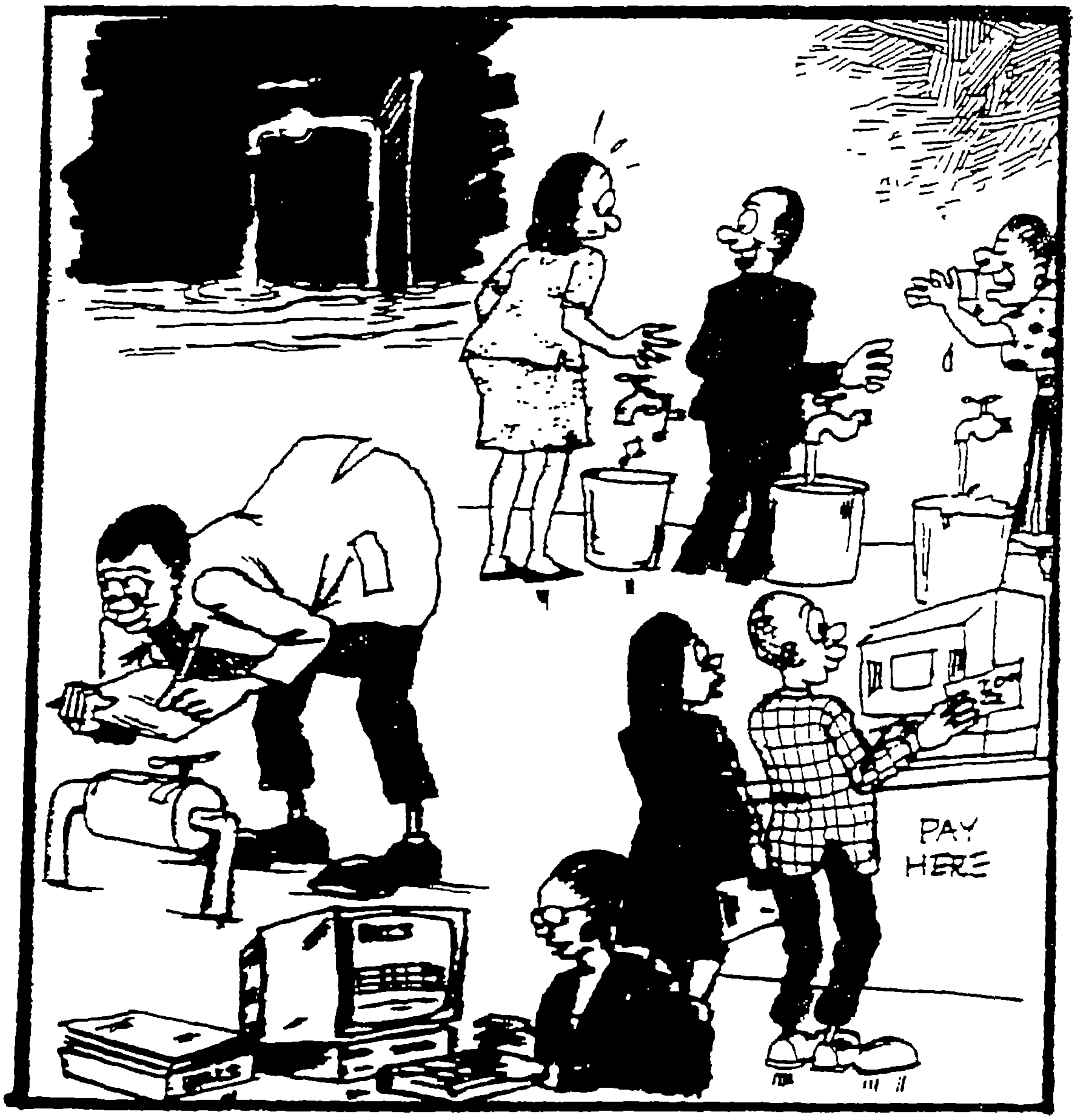
Manual on

PRICE AND TARIFF SETTING

FOR

PIPED WATER SUPPLIES



MANUAL

ON

PRICES AND TARIFF SETTING

FOR

PIPED WATER SUPPLIES

Prepared for SIDA
by
BER

May 1998

Preface

Manual No. 1, *Meter-Based Water Management System*, explained why we need to pay for water. It also discussed two of the most commonly found water charging methods in piped water supplies: flat rate and metered charges and indicated the comparative superiority of metered charging methods.

This Manual No. 2, *Water Prices and Tariff Setting*, describes the factors which need to be considered in developing and establishing water prices and tariff structures for piped water supplies It also explains how water prices and tariffs are set and revised at a well managed water scheme.

Proper setting of water prices and tariffs is a task which requires specialized skills and knowledge. It is unlikely that such skills are found, in-house, in community managed water supplies. It is not the aim of this manual to enable the community scheme manager price water services at his/her supply (although if this is achieved it will be a useful by-product), rather, the manual aims at making him/her aware of the general nature and environment of price and tariff setting. Stages I and II of the manual attempt to explain, as simply as possible, the factors which are normally taken in proper pricing of water services. A scheme manager who has achieved Division III in KCE should be able to follow and understand the two stages We believe that, if and when the manager of a water supply, appreciates both the factors and the process behind pricing, he/she will be in a position to explain prices to consumers.

A community-managed supply in need of proper pricing of its water services is advised to seek specialized skills. Stage III of the Manual provides broad guidelines to such specialized personnel who may be requested to prepare prices and tariffs for water supplies.

Therefore, this manual aims at making the manager and the committee

- appreciate the meaning of a water price and tariff structure and what lies behind prices and tariff structures,
- understand the factors which need to be considered when setting water prices and tariffs,
- appreciate how water prices and tariffs are developed and the need for their periodic revision, and,
- appreciate the need for recruiting specialized skills when formulating water prices and tariff.

We have attempted to simplify a complicated process into easily understood steps which you, the manager, may need to simplify even further for your committee.
It is our hope that the manual will enable you appreciate water pricing and tariff setting and will be of assistance to you when explaining prices to your consumer members.
We also hope that specialized personnel will find Stage III useful when setting water prices and tariffs.

Introduction

The price of any commodity or service is the *amount of money we exchange to obtain* it. I pay Shs. 15/- to the shopkeeper for a loaf of bread, Shs. 10/- for a cup of tea at a restaurant and Shs. 5,000/- per term for my daughter's education. These are the prices I pay for a loaf of bread, a cup of tea and for my daughter's education. Similarly, the price of water is the *amount of money we exchange to obtain* it.

The water we use at a water supply, as was pointed out in Manual 1, is not produced literally It exists naturally at rivers, lakes, swamps, or underground. Production of water means *improving its quality* and/or *delivering it away from its natural location; to unnatural points* such as homesteads perched up high at hilltops. The *cost of producing water means the amount of money and effort applied in improving its quality* and/or *delivering it away from its natural locations to other more desirable or convenient points*, such as homesteads.

A water supply may be compared to a car. It consists of many parts and components which work together. A car has an engine, wheels, tyres, gears brakes, etc.; a water supply has an intake, rising/gravity main, storage tank, pipes, etc. These represent capital investment. For the car to carry us, it requires, in addition to itself, some fuel, oil, air in the tyres and a driver. Similarly, a water supply needs, among other things, energy (gravity, diesel, electricity) and labour. These are the operating capital. Without them the car cannot move nor can the water supply provide water. The car needs service and regular changing of oil and punctured tyres need to be repaired; similarly, bursts in pipes need to be mended, and tanks and intakes need to be cleaned In other words, both a car and installations in a water supply, need to be constantly maintained. Costs are incurred in the development, operation and maintenance of a water supply, just as costs are incurred acquiring, operating and maintaining a car.

There are different types of water supplies. As would be expected, the type of technology employed, type of water source, scheme complexity, size, level of service, and quality of water aimed at, all determine the kinds and character of investments made. Some water supplies pump water from rivers or underground to desired points using diesel, or electric engines; others simply gravitate water to desired points; some supplies treat their water using chemicals and filters Water supplies are organized and managed differently; some are closely managed and controlled with monthly metered charging systems and billings, while others are thinly managed with practically no controls over consumption. These differences in sources, technologies, physical installations, quality and level of services and management, in turn,

result in differing expenses and costs in the provision of water services. But, all, *incur costs* .

To be able to provide and sustain water services to consumers, a water supply must *generate sufficient revenues* to ensure adequate operation and maintenance, replacement of worn out assets and undertake necessary developments. But, what is "sufficient revenue" and how is it to be estimated? From whom is the revenue to be received and through what mechanism?

"Sufficient revenue" is defined as that amount of income *equal to* the *total cost* of the provision of the water service.[1] Chapters 1 and 2 discuss the elements which compose sufficient revenue and the cost of water services.

The revenue is expected *from the consumer (or recipient)* of the water services through *pricing the service.*

The price of water must be such that it enables the water supply to receive sufficient revenues to provide and sustain water services Fig. 1 indicates the three basic stages which need to be followed in pricing water.

- The first Stage is establishing, as accurately as possible, the revenue requirements at each water supply. To do so requires estimating *all* the costs that the supply is likely to meet. Stage I discusses the revenue requirements of a water supply.
- Estimating the base unit cost of the water service is addressed in Stage II. If the water supply does not recover, *fully*, the unit cost of providing its services, then either somebody else is subsidizing the water or the supply will, sooner or later, halt its services as equipment and operations deteriorate.
- The final Stage discusses development of a price and tariff structure anchored on the base cost.

To illustrate the various steps and considerations which need to be taken to develop cost-based pricing we shall use two cases: Matopeni and Nsoko-ime Water Supplies. Matopeni Self-Help Water Supply is a small electric pumping scheme serving about 300 account-holders within a $3km^2$ area. It provides chlorinated water for human, domestic, livestock, and limited irrigation and commercial purposes. Nsoko-ime Self-Help Water Supply is the full gravity-fed variant of Matopeni, identical in virtually all aspects except those relating to pumping, water production and sales. Both have existed for some time and have maintained excellent records on their operations and activities However, to help us illustrate the various considerations, we shall treat them as brand new at the beginning of 1998.

---

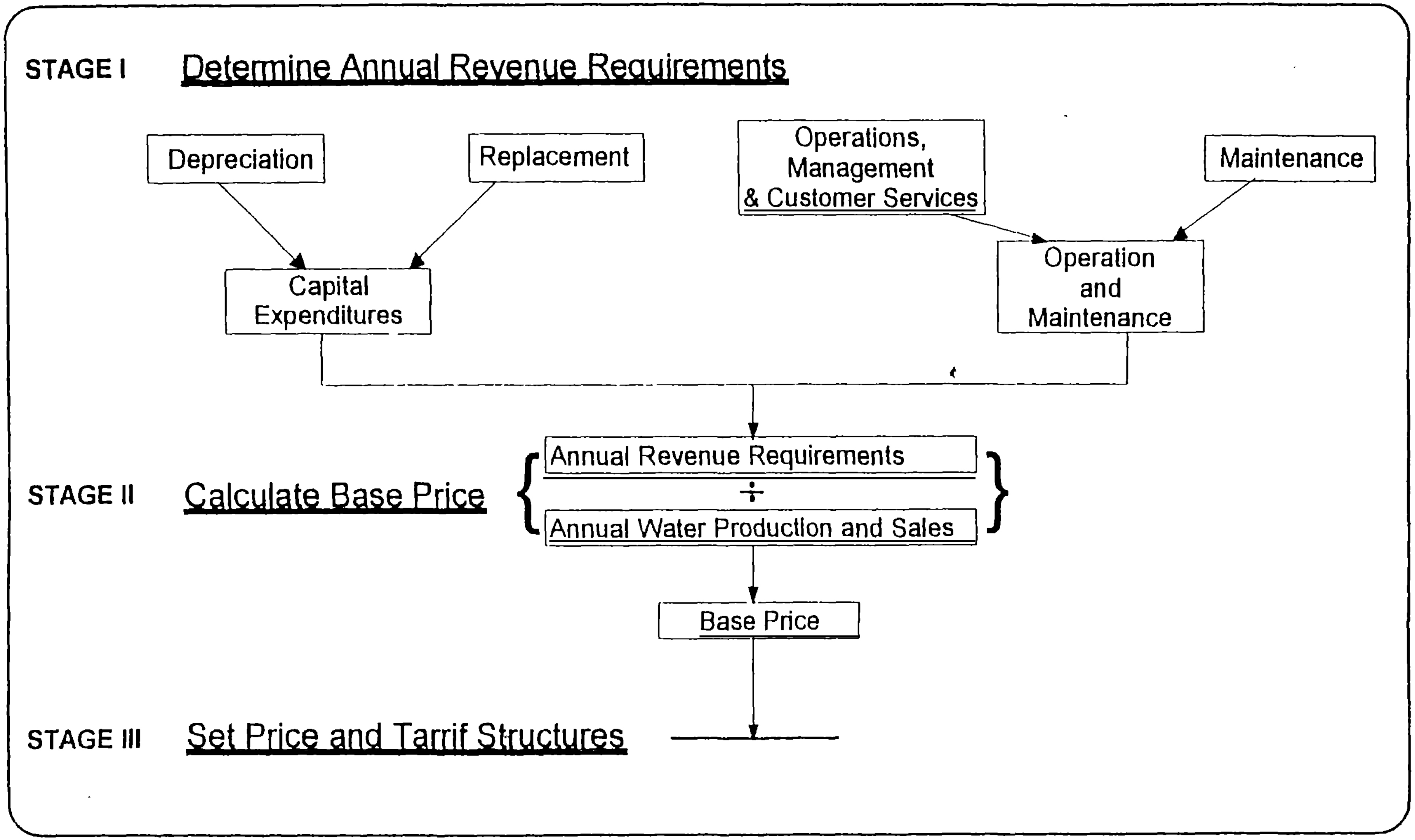
1 An argument is often repeated to the effect that water is both an economic and a social good and, therefore, its pricing should not be guided by costs of production. Rather, the price of water should be below cost. Water is at par with the rest of food, yet arguments are not made to maintain permanent food subsidies. This manual shall not address itself any further to this argument. Somebody has to pay the difference between the cost of production and the sale price if the latter is below cost.

The costs incurred in any water supply, including Matopeni and Nsoko-ime, fall under three headings:

- cost of capital used
- cost of operating and managing the supply, plant and equipment
- cost of maintaining the plant and equipment

The cost of providing water services is the summation of these three costs.

— Fig 1 —


STAGE I
Determine Annual Revenue Requirements
Depreciation
Replacement
Operations, Management & Customer Services
Maintenance
Capital Expenditures
Operation and Maintenance
STAGE II
Calculate Base Price
Annual Revenue Requirements
÷
Annual Water Production and Sales
Base Price
STAGE III
Set Price and Tarrif Structures

The development of Matopeni and Nsoko-ime Water Supplies cost Shs. 5.5million and 3.6million from the following sources.

Source	Matopeni	Nsoko-ime
Members	1,500,000	2,000,000
Government	500,000	1,000,000
Donors	3,500,000	586,000
Total	5,500,000	3,586,000

All the capital invested in the two projects was non-repayable contribution.[2]

Depreciation and Replacement Costs

All capital assets, except land, are progressively "consumed" during production: the wear of the concrete weir is a good example. The working condition of some assets deteriorates over time: for instance, a pumps's efficiency declines with use and age Yet, other assets become too aged and too expensive to service and maintain: a good example being an engine. Assets also become obsolete as improved versions are manufactured. Capital 'consumption', deterioration and obsolescence mean incurring costs under a general heading titled *depreciation*. In this connection, all assets need to be *replaced* at the end of their useful lives.

IF the members of a water supply, or their descendants, hope and wish to continue obtaining water services in future, it is necessary and essential that they provide for depreciation to be able to replace or renew the capital assets installed as the need arises. *IF* such a provision is not made, *a time will surely come* when the assets will be *unable* to provide water services.

How does a water supply estimate the depreciation and replacement costs of its assets? To do so one would need to know

a) the estimated useful or 'economic' life of the assets, and,
b) the future cost (price) of the assets to be replaced.

The Ministry of Water Resources (MWR) normally plans a water supply with a 20 years time horizon. It also suggests 'economic lifes' of some of the more common assets found at water supplies as shown in Table 1.3 below. The 20 years planning horizon does not mean that the water supply will cease to operate after 20 years; nor is the indicated 'economic life' of an asset fast and unchangeable. Rather, the 20 year planning horizon is a planning tool within which most of the considerations taken while designing a project may be expected, by and large, to continue holding. The useful or 'economic life' of an asset, is, similarly, a planning indication. Depending on the manner of use, the life of an asset may be considerably extended or shortened. The economic life indicated is simply a prudent suggestion of the period an asset may be expected to remain usable, assuming proper care.

2 Contributions of funds, materials and unskilled labour by members plus sourcing assistance from donor agencies, NGOs and government ministries and depatments have been the principal ways in which capital developments have been financed in self-help water projects. Loan funds have not featured in community water supplies in Kenya although there are now moves to establish such credit facilities.

Stage I: Revenue Requirements

the capital costs of water services

This chapter will describe the different capital costs of providing water services explaining how each is estimated and calculated.

Capital investments in a water supply consist of all plant and equipment developed and installed for the production, distribution and provision of water, such as, intake works, pumping equipment, treatment works, gravity or rising mains, all piping, storage tanks, valves, washouts, chambers, buildings, office equipment, etc. Tables 1 1 and 1.2 provide the value of Matopeni and Nsoko-ime's assets at commissioning in 1997.

Table 1.1: Value of Capital Assets at Matopeni Water Supply, 1997 in Kshs.

Capital Asset	Shs	Capital Asset	Shs
Office Block/store	145,000	Gravity main	700,000
Staff Quarters	95,000	Rising main	700,000
Pump house	385,000	Distribution	530,000
Fences	60,000	Service lines	205,000
Latrines	10,000	AVs, SVs, Chambers	130,000
Access Road	100,000	Storage Tanks	240,000
Weir	100,000	Tools	50,000
Sump	42,000	Desks, Chairs	70,000
Dosers	100,000	Cabinets	15,000
Instruments	100,000	Calculators	4,000
Treatment Works	500,000	Meters	432,000
Pumps	574,000	Total	5,500,000
Motors, cables	213,000		

Table 1.2: Value of Capital Assets at Nsoko-ime Water Supply, 1997 in Kshs.

Capital Asset	Shs	Capital Asset	Shs
Office Block/store	145,000	Service lines	205,000
Staff Quarters	95,000	AVs, SVs, Chambers	130,000
Latrines	10,000	Storage Tanks	240,000
Fences	60,000	Meters	432,000
Access Road	100,000	Tools	50,000
Weir	100,000	Desks, Chairs	70,000
Dosers	100,000	Cabinets	15,000
Instruments	100,000	Calculators	4,000
Treatment Works	500,000	Total	3,586,000
Gravity main	700,000		
Distribution	530,000		

Table of Contents

Manuals in this series

Manual No. 1	Meter-Based Water Management System
Manual No. 2	Water Prices and Tariff Setting
Manual No. 3	Financial Accounting System
Manual No. 4	Budgeting and Budgetary Controls

Table 1.3 MWR suggested 'economic lives' of Capital Assets in water supplies

Asset	'economic life', in years	Asset	'economic life', in years
Office Block/store	30	Gravity main	40
Staff Quarters	30	Rising main	40
Pump house	30	Distribution	40
Fences	10	Service lines	40
Latrines	20	AVs, SVs, Chambers	40
Access Road	30	Storage Tanks	30
Weir	40	Kiosks, Cwps	20
Sump	40	Meters	10
Dosers	10	Tools	10
Lab Instruments	5	Desks, Chairs	10
Treatment Works	30	Cabinets	10
Pumps	10	Calculators	3
Motors, cables, etc.	10		

Source: MWR, Design Manual, 1984, Table 16.2, p 184. The last three items are not mentioned in the manual.

It is apparent that the estimated economic life of the assets varies markedly: calculators may need to be replaced every 3 years, while pipelines and storage tanks may be expected to last for much longer periods.

An asset is depreciated by writing its value off over its 'economic life'. For instance, to calculate the annual depreciation of the Office Block and Store at Matopeni, one simply divides its value (Shs 145,000 as shown in Table 1.1) by number of years in its 'economic life' (30 years as shown in Table 1.3).

annual depreciation amount = Shs. 145,000 ÷ 30 years
= Shs. 4,833

To estimate the annual depreciation of the desks and chairs at Nsoko-ime similar calculation would be made:-

70,000 ÷ 10 = shs 7,000.

Following similar calculations we have estimated the annual depreciation for the assets at Matopeni and Nsoko-ime to be as indicated in Tables 1.4 and 1.5.

Table 1.4 1997 Depreciation of Matopeni assets
straight line calculations

Asset	Value	Economic Life	Depreciation
Calculators	4,000	3	1,333
Lab. Instruments	100,000	5	20,000
Cabinets	15,000	10	1,500
Meters	432,000	10	43,200
Desks, Chairs	70,000	10	7,000
Dosers	100,000	10	10,000
Fences	60,000	10	6,000
Tools	50,000	10	5,000
Motors, cables, etc.	213,000	10	21,300
Pumps	574,000	10	57,400
Kiosks, Cwps	36,000	20	1,800
Latrines	10,000	20	500
Access Road	100,000	30	3,333
Office Block/store	145,000	30	4,833
Pump house	385,000	30	12,833
Staff Quarters	95,000	30	3,167
Storage Tanks	240,000	30	8,000
Treatment Works	500,000	30	16,667
AVs, SVs, Chambers	130,000	40	3,250
Distribution	530,000	40	13,250
Gravity main	700,000	40	17,500
Rising main	700,000	40	17,500
Service lines	205,000	40	5,125
Sump	42,000	40	1,050
Weir	100,000	40	2,500
Total	**5,536,000**		**284,042**

Table 1.5. 1997 Depreciation of Nsoko-ime assets straight line calculations

Asset	Value shs	Economic Life	Depreciation
Calculators	4,000	3	1,333
Lab Instruments	100,000	5	20,000
Cabinets	15,000	10	1,500
Meters	432,000	10	43,200
Desks, Chairs	70,000	10	7,000
Dosers	100,000	10	10,000
Fences	60,000	10	6,000
Tools	50,000	10	5,000
Kiosks, Cwps	36,000	20	1,800
Latrines	10,000	20	500
Access Road	100,000	30	3,333
Office Block/store	145,000	30	4,833
Staff Quarters	95,000	30	3,167
Storage Tanks	240,000	30	8,000
Treatment Works	500,000	30	16,667
AVs, SVs, Chambers	130,000	40	3,250
Distribution	530,000	40	13,250
Gravity main	700,000	40	17,500
Service lines	205,000	40	5,125
Weir	100,000	40	2,500
Total	**3,622,000**		**173,958**

Depreciation, is a real cost which must be included in estimating a water supply's revenue requirements. From the above calculations, it is apparent that, Matopeni Water Supply would incur a minimum shs 284,042 annual depreciation while Nsoko-ime would incur not less than shs 173,958 annually in depreciation. The fact that depreciation expenses are not cash expenses should not detract us from seeing it as a cost. Members, and especially management committee members should be made aware of this "hidden" cost.

But will the depreciation amounts calculated above be sufficient to replace assets when the need arises in the future?

We believe not. The amount of funds which can be expected to be realized from the level of depreciation calculated above will be unlikely to be adequate to replace the assets worn out. This is on account of price increases or inflation. This insufficiency may be illustrated.

For instance, Matopeni's pumps, motors and cables have an estimated 10 years useful life and cost shs 787,000 today. Table 1.4 indicates that at an annual depreciation of shs 78,700 today's cost price (shs 787,700) will have been fully recovered in 10 years. But, the price of pumps, motors and cables may have risen 2.5 times in 10 years to stand at about shs 1,961,750/-. Were it to become necessary to replace the pumps, motors and cables at the beginning of the 11th year, the Matopeni depreciation account would have only shs 787,000 for pumps, cables and motors while shs 1,967,500 will be required to replace the three items. Thus, Matopeni members would have a shortfall of shs 1,180,,500 and will be unable to replace the pumps, motors and cables.

They will, therefore, be unable to pump water unless other measures were taken to finance the shortfall.

This situation may be expected to be repeated for other assets. To enable the water supply generate *sufficient funds to replace* the assets when the need arises, *it is necessary to take inflation into account* when determining the level of annual depreciation. The level of annual depreciation arrived at *must be such that it will always be sufficient and adequate to replace any capital asset when the need arises.*[3]

Capital for improvements

Matopeni and Nsoko-ime members may also have decided that for the next 5 years they would be improving and extending distribution mains and service lines at an annual cost of Shs 65,000 without contracting a loan or seeking contributions from members. This expenditure towards improvements is also part of the revenue requirements of the two water supplies. Assuming an average annual inflation rate of 10%, this capital expenditure would rise from shs 65,000 in 1997 to shs 105,000 in the 5th year to retain its today's real value.

Summary Capital Costs

Table 1.6 summarizes the depreciation, replacement and capital improvements costs discussed for the 1997.

Table 1.6 Summary Capital Costs for the 1997 at Matopeni and Nsoko-ime in shs

Cost Item	Matopeni	Nsoko-ime
Depreciation/replacement	284,000	174,000
Improvements	65,000	65,000
Total	349,000	239,000

3 Of course, this refers to scheduled needs arising normally, not to replacement needs brought on by emergencies or unexpected disasters, like the recent El Nino rains which brought down many storage tanks and disrupted pipelines.

operations and maintenance costs of water services

Following on our analogy, a car needs to be properly and competently driven and operated and its parts to be well maintained, serviced and kept in good repair if it is to provide reliable service.

Likewise, the physical capital assets installed at a water supply require to be *well and competently operated* and to be *adequately maintained* to provide consumers with satisfactory and reliable services. A water supply incurs expenses in the actual production, distribution and reticulation of water. Such expenses are referred to as *operational expenses or costs*.. Maintaining assets calls for expenses. Expenses incurred in taking such care and attention are referred to as *maintenance costs*. Theoretically, operations costs are distinct from maintenance costs. In practice, however, the two are often fused into each other and it is difficult to separate them. We shall, however, treat the two separately for clarity.

Operational Costs

To operate is to run, to make to work. To operate a water supply, therefore, means to make it work, to make it provide the service it was designed for In operating a water supply, expenses are incurred on such items as,

- Staff,
- Transport,
- Production Inputs such as
- fuel, chemicals, filters
- Office Equipment,
- Traveling and Accommodation,
- Postage and telephones,
- Repair
- Audits
- Committee Members,
- Conservancy and rates,
- Bad debts
- Entertainment,
- Stationery, Printing,
- Education and Training.
- Consultancy Services

Tables 1 7 and 1.8 describe the reported operational expenses incurred at Matopeni and Nsoko-ime in 1997

Table 1.7· Matopeni Operational Costs, 1997

OPERATIONS ITEM	SUPPLY A
PERSONNEL EMOLUMENTS	128,000
ELECTRICITY BILLS	285,000
CHEMICALS	120,000
REPAIRS	68,000
STATIONERY & PRINTING	8,000
PUBLIC TRANSPORT	6,500
ENTERTAINMENT	6,000
COMMITTEE EXPENSES	15,000
TELEPHONE & POSTAGE	3,000
GENERAL OFFICE EXPENSES	8,000
STUDY TOURS	12,000
WATER CHARGES	500
BANK CHARGES	1,000
BAD DEBTS	17,000
MISC.	20,000
TOTAL	698,000

Table 1 8 Nsoko-ime Operational Costs, 1997

OPERATIONS ITEM	SUPPLY A
PERSONNEL EMOLUMENTS	128,000
CHEMICALS	120,000
REPAIRS	50,000
STATIONERY & PRINTING	8,000
PUBLIC TRANSPORT	6,500
ENTERTAINMENT	6,000
COMMITTEE EXPENSES	15,000
TELEPHONE & POSTAGE	3,000
GENERAL OFFICE EXPENSES	8,000
STUDY TOURS	12,000
WATER CHARGES	500
BANK CHARGES	1,000
BAD DEBTS	50,000
MISC.	20,000
TOTAL	428,000

Operational expenses are more easily understood and accepted than other expenses in a water supply. Perhaps this is because they are more visible and their absence often results in visible repercussions in the provision of water. In estimating operational expenses, care needs to be taken to ensure that all operational expenses are included.[4] For existing water supplies, past lists of annual expenses may help in ensuring that all operational expenses are taken into account. Budget items and lines used in drawing up budget estimates should, also, be of assistance in this connection. New water supplies should draw up their schedule of operations. The DWE or the local DWO could assist them in drawing up

4 The Schedule of Accounts provided in the Supply's Accounting System should assist him/her in this. See Manual No. 3, *Financial Accounting and Management System*.

such a schedule which would be the basis for preparing their first operational budget. Staff at older schemes could also assist.

Experience also shows that some consumers do not pay their bills when due. This failure to pay water bills means, in fact, that some of the water actually billed is often not paid for [5] The cost of the loss brought about by non-payment of bills should be included in the cost of the service explaining why we have included bad debts as part of operational costs.

Operational costs should be reviewed often, say once every year at the preparation of the annual budget.

Maintenance Costs

All man-made assets in the supply *require and need* to be maintained. For instance all the assets at Matopeni and Nsoko-ime listed in Tables 1.1 and 1.2 require adequate maintenance.

How would maintenance requirements at Matopeni and Nsoko-ime be estimated or assessed?

The MWR has prepared guidelines on how such estimates can be made. The guidelines for estimating the annual level of resources required for maintaining assets are percentages based on value and kind of asset providing ideal maintenance resources. Table 1.9 provides some of the MWR percentage guidelines.

Table 1.9 MWR Suggested Percentage of Value for Estimating Annual Maintenance Costs of selected assets

Asset	% Installation Cost	Asset	% Installation Cost
Office Block/store	1	Motors, cables, etc	5
Staff Quarters	1	Gravity main	1
Pump house	1	Rising main	1
Fences	1	Distribution	1
Latrines	2	Service lines	1
Access Road	1	AVs, SVs, Chambers	1
Weir	1	Storage Tanks	1
Sump	1	BP Tanks	1
Dosers	5	Kiosks, Cwps	2
Laboratory Instruments	5	Meters Product. & distr	5
Treatment Works	1	Meters: Consumer	5
Pumps	5	Tools	2
Engines	5		

Source MWR, Design Manual, 1984, Table 16.2, p. 184..

5 The magnitude of the situation is, in many ways, related to the extent of laxity in enforcement of payment regulations. In many government schemes as much as 60% of the billed revenue is not paid.

To estimate the amount of annual financial resources that would be required to adequately maintain the assets, one needs to multiply the value of the asset with its corresponding suggested percentage. For instance, if we wished to estimate the amount of funds which would be needed to adequately maintain the pumps at Matopeni, we would look up their value in Table 1.1.(Shs. 574,000) and multiply the value with the relevant percentage in Table 1.9 (5%)

Annual Maintenance Requirement of the pumps

$$= \text{Shs. } 574{,}000 \times \frac{5}{100} = \text{Shs. } 28{,}700$$

Similarly, the annual maintenance requirements of the gravity main at Nsoko-ime would be

$$= \text{Shs.} 700{,}000 \times \frac{1}{100} = \text{Shs. } 7{,}000$$

Using similar calculations, we have estimated the 1997 maintenance requirements of all the assets at Matopeni and Nsoko-ime to be as described in Tables 1 10 and 1.11.

Table 1 10. Estimated 1997 Maintenance Requirements at Matopeni
in shs

Asset	Value shs	% Value	Required Maintenance Amount
Access Road	100,000	1	1,000
AVs, SVs, Chambers	130,000	1	1,300
Cabinets	15,000		
Calculators	4,000		
Meters	432,000	5	21,600
Desks, Chairs	70,000		
Distribution	530,000	1	5,300
Dosers	100,000	5	5,000
Fences	60,000	1	600
Gravity main	700,000	1	7,000
Kiosks, Cwps	36,000	2	720
Laboratory Instruments	100,000	5	5,000
Latrines	10,000	2	200
Motors, cables, etc.	213,000	5	10,650
Office Block/store	145,000	1	1,450
Pump house	385,000	1	3,850
Pumps	574,000	5	28,700
Rising main	700,000	1	7,000
Service lines	205,000	1	2,050
Staff Quarters	95,000	1	950
Storage Tanks	240,000	1	2,400
Sump	42,000	1	420
Tools	50,000	2	1,000
Treatment Works	500,000	1	5,000
Weir	100,000	1	1,000
Total	5,536,000		112,190

Table 1.11 Estimated 1997 Maintenance Requirements at Nsoko-ime
in shs

Asset	Value shs	% Value	Required Maintenance Amount
Access Road	100,000	1	1,000
AVs, SVs, Chambers	130,000	1	1,300
Cabinets	15,000		
Calculators	4,000		
Meters	432,000	5	21,600
Desks, Chairs	70,000		
Distribution	530,000	1	5,300
Dosers	100,000	5	5,000
Fences	60,000	1	600
Gravity main	700,000	1	7,000
Kiosks, Cwps	36,000	2	720
Laboratory Instruments	100,000	5	5,000
Latrines	10,000	2	200
Office Block/store	145,000	1	1,450
Service lines	205,000	1	2,050
Staff Quarters	95,000	1	950
Storage Tanks	240,000	1	2,400
Tools	50,000	2	1,000
Treatment Works	500,000	1	5,000
Weir	100,000	1	1,000
Total	3,622,000		61,570

From the two tables, it is apparent that the 1997 maintenance requirements at Matopeni and Nsoko-ime should have been shs 112,190 and 61,570, respectively.[6] This cost is subject to the same price escalations we have mentioned elsewhere. Assuming 10% annual inflation rate, the annual maintenance requirements at Matopeni would increase from shs 112,190 in 1997 to shs 180,000, five years later. Similarly, Nsoko-ime's estimated annual maintenance requirement of shs 61,570 in 1997 will have risen to about shs 100,000 in the same period. As in the case of depreciation and replacement costs, *it is essential that inflation be taken into consideration* when estimating revenue requirements.

Summary O&M Costs

The foregoing discussion has described how to estimate and calculate the costs relating to capital, operations and maintenance requirements. Table 1.12 summarizes the 1997 costs or requirements for Matopeni and Nsoko-ime Water Supplies.

Table 1.12· 1997 O&M costs at Matopeni and Nsoko-ime
in shs

Expense Item	Matopeni	Nsoko-ime
Operations	698,000	428,000
Maintenance	113,000	62,000
Total	811,000	490,000

---

6 Unfortunately, sufficient attention is not paid to maintenance resources in Kenyan water supplies resulting in too rapid deterioration of assets.

The cost calculated here is referred to as the *base* cost, defined as the overall unit cost of providing water services. Incidentally, the two base costs suggest the wide differences in the cost of providing water services at gravity and pumping schemes.

But, the base unit cost is not a the real unit cost and should not be used for charging purposes on account of a number of reasons. To begin with, considerable amounts of water which have occasioned some expenses are lost and cannot be expected to contribute to revenue. In 1997, Matopeni lost 36% of all water produced, while Nsoko-ime lost 50% of its water. How are these losses explained?

First, water supplies, necessarily incur *water losses* during production, storage and distribution and *before* the water reaches a consumer's meter. Experience indicates that, a 25% loss is almost practically unavoidable as it arises from production, storage and distribution losses as well as inaccuracies in meter readings.

Second, substantial proportions of water produced may also not be sold on account of insufficient demand, sometimes brought about by seasonal fluctuations. This is especially so in rural water supplies. In 1997, for instance, the average volume of water billed for, monthly, at Matopeni during the wet months of April, May, November and December was $67m^3$ while at Nsoko-ime it was $90m^3$ although installed production capacities were for $3{,}800m^3$ and $11{,}100m^3$ per month, respectively. While at Matopeni it was possible to adjust pumping hours to meet the reduced demand, it was not possible to do so at Nsoko-ime, partly explaining the relatively larger volume of water losses at the latter supply.

Third, some consumers interfere with meters, slowing their readings or by-passing them. Some years back, as many as 8% of the connection holders at Matopeni were found to be interfering with consumer meters. Unfortunately, experience has shown that such practices persist with the knowledge of some staff members.[7]

Unsold water (whatever the cause) should be excluded from the calculation of unit cost. In that case, the 1997 unit cost of water at Matopeni where 64% of the water produced was *actually billed for*, would have been

$$= \frac{\text{cost of service}}{\text{Volume billed}} \qquad = \text{shs } \frac{1{,}160{,}000}{28{,}835}$$

$$= \text{shs } 40.25/m^3$$

At Nsoko-ime where only 50% of the water produced was billed for, the unit cost would have been

$$= \frac{\text{cost of service}}{\text{Volume Produced}} \qquad = \text{shs } \frac{729{,}000}{65{,}000}$$

$$= \text{shs } 11.25/m^3$$

---

7 Stringent enforcement of byelaws, including imposition of fines, temporary (6 months) disconnections and disciplinary measures on the staff members involved reduced the incidence of water theft.

Stage II: Estimating the unit cost of Water Services

The foregoing discussion has described how to estimate and calculate the annual costs relating to capital, operations and maintenance requirements. Table 2.1 summarizes the 1997 costs for Matopeni and Nsoko-ime Water Supplies.

Table 2 1. 1997 Costs at Matopeni and Nsoko-ime
in shs

Expense Item	Matopeni	Nsoko-ime
Capital	349,000	239,000
	284,000	*174,000*
Depreciation /Repl. Improvements	*65,000*	*65,000*
Operations	698,000	428,000
Maintenance	113,000	62,000
Total	1,160,000	729,000

The next step is to estimate the unit cost of the water service at Matopeni and Nsoko-ime water supplies. To do so, it will be necessary to estimate the amounts of water produced and sold in the two supplies during that year.

Records maintained at Matopeni water Supply indicate that during 1997, the supply produced 44,900m^3 of which 28,835m^3 was billed to the supply's 300 Account holders. Similar records at Nsoko-ime show that 130,000m^3 was produced in the same year, but only 65,000m^3 was billed for. What was *the unit cost* of water at Matopeni and Nsoko-ime in 1997?

Calculating the base unit cost of water services

Simply, the unit cost of water at Matopeni should have been

$$= \frac{\text{cost of service}}{\text{Volume Produced}} \qquad = \text{shs } \frac{1,160,000}{44,900}$$

$$= \text{shs } 25.85/m^3$$

while at Nsoko-ime it should have been

$$= \frac{\text{cost of service}}{\text{Volume Produced}} \qquad = \text{shs } \frac{729,000}{130,000}$$

$$= \text{shs } 5.60/m^3$$

These latter two unit costs, indicate the effects water losses or unsold water have on the base unit cost. The base unit cost at Nsoko-ime should have doubled to cover the costs of providing the service, including unsold volumes of water, while at Matopeni it should have risen by 55% As suggested in Manual No. 1, it is imperative that scheme management, staff and members endeavour to keep water losses at a minimum Of course, and as mentioned earlier, the losses occasioned by non-payment of bills should be included, as we have done already, in the cost of the service.

If the proportion of water loss at Matopeni and Nsoko-ime had been reduced to about 25%, the 1997 base unit cost would have been

at Matopeni $=\text{shs } \frac{1,160,000}{33,675}$

$=\text{shs } 34.45/m^3$

and at Nsoko-ime $=\text{shs } \frac{729,000}{97,500}$

$=\text{shs } 7.50/m^3$

From these calculations one is able to establish the base unit cost range, a range which sets the likely cost parameters of the service. The 1997 unit cost range at Matopeni was shs 40.25-34 45 per m^3 depending on the extent to which the proportion of water losses or unsold could be reduced while it was shs 10.75-7.50/m^3 at Nsoko-ime It is apparent that the level of water losses, or unsold water or unaccounted water would have been an important determinant of the actual unit cost *within* the cost range. Proper pricing of water at the two supplies in 1997 would have aimed at recovering, at the overall level, the unit cost of the service. The next Stage III of this manual addresses itself to pricing and setting of tariffs.

Stage III: Setting prices and tariff structures

The discussion in Stages I and II was meant to introduce the scheme manager and the management committee to the cost of providing water services as the basis for developing adequate prices and tariff structures.

This final stage of the manual is meant for knowledgeable persons who may be involved in price and tariff setting. It aims at stating in clearer terms the considerations which must be made when setting water prices and tariffs. We reproduce Table 2.1 which summarized the different cost components of providing water services at the two supplies to help us continue our illustrations.

1997 Costs at Matopeni and Nsoko-ime
in shs

Expense Item	Matopeni	Nsoko-ime
Capital	349,000	239,000
Depreciation	*284,000*	*174,000*
/Repl. Improvements	*65,000*	*65,000*
Operations	698,000	428,000
Maintenance	113,000	62,000
Total	1,160,000	729,000

Need for explicit pricing objectives

To be able to set prices, it is important that the pricing objectives adopted by the scheme be explicit and well specified. Management committees or authorities at Matopeni and Nsoko-ime, for instance, should be clear at what costs the prices being sought should aim at recovering. Some management authorities may aim at recovering the full cost of the service, capital plus operations and maintenance, while others aim at recouping only a part of the cost, say operations costs. In either case, it is the responsibility of the person setting prices to properly appraise the management authority of the implications of the objectives. This is especially the case in reference to partial recovery of costs. The authorities must be sufficiently informed of the implications of the costs being excluded for the short, medium and long term chances of continued provision of water services.[8]

---

8 Many water authorities have, in the past, only aimed at partial recovery of costs hoping that the state Treasury will be able to subsidize the unrecovered portion. Others have neglected to

Need to estimate the price changes of assets and inputs

Price Inflation of inputs and services required by water supplies must be thoroughly considered and properly built into projected costs. Annual inflation rates of 5% or less and which are common in industrialized countries, seem to have limited impact on costs. This is not the case in many developing countries which have been experiencing macro-economic instability and annual inflation rates in excess of 20%. These latter rates of annual inflation raise the cost of an input or service by a factor of 6 in 10 years in comparison to a factor of 1.3 in industrial countries over a similar time span Yet, one cannot wish away these high inflation rates, one can only hope that macro-economic stability will be created to reduce inflation rates Even so, it would be unrealistic to expect inflation rates to be sustained at levels below 10% annually for any length of time.

Need to define an appropriate time span within which prices and tariffs may be expected to obtain

While price setting should be related to the entire lifespan of the service and its assets, 20-40 years periods are too long for charging purposes. Many of the assumptions that may need to be made may not be expected to hold for such lengthy periods. Therefore, it is advisable to break the entire period of service to shorter and more manageable sub-periods, say 5 to 10 years.

Need to have a adequate understanding of the socio-economy and patterns of water use within the supply

To be able to price water services adequately, one requires, in addition to costs, a thorough knowledge of the socio-economics of the supply area. This understanding is normally obtained through consumer studies aimed at generating data and information on such aspects as

- consumer categories and their relative importance,
- patterns of water use and applications,
- water as an input in the areas economic activities including cultivation and livestock rearing,
- the economy of the supply area,
- social distribution of incomes and assets among area residents,
- water consumption and payment behaviour, etc.

Of course, information and data on some of these aspects is only possible in older schemes which have well maintained data. But, it is now possible to gather helpful information from comparable schemes in different parts of the country. It is also possible to use related data from the numerous studies being undertaken by different organizations.[9]

---

recover depreciation and maintenance costs. In both cases water supplies have sufferERD, deteriorated, ceased operations or just limp along.

9 It is actually these days to go into completely virgin territories where no studies have not been undertaken.

Projecting Costs of Service
The 1997 costs of providing water services at Matopeni and Nsoko-ime need to be projected over the defined period, 5 years and on the basis of the estimated annual inflation rate, say 10%. Using the following formula will yield the projections required where

$$C=C_1(1+r)n$$

where

C	=	Cost,
C_1	=	Cost in base year,
r	=	Annual Inflation Rate, in our case 10%,
n	=	Year desired

The following are the projected costs of water services at Matopeni and Nsoko-ime for the period 1998-2007.

Table 3. 1· Cost Projections of water services at Matopeni and Nsoko-ime in shs

Year	Matopeni	Nsoko-ime
1998	1,276,000	801,900
1999	1,403,600	882,090
2000	1,547,440	972,486
2001	1,698,240	1,067,256
2002	1,867,600	1,173,690
subtotal	**7,792,880**	**4,897,422**
2003	2,055,520	1,291,788
2004	2,260,840	1,420,821
2005	2,487,040	1,562,976
2006	2,735,280	1,718,982
2007	3,009,040	1,891,026
subtotal	**12,547,720**	**7,885,593**
Total	**20,340,600**	**12,783,015**

Where the aim of pricing is to recover the full costs of service, the costs shown in Table 3.1 need to be recovered from consumers. These costs will therefore, need to be borne by each m^3 of sale. Of course, where the ambition of pricing is less than full cost recovery, the cost to be recouped from consumers should be appropriately configured.

Projecting the volumes of water produced and sold
Where data and information are available one needs to examine trends of production , consumption, consumption rates and sales to be able to project the likely trends in production, consumption and sales. If past records at Matopeni and Nsoko-ime reveal that the average annual increase in volumes sold has averaged 2%, we can use this rate for projecting future sales tempered only by the installed production capacities. Table 3.2 presents such sales projections on the basis of the volumes sold in 1997.

Table 3.2: Projected Volumes of sales at Matopeni and Nsoko-ime, 1998-2007
in m^3

Year	Matopeni	Nsoko-ime
1998	29,412	66,300
1999	29,988	67,600
2000	30,594	68,965
2001	31,199	70,330
2002	31,834	71,760
subtotal	**153,027**	**344,955**
2003	32,468	73,190
2004	33,131	74,685
2005	33,795	76,180
2006	34,458	77,675
2007	35,150	79,235
subtotal	**169,002**	**380,965**
Total	**322,029**	**725,920**

It should be apparent that unless the loss levels were reduced the two supplies could hit their production limits within the 10 year period Nsoko-ime would have to start reducing its water losses as early as the second year, 1998 to satisfy projected demand and it will have to continue doing so annually to beyond the 10 year period to cope with the projected increased demand. At Matopeni unless major reductions in water losses were made it would be unable to meet projected demand in Year 2006. Assume that the two supplies were indeed able to reduce losses to meet projected demand. Since the costs indicated in Table 3.1 include all losses, including those from non-payment of bills, then the appropriate annual price sufficient to recover the full costs of the service would be as indicated in Table 3.3.

Table 3.3: Full Cost Recovery Prices at Matopeni and Nsoko-ime
in shs/m3

Year	Matopeni shs/m3	Nsoko-ime shs/m3
1998	43.38	12.10
1999	46.80	13.05
2000	50.58	14.10
2001	54.43	15.17
2002	58.67	16.36
subtotal	50.92	14.20
2003	63.31	17.65
2004	68.24	19.02
2005	73.59	20.52
2006	79.38	22.13
2007	85.61	23.87
subtotal	74.25	20.70
Total	63.16	17.61

These prices may appear disturbingly high but it needs to be remembered that at 10% inflation, the discounted value of one 1998 shilling will be shs 0 39 in 10 years This is to say that the projected 2007 price of shs 85 60 at Matopeni is equivalent to shs 33.38 in 1998 prices.

Ten years may be considered too long and the consultant may adopt 5 years as the period for which prices may be expected to obtain. Even then, it may not be appropriate to be revising prices annually. It may be more desirable and politically more acceptable to provide an average price for say the 5 years and then revise the price at the end of the period. In such a case, the price of water which should be charged to recover the full costs of service during the period 1998-Year 2002 would be shs 50.95 and shs 14.20 per m^3 of water at Matopeni and Nsoko-ime, respectively.

Where consumers pay a monthly standing charge of, say shs 100 per account the revenue expected from the standing charge should be deducted from the total yearly revenue required and the price per m^3 appropriately lowered.

Uniform or fixed price

A uniform or fixed price of water is one which does not vary by classes of users, volumes of consumption, or types of uses. All categories of uses and volumes of consumption are charged the same unit price The management committee at Matopeni may, for instance, have decided to adopt a shs 40.25 per m^3 sold as the uniform price in 1997. Such a price would have been sufficient to recover, fully, the cost of providing water services that year:

Cost of service	=		shs 1,160,000
Revenue Expected	=		
volume sold x price	=	22,835 x 40.25	=shs 1,160,609

The above uniform price would have recovered the full costs of service at Matopeni in 1997.

Differentiated tariff and price structures
Matopeni's management may, however, have desired to realize other objectives in addition to recovering the cost of water production. It may, for instance, have wished to discourage waste and encourage certain types of uses and applications of water, --say cultivation of cut flowers. It may also wish to subsidize the small, often, relatively poorer consumers.

To realize these additional objectives while recovering the cost of providing the service, management would require to have a *progressive* tariff structure, progressive prices men that as consumption increases in volume so does the unit price. A tariff structure is a systematic schedule of prices and charges by levels of consumption or classes of consumers or both. The schedule is developed with the additional objectives set by the management in mind. In the case of Matopeni the following would be the objectives of the tariff structure:-

- to realize financial health and integrity of the supply by recovering the cost of the service from revenues,
- to subsidize the smaller consumers by charging them prices which are below the cost of providing the service,
- to penalize wastage by charging steep prices for uneconomic or wasteful use of water,
- to encourage commercial irrigation of cut flowers by setting steeply increasing prices which can only be supported by high value crops such as cut flowers.

To be able to successfully develop a price and tariff structure which would achieve the above objectives, there is need to know

- the patterns of water consumption, including level of minimum, but reasonable human domestic consumption, *without* any non-human use,
- the incidence and magnitude of watering livestock,
- the general distribution of incomes among consumers,
- the magnitude and extent of irrigation within the supply area, and,
- the incidence of cultivation of cut flowers in agricultural production in the supply area.

As noted in the preface, Matopeni's management will need to engage the services of an experienced person in tariff setting to prepare an adequate price and tariff structure. Through detailed examination of Matopeni's customer accounts over some years such a person may conclude that

- consumption of 4-6m^3 per month. per household marks the lowest reasonable level of water use among the poorer households in the area,
- the incomes of Matopeni's households range from shs 3,000-50,000 per month,
- 50% of Matopeni members carry on some form of irrigation using scheme water, and,
- 15% of the members cultivate cut flowers seasonally.

Taking this information into consideration a price and tariff structure may be created which realizes all the objectives set by the management committee for 1997. Table 3.14 describes a possible price and tariff structure which would have realized the objectives set at Matopeni for 1997.

Table 3.4 A Price and Tariffs Structure for Matopeni

Monthly Range m3	Price shs/m3	5 Years Volume m3	% Volume Sales	Revenue shs	% Revenue
1 - 5	18	12,242	8%	220,359	2%
5 - 9	22	15,303	10%	336,659	4%
10-15	35	30,605	20%	1,071,189	14%
16-30	45	26,015	17%	1,170,657	13%
31-50	50	45,908	30%	2,295,405	26%
Over 50	55	22,954	15%	1,262,473	14%
Subtotal		153,027	100%	6,356,742	73%
Monthly Stand. Charge*				1,440,000	18%
Total Revenue				7,796,742	100%
Revenue Required				7,792,880	

NB: * at shs 70/acc.

It may be noted that such a price and tariff structure would

- raise shs 7,796,742 while the revenue required was shs 7,792,880,
- subsidize the smallest consumers,
- place a heavy financial penalty on misuse and allows those who cultivate high value products, such as cut flowers, to now grow such products across all seasons.

A similar differentiated or progressive tariff and price structure could be prepared for Nsoko-ime.

Conclusions

The development of proper water prices and tariffs requires a full understanding of the

- different cost components of providing water services,
- forces underlying those components,
- patterns of water use and consumption, payment behaviour, economy of the supply area and the broad distribution of incomes (where this is not already available every effort should be made to make intelligent use of related information),

The management authority should also be clear and explicit on the extent of cost recovery envisaged.