ensuring that standards were never more severe than necessary, would doubtless allow considerable economies in sewage treatment facilities to be made.

4.5.3 Investigation is required into the Financial Implications of Water Pollution Control

Water pollution control tends to aim at an ideal state where no water resource is polluted. The results of a vigorous water pollution control policy are sewage treatment expenses for communities and for factories.

A developing country such as Kenya cannot afford to maintain pollution-free water resources; some balance has to be reached between what is desirable and what the country can afford. This is no easy problem to solve and requires detailed study which, it is recommended, should start as soon as possible.

4.5.4 The Location of Industries

It is not yet nationally recognized that the costs of disposing of the effluent from a new factory can vary very greatly, depending upon the particular water resource into which it is discharged. This is because the quality standards of an effluent discharging into a water resource which provides considerable dilution, or which is not used for drinking, can usually be very much lower than the standards required for discharge into a small, but important, watercourse.

It is strongly recommended that those Government officers responsible for water pollution control should be invited to make comments and attend negotiations at the planning stage of any new industry. These officers should also have powers to prevent the location of a new factory on a particular site if they consider that it will endanger an important water resource.

4.5.5 Steps should be taken to reduce Soil Erosion

Eroded soil entering a water resource is just as much a pollutant as are many types of industrial effluents. However, eroded soil enters water resources naturally, during rain, and therefore cannot be controlled by a normal water pollution control programme.

It is strongly recommended that the Ministry of Agriculture should look into methods of reducing soil erosion, not only because it is a pollutant but because it is also a tremendous waste of Kenya's resources.

4.6 Water Resources

4.6.1 The Availability of and Demand for important Water Resources should be balanced

Any water resource in Kenya is limited in quantity. Therefore, if the possibility of over-committing its resources is to be avoided, the Water Apportionment Board must accurately know the volume of uncommitted water before it can properly agree to a new abstraction request.

In fact, at the present time, the Water Apportionment Board very rarely has this information, and it is therefore recommended that the necessary work to supply this data should be commenced as soon as possible.

4.6.2 Kenya's Groundwater Resources should be investigated and Mapped

Knowledge of the whereabouts and volumes of Kenya's groundwater resources is very sketchy. Much more information is necessary if groundwater is to be properly developed and managed, and it is therefore recommended that appropriate systematic investigations should commence.

5 RECOMMENDATIONS WHICH CAN BE IMPLEMENTED BY THE
DIRECTOR OF WATER DEVELOPMENT

5.1 Management, Organization and Manpower

5.1.1 More Effective Steering of the MOWD's Activities should
be provided

The MOWD is basically functionally organized and a number of varied work programmes, competing for the Ministry's resources, are going on simultaneously. (The major current programmes were described in Clause 3.1.2 of this Report).

Effective steering from the top of the organization is essential when so many programmes have to be executed in parallel. Priorities between the programmes must be established and continually reviewed by the senior management of the MOWD.

It is recommended that a Management Committee, chaired by the Director of Water Development and consisting of Branch Heads plus the Heads of the Water Supply and Sewerage Planning Sections, should meet regularly to establish objectives and priorities, to report progress and to identify and solve problems.

5.1.2 The Ministry of Water Development (MOWD) should continue
to Utilize the Services of Consultants and Contractors

It is not feasible to build up the Ministry's manpower resources sufficiently to be able to carry out the development of sewerage and of major and intermediate water supplies by internal resources. The services of consultants and contractors should therefore be utilized. It is recommended that the work is distributed over a number of consultant firms, to encourage competition and to avoid the capacities of the consultants from becoming a constraint. On the other hand, the number of firms should be limited as the MOWD work volume on supervision increases with the number of firms.

5.1.3 The Training Needs and Programmes of sub-professional Technicians should be determined and compared

At the present time, there is insufficient co-ordination between the MOWD Training School and the various polytechnics engaged in training technicians. Discussions are required between these various teaching institutions to decide upon the optimum way in which proper training can be given to the many sub-professional recruits the MOWD will require in the future.

Contact should also be made with the University of Nairobi and the Ministry of Health Medical Training Centre with a view to making optimum use of the limited, relevant teaching expertise currently available in Kenya.

5.1.4 The Ministry of Water Development (MOWD) Training Facilities should be concentrated in one area

The construction of a hostel for the Training School on a site about two kilometres from the MOWD Industrial Area Headquarters is nearing completion. It is proposed to build a new workshop plus new classrooms on the same site.

It is recommended that this work should be given priority so that the lack of such facilities does not become a constraint on the training of the technical personnel required by the MOWD.

5.1.5 The Ministry of Water Development (MOWD) should offer Scholarships and Vocational Employment

The MOWD should offer both first degree and post-graduate scholarships for students to pursue relevant studies. Students should be bonded to work with the Ministry for at least two years after the end of the course.

It is suggested that the more successful polytechnic-trained sub-professionals in the MOWD would be suitable candidates for sponsored first degree courses, after they have proved their interest and abilities during say two years' practical experience.

In the past, the MOWD employed second-year University students during their short and long vacations. This resulted in students joining the MOWD when they graduated. Provided that under-graduates can be interestingly employed at the MOWD, without adversely affecting the development and other programmes, then offering vocational work of this type seems an excellent method of attracting new recruits to the Ministry.

5.1.6 Ministry of Water Development (MOWD) Personnel should be encouraged to attend Evening Classes for Further Education and, if they do this, should have their fees paid

Evening classes in various subjects are offered by the University of Nairobi and other training institutions. Although the fees are usually low - for example, the University offers courses in computer programming for approximately 100 shillings - they are sufficiently high to be a constraint for many employees who would like to attend them.

It is suggested that staff of all grades in the MOWD should be encouraged to attend courses which will increase their technical knowledge, and that such demonstrations of enthusiasm should be noted on their personnel records. Funds for this type of training are available through the Ministry, but the procedures to obtain such support need to be streamlined. The availability of funds for further education should be widely advertised amongst the MOWD employees.

5.1.7 Regular Seminars should be held for both Field and Headquarters Staff

The twice-yearly seminar for Provincial Water Engineers/Officers has proved very useful in providing a better understanding by Provincial and Headquarters' staff of the other parties' problems; they have also improved communications between Headquarters and the Provinces.

It is suggested that similar regular seminars should be held for other types of staff within the Ministry. The seminars could include some element of training. It is suggested that seminars would be particularly useful for water bailiffs, hydrological assistants, water pollution control inspectors and sewerage personnel.

5.1.8 The Provincial and District Organizations should be Strengthened and Expanded

Out of the seven provinces and Nairobi Extra Province, only three are headed by qualified engineers.

Responsibility for the development work is being centralized at the Headquarters in Nairobi, but the work volume on operation and maintenance is expanding and the main responsibilities rest with the Provincial Water Engineers/Officers; they therefore require technical staff and also considerable input from accounting and personnel staff. To date, there has been no significant increase in numbers of Provincial staff.

For each gazetted water supply, operation charts are prepared monthly for each scheme and submitted to the Provincial Water Officer through the Water Inspectors. One copy of each chart is submitted to the Operations Branch of the Headquarters in Nairobi. A study of these charts reveals that the follow-up by the Provincial staff is considerably less today than a few years ago.

Because the work programme of the MOWD in the past has been concentrated on the urban areas, the Ministry is relatively poorly represented in the rural areas. With the introduction of the current large rural water development programme, the organization is facing maintenance problems in these areas.

It is recommended that the programme of establishing mobile district teams to service the rural supplies is accelerated.

5.1.9 The efficiency of the Secretarial Services provided should be improved

The shortage of skilled secretaries is a constant complaint within the MOWD. Important letters and reports are often delayed because of the shortage of secretarial capacity. Often, these documents have to be corrected and re-typed several times before they reach a reasonable standard. The result is that time is wasted for the already overworked technical personnel in the Ministry.

It is recommended that positive action should be taken to improve this situation.

5.1.10 The Efficiency of Support Services should be improved

Technical staff frequently lose time because of the inefficiency of support and back-up services. In particular, discipline seems frequently to be lacking amongst more junior personnel, such as messengers. Often junior staff cannot be found at their posts and this can cause serious delays. Telephone calls are difficult to make out of and into the Ministry and it seems likely that this difficulty is due, at least in part, to junior staff using the telephone for private conversations.

It is recommended that positive action should be taken to improve the efficiency of these services.

5.1.11 The Departmental Filing System needs improving

The present filing system has several defects which result in letters being incorrectly filed and in the bulk of correspondence being filed on relatively few general files.

It is recommended that the filing system should be thoroughly overhauled, with a view to making it more efficient.

5.1.12 The Liaison between Unit Heads and their Staff should be Improved to Motivate People in their Work

In order to motivate the employees, there should be close liaison between unit heads and their staff.

Regular staff meetings, where all the members of a Division or Section can have an overall view of the on-going activities and an opportunity to air their problems and express their views, can greatly improve the morale among the staff.

5.1.13 The Time Distribution System should be Re-Introduced

During 1970, a time distribution system was introduced to record time spent by all officers on the various programmes and also on individual schemes within the programmes. The emphasis of the system was concentrated on obtaining a true picture of overhead costs.

The analysis of the data was complicated and there were considerable delays between the collection of data and the reporting of analyses, which meant that the reports could not be used by senior management as a tool for allocating resources.

The system deteriorated and was abandoned after about a year and a half.

It is recommended that the system should be re-introduced and that it should be operated by the Water Supply Planning Section. Reports on monthly and accumulative utilization of the Ministry's manpower resources should be issued to the Management Committee.

The collected data would assist the establishment of priorities and the allocation of manpower resources to the various work programmes.

5.1.14 Shortage of Transport should not be allowed to become a constraint

The work of the MOWD covers the whole country. Also, the nature of the work carried out by the Ministry is such that matters which need urgent attention often occur.

It is recommended that all officers holding responsible posts should be given the authority to solve their personal transport problems. If no official vehicle is immediately available and a journey is necessary, then they should be allowed to use their private vehicles and be reimbursed accordingly with a minimum of formality.

5.1.15 Increased temporary Office Accommodation will be required pending the construction of the new Ministry of Water Development Headquarters

With reference to Clause 4.1.3, the proposed permanent offices for the MOWD will not be ready for occupation for some time. In the meantime, recruitment is rapidly increasing the number of staff within the Ministry. Accommodation in the Industrial Area offices is already overcrowded and it is recommended that serious thought should be given immediately to where the new recruits are to work.

Adequate office accommodation is important to morale and efficiency.

5.2 Water Legislation

5.2.1 Model Sanitary Bye-Laws should be prepared for adoption by Local Authorities

Most of the deficiencies in the sanitary legislation of Kenya concern local sanitary bye-laws, and it is recommended that the preparation of model bye-laws should be treated as urgent.

However, it should be noted that the recruitment and training of persons to enforce these bye-laws must parallel their preparation, if the bye-laws are to produce the desired results.

5.2.2 Establish Procedures and publish Related Forms

Many of the powers of the MOWD in the Sewerage and Water Pollution Control Sectors are only now being exercised for the first time; the time is therefore appropriate to lay down formal procedures for recurring tasks and operations.

This is particularly true concerning the enforcement of sanitary and water pollution control legislation. Efficiency will be increased and the work involved reduced, if standard forms are published to cover the various requests and steps involved.

It is recommended that procedures should be established and related forms should be published as soon as possible.

However, these should only be done when there are sufficient competent persons available to deal with the forms and to enforce the legislation.

5.3 Water Supply

5.3.1 A Marketing Section should be Established within the Operations Branch of the Department

Consumers should be actively encouraged to have individual piped connections to their premises wherever circumstances allow.

The marginal cost for connecting additional customers to piped water supply systems is often very low. The economies of many urban supplies could be improved if efforts were made to encourage additional households within the limits of supply to obtain connections.

The utilization and benefits from rural supplies increase with the number of individual connections. During the early stages of large rural supply projects, a sales drive to promote individual connections, immediately followed by the installation of ordered connections, would be likely to result in a higher degree of utilization of the supplies, more benefits and a better overall economy of the schemes.

5.3.2 Degree of Service - Water Supplies

The following degrees of service are recommended for water supply:-

Urban Areas

Individual water connections to homes should be the aim. The water should be treated to WHO standards; that is, the water should be safe and pleasant to taste, colour and smell. The per caput water supplied should be from 75 to 300 litres per day, depending upon the class of housing. For urban squatters in very low cost housing, water will probably have to be supplied on a communal basis. Storage facilities for emergencies should be included in urban supplies, to improve their reliability.

Rural Areas, High and Medium Potential

In high and medium potential areas (as categorised in the Kenya Atlas on the basis of rainfall and soil conditions) the aim should be to provide water points to most individual farms. It is not expected that a complete coverage of individual connections will be reached, even in the richest rural areas. However, if the Government adopts a pricing policy which encourages the farmers to request individual connections, it is estimated that ultimately about 60 per cent of farms in high and rather fewer in medium potential areas will be connected. The extra costs of this higher degree of service compared with communal water points would almost certainly be offset by the extra revenue earned by the Government.

Initially communal water points should be included in the schemes, but they should be few and simple in order to encourage individual connections. Although it is almost impossible to quantify the benefits from a rural water supply, it is clear that the economic, social and health benefits are considerably higher from individual connections when compared with communal water points. It is recommended that the quantity of water supplied should be 50 litres per head per day, based upon the expected population twenty years hence.

The water supplied should be safe, but WHO standards covering taste, colour and smell could be relaxed for rural water supplies.

It is not recommended that storage facilities for emergencies should be included in rural schemes.

Rural Areas, Low Potential

It is recommended that the populations in low potential areas should be served through communal water facilities. In areas with nomadic population, point sources without distribution systems are acceptable. The quantity of water supplied should be based upon an average daily consumption of 20 litres.

The aim should be to provide safe water. However, it is very difficult to protect point sources from contamination by cattle and people.

5.4 Sewerage

5.4.1 Degree of Service - Sewerage

It is not economically feasible to provide sewerage (that is, a system of public sewers followed by treatment of the collected sewage at a communal works) for every community in Kenya. It is recommended that sewerage should be provided only in those communities where it is:-

- (a) The only practical method of domestic sewage disposal; or
- (b) The most economical method of domestic sewage disposal; or
- (c) warranted because of health considerations.

Thus, sewers should be provided for all communities where the population density exceeds approximately 124 persons per hectare (50 per acre). Sewerage should also be provided for less densely-populated communities located on impermeable ground and for communities where the water supply is from shallow wells.

Elsewhere, it is envisaged that, even by the year 2000, the normal method of domestic sewage disposal will be by means of individual-type facilities at each building. The particular type of installation provided should have been selected in accordance with the local ground conditions and other circumstances.

5.4.2 Manuals, Codes of Practice and Model Documents should be Prepared to give National Guidance and to Co-ordinate Development in the Sewerage Sector

Even internationally, there is a great shortage of publications covering the design, construction and operation and maintenance of sewerage systems and sewage disposal installations in warmer countries, such as Kenya. If this deficiency could be overcome in Kenya, the training of personnel, the design and construction and the proper operation and maintenance of sanitary installations would become so very much simpler, and at the same time cheaper.

5.4.3 Master Sewerage Plans should be Prepared prior to Sewerage Development

It is recommended that a Master Sewerage Plan should be prepared before any sewerage facilities are constructed in a town. This Master Plan should be based upon the best long-range forecasts of the community's future physical development.

This is to avoid past and current problems of sewerage systems and sewage treatment facilities proving incapable of expansion as a town develops.

5.4.4 The Ministry of Water Development (MOWD) should accept the responsibility for Training all Technical Sewerage Personnel

Hitherto in Kenya, there has been no proper training of technical personnel employed on sewerage development and operation and maintenance.

It is recommended that the MOWD is the appropriate agency for training all present and prospective sewerage personnel, whether they are employed by the Government, or by local authorities or by consultants and contractors. This is not to suggest that all training of these persons should be carried out at the MOWD Training School; it is rather that training requirements and programmes should be directed and co-ordinated by the Ministry.

5.4.5 Communal Ablution/Latrine Blocks shall be Provided to serve Citizens in densely-populated Urban Areas who cannot afford Individual Water Supplies

Although it is anticipated that all densely-populated urban areas in Kenya will have piped water supplies by 1983, it is certain that many of the citizens living in such communities will not be able to afford individual water supplies.

It is recommended that communal ablution/latrine installations, with piped water and water-borne sanitation, should be provided for them. It is further recommended that the MOWD is the most appropriate agency for designing, constructing and then studying the efficiencies of prototype communal ablution/latrine blocks.

5.5 Water Pollution Control

5.5.1 Manuals should be prepared to give National Guidance in the Water Pollution Control Sector

Even internationally, there is a great shortage of publications covering water pollution control in warmer countries, such as Kenya. It is recommended that such documents should be prepared, for use as training manuals, to describe procedures and the various forms which will be used to control discharges, and to standardize tests and methods of analysis appropriate to this country.

5.5.2 The Ministry of Water Development (MOWD) should give Guidance on Industrial Effluent Treatment Techniques

It is not suggested that the Water Pollution Control Section of the Ministry should interest itself generally in industrial effluent treatment; the role of the MOWD is rather to act as a policeman to ensure that others carry out treatment correctly.

However, it is recommended that the Water Pollution Control Section could help develop inexpensive means of treating particular industrial effluents which are widespread throughout Kenya. The Section is in fact already doing this with regard to coffee processing wastes; the treatment of sisal processing wastes and the wastes from typical fruit and vegetable canning factories are other spheres in which it could perhaps assist.

5.6 Water Resources

5.6.1 The Ministry of Water Development (MOWD) should launch a vigorous Programme to Monitor the Country's Surface Water Resources

The monitoring of Kenya's rivers, and the collection and processing of relevant data, received an impetus during the Sectorial Study.

A proper knowledge of Kenya's water resources is essential if they are to be properly developed and managed in the future. It is recommended that the programme of establishing river gauging stations and of monitoring river flows should be given priority and should accelerate as soon as possible.

A P P E N D I X A

WHO Staffing Schedule
for the Project (Phase I)

A P P E N D I X B

Extract from Amendment No 2
to the Plan of Operation
for the Sectorial Study

GOVERNMENT OF KENYA/WORLD HEALTH ORGANIZATION

AMENDMENT NO 2 TO PLAN OF OPERATION

Project: Sectorial Study and National Programming for
Community and Rural Water Supply, Sewerage
and Water Pollution Control

This second Amendment is an integral part of the Plan of Operation signed by the Government on 26 January 1971 and by WHO on 3 December 1970, amended by the first Amendment signed by the Government on 7 July 1972 and WHO on 16 May 1972. It modifies certain parts of it as hereafter stated, the other parts remain valid.

PREAMBLE

At the present time, the Kenya Government has very limited expertise and experience in the fields of sewage disposal and water pollution control.

In the past, divided responsibility for sewage disposal and water pollution control in Kenya has resulted in some inefficiencies and in a large backlog in the development of proper sanitation throughout the country.

The Government is now making a determined effort, and is allocating considerable funds, to improve this situation; reports from the Sectorial Study make recommendations as to how this should be done. The intention of this Amendment is to provide for a period of thirty months a senior WHO Sanitary Engineer who, by giving advice and active assistance, will help Kenya implement the recommendations made; the Expert will work with the Water Department of the Government of Kenya.

I OBJECTIVES AND DESCRIPTION OF PROJECT

Include the following clauses:-

1.10 To assist in the implementation of the policies of the Water Department of the Government of Kenya on sewerage, sewage treatment and disposal and water pollution control; in particular, to assist in the implementation of the proposals made in the relevant Sectorial Study reports.

1.11 To prepare manuals, codes of practice and model documents as follows:-

Training manuals covering sewerage and sewage treatment and disposal, including design, implementation and operation and maintenance.

Design manuals for sewerage and sewage treatment and disposal.

Codes of practice, design criteria, standards and model specifications as necessary, for sewerage and sewage treatment and disposal.

Operation, maintenance and safety manuals for sewerage, including pumping stations, and for sewage treatment and disposal.

1.12 To prepare a detailed draft 5-year national Development Plan for sewerage, after liaison with all interested national bodies, and to prepare terms of reference for consulting firms and supervise feasibility and other studies as necessary for the implementation of the Plan.

1.13 To prepare, in draft, a detailed programme for training the personnel required to implement this national Development Plan, including the supervision, operation and maintenance of both existing and proposed sewage collection and disposal systems, arrangements and installations.

1.14 To assist in the design of relevant projects whether carried out by the Water Department or by Consultants.

1.15 To assist in the supervision of the construction of sewerage projects, whether carried out by direct labour or by Contract.

1.16 To assist in the implementation of the programmes and standards proposed under the above clauses, and in earlier relevant reports.

1.17 To advise on pricing policy and charging schemes, revenue collection and financing systems.

1.18 Provided that there is sufficient time available, to carry out any other relevant work, such as:-

i) Give technical and practical advice in order to help improve qualities of materials and standards of workmanship; also advise on the standardization of designs, components and equipment.

ii) Help formulate new legislation, including bye-laws, and standards for sewage discharges.

iii) Help in the planning of a national research organization and advise on suitable research projects.

A P P E N D I X C

Handing-Over of Equipment and Material

HANDING OVER OF EQUIPMENT AND MATERIAL

1 WHO Equipment

Upon completion of the first phase of the Project, the following equipment was handed over to the Kenya Government in accordance with the Plan of Operation:-

- 1 Volkswagen Kombi
- 1 Land Rover
- 1 Manual Typewriter
- 1 Field Laboratory for Chemical Analysis
- 1 Field Laboratory for Bacteriological Analysis

The following items were handed over to the Sanitary Engineer (Sewerage) on 15 October, 1973, for use during the Project extension:-

- 1 Land Rover
- 1 Field Laboratory for Chemical Analysis
- 1 Electric Typewriter

Two altimeters provided to the Project on loan from WHO Headquarters were returned.

A field sewerage kit also provided on loan from WHO Headquarters was retained for use during the Project extension.

The library of books purchased from Project funds and the Project files were handed over to the Sanitary Engineer (Sewerage) for use during the Project extension.

2 Kenya Government Equipment

A dissolved oxygen meter, camping equipment and most of the furniture purchased by the Kenya Government for the Project were returned to the Government.

A steel filing cabinet, dictaphone and furniture required by the Sanitary Engineer (Sewerage) and his Secretary during the Project extension were retained.

A P P E N D I X D

List of WHO Sectorial Study Reports

LIST OF WHO SECTORIAL STUDY REPORTS

<u>REPORT NUMBER</u>	<u>TITLE</u>
1	General Community Water Supply Problems
2	Recommendations on National Programme for Community Water Supply Development
3	Current Sewage Disposal Methods and Problems
4	Design and Selection Criteria for Community Water Supplies
5	Water Pollution Control
6	Water Legislation
7	Groundwater Resources in Kenya
8	Recommendations on a National Programme for Sewage Disposal
9	Selection and Design Criteria for Sewerage Projects
10	Recommendations on Administration and Organizational Structure for Water Supply Development.
11	Manpower and Training Requirements
12	Ten Year Development Programme for Community Water Supply
13	Ten Year Development Programme for Sewerage
14	Preliminary Design of Ngariania Water Supply
15	Preliminary Design of Ngong Sewerage Scheme
16	Surface Water Resources in Kenya
17	FINAL REPORT