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Impact and Economics of Community Water Supply

A Study of Rural Water Investment in Kenya

by
I. D. CARRUTHERS

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Currency

1 Kenya shilling (Ksh.)	=	100 cents (Kenya)
1 Kenya pound (K£)	=	20 Kenya shillings
K£1	=	U.S. $2.8 = £1.167 (Sterling)
U.S. $1	=	K.sh. 7.14
£1 (Sterling)	=	K.sh. 17.14

NOTE: Unless otherwise stated, all values in the study are in Kenya currency.

Weight

1 long ton	=	1,016 kg.
1 kg.	=	2.205 lb.
1 acre	=	0.405 hectare
2.5 acres	=	1 hectare

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FOREWORD

This study documents experience and discusses problems related to rural water development in Kenya. Kenya is probably the country with most experience in this field of activity outside Latin America. The topic is important because developing countries as diverse as Brazil, Ghana, Ethiopia, Tanzania, India, Thailand and Indonesia are committed to large rural water investment programmes and several other countries are formulating similar plans as part of their rural development strategies. There is a dearth of literature on the impact and economics of investment in potable water systems.

It is the specific objective of this study to integrate the various technical, engineering, agricultural and medical aspects of this investment process using an economist's approach. It is hoped that it will indicate to these specialists the value of economic analysis and that it will also serve to present to economists a complicated real-world problem. The complexities preclude use of formal cost-benefit analysis but other concepts and techniques are relevant and, indeed, vital if resources are to be judiciously allocated.

Kenya has embarked on an ambitious programme of rural water development which aims to provide a modern supply to all Kenyans by the year 2000 A.D. Rural water supply improvement is viewed, by the Kenya Government, to be an important component of a new development strategy which has a rural basis, which emphasises employment, and access to economic and social services, as well as increased per capita income. Water development is expected to bring health benefits, new agricultural and other economic gains and to promote social welfare. This study examines the rationale of the new policy, assesses the evidence supporting the premises and appraises the means being adopted to achieve the programme objectives. Recommendations are made on ways to improve the cost-effectiveness of the investment.

Water investments have traditionally been regarded as public utilities and required to pass financial productivity tests. In consequence, only an urban minority benefit from these services. A recent shift in emphasis from financial to economic criteria, and from urban to rural development, has helped to generate interest in rural water investments. It was anticipated that rural water supplies would generate social benefits exceeding social costs. The evidence of this study is that few of the potential health and economic gains are being

realised at present. This is because of the design choice of a communal point distribution system and the lack of complementary or "back up" agricultural and health facilities. Although financial criteria are no longer pre-eminent, the financial pressures upon the programme are real and important and, in this study, a new policy is proposed to take account of these realities. Rural water investments are an important part of rural infrastructure. The needs and priorities cannot be satisfactorily evaluated by reference to any single criterion whether financial, economic or social.

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RESOURCES AVAILABILITY AND EXPLOITATION

Growth Without Development

In poor countries the needs and goals of the community necessarily diverge. Resources are generally scarce, therefore even basic services such as a potable water supply must compete for inadequate sector allocations. Taken in isolation, the need for domestic water supply improvement in both urban and rural areas is very great. Urban water supplies must have first call on resources because a modern city can barely survive without an adequate piped water supply. Alternative water sources are generally either absent, inadequate, distant, polluted or unreliable and in consequence a poor supply leads to hardship and disease. Despite these facts, the World Health Organisation (WHO) estimate that 49 per cent of the urban population in poor countries have no public water service and a further 26 per cent rely upon public standpipes.

A modern water supply is perceived by many rural communities in poor countries, and in particular in Kenya, to be a most important input for agricultural production and personal welfare. The current state of development of facilities is viewed in most cases as inadequate, constraining personal development goals. The Kenyan Government has recognised the needs and has embarked upon an ambitious investment programme. However, for many people, the pace of public activity is too slow and, therefore, self-help water projects are being initiated. Investment in rural water supplies is seen as part of the policy supporting the strategic goal of rural development. Rural regions are only rarely, at present, served by piped or protected supplies. Rural water schemes are deficient because of the relatively high cost per person served and the poor prospect for effective public utility pricing in the low income situations typically found in rural areas. Furthermore, in many rural areas an adequate traditional water supply may exist. Interest in rural water development is increasing with full realisation that rural areas will continue to contain the bulk of the population and provide the backbone to the economy for many decades to come. Improved rural amenities may reduce urban-rural income disparities, promote economic development in the countryside and help stem the flow of migrants to the cities (it is also conceivable that improved rural amenities will promote rural-urban migration). Where supplies are presently grossly inadequate Government may see its role as providing a minimal standard of service.

Water supply investment, whether in the form of durable physical assets such as pumps and pipes, or in recurrent items such as chemicals, or in technical assistance for health advisers and so on, will certainly promote economic growth. In recent times the use of national income growth as a prime goal has been subject to critical examination. In developed countries, the main grounds for these questions relate to the external diseconomies leading to pollution which are associated with normal growth, the rapid rate at which natural resources are being irreversibly consumed and the general threat to the quality of life.

In developing countries the emphasis is different. Here growth is questioned because it has been shown to be an inadequate condition for overall development. It has been shown that satisfaction with healthy GNP or per capita income growth can prevent the diagnosis of extreme income inequality within the country. Inequality is today recognised to be a major problem internationally, between rich and poor countries. Similarly, within countries there are rich and poor regions; rich and poor sectors, the poorest is usually agriculture; and rich and poor individuals. This has occurred both with and without growth. Furthermore, contrary to accepted Keynesian economics, successful high levels of growth have not brought full employment. The continued and growing existence of unemployment and underemployment is one of the main reasons for questioning conventional national aspirations set out in GNP growth targets in poor countries.

Public investment in improved water supply is a measure which improves general welfare. The degree of welfare improvement to low income families depends upon the standard of the new service and the level of hardship previously endured. Some approximate indication of this can be obtained from studying the present status of supplies, available water resources, the population distribution in relation to these resources and the current stock of investments and trends in expenditure. Armed with this information national objectives in relation to water supply can be formulated and evaluated.

Urban and Rural Water Supply Conditions

Many, if not the majority, of cities in developing countries have water supply systems which are over-extended and operating above design capacity. This leads to a general, sometimes serious, deterioration in the quality of service, *e.g.*, low pressures, contamination of mains with sewage, private investment in expensive supplementary water facilities, use of polluted alternative supplies and so on. Even where supplies are operated near or above capacity the level of service

is often minimal, taking the form of public standposts, as Table 1 shows.

TABLE 1

Water Supply Conditions in Selected Cities of Developing Countries

	GNP $/capita	% population served private connections	public taps	Unaccounted for water (%)
Sao Paulo, Brazil	250	59	1	36
Bujumbura, Burundi	50	30*	70*	30
Yaounda, Cameroon	140	20	80	20
Bogota, Colombia	310	97		25
Addis Ababa, Ethiopia	70	67	20	27
Accra, Ghana	170	50	50	31
Kuala Lumpur, Malaysia	330	75*	10*	19
Lahore, Pakistan	100	38	26	37
Dacca, Bangladesh	100	32	63	53
Sonede, Tunisia	220	45	55	23

* Date uncertain.

Source: "Water Supply and Sewerage Sector Working Paper", World Bank. 1971.

TABLE 2

Overall Situation of Population Served by Improved Water Supply in Poor Countries

	World				Latin America				Kenya[e]			
	Rural		Urban		Rural		Urban		Rural		Urban	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1961:												
	N.A.	10	N.A.	59[a]	8 mil	7	61 mil	60	N.A.	N.A.	N.A.	N.A.
1971:												
	N.A.	12	N.A.	70[b]	31 mil	24[c]	121 mil	78[d]	0.9 m.	9	1.3 m.	85

a. Estimated from 75 developing countries
b. Estimated from 90 developing countries
c. House connection and standpipes
d. House connection and easy access
e. 1972 estimates

Sources: World and Latin America; WHO, Geneva, unpublished material.
Kenya; WHO Sectorial Study Report No. 2.
Brazzaville, 1972.

Precise data on the numbers and proportion of population served by improved water supply in rural and urban areas are not available. However, the information in Table 2, though imperfect, is indicative

of the current situation and the trend. The urban water supply situation is slowly improving but in the rural areas very few people have the benefit of a protected water supply.* Only in Latin America has any real progress been made in rural regions. In many areas this lack of piped water has been of little consequence. Rural settlements are often sited so as to have access to reliable clean water supplies. However, increasing population pressures and urbanisation have created additional and new pollution hazards and many age-old sources are no longer safe. Furthermore, there is currently a broad-based attempt to increase rural living standards and the creation of a progressive rural structure including improved rural water supplies would appear to be an important part of this strategy. Age-old practices such as carrying water loads long distances or tolerating turbid or contaminated sources are becoming socially unacceptable.

Table 2 illustrates that very slow progress is being made but it is known that this hides the fact that in many countries the situation is deteriorating. In Kenya, which was the main focus for the research described in this study, conditions are relatively good and it is a priority Government policy to maintain and improve public water supplies. Investment levels are high, and increasing, and operation is relatively efficient. For instance, the proportion of water unaccounted for in a system is a fair index of management performance. Tables 1 and 3 show that Kenya compares very favourably in this respect, with the situation in many countries of the world.

Water Resources in Kenya

Kenya is a country of 583,00 square kilometres (225,000 square miles) that lies across the equator in eastern Africa. It has a 400 kilometre eastern border with the Indian Ocean and a western boundary with Lake Victoria. This combination of an equatorial and oceanic situation might lead to the supposition that Kenya is a hot, well watered country with an ecology that is predominantly tropical rain forest. The Congo and the Amazon Basin share similar latitude and roughly correspond to these conditions. In fact there are wide variations in climate due to great differences in altitude. Approximately 80 per cent of the land area may be classed arid or semi-arid desert. The humid and tropical coastal strip is extremely narrow, being seldom more than 30 kilometres wide. The temperate highland plateau, including the central part of the Rift Valley has a relatively high

* WHO state that "in many developing countries the present rate of increase in urban community supplies is not even sufficient to make up for past neglect, let alone keep pace with the population increase; the present rate of progress in improving rural water supplies is so slow that it will take more than 100 years to reach a satisfactory level". (WHO, 1969).

annual rainfall ranging from 630 mm. (25 inches) up to more than 2,030 mm. (80 inches) in the mountain areas. However, this is barely adequate. Even in the well watered zones it is common for annual potential crop evapotranspiration to exceed rainfall. In addition, the rainfall is poorly distributed over the year. Almost all the rain falls in two (sometimes one) clearly defined rainfall seasons.

TABLE 3

Unaccounted for Water in Distribution Systems

City	Percent of Produced Water Unaccounted
Nairobi	15
Mombasa	9
Kakamega	10
Bondo	15
Homa Bay	2
Kericho	15
Narok	2
Fort Hall	15
Kerugoya	12
Kiambu	7
Embu	12
Meru	5

Source: Water Department operation charts 1970-71.

It is evident that success of the agriculture sector is dependent to a large extent upon the duration, intensity and dispersion of rainfall in a particular year. Fluctuations in agricultural output may be correlated with these climatic factors. In 1969 and 1970 low rainfall considerably reduced agricultural growth, affected food supplies and in due course, because of the weight of the agricultural sector in the economy, affected national income growth. The degree of erratic rainfall is greater in the dry areas because decreasing total rainfall is correlated with an increasing variance in this total. In the semi-arid areas annual rainfall may be less than 50 per cent or more than 200 per cent of the mean.

The importance of rainfall and the consequent streams, rivers and lakes to the economic well-being of the country has resulted in considerable public investment in water resource conservation and development. Overall responsibility for this investment lies with the Water Department of the Ministry of Agriculture. Each province has either a water engineer or water officer responsible for water resource development within the provincial boundary. Unfortunately the catchment areas and drainage systems do not coincide with these civil boundaries.

Table 4 shows the main statistical information on the five drainage areas and major rivers. The total annual flow of nearly 15 billion cubic metres might appear to be immense and quite sufficient for the Kenya population. However, it is necessary to examine the distribution of the population in relation to water availability.

TABLE 4

Drainage Areas and Main River Runoff

Drainage Area	Area (sq. km.)	Percentage of total Kenya	River	Mean annual runoff (million cubic m.)	
1. Lake Victoria (Discharge into Nile system)	49,000	8.4	Nzoia	1,920	
			Yala	966	
			Nyando	500	
			Sondu	1,236	
			Gucha-Migori	870	
			Others	1,800	
			Sub-total		7,292
2. Rift Valley (Internal discharge to Lake Rudolf, Lake Natron & other lakes)	127,000	21.8	Melawa	185	
			Gilgil	28	
			Molo	39	
			Perkerra	126	
			Others	432	
			Sub-total		810
3. Athi River (Eventual discharge into Indian Ocean)	70,000	12.0	Athi	749	
			Tsavo	138	
			Njoro-Lumi	293	
			Others	115	
			Sub-total		1,295
4. Tana (Discharge into Indian Ocean)	132,000	22.7	Tana-Garissa		4,700
5. Ewaso Ng'iro (Discharge into Lorian Swamp and in exceptional wet years to Somalia)	205,000	35.1	At Archers Post		739
Total	583,000	100			14,836

Source: Water Department, Nairobi.

Population Distribution

The major spatial pattern of population in Kenya closely follows the rainfall distribution. High rainfall areas are, therefore, densely populated and the arid areas sparsely settled. Occasionally pockets of high potential land are sparsely settled, such as parts of Narok area where pastoral Masai have forcibly prevented incursions by cultivators from neighbouring areas. Similarly, there are dry, medium potential areas where relatively high population densities exist, such as parts of Machakos or the Western Province.

In common with most developing countries the vast majority of Kenyans live in rural areas. Less than 10 per cent of the population are resident in towns. There are very few large urban areas. Only 11 towns have populations exceeding 10,000 people. The two largest, Nairobi and Mombasa with a total population of 756,000 (1969), contain 70 per cent of all urban dwellers.

Until 1969 Kenya placed emphasis upon urban water development. In the United Nations terminology "urban" is a settlement of 20,000 or over but in Kenya the figure of 2,000 is utilised. Even with this definition less than 10 per cent of the population is in urban areas but there is a growth rate of six per cent per year, nearly double the national average.

Population Served by Adequate Water Service

Every major town in Kenya is presently served by a piped water supply. Nearly 20 per cent of the total Kenyan population is served by a modern water service, more than double the percentage typical of developing countries. By 1980 it is planned that this percentage will have increased to 30 per cent and the population served, from 2.27 million in 1972 to 4.96 million. To achieve this progress considerable resources will need to be allocated to the water sector. A summary of the present distribution of population served is presented in Table 5. This information, though the best available, has to be treated with caution. No census was taken and the rural figures in particular are only sketchy estimates. More precise information is unlikely to be obtained in the short term. What is clear, however, is that although the situation may be described as relatively good, there is a considerable backlog to be cleared before the goals of providing safe water to all by the year 2000 are achieved.

TABLE 5

Estimated Population Served by Protected Water Supply 1972

Province	URBAN Major Centre	URBAN Urban Centre	URBAN Rural Centre	RURAL High Potential	RURAL Medium Potential	RURAL Low Potential	Total
Central	600,000	105,400	41,000	193,500	18,000	8,000	965,90
Nyanza	—	45,700	7,500	15,000	87,500	25,000	180,70
Eastern	—	19,000	24,000	38,500	19,500	112,000	213,00
N. Eastern	—	—	10,000	—	—	21,000	31,00
Rift	—	122,400	32,000	137,000	46,500	43,500	381,40
Coast	286,000	—	30,000	27,500	28,000	36,000	407,50
Western	—	12,500	2,000	73,500	2,500	—	90,50
Total	886,000	305,000	146,500	485,000	202,000	245,500	2,270,00

Source: WHO Sectorial Study Report, No. 2, 1972.

POPULATION GROWTH

Rapid population growth in Kenya is a fact that must dominate all planning activities. The present population (1972) is estimated to be 12.09 millions, increasing at a rate of 3.3 per cent annually. This rate implies a doubling of the population every 20 years. It is achieved despite an infant mortality rate of 160-170 per 1,000, and despite the fact that at least one-third of all children born fail to reach adolescence. In many rural areas the death rate is nearly double this figure. Life expectancy is at present about 49 years. There is a combined effect of high fertility rates and falling mortality causing this rapid growth. Population growth in the urban areas is very rapid averaging 6.9 per cent per year between 1962 and 1969. If the African population is considered in isolation from other ethnic groups a more rapid influx is apparent, with an annual growth rate for the same period of 10.6 per cent per annum.

This rapid increase in urban population stems from a combination of the population's demographic characteristics and the level of rural to urban migration. This latter phenomenon is influenced by several factors, the most important of which is the wage differential between rural and urban areas. It is estimated that this differential ranges from 4 : 1 for the wage employed to 10 : 1 for overall farm incomes (NCCK, 1972). Other factors include the improved communications between rural and urban areas combined with continued strong links between relatives and friends. Established urban inhabitants sustain rural migrants whilst they search for employment. Naturally the

influx of rural job seekers tends to follow a time pattern which coincides with slack periods of the agricultural calendar. It is likely that the higher general level of services in towns, particularly medical services, are a big attraction to migrants. Good water supplies are a minor part of this complex of improved services.

Kenya Government Investments

All forms of water development are accorded high priority by the Government of Kenya. In Table 6 the level and trend of Government development expenditures can be studied. Over a five-year period they have risen by 170 per cent from £1.4 million to £3.9 million per year. The greatest proportional increase has been in rural water development. The 1970-71 estimate is nearly five per cent of total public sector capital expenditures.

Table 6

Central Government and Other Public Authority Development Expenditures on Water Supplies and Related Services

	1967/68	68/69	69/70	70/71	71/72†
Municipal Water*	982	491	360	1,644	2,284
Small Towns	162	211	81	134	208
Rural Water	58	139	253	408	654
Settlement	97	214	89	53	114
Health and Self-Help	47	70	46	56	59
Range Water	6	7	11	6	392
Planning	91	80	162	206	140
Total	1,443	1,212	1,002	2,507	3,851

* including sewerage

† provisional estimates

Source: Economic Survey, 1972.

In the financial year 1970-71 some £5.3 million was budgeted to be spent by Central Government and other public authorities on water development. Of this total £1.7 was allocated for development expenditure. Table 7 shows a breakdown of this total taken from the 1971 Economic Survey. More than half the investment activity is centred on the Water Department of the Ministry of Agriculture (WD), who have overall responsibility for water development. It would appear from these statistics that total water expenditures have increased by 55 per cent over the previous five years expenditures.

However, such a conclusion requires considerable qualification. First the expenditures are at actual cost and if corrections were made to constant (1964) costs the 1970–71 total would be somewhat deflated. Secondly, the 1970–71 data are provisional estimates. Actual expenditures were considerably lower because of the influence of several factors. For instance, approved development estimates for WD including supplementary estimates were £1.30 million. Expenditures were £0.78 million. For rural water approved estimates were £0.86 million and expenditures only £0.41 million. Basically the problem within WD is that the accelerated development programme is not well balanced. There are severe staffing problems at all levels and the administrative procedures are not able to cope with the increased pace of development. A few examples will highlight these twin problem areas.

TABLE 7

Estimated Expenditure on Community Water Development
(K£'000)

	1966/67		1970/71	
	Development	Recurrent	Development	Recurrent
Water Development Division	174	1,169	944	1,540
Mombasa Pipeline Board	111	473	45	552
Ministry of Health	26	+	33	+
Ministry of Lands and Settlement	80	+	64	+
Ministry of Co-operative and Social Services	10	+	23	+
Local Authorities	549	821	603	1,469
Total	950		1,712	

* Provisional estimates

\+ Not available

Source: Economic Survey, 1971.

In 1972, 44 per cent of the established professional posts in WD were vacant. According to a recent staffing report WD will require an additional 65 engineers up to 1980 (Rundgren, 1971). Assuming that the University of Dar es Salaam is producing engineers in 1975 then the total supply of Kenyan civil engineers trained in East Africa from 1972 up to 1980 will be about 225. There is little hope that WD will be able to obtain more than a small portion of these graduates. They must compete with public and private construction, roads,

railways, harbours, irrigation and other sectors. Staff shortages contribute greatly to data problems which in turn leads to deficiencies in planning.

However, these problems would be less serious if their effects were not exacerbated by deficiencies in administrative procedures. These deficiencies are most evident on the financial side. Over the last three years the development budget has increased fourfold (Swedish credit has assisted this) whereas the recurrent budget has been pegged to an increase of only 25 per cent (Swedish credit not available). This would not be too serious, at this time, if the recurrent budget simply covered operation and maintenance of water supplies; but in the present system a number of items such as planning and engineering of water supplies, capital cost of equipment for planning and transport, workshop for vehicles, petrol, drawing office materials and stationery can only be obtained from the recurrent votes. As a result of recurrent fund shortages some of the development funds cannot be spent. There are also problems on the development side which leads to under-expenditure. For instance, urban water development has been financed by loans from the UK Government since 1966–67. These loans are tied to 40 percent UK import component (delivery 6–12 months), the remainder local purchase. According to WHO Sectorial Study (WHD, 1971) from 1968–69 to date, estimates of £816,820 have been approved for urban water but only £377,914 spent, which may have reached £463,000 in the 1971–72 financial year. One reason for this is that the information detailing UK component of past expenditures cannot be extracted from the accounting system. Therefore, credit cannot be obtained from the tied UK loan. Furthermore, there are irregular delays in the issue of funds so that spending planned amounts within the financial year is made impossible. Unspent money from one financial year is not automatically revoted for the following year.

A third reason for viewing the data in Table 7 with caution is that there are errors of omission and classification. The most important omission is expenditures of Nairobi City Council. Unfortunately the Municipalities operate with a calendar year so straight comparisons are not possible. Increase in population and high demand from existing population create the need for approximately one million pounds per year of augmentation expenditure. In consequence Nairobi receives about 45 per cent of total public development expenditures on water. In the item detailing the Ministry of Local Government, sewerage expenditure is included and this is 75 per cent of the total. The WHO Sectorial Study estimates that development funds available for water in 1971–72 at £2.89 million made up as follows:—

WDD, £1.12 million; Nairobi City Council, £1.20 million; Municipalities, £0.13 million; Health, £0.15 million; Lands and Settlement, £0.09 million; and Co-operative and Social Services, £0.10 million. To summarise, the best estimate which can be made of total public expenditures on water in 1971-72 is that it is close to £6 million per year, rising at present by up to £2 million per year. It may reach £10 million per year by 1975.

Urban or Rural Water Development

It is perhaps misleading to suggest that urban and rural development are alternatives. Both will be necessary. Urban areas generally deserve priority over rural areas because urban dwellers are less able to help themselves; population is increasing more rapidly than in rural areas; needs and effective demand increase at a more rapid rate than population growth; high population density makes inadequate and pollutes traditional sources and consequently in urban areas public health gains from improved supply will be greater; investment costs per unit of installed capacity should be lower because of economies of scale in planning, construction and operation. (World Bank, 1971.)

Although potential economies of scale in urban areas do exist, stemming from the densely settled areas served and the functional relationship between storage capacity or pipe capacity and cost, the per capita costs of urban development are in fact higher than in rural areas. In Nairobi and Mombasa augmentation costs are approximately £20 per head and in Kampala, Uganda, about £14 per head. Small urban schemes in Kenya cost about £10 per head but rural schemes vary between £4 and £7 per head. The reasons for this higher urban cost is that consumption rates per head are higher because of higher living standards and industrial requirements, higher standards of quality and reliability are utilised, storage is increased, fire fighting requirements dictate larger mains and higher pressures, pipelaying conditions are much more difficult and an adequate source is often distant from the city.

Though the needs of urban areas are paramount, rural areas may be given equal rating for other reasons. In Kenya rural development is a key national policy and rural water improvement is viewed as an instrument of this policy. Rural and urban water development are not normally regarded as alternatives in Kenya but it is inevitable that with the scarcity of resources, particularly engineering staff, a choice has often to be made between them.

Historical Considerations

The relatively good standard of public water supply is a consequence of a continued investment programme over the last fifty years. The first piped water supplies in East Africa were developed by the Kenya-Uganda Railways in the early years of this century. The initial water supply for Nairobi came from the railways installation at Kikuyu Springs. Extensive building was conducted in 1916 at the springs to ensure an adequate, safe supply. The City Council took over the works in 1920-21 but agreed to supply water at concessionary terms to the railway, an arrangement which continues to date.

Today the railway runs 85 supplies in Kenya with a total capacity of 40,500 m^3/day (9.0 million g.p.d.). This ranges from small schemes such as Thompsons Falls 48.2 m^3/day (10,700 g.p.d.) to large schemes such as Athi River 3,100 m^3/day (691,000 g.p.d.). They have a total storage capacity of 27,000 m^3 (6 million gallons). With the switch to diesel locomotives the railway demand will considerably diminish. Whilst some schemes are badly sited from a general development viewpoint, many could provide a useful service to the neighbourhood. For example the Nol Turesh pipeline was built in 1965 at a cost of approximately one million pounds. It has a design capacity of 2,000 m^3/day (450,000 g.p.d.). Along the pipeline there is a present demand for ranching of 310 m^3/day and this will increase. Generally these supplies are for railway use though in rare instances public connections are permitted.

Nairobi water supply has grown twentyfold from the original Kikuyu Springs installation. Augmentation is presently taking place which will nearly double the existing supply. Mombasa received its first piped supply in 1916 by a gravity main from the Mrere Springs in the Shimba Hills. This supply was sufficient for only about ten years. In the early 1930's the pipeline was replaced by a larger main which is still working today. This was originally a gravity line, was switched to pressure when demand grew and switched back to gravity operation when the large Mzima Springs pipeline opened in 1956. In view of the recent water shortages caused by demand reaching available supply levels in the coastal areas it is intended to return again to pressure operation on the Mrere pipeline.

The majority of the other seven municipal supplies operated by the Ministry of Local Government and the 86 small urban supplies currently operated by the Water Department of the Ministry of Agriculture have been developed over the last 25 years. Nearly 30 per cent of these schemes use boreholes as a source, 45 per cent are pumped from springs, rivers or lakes, and the remainder are gravity

schemes. Most of these schemes provide a reliable and high quality supply but the majority now require augmentation largely as a consequence of very rapid urban growth. A request has recently been made by the Kenya Government to an aid donor for technical and financial assistance for a three-year programme with a budget totalling £3 million.

Improved rural water supplies for domestic use have been neglected until recent years. Investment in public supplies for small farmers and cattle owners was initiated by the African Land Development Organisation (later known as Aldev) in 1945. In the period 1945 to 1962, 1,590 permanent and temporary dams were constructed, 310 subsurface dams in "sand rivers", 105 boreholes, 75 pipe water schemes and a large number of rock catchment tanks, weirs, protected springs and wells.

Since Independence expenditure on rural water has gradually increased. Early in 1972 a second credit agreement was signed with SIDA for £1.65 million credit to cover a two-year period.

In 1952 a body of legislation known as the Water Ordinance was enacted which has helped to regulate recent water development in Kenya. This is a well conceived and comprehensive legal framework, though its provisions are not always enforced. Responsibility for development of water resources has shifted several times since the 1952 Water Ordinance was published. In this Ordinance, together with amendments, revisions and subsidiary legislation, wide powers are vested with the Minister responsible for water resources. This has been in turn within the portfolio of the Minister for Land Settlement and Water Development, Minister for Natural Resources, Wildlife and Tourism and since 1968, Minister for Agriculture. In the Ordinance a wide range of functions are specified including protection of any body of water whether used for cattle, fishing or as a source of drinking water; flood protection and construction and maintenance of works necessary for proper use of water. As a result other ministries have responsibility for certain aspects of water development and conservation. These include Ministry of Works, Ministry of Health, Ministry of Lands and Settlement, Ministry of Local Government and Ministry of Co-operatives and Social Services. Other agencies are concerned with rural water including voluntary bodies such as OXFAM, international agencies such as UNICEF and WHO and other aid bodies such as SIDA (Swedish International Development Association) and USAID. The contribution of these agencies was not well co-ordinated in the past but efforts are now being made to co-ordinate through the activities of the enlarged Water Development Division, recently upgraded to the status of Water Department.

This statement of the context and level of water development serves as an introduction to the next chapter which discusses in more detail Kenya Government objectives with regard to water. The characteristics of the investment, the number of people to be served and the water resource endowment are all necessary inputs to the process of formulating objectives and designing effective instruments for achieving them.

Chapter II

NATIONAL OBJECTIVES AND WATER SUPPLY

It is clearly important to know a destination in order to plan a route. This simple statement should explain the central importance of objectives in implementing or evaluating any policy. Objectives and goals need to be specified at all levels of activity, from the highest policy level to the lowest operational level. A simple planning procedure might follow this sequence: define objectives; test alternative means; plan expenditure; spend; evaluate outcome and feedback information to first stage. Unless this first stage of defining objectives is given full consideration, the efforts of those responsible for the water programme are in danger of being likened to the man who by running very fast succeeds in jumping on the wrong bus.

Ends and Means Hierarchy

Within any State a hierarchy of objectives exist in a sequence of means and ends. For example, the end which the rural water programme is to achieve is a safe water supply to all rural inhabitants. But this is the means for achieving a higher level objective namely, promotion of rural development. This is in turn the means for achieving another higher level objective namely ensuring a more equitable rural/urban income balance. In turn this is a means for obtaining a prime objective of social justice for all Kenyans. From this it can be seen that all objectives are at the same time the means for obtaining a higher level objective. In other words all programmes and policies are subject to a system of goals and means.

The main ethos, economic goals and development strategy are set out in the 1970-74 Development Plan (Government of Kenya, 1969). In the introduction the President states that the main objective is social justice for everyone obtained by exploiting growing economic strength. A more detailed statement of objectives (or means to achieve the prime goal) is contained in Sessional Paper No. 10 (Government of Kenya, 1965). These include universal freedom from want, disease and exploitation; equal opportunities for advancement; high and growing per capita incomes equitably distributed among the population. There are some fairly obvious competitive and conflicting aims in this list. For example, the second is a means for achieving the first and the final aim could be internally inconsistent in that it is possible, in some circumstances, for equitable distribution of income to prevent high and growing incomes. The Kenya Government is

committed to building a modern mixed economy and it is attempting to mobilise both domestic and overseas resources to facilitate this development. Economic independence, social justice and a rising standard of living for all citizens are seen as being dependent upon growing economic strength. Therefore, this economic strength cannot be dissipated in achieving in the short-term, wholesale redistribution and/or increased aggregate consumption, however laudable these objectives might appear. Hence, investments in programmes with these objectives are to some extent dependent upon the increments to wealth produced by a large and steady increase in the national income. The basic principle of the current plan is that an increasing share of total resources should be made available to the rural areas. This can be considered to be both in the interests of balanced and overall growth (bulk of national resources are located in rural areas) and in the interests of income distribution (urban areas have received more than their fair share of resources).

Water investment may be considered a productive investment adding to growth prospects or as a consumption good facilitating redistribution of income. Either interpretation will leave no doubt that it fits into the general national political philosophies and social aims.

Working within this framework the Water Department has developed three main objectives: to achieve a vigorous expansion of water installations in the rural areas, for both human and animal husbandry needs; to ensure that the growth of urban water systems is sufficient to meet demand; to improve the state of knowledge of the country's water resources and hydrology and develop adequate long-term master plans for urban and rural water development.

The first objective is being achieved with technical and financial assistance from an aid donor (Sweden). The strategies for the second objective are somewhat similar but have been less successful. Attempts to obtain assistance have failed and currently Norway is being approached for help. The third objective is being achieved by means of a community water supply Sectorial Study aided by WHO which is to be followed by a Water Master Plan study.

Production and Distribution Objectives

Water supplies can be considered to be either productive or distributive investments depending upon their location and use. For this reason the analytical framework for testing agricultural policy developed by Rainer Schickele is considered valuable in determining criteria for testing the efficacy of the objectives of water policy.

(Schickele, 1954). He identifies two major goals and from a "norm" or definition of these goals he derives tests or criteria for each. The two goals are either maximum production or optimum income distribution. The productive norm is that "the factors of production should be allocated among all the various lines of production in such a way that their marginal product values are equal throughout the economy". The derived policy test: "is a particular policy likely to increase or decrease the social product; will it better or worsen resource allocation by equalizing or widening marginal returns in various production fields; does it complement or seriously conflict with other policies".

With regard to the distributive norm or definition which looks for optimum income distribution, Schickele divides it into two parts which he terms the "subsistence principle" and the "contributive principle". The former requires that "public policy be directed at reducing to a practical minimum the number of persons in the community whose level of living falls below an acceptable standard of subsistence concerning food, clothes, housing, medical care, and education". The contributive principle "requires that public policy be directed at increasing the contribution to the social product of persons who are now so employed (or unemployed!) that they earn inadequate incomes and ensuring that labour earnings do, in fact, correspond as closely as possible to the worker's productivity". This suggests that there is a basic minimum standard the State should set for services and that when this is achieved people should earn what they can, or could, contribute to the social product. This leads to the policy test for the contributive norm: "is a particular policy likely to reduce the number of farm families living below subsistence standards; is it expending the individual's opportunities to contribute more to social product; is it helping him to secure more nearly a labour reward commensurate with his actual or potential productivity".

If these two policy tests are applied to the urban and rural water programmes we would find that urban water investment performs best under the production objective though with very rapid expansion of the low-income urban inhabitants' needs, some action under the distribution objective is necessary and increasing. In rural areas the distributive objective is at present mainly to be followed. As will be shown this is largely because of the absence of complementary factors which could enable farmers to capitalise upon farm water investments. There are some rural areas where water investments can be judged as immediately productive but generally water schemes only facilitate the more even distribution of income. Water is mainly an investment which acts on the subsistence level, helping to bring living standards

to an acceptable minimum. It is clear that water alone is not sufficient to help farmers contribute more to the social product. Additional inputs such as education and health care are required before people can realise their potential. Nevertheless, it is a necessary if not a sufficient pre-condition.

It is a debatable point as to whether redistribution of national resources to poor areas will result in an increase in aggregate income. If disparities are great it is possible to take either of two extreme views of the consequence. Firstly, with a wide disparity, the rich may engage in non-productive conspicuous consumption with a high foreign exchange component. The alternative view is that the rich, having a higher propensity to save and facility to make productive investment, will cause greater economic strength. Equivalent views of the poverty end of the scale are that the poor are an unproductive area to invest in, because of the broad spectrum of deficiencies that would require vast investments to remove. Alternatively, the alleviation of poverty is frustrated by their lack of access to basic facilities which results in the poor not realising their potential, a realisation process which would have high cost-effectiveness.

This type of debate, posed in a less extreme form, underlies many development planning issues in East Africa today. To some extent the Tanzanian and the Kenyan paths to similar national goals illustrate a divergent view of the best means. Tanzania is redistributing, at an early stage, the bulk of national resources to poor rural areas. Kenya has given more emphasis to redistribution in recent years, but it is mainly the increments in income which are distributed and care is taken not to destroy the incentive of the highly productive sectors and people within the economy.*

Rural water investment is generally promoted in the guise of a productive programme. The 1970-74 Development Plan emphasises the time savings which result after water investment, the productive use that could be achieved from the additional labour and the saving of medical expenses when safe water is provided. As will be shown later in this study, rural water investment, as presently executed,

* There is at present continuing debate between various interested parties on the role of the extension service (see for instance Ascroft *et al*, 1971). In the past, scarce extension service personnel have been concentrated upon progressive farmers who have as a result consolidated or increased their relative standing within rural society. This has no doubt resulted in the most productive use of extension personnel. However, as time passes diminishing returns set in with extension efforts on this progressive group and secondly, a point comes when the productive principle promoting progressive farmers is superseded by the contributive principle applied to the laggards. In other words, investment in the laggards in rural society becomes necessary for social, productive and contributory reasons.

affects rural people mainly through the subsistence norm and the contributory norm rather than the productive norm. This is because improved water is not a sufficient input to ensure any benefit except the obvious amenity benefit. For all other benefits complementary inputs are required.

An Operational Role for Objectives

In the Water Department, the main executive arm of public water development, objectives below the high level general objectives previously discussed play an insignificant part in planning and execution. Apart from the general programme contained in a credit agreement and the financial limits set by the annual budget, little or no use is made by the various sections of planning by setting goals. Monthly or annual work programmes are not specified, hence cannot be evaluated. This is unfortunate because objectives can create a challenge and a sense of purpose. Where individuals or sections have set some form of work programme this is too frequently not integrated with the total organisation's goal and the overall situation.

This situation should be remedied because scarce resources are evidently being dissipated. Each section of the organisation should be encouraged to define its purpose, its main function and scope, the limits of its authority and its detailed work programme for a short and medium term period. This should then be evaluated and monitored by the senior management. Such a programme could have dramatic impact because of "the power of imaginative, clear cut and inspiring goals to evoke extraordinary performance from people—and the power of these goals to help groups merge efforts and produce joint results which transcend the simple sum of their individual capacities" (Schaffer, 1964). If the ambitious high level objective of providing safe water to all Kenyans by the year 2000 is to be achieved then setting and evaluating sub-objectives will have a key operational role.

Specific Sector Plans and Targets

Data on the present level of water supply service presented in Table 5 shows that 80 per cent of population are not served. A considerable investment is required if the whole population, including net additions, are to be adequately served by the year 2000. The order of resources that will be committed will depend mainly upon the level of service and method of installing supplies and upon the dispersion of population and trends in its increase. The procedure for analysing the impact of these factors was as follows. Unit costs for development were obtained by engineers who utilised recent recorded experience

in East Africa for urban and rural works. Estimates were made for gravity, pumped, borehole and open source schemes. These costs were checked by model scheme calculations for various categories of supply. Costs were expressed as a cost per head of current population but normally the major part of the design allowed for demand of a population projected forward for 20 years. In addition to population growth, such factors as a shift from communal to private connections and an increase in livestock husbandry were considered. Three alternative population growth rates were utilised and various policies, related to the standard of service, were evaluated. Higher standards of service generally mean more people with private household connections which generate higher costs and higher benefits. Evaluation of the cost-effectiveness of these alternative strategies is the substance of Chapter III and IV.

If the conclusion of this evaluation is anticipated the resource requirements can be estimated. The finance requirement projections shown in Table 8 are based upon plans to provide individual connections in urban areas and rural growth centres, a mixture of individual connections and communal points in rich rural areas, and communal points in poor and low potential rural areas.

If design standards are lowered in all rural areas so that only communal points are provided there is a net saving of £35.0 million over the period 1972-2000 or £3.1 million from 1972 to 1979.

The individual connection policy will require an average of 4.4 per cent of forecast Government development expenditure up to the year 2000 with requirements for any one year never exceeding 6.5 per cent. Of this total 35 per cent is for the two cities of Nairobi and Mombasa and 34 per cent is for rural areas. The balance is required for small urban centres. These expenditures are for water supply only and therefore exclude the considerable demands for urban sewerage investment.

Water supply investments generate recurrent expenditures which are relatively low compared to other forms of social investments such as educational establishments and hospitals. However, they are not insignificant and may reach 10 per cent of development costs. Table 9 shows the forecast recurrent costs of the development programme set out in Table 8. The likely levels of revenue and derived net government costs are discussed later in this report.

Detailed staff requirements have not been estimated but an approximate figure for the year 1980 has been calculated. For all developments outside Nairobi and Mombasa it is estimated that 67 engineers, 330 technical officers, 200 foremen and 1,400 artisans will

be required. It is estimated that a further 30 engineers will be required for operation and administrative duties and 2,000 operators or pump attendants. Nairobi and Mombasa might increase these requirements by 25 per cent.

TABLE 8

Forecast Development Expenditure
(£ million)

	Nairobi and Mombasa	Urban Centres	Medium and high potential rural areas	Low potential rural areas	Total
1972-4	9.2	2.0	1.3	0.2	12.7
1975-9	14.8	5.6	5.1	0.4	25.9
1980-4	10.7	11.0	10.4	1.0	43.1
1985-9	8.8	13.0	16.3	2.1	40.2
1990-2000	32.5	44.1	41.2	7.0	124.8
Total	86.0	75.7	75.3	10.7	246.7

TABLE 9

Forecast Recurrent Expenditures
(£ million)

	Nairobi and Mombasa	Urban Centres and rural areas	Total
1972-4	2.8	2.8	5.6
1975-9	5.9	7.6	13.5
1980-4	7.9	14.6	22.9
1985-9	10.6	15.8	26.4
1990-2000	39.0	116.5	156.5
Total	66.2	157.3	224.9

The staffing situation at the Water Department is at present not good. In late 1971 there were 25 established professional posts, 11 of which were vacant. There were only five Kenyan engineers. In addition, there were 10 expatriates on full aid terms and about 40 foreign volunteers with a degree in civil engineering. The output from the University is at present 45 engineers per year to be shared among the construction sector, roads, railways, ports, airports,

irrigation, armed services and other organisations. Clearly this is an inadequate output and scarcity of professional staff will seriously jeopardise the objectives of the water sector. For technical officers and lower grades of personnel, recent moves, including the establishment of a Water Department Training School, will ensure that supply and demand equate.

The main conclusion of this chapter is that development of water supply in rural and urban areas is a desirable objective, consistent with the national aspirations. The rural programme in particular is in line with programmes for developing rural areas and effecting regional and personal income redistribution. The specific goal of providing safe water to all Kenyans by the year 2000 is an ambitious one, but technically and economically feasible. The main obstacle is likely to be shortage of technically qualified and experienced staff unless unprecedented efforts are made to obtain them over the next ten years.

Chapter III

IMPACT OF WATER INVESTMENTS UPON AGRICULTURE

Water Use in Urban and Rural Areas

Several factors influence the level of demand for water. In planning the system, the most important factor to consider is the level of service. Where there are household connections there will be much higher levels of demand, anything from three to ten times that from a communal point, public fountain or kiosk system. The degree of service to be installed depends upon such factors as the level of income of householders, the needs of industries and institutions, the requirements of livestock and other agricultural needs. Once the planned capacity is installed the level of use will depend to some extent upon the price charged and the system of charging; the existence of alternative natural sources, their condition, proximity and reliability; and the design and operating status of the scheme.

A considerable amount of data exists on the water consumption rates in various parts of East Africa. The average rates of consumption are as follows:—

Nairobi, Mombasa and Municipalities	126 litres per head per day
Water Department Urban Centres	108 litres per head per day
Water Department Rural Centres	67 litres per head per day
Water Department Market Centres	36 litres per head per day
Rural Schemes with communal source	15 litres per head per day
Kiosk sales	10 litres per head per day
Traditional sources	10 litres per head per day

These are average figures and a wide range exists. Local differences are extremely important. For example, on the large-scale Chepalungu rural water project insufficient account was taken of livestock requirements. The welfare of these rural people is so intimately tied to their livestock that they found it inconceivable that Government could provide water simply for human needs. In consequence, a separate scheme is now being prepared for livestock water. A second example could be quoted for the Coast region where tourism demands for water cannot presently be met in full. Each hotel bed adds at least 1,000 litres per day to the water demand during the tourist season.

The benefit from a water supply cannot be considered independent of the level of use. In the following sections the relationship between type of service, water consumption levels and overall impact upon agriculture is explored. In the next chapter the impact upon public health is discussed.

Economic and Social Criteria

President Kenyatta recently stated that "the real strength and spirit of a nation lies in the contentment of the people and their knowledge that structures of development have a measurable effect on their own lives". Water supplies must rank very high in meeting this criterion.

All water investments will have an important benefit unrelated to economics, public health or even leisure. It is this element which creates one of the principal planning and resource allocation problems. Suppose, for example, it could be shown that time released by bringing water to the home creates no new income earning opportunities, that health benefits are not significant because other diseases abound and that leisure is already available in abundance. Would it follow that water investments should not be made? It is inconceivable that they would not. Nevertheless this information would be valuable to planners in deciding the level and rate of investment and the type of service to be provided.

It is possible to regard rural water facilities as investments in social overhead capital. As such they are not subject to rigorous financial evaluation and because of real problems of cost and benefit estimation not easily amenable to economic appraisal. Indeed, it is a commonly held view among non-economists, that decisions regarding investments that are designed to achieve mainly political or social objectives, do not lend themselves to economic analysis. This cannot be accepted because these investments employ scarce resources, which have alternative uses and therefore opportunity costs. Although at times it may be difficult, or even impossible, to quantify the cost and benefits, the concepts of economic science are relevant and if properly applied will help improve decision making.

In the absence of a proper evaluation there is a danger that programmes will have an undesirable balance; in other words, equimarginal returns will not be obtained. It may be possible for departments concerned with an issue of an emotional nature to obtain more than the due share of resources. It is also possible to use an untested premise as a basis for obtaining funds. For example, the proposition that improved water supply is essential for economic and social development is largely unproven at present but it is stated by advocates of water investment. On the other hand, sophisticated methods of appraisal may impress those allocating investment resources and result in an excessive share going to the well presented case. It is possible to argue that the professional approach of the highly qualified staff of the Kenya Ministry of Works has been an important factor in obtaining an allocation of £43 million for road

investment 1970-74, 22 per cent of total public sector expenditure (Republic of Kenya, 1969). Although the technique of cost benefit analysis is basically simple, numerous interpretations are possible and pure sophistry is not unknown.

Before examining the evidence available at present on the impact of existing or alternative water investments it is necessary to divert at some length to make a preliminary assessment of the value of cost benefit analysis in this area. In other words a cost-effectiveness analysis of cost-benefit or cost-effectiveness analysis. This is necessary because it has been suggested that analysis is likely to be an unproductive exercise absorbing talent which would best be employed elsewhere. For example Padfield (1971) is a rather staunch advocate of this position. He suggests that cost-benefit studies for water are "a trivial but expensive exercise" but he weakens his case by making the extreme suggestion that in the Kenya water field there is "implicit reliance upon cost-benefit criteria as the only operational index of performance". This is simply not a true statement. Few people would claim more of cost-benefit analysis than that it provides a useful conceptional framework, that it is only one of many criteria and that it is nothing more than a good check and never a final arbiter. It is more true to suggest that proper use of cost-benefit analysis is not made on the majority of agricultural projects at present.

Excessive emphasis should not be placed on the outcome of any cost-benefit assessments, even if the project output is readily identified and easily valued, as is the case with most industrial projects and some agricultural schemes such as irrigation projects. When one is dealing with sectors such as transport and power, there are special appraisal problems associated with identification, enumeration, quantification and valuation of costs and benefits. Those problems are even greater with domestic water supply investments for here the link with the production process and readily valued output is even less distinct. Whilst gains of a productive, health, or social nature from water investments may be real and important, the translation of these gains into conventional economic units presents both conceptual and empirical problems. Furthermore, an improved domestic water system supplies only potential gains and often a joint input is necessary for this gain to be realised. For example, accessible and plentiful water supply undoubtedly creates opportunities for improved dairy husbandry but dairy cows have to be available and credit is often required before the opportunity can be realised. It is, therefore, reasonable to question the feasibility and utility of attempting to attribute benefits to such joint inputs.

Role for Cost-Benefit Analysis

It is possible to take an extreme position and contend that all types of cost-benefit analysis are worthless in areas such as water supply where the problems are complex and, in comparison, the analytical procedures are simplistic. An alternative view, at the other extreme, is that quantification is possible, assumptions have to be made and in a quantitative model they are explicit and therefore decisions should be based upon such procedures. The viewpoint of the writer is that there is a broad spectrum between these extremes within which meaningful analytical procedures can be utilised to improve decision making. It is accepted that decisions are taken on the basis of intuition and judgement; it should also be accepted that cost-effectiveness analysis has a role to sharpen judgement.

The analyst performs this role by identifying and structuring the problems, asking key questions, evaluating and collecting relevant information and by defining and assessing alternative actions. Use of this procedure in water appraisal will reveal some approximate measures of value and some insight which will facilitate use of expert intuition and judgement in making decisions which, in any event, have to be made. Decision makers, often politicians, are constantly abused for bad decisions. In some instances this is unfair as the relevant information was not provided. Hence, in this situation, the mix of intuition and judgement has to be heavily weighted towards intuition—resulting in an extremely erratic performance.

Kenyan authorities have sponsored a number of efforts to develop appraisal methodology. The problems associated with empirical application of these methods have become evident. This does not mean that efforts have been wasted, only that they were perhaps misdirected. First, emphasis has mainly been placed upon gaining knowledge which would help appraise the programme and it should perhaps have been placed first upon particular projects. Second, "evaluation" has been the keyword implying a value could be derived and hence a testing procedure to sort out the more and less productive schemes. It is now evident that the level of the programme cannot yet be vetted using traditional cost-benefit studies because the information is not sufficiently reliable and the precise meaning of particular measures are not clear. Furthermore, information for comparable areas such as education and health are not available (this is surely a gap—certain health programmes have shown themselves to be amenable to meaningful cost-benefit appraisal). The objective of individual project cost-utility analysis is to improve that particular scheme and provide planning feedback for similar schemes. The scale

of such assessments has to be limited and only a few schemes can be thoroughly tested. Bearing in mind the limitations of the case study method, this should improve planning and implementation.

Hypothetical Benefits

It is reasonable to anticipate that water investment will in fact generate opportunity for four types of benefits: higher cash income; increased and more reliable subsistence; improved health; and increased leisure. Attempts to identify the components contributing to each type of benefit flounder upon the twin problems of isolating the effects due to water and evaluating the non-marketed benefits. It is suggested that progress in this area is likely to be slow and unproductive and that a new way of handling the benefit question is required.

There will be a number of direct benefits from water improvements in rural areas, the most vital being that the time and energy used in collection is reduced. In addition the water quantity consumed should be increased; the quality improved as well as the reliability of the supply. The importance of these primary effects depends upon certain other factors. Clearly, the time and energy saved will be dependent partly upon the proximity of the new source to the consumer. It is also well established that proximity is the prime factor in determining quantity consumed. There is a sharp fall in quantity consumed per head once the source is moved outside the house or courtyard. Unless there is a household connection, daily consumption seldom exceeds 15 litres per head. Quality and reliability improvement is dependent upon design features, such as treatment plants and storage capacities.

These direct effects will in turn generate what can be termed "First order benefits". Thus time saved will release labour and saved energy will increase labour quality. Quality and quantity improvement will affect hygiene and health. Reliability will reduce risks associated with supply failure. These benefits are only potential benefits and are themselves dependent upon certain conditions being met. First of all, the new source of supply must be used by the consumer in place of the traditional source of water supply. This is not always the case. Furthermore, sufficient water must be used to generate health benefits, a large part of which are known to be dependent upon the high rates of use, and this is only associated with household connections.

Proper realisation of first order benefits is a pre-condition for obtaining second order benefits. However, the second order benefits are themselves dependent upon certain conditions and complementary facilities unrelated to the water supply. Second order benefits which

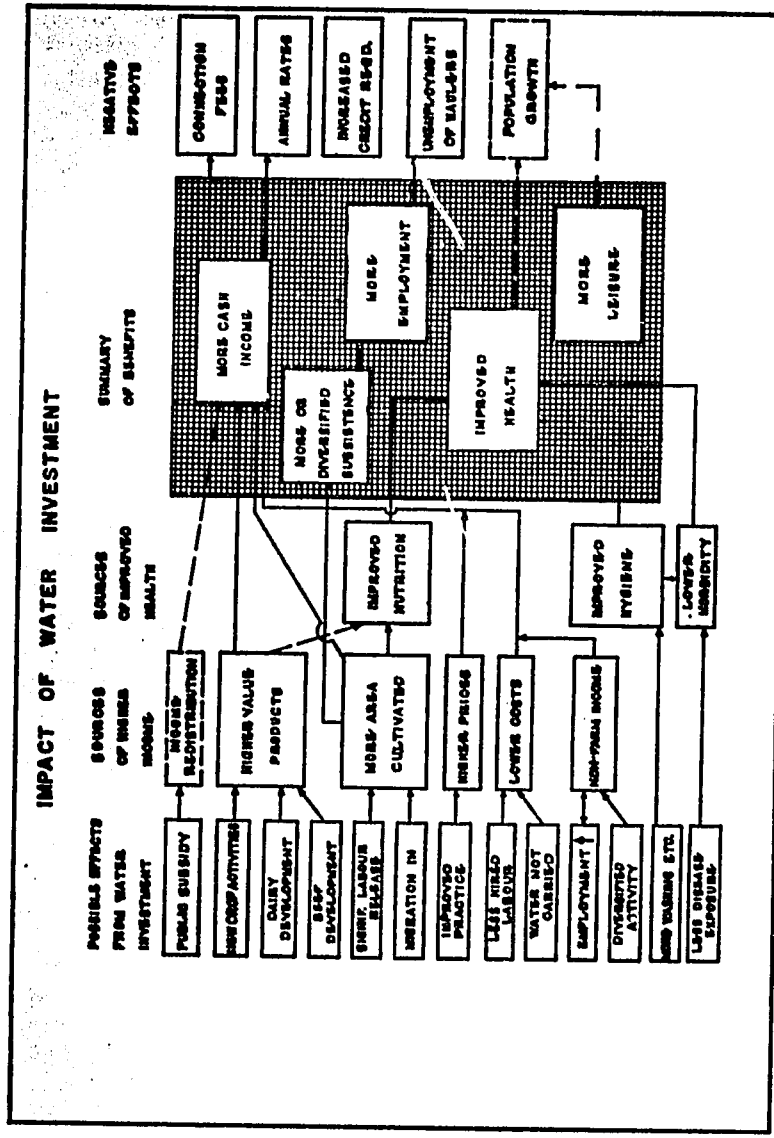
may be generated include: more crops; more high value crops; new crops; higher yields; lower production costs; new livestock activities; improved animal production; lower animal mortality; higher milk yields; improved dairy technology and higher quality milk, more leisure; lower family health maintenance costs; increased sense of well-being through better health; and long-term improvement in family planning through a perceived permanent reduction of infant mortality.

Second order benefits will be gained providing that one or more of the following conditions are met: that the increased labour availability is utilised; that labour was previously at some time a development constraint; that land is available or can be released; that complementary resources, such as farm credit, are available; that farmers are made aware of opportunities and given technical information; that grade cattle are purchased; that health, home economics and family welfare advice is given; and that complementary sanitary facilities are installed.

Two things emerge clearly from this discussion: the first relates to the necessity of complementary inputs; the second to the standard of service. Water investments require a number of complementary conditions for complete success. Water is perhaps a necessary condition for development. But, it is demonstrably not a sufficient condition. This explains, perhaps, why it is the richer, high potential areas, which are relatively well watered, that are most active in demanding and providing improved water facilities through self-help water projects. It is in these areas that the necessary complementary facilities exist to make water investment productive.

The approach suggested by this argument is to regard water as one important input for rapid rural development and to concentrate efforts upon assessing the local potential and the complementary inputs required to realise this potential. An area with few complementary facilities will give a lower return to water investment than an area which has similar potential but is more well endowed. In the latter area there will be a higher benefit from the release of labour, improvements in its health and so on. For example the economic gains from investing in areas where all-weather tea roads are available will be greater than in areas with a similar ecology but where there are unimproved murram tracks.

Figure 1 illustrates schematically the major sources of benefit which a project may create. This should trigger key questions which will help the planning and appraisal procedure. The water planner cannot be expected to make an integrated development plan for the whole



area. However, it would not be too difficult to list complementary facilities and notify authorities responsible for missing facilities of the opportunities likely to be available. In this way the proportion of potential benefits realised should be improved. For instance, in an

area with dairy potential, the agricultural extension staff, credit agencies, dairy co-operatives, A.I. and animal disease officers should be officially informed of the water scheme plans. Similar information should be given to the public health authorities and Community Development Officers. In almost all rural schemes there is excess capacity which could be used at low or zero cost. Water marketing officers should be appointed to encourage individuals to obtain connections and to explain why and how to use large quantities of water.

Information on the development potential of an area and the existing facilities is of value to decision makers for selection and to planners in design. If decision makers require growth at least cost, they will choose schemes with apparent potential and existing infra-structure. However, this will result in a policy of giving more to those with existing facilities and the neglected areas will become relatively more neglected. If the opposite policy of compensating backward areas is pursued then the necessary complementary facilities should be specified. If this procedure is adopted planners will have more information to assess the technical proposals. For example, there is a better case for on-farm connections in dairy development areas.

Individual Connections versus Communal Points

There is not major competition or choice between individual connections and communal points in all areas of Kenya. In some areas the issue will be clear cut, either one or the other. Nevertheless, on every scheme, even those in the poorest, driest areas, there will be some effective demand for private connections. When private demand is a small proportion of total demand, planning is relatively simple. The problem becomes a major one when considering rural, high and medium potential areas, the areas where the majority of Kenyans live.

Table 10 sets out the arguments for and against individual connections. There are certain agricultural benefits which will not be available unless on-farm connections are made. For example, an ample supply of clean water is essential if the densely settled high altitude areas are to successfully adopt high quality livestock enterprises, particularly high grade cattle. Ample water at the homestead is necessary, firstly because this obviates the animals energy-absorbing walk down the ridges to water sources. This walk is inevitably through tick-infested vegetation and tick-borne disease is often fatal to grade stock. Secondly, it enables high standards of cleanliness in housing and dairy. Cattle may be kept in fenced paddocks or a zero grazing system can be adopted.

It is possible to conceive of other potential benefits from on-farm water investments. Some farmers have suggested that access to clean water for crop spraying is an important benefit. This is particularly the case with coffee since coffee berry disease became a widespread disease. Piped water at the homestead may also facilitate use of supplementary water supplies on high value crops at periods of extreme water stress. It is also possible to maintain seed beds in the dry season for crops such as brassicas, onions or chillies that are transplanted at the beginning of the rainy season. However, with most designs the discharge is too limited for extensive irrigation. Water that is spare is seldom used in this way, perhaps because of lack of awareness of motivation. Engineers ought not to rule out the possibility of irrigation until they have simultaneously examined capacity-cost and capacity-benefit relationships.

It is not possible to analyse fully the factors set out in Table 10 and give each a weighting and derive an objective measure for each area. Many of the factors are a matter for judgement; some will become less so with more experience and research but the element of judgement will remain.

TABLE 10

Comparison Between Individual Connections, Communal Water Points and Traditional Source, in High and Medium Potential Areas

Variable	Individual Connections	Communal Water Points	Traditional Source
1. Number of users	Maximum users per scheme	Estimated 2-3 users only	—
2. Water consumed	Estimated 50 litres/person	Estimated 5 litres/person	Estimated 5-15 litres/person
3. Time saved	Maximum	Some	None
4. Energy conserved	Maximum	Some	None
5. On farm use (livestock, dairy), minor irrigation, spraying	Good opportunities	Few opportunities	Few opportunities
6. Hygiene potential	Maximum	Low	Minimal
7. Contamination risk	Very low	Low	High
8. Reliability of supply	High	High	Varies
9. Potential for revenue collection	High	Very low if any	—
10. Investment/ consumer	Weighted average estimated at £6.3	Weighted average estimated at £3.2 of total population. Per user—£4.8	
11. Government subsidy	Low	High	None

It is the writer's contention that the total benefit to the Kenya economy, and to the people who manage and work it, will be greatest if resources are generally concentrated upon individual connections. It is therefore recommended that efforts are made to expand the presently small base of connected farms and institutions. This is recommended in the knowledge that the costs are at least double those on equivalent communal point schemes. However, the direct benefits will be significant and the revenue accruing from the scheme, to Government, sufficient to provide a sustained service in the long-term on a proper utility basis.

Almost everyone agrees on the desirability of individual connections and most experts agree that the economic benefits are considerable. The debate has to hinge on timing of this desirable investment. It has been established that rural supplies should follow urban supplies (McJunkin, 1969). Kenya generally has a good urban network, though this is not to deny a considerable backlog of work of extension and augmentation. Rural incomes are increasing as a consequence of Government policies and investments. There is evidence, such as that discussed later under self-help, that the time has come to install private connections in the rich, high and medium potential areas. This must be combined with a rigorous enforcement of revenue collection. Alternatively, proper communal point schemes should be built. The present policy of building main line capacity for individual connections, but decorating the amenity with communal points, is not economical. Either communal point schemes (£3 to £5 per head) or individual connections (£3.5 to £10 per head) should be built initially.

In the drier and generally poorer parts of the country private connections are not normally advisable at present. There are two main reasons for this. In the first place, the installation costs are very much higher. Secondly, to a large extent, demand for private connections is a consequence rather than a cause of development and there is not much evidence of effective demand at present. Existing Water Department schemes have few connected consumers. There are important benefits to be realised from assured, safe, communal sources. These include benefits from permanent settlements in the drier areas where seasonal rainfall makes only catch cropping possible. In livestock areas it is impossible to distinguish between communal water supplies and range water supplies. In some areas the number of cattle is determined more by water availability in dry periods than by fodder availability. Increase in water supply will increase cattle numbers and potential off-take. Care must be taken because an increase

in cattle numbers may increase less valuable annual grasses and also denude cover; increase run off thereby lowering production of pasture which is in turn limited by rainfall infiltration. Erosion is a secondary though important hazard. It is probably a fair criticism of WD that there is a harmful division between range management and community water supply.

In certain areas such as Amboseli, the key to rationalising competing uses of land hinges around water supply. The Masai herdsmen and their stock traditionally use the lake in the uniquely rich and accessible Amboseli game viewing area as a dry season water source. Their herds have increased in size as a result of improved veterinary attention and now the game is threatened by competition. This in turn threatens the high foreign exchange earnings from tourism. Alternative water sources away from the game viewing area are a pre-condition to solving the social and economic problems presented.

The hypothesis that a progressive rural structure is a major deterrent to rural-urban migration lies behind some current rural development strategies. There is little evidence to support this proposition and, in fact, the opposite situation may occur. Surveys in Africa have shown that the urban unemployed come largely from the better-off rural areas. Nevertheless, many rural water schemes are selected with the objective of modifying migration patterns. As previously stated, the modification may not accord with the design if the consumer reacts favourably to this part of the "modern-living" package and consequently moves to town to obtain the full range of facilities.

One final potential benefit, largely a social one, exists in the arid areas such as Turkana where the hardships of the inhabitants are increased by inadequate and unreliable water sources. Provision of water to these areas would bring some measure of relief and if it stimulated productive activity it might effect some public savings in famine relief expenditures. However, it is also possible that improved water supplies might reduce outward migration from such areas. This would be unfortunate because the basic problem is that these areas are over-populated in relation to natural resources.

Empirical Studies of Impact

A number of studies have been completed in East Africa which have attempted to assess the impact of water on realising these potential benefits. In Kenya the best known and studied scheme is the Zaina scheme in Nyeri District. The scheme has been subject to two major surveys (Fenwick, 1965; Jacobsen *et al*, 1971), to critical evaluation (White *et al*, 1972; Carruthers, 1971) and is quoted to international gatherings as what could be achieved in rural areas (Wood, 1970).

The most comprehensive and recent survey is that by Jacobsen *et al.* There are a number of conclusions from this study which are relevant to other projects in Kenya. A large number of the water outlets have never functioned since construction in 1963 hence there must be design defects. These design defects were not corrected during the commissioning phase. Since that time other defects have occurred and not been remedied so that in 1970, 30 per cent of all outlets were perennially dry. It is concluded that to obtain efficient operation of large-scale water projects competent design is required. The Water Department by undertaking all design or appointing internationally recognised consulting engineers for all water schemes above £2,000 capital cost, including self-help schemes, have ensured this condition. In addition, provision for operation and maintenance has to be satisfactory which implies, under present circumstances, that responsibility be vested with the Water Department of the Ministry of Agriculture. The Zaina scheme is operated by the County Council of Nyeri.

It was found that those persons close to water outlets used quantities greatly exceeding more distant consumers. Some 37 per cent of Zaina consumers could no longer estimate their consumption as it was too high. This is in line with research findings through East Africa. Where water is available at the homestead, consumption per head may range from 25 to 120 litres per day. It is established that some benefits, particularly some health benefits, require large quantities of water in order to be realised. The health impact of Zaina is discussed in the next chapter.

At Zaina capacity was found to be insufficient to allow for population growth. In the current designs of the Water Department and consultants there is provision for population levels forecast for 10 to 20 years hence.

When water is available on the farm about 100 minutes per household per day are saved from the water collecting activity. At Zaina 3 to 4 persons were typically involved in water collection activities. The Zaina investigators gained the impression that this time was put mainly to use within the household in activities that had in any event to be carried out such as cooking, cleaning and washing. It was noticeable that the household had more time for social activities and data was collected which verified this. Very little additional time was spent by those with a water supply upon agricultural work. It was the household which benefited rather than the crops.

These are real benefits which will be a consequence of both the saved energy from carrying heavy water loads and the saved time. It is relevant to note that the savings in energy and time will be much less with a communal point network.

It is surprising that there was little change in agricultural output or in cropping patterns in the Zaina area. Small-scale, out of season vegetable production is a generally anticipated benefit from water schemes. In the Zaina area the valley bottoms are well watered and are utilised throughout the year for vegetable production. The only group to expand vegetable production was the landless village dwellers who cultivated around their houses.

At Zaina between 1961 and 1965 the number of grade cattle increased from 3,640 to 6,025, an increase of 66 per cent. In the control area the increase was from 3,115 to 4,250 or 36 per cent. In consequence milk sales to the dairy co-operative have also increased. A similar increase has occurred in the number of pigs in Zaina. Data for livestock numbers are presented in Table 11.

TABLE 11

Livestock Development in Zaina

		1961	1962	1963	1964	1965
Grade Cattle	Zaina	3,640	—	—	—	6,025
	Control	3,115	—	—	—	4,250
Milk sales to co-operative (gallons)	Zaina	—	54,800	109,700	133,500	110,600
	Control	—	23,400	40,400	56,200	44,600
Pig sales	Zaina	88	235	347	564	1,258
	Control	22	53	60	13	173

Source: Zaina Report, Fenwick, 1965.

It might be misleading to assume that this improvement in livestock was simply due to water investment. Other factors such as the existence of a milk marketing scheme might be more vital. In the 1970 survey of Zaina there was no difference in the herd size or the proportion of farmers owning grade cattle, sheep, goats or pigs between Zaina and the control area. The only benefit actually noted came from higher milk yields on farms with access to water. Average cash income per year from milk for progressive farmers with grade cows in Zaina was Shs. 1,206 whereas in the control area it was only Shs. 456.* The authors of the study assumed the reasons for little impact to be a land constraint but this can only be a partial explanation.

* It might be that higher cash income came in part from higher quality milk. Certainly on-farm connection would seem to be a pre-requisite for the dairy hygiene necessary to obtain top grade milk.

There are a number of alternative hypotheses which include a lack of credit, inadequate supply of grade animals, lack of knowledge of animal husbandry or advanced pasture management and fodder conservation and poor marketing arrangements. The conclusion of these previous paragraphs must be that water investment will not automatically lead to increases in agricultural production. Water creates only necessary conditions for successful extension, credit, production and marketing improvement programmes.

Kabare-Inoi Impact Study

A pilot survey of the impact of water supply at a similar scheme at Kabare, was conducted by the writer in 1969 to test the hypothesis that water supplies to the farm lead to economic progress (Carruthers, 1970). Kabare and the adjacent control area of Inoi, are locations situated in Kirinyaga District of Central Province. They are located on the southern slopes of Mount Kenya between 2,000 metres and 1,400 metres. In area they are 66 and 81 square kilometres and they have populations of 19,830 and 29,585 respectively (1969).

Kabare was chosen for the survey because it received a reticulated piped water scheme in 1961, eight years prior to the survey. In eight years some of the benefits from water supply ought to be evident. The scheme had worked continuously since installation with only one or two relatively minor breakdowns. A most important characteristic of the scheme which influenced selection was that each farm was provided with an individual connection within the farm boundary. Inoi, which was selected as a control area, is the adjacent location to Kabare. Superficial enquiries suggested that in 1961 there were no differences between the two locations. Furthermore with regard to ecology, cropping patterns, farm size, tribal groups and other indices there appeared to be a marked similarity between the two areas. Two university economics students, with practical training in survey methods, worked from June to September on a conventional farm economic type survey.

The main hypothesis to be tested was that an area with an improved water supply would, in time, show a higher level of economic progress than an area without a water supply. Hence, it was anticipated that farm incomes in Kabare would be higher than in Inoi. In total, 78 farms were surveyed at Kabare (6 per cent sample) and 88 at Inoi. They were selected at random from a land register. Average farm size in the samples were 5.4 acres in both areas. Rather surprisingly, average annual farm income was estimated to be Shs. 1,115 in Kabare but Shs. 1,338 in Inoi. This figure is approximate and derivation was

plagued with the usual problems with data, valuation of farm subsistence, inconsistencies with co-operative society records and so on. However, it is indicative and the direction, if not the magnitude, is correct. These indications were supported by other data showing the percentage of farmers keeping grade cattle to be 17 per cent in Inoi but only 13 per cent in Kabare. Although all the reasons for this failure to reap economic advantage are not clear, probably a complex of constraints exists including lack of credit for stock purchase, lack of land for fodder without uprooting cash crops such as coffee or having less staple foodstuffs, such as maize—a high risk strategy, lack of marketing and processing facilities and less local initiative than in Zaina.

A medical indication was provided from a sample of 100 school children at Kirinyaga Secondary School. Stool samples were taken from fifty children from each location. These were analysed at the Institute for Tropical Hygiene in Amsterdam, Holland, and there was no significant difference in the two samples. Each was liberally contaminated with parasites and pathogenic diseases (A. Klasse-Bos, private communication).

It is interesting to note that at Kabare estimates of water use were below 10 litres per head per day despite on-farm connections. At Inoi where traditional sources had to be tapped, consumption was also about 9 litres per head per day. As water use did not increase it is not surprising that health benefits are not evident.

In Inoi some 10 per cent of the population had organised self-help water schemes. Ten were operating in 1969 and a further eighteen were registered and collecting funds. This demonstration of widespread public interest was one factor that led to the selection of Inoi for a public scheme. The communal point network will be completed during 1972 at the relatively low cost of £62,500 or £2 per head.

Kibichori Water Supply

Kibichori water supply in Bungoma District, Western Province, was installed in 1964, just after the Kabare and Zaina schemes, and to approximately similar standards. Each farm, therefore, has an on-plot single outlet releasing 450 litres per day. It is a gravity scheme serving 1,200 families living on their small (4.9 acre) farms. Before the scheme was installed water was collected from springs and rivers. Fifty per cent of farmers were within 2 or 3 kilometres of a traditional source. It was customary for the women to fetch water for household use, a task performed two or three times per day. Men took livestock for water once or twice per day. Livestock are an important source of food for the farmers with an average of six animals per family.

Tick-borne diseases are endemic and the gains from additional fodder obtained on the walk to water has to be offset by the risk of infection. With water available, it was anticipated that cattle would remain on the farm. This has not occurred and cattle are still generally watered at the river. A sociologist commenting on this has suggested the following reasons:—

"1. The cattle get their need of salt satisfied at the river (that is what is behind the expression 'sweeter').
2. The cattle get grass along the paths to subsidize the small amount of grass the farmers could afford to set aside for the cattle.
3. It is a man's duty to take the cattle to the river; therefore, it does not disturb the agricultural working rhythm as most emphasis is on the labour of the women.
4. In any case, the men have to get away from their homestead to get information and remain currently oriented on 'bush politics'.
5. It contributes to enhancing the prestige of a man that he has cattle and especially good looking cattle. By taking his cattle to the river the man gets an opportunity to show off his cattle." (B. Storgaard, 1970).

There has been a very disappointing level of rate payment at Zaina, Kabare and Kibichori despite the private connections. At Kibichori it may be partly because there are few dramatic changes as a result of the scheme. Grade cattle have not been introduced for reasons relating to the risks associated with high grade animals; the absence of cattle dips; expenses for veterinary treatment; lack of effective loans; and the generally small farm size. Household use does not appear to be dramatically increased. One reason for this is that the outlet is often on the opposite side of the farm from the house. One positive gain is illustrated by the fact that more than 30 per cent of farmers have a small vegetable plot which receives supplementary water.

Kyeni Rural Water Scheme

At Kyeni there are reasons to suspect that to date conventional wisdom regarding benefits is not applicable. Firstly, with the widely spaced communal points, walking distances are not greatly reduced. Secondly, 35 per cent of families do not use the piped supplies and, indeed, they may be wise not to do so. This is because the piped water is at present untreated and from one intake it is classified as unsafe. Tap contamination may also be a problem. In some instances the distance to the communal point is greater than traditional sources. The main question on health is whether the water from the forest,

admittedly unsafe, is less contaminated than traditional sources. The vision of a traditional source which is a heavily polluted stream is not applicable throughout Kyeni. The writer has visited some seepage areas and springs within the location, which are probably safer than some of the present (1972) piped water. The installation of chlorinators, which is being carried out, will facilitate an improvement in the pipe supply.

At Kyeni the planners recognised early that piped water was not sufficient to guarantee development. In 1968 the Minister for Agriculture chaired a meeting in which he directed that the Ministry Officials concentrated upon Kyeni. Specifically, the meeting suggested emphasis upon farm planning; that the Director of Veterinary Services diverted dip grants to Kyeni location and stepped up AI; that the Tea Officer increased the rate of planting; that the Coffee Officer campaigned for increased yield and quality; that the location co-operative society produced fruit and vegetable seedlings for distribution and that in the lower area block mechanisation schemes were to be introduced. Given this unprecedented activity it would be impossible to ascribe any particular increases in agriculture production to the water scheme. Nevertheless, without the water scheme there would have been little activity and it certainly allows leverage and facilitates some of the developments, particularly in the livestock field.

Despite these plans there is little evidence that additional inputs have been provided or that increased agriculture productivity has occurred since the water scheme was installed. Livestock sector investment is, however, noticeably increasing. There are more cattle dips in Kyeni location than in any other location of Embu Division. Six of these dips have a direct connection with the water scheme. However, much more effort in agricultural extension and credit disbursement would seem to be called for if the potential benefits are to be realised. Similarly, the health authorities should mount effective campaigns of instruction and education. Credit agencies should consider giving loans for connection charges and Water Department officials should encourage full and early use of the installed capacity. It is only through joint action by several agencies that the economy and individuals will realise the potential benefits from this important public investment.

Impact Studies in Tanzania

Tanzania has an ambitious programme for rural water development. Large allocations have been made indicating the priority which is accorded to rural water supplies. In the revised second plan it was indicated that rural water was to receive 11 per cent of Central

Government development expenditure. Although Tanzania regards this expenditure as an essential social investment, there have been a number of Government supported studies of the effects of this investment. These include studies by Warner (1970), Heijnen and Conyers (1971), and other BRALUP studies (BRALUP, 1969, 1970). The most comprehensive study is that of Warner, the final results of which have yet to be published. In their review article Heijnen and Conyers examine evidence supporting or conflicting with 14 hypotheses related to water investment. Their conclusions are very tentative because of the general lack of information. The major finding is that very few of the benefits expected from water occur spontaneously thus supporting the "package of inputs" strategy for rural development. They find that the distance to water generally decreases though usually this is most apparent in the dry season when farming activities are minimal. Many of the schemes have been constructed in settlement areas where water supplies are already of above average standard and close to farmers. This is true of Kenya also, as the bulk of the funds to date have been spent on the wet high potential areas. Surprisingly, Heijnen and Conyers quote instances which show that the quality of water does not always improve with a new scheme either chemically or from a disease point of view. A pipeline taken from a polluted source clearly poses a risk and instances of high coliform counts are quoted. Health surveys have revealed that health education is an essential complement to a new supply. If water is untreated then this and the implication should be explained to the consumers. Mass treatment for existing diseases is recommended when the water is installed. Instances are quoted where little or no health benefits have occurred and they suggest that the risks of epidemics, hookworm and bilharzia may outweigh health benefits. Time and energy expended is largely a function of the distance travelled. As this generally decreased so time and energy savings occurred. However, there were instances where the time savings stemmed from elimination of queueing and one where more time was spent because more water was consumed. (At Kyeni in Kenya the writer found some people walking to a communal point at a greater distance than their traditional (polluted) source.)

Consumption in Tanzania has been found to both increase and decrease with a new scheme. However, except for persons living within five minutes walk from the tap, generally, no increase in consumption above the 10-15 litres per head figure was recorded. Reliability is normally improved with a new borehole or piped supply but with time the maintenance problem increases and reliability falls. They find that generally all people living within a 1½ to 2-hour walking distance use a new supply but this is not inevitable.

In some areas longer distances are travelled to the preferred traditional source.

Attempts to measure the impact on farming stemming from the higher quantity and quality of female labour have floundered on the usual problems of measuring supply and demand for farm labour and the benefits from increased domestic activity. Evidence is presently inconclusive though further light should be shed by Warner's forthcoming final report.

No assessment has been made of the impact of water on livestock in Tanzania. Preliminary studies show clearly that although in some instances water is the limiting factor to development, more usually other factors such as lack of disease control, overstocking with resulting lack of grazing and erosion, and unwillingness of herdsmen to market animals are all equally important constraints. Similarly, it has been found that irrigation and fishing potential of schemes are not exploited. On the other hand, growth of water using industries such as brick-making have been observed in newly served villages together with more extensive commercial activity. However, it is quite possible that the water scheme played a very small part in stimulating such activity.

A final hypothesis examined by Heijnen and Conyers is that water schemes encourage clustered settlement round a water point. They conclude that water is not the main factor in determining the location of settlement.

Conclusion

The main conclusion from this review of empirical evidence of economic impact of water, together with the evidence discussed in the next chapter related to health, is that water investment, though perhaps necessary for creating a progressive rural environment, is clearly not sufficient. However, a safe water supply creates numerous opportunities for extension workers in agriculture, animal husbandry, home economics, child welfare and public health. In many instances these opportunities can be exploited at very low cost, sometimes at only the cost of conveying information. It is important that the potential benefits are realised because these water investments are made at a considerable expense of scarce manpower and financial resources.

Chapter IV

WATER SUPPLIES AND PUBLIC HEALTH

A Problem of Resource Allocation

Provision of a safe water supply would, at first sight, appear to be a laudable and undisputed objective. Safe water should be hygienic, not unpalatable, aesthetically satisfactory and therefore, not discoloured or containing visible solid matter. The two main problems involved in translating this desirable objective into an operational procedure relate first to the fact that safety is not an absolute standard—water can be more or less safe, and second to the capital and recurrent costs which are inevitably generated in the process of improvement. These resources are scarce and there are many alternative ways in which they might be utilised. Furthermore, the direct relationship between safe water supplies and high standards of public health are not obvious and undisputed. The Professor of Community Health at the (former) University of East Africa, in advising a Kenya Government Research Committee, categorically stated "there is no medical need to demonstrate once again the public health value of a safe domestic water supply in any community. This can be taken for granted in Kenya and, in fact, is accepted by the health authorities of this country"

This is, however, too simple a view of the problem. Whilst it is not disputed that an unsafe supply is a hazard to health, and a safe supply is perhaps necessary for improved health, a safe supply is by no means sufficient for improved health. In addition, it is desirable to expand the meaning of the word "safe" to include quantity as well as quality. Very low per capita consumption levels (say less than 10 litres per head per day) do not constitute a safe domestic water supply even if the water is free of contamination.

Continued research and thought has to be given to devising means whereby improved water supplies can be fully effective in realising potential public health gains. Difficulties will continue to be present. For example, beneficiaries of a protected supply will continue to be at risk when visiting friends and relations without a protected water source. Though the acquired immunity of persons continuing to use polluted sources is probably overstressed, and the risk of its loss is certainly no argument against protecting piped supplies, it appears to be practically important for certain intestinal diseases. Beneficiaries of a protected supply will also risk infection when using polluted streams

for recreation purposes. In particular, children are likely to use rivers, ponds and other polluted sources for swimming and fishing no matter how closely they are disciplined or how well they are informed of the risks.

Several diseases can certainly be reduced and occasionally eliminated by improved water supplies. In urban areas and densely settled rural areas protected supplies are essential preventive measures. However, if the problem is viewed narrowly there are many ways of improving supplies and the levels of costs and benefits vary. Alternative development strategies need to be evaluated in order to ensure optimum use of scarce, valuable resources. These evaluations cannot be achieved without knowledge and data and in many areas there is a dearth of information.

If the simple statement that "improved water supply means good health" is accepted uncritically then key questions are avoided; questions which must be posed if good planning is to be carried out. Viewed more broadly, the total public health policy has to be examined. At present there is no public doctor in North East Province of Kenya and a doctor/patient ratio of 1 : 186,000 in Western Province. Some resources devoted to public water supply could be utilised for training or recruiting doctors. Therefore, some estimate or assumption on the level of benefits for alternative public health measures is required. Questions relating to the efficacy of alternative strategies have also to be answered. We need to know much more about the risks of epidemics of typhoid and para-typhoid, cholera and other water borne disease. More needs to be known about the mode of transmission of amoebic and virus dysentery and of the phenomena of acquired resistance. More research is required into the special conditions of tropical countries compared to more temperate countries. Hence the direct transfer of experience in reduction of typhoid in New York may be misleading. For example, public health improvement in New York may be as much a consequence of exogenous factors such as improvement in education, sewerage or diet as improvement in water supply. Certainly there is a danger of misleading, if not spurious, association and transmission of experience from temperate development countries to tropical developing countries unless a critical approach is assumed.

Ultimately, there must be direct and indirect economic benefits from an improvement in health. It would seem reasonable to postulate that use of an infected water source will lead to poor health of persons using this supply. Also if domestic water supplies are restricted (and unsanitary) then household cleanliness will suffer, including food hygiene, giving rise to additional risk of infection.

One link between health and economic benefits is that with improved supplies, savings may be possible on health expenditure. In particular savings on staff and drugs, providing that preventable diseases are in fact avoided. In addition, increased fitness of agricultural workers should facilitate higher labour inputs at critical periods of the agricultural calendar and a higher quality of work. It is generally appreciated that lack of labour at key periods may limit the total area cropped, the area of high value crops, and planting and weeding of all crops at an optimum time with subsequent lower farm income. However, the extent to which sickness at critical time periods (such as planting, weeding and harvesting) actually reduces the time available for agricultural labour, and the efficiency with which tasks are carried out, has not been determined in East Africa.

In the longer term the debilitating effects of childhood infection are also important for these may lower potential energy output in subsequent adult working life. Given the high incidence of diseases in rural areas it would be plausible to postulate that preventable sickness must be an important factor constraining agricultural output. Therefore, economic gains are to be obtained from elimination of sickness. However attractive such a hypothesis, it is not possible to quantify potential gains empirically.

Classification of Water Related Disease

Practical studies of the health impact of improved water supplies, though scarce, are not totally absent. Dr. D. J. Bradley, joint author of a book on domestic water use in East Africa (White and Bradley, 1972) and an acknowledged authority on the medical impact of improved water supplies has written: "There are sufficient studies on record, careful ones, that have shown no benefit at all from improvement in village supplies that we should take warning. Probably more than just water is needed."

In order to promote an understanding of the likely impact of alternative forms of water investment it is useful to distinguish between different forms of water related disease. In Table 12, the classification of Bradley (Bradley, 1971) is presented. He distinguishes first between diseases that are water-borne, water-washed, water-based, water-related by insect vectors and mineral contamination. Water-borne disease is of two types. First highly infective types from low-dose contamination, the most important of which are typhoid and cholera. Cholera was not recorded in East Africa from the end of the nineteenth century until 1971 when there were several outbreaks, mainly in Northern Kenya. Typhoid epidemics have occurred in Kenya but they are rare. However, the risks of these common source infections

is still great and one of the most important arguments for a universal policy of protected urban water supplies.

TABLE 12

Bradley's Classification of Water Related Disease

Type of Disease	Water-borne	Water-washed	Water-based	Water-related insect vector
Main diseases	*Low dose:* Typhoid Cholera Leptospirosis *High dose:* Bacillary dysentery Amoebic dysentery Tularaemia Paratyphoid Infective hepatitis Enteroviruses	*Intestinal:* Gastroenteritis Ascariasis *Cutaneous* Otitis externa Louis borne typhus Skin sepsis Chronic skin ulcer Trachoma Conjunctivitis Scabies Yaws Tinea Leprosy Louse borne relapsing fever	*Per cutaneous:* Urinary schistosomiasis Lactal schistosomiasis *Ingested:* Guinea worm	Onchoceriasis Malaria Gambian sleeping sickness
Main method of improvement	Improved water quality	Increased water quantity	Increased water quality	Protected water source
Mineral quality of water:		Contamination by pesticides, etc. Excess sulphate salts Excess fluorides		

Source: Bradley, D. J. "Infective disease and domestic water supplies" in BRALUP (1971).

The second group of water-borne diseases requires relatively high levels of contamination. However, they can be very serious and cause severe sickness and deaths, particularly among infants and young children. The main means of prevention in the case of the first and second group is to provide safe water through chlorination. The urban supplies in Kenya are generally safe though occasional contamination through leaking mains and sewers have been recorded.

In 1970-71 there was considerable apprehension that the cholera epidemic in Ethiopia would spread south throughout Kenya. However, the incidence was mainly confined to the rural northern areas of the country and has since been controlled. There can be little doubt that the sound urban water supply network played an important role in this containment. Kenya Government is now giving consideration to a proposal that all rural water supplies on the main immigration routes of pastoralists bringing cattle down from Ethiopia, should receive priority for improvement. This would ensure that infected immigrants did not start local epidemics which might later spread throughout rural Kenya.

Although water-borne diseases are best prevented through chlorination, in the case of water-washed diseases the quantity of water utilised is as important, perhaps more so. Water-washed diseases are both intestinal and cutaneous. It is hypothesised that there is a diluting effect by using large quantities of water which helps minimise impact. If this is the case there are important implications for design of water schemes. If large per capita quantities are supplied, then higher system capacities are needed and also connections at or near the household. In rural Kenya this typically increased per capita costs two to three times above communal point systems.

Bradley (1971) supports this hypothesis: "We should be quite clear that increasing the availability of water alone without improving quality at all will reduce greatly the incidence of several unpleasant infections". He notes that qualitative data for their reduction is good though the degree of reduction is uncertain. He makes the rather surprising assertion that diarrhoeal diseases have been shown to be primarily related to degree of availability of water rather than the quality of water. These diseases are a major cause of illness and death among infants and young children in Kenya. Hence, it seems reasonable to conclude that if an important proportion of health benefits are to be realised then on-farm connections and consequent high costs are necessary. The final two groups are water-based and water-related through insect vectors. They include two of the most common and important debilitating diseases in Kenya, namely bilharzia and malaria. If improvements in water supplies are combined with protection or drainage of possible local sources of infection then health benefits will accrue. Unfortunately, this is seldom considered and is in some instances impractical. It is, therefore, conceivable that water development may make little or no contribution to health improvement. In certain instances water development may even make health worse. Open tanks constructed for cattle and people in semi-arid areas may

be a source of malarial mosquitoes, the perennial water supply may ensure continuity of the insects through the dry season. Wastage from communal or private water points often lies in muddy pools which make ideal mosquito breeding grounds.

The incidence of bilharzia is such, in some areas of Kenya, that it is almost impossible to eliminate the disease. Often people are exposed to the disease in the course of earning their living on irrigation projects or by fishing. It is practically impossible to prevent children using rivers for bathing in hot weather. In these cases treatment may not be economic because the incidence of reinfection is very high and the level of tolerance among the majority of the population is high. Provision of protected water may, however, be a first step in restricting the disease. If this is combined with an effective environmental sanitation programme and protected recreational facilities, some progress can be anticipated. Such a programme can be mounted on irrigation and settlement schemes where there is an effective organisation and some control. Quite successful control of host snails by molluscicides and consequent reduction in incidence of bilharziasis has been achieved at Kenya's National Irrigation Board project in Kenya at an annual cost of Shs. 7.72 per hectare (Range Shs. 5-13, Transport Shs. 1.20, Molluscicides Shs. 3.22, Labour 3.30).

In the case of community water supply it is important to make it unnecessary for women to enter open water. This means that clothes washing facilities should be provided at convenient points and, where practicable, public showers. Where bilharzia exists it is important to prevent cercariae from snails entering the water supply system. This may be effected by design of the system to include a water storage period (cercariae die within 24 hours if no mammalian host is encountered), design of intake to exclude snails and eggs, provision of treatment works from inception of the scheme and regular maintenance of treatment plant.

Water may be rendered unsafe by an excess (or deficiency) of naturally occurring or man-made chemical substances as well as by pathogenic micro-organisms or larger forms of life such as worms. In East Africa the most common chemical contamination is excessive sulphate salts and the most troublesome form of chemical pollution is fluorine in borehole water. This is particularly a problem in parts of Tanzania (Bugaisa, 1971). In Kenya some of the boreholes in the Rift Valley have potentially harmful levels of fluorine (*i.e.*, above 1.5 parts per million). Although national and international standards for water quality are valuable for the purposes of surveillance, considerable judgement and flexibility is required in application. Water considered

unsafe by, say, WHO standards may, nevertheless, represent a marked improvement over the previous supply. In some communities no alternative water source may exist and therefore, chemically unsafe water has to be consumed. Chemically unsafe water may also be a valuable additional supply to existing surface sources and mixing may reduce toxicity to tolerable levels.

Cost and Benefits of Health Improvement

Piped chlorinated water supplies to every house in Kenya is impossible within the foreseeable future. Such a goal has to be seen to be unrealistic. Even if it were achieved health benefits would not necessarily be complete because of the continued exposure to, and use of, polluted sources. Once again we can see the necessity of deriving second-best solutions in line with the needs and resources of the country. It is evident no nationwide hard rules can be laid down (except perhaps the necessity to treat urban supplies) and guidelines appropriate for planners today, may be obsolete in one or two years time with changes in circumstances and priorities.

The precise weight to be given to health benefits stemming from water supply improvements to the benefit side of the overall cost benefit equation cannot be estimated with present knowledge. Indeed, it is so intimately tied up with other factors it may never be possible to do so. However, it is considered worthwhile identifying and discussing potential sources of health benefit and costs.

Cost of Sickness and Price of Health*

Investment in safe water supplies create necessary conditions for improvement in public health. In urban areas the impact is visible and almost immediate. In rural areas there may be a lag before impact is noticeable because of the lack of knowledge, sufficient water or other complementary facilities. If and when these improvements in public health manifest themselves there will clearly be gains to the individuals concerned. It is not possible to value the increased well-being felt by a man who was previously sick but who is now cured or protected from disease. Nevertheless, the benefit is real and it will contribute toward one of the many goals of society.

However, not all the effects of improvement in public health will be an unequivocal benefit. In low income situations the major economic effect of a disease reduction and/or elimination may, in the short-term, be a harmful population expansion and a consequent slowing of the increase in per capita income, or even a fall. Pointing

* Title borrowed from C. E. A. Winslow, *The Cost of Sickness and the Price of Health.* WHO Monograph Series, No. 7; Geneva, 1951.

out possible harmful economic effects does not mean that the economist regards them as pre-eminent, nor does it belittle non-economic effects. In particular, it does not imply that the economist is advocating the withholding of public health facilities in order to stimulate economic growth. Economists as a group are more interested in development than growth. Nevertheless, it is their duty to point out both negative and positive aspects of policies and programmes. It may well be rational to adopt a programme that will cause a fall in per capita income but decision makers should be aware of these effects. For example, it might be economic to grow wheat in Nairobi Game Park or give priority in medical treatment in Kenya to wealthy middle-aged men. However, both these proposals should be rejected because alternative proposals would contribute greatly to other goals, such as the conservation of unique wildlife habitats or the diminution of suffering according to need irrespective of the age and status of the individual.

Any proposal for public expenditures requires scrutiny and this process should include assessments of the contribution to multiple national objectives. It is for this reason that the health effects of improved water supplies have been classified and set out in Table 13. This classification system is derived from the work of Barlow (1967) on malaria eradication in Ceylon where he demonstrated early economic gains through increased quantity and quality of labour but later negative impact as the unemployment problem in its diverse guises began to assume importance. His analysis led to the conclusion that such public programmes should be accompanied by birth control programmes if economic gains from improved health are to be realised.

The objective of this section was to point out that numerous and complex relationships exist between costs and benefits of water supply investments. The cost of sickness is represented by the suffering of individuals and losses to the economy; the price of health is the expenditures on preventive and curative measures, plus the longer term impact of changes in population growth. Though the impact of technical change upon population growth is most dramatically illustrated by the overall impact of chemotherapy and antibiotics upon poor countries, it is likely that improved public health measures are at least equally important. It is hoped that the content of this section merits the title although not a single cost or benefit has been estimated.

TABLE 13

Classification of Possible Effects of Improvements in Public Health

Effect Upon	Primary Effect	Subsidiary Effect and/or Explanation
Population size	Increased population growth rate from (i) lower death rate.	Reduced per capita income. Fewer deaths from water disease. Greater resistance to other diseases. (NOTE: Savings from fewer premature deaths).
	(ii) raise birth rate.	Lower rate of miscarriage higher rate of conception.
Labour inputs	Reduced mortality (deaths)	Increase in labour quantity with children after a lag.
	Reduced morbidity (sickness sufficient to prevent work).	Increase in labour quantity.
	Reduced debility (sickness effecting productivity at work).	Increase in labour quality. (NOTE: Decreased production from team as result of key member being absent, *e.g.*, if ground opening (man's work) is not initiated, weeding (women's work) will not be initiated.
Capital inputs	Larger population means more consumption and less saving.	Less capital formation therefore slower growth of future per capita income.
	Larger population means more investment of savings in relatively unproductive capital stock, *e.g.*, housing.	
	Private and public expenditures on prevention and treatment.	Saved costs of detection, treatment, rehabilitation. Funds released may be saved and invested.
	Larger population means more investment in traditional services, less available for new projects.	
Other effects	Opens diseased areas to settlement. Change in attitude to family size because of perceived reduction in infant mortality.	Long term gains.

Health Impact Studies

There are very few specific studies of the impact of improved water supplies upon community health. Most studies have been carried out in relation to Bilharziasis (*e.g.*, Sturrock, 1970). Such studies have suggested that public water supplies can be instrumental in increasing risk of infection or high levels of infection unless the facility is well designed and maintained. There are strong indications that people develop a faith in the purity of water from a pipe source which, because of non-treatment, or irregular treatment, may not be justified. (Kreysler, 1970).

Saunders and Warford (1973) summarise the results of twenty-six empirical studies from several parts of the world which purport to examine some of the relationships between quantity and quality of water and the health of consumers. They conclude, "it is found, particularly for diarrhoeal diseases, that a more convenient water supply outlet (closer to the user) is generally associated with lower infection rates . . . . However, it is not possible to develop a specific predictive statement which could be used to forecast with acceptable accuracy, the improvements in health which would result from a specific improvement in the water supply of a given village".

One of the major studies in Kenya was carried out at Zaina by Fenwick (undated but approximately 1965) before and after the installation of a piped chlorinated water scheme. This study is often quoted as an example to demonstrate the efficacy of water supply investments (*e.g.*, Wood, 1970). It is a well documented study that is both longitudinal (before and after rural water investment) and horizontal (with and without piped water, investigated at a single point in time). Although there are a number of methodological inadequacies, probably inevitable in the circumstances; nevertheless, the data is the best currently available for East Africa. The Zaina scheme has supplied piped chlorinated water to nearly 6,000 people since 1961. The area was subjected to a health and general living condition survey in 1961 before the water was available together with a nearby area—Thegenge, which was considered to be similar in all respects with the exception of piped water. Four years after piped water became available to Zaina, both were resurveyed and it was found that the general level of health had improved dramatically in Zaina among children but declined slightly among adults. In the control area the general level of adults and children had declined. Details are shown in Table 14.

One of the most interesting facts derived from this table is that an adult is sick for less than half a day per month and that piped water has apparently made no improvement. Therefore, on the basis of this

TABLE 14

Morbidity in Zaina and Thegenge (days illness per person March to September)

Age	1961 Zaina	1961 Thegenge	1965 Zaina	1965 Thegenge	1965 as % of 1961 Zaina	1965 as % of 1961 Thegenge
1 year	16.1	9.1	4.3	8.1	27	89
1-2 years	13.0	7.2	7.5	10.1	58	141
3-6 years	11.1	10.0	5.1	9.5	46	95
7-12 years	5.4	2.5	3.1	4.0	58	159
Children						
All ages	9.4	6.2	4.7	7.3	50	118
Adults	3.28	2.70	3.71	3.15	113	117

Source: Fenwick, 1965.

data, we cannot substantiate the hypothesis that large potential gains in labour output can be obtained from a general improvement in health and, indeed, even if piped water removed all sickness, the gain to the labour force would be less than half a man day per month—perhaps 1.5 days per holding per month.

The improvement in the general health of children in Zaina between 1961 and 1965 is striking and this contrasts with the slight deterioration in Thegenge. The author of the Zaina study attributes this to piped water inputs and predicts that the difference between the two areas will widen as time passes.

It is not simply piped water that has changed life in Zaina. A more significant effect can be attributed to the presence of doctors, health assistants, nurses and others preoccupied with health, hygiene and general environmental improvement for an extensive period. There was also an improvement in other indices of a healthy environment such as improved roofing, larger houses, better ventilation and lower presence of vectors such as fleas, bedbugs, rats, mice and cockroaches. Similar teams of personnel were present in the control area and although some improvement was noted in most aspects, this was considerably less than in Zaina. It is interesting to note that the control investigation has possibly resulted in local action. Thegenge is now scheduled for a similar reticulated water scheme and construction is in progress. From an academic viewpoint this has its drawbacks because it will end the control for future appraisals.

It has already been pointed out that an improved water supply is no guarantee of public health improvement. Other diseases such as respiratory diseases continue to cause high morbidity or, with the piped supply, water associated disease may continue. This is because

the population is still exposed to infection (*e.g.*, infected from purchased vegetables, infected whilst on visits to friends, infected by mosquitoes breeding in waste water areas, infected by sleeping sickness from tsetse flies whilst walking through swamps to market produce, infected because other aspects of hygiene are neglected, infected because, say, for shortage of funds, water is not chlorinated). This presents a depressing view-point for it means that to be successful an extemely large area has to be supplied with protected water and all necessary aspects of health and hygiene education satisfied. The main implication is that it is not possible to claim with certainty that the benefits from protected water will equal the total savings in health expenditure and saved working time because water related illness may continue to be a social cost.

For some of the water associated diseases it is possible to consider alternative methods of control. Typhoid could be prevented by TAB vaccination and yellow fever by appropriate vaccination. Malaria can be prevented by chemoprophylaxis and ascariosis, yaws and others by regular mass treatment. Perhaps the most simple method of improving hygiene is to boil all water used for drinking, cooking and washing utensils. This latter proposal has proved difficult to implement in many countries. There are, however, several drawbacks to alternatives to piped water including the cost of the services and important practical objections. In addition, there are a number of infections that it is not feasible to prevent with alternative means.

Conclusion

Studies of health impact are limited, not simply because the medical authorities consider the case proven, but also because of the scarcity of personnel and the costs of survey. However, certain principles seem well established. Schemes must be well designed and maintained to prevent polluted sources, tap contamination or risk of infection from hookworms or mosquitoes near communal points. Health education has to be combined with water supply investments. Even if, at present, few public health benefits are accruing this is no argument against water investment. Protected water supplies are a precondition for public health and the cycle of poor water leading to poor health, this in turn causing poor water, has to be broken somewhere. Not all necessary supplies can be built as and when complementary resources are available. Therefore, either other means for justifying investments in water are necessary in the early years of development (*e.g.*, amenity improvement or economic gains) or a long-term perspective has to be maintained.

Empirical studies of the impact of water on the economy and welfare of rural inhabitants are few in number and still short on facts. However, this classification of issues and concepts, classification of hypotheses, and recording of known facts is a step forward. There is a very apt Jewish proverb that states "for example is not proof". However, the costs of obtaining proof of the precise impact of water is likely to be excessive. The main conclusion of this section of the study is that potential benefits of water are not presently being realised. Therefore, future emphasis should be placed on mobilising the back-up facilities and personnel to achieve proper impact rather than in obtaining precise measures of the costs of their absence.

Chapter V

SELECTION AND DESIGN OF WATER PROJECTS

Scope and Purpose of Criteria

Whenever there are alternative schemes, or alternative ways of achieving development on a particular scheme, a selection or choice has to be made. Selection and design criteria are the rules or guidelines by which alternative proposals are tested against specified objectives. This chapter is concerned with discussing the setting of criteria for selection and design appropriate in the current Kenyan context. The criteria, therefore, take account of the current problems and the long-term programme objectives.

The function of design appraisal is to ensure that the current scheme is selected; that the structure fits the objectives; that the elements and processes are appropriate to the local resource endowment; and that the procedure for implementation is workable. Hence, we must determine the technical competence of the proposal; that the design is not excessively complicated; that it is complete; that practices, particularly those established for developing countries, are not slavishly followed; and that new improved materials and methods are utilised 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 planners and 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.

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. One can quote as examples the level of storage on certain Water Department schemes and the excess capacity at Thika where installed capacity is three times current consumption. Table 15 shows key variables and assumptions made by four firms of

TABLE 15

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 ÷ Av. flow
Uyoma	Communal points (no point storage)	5 years × 3.1 per cent	22 l.p.c.d. (5 g.p.d.)	22 l.p.cow.d. (5 g.cow.d.)	included	3.0 domestic 2.0 livestock
Tetu-Thegenge	Communal points (point storage)	20 years × 1.2 per cent	50 l.p.c.d. (11 g.p.d.)	90 l.p.grade cow.d. (20 g.p.d.) 45 l.native cattle.d. (10 g.p.d.) 18 l.small stock.d. (4 g.p.d.)	half included	not used
Gatango	Communal points	None allowed	Plots 2 acres 135 l.p.c.d. (30 g.p.d.) Plots 2–4 acres 270 l.p.c.d. (60 g.p.d.) Plots 4 acres 450 l.p.c.d. (100 g.p.d.)	No separate provision	Yes	—
Inoi	Communal points (point storage)	None allowed	,,	No separate provision	Yes	2.4
W. Karachuonyo	Communal points (No point storage)	Present population	22 l.p.c.d. (5 g.p.d.)	—	No	2.0
Ndivisi	Communal points	Present population	45 l.p.c.d. (10 g.p.d.)	—	Yes	Not used
Chepalungu	(No point storage)	None allowed	22 l.p.c.d. (5 g.p.d.)	No provision has led to great difficulty. People depend upon cattle		2.0

consultants to the Water Department acting independently before guidelines were issued. The "standardization" school suffers from their oversimplified, inflexible approach. The most obvious example of this is the WHO/UNICEF assisted Community Water Supply Programme which emphasised standardisation. A recent survey revealed over 50 per cent of the schemes are not working, mainly as a consequence of design defects (WHO, 1971). There are many other schemes in Kenya where lack of designers' skills and judgements have resulted in uneconomical designs or complete break-downs.

The approach adopted by the Water Department represents a middle way between these extremes. It is appreciated that some guidelines are necessary to record experience and to define present standards in an indicative rather than a definitive way. As with all planning work, constant revision will be required. It is recognised that today's standards, materials and methods will inevitably be in some way inappropriate tomorrow. One of the main dangers of a volume such as the current "Guidelines" (Water Department, 1971) is that it may be placed on one side as a finished task. Design criteria are never complete and must be continuously revised.

Selection Criteria

Although poor design can generate higher costs to the economy than poor scheme selection, the importance of intelligent and discriminate selection should not be underestimated. Optimum scheme selection is a complex process, because of the large number and 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 generalisation regarding scheme selection is important for policy, and it does appear to have empirical backing. This generalisation is that an improved water supply, though perhaps necessary for improved health, welfare and economic progress, is not sufficient to ensure any desirable change within the community. The discussion in Chapters III and IV showed that there are a large number of water projects scattered throughout Kenya where the way of life and standard of living of the direct beneficiaries have not changed as a consequence of the investment. The conclusion from this observation is that water investment has to be coupled with complementary investments to ensure success. These complementary investments could be directly productive, *e.g.*, tea development or dairy development projects, or simply educational such as public health campaigns. The corollary of this conclusion is that District Development Committees, who are responsible for setting local priorities, should link water proposals with existing or proposed development programmes.

They should not regard water schemes as compensation for an area which did not receive new schools or other forms of public investment. The principle that water is a service supporting other forms of public investment lies behind much of the discussion in this report. It is applicable when discussing the whole spectrum of investment alternatives from the poor and needy areas, where water supply is at present very limited, to the highly developed and productive areas. Water investment ought to be linked to complementary programmes and schemes should be selected on the basis of the existence and advancement of these supporting programmes.

It is concluded that the present system of making financial allocations to Districts on the basis of numbers unserved by a potable water supply is reasonable. However, the allocation of this money to particular areas should be according to more complex criteria. In selecting one scheme from many alternatives, either the benefits or the costs may receive first consideration. On the benefit side, if there is a poor standard of present supplies a considerable benefit may be expected from any improvement. For example, this would be the case if present supplies were heavily polluted or if they were very distant or unreliable. If recent infra-structure or agricultural investments had been, or were in the process of being made, then benefits from water would be high. This would be the case in Special Rural Development Project areas or in backward areas that had received new investments to compensate for past neglect. In these instances water could "piggy-back" to success on these complementary investments. In some circumstances water might be considered a necessary input to enable some other policy to succeed. For example, a new supply could be used to encourage permanent settlement in a particular area. New supplies might be installed to prevent a focus of cholera from developing in the areas at risk on the stock routes from Ethiopia. All these examples relate to selection on the basis of the size of the benefit.

On the cost side, there is the obvious fact that urban growth centres should receive priority. For a given level of service the cost per head is lower. Although costs per head quoted for urban areas are often higher than rural areas, this is because of the higher levels of consumption and standard of service. Within rural areas, cost per head should be an important criterion for selecting and this may vary enormously depending upon such factors as topography and distance to source. The actual cost may be lowest where Government rehabilitates existing, but broken down or badly managed, water schemes. Where they are not working the original investment is

largely a bygone or sunk cost, so cost-effectiveness for rehabilitation can be high. Similarly, in some communities, self-help efforts are substantial. These are usually offers of labour and sometimes cash or materials. These contributions all help to lower the "cost to Government" per head served.

There can be no objective way of choosing between one high benefit scheme and an alternative low-cost scheme. However, it is recommended that separate sets of guidelines on key issues and partial criteria should be prepared and issued to District Development Committees. If they are issued with such guidelines they can then come to what is essentially a political decision on the basis of relevant technical and economic backing.

Design Criteria at Kyeni

Kyeni was the first rural water project in the current programme. The basic design criteria at Kyeni were that the intakes and main pipelines had capacity for 450 litres per day (100 g.p.d.) for each farm. In the initial period, consumption would be from communal points, placed at 0.8 kilometer (half-mile) intervals in the densely settled high altitude areas and a maximum of twice this spacing in the low altitude areas. It was anticipated that in the early years of the project consumption would be low, perhaps 18 litres per head per day. No allowance was made for population increase, or sub-division of plots. It was forecast that demand would equal capacity 20 years after construction when most farms would have a private connection. The branch lines necessary to serve all farms were deferred until a second phase.

Performance of the Project

In September, 1971, average daily consumption through the main intake was 740,000 litres per day (164,000 g.p.d.). The average consumption rate at the 50 metered cwp's (communal water points) implies a scheme consumption of only 360,000 litres per day (80,000 g.p.d.). The difference can be partly explained by leaks within the system. However, the main reason was that the major consumer, Kyeni Hospital, had a two-inch service pipe and no system for stopping overflow when storage was full. Within one day of installing a meter the hospital authorities had made adequate arrangements to prevent wastage.

Six months' records (from June to November, 1971) of metered consumption at Kyeni cwp's have been analysed. These records show that there is no trend of increase in consumption. However, it is evident that weather patterns play an important part in deciding

the level of consumption and a slight increase may be obscured by this. The average consumption at 50 communal points serving 759 families (about 7,600 people) was 143 litres per day. This is approximately 14 litres per head (3.1 gallons). According to the designated user groups 1,080 families should be using these cwp's. In other words, 30 per cent of the population continues to use traditional sources. The main reason for this was found from a survey at five water points to be that the traditional source is closer.

Consumption appears to be fairly closely related to family size and not constant for a family. For two points where precise data on family size was available family consumption was 118 and 185 litres per day but consumption per head was 13 and 15.2 litres respectively. This data supports the hypothesis that if water is carried any distance, consumption falls to about 15 litres/head. This is considered to be too low to enable all health benefits to be obtained.

On 24th and 25th August, 1971, careful measures were taken of water consumed at two water points. The results are shown in Table 16. Previous recordings indicated that consumption during these two days was 30 per cent below average. Measurements were carried out by hourly readings of storage and meter. Estimates of household use were made by visually assessing capacity of containers.

TABLE 16

Water Consumption at Kyeni Water Points

Water Point No.	12	12	124
Date of observation	24.8.71 Wet, cool	25.8.71 Wet, cool	25.8.71 Dry, cool
Total usage (litres)	2,000	2,336	2,264
Carried to household (litres)	1,044	905	1,085
Used at point (litres)	956	1,432	1,179
Per cent to household	52	39	48
No. of households	26	26	44
Total consumption household (litres)	77	90	56
Consumption at household (litres)	42	35	25
Long term consumption/household (litres)	118	118	185
Daily consumption during July, 1971	3,300	3,300	3,700

It can be seen from Table 17 that only 70-80 per cent of authorised consumers are actually using the facilities. The precise reasons for this have not been established.

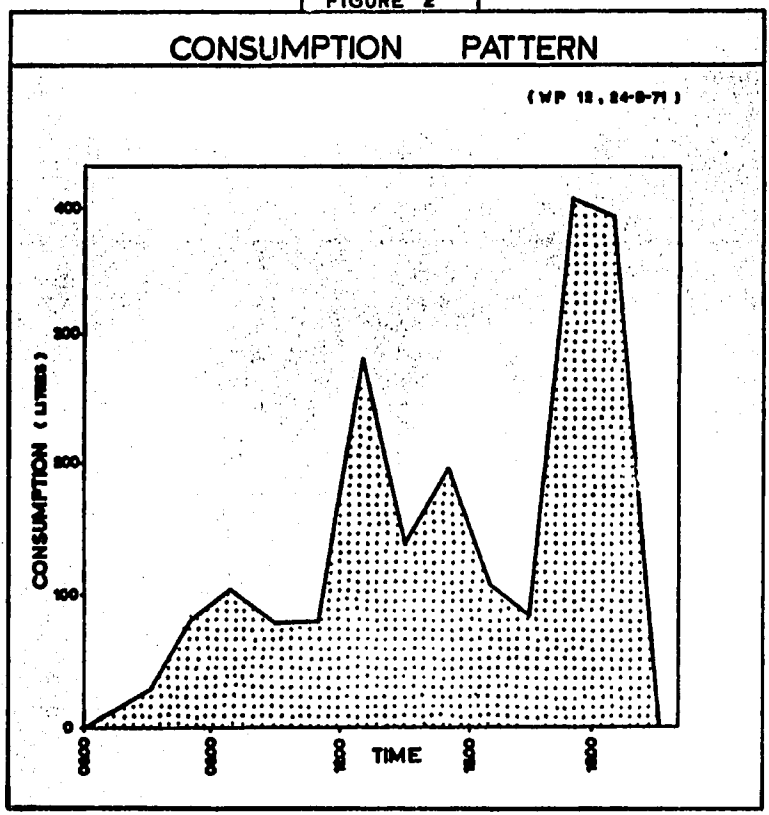
TABLE 17

Authorised and Actual Users

Water Point	Authorised Users	Actual Users	Actual % Authorised
12	35	26	71
124	58	44	76

Figure 2 shows the pattern of daily consumption at one water point. The peak factor on the observed points ranged from 4.2 to 5.6. This is higher than the anticipated peak factor. However, it should be noted that this is a relatively low water point peak volume (550 litres per hour) and a very low hourly average (100 litres per hour). With little or no base load from industry and institutional users, we can anticipate high peak factors in rural areas.

FIGURE 2



Peak demand occurs in the evening. It is certainly questionable whether factors such as this, even if found in other areas, should be utilised for design. It was observed that the existing capacity far exceeds demand. The consumers withdraw from each point 2,000 to 3,000 litres per day; the supply exceeds 4,500 litres per day; the tank holds one to two days' supply, the taps have a capacity of 77,760 litres per day. In few cases did hourly withdrawals exceed hourly inputs and in no case did daily withdrawals exceed daily input. It is also suggested that rural inhabitants can adjust to peak periods either by avoiding collection at this time or by queueing.

Use of Tank Storage

The implication of the observed consumption levels is that very little of the existing 4,500 litres (1,000 gallons) storage is used even at the peaks. It was estimated that at the tanks' studies there was a fall in water level of not more than 8 inches—*i.e.*, less than 10 per cent of the capacity was utilised. It is, therefore, of questionable value. Furthermore, these tanks absorbed more than 10 per cent of the capital costs and they have been the biggest source of maintenance problems. If there is wide scale adoption of individual connections they will be redundant.

Against this, storage tanks give certain advantages including a more even pressure through the distribution system and the possibility of a continued supply during line breakdowns. However, in rural areas it is quite likely that a breakdown will not be discovered until the storage is empty. Fluctuating pressures are unlikely to prove a problem in providing supplies because the main system is designed with capacity for individual connections at 450 litres (100 gallons) per household. In comparison to urban areas, breakdowns are less of a problem because alternative supplies do generally exist. The question has, therefore, to be posed as to whether the additional costs of storage tanks are a worthwhile premium to pay for the limited advantage.

Design of the Communal Point

The simple low cost design is considered appropriate. Consumers do not appear to regard these points as a social focus. They are very businesslike in their approach to work at the communal point and a minimum of time is spent at the point. It is possible, of course, that the functional nature of the design discourages long spells at the point. More probably, it is the large number of taps, high discharge, and consequent absence of queueing which contributes most to the lack of social focus at the communal point. (Hence if you want to encourage a social meeting at the point have few taps and slow discharge!)

For the most part, communal points are kept very clean and tidy. Drainage water is not a problem and on a number of points it is being utilised for vegetables. The cheap taps are practically never left running and more expensive "waste-not" taps do not seem to be justified. In the gravity schemes with excess water capacity in early years, water wastage is not a real problem. Some small savings could be made in the design by having less taps (say one per 20 families); with the present design the whole day's consumption could be collected in 45 minutes. The mounting for the taps has to be rigid as this is used to balance loaded water drums. Attention should also be paid to fixing rigid input pipes to the tank to prevent damage by children who regard it as a climbing frame. The timber deck for the storage tanks should in future be concrete as these are invariably wet from small leaks in the tank and may rot.

Individual Connections

Installation of individual connections started in late November, 1971. In five weeks 30 individuals had paid for a connection (shs. 250.00 plus shs. 60.00 deposit). This low number could possibly be accounted for by the high cost and competing demands for money at Christmas and for School fees. More than 66 per cent of consumers on non-constructed branch lines is required before the Water Department will construct. This lowers the number of potential consumers and causes discontent. However, revision is not advocated at present because finance is not available and it is an effective rationing device whilst a backlog of work is on hand. In May, 1972, the connection fee had been lowered, in line with all Water Department rural water schemes, to shs. 150.00 plus shs. 60.00 deposit. Even this did not stimulate large numbers of connections. In July, 1972, only 55 connections had been made but no more applications were being accepted because of the absence of meters.

Average consumption at the individual connections owned by farmers is 425 litres per day (94 gallons). This is very close to the design figure of 450 litres per day. Sixty-four per cent of all connections are owned by farmers, 16 per cent by schools, 11 per cent cattle dips and 7 per cent by churches. It is noted that a large proportion of individuals with connections are part-time farmers having jobs with schools, churches, hospitals, police or businesses. It is not known whether it is the income derived from this job which encouraged early connections or other factors such as education.

Construction

The Head Office of the Water Development Division were responsible for construction. A Peace Corps volunteer was responsible for site supervision. Once money was released by Treasury, construction began. Construction at Kyeni was plagued by problems, many of which should not recur. The main problem was bad planning. Design drawings were incomplete, yet people were moved to the site. This meant that proper material schedules were not available, and consequently, purchasing was delayed and pipes and fittings were arriving late. Trenches were opened at the site sometimes months before pipe was laid. Problems of late purchasing were magnified by problems of lost orders and double orders. The main cause of this bad scheduling was pressure from many sides to get things moving on at least one rural water scheme.

To some extent, however, Kyeni had an advantage not to be repeated. For instance, resources were concentrated on that scheme. Records reveal that staff were transferred to Kyeni to release bottlenecks, transfers away were generally refused and both senior and junior staff worked hard to complete construction.

In spite of this, construction lasted 23 months from April, 1969, to March, 1971. One officer (not an engineer) predicted construction would take six months, but the majority of bar-diagrams showed a planned 12 months' period.

Some minor hold-ups were ascribed to weather though it is not clear why construction teams were surprised when it rained. Four-wheel drive, five-ton lorries would have helped to keep the pace of construction up during wet weather but none were available (nor are there any with WD to date). The effects of the weather would have been lessened if the County Council roads had been well maintained. Availability of transport was at times a constraint. Material was generally sent from Nairobi and loading lorries in Nairobi often caused delays.

Concreting of the storage tanks was not carried out satisfactorily. Supervision by WD staff was not adequate and a language problem existed between site supervisors and the contractors' site representative. Difficulties with self-help labour were largely the result of poor supervision by WD employed checkers. In the low altitude area where many farms are presently unpopulated the Chief had to obtain prison labour to complete trenches. This worked satisfactorily and might be considered for other schemes. However, an attempt to utilise the army for assistance with transporting pipes failed, mainly because the army was primarily interested in conserving their vehicles and carried small loads.

It would be unfair to finish this section without paying tribute to the application of the WD construction staff who worked long hours and coped ably with problems that were generally not of their own making.

DESIGN CONSIDERATIONS

The basic Kyeni design followed the tradition set in the other pre-Independence large reticulated gravity schemes in Kenya at Kabare, Zania and elsewhere. This can be described as a restricted flow system. The principle is that relatively small diameter pipes are utilised facilitating cost savings. However, these savings have to be offset against the larger expenditure on the service storage tanks that are required and additional operational problems.

Pipe diameters, and therefore, costs at Kyeni were not the minimum possible because allowance was made for consumption levels associated with individual connection. The storage is of two types; small 4,500 litre (1,000 gallon) tanks at water points and large masonry tanks in the main system. Water point storage was provided mainly to maintain pressure during peaks. It has been found that 80-90 per cent of this storage is not used even during peaks. This is because of the low water consumption levels associated with communal water points. It is now clear that use of pipes with sufficient capacity for subsequent individual connections will allow for peak requirements with a communal water point system, even in the absence of communal point storage.

Another use of storage is in retaining night flow for use during the following day. At Kyeni the main line masonry tanks are the major storage facility involved. This can be important when stream flow is so low that daily consumption exceeds the 12-hour withdrawal. Because of leaks in a diversion structure this situation has occurred twice in the 12 month operation of one of the two lines at Kyeni. However, total main line storage is equivalent to the design level for 24-hour withdrawals. This is at least double the requirements. Furthermore, whilst per capita consumption is at 30 per cent of design, storage for much less than 12 hours of maximum or ultimate withdrawals would certainly suffice. It may be concluded that too much storage has been built too soon in the Kyeni project.

Translation of this conclusion to other schemes requires considerable caution. There are other relevant considerations. For instance, the case for storage improves as the distance from source to consumption point increases. At Kyeni the source is close to the consumption area. The relative economics of providing different amounts of storage can only be assessed by considering each particular case. Design factors will include topography, type of pipe, range of pipe diameters, break pressure requirements, capacity of source and so on.

Importance of Flexibility

In rural Kenya it is evident that a major change is taking place but there is uncertainty on the direction of that change. Population growth, changes in agricultural technology, population shifts to urban areas are some of the factors stimulating this change, but the magnitude and weight are not known. In consequence, land-use patterns in specific areas in 10 or 20 years time are uncertain and largely unpredictable.

One essential characteristic of rural water schemes which appears to receive insufficient attention in the design stage at present is the low initial consumption rates and the potential for a largely unpredictable increase to several times present levels. There are many factors likely to promote this shift in consumption in rural areas, the most important of which are a change to individual connections, a large increase in dairy farming and small-scale crop watering. At Kyeni flexibility was achieved by use of pipes large enough to supply every farm with an individual connection. As was previously explained this has increased the cost without increasing the level of service.

What is required are not more papers on design criteria which are quickly agreed and ignored, but a design philosophy. WD need to identify such basic principles as exist and relate these to their knowledge of rural Kenya.

The importance of unpredictable change to design of schemes is that maximum flexibility is an extremely desirable characteristic of the design. A design is required which for a reasonable initial investment will be capable of low cost expansion, if and when this is required. An example, using Kyeni data, would help to demonstrate this. This is shown in Table 18. If we assume a 3 per cent population growth and a shift to individual connections which would increase average consumption to 20 gallons per head in 15 years, capacity at Kyeni becomes a constraint after about 8 years operation. Although these are extreme assumptions they are not too unrealistic.

Table 18

Forecast Consumption at Kyeni

Year	Population	Consumption/hd 'gpd)	Consumption for Scheme (gpd)
1971	21,000	3	63,000
1976	24,400	10	244,000
1981	28,200	15	424,000
1986	32,600	20	652,000

If large numbers of individual connections are made, small service storage tanks at the household will be required because the pipe diameters are not sufficiently large to cope with full peak flow at pressure. Thus it can be seen that the present design has only limited flexibility.

For gravity schemes like Kyeni, with virtually unrestricted water at the source, the low marginal cost for increased pipe diameter is important. In view of this it is recommended that careful consideration is given to designing future large gravity schemes similar to Kyeni to an amended design philosophy. First, construction should be phased. In the initial phase, designs are prepared with a pressure system where full peak flow is taken into account. This has the advantage that main line or service storage tanks are not necessary though small break-pressure tanks are essential. Troublesome small bore pipes are not used and, therefore, a narrower range of pipe diameters are utilised and standardised fittings are possible. This system is the most flexible because if and when total demands begin to rise and pressures drop, main line and service storage can be added and the system converted to a pressure system with restricted peak flow. Eventually, when demands increase, a restricted flow system can be adopted with relatively large service storage. Initial investment with this system will probably be higher but the extra cost will be small and must be balanced against the additional flexibility.

An estimate was made of the financial implications of increasing pipe diameters at Kyeni to cope with a peak flow of 2-4 times average in all pipelines. All pipes of 1.5 inches diameter and below can already take this peak flow. All other pipe diameters if increased by a minimum of 40 per cent would result in a total cost increase of £12,600. Savings on main storage can, however, be made to a value of £10,000. More storage could be saved but some is required to conserve night-time flow. Thus, the net addition to costs would be £2,600, less than four per cent of capital costs. The benefit from this premium would be the additional flexibility in being able to increase capacity by a phased storage construction programme to 2.4 times the existing capacity.

Operation and Maintenance

Proposals for the operation and maintenance team are that there should be a team of nine men (operator/plumber, clerk, tractor driver, watchman and labourers.)

Total cost of this would be £1,240 per year. Additional costs are expected to be £182 for transport, £580 for materials, a total of £2,000 per year. These costs are based upon the assumption that each line should be patrolled daily and all gate and air valves checked. The

assumption that each line should be patrolled daily is open to question. Failure of a pipe or fitting which affects the supply would eventually be noted and reported by the local inhabitants without severe damage or hardship. As this is a simple gravity scheme consideration might be given to a less complete operation team.

Separate but related to operation and maintenance is the installation and maintenance of individual connections. If, as seems likely, all or most of the connections have a meter there is also the problem of making regular meter readings. At present there are 50 meters widely spread throughout the location. It is estimated that a full-time meter reader would be required for the first 500 meters but two readers could cope with perhaps 1,500. Except for research purposes, meters are not advised for rural areas because of capital costs, maintenance and administration problems. Flat rate systems with flow restriction if and when necessary are preferable. Installation of private connections by a team of three men could proceed at a rate of perhaps 30-40 connections per month depending upon availability of transport, materials, branch lines and so on.

Current Design Standards on Other Schemes

Up to 1971 there was practically no regulation of design standards. This is well illustrated by Table 15. If West-Karachuonyo had been designed to the standards of Tetu-Thegenge capacity would have been 275 per cent higher. If Chepalungu had made provision for population expansion, a higher per capita consumption and cattle watering, then capacity would have been more than 600 per cent higher. This would have required a quite different technical solution as the current scheme is a small pump scheme. The gravity alternative is much more attractive if a larger scheme is proposed. The Chepalungu scheme is at present under construction and it is already evident that there will be insufficient water from the start. Consequently, emergency plans are being implemented to provide alternative cattle watering facilities.

In 1971 the then Water Development Division of the Ministry of Agriculture issued a document entitled "Guidelines for Pre-Development Studies" (Water Development Division, 1971). The purpose of this document was to assist consultants and Ministry engineers outside Nairobi in deriving water proposals and designs as comparable as possible. The guidelines included compulsory instructions, recommendations and miscellaneous technical data, formulas, diagrams, check-lists and so on to aid planning.

In many ways the issuing of guidelines marked a great advance in water planning in Kenya. Design criteria for water consumption and water quality standards were set out together with information on

cost estimates. The format and contents of preliminary and final predevelopment study reports were listed. But most important from the viewpoint of this study, economic criteria were given considerable prominence. Guidelines were given on a procedure for social-economic feasibility assessment (which proved to be unworkable) and on economic tests for design alternatives. Discounting procedures were outlined to test alternative designs. For example, in the guidelines procedures were established to assist choice between a high capital cost, low recurrent cost gravity scheme and an alternative low capital, high recurrent cost pump scheme. As an illustration the Chepalungu proposal for a pump scheme was tested. The result is presented in Table 19.

TABLE 19

Comparison of Chepalungu Pump and Gravity Options

	Pump option		Gravity option	
Interest rate (%)	6	6	6	6
Life of scheme (years)	20	30	20	30
Capital costs ('000)	546	546	880	880
Replacements (present value)	57	89	—	—
Maintenance (present value)	104	124	92	110
Operation (present value)	480	587	—	—
Attendants	117	143	—	—
	1,304	1,489	972	990
Indirect cost 20%	261	298	194	198
Total cost (present value)	1,565	1,787	1,166	1,188

Source: Water Development Division, 1971.

These calculations clearly suggest that the gravity option is more favourable. Although these calculations were available in November, 1971, before construction commenced, no changes in design were made. In the first instance the consultants were clearly at fault because they dismissed the gravity option without any explicit calculation. The consultants merely stated: "In our opinion this (gravity) solution is not economical". In the second instance the Water Department might have acted on the evidence presented by their own technical officers.

If the 6 per cent discount rate recommended in the guidelines is substituted by a 10 per cent rate, which is much closer to the opportunity cost of capital, then pump solutions such as Chepalungu become more attractive. However, even with a 10 per cent rate the pumped scheme is still 10.7 per cent more expensive.

The current design criteria have been reviewed and evaluated in a recent WHO report (WHO, 1972b) and the Water Department is considering the recommendations and will, if necessary, amend its guidelines. It can be concluded that subject to certain criticisms, some of which are set out in the Kyeni case study, design and selection are basically sound. The present design criteria for consumption are present in Table 20. Gravity intakes are designed for a 24 hour flow of ultimate (20 years) demand. Pump intakes are designed for ultimate flow on a 16 hour pumping basis (24 hour for electric motors). Water quality standards are set for bacteria limits, physical quality and chemical content; but, at present, these standards are applied irregularly. Although almost all urban schemes are treated at present, the vast majority of rural schemes are untreated. There is much uncertainty of the wisdom of this policy with some planners claiming treated water will destroy valuable and necessary resistance or immunity to diseases.

TABLE 20

Design Criteria for Water Consumption (litres/capita/day)

		High potential areas (> 40 in. rainfall)	Medium potential areas (30-40 in. rainfall)
Either:	People communal sources	25	20
	household or on-plot source	50	50
	Livestock (1 adult grade cattle = 3 zebu cattle = 15 smallstock)	75	75
Or:	Farms > 4 hectares	1,000	600
	2-4 hectares	600	300
	< 2 hectares	400	100
Plus:	Offices per occupant	25	
	Hospitals (Grades I to III) per bed	400 to 100	
	Dispensary (per outpatient)	50	
	Schools boarding	25 to 50	
	Schools day	10 to 25	
	Hotels (Grades I and II) per bed	200 to 400	
	Boarding-house (without WC's) per bed	20	
	Bars (per guest)	2	

N.B. Per capita figures are applied to the 10 year population forecast (except for pumps, etc., where phasing is allowed).

Source: Water Development Division, 1971.

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Others claim that once water is piped it must be made safe; although this must decrease available funds and slow down the pace of investment elsewhere. The anti-treatment lobby are against partial or full treatment in every instance, because of problems of effective maintenance and genuine doubts on the benefits to be obtained in the present unhealthy environment where they are installed.

According to the Guidelines pump units should never exceed four and be initially based on an eight-hour day pumping time for current demand. Standby units should not fall below 33 per cent but should be as near to this as is possible. This means that if only one unit is required a standby unit must be provided giving 200 per cent capacity. With two units there is only 150 per cent capacity. This seems an excessive level of capacity. As two shifts are feasible there is 166 to 300 per cent excess capacity built into this criterion. Some excess capacity is inevitable because of problems associated with breakdown and growth in demand. Nevertheless, this level of standby capacity seems excessive for rural areas where alternative water sources are generally available.

Rising mains from pump installations are to be generally dimensioned for ultimate demand with no phasing. Presumably this advice is critically examined by the engineer during design, taking full account of the "time value of money". Storage at the end of the rising main is simply to assist peak operation. No storage to cope with a pump breakdown is provided. Storage is 50 per cent of initial daily demand but this can be supplemented during the life of the project.

Judging the proper level of storage on main lines is a difficult problem. Most of the important factors are detailed in Table 21. Empirical measures by the writer and others showed that the level of storage presently installed is excessive. Consequently, new instructions are being issued by the Water Department. Design of main lines and branch lines is for a 24 hour flow on ultimate (20 year) demand. If it is assumed that per capita demand is presently 50 per cent of ultimate demand, and that population growth will be 3.0 per cent per annum, then in 20 years present demand will be increased by a factor of 3.6. Consequently, on-line storage can be deferred for at least 10 years. Peak flow factors are expected to be 3 for pipes of 75 mm. or greater, and 4 for smaller pipes. Final choice is, of course, dependent upon engineering assessment of other design factors including topography, type of pipe, range of sizes available, capacity of source, rate of increase in consumption, peak requirements and limits to finance.

TABLE 21

Factors to be Considered in Choosing Consumption Point Storage Capacity for Rural Schemes

With storage	Without storage
Smaller main pipes	Larger mains (30% greater if peak flow 2 × average)
Less flexible design	Scope for low cost augmentation by adding storage
Higher maintenance because of tank fittings	Lower maintenance costs
Less interruptions (if fault detected and corrected)	Good initial design prevents most interruptions
Tank pollution risk	Less risk of pollution
Break pressure tanks may be required which can duplicate as storage	

Pipes are not to be less than 25 mm. unless serving a single household. The Guidelines suggest plugged T's should be installed in pipelines for expected individual connections but recent developments in simple means for tapping plastic pipes, even under pressure, have made this unnecessary.

The biggest single technological factor that has assisted economical water development in recent years is the innovation of plastic pipe. Unplasticised polyvinyl chloride pipe and fittings are manufactured in Kenya and low density and high density polythene is also available. The main advantages of plastic pipe are the relatively low cost and excellent resistance to corrosive water and corrosive soils, bacteriological inertness, low thermal conductivity, extreme lightness and flexibility, very smooth internal surface, good workability and availability in longer lengths. However, they are sensitive to light (ultraviolet) and weather, have a high thermal expansion, the mechanical strength decreases with increase in temperature but impact strength decreases with a fall in temperature, and they require bedding in rocky ground. In 1972 a plastic pipe was used as a main beneath Kilifi creek and it was penetrated by a marine borer within a matter of weeks rendering it completely unfit for use. Despite these limitations, every year plastic piping makes inroads into areas where cast iron, steel, asbestos-cement or concrete pipe was previously used.

Initially, communal points are to be installed for distribution. These are at present fairly elaborate structures, each with four outlets, with a minimum flow of 40 litres per minute. They are sited so that no family is more than one to three kilometers from an outlet. Washing slabs or cattle troughs may be provided if local interest is evident. In

some areas licensed retailers will be appointed to supervise outlets and collect revenue. WD kiosks will no longer be built. Field work by the writer suggests that four simple standpipes evenly spaced along the pipelines would give greater benefit than the present communal point at a little, if any, extra cost.

Present policy of the Water Department is to encourage private connections. A connection fee of sh. 150 is paid plus a sh. 60 deposit against non-payment of rates. Monthly rates vary though they are seldom less than sh. 15. There is no meter unless consumption exceeds 1,000 l.p.d. and there is insufficient capacity or high operating costs. In this event, flow restricting devices may be used and the consumer must provide point storage. This policy is new (1972) and not yet being implemented. The main lines generally have sufficient capacity to enable 50 per cent of plots to have individual connections.

Economies of Scale

If pipe diameters are doubled the water carrying capacity increases five-fold, the price up to three-fold; trenching, laying and jointing increase up to double. Valves and fittings may increase in line with capacity increases. Design effort will scarcely increase at all. The average cost increase for a five-fold increase in supply is a factor of about 2.5. These functional relationships are very relevant in deciding upon the amount of water to serve to a given area because the marginal cost is much less than the unit cost for the initial investment. Therefore, these economies of scale are very relevant in choosing between capacity to serve private connections or communal points. However, they are much less relevant with respect to the area to be covered. Other factors then have to be considered including the additional costs of carrying water longer distances, the increased risks with a single source, and the increased size and complication in treatment works.

Unit Costs

Although piped water is viewed by many Kenyans as a necessity it is in fact a high-cost amenity. Even in rich countries, such as those of Western Europe, piped water supplies have been general for less than 70 years. Remote and isolated communities still rely upon wells and springs. A recent study in England of the problem of rural water development concluded that on water supply grounds alone "the costs of maintaining the existing settlement patterns would exceed those incurred in providing similar facilities by relocation". (Warford, 1969). In other words, it is sometimes cheaper to move communities than to pipe water to them.

Almost certainly this will be true in all but the high potential areas in Kenya. Indeed, in Tanzania, one of the motivations for Ujamaa village settlement is that this will provide opportunity for low per capita costs of services such as water.

Cost estimates for water schemes vary widely because of the influence of several factors such as topography, ground conditions, location of source, location of scheme, population density and design standards. Despite this wide variation, average or modal costs estimates are useful guides when assessing the likely magnitude of national programmes and whether a particular scheme is high or low-cost.

TABLE 22

Forecast Unit Costs for Water Development

(£/person with capacity for year 20 demand)

Type of Service	Urban			Rural		
	Nairobi + Mombasa	Municipalities	Small towns	High potential	Medium potential	Low potential
Private connections	20.0	15.0	10.0	5.5	7.5	6.5
Communal point (with main capacity for private connections)				4.0	5.3	5.5
Communal water points				3.0	3.6	4.0
Point sources, hafirs, wells, etc. (Untreated)						3.5

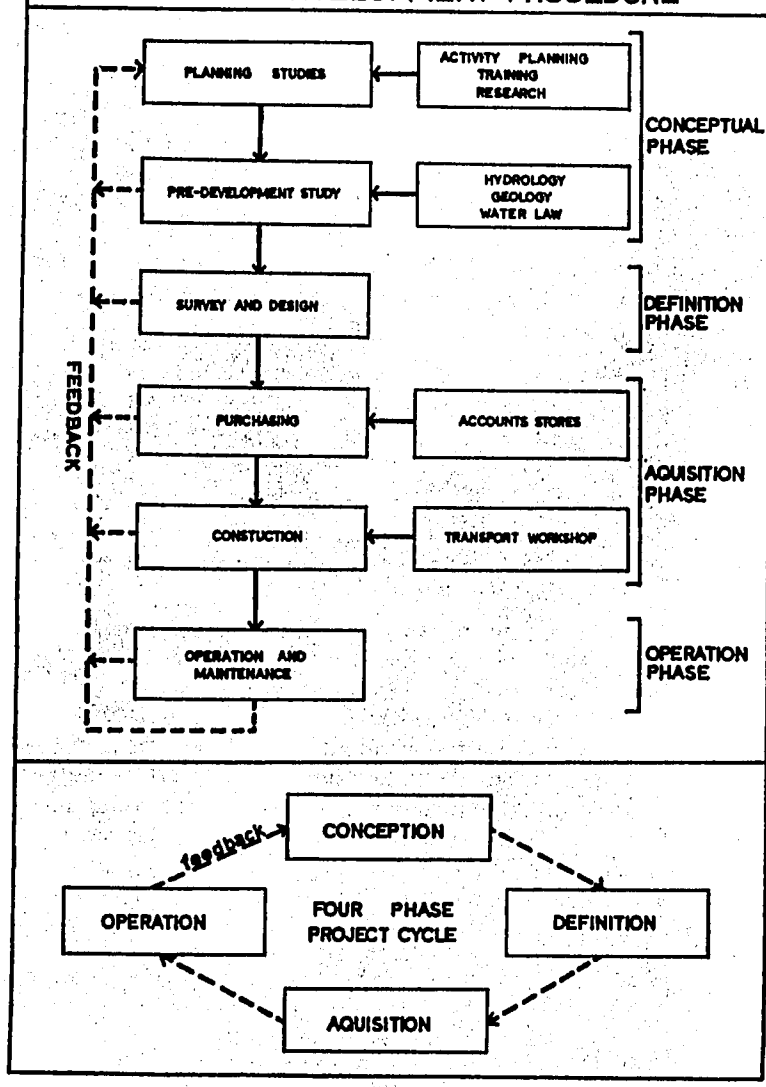
Source: WHO Report, No. 2, 1972 (a).

Empirical data on scheme costs are either scarce or need critical interpretation. This is, in part, because of a wide variety of design standards which prevent a direct comparison between schemes, and partly because of inadequate cost accounting procedures. The most recent and comprehensive investigation of unit costs was completed by WHO in 1972 (WHO, 1972a). They reviewed urban and rural experience from the three East African territories and costed model schemes for a variety of settlement patterns. Their conclusions presented in Table 22 are on the basis of people served at time of installation for new schemes or additional people served for augmentation. Certain items of cost are omitted such as planning and design, engineering supervision and on-plot and household plumbing, and equipment from the near boundary standpipe. Analysis showed that

annual recurrent costs for individual schemes (1971) range from shs. 3.50 per capita in Isiolo to shs. 115 per capita in Kwale (this is more than double the next most expensive scheme). The average for WD Schemes is shs. 14.00 per year, somewhat higher than is technically possible because of the inflationary effects capital rationing has upon operating costs (old schemes and over-extended schemes generate high recurrent costs).

FIGURE 3

SCHEME DEVELOPMENT PROCEDURE



From these cost estimates it can be seen that annual costs of piped water for rural schemes are of the order of £1.1 per head per year or £6 to £10 per family. Comparing this to average cash incomes we find costs of the order of one-quarter of total cash incomes. Rates usually amount to £2 per annum, about 3-5 per cent of cash incomes. Thus, from the private individual's point of view water might be regarded as low-cost; (the writer's valued judgement) but because private costs are only 20-33 per cent of direct public costs it is not so clear-cut from the public investment viewpoint. There are significant income transfers occurring from the general public to the beneficiaries of water schemes. This is all the more so if rates are not paid, which is generally the case in rural areas.

PRIMACY OF OPERATION AND MAINTENANCE

Water Department schemes are well run and well maintained. Operational problems on these schemes stem from the continual running of schemes at or near capacity. Some 25 per cent of gazetted schemes require augmentation (WHO, 1971). County Council schemes, Lands and Settlement schemes and the majority of self-help schemes have major operation and maintenance problems. For example 51 per cent of WHO/UNICEF assisted schemes in the 1963 to 1970 programme are not working (WHO, 1971). A higher proportion of pump schemes than gravity schemes are not working. As the Water Department increases the number of schemes and the proportion of rural to urban schemes increases more problems can be anticipated with operation and maintenance.

The basic problem with rural schemes is that they are small and cannot afford a sufficient standard of skilled staff, equipment and transport facilities. Repair and fuel supplies to isolated areas are expensive and difficult to organise. Proper revenue payment and financial provision is not, or cannot, be made. This latter point we have seen is true of Water Department schemes. Unless the authorities appreciate the magnitude of the financial and organisational problems stemming from recent and planned capital expenditures on rural water supply, much of the effort and the resources will have been wasted. Providing the magnitude of recurrent financial requirements is fully appreciated then the organisational recommendations set out below will help ensure successful operation and maintenance. This involves strengthening the Provincial water authorities and setting up District maintenance terms.

Figure 3 illustrates the scheme development procedure utilised by the Water Department in Kenya. In the following sections the feasibility and desirability of reforms in three areas of this system are explored: changes in the input mix; changes in the process; and lastly, criteria and procedures for obtaining feedback information.

Major Scarcities and Constraints

Conventional views of resource endowment situations in underdeveloped countries are that there are capital and skilled labour scarcities and abundant unskilled labour. This leads to policies which economise on the use of scarce factors and liberal use of plentiful factors. However, within an economy where this resource base is generally to be found there will be areas where there is an unusual mix of resources. This is to say that resources are not always transferable from one situation to another. For instance, capital available for water development may not be equally available for prison development.

Three main constraints exist in the area of water development in Kenya. These have been identified in a recent WHO report (WHO, 1971) as financial limitations, staff shortages and deficient administrative procedures. It is one hypothesis of this paper that capital need not be considered a limiting resource for water development and, therefore, capital intensive solutions to problems where capital and labour substitute for another constraint should be sought. This is an extremely uncommon solution to be advocated for a developing country.

Capital Availability

The contention that capital finance is not a significantly scarce resource has to be supported by evidence. First there is the indirect evidence that water investment is likely to receive high priority for local and, more important, donor finance because it has a number of highly favourable characteristics. These include the undoubted improvement that results in: the quality of human life; the widespread and readily visible impact; the high degree of public acceptance; the promise of health, comfort and economic returns; and the availability of the required technology. In the context of Swedish (SIDA) aid to Kenya, one could perhaps add that water's special "basic to life" connotation, the egalitarian nature of the investment, the income redistribution aspects and the rural emphasis, are also important factors. In summary, therefore, it can be concluded that water development has many attributes that will attract ready outside financial aid and assistance.

More direct evidence that capital is not a constraint is that the 1971 SIDA Mission assessed the application of Kenya Government for Swedish support and judged that only two-thirds of the £5.0 million Kenya submission could be spent. It is important to note that the application was cut, not for reasons of economy on the part of SIDA, but because they considered that other constraints were operating which would prevent utilisation of the requested amount.

Evidence relating to budgeted and actual expenditures would tend to support their judgement. In 1970–71 the development estimates were scaled down but, even so, less than half the allocation for rural water was spent. In the case of urban water development, and recurrent funds for urban and rural development, a surfeit of funds is not evident. However, this is considered to be a consequence of inadequate budgeting and aid-seeking, rather than problems associated with these specific items.

It is concluded that the characteristics of water development are such that finance is, at least potentially, readily available, and that in particular SIDA finance is potentially sufficient to meet all reasonable requests for assistance. Thus, if capital itself is not a bottleneck, we should look for possible trade-offs whereby capital can be substituted for other required inputs. First it is necessary to identify possible institutional arrangements whereby potential capital resources could be made available.

Institutional Change

The key agent in the process phase is the Water Department. It has been suggested that the failure to keep pace with expenditure is a symptom of needed change within this institution. If reforms are deemed important within the Department, it is necessary to ask questions about the form these should take. Two general approaches to institutional reform for developing countries may be discussed. The first requires strengthening of existing institutions. The new institution approach relies largely for its success on release for a period from the constraints imposed by bureaucracy whose main function is stability and control. In this period, which is unlikely to last more than ten years, competent staff can be attracted by high salaries and other conditions, other resources can be obtained and utilised. All too often the costs incurred elsewhere in the economy by attracting staff are not taken into account. There may be an inelastic supply of staff, *e.g.*, engineers. Many of the binding constraints may not be of an institutional character and a new institution will not therefore improve efficiency. A change in departmental status will not result in an overnight improvement, particularly where there are staff vacancies and inexperienced staff within the department, occupying inadequate offices with insufficient funds for administration.

Nevertheless, recommendations for new institutions are regularly made in developing countries. Since 1957 there have been at least ten reports on the organisation of water development in Kenya, six of which have recommended a new Ministry or Water Authority.

After studying a number of these and other reports it would appear to the writer that an international agency could perform a money-saving service by preparing a standard "Management Consultant Report" with sufficient blank spaces to ensure wide use. It would open in this form. "The Sector has been examined and found to be characterised by a lack of *co-ordination*, scarcity of *finance* and inadequate *staffing*. We recommend creation of a new *Independent Authority* to handle this sector, and to give it power we recommend it is located directly under Prime Minister's (President's) office—(continue in the same vein)". This parody of a standard report could be used by most sector consultants including education, transport, health, water supply, foodstuffs and would have as much impact as the majority of such expert evaluation, with considerable saving in interview and writing-up time.

In these consultant reports, co-ordination, or the lack of it, appears to be a predominant concern. Evidence of a lack of co-ordination abounds but the extent of waste generated is not evident. Furthermore, the gains to be obtained from the elimination of this waste may not exceed the costs. Even a net gain is not a sufficient condition for tackling co-ordination wastage because the scarce administrative personnel have opportunity costs elsewhere which should be exceeded before a "co-ordination" exercise is mounted. In such a fundamental area as water supply it is inevitable that almost every Ministry will have an interest in the activity. Co-ordination should not be equated with central control. Indeed a single agency responsible for all activities may not always assist economy and performance. An alternative to central control is clear terms of reference for participating agencies to prevent the worst examples of duplication and varying standards.

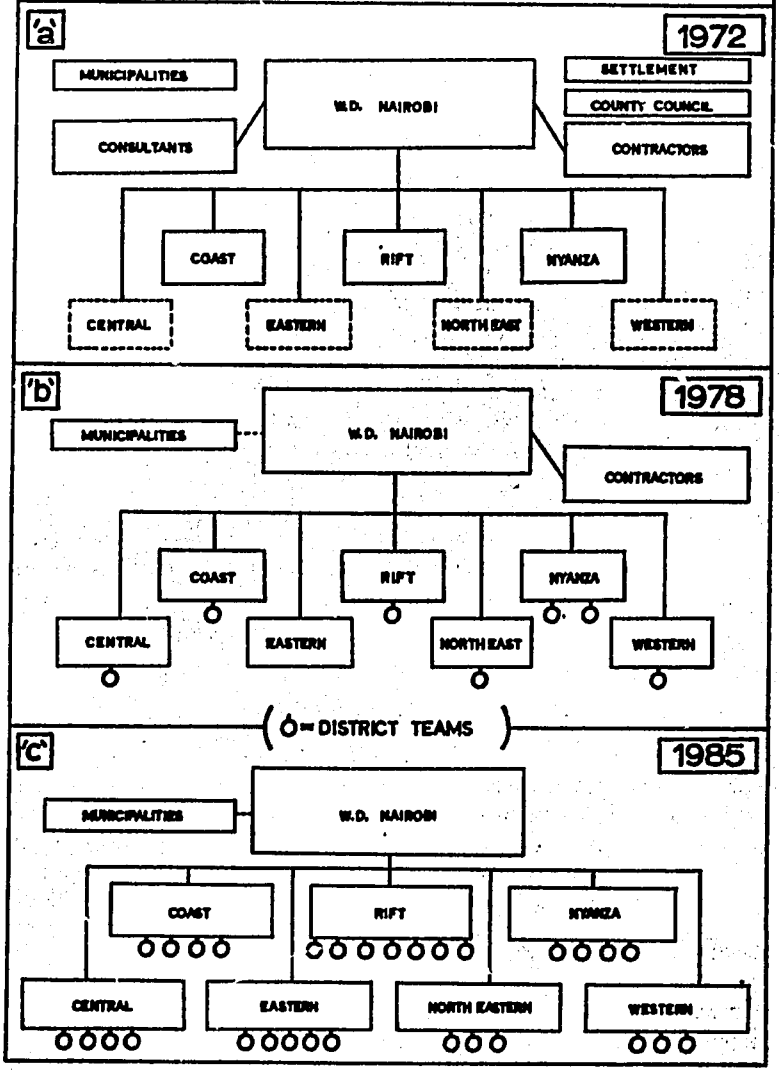
Dynamics of Growth

The Government of Kenya has opted for the second of these alternatives and is strengthening an existing institution, namely the Water Department. At present there are a number of deficiencies in the organisation, particularly with regard to staffing. In mid-1972, 44 per cent of professional posts were vacant. Training plans will be barely sufficient to fill the gap within a 10 year period. Nevertheless, the Department is set upon a period of growth.

A number of models for growth are possible. Figure 4 shows the present structure with a relatively strong central office supplying the seven Provincial offices. With growth, technical services should gradually be devolved to the Provinces. Management and specialist

FIGURE 4

PRESENT STRUCTURE AND PROPOSED CHANGES IN WATER DEVELOPMENT ORGANISATION



services should remain at headquarters. At present almost all services are regarded as specialist. For example, surveying teams are sent out from head office. Gradually responsibility for project preparation, design and implementation should grow in the Provinces leaving head office with a consultant role. With the growth of provincial services, District service teams could be properly maintained. They would need to be created mainly to ensure proper operation and maintenance which has proved to be the most difficult and vital function to organise. Growth in each province would not be equal because needs differ. However, a reasonable objective would be to have the structure in Figure 4c by 1985.

Municipal water supplies to the larger towns in the Province are usually a local Government responsibility. The municipalities are generally keen on this arrangement partly because they see water as an important revenue raising activity. If proper accounting procedures were utilised, water supplies as presently operated would be found to be rarely, if ever, money earning. It is recommended that considerable caution should be exercised before the Water Department hands over responsibility for water supplies to a municipality. The Department should ensure that the municipality has reached both technical and financial maturity. A five-year handing-over period during which time staff could be seconded might be a desirable means of assessing their capacity. Smaller schemes such as County Council schemes and Settlement schemes are not generally well run. It is suggested that they should be operated by the Water Department, if necessary, by means of an operation and maintenance contract.

Finance Availability and Input Trade-offs

If it is assumed that the Water Department can obtain sufficient finance to manipulate the input mix, and a flexible system for allocating it to needs, it still remains to examine the scope for trade-offs between finance and other constraints. Superficially there would seem to be few areas for such substitution. However, further examination reveals a number of significant improvements.

One of the scarce resources is skilled engineering manpower. There are several ways in which this manpower could be made more productive. For example, more staff could be recruited locally or internationally as consultants and contractors. Existing staff could be made more efficient by improved services and their productive life increased by reduced staff turnover.

Consultant and contractor schemes are at present something of the order of 40-80 per cent more expensive than department executed schemes. Precise comparisons are not possible because departmental cost accounting is deficient. However, costs of consultants could be cut by more use of standard drawings. Contractor costs are presently high because it is a new venture for most contractors and, therefore, it is risky. Many of the schemes are in remote areas leading to high haulage costs, nonavailability of materials and semi-skilled labour. Efficiency of Water Departments in the past in keeping to contractual obligations has not always been high. Items which lead to contractors estimating high rates include risk of client failing to deliver material on time, to pay bills in a specified period and to award contracts in time to avoid rainy seasons. With experience improved procedures are being adopted and contract rates can be expected to fall. If finance is not a constraint the higher costs could be accepted and the programme objectives realised.

Existing staff might be made more productive by improved services from machines. Scope for this ranges from the increased use of aircraft for such activities as dam and tank siting and use of air photographs in design, to small equipment such as purchase of electronic calculating machines and improved telephone systems. There is also room for management services to improve working procedures and methods. At present there are no management specialists working within the department hence basic information such as time distribution, planning costs, etc., is not readily available. This means it is not possible to allocate staff to particular types of schemes (*e.g.*, large gravity schemes) with confidence that departmental efficiency will improve. When instances of inefficiency are detected there is little flexibility in procedures. For example, it was established that in 1970-71, 60 per cent of local purchase orders which generate considerable paperwork with time consuming procedures such as obtaining quotations, cover only 4 per cent of expenditures. Nevertheless, no changes in procedures were instigated.

Efficiency of professional staff could also be increased by more sub-professional support staff, the supply of which is relatively elastic. If support staff and services were improved it would probably help to decrease the high staff turnover rate. This is one of the most costly phenomena to the Department and is a characteristic of both Kenyan and expatriate staff.

One major improvement in efficiency has stemmed from the introduction of planning and design guidelines for both consultant and departmental use. Although scope for standardisation is limited

by the individual characteristics of each scheme, there is room for a large measure of duplication. By issuing guidelines and standard drawings, considerable improvement has been effected over the situation in the 1960's when each engineer used his own personal design criteria.

There is one other reason for advocating more capital intensive solutions despite the well-known factor endowment situation of Kenya. This relates to the practical problem of obtaining funds for maintenance and replacement of parts as opposed to development expenditures. This institutional characteristic is a real factor which leads engineers to work according to the principle of "preventive maintenance" (Ferguson, 1967). Preventive maintenance may be built, to some extent, into the design by using higher safety standards and higher quality materials. If donor aid on favourable terms is available and recurrent finance is scarce, then capital intensive prevention maintenance is a rational policy.

It can be concluded that within the Water Department there is a case for improved procedures for obtaining and allocating finance and that this finance could be utilised to change the input mix to improve output performance.

Chapter VI
SELF-HELP WATER SCHEMES

Scale of Self-help Activity

One of the most original and significant phenomena of post-independence development activity has been the Harambee or Self-Help movement. In the early years of the Self-Help movement the emphasis was upon education and small development projects. To a great extent the education vacuum at primary and secondary level has been filled though considerable effort is being put into vocational training through village polytechnics and the proposed institutes of science and technology. Of greater interest in the context of the current study is the shift from smaller scale projects such as spring protection, borehole installation, cattle dip construction and other minor works to large-scale major investments such as the proposed £1.6 million Kandara Water Scheme.

In Kenya today, water development probably ranks equally with education as the type of project which is given highest priority by the farmers and labourers at the "grass root" level. Evidence for this statement could be found in several sources. For example, demands are articulated by political leaders and recorded in the proceedings of the National Assembly. There is seldom, if any, problem of acceptance of water schemes though there may be resistance to certain aspects such as revenue payment.

It is interesting to speculate on the reasons why water development now ranks foremost among the demands of people in rural areas. There are numerous interrelated reasons. Firstly, the educational needs are in the main satisfied. Secondly, water affects each and every member of an area, in a direct way which other projects such as roads do not. This fact does not escape the notice of political leaders, therefore, local leadership is assured. Thirdly, with development, certain age-old practices become no longer necessary or acceptable. Carrying heavy loads up steep slopes or over long distances is one such activity. Water demand is both a consequence and a cause of development. Fourthly, there is also the demonstration effect in the 1950's and 1960's of the former ALDEV schemes and the WHO/UNICEF Environmental Sanitation programme. These programmes have resulted in water schemes in every district in Kenya and this has probably helped create the present widespread interest. Fifthly, agricultural development results in an increased demand for water for

new enterprises and activities. This may stem from demands of farmers derived from their crop and livestock needs. Finally, throughout Kenya the main burden of water carrying is borne by the women. In recent years women's education, together with social and political activity, has been strengthened. It is reasonable to hypothesize that this organisation has resulted in a shift in priority toward water development.

These and other reasons have resulted in the current wave of interest in water schemes, an interest which can be expected to increase rather than diminish. Numerous self-help schemes are a symptom that the public are dissatisfied with the Government's ability to provide public schemes.

The goals of public water development in Kenya are to provide an adequate water supply throughout the country within 30 years. This extensive time period is realistic in view of the large area to be covered, the complexity of the programme and the limited resources which are available to promote investment. There are numerous indications that this time span, realistic though it may be from a Government viewpoint, is totally inadequate from the viewpoint of those awaiting the improved service. Casual interviews, findings of research and people's aspirations as voiced by their political leaders, indicate that they perceive an improved water supply as being a very high priority and a vital aid to improvement in living standards.

Private, individual water schemes are high cost and public resources are limited. It is, therefore, understandable that large numbers of self-help water associations are springing up throughout the country.

Self-help water improvement is not a new activity. In 1967, 764 water supplies were completed at a cost of £77,000 (78 piped supplies, 157 wells, 84 spring protection and 156 dams and catchments. Ministry of Planning, 1968). What is new is the scale of some of the recent projects. For example, Kandara Water Scheme in Murang'a District is a self-help project likely to cost £1.6 million. Mathira Division near Nyeri has a series of water schemes under construction costing between £0.1 and £0.2 million. Plans are afoot in other districts for schemes on a similar scale.

It is not fully clear why these very large and ambitious investments are being initiated by local residents. In part it is due to the characteristics of the scheme. Water supply affects every member of the community and, therefore, all are interested in its improvement. Political leaders are not slow to realise that in water schemes they have a project which affects all their constituents and which accords with their needs. Therefore, leadership of the self-help group is assured.

Quite often political boundaries accord with rivers and thus a scheme can be easily and naturally designed to cover a constituency. Furthermore, economies of scale do exist in many schemes. Thus by increasing size, average cost per head is lowered. Many self-help water associations have as their main objective effective lobbying of Government to obtain a public scheme. Clearly, the larger the membership the more effective is the lobbying. This lobbying is understandable because the average cost of communal point water schemes in Kenya are at present £45 per family and recurrent costs about £5 per family per year. This means average annual costs are of the order of £9 per year per family. Rates are generally £2 per year and, therefore, each family receives a direct income transfer from public funds of £7 per year.

The development expenditures for rural water which fall within the purview of the National Plan are of the order of £1.1 million per year. Only one scheme such as Kandara or six schemes such as Mathira would utilize all these resources. Consequently, Government is anxious to find out more about the technical feasibility, the economic benefits and the capacity of the operators to maintain schemes of this size. Furthermore, large-scale adoption of major schemes by self-help groups would distort the strategy of the plan and possibly divert resources from activities which are benefiting from public support.

In the past technical co-ordination has not always been very good. The Mathira scheme has numerous technical deficiencies discussed below. To overcome this type of problem Government has agreed to provide free technical services for large schemes. If WD cannot provide these services they will engage engineering consultants (*e.g.*, as at Kandara). However, there are signs that the demands for technical services may soon exceed the capacity to fund consultants.

Methods of fund raising merit some study. Various degrees of coercion are employed.* Several instances have been reported over the last year in the Kenya press. During field work the writer found one family that had been denied access to one self-help project—a school—because they refused to support another project, in this case a dispensary. Some self-help water schemes almost certainly utilise similar methods.

* For example, this is a copy of a circular in the possession of the writer, applicable to all staff of a County Council. Very few of the staff would benefit directly from the project:—

"All Heads of Departments,
X County Council

X Harambee Water Project

Please arrange to collect from staff within your Department towards the above important project as follows:—

Heads of Departments	20/-
Their Deputies Shs.	15/-
and the rest Shs.	5/- per person

Please let me have your contributions by Monday, 4th October, 1971 for transmission to the D.C. on 5th October, 1971 without fail."

This letter was signed by the Clerk to Council.

Kyeni Water Project

Kyeni Water Scheme has been discussed previously. A major reason for Kyeni becoming a priority scheme must be attributed to the existence of an enthusiastic and hard-working self-help association. However, from a national point of view, activities such as they engage in are not necessarily so laudable. In terms of finance the self-help group collected very little. In February, 1968, shs. 1,400.00 had been collected, less than 0.1 per cent of capital costs. Nevertheless, this sum is several times mentioned in committees and reports as a laudable and considerable contribution. Discussion took place on how to utilise this money and it was decided to offset early water rates. It is not known if this, in fact, occurred but in any event it is less than one week's rating for the scheme.

However, the amount collected in this case is almost irrelevant to the main point, which is to what extent should self-help donations and activity be utilised in determining public priorities. There is no agreed procedure for channelling the valuable energies of self-help groups in productive directions though guidelines are presently being discussed within the Government.

Self-help can take the form of labour as well as money. In many instances this is all recipients can offer. In Kyeni 90 per cent of the initial digging of trenches for pipes was constructed by self-help labour. In the early stages this did not work well but the introduction of a task system of 170 foot lengths with numbered pegs and a muster roll enabled control to be made and responsibility for a particular section pin-pointed. After this was introduced the self-help digging was satisfactory. It was usually necessary for a paid labourer to straighten and level the trench but he was able to complete 33 metres per day as opposed to only 16 to 23 metres when starting from undug land.

Nevertheless, after completion of the project the engineer in charge considered that there was little merit in trying to integrate self-help into large engineering schemes. The organisation of labour and subsequent upgrading of their work was extremely time-consuming. The total value of their work was less than 5 per cent of the capital costs. Furthermore, many residents thought that by contributing labour to the scheme their responsibility for payment of the initial cost and operation and maintenance cost was discharged and it became the Government's sole responsibility. Certainly their revenue payment performance discussed later is consistent with this view. It has been said that the best form of self-help for any water scheme is to undertake to regularly pay water fees. This is partially true. An undertaking is,

however, an insufficient guarantee, as can be seen from the discussion on financial performance. It is worth noting that at other schemes such as Tezo-Roka, in Coast Province, self-help labour has been valuable and successful.

The Kandara Project

Kandara Division is located 50 km. north of Nairobi in Muranga District of Central Province. It is a high/medium potential small farming agricultural area covering 42,000 hectares with a present population of 140,000. The vast majority of the inhabitants live on farm plots of approximately two hectares and achieve a gross annual income of about Shs. 650 per capita. There is, of course, a wide range of incomes but this gives some indication of the productive base of the agricultural economy. The main income earning enterprises are coffee, producing 75 per cent of gross income; grade and local cattle products (10 per cent), and English potatoes, maize, wattle bark and pigs (3.5, 2.8, 2.3 and 1.8 per cent respectively).

The water scheme proposals by the engineering consultants are to lay a network of water pipes to serve the whole Division with a treated water supply from a single source in the Aberdare forest (Gauff, 1972). This scheme is an ambitious self-help project, which by virtue of its scale, represents a new departure in the national Self-Help movement.

A project of this scale inevitably generates high costs. On the basis of a design serving 50 per cent of all farms with private connections and the remainder with communal points, the estimated cost is shs. 33.0 million. This represents a capital investment of approximately shs. 1,400 per family.

Despite these high costs the scheme cannot be considered an infeasible self-help project. Three factors need to be taken into consideration. First, the people clearly give water development high priority and claim to be willing to make some sacrifice in order to make the proposal a reality. Although many of the inhabitants are poor they will be able to provide labour services. It is estimated that unskilled labour represents 17 per cent of capital costs. The second factor is that Kandara Division has a relatively large proportion of the adult male population in wage employment in nearby Thika and Nairobi. This group may prove to be a valuable source of finance. The third and most important factor is that the project has the considerable assets of a powerful and energetic group of Trustees ably led by a dynamic chairman who is Member of Parliament for Kandara. The Trustees have explored several alternative sources of funds including overseas

donors. They feel confident that the capital costs will be forthcoming. Recurrent costs are very low for this gravity scheme and should present no financial difficulties.

Self-help projects are most likely to be successful when the gestation period is short. Large-scale water projects typically take many months, even years to plan and construct. It is no easy matter to maintain interest and enthusiasm for a harambee project that will take some years to complete. Until construction started on the Kandara Water Scheme the Trustees were to be congratulated for their judicious balancing of the requirements of proper planning and the needs of a "harambee" scheme. Planning requires painstaking and thorough groundwork of survey, design, and detailed appraisal before construction is contemplated. For those involved in "harambee" this may not be fully appreciated because they are impatient to see physical works.

After the Kandara Water Project was conceived in 1969-70 the project leaders followed proper procedures and requested the Water Department to make a pre-development study. This was carried out and established in a very general way that the project was feasible. As the project was so large a mere detailed feasibility study was required. On Government advice an internationally qualified firm of consultant engineers were engaged to carry out this study. This was basically because the Water Department did not have sufficient staff resources to carry out the study. Later, Government agreed to pay the fees for such planning work. In turn the Swedish International Development Agency (SIDA) agreed to include such payments under the Rural Water Credit Agreement.

Before the Kandara feasibility study was available the special needs of "harambee" for visible physical works was evident. The consultants were diverted from the feasibility study to more detailed design work for the first section from the intake and the feasibility study was delayed. Local people were mobilised and the forest cleared for several acres round the intake site. Roads were constructed through the forest though the feasibility had not been established.

This type of activity is understandable and the costs of it are not great. However, there is a real danger that financial and technical feasibility are confused. That the project is technically feasible does not guarantee in any way that it is financially sound. It is assumed that Government has a responsibility to ensure that there is both sound finance and technical competence. Construction should not be initiated until both financial budgets and technical feasibility are approved. By paying for consultancy services and, therefore, possessing the designs, the Government can exercise some control over construction.

A Case of Inadequate Planning

The planning procedures for Kandara, however uncertain the financial aspects, are a shining example in contrast to another large divisional self-help project in Central Province. The scheme which illustrates most of the dangers of uncontrolled self-help for large-scale civil engineering undertakings is located in Mathira Division. In this area there is a very large number of self-help schemes. Each one is part of a plan to bring water to the bulk of the families in the Division. In most instances individual connections are planned. Construction is in progress in several parts of the Division. Estimated costs are between £100,000 and £200,000.

In view of the very large expenditures involved and the obvious enthusiasm of the people, the following observations are extremely disturbing (these were made during 1971):—

1. There were no maps, plans or drawings available and none in use at any of the construction sites. Apparently none exist.
2. No survey levels have been taken. As a consequence, one 50,000 gallon masonry storage tank is out of command and cannot be filled.
3. An additional foot of head is being provided at the intake site to attempt to overcome this problem. Almost certainly this is inadequate.
4. Throughout the Division galvanised iron pipe is being used. This is generally too small a diameter for planned water consumption. Furthermore, plastic PVC would be more than adequate at half the cost. Storage tanks are in some instances too big and in others too small.
5. An interesting method of finding levels is now in use as a consequence of (2) above. A half-inch steel pipe is run across country and, if water flows, the three-inch main is then constructed.
6. One hydram installed is clearly giving inadequate discharge. No calculation was done and, indeed, in the absence of technical know-how, the empirical approach, though wasteful, is the only alternative.
7. From one intake, for perhaps half a mile, a three-inch G.I. main has been installed on either side of the road. One four-inch PVC main would have served the same purpose at 50 per cent of the cost. It is understood that PVC is latterly being utilised on parts of the scheme.

8. At a spring catchment there was a unique but expensive masonry silt removal device.
9. A rectangular masonry water storage tank was constructed with fairly obvious design faults which, on being filled, collapsed.

These are admittedly casual observations. However, it is clear that something is very wrong. Technical assistance was not requested from WD and the normal registration and consultation procedures for self-help water schemes were not utilised. The system should be such as to prevent this type of wasted effort. The people the scheme should serve are not wealthy and the wasted effort and money is little short of tragic.

Co-ordination and Control

The Provincial Water Engineer does not have one file on the Mathira Water Scheme although it is one of the largest water investments of the Province. This situation can be avoided by giving legal authority to the Water Department to enable them to exercise control over all water investments. It was proposed by WD that:—

> "The Government has to make up its mind on its real attitude to self-help water schemes. Whilst they may be welcomed in principle, it must be pointed out that self-help schemes can only be effectively executed if they are less than a certain size or complexity. Beyond that point they should be undertaken by professionals either by the Department or by (registered and approved?) Contractors.
>
> 3 Classes of activity are envisaged—
>
> (*a*) Very small schemes—up to £3,000 magnitude say, entirely self-help executed with only general supervision by W.D.D. or Ministry of Health.
>
> (*b*) Intermediate-sized schemes, say £3,000 to £15,000 with self-help labour and cash contributions but detailed supervision and organisation by W.D.D.
>
> (*c*) Large sized—over £15,000 entirely professional execution under W.D.D.
>
> This classification may well be varied nationally or locally according to particular situations, but we do require to have laid-down rules so that people know exactly what they can get, and so that our resources commitment is determinable.
>
> The authority (perhaps a reconstituted Water Resources Authority) that will co-ordinate the national self-help water activity must also be established together with the broad procedures.

Some indication of the annual level of activity will have to be laid down in order to regulate the work flow and hence limit the Division's resource commitment. Until we have this we are not in a position to tackle the task satisfactorily."
(Water Department memorandum, 1971.)

This statement is extremely sensible and it is regretted that no action has been taken on this document. In the case of Kandara the recommended procedure was more or less followed.

Government co-ordination and control may be justified although self-help activities may use no public resources. This is because self-help water projects utilise resources of material and manpower which may be required elsewhere. It is possible that waste will occur as is the case in the Mathira scheme. Government has a role to protect the interest of the poor who may not be able to judge the merits against the costs of alternative proposals. This Government role is particularly important when voluntary payments by various means become compulsory payments. A final reason for Government interest is that the full benefit from water investments require many complementary inputs such as agricultural extension and public health education which is fully Government's responsibility.

Priority for Water Department Schemes is decided largely by the District Development Committee. Their selection procedure is generally fairly simple and in the case of Muranga was basically historical precedent. The schemes which were first proposed, namely Gatango and Kahuti, were accepted, together with a relatively low-cost small scheme in the low-altitude dry part of the District where the need was great.

Once a public scheme is initiated the bulk of the cost, all the first phase and communal points, are borne by Government. Local participation is limited to unskilled harambee labour though this is often not requested because of the difficult organisational problems it creates. Although a water scheme then becomes liable for water rates, these are modest in relation to the costs or the benefits. Thus, the rewards for public selection are great. It is reasonable to question whether sufficient account is taken of the keenness of the population of an area to assist Government through self-help measures in cash or kind.

It is all too easy and tempting to be disparaging about the activities of groups such as that promoting the Kandara project. At best their activities are sometimes viewed as a strategy for queue jumping local and regional priority listings. It is a common observation among self-help activities in Kenya that the project initiators regard initiation

as their function and anticipate that in due course Government will be either willing or forced to assume responsibility for completion and/or operation. This type of self-help development can be viewed as operating on a ratchet principle. The first stage requires that as early as possible the proposal is registered. Once in motion the project is irreversible and has in-built momentum. Considerable political impetus may be generated. Furthermore, once funds have been expended, quite attractive marginal returns can be demonstrated. Thus, subsequent stages are politically and economically attractive and it is rational to continue.

It is possible to be cynical and regard this as a calculated strategy but whether it is calculated or an accidental consequence of over-ambitious planning the effect to Government is the same, namely, unplanned expenditures and distorted priorities which may be difficult to implement because of resources constraints.

The increased demand for water development reflected in self-help activity raises important policy questions. Of prime importance is the issue of scheme selection. At present, district priorities for Government financed schemes are set by the District Development Committees according to local priorities. No guidelines are currently issued setting out criteria which might be applied to test alternatives. In certain instances, a project considered important by a self-help association, ranks low in terms of district priorities. For example, the Kandara scheme was ranked fourth by the District Development Committee despite the unprecedented fund-raising efforts of the local people.

This illustrates some of the difficult problems to be resolved. If the local community had the capacity to raise sufficient capital and recurrent finance to pay for a feasibility study, detailed design, contract documents, construction, operation and maintenance then the problem is minimised. However, this is seldom the case. In most instances, at least the operation has to be taken over by Government. Rural people understand the need for capital but seem reluctant to face operation and maintenance costs. Generally, insufficient funds are raised to pay even for the initial installation. Nevertheless, sufficient funds are raised to demonstrate widespread public interest and sufficient to merit some form of Government support. A well organised and well supported self-help group can, therefore, attempt to by-pass the existing procedure for setting District priorities, and if these are relatively large projects they could distort planned allocations within the water sector or even within the National Plan itself.

Self-Help for Service

A new type of self-help water scheme is being developed that also has important implications for policy. Current Government projects supply a basic pipe network and communal water points are spaced so that the vast majority of the population have less than one kilometre to walk. In the richer, relatively well-watered, high potential areas this type of service, though an improvement, is not greatly better than existing traditional sources. Large numbers of people from schemes such as Kyeni, Inoi, Gatango, Ngecha, West Karachonjo and Tartar-Keringet are now petitioning for private on-farm connections. These are planned for 50 per cent of farms in Kandara; there are sound reasons to support this trend which were discussed previously in this report.

The main problem is finance for the costs are at least double. In some schemes this is to some extent being tackled by self-help activity. For example, at Inoi there is a WD scheme being constructed at a cost of £75,000 for the communal point network. The inhabitants are petitioning through the Chairman of the Self-help Water Association for individual connections and they have raised £4,000 and have a commitment to £25,000 to be used to meet this objective. Approximate estimates indicate that the additional cost of providing loop mains and hanging branch lines, plus a simple on-plot standpipe for 50 per cent of registered plots is £100,000 to £200,000 depending upon the standard of design and method of construction.

Government has, therefore, to consider whether it can accord to the wishes of the people of Inoi and provide finance for the higher degree of service. It is not a simple decision. It might be thought that by virtue of the communal point network the people of Inoi are already highly privileged and they should be content. This is perhaps true but it is also known that with private connections more people will use the main facilities, they will use more water and, therefore, obtain important health benefits, and the rate collection performance will be greatly improved. These are tangible benefits which have to be weighed against the increased cost of the superior service.

Rates for Self-Help Schemes

Once a scheme is constructed there at least two alternatives for operation and maintenance procedures. The self-help association may continue to administer the scheme or it could be handed over to Government. The latter course has much to recommend it as the Water Department has the necessary expertise and experience, machines, and equipment to ensure economical service.

In the event of Government assuming responsibility there are difficult policy issues to be resolved. These relate particularly to the proposed rate structure and level of charges. If the scheme manages to raise all capital charges, it is relevant to ask how this can be allowed for in the rate structure. At present there is no clear cut policy on this issue though the problem is cropping up with greater frequency as larger public schemes are designed incorporating existing self-help projects. Indeed, at Kandara there are 14 operating self-help projects. In some instances it will be possible to connect them to the new gravity lines, thus serving the self-help group members pumping costs and delivering to them higher quality water.

Engineers often have an aversion to self-help labour on large schemes because of experience in the difficult organisational problems and the volunteers' lack of necessary skills. Fairly simple tasks such as the digging of level and straight trenches requires some skill. It has been found also that a self-help contribution, whether 5, 20 or 100 per cent of the capital cost of the scheme, leads to difficulties in rating during operation. The self-help efforts or donations are regarded by many consumers as their total contribution for all time. Government, or those who did not contribute initially, are expected to look after the scheme henceforth.

What is urgently required is some means of providing recognition for self-help efforts while making it quite clear that additional costs will be generated and have to be covered.

It is considered that this might be achieved by the following procedure. The total value of self-help labour, materials and cash donations is computed and set against the due rates. The rates will be levied in the normal fashion which is on the general ability of the region to pay for the service. For example, let us consider a hypothetical scheme serving 1,000 households with capital costs £30,000, with annual costs of £2,000 which is assessed at the rate C1, which implies a due annual revenue of £1,800. Let us assume that the self-help association provided, during construction, labour valued at £6,000 and materials valued at £2,100, a total contribution of £8,100. In this event the local residents would have made available resources whose value was equal to 4.5 years of rates. It is recommended that on this scheme it would be announced that rates would be set aside for four and a half years. This proposal is in line with the rural water policy that rates should be low initially. It has the additional advantage that in this case water rates will not contribute to financial scarcity in the early years of the scheme operation. It is at this time that capital is required for many purposes including purchase of the

complementary inputs required to achieve the benefits expected from the water supply.

Evidence of the need for Central Government to assume responsibility for operation and maintenance costs can be found by comparing the water schemes operated by local authorities with those operated by WD. WD gazetted water schemes are presently operating efficiently. Although no detailed statistics are available for County Council schemes, it is known that large members are either non-operational or partially defective. Of the WHO/UNICEF aided schemes scheduled for construction between 1960 and 1971, 48 per cent were not working. County Council schemes seldom exceed a revenue collection performance of 50 per cent of rates due but for Water Department Gazetted Schemes, 97 per cent of all revenue is collected.

Conclusion

However laudable self-help activities may be they cannot be used to distort National priorities, nor should the impatience of participators be permitted to result in a waste of their own scarce resources. It is recommended that a greatly strengthened self-help technical service is provided by the Water Department but that large schemes (over £15,000) be discouraged and, if formulated, made the responsibility of Central Government. Self-help collections for large schemes should be taken account of in selection, and allowed for in later revenue levies. The proposed District Water Teams will have to assume responsibility for operation and maintenance of all but the very smallest schemes.

CHAPTER VII

KEY ISSUES IN FINANCE*

In common with many developing countries Kenya has well established social welfare criteria in determining development policy. However, many of the investments considered important and consuming considerable resources, such as health services or education, are either non-revenue raising or subsidised. There is an extremely narrow tax base and consequently the sources of development and recurrent finance have to be carefully evaluated. Water supply is traditionally and conventionally regarded as a public utility and has therefore been evaluated on the basis of financial criteria.

In the last twenty years project preparation and analysis has advanced from a narrow technical and financial basis to a more comprehensive and complex level. Several appraisal criteria are now applied to any proposal, the most important being economic tests. Key concepts and procedures relating to the timing of inputs and the measurement and evaluation of impact have been incorporated and now dominate project selection procedures. In many ways this is appropriate. However, in the case of water supply it is very difficult to justify investments as most of the benefits are intermediate inputs to other processes. Therefore, only a derived demand exists.

In project appraisal, analysts are typically faced with four categories of project. These are set out in Table 23. In the past, water supply was regarded as category I or II. When financial tests are strictly applied most rural areas fail to perform adequately. In some of these areas economic benefits are real, *i.e.*, it is a category III investment, but for many situations it will be a category IV amenity or charity scheme.

In these situations a number of rating strategies are feasible. At present, urban water rates throughout Kenya vary depending upon the (historical) costs of development. In rural areas a new policy is being pursued whereby rates are levied depending upon an assessment of the region's ability to pay. It appears from a study of revenue (Carruthers, 1972b) that larger urban water supplies make a profit. However, this profit is more apparent than real because insufficient provision is made for replacement and augmentation and in practice most urban supplies require considerable investments.

* The economic theory, current policies and recommendations for a modified approach to this important subject is presented at greater length in an article by the writer "A new approach to domestic water rating", *Eastern Africa Economic Review*, Vol. 4, No. 2, 1972. Oxford University Press, Nairobi.

TABLE 23

Categories of Projects Submitted for Development

	Financial test	Economic test	Example
Category I	Productive	Productive	Agricultural investments in favoured areas; some import substitution enterprises
Category II	Productive	Negative	Many industrial projects with high tariff protection, often domestic sugar
Category III	Negative	Productive	Many amenity investments, *e.g.*, water supply, education
Category IV	Negative	Negative	Many investments in low income areas with poor natural resource endowment

Water rates in municipalities and towns are levied on metered supplies and vary from shs. 0.50 to shs. 1.40 per cubic metre with a modal charge of shs. 1.31 per cubic metre. There is a connection fee at cost. New rural schemes are being installed on a basis of initially providing communal water point service to consumers. The normal rate is in the range of sh. 2 to sh. 3 per family per month. Individual connections may be provided after the initial scheme has been installed. These cost the consumer a connection fee (shs. 150/-) and a flat monthly rate (no metering) in the range of sh. 10-20 per month. The present schedule of tariffs is shown in Table 24. Tariffs A to C are for rural areas with D to L for urban areas. Tariffs C1 and G are most frequently levied.

The majority of small urban and rural water schemes do not cover full costs by means of water rates. Some subsidies are involved though they may be hidden. Hence, most water investment involves a transfer of resources from public funds to consumers. This is partly because some rates are set below full financial costs but mainly because of inefficient or ineffective collection procedures. Collection rates vary from practically zero for many County Council schemes, to 50 per cent for settlements, to more than 95 per cent for Water Department gazetted schemes.

RATE FUNCTIONS

Water pricing is a complex subject in both theory and practice. The basic problem is that there are at least three functions for the rating procedure. These functions are *economic*, *financial* and *social*.

TABLE 24

Standard Tariffs for WD Water Schemes

Supply	Tariff														
	D	E	F	G	H	I	J	K	L	A1	A2	B1	B2	C1	C2
	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.
1. Where no meter is installed a monthly charge of:—															
(i) For domestic purposes only	17 50	20 00	22 50	25 00	27 50	30 00	32 00	37 00	42 00	6 00	7 00	8 50	10 00	12 50	15 00
(ii) For building or industrial purposes	70 00	80 00	90 00	100 00	110 00	120 00	130 00	150 00	170 00	40 00	40 00	40 00	40 00	50 00	60 00
2. Where a meter is installed a monthly charge according to the reading of the meter per 1,000 litres (1 cu. metre)	0 98	1 10	1 20	1 32	1 42	1 53	1 64	1 97	1 30	0 50	0 60	0 70	0 80	0 90	1 00
3. Where water is sold to a licensed retailer per 1,000 litres (1 cu. metre)	0 87	0 87	0 87	1 10	1 20	1 32	1 42	1 64	1 32	0 35	0 60	0 60	0 70	0 70	0 80
4. Retail charge for water sold by a licensed retailer or at a kiosk per unit of 25 litres or part thereof	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05	0 05
5. At supplies where a bulk rate is authorised, for water sold in excess of 140 cu. metres, through one meter in any one month per 1,000 litres (1 cu. metre)	0 78	0 87	0 96	1 05	1 14	1 23	1 32	1 75	2 08	—	—	—	—	0 70	0 80
6. Minimum charge for water at a metered connexion: per month	9 00	10 00	11 00	12 00	13 00	14 00	15 00	18 00	21 00	4 00	4 50	5 50	6 50	7 00	8 00

Source: Republic of Kenya—Legal Notice No. 288, 1971.

The economic function is to ensure that resources are efficiently utilised. Hence the appropriate criterion is whether the price charged is equal to society's valuation of the resources utilised in producing the service. If the consumer price exceeds the marginal cost of providing water, full economic utilisation is likely to be prevented.

In the case of urban water supplies, prices are generally lower than long run marginal costs because easier and cheaper sources were available and because of the effects of inflation. Prices may also be lower than short run marginal costs because of political difficulties in increasing rates necessitated by either inflation or rising marginal costs. In this situation water is cheaper to the consumer than the real cost. This may in turn lead to demand exceeding supply at the going price, to water shortages and demands for new, even higher cost augmentation.

The financial function is that the rates should cover the costs of the service. These costs include capital costs, operation and maintenance costs and revenue collection costs. In this case inflation also has to be taken into account. Ideally, these charges should cover the costs of external diseconomies—for example, the costed loss to fishing should be included if the level of a lake reservoir falls too low to sustain fish life. The social function is a mixed bag of policies and actions whereby water pricing may be used to promote income redistribution, economic stability, develop backward areas and encourage investment by beneficiaries.

Pattern of Demand

For urban areas, the demand schedule is relatively inelastic. This is because water is a necessity. In principle, we can anticipate some price at which alternative sources would be sought, or consumption curtailed, but in urban areas these are generally outside the operational area either because alternative sources do not exist or they are heavily polluted or they are very distant. In rural areas alternative sources at low or zero cost are generally available, hence substitution is possible. Therefore, the demand curve is more elastic over a given range.

With higher levels of income the marginal utility of income can be expected to fall. Thus, at a given price more water will be consumed. However, part of this water will be for non-essential use hence the demand schedule will be more elastic. Therefore, the urban high income consumer may forego garden watering or car washing with high prices but indulge in lavish use if low prices obtain. This tendency for elasticity is modified by the fact that water expenditure is relatively low in the total budget of high income consumers.

Industry is likely to be more or less sensitive to price depending upon the cost of water in total production cost and the opportunity for substituting water using techniques for other methods. For example, if water is expensive, air cooling may be used rather than water cooling, or provision may be made for recycling water and so on. In addition, industry is in a position to provide alternative sources by boreholes or other means. In many instances there will be little opportunity for substitution, *e.g.*, brewing. Nevertheless, the industry demand curve is likely to be more elastic over certain ranges than high or low income consumers.

The potential for using rates as a policy instrument to modify demand will be realised only if there is operational flexibility in the rating system. Rigidity rather than flexibility is the norm in rating. Rates are changed seldom, which may appear to be generally good, and the increase is usually small. However, if the price stability is maintained in the face of major shifts in costs the financial implications may be considerable.

Cost Structure

In the case of water supplies, the cost structure is different from most other utilities. Fixed costs are high and there are increasing returns to size. Increasing returns occur because of the functional relationship between capacity and costs. For example, this holds for pipe investments and is particularly true as the distance from source to delivery point increases. With an increase in distance, pipes are an increasing proportion of total costs. Though laid costs are roughly proportional to pipe diameter carrying capacity increases more rapidly, being roughly given by the relationship $\sqrt{d^5}$ where d is pipe diameter. However, there is a dynamic aspect to the problem. The decreasing cost/capacity relationship has to be balanced by the temporal pattern of demand, which is lowest at the beginning of the project, and by the costs involved in having capital invested in excess capacity.

In addition to high fixed investment costs there is a large part of recurrent cost which is not variable with amount of water consumed. For example, the costs of operator and maintenance staff are independent of the level of use. These are sometimes called "indivisible costs". For a gravity water scheme true short run marginal costs are practically zero. To summarise, over a considerable operational range unit costs fall with an increasing level of utilisation. These factors have considerable impact upon pricing policy.

Long run average costs may be either increasing or decreasing. In well-developed city areas, such as Nairobi and Mombasa, long run average costs are rising. But domestic and industrial rates do not

reflect rising long run average and marginal costs. If the high long run marginal cost is charged as a rate, a considerable financial surplus would be generated. If the short run marginal or even average cost is charged, recurrent capacity crises would occur should consumers respond rationally to low charges. In rural and small urban schemes, it is common to find decreasing average costs, because of the economies of scale and high fixed costs for intakes, pumping plant, treatment works, etc. In this case marginal cost pricing will not generate enough revenue. Average cost pricing would cover costs but restrict economic use. This is particularly well-illustrated with gravity schemes such as Kyeni where capacity is installed to meet demand levels in ten or twenty years.* Short run marginal costs are practically zero, but most rating systems will discourage use of the water. Long run marginal costs are likely to be less than those of another new scheme because of the possibility of utilising the existing survey, break pressure tanks and other facilities. These factors suggest that a rating policy might be devised whereby financial surpluses from well-developed urban systems could be used to cover rural deficits.

In theory we should aim for a capacity level and level of use where the average and marginal costs are equal. In the case of most water supplies this is seldom possible because of the small size of variable costs relative to fixed costs. Variable costs never increase sufficiently to result in a rising average cost curve, hence all capacity is utilised before the rising marginal cost curve intersects the average cost curve. Therefore, the theoretical optimum capacity level is not feasible.

Costs for eighty-nine rural and urban water schemes operated by WD in Kenya, taken from a recent WHO Report, have the structure presented in Table 25. This shows that only 12 per cent of annual costs will vary with level of water use. More than 70 per cent of those schemes are pump schemes. For new rural schemes a much lower percentage will be pumped because they are larger schemes and can carry the higher initial costs of tapping a gravity source. Therefore, the proportion of costs which vary with level of consumption are likely to be less than 10 per cent in future rural schemes.

* A novel procedure is proposed on one large self-help scheme to get some benefit from temporary excess capacity that always exists in the early years of operation when demand is below capacity. In this case break pressure tanks will be allowed to overflow and excess water taken by furrow to licensed horticultural producers. These farmers will have this water by grace and favour. Their licence terms will clearly indicate that this is a windfall gain which will in due course be removed. If consumption levels do not reach the anticipated level (a real possibility, when design consumption is 90 litres per capita per day), this will be a permanent source of minor irrigation water. Given the economies of scale in pipe capacity the marginal cost of providing this water is low, allowing us to accommodate low value agricultural users.

TABLE 25

Cost Structure of WD Operated Water Schemes

Capacity cost (estimated current cost)	£6.5 per head
Annual cost at 8 per cent 30 years	shs 11.55 per head
Recurrent costs	
Indivisible costs	
Pipe maintenance and repair	shs 2.00 per head
Wages of operators	shs 5.00 per head
Maintenance of structures	shs 0.25 per head
Miscellaneous:	
Uniforms, transport, etc.	shs 2.65 per head
Variable costs	
Maintenance and repair of equipment	shs 0.60 per head
Fuel and lubricants	shs 1.80 per head
Chemicals	shs 0.70 per head
Total annual costs	shs 24.55 per head
Total variable costs	shs 3.10 per head

Source: WHO, 1972 (a).

From Government's viewpoint, the low marginal cost is not sufficient justification for investment in capacity above domestic requirements, in any given area because the major part of the rural area is not yet served. Hence they would forego high marginal returns from the initial supply to unserved areas if resources are concentrated on few schemes. Furthermore, even if it could be demonstrated that there is a high ratio of gains to costs by concentrating upon a few schemes and capturing economies of scale, there are political factors in favour of spreading investment which cannot be ignored.

Effective demand for safe accessible water is at present low. Evidence for this statement includes excess capacity in existing water schemes and the scant coverage of many self-help schemes. The consumers' demand schedule generally lies wholly beneath the average cost curve and, therefore, recovery of full costs is impossible. Indeed, in many instances effective demand is below the low marginal cost curve. If, as is often the case, the demand is lacking partly because consumers are not educated to appreciate the real value of safe water, then a promotional pricing policy (and educational programmes) has much to recommend it.

In a low income situation, social criteria are likely to rank foremost due in part to the desire of Government to redistribute income. They may therefore elevate certain goods above market criteria. These

"merit wants" are politically determined. In Kenya, rural development receives emphasis and it is clear that water development would also receive strong support even if the economic and financial advantages were demonstrably low. One of the first functions of the State is to ensure that all people participate in a real sense in the community and thus help to formulate the common standards or objectives of the community. It is possible for members of the community to possess political and legal rights yet not be able to participate because of their poverty. In this case one of the first functions of the State is to provide the means for participation, in other words to remove abject poverty. In pursuing this aim of ensuring a minimum living standard, financial factors must be secondary. There is a clear indication that Government regards water development as part of its responsibility for providing minimum standards.

It can be seen from the preceding discussion that social and economic functions of rating for *rural* water supplies are likely to coincide. The cost structure is such that marginal costs are low, excess capacity is available thus a low price policy has economic as well as social attractions.

Rate System Alternatives

We have established that financial and economic and social objectives are likely to conflict. One possible way to reconcile conflicting functions is to exercise price discrimination by which groups of users known to benefit most from the scheme pay an additional charge above marginal cost. A downward sloping demand curve implies the existence of a consumer's surplus. Price discrimination enables the utility to tap part of this consumer surplus. Revenue raised by a supplementary charge can help meet a financial deficit which marginal cost pricing may generate. It is admitted that the conditions of economic efficiency will not be fully met because the group discriminated against pays more than marginal cost.

To achieve price discrimination, the consumers must be grouped into separate categories. It is feasible to separate those with individual connections from those using communal points. Although it is possible to conceive of individual consumers paying more than either marginal or average costs, it is not recommended that they pay more than national average costs. This is because the additional benefits from private connections are high and costs relatively low. As discussed later it is recommended that communal facilities are made free by a subsidy from Central Government.

Another form of price discrimination practised by some County Councils, including Kiambu, involves having a high priced domestic

rate and a low priced cattle rate. The markets are separated by having cattle watering at few public watering places. The domestic rate is set to cover fixed and variable costs but the cattle rate only covers variable pumping costs.

A second approach to reconciling conflicting functions also requires an additional fee. This is a two-part tariff with a flat rate irrespective of quantity, plus a marginal cost rate for quantity. The flat fee would have to be relatively high in most rural areas if this method is to be used to approach financial targets.

A third possibility is to make an explicit subsidy from general revenue for any shortfall. This could be the simplest procedure. However, this would be straight income redistribution with Government funds diverted from economically attractive alternatives. The merits of each of these alternatives has to be weighed by consideration of social values. In the present context in Kenya where relatively few people benefit from improved water schemes, and there is a wide disparity in benefits, some form of price discrimination has most appeal.

Practical Constraints Upon Theoretical Systems

The system which operates at present is "compulsory" in the sense that there are legal sanctions which can be invoked to enforce payment but "voluntary" in the sense that in many instances the will and means for enforcement are absent. Though, in most places in Kenya, there is recognition that water service from pipes is "different" from traditional water, and therefore, payment must be made to reimburse Government for its expenditure, this measure of assent is likely to be overthrown. This is because of the sheer weight of habit and rapid spread from a focus of non-payment. To date Government has failed to find a workable system of collecting revenue from communal water points, which is the present basis for all rural schemes. Furthermore, the division of responsibility between Water Department, who operate projects and set rates, and the Administration who, somewhat reluctantly, collect rates, threatens to prevent rating working in rural areas, even with individual connections.

Individual connections offer the possibility of high revenue collection. This possibility can be realised only by exercising strict cut-off for non-payment. At the three rural water schemes with individual connections (Zaina, Kabare, Kibichori) revenue has never exceeded 50 per cent of levy. This is largely because of the reluctance of the respective County Councils to exercise sanctions in the politically sensitive area of water supply. However, the gazetted water schemes

operated by Central Government, which are nearly all individual connection schemes, collected 97 per cent of revenue due in 1969-70 and 1970-71.

It is both urgent and important that agreement is reached upon an operational rating policy, which is satisfactory from an economic and financial viewpoint and workable in the Kenyan context. In particular the policy should take account of underlying social forces. In the following sections a rating system is proposed which embodies the pervasive institutional, economic and political factors which limit the flexibility of pricing and fiscal policies.

Recommended Rate Philosophy

In the first instance we distinguish between public communal water points and private, household, industrial or commercial connections. The former provide a minimal level of service and require the consumers to walk some distance and carry water back to their premises. It is established that when water is carried, levels of consumption are very low. Provision of this basic communal service can be regarded as a Government responsibility, assisting in a small way to relieve poverty among low-income groups. Therefore, in this case, Government should assume responsibility for all charges. This will involve a loss of revenue. However, the loss will be very small because it has been found practically impossible to enforce revenue payments from communal points without using kiosks or licensed retailers. Whichever method is used, collection costs are high relative to revenue payments. Granting of free supplies will make legal the activities of those presently using points, without paying, in the knowledge that they are liable for charges. There can be little merit in creating several thousand law-breakers among normally law-abiding people, or in allowing non-payment for Government investments which can help create a mentality which spills over to other areas such as agricultural credit, Government taxes and so on. The conclusion is that all services from communal water points and lesser degrees of service for domestic use should in future be provided free of charge, the cost being borne by the Treasury. This income redistribution measure will coincide with the economic optima for many schemes because marginal costs are close to zero.

Kiosks and licensed retailers work quite well in certain areas such as the Coast, so it is reasonable to question whether or not this form of communal service should continue. The writer contends that service from this type of communal point should also be free. This is because the basic reason for recommending a free service is social. A communal service is the minimum acceptable level of public water

service to be given to low income consumers. In the areas where kiosks or licensed retailers work, population density is high. In the rural context this may imply small farm size and very low incomes. Furthermore, kiosk or licensed retailers are often favoured where water is scarce. This is generally the case in low-rainfall situations which are also low income areas. Where water is scarce, or expensive, clearly some rationing device is required. This may be price through a supervised outlet. However, it is known that where water is carried, consumption is low, near the minimum, even if supply is free. Therefore, price rationing is unnecessary because the quantity of water used has a ceiling which is unaffected by price.* Some supervision of communal water points on pumped or expensive schemes would be desirable but a number of alternative administrative devices are possible to prevent wastage. For example, supervision could be maintained by a salaried official or low discharge outlets could be provided.

The suggestion that communal points including kiosks and licensed retailers are made free should be seen against another recommendation which is that this form of connection should be rarely installed and where possible actively discouraged. It should be discouraged by the positive promotion of individual connections as recommended below.

Individual connections should be encouraged for reasons which may be briefly summarised: consumption will increase to higher levels leading to health benefits; the number of consumers will increase; and revenue performance will improve. It is contended that connections should be encouraged by means of a low initial connection fee, the costs of connections to be recouped where possible by means of water rates. A modest connection fee has the merit of providing some discouragement for irresponsible connections whilst raising a small amount of revenue. It should be low because it will encourage large numbers of connections hence higher aggregate benefits and lower average connection costs. Furthermore, water only gives potential benefits and complementary investments are required. Some of these complementary investments, such as grade cattle, require large amounts of finance. A high connection fee has the disadvantage of creating capital shortage at a critical time.

At present the connection fee for rural areas is standard at shs. 150.00 throughout Kenya, subject to a cost ceiling of shs. 400.00. The principle of a standard fee is sound. However, when the shs. 60.00 deposit is included, a prospective consumer has to pay shs. 210.00 for

* The ceiling will be higher than current demands. Research at the Coast and experience in Tanzania indicates that a free supply will double kiosk demand.

a connection. Whilst this cannot be regarded as a high charge in relation to the capital costs and the service provided, it is set too high for the mass adoption of this innovation which is considered desirable. A reasonable aim would be to connect 40 per cent of potential consumers within the first twelve months of scheme operation. To facilitate this, a connection fee of shs. 100.00 including the shs. 60.00 deposit is judged to be an appropriate maximum fee.

The minimum monthly rate of shs. 15.00 should also be abolished. It may be financially worthwhile in an area with low operating costs and a flat rate system, to charge as low as shs. 5.00 per month, payable quarterly. If this increases consumption there is also social and economic merit in the proposal.

Recommended Rating Policy

As previously stated, all communal facilities should be free. For individual connections in urban areas metered connections are the norm. The rate system could be improved by having a two-part tariff with the first part a minimum charge designed to produce some revenue, the second a low rate of reflecting marginal cost (low where excess capacity exists). It seems unlikely that revenue will fully cover capital and recurrent charges as indicated later.

In urban areas authorities are going to be faced increasingly with the problem of low-income consumers. Many will be serviced by a communal facility. However, a large number will have "site and service" plots which include a water point. A sound case can be made on social welfare grounds for a minimum service at low cost. Certainly the proposal for using the initial volume of water for revenue raising would prove a hardship to many families. Therefore, the authorities should explore the possibility of a low initial rate for up to 4.5 cubic metres per month, a high revenue raising intermediate rate for up to 50 cubic metres and a rate reflecting marginal cost for bulk supplies. This may at first seem a cumbersome procedure but billing techniques are becoming very sophisticated and with computer facilities this is no more difficult than any other procedure.

In the cities of Mombasa and Nairobi, current rating practice should be largely continued. This implies some subsidy on capital costs. However, the option to increase rates should be exercised whenever prices get excessively out of line with long run marginal costs. It is particularly important to increase rates for bulk supplies. Special measures such as a temporary surcharge might be levied in order to deter consumption when, as at present in both Nairobi and Mombasa, demand approaches available capacity supplies. Growth in demand

may be generated largely by particular industries. For example, hotel developments at the Coast. In this instance there is a case for charging long run marginal costs for all new hotel connections by a special hotel connection fee and special hotel water rates.

It is recommended that industrial users pay rates roughly approximating to long run marginal costs. Locations such as Thika with a comparative advantage should have a low-cost rating policy which may attract large water-using industries. A two-part tariff system has economic and financial attractions. Where a marginal cost policy for industry would cause financial loss to the Water Undertakers, Treasury should reimburse them for the differences between the optimum social revenue and the financial cost.

For individual connections in rural areas consumers should normally pay equal rates on each scheme. There should be no meters but flow regulation devices. Where a large scheme is being considered, which covers a number of ecological zones, it might be necessary to have zone rates according to the zonal "ability to pay".

The writer considers regional ability to pay to be the main criterion for deciding the level of rural rates. This can only be a matter for judgement because there is scant knowledge of the levels of rural incomes. Furthermore, even if this information was available it is a value judgement as to what proportion of disposable income can be represented as "ability to pay".

For most of the high and medium potential rural areas, shs. 10.00 to shs. 15.00 per month might be considered to be the average ability to pay, though this will increase with development. Any rating system ultimately relies for its success on the efficiency of the collection procedures. No major change is required in the procedures for urban and municipal rate collection though more efficiency in lowering the number of unpaid bills is required. For County Council schemes, this is especially true. On rural schemes the present collection system is completely unworkable for a number of reasons. First, the field staff of the Administration, though charged with responsibility for collection, have to date failed to make the necessary administrative arrangements to ensure consumer agreement forms are signed and that non-payment is punished. They claim problems with staffing and with the workings of the system. For example, all inhabitants of an area are theoretically liable to pay for communal point rates whether they use water or not, whether they use daily or irregularly, whether they use 10 gallons or 1,000 gallons per week. Settlement scheme rates should be in line with other Government rates.

The Case for Strict Financial Criteria

It is necessary to consider the case put forward strongly by some authorities, notably the World Bank Group, that water supplies are revenue raising utilities and that they should observe strict financial discipline. For example, one spokesman of the Bank Group has stated: "The idea that water for drinking and hygiene should be free, or heavily subsidised, tends to inhibit financing for water supply and is a major cause of the shortage in less developed countries which already is critical and is growing worse". (Ripman, 1967.)

"In fact, rates charged by long-established utilities in some less developed countries bear no close relation to real costs, but are held low for socio-political reasons. The utilities are subsidized. While the subsidies may be too small and uncertain to assure satisfactory service, they place a heavy burden on the Government's scarce revenues and often lead to inflationary borrowing. In some cases, utility revenues themselves are diverted to other purposes to relieve pressure on the budget. Service inevitably deteriorates, falling progressively farther behind demand. Public indignation over poor service and resistance to higher rates grow simultaneously feeding upon each other, while development is inhibited by the shortage of services that are basic to the health, mobility and productivity of people. It would be unrealistic to expect any other resources available to the Government of a less developed country, the many pressing demands that are made upon them, and the relative political impotence of a financially dependent utility system.

The Bank Group's experience in less developed countries has indicated clearly that revenue-producing public utility projects almost invariably will fail to meet the needs of economic development unless they are made to pay their own way. Consequently, the Bank and IDA make the adoption of sound financial policies a precondition of their lending for such projects. They require especially that rates be established which will cover all operating and maintenance costs, including debt requirements, and produce a surplus which will help finance future extensions. These conditions apply whether the utility is publicly or privately owned." (Ripman, 1967.)

The writer contends that a proper subsidy scheme will not *inevitably* lead to poor service. Indeed many sound utilities are in fact recipients of open and disguised subsidies. If the service really is basic to the health, mobility and productivity of the people, it cannot be left to the chance that rates and effective demand will equate at a socially optimum level. Furthermore it is reasonable to question the logic and morality of requiring people at the foot of the income ladder to

provide not only for their own costs but funds for future extensions. For Managua in Nicaragua, IDA encouraged pricing policies which covered "operation and maintenance, depreciation, interest and amortization payments, normal year-to-year extensions of service, and a reasonable proportion of major expansion programs as they became necessary". (Ripman, *op cit.*). By paying depreciation and interest and amortization consumers were paying twice for the same charge as well as setting up funds for future extensions.

In advocating such strict financial discipline the Bank ignores the present low income of consumers, the important role of water service in generating income and amenity, the indivisibilities and economies of scale in capacity construction and the consequent excess capacity which is idle but which could be used at low cost. For example, there is 40 per cent excess capacity in WD schemes (excluding Mombasa) which could be utilised at the minimal cost of fuel and chemicals.

The practice of fixing rates according to the financial terms of the loan should be discontinued. If an asset with a 50-year life is acquired on a 20-year loan it is the duty of Government to meet loan requirements. If the beneficiaries have to be charged according to financial costs then the charges should be spread over a 50-year, rather than a 20-year, repayment period. Government then acts as a broker between the lender and beneficiary.

The Case for Budgetary Reform

In discussion the officers of the Water Department identify shortage of finance, particularly recurrent finance, as the major constraint. This they view as the basic cause of the present malaise and the other problems are merely symptoms. The basic contention of this section is that for rural water finance need not in any way be a constraint. How is it possible to reconcile these apparently opposing views? Clearly, if the diagnosis that finance is the key constraint is correct and a prescription is found whereby finance can be made available, rural water development will be placed on a sound basis. It is therefore necessary to examine the system of obtaining and allocating the money. Central to this is the budgeting system.

The major function of the present budgeting procedure is to translate the broad objectives of Government, confirmed by Parliament, into operational decisions. It is thus the central record of the way in which available resources will be allocated. For analytical purposes three sub-functions can be identified. These may be termed control of spending, management of ongoing activities and planning. Any budget

system includes elements of all three functions. In part they are complementary but important differences in philosophy and impact occur depending upon the weight given to each function. For example the main ethos of the Treasury system of Kenya is control of spending, balancing the one-year budget, and prevention of fraud. Hence, it is a conservative and negative force whereas the planning function is innovative and expansionist. Control emphasises saving, planning generates orderly spending.

The management of activities is receiving more emphasis with the increasing number of projects. With the management function the budget represents a work programme and the orientation is toward tasks to be completed. The main tools to improve performance are cost accounting and scientific management. The Water Department is struggling to escape from the control system toward a management, and therefore task, project and performance orientated approach. Considerable effort and expertise will be diverted to this end. The question which the writer wishes to pose is whether this intermediate goal is the appropriate one. Perhaps a planning approach should be adopted from the start.

A management approach to the budget is "ends" orientated. If a planning approach was adopted objectives would become pre-eminent and thus the budget would be "means" orientated. The planning view of the budget is that this is a statement of resources required to reach carefully specified strategic objectives. Hence, resources are allocated on the basis of policy and in fact the budget can be regarded as a statement of policy. Resources are therefore allocated from the top downwards. In the management and control systems the budget is built up from the lowest levels, aggregated and adjusted to meet estimated resource availability. In the current context in Kenya the upward movement of estimates is very inefficient.

In Kenya, planning and budgeting activities have been viewed as parallel but quite separate activities. More and more planning is impinging upon the budget function and the merging of the Ministries of Finance and Economic Planning is a healthy symptom. However, this is only a necessary condition for more influence of long-term objectives and policy upon the budget process. The still separate grouping and personal identification of staff within the Ministry as "Planning" or "Treasury" staff is indicative of a long road still to be covered.

Whilst a planning approach to budgeting may not be suitable for all programmes it is considered that the water development programme has characteristics which make it extremely appropriate. First, the

water development programme is long range; it is likely to take at least 30 years to complete the first phase. Second, there are long gestation periods for project components. Third, the programme is being rapidly expanded and a planning approach to budgeting which goes from objectives to resources is more able to cope with large adjustments than is a control or management approach. There is a tendency for the latter to accept the historical and present levels of the budget and allow only small increments to establish votes. Even where there is allowed a discontinuity in the trend of one item, others may lag. For instance, in the case of rural water, Swedish credits have allowed big increases in development expenditures to be obtained, but recurrent votes have been tied to national average increases. This has the effect of preventing full utilisation of available development funds.

The fourth characteristic of the water programme is that its recent origin increases the need for a policy orientation. Many options are still open and analytical tools of planning will help in evaluating alternatives.

There is an important implication if it is accepted that water development would improve with a greater emphasis upon the planning as opposed to the management and control aspects of the budget. This is the question of what institutional framework would facilitate a planning emphasis. Although there are certain signs of convergence of planning and control functions within the Kenya Government system, there are also indications that opposing forces are operating. For example, the increasing use of devices such as control purchasing, open tenders and preoccupation with civil service reform and standard accounting procedures. The current trend of bringing of parastatal bodies within the Civil Service regulatory framework is another example.

There is little possibility of radical general reform of public budgeting procedures in the near future. Hence, if budgeting in water development is a key constraint perhaps a water development institution outside Government should be contemplated. Alternatively the Water Department could demonstrate that its function is different to most Government departments in that it is basically an engineering design and construction agency with an operation phase that has peculiar problems such as the likelihood of sudden and urgent maintenance problems. Therefore, special provision could perhaps be negotiated to make the Department operational, either as a separate Ministry or as a Department of the present Ministry. In the view of the author, any shift of institutional arrangements must be accom-

panied by budgetary reform if the Water Department is to effect major improvements. Special needs such as these have been recognised in the past; for example, in creating the semi-independent National Irrigation Board and the devising of new procedures for the functionally similar Road Branch of the Ministry of Works.

The Kenya Government splits the budget into development and recurrent components. In normal accounting, the recurrent votes primarily cover operation and maintenance of water supplies. However, in the Kenya Government accounting procedures several items of a development nature are charged to recurrent funds. For instance cost of planning, survey, design draughting, capital cost of construction equipment, vehicle replacement, transport workshop, purchasing and stores are all included as recurrent costs.

The importance of this is that in the past the external credit agreements on water have been tied only to development funds. This has resulted in a fourfold increase in development budget in the last three years. However, the recurrent budget, though closely related to development expenditure, has been tied to the national average annual increase of 7 per cent. Therefore, over the three years 1968-71 only 25 per cent increase in recurrent budget was obtained. The SIDA credit agreement operating from 1972 wisely includes credit for items classified as recurrent expenditure.

One of the main recommendations of a recent Kenya Government Commission relating to management of public finance (Government of Kenya, 1971) was that the recurrent and the development estimates should be combined into one integrated financial plan. This recommendation, if accepted, would be the biggest single gain to the rural water programme. It would help facilitate a planning rather than a control function. Given this, together with the characteristics of water supply which ensure donor finance, the national objectives for water development become realistic.

Financial Conclusions

If there is to be widespread adoption of piped water supplies subsidies will be necessary. If water supplies are regarded as utilities required to earn sufficient revenue to cover costs, then only an urban minority will receive the service. This policy is not recommended. Considerable economies of scale exist in water supplies and short run marginal costs are very low. Hence, to exploit economic use a low price and a subsidy are required. There are other reasons in favour of a subsidy. Protected water is an important amenity which might be regarded as a "merit want". From communal facilities revenue

collection is impractical. Benefits from private connections are potentially large. However, water rates set at the financial level may preclude the adoption of private connections in low income situations. It is concluded that subsidised water rating is necessary if Government objectives in this area are to be realised and that such subsidies may prove to be an efficient means of income redistribution.

It is largely because of the historical fact that water development was first carried out in urban areas, where water was a saleable commodity, that it is customary for water supply undertakings to be regarded as revenue raising public utilities. There is no more logical ground for this than for the alternative of regarding them as social services to be paid from general revenue. Other public services such as dispensaries and libraries are not regarded as revenue raising services though the possibility exists for such a procedure. The main reason for this is that the level of use of these socially desirable services would certainly fall if they had to cover full costs.

It is recommended that public water supply undertakings in developing countries such as Kenya, particularly those in rural areas, should be regarded as a social rather than as a self-financing institution. This does not preclude a revenue function which is considered desirable for private connections. If the service really is basic to the health, mobility and productivity of the people, it cannot be left to the chance that water rates and effective demand will equate at a socially optimum level.

The current policy aims to provide all Kenyans with access to protected water within 30 years. To achieve this objective recognition has to be given to a new status for water supplies, namely that of a public service, and to the financial obligations that this recognition will impose upon the Treasury.

MAIN FINDINGS AND RECOMMENDATIONS

1 Rural water development is seen by the Kenyan authorities as an important component of a new, broad strategy for rural development that emphasises employment, availability of economic and social services, as well as per capita income. Some 5 per cent of public sector development expenditure will be allocated to water supply.

2. Given the stated objective of a generally available potable water supply by the year 2000, development expenditures approaching £250 million will be required, of which £86 million will be for rural areas. This is technically feasible but the main constraints are likely to be shortages of engineers and recurrent finance.

3. Potential health and economic impact from this investment is substantial but at present realised benefits are insignificant. This is because of the neglect of complementary facilities such as health and agricultural education, agricultural credit, and production and marketing programmes. It is recommended that schemes be selected to support viable production programmes so that the necessary complementary facilities are made available.

4. It is recommended that either low cost, low-impact communal point systems should be installed initially, or high-cost, high-benefit individual connection systems, and not the present high-cost communal networks. In high and medium potential rural areas, however, individual connections from the start are generally recommended.

5. Great improvements have been made in selection and design criteria and these can no longer be regarded as a major problem.

6. Operation and maintenance of water systems need additional resources and improved procedures because they are the most difficult and vital part of rural water supply. Provincial and District organisation requires strengthening.

7. The present practice of setting and applying water rates is not financially sound, nor is it economically or socially optimal. Rural water supplies should be regarded as a basic social service and new financial arrangements made in line with this policy. In particular, communal points should be free and private connections should have a low connection fee with rates set according to regional income levels.

8. Self-help activity is a remarkable and powerful phenomenon occurring on a vast scale. It requires firm Central Government direction and control if resources are not to be wasted.

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