WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

INTRODUCTION TO WATER SERVICES MANAGEMENT IN SOUTH AFRICA'S URBAN AREAS

(Executive summary of guidelines)

January 1998

PALMER DEVELOPMENT GROUP
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PREFACE

This module forms part of the series "Management guidelines for water service institutions". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

Executive summary: Introduction to urban services management

Module 1: An introduction to organisational arrangements for water service providers

Module 2: Preparation of a water services development plan

Module 3: Customer profile and demand for services

Module 4: Setting water tariffs

Module 5: Setting sanitation tariffs

Module 6: Reporting procedures for water services

Module 7: Reporting procedures for sanitation services

Acknowledgements

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The Steering Committee for this project includes the following people:

Mr J Bhagwan	Water Research Commission
Dr GR Backeberg	Water Research Commission
Ms J Burke	Johannesburg Metro Council
Mr DQ Ramsay	Southern Peninsula Metro Local Council
Mr NA Macloed	Durban Water and Waste
Mr CJ Francis	Newcastle TLC
Mr B Jackson	Development Bank of Southern Africa
Mr H Muller	Department of Water Affairs and Forestry
Ms L Colvin	Department of Water Affairs and Forestry
Mr Z Nofumela	Department of Constitutional Development

The project team is indebted to the steering committee for their valuable input in assisting to meet the objectives of the project, and gratefully acknowledge their contribution. The support and finance provided for the project by the Water Research Commission is acknowledged and sincerely appreciated.

Project team

The project team instrumental in developing these guidelines comprised Ian Palmer, Richard Tainton and Bee Thompson, all from Palmer Development Group. Craig Bekker assisted with figures and formatting.

1. INTRODUCTION

1.1 Background to this guideline series

This summary serves as introduction to a guideline series of seven modules dealing with the management activities of water service providers in South Africa. The series originated from a recognition that the improvement of water services provision, including the provision of services to the presently unserved, rests largely in the hands of the managers of water service providers. In the current South African urban context the great majority of such managers are in local government, responsible for running water supply and sanitation departments.

In setting out to assist these managers, and those who support them, the first step taken was to carry out a survey of their research needs. This survey was carried out by Palmer Development Group for the Water Research Commission, in late 1995[1]. It generated a list of high priority topics and an understanding that local authorities need to have information which was in a form which was useful to them, particularly "practical guidelines". The study concluded with recommendations that the following guideline topics should be given highest priority:

- Tariff setting
- Dealing with consumers
- Reporting procedures
- Determining need and demand for services
- Structuring effective water and waste agencies

The Water Research Commission proceeded to fund a project to prepare these guidelines (this project - K5/758), which was started in 1996. A steering committee was established to guide the project and, at their second meeting, the orientation of the guidelines was reviewed. It was decided that, with the publication of the Water Services Bill, water services development planning was going to be an important activity for water service authorities in the near future. Thus the module on consumer relations was replaced by one on water services development planning. The other modules have remained the same, with some changes to the wording of their names.

1.2 Scope

The term "water services"[2] includes both water supply and sanitation and both of these services are covered by this guideline series. In assessing the scope of the series overall it is appropriate to refer to the guidelines matrix described in the following sub-section. At the broadest level they cover water service institutions in urban areas. These institutions are typically either local councils or organisations contracted to them. Thus they focus on the urban local authority environment. **The initial 7 guidelines in this series do not cover the water service authority activity and deal specifically with**

[1] Palmer Development Group, 1996, 'Local authority water and waste research needs assessment'. Report prepared for the Water Research Commission.

[2] See Module 1 for definitions of the terms used here.

water service provider activities. However, the module on water service development planning (Module 2) does also apply to water service authorities.

Finally, the point made in Section 1.1 needs to be confirmed: the 7 modules which are included here are not intended to be a comprehensive series of guidelines. They represent a first step.

Turning to this introductory summary, it is intended partly to serve as an introduction to the series, partly to deal with inter-relationships between the guidelines and partly as a summary of the series.

1.3 Using these guidelines

This guideline series is intended to assist those who are responsible for providing water services to customers. The approach taken is, as far as possible, to identify best practice and to provide a methodology for carrying out various key activities. The series does not represent statutory requirements and the provisions of the various modules are to be used at the discretion of the user of the series. However, the series has been prepared with input from key national government departments and senior representatives of local government. Thus the guideline series represents a 'reasonable consensus' with regard to an approach to the key activities addressed in the series.

The series has been written primarily for people with some experience in the field of water service provision. However, the series may also be of use as an educational tool for those who are new in the water services field.

1.4 A guidelines matrix

It is the medium term intention of the Department of Water Affairs and Forestry (DWAF) and the Water Research Commission to work towards a fuller guideline series which will deal with both urban and rural areas and focus on the various types of institutions involved with water services. These institutions can be divided into the following groups:

- **Water service institutions** which include water service authorities and water service providers. These are put into sub-groups which follow the structure of local authorities:
    - ◊ District councils (with regard to service provision they have a primarily rural orientation)
    - ◊ Local councils (urban)
    - ◊ Rural councils (rural)
    - ◊ Community based organisations such as water committees (rural)
- **Organisations involved with implementing projects** which include:
    - ◊ Developers (urban)
    - ◊ Implementation agents (rural and possibly urban fringe)
    - ◊ Designers (urban and rural)
    - ◊ Contractors (urban and rural)

- **Community groups who are not service providers, and individuals** including:
    - ◊ Community leaders (urban)
    - ◊ Community leaders (rural)
    - ◊ Customers

It is considered essential for guidelines to be written for specific types of institutions and thus this categorisation of institutions forms the primary basis for separating guidelines in an overall matrix of guidelines.

In preparing guidelines it then becomes important to group these guidelines based on the activities of the organisations which they are aimed at guiding. The activities are divided as follows:

- **Institutional and organisational arrangements**
- **Finance**
- **Planning**
    - ◊ Area planning
    - ◊ Water services development planning
    - ◊ Bulk services planning
    - ◊ Engineering services planning
- **Projects**
    - ◊ Project planning
    - ◊ Design of services
    - ◊ Construction
- **Operations**

A description of each of these activities is given in Module 1 of the water service institutions series (this series).

Based on these two categorisations for guideline series, a guidelines matrix has been prepared and is given as Table A. Where guidelines are available or are under preparation they are shown in the matrix. With regard to the blank cells, there are some places where guidelines will be needed in the future; but it is not intended that every cell in the matrix should have a guideline. The intention of the matrix is rather to structure the way guidelines are prepared and show the relationships between them.

The approach to guidelines in the water service institutions series (this series) needs to be seen in the context of water service provision and water service authority functions. The relationships between these functions is described in Module 1 of this series. As mentioned above, the first 7 modules of the series, which are included here, deal largely with water service provider and not water service authority functions.

Table 1: WATER SERVICES GUIDELINE MATRIX

		WATER SERVICE INSTITUTIONS				IMPLEMENTING BODIES				COMMUNITY		
		District Councils	Local Councils	Rural Councils	Village	Developers	Rural implementers	Designers	Contractors	Community Leaders		Customers
										Urban	Rural	
ORGANISATIONAL ARRAANGEMENTS		DWAF-RO	MGWW		Mvula					HBCL		
FINANCE		DWAF-RO	MGWW		Mvula		DWAF-FW, CEG					
PLANNING	Area Planning											
	Water Services Plan	DWAF-RO	MGWW									
	Bulk Services Plan							RB			ATHCL RBMC	
	Engineering Services						ATHDA	RB		HBCL		
PROJECTS	Project Planning		P&LA		Mvula	P&DEV M&TG				HBCL RBMC	ATHCL RBMC	
	Design of Services						ATHDA				ATHCL	
	Construction						M&TG ATHDA		SABS		ATHCL	
OPERATIONS			REGLA MGWW		Mvula					HBCL		

ATHCL	CSIR, 1996, Guidelines on Appropriate Technologies for Water and Sanitation in Developing Communities - A Series of Handbooks for Community Leaders, WRC.
ATHDA	CSIR, 1996, Guidelines on Appropriate Technologies for Water and Sanitation in Developing Communities - A Series of Handbooks for Development Agents, WRC
CEG	CSIR, 1993, Guidelines on the Cost Effectiveness of Rural Water and Sanitation Projects, WRC Report No. 231/1/93.
DWAF-RO	DWA, 1997, Proposed new guideline series for district councils.
DWAF-FW	DWA, 1997, Framework for establishing water service providers in rural areas
HBCL	PDG, 1994, Water and sanitation handbook for Community Leaders, WRC
M&TG	CSIR, 1993, Guidelines on the Technology for and the Management of Rural Water and Sanitation Projects, WRC Report No. 231/1/93.
MGWW	PDG, 1998, Management Guidelines for the Water Services Institutions, WRC.
Mvula	Mvula Trust, 1997, Guideline series for water committees
P&DEV	PDG, 1995, Planning and Implementation of Water and Sanitation Services to Urban Communities in South Africa - Guidelines for Developers, WRC.
P&LA	PDG, 1995, Planning and Implementation of Water and Sanitation Services to Urban Communities in South Africa - Guidelines for Local Authorities, WRC.
RB	CSIR, 1995, Guidelines for the Provision of Engineering Amenities in Residential Development
RBMC	CSIR, 1995, Guidelines for the Provision of Engineering Amenities in Residential Development - A Management Companion
REGLA	DWAF, 1996, National Water Supply Regulations - Parts 1 & 2

1.5 Policy framework

A brief introduction to policy issues is given in Module 1 of this series. This is not repeated here but three important provisions of the Water Services Bill, 1997, need to be mentioned:

- The Act identifies **water service authorities** as the local government responsible for service provision in terms of the constitution. But service authorities do not need to undertake the actual work required to provide service themselves. They may choose to contract this out to others.
- The Act identifies **water service providers** as the body actually providing the service, including the day to day activities needed to keep a water supply and/or sanitation system running effectively.
- The Act requires that a **water service development plan** be prepared, to set down what is to be provided, how it is to be done and how it is to be financed.

1.6 Local government and water services

Following from the above provision of the Water Services Bill, and those in the Local Government Transition Act and the Constitution, local government has primary responsibility for ensuring that people in their areas of jurisdiction get water supply and sanitation services. In particular local government needs to be allocated the function of water service authority. In an urban context this is fairly straight forward outside the metropolitan areas as the local council is generally the obvious sphere of local government to take on this responsibility. However in metropolitan areas the allocation of the water service authority function may be made to the metro local council or the metro council.

Having the function of water service authority, the local government then needs to decide whether it will be the water service provider itself or whether this will be contracted out to others: the private sector, a neighbouring local authority or a water board, for example. Whatever option is chosen, these guidelines are applicable to the body which undertakes the water service provision activity.

If a local government is both the water service authority and water service provider, it is essential for the two functions to be dealt with separately within the organisation.

The relationship between water service authority and service provider are discussed further in Module 1.

1.7 Definitions

A set of key definitions is given in Module 1. These are not repeated in the other modules.

2. ACTIVITIES OF WATER SERVICE PROVIDERS

The activities of water service providers are given as follows in Module 1:

- Governance
- Management and administration
- Finance
- Planning
- Projects
- Customer relations
- Operations

A description of what these activities involve is included in Module 1. While in the medium term it may be possible to produce guidelines for each of these activities, the first 7 modules in the series have the more limited objective of starting with those which are seen to have a higher priority. In fact the 7 modules deal with only three of the activities listed:

Module 1 is an introduction to organisational arrangements, which fits into the management and administration activity.

Modules 4 and 5, which relate to tariff setting for water supply and sanitation, fit within the finance activity.

Modules 2, 3, 6 and 7 deal with water services development planning, customer profile and demand for services and reporting procedures. These fit within the planning activity. However, reporting procedures also relate to activities outside those of the water service provider itself. The information has been structured to be useful for the monitoring of water service providers both by the water service authority, other spheres of government and customers.

An overview of the provisions of each module, and key relationships between them, is discussed further in the following sections, under the activities of which they form a part.

3. ORGANISATIONAL ARRANGEMENTS

Module 1 in the series is an introduction to organisational arrangements. It:

- provides an introduction to policy issues;
- fits the water service provider into the overall institutional structure associated with water supply and sanitation;
- looks at various ownership and contractual options for water service providers;
- describes an approach to setting up effective organisations; and
- describes the various activities which water service providers undertake.

It is not a comprehensive guide to managing water service providers. This would require a much greater volume. Rather it is intended to provide an introduction and a framework for understanding what service providers do. It also provides a framework for the other modules as these deal with specific activities, as described previously.

There is a further, more specific, link between Module 1 and Modules 6 and 7 which deal with reporting. Primarily this relates to the last page of the reporting sheets (WG and SG) which deal with organisational arrangements. Much of the information required for these sheets is described in Module 1.

4. PLANNING

An introduction to planning related to water services and to broader local government issues is given in Module 2: Preparation of a water services development plan. It is noted that there are a number of planning processes which are inter-linked. But the water services development plan (WSDP) should be seen as central to all other planning processes relating to the water sector.

A WSDP is a comprehensive plan which deals with socio-economic, technical, financial, organisational and environmental issues. Thus there are clear links to this planning guideline from all of the other modules:

- Module 3: "Customer profile and demand for services", deals largely with socio-economic issues but also addresses several other matters which are essential input to the planning process, notably levels of service and demand projection. Thus this module serves as an introductory module to planning.
- The plan deals with finance and has tariffs as one of its most important elements. The two tariff setting modules (Modules 4 and 5) thus serve as input to the WSDP, dealing as they do with the methodology for setting tariffs.
- Organisational arrangements are part of the WSDP and Module 1 serves as input in this regard.
- The plan generates information which needs to be disseminated. The proposed method for doing this is given in the reporting modules (Modules 6 and 7).

Computer models associated with planning

The use of computer models to assist in the planning process is described in Module 2. Two models exist, one for water supply services and one for sanitation services. Printouts from the screens for the former model are included as an annexure to Module 2 so that, should this model be used, the tables are cross referenced in the description of the components of the WSDP.

The models also serve to provide links between various elements associated with a WSDP: customer profile, level of service, demand for services, investment planning, tariff setting and water and wastewater flow projections.

Finally, the models directly generate the first two information sheets proposed as reporting requirements (Modules 6 and 7: Sheets WB, WC, SB and SC).

5. FINANCE

In module 1 the sub-activities which make up finance are described under the following headings:

- Planning investment
- Raising capital
- Budgeting
- Setting tariffs
- Sales
- Maintaining accounts

The modules in this series are clearly focused on setting tariffs. However, budgeting and investment planning is required as an input to the tariff setting process. Thus Modules 4 and 5 deal with these aspects, but not comprehensively. The seven modules in the series do not deal with raising capital, sales or accounts.

There are important links between the tariff modules and the water service development planning module (Module 2). Tariffs are an important component of the plan and thus the tariff setting modules serve as input to the plan. They also serve as background to the tariff setting provisions of the computer models which are mentioned in the previous section and are intended to assist with the analysis required for a WSDP.

There is in fact an interactive relationship between tariff setting and the WSDP. The WSDP generates an investment programme which needs to be funded, often through loans which are serviced through income raised from tariffs.

Finally, it needs to noted that there is information given as an annexure to the sanitation tariff setting module (Module 5) which deals with a water balance, in order to generate relationships between water supplied to customers and wastewater generated. This is not strictly related to tariffs and in fact is associated with demand projections. Thus this represents a link from Module 5 to Module 3.

6. MONITORING AND EVALUATION

This guideline series does not deal with monitoring and evaluation comprehensively, as the primary responsibility for these activities does not belong with the water service provider. This is not to suggest that monitoring and evaluation are not important, they are essential activities and need to be introduced where they do not already exist. While they are not addressed comprehensively in this series, some attention is given to these activities in Module 2 (WSDP) where a general approach to monitoring is described. It is noted there that the WSDP is central to the process of monitoring water service provider performance.

For monitoring to be possible, information is required and the reporting requirements modules (6 and 7) are intended to set down the information which needs to be provided for monitoring purposes. This is essentially output from the WSDP, complemented with additional information to be provided by water service providers on an annual basis.

WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Module 1

INTRODUCTION TO ORGANISATIONAL ARRANGEMENTS FOR WATER SERVICE PROVIDERS

January 1998

PALMER DEVELOPMENT GROUP

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PREFACE

This module forms part of the series "Management guidelines for water service institutions". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

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1. INTRODUCTION

1.1 Scope

This document is a guide to those involved with the management of water supply and sanitation service provision in urban areas, focusing on organisational arrangements which will encourage effective service delivery. Given the complexity of the arrangements needed to provide these services successfully, the document deals only with broader issues and should be seen as an introduction to the topic. It is recognised that more detailed guidelines may be necessary in certain instances, but these are not dealt with here.

1.2 Relationship to other guidelines

This module forms part of a series of 7 modules dealing with management for water service providers (see list in preface). Further the module can be related to other guidelines dealing with the full range of institutions and topics in the water sector. A matrix showing this broader range of guidelines is given in the summary at the start of this series.

1.3 Policy framework

This module is based on a number of policy provisions which are summarised below.

1.3.1 The Local Government Act

The Local Government Transition Act provides for the establishment of local government throughout South Africa. In metropolitan areas local government has two spheres. Firstly, Metropolitan Councils have been established to look after the larger scale functions in their areas, whilst, within them, Metropolitan Local Councils have been established with responsibility for more local activities. The actual responsibilities assigned to each sphere needs to be worked out between them and authorised by the provincial government. In fact the situation differs between different metro areas – for example, in Durban the metropolitan council has strong service provision responsibilities, in contrast to the Khayalami metropolitan council which focuses primarily on support functions to the metropolitan local councils.

Secondly, outside the metro areas urban local government is established in the form of local councils. These local councils elect representatives to the district councils which are established to provide local government services to the underdeveloped, generally rural, areas in their jurisdictions. The district councils can also serve to support small local councils.

A further important provision of the Local Government Act is that **all local authorities must prepare an integrated development plan.**

1.3.2 The Development Facilitation Act

The Development Facilitation Act - Act 67 of 1995 has been promulgated to regulate the way in which land is developed. From the point of view of water services the important provision relates to the requirement for land development objectives (LDOs) to be set and approved before land development can proceed. Clause 28 of the Act describes the subject matter of these objectives which include objectives relating to:

- access to and standard of services, including water and health;

- provision of bulk infrastructure;
- access to finance.

These requirements parallel those of the integrated development plan and the water services development plan, discussed below. While it is possible for the LDOs to be integrated with these other plans, it is not certain at this stage how such integration will be handled under the law.

1.3.3 The new Water Services Bill

The Department of Water Affairs and Forestry (DWAF) has recently published the Water Services Act. This Act deals with the way water services are to be provided. Most notably it provides for the following:

a) The recognition of a Water Service Authority which has the statutory responsibility to ensure that water services are provided. Typically this would be the local government in the area.

b) The recognition of a Water Service Provider which is the body actually responsible for providing the service.

c) The requirement that a Water Services Development Plan needs to be prepared, which describes the arrangements for water service provision, both present and future.

d) Provisions for the establishment of Water Boards and statutory water service committees.

1.3.4 The Water and Sanitation White Paper

A summary of the key provisions of the White Paper, published in November 1994 are given below.

a) Policy principles

The following basic principles are stated:

- Development should be demand-driven and community-based.
- Basic services are a human right.
- "Some for all" rather than "all for some".
- Equitable regional allocation of development resources.
- Water has economic value.
- The user pays.
- Integrated development.
- Environmental integrity.

b) Institutional framework

The key elements of the institutional framework are summarised below.

Central government: The central government has two primary functions. With regard to the water services element, which is of primary relevance here, central government responsibility includes:

- establishing national policy guidelines;
- a national water development strategy;
- formulating criteria for state subsidies;

- setting minimum service standards;
- monitoring and regulating service provision.

It is not specifically stated in the White Paper, but central government also plays a central role in setting up new water-related institutions such as water boards.

Provincial government: In the White Paper a key activity of the provinces is the promotion of effective local government. Where local government does not have the capacity to carry out its service function provincial government can take over.

Local government: The White Paper recognises the primary responsibility which local authorities have for service provision.

Water boards: The White Paper identifies an expanded role for water boards, beyond their previous function of bulk water supply. Key provisions in the White Paper are summarised below:

- Boards can act as agents to undertake basic services, receiving subsidies channelled via local authorities.
- Areas of supply of Boards will be redefined, particularly to include previous homeland areas.
- The functions of boards are to be redefined to include sanitation and allow them to provide services direct to communities.
- New water boards may be established.

Water service committees: The White Paper also provides for the establishment of local water service committees, statutory bodies which have the task of providing water supply and sanitation services.

Private sector: A key role is envisaged for the private sector, with the following mentioned specifically:

- capital investment;
- operation and maintenance;
- training, capacity building and organisational development;
- financing and commercial services;
- professional services.

Non-government organisations: Finally, the White Paper recognises the important part which NGOs have played and can continue to play in water service provision.

c) Basic service provision policy

The White Paper defines a basic level of service for water and sanitation. For water, a basic service is defined as a supply of 25 litres per person per day, available within a walking distance of 200 metres. Other criteria relating to availability, assurance of supply, quality, and upgradability are defined. The sanitation aspects have been taken further in a separate white paper and are discussed in the next section.

d) Finance and tariff policy

The basic policy of the government is that services should be self-financing at a local and regional level. The only exception to this is that, where poor communities are not able to afford basic services, government may subsidise the cost of construction of basic minimum services but not the operating, maintenance or replacement costs. The Paper recognises the need for grant finance to be seen as a component of capital finance, together with user contributions and loans. Issues relating to the raising of

loans, particularly from the private sector, are dealt with in broad terms. Where service levels beyond basic minimum standards are required these must be paid for by the communities, with local authorities or water boards playing a role.

1.3.5 The Sanitation White Paper

Specific points of note regarding the Sanitation White Paper are:

- the specific emphasis on the health and hygiene aspects of sanitation;
- the importance of integrating community development with sanitation projects;
- the need for households to take responsibility for their own toilets;
- financial assistance to be provided by the state to those who have organised themselves, in the form of a capital subsidy per household;
- financial support by the state is oriented towards the provision of a basic service level which is defines as a ventilated improved pit (VIP) toilet or equivalent;
- technical solutions are to have affordability as a prime criterion for selection.

The responsibility for taking the policy forward to implementation stage has been assigned to the National Sanitation Co-ordinating Office (NaSCO), which is located within DWAF.

With regard to subsidies, the amount has been set at R600 per household, with provision for a further amount where geo-technical conditions are severe.

1.4 Categories of service provider

The ability of service providers to perform water service activities and fulfil certain obligations is, to a large extent, dependent on their size and financial strength. Thus, in order not to overburden smaller service providers, different requirements would typically apply to different categories of service provider. The following four groups are identified:

- *Micro:* A service provider with fewer than 5 000 people in its area of supply, or income from water-related charges of less than R500 000 a year.
- *Small:* A service provider with between 5 000 and 50 000 people in its area of supply, or income from water-related charges (water and sanitation) between R500 000 and R5 million per year.
- *Medium:* A service provider with between 50 000 and 500 000 people in its area of supply, or income from water-related charges (water and sanitation) between R5 million and R50 million per year.
- *Large:* A service provider with more than 500 000 people in its area of supply, or income from water-related charges (water and sanitation) of R50 million or more per year.

1.5 Definitions

Key definitions relating to water service provision are given below. Those which are taken directly from the Water Services Bill, 1997, are marked with an asterisk (*).

Bulk water services: The arrangements for extracting water from the resource (surface or groundwater), treating it and transferring it to the distribution reservoir serving a settlement.

Bulk sanitation services: The arrangements to receive wastewater from a collector system, treat it and return it to the resource. With regard to non-waterborne

sanitation, the arrangements to collect, treat and dispose of sludge from digesters, pits etc.

Bulk services: Bulk water and bulk sanitation services.

Bulk service providers: Those who provide bulk water and/or sanitation services.

Collector services: In the case of waterborne sanitation, the arrangements to collect wastewater from customers and transfer it to a bulk wastewater system. In the case of other forms of sanitation, all the on-site and local arrangements needed to provide effective sanitation.

Community: A group of customers.

*Consumer:** Any end user who receives water services from a water services institution, including an end user in an informal settlement.

Customer: The term "customer" is used in this guideline series rather than "consumer" as it implies both individuals who receive water or sanitation services or have the right to receive such services. Further it implies a service ethic on behalf of service authorities and service providers. In terms of the Water Services Bill, "customer" is synonymous with "consumer".

Distribution services: With regard to water supply: the arrangements for storing water received in bulk and distributing it to customers, including reservoirs, local pump stations, connector pipelines, reticulation and water sales arrangements.

*Sanitation services:** The collection, removal, disposal or purification of human excreta, domestic wastewater, sewage and effluent arising from the use f water for commercial purposes. (Note: The Bill does not deal with collector and bulk sanitation services separately; however, the separation is created here in this guideline series as there are specific characteristics related to collection and bulk services.)

*Water services:** Water supply services and sanitation services.

*Water services authority:** Any municipality responsible for ensuring access to water services.

*Water services provider:** Any person who provides water services to consumers or to another water services institution but does not include a water services intermediary. (Note: (1) This includes bulk service providers as defined here, but this guideline series identifies issues which are specific to such bulk service providers. (2) The term "customers can be substituted for "consumers" here.)

*Water supply services:** The abstraction, conveyance, treatment and distribution of potable water or water intended to be converted to potable water. (Note: The Bill does not deal with distribution services and bulk water services separately; however, the separation is created here in this guideline series as there are specific characteristics related to distribution and bulk water services.)

1.6 Water service objectives

The process of setting up sound institutional arrangements is part of a broader process associated with sustainable services provision. Here the broad set of objectives can be identified as follows:

a) Promote good governance, including a sound framework for inter-relationships between parties.

b) Ensure access to services based on:
   - equity (equal opportunities to all groups); and
   - affordability (within the constraint of ability to pay).

c) Provide services of good standard with respect to:
   - reliability;
   - product quality;
   - relations between service provider and customer; and
   - price.

d) Promote effective institutions which are:
   - sustainable;
   - financially viable;
   - organisationally efficient; and
   - water use efficient.

e) Ensure that services are environmentally sustainable.

2. RELATIONS EXTERNAL TO THE SERVICE PROVIDER

This section deals with other organisations which exist around the service provider, each of which is discussed in the sub-sections which follow. They are:

- The water service authority.
- Bulk service providers.
- Neighbouring authorities.
- Metropolitan structures.
- District councils.

2.1 The water service authority

The Water Services Act differentiates between water service authorities and water service providers.

2.1.1 Identifying the water service authority

The water service authority will generally be that sphere of local government which has been given executive responsibility by the provincial government for providing services.

This is generally fairly clear outside metropolitan areas where the local council will be the water service authority. Within metropolitan areas the decision needs to be made as to who will be the water service authority. Typically it will be the metropolitan local council (sub-structure), as this is the organisation closest to the customers. In certain circumstances it is also possible for the provincial government to take on the responsibility of water service authority if it believes that local government does not have the ability to perform. This is, however, an unlikely situation.

2.1.2 Functions of the water service authority

The water service authority has the following functions which are separate from those of the water service provider:

a) *Governance:* to understand the interests of its constituents and ensure that these are translated into actions which will lead to services being provided.

b) *Planning:* to prepare a water services development plan.

c) *Finance:* to act as the channel through which grants from central and provincial government are transferred to service providers.

d) *Contracts:* to ensure that a contract is drawn up with water service providers, using the water services development plan as the basis.

e) *Monitoring:* to ensure that the service provider performs in terms of the contract.

f) *Dispute resolution:* where disputes arise between customers and the service provider, the service authority needs to have mechanisms to resolve these.

g) *Regulation:* to take the necessary actions to ensure that service providers comply with the contract (and thus the water services development plan).

2.1.3 Setting up relationships between service authority and service provider

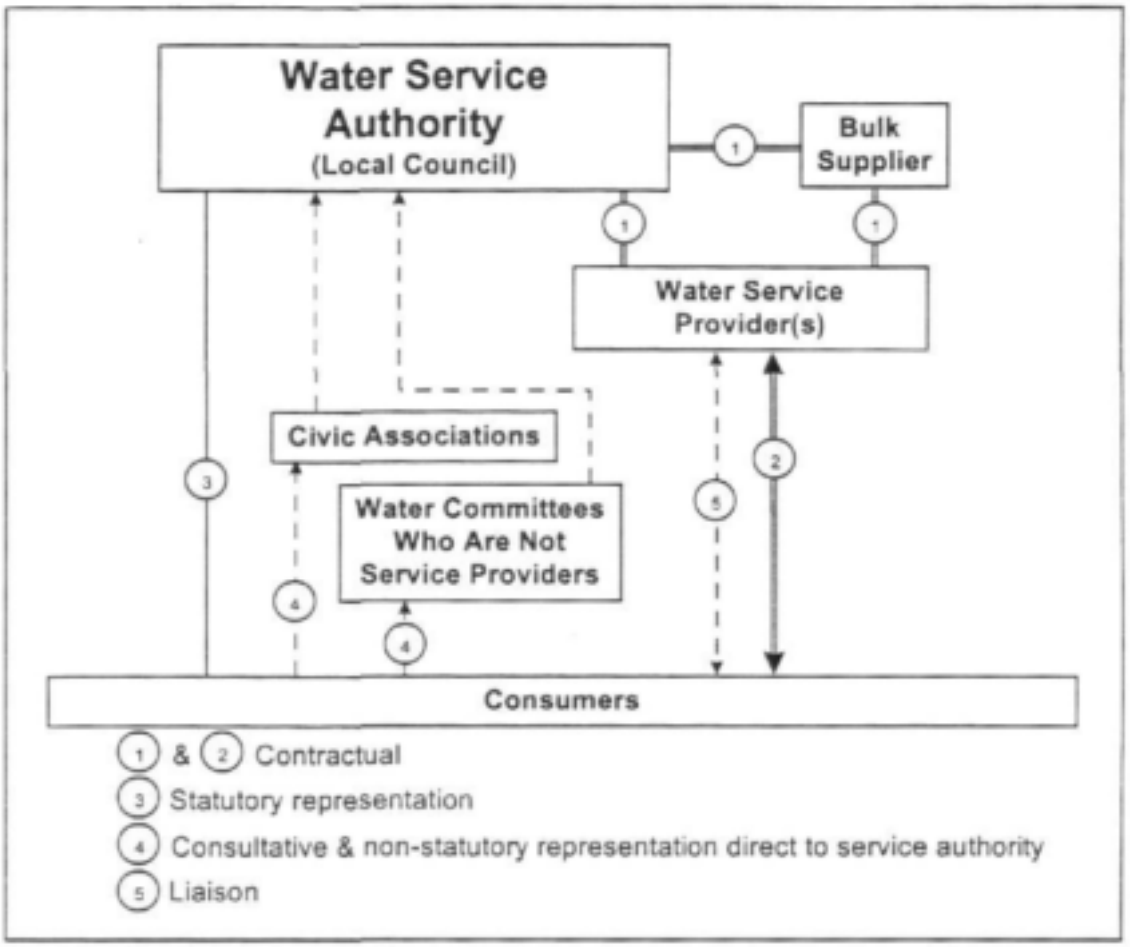
It is important for proper relationships to be structured between water service authorities and their service providers. This relationship may be quite simple if, for example, a local council is both the service authority and the service provider. However, there may be complexities if there is a separate bulk supplier and, possibly, more than one service provider. Also, there is greater complexity in metro areas where there are two spheres of local government as well as bulk service providers (typically water boards).

Figure 1 can be used to explain the relationships.

The nature of the relationships is discussed briefly below.

- *Contractual relationships:* The water service authority enters into a contract with a water service provider and the service provider essentially has a contract with the customers to provide them with services. (Note that, even if the water service authority is also the service provider, there is still an effective contract between the council and the department or section doing the service provision.) The contract with the customers describes what the service provider has to do, in terms of a water services development plan which has been prepared with the participation of all stakeholders. If a separate bulk service provider is involved, a contract will also need to exist between the bulk service provider and both the water service provider and water service authority.
- *Liaison:* It is necessary for the service provider to keep in touch with its customers' needs, and hence there is a liaison and feedback element to the relationship between service provider and customer.
- *Statutory representation:* The statutory arrangements are those where the interests of individuals (who are also customers) are represented via councillors elected to local government. This relationship is important, firstly in the process of setting up the service provision arrangement and, secondly, to deal with possible dissatisfaction of customers relating to service provision. This is needed if the relationships between service provider and customers are not functioning well.
- *Consultative and non-statutory representation:* There are several other institutional structures which exist to represent the interests of individuals in various ways. These are generally in the form of civic associations or ratepayers associations.

Figure 1: Service provider relationships



While the contractual and statutory relationships may be reasonably clear, there is often considerable lack of clarity regarding the consultative and non-statutory representative relationships. It is extremely important, however, to structure these relationships properly: consultative and non-statutory representative relationships must flow via the service authority, not the service provider. While individual customers may first attempt to sort out disputes directly with the service provider, through contractual and liaison channels, the structured arrangements for resolving disputes and representing interests through non-statutory bodies must be set up with the service authority.

2.2 Bulk service providers

2.2.1 Typical arrangements

At present the great majority of service providers in South Africa are local authorities, many of which run their own bulk service arrangements, both for water supply and wastewater. There are also many local authorities, however, particularly in larger centres, which secure their bulk services from other sources. Here the options include:

- *A water board:* Typically, a water board operates a water supply system, but some boards (such as Umgeni and Mhlatuze) also run bulk wastewater services.
- *A metropolitan council:* Where a metropolitan local council is the service provider it would typically obtain bulk services from the metropolitan council.

- *Another local authority:* Sometimes it is advantageous for the bulk service to be provided by another local authority, typically a neighbour.
- *A private company:* In the East Rand, for example, a private company (Erwat) runs the bulk sanitation system.

2.2.2 Contractual relationship

While this is not common at present, it is to become a requirement that bulk suppliers such as water boards have contracts with the service providers to which they provide bulk services.

2.2.3 Internal vs. external bulk

In metropolitan areas a distinction is sometimes made between internal and external bulk services. The internal bulk service is that provided by the service provider, while the external bulk is generally provided by a regional-scale bulk supplier.

2.2.4 Management support from water boards

The role of water boards has been changing and many are currently involved in more than just bulk service provision. In some cases (such as ThabaNchu) boards are acting as service providers, supplying water services direct to customers. They are also being required to provide a support function, primarily in the form of advice, to service providers with whom they have contracts to supply bulk services.

2.3 District councils and their role

In terms of service provision the focus of district councils is largely on the rural areas within their boundaries. They can also act as important support organisations for (urban) local councils, however, making advice and funding available to them. In fact, in areas where there are many small towns, there are benefits to locating certain high level expertise in the district council, where it can be shared, rather than at local council level.

2.4 Arrangements with neighbours

Sharing of expertise can also take place through arrangements with neighbours, or even two authorities which are not contiguous. For an assessment of this "twinning" approach, see Cooper (1990).

3. Service Providers: Ownership Options

The term "ownership" is used here to deal with the way the organisation is owned and controlled. There is a range of options here, from government ownership (where a government body would be the service provider) to private ownership (where a company, often profit-making, is the service provider).

3.1 Government service providers

As mentioned earlier, in the large majority of cases in South Africa local authorities carry the responsibility of service provider to customers in their jurisdictions. Consequently, all assets, liabilities, income and risks related to water and sanitation services are carried by the local authority. In the past, the distinction between water service provider and water service authority has not been made clearly in all cases, although there are sound reasons for clearly separating the two functions.

In metropolitan areas, it is typically the Metropolitan Local Council which acts as service provider, although in some cases, it is the regional sphere of local government, the Metropolitan Council, which acts as water service provider (an example of the latter is Durban).

3.2 The parastatal option: water boards

Water boards have been operational in South Africa since the start of the century when Rand Water Board was established. Water boards' existence and role has been re-asserted in the new Water Services Act. They are organisations established under this Act with specific requirements about they way they should function. Two key features are that they have a board appointed by the Minister of Water Affairs and Forestry, and that they do not have a mandate to make a profit.

It is important to differentiate between the bulk supply and service provider roles of water boards. Traditionally in South Africa, water boards have supplied only bulk services, and largely to urban areas. Over the last five years, however, certain boards have provided services directly to customers and have thus acted as service providers, including in rural areas.

3.3 Using the private sector

There are currently a number of initiatives in South Africa aimed at promoting partnerships between the public and private sector. The broader policy issues and support arrangements for local government are being handled by the Department of Constitutional Development (Dept of Constitutional Development, 1997).

The water sector is also promoting private sector participation and a guideline relating to private sector involvement in water supply and sanitation services is available (Pybus, 1995). This guideline describes the options and processes to be followed. Here it is only necessary to summarise the major options identified in this guideline for involving private partners:

a) Service contracts.
b) Corporatisation.
c) Management contracts.
d) Renting of assets.
e) Investment linked contracts.
f) Privatisation.

Service contracts relate to the use of the private sector for only particular elements of service provision (for example, planning, monitoring water quality, or meter-reading). The use of such contracts for specific activities is discussed later in this document.

Corporatisation, also referred to as joint ownership or commercialisation, is a "home-grown" partnership process where the local authority initially facilitates the establishment of a business unit for the service and then creates a company to run it, generally wholly-owned by the local authority or a group of authorities.

The remaining four options involve increasing levels of risk-taking by the private sector. Under *management contracts,* a private contractor typically runs the operations but does not take the risk related to raising income from customers. Consequently these contracts generally involve little risk-taking either on the current or capital account.

In the case of *renting (leasing) of assets*, the contractor would be responsible for maintenance and income-generation from customers, but capital investment remains the responsibility of local government.

Investment linked contracts (concessions) require the contractor to raise the capital for expansion of the system, in addition to operating the system as in the previous cases, although ownership of the assets remains with local government in the long term.

Finally, in the case of *privatisation*, the entire operation, including all existing assets, are sold off to private companies which carry full risks on both the capital and current accounts in the future. This approach is currently not being supported by government in South Africa.

4. APPROACH TO SETTING UP EFFECTIVE ORGANISATIONS

4.1 Introduction

Thus far this guideline has dealt with arrangements external to the service provider. With regard to internal arrangements, this section commences with general issues of relevance, whilst following sections move onto specific issues.

The following broader issues associated with managing effective service provision are covered:

a) Objectives.
b) Identification of activities.
c) Structure of the organisation.
d) Contracting out.

4.2 Objectives

Within the framework of the overall objectives for service provision (see section 1.6) a set of objectives specific organisational objectives need to be identified. These may vary from one service provider to another but would typically include:

- good governance;
- community participation;
- efficient management;
- access to necessary specialist services;
- optimised employment arrangements;
- low cost.

While each of these objectives is not discussed specifically in this guideline, they are implicit in many of the approaches to service provision which are discussed here.

4.3 Identification of activities

In setting up sound arrangements for service provision it is important to understand the activities which an organisation needs to perform. These activities can be identified as follows:

- governance;
- management and administration;
- finance;
- planning;
- projects;
- customer relations (liaison);
- operations.

Although these activities are often separated in an organisation, it is not necessary for this to be so – for example, in small organisations one or more of these activities may be performed by one group of people or even by a single person. Nevertheless, it remains important to identify them separately.

The effective running of each of these activities is at the heart of effective service provision and thus each one is dealt with in some detail in the later sections of this document (Sections 5 to 11).

4.4 Structure of the organisation

4.4.1 The relationship of structure to size

It is obvious that the structure of an organisation becomes more important as the size of the organisation increases, with more people and more tasks to be managed. There is also no universal structure which is applicable at each size, but it is useful to consider some generalised arrangements related to size. The emphasis here is on local government as service provider, as this is by far the most important model used in South Africa at present.

a) Micro-scale

At this size (typically less than 5 000 people served) there is often no need to have any full-time employees. If staff are employed full-time by the service provider, it is unlikely that there will be more than about five people. Here, the service levels used and the extent to which bulk services are run by the organisation are influencing factors. These arrangements are more typical of rural service providers and this document's companion guideline – applicable to rural areas – should be consulted (DWAF, 1997b).

b) Small-scale

At small scale (typically 5 000 to 50 000 people served) the possibility arises of employing a full-time professional to run the services in a town, typically a town engineer. It is seldom possible, however, for a professional person to be employed as a manager dedicated to water services. Thus the water services are typically managed as part of the total services package, including solid waste, roads, stormwater and, in some cases, electricity. At this scale there would typically be something in the range of two to 50 workers and operators dedicated specifically to water supply and sanitation. Again, the size and tasks of the workforce would be strongly influenced by the inclusion of bulk services in the responsibility of the service provider.

c) Medium-scale

In the size range of 50 000 to 500 000 people served, organisations need to become more careful about structure as there may be several hundred employees to manage. Here it becomes possible to set up professionally managed units dedicated to water service provision. These, in turn, may be subdivided into units dealing with, for example, bulk supply, water distribution and sanitation.

d) Large-scale

There are fewer than ten service providers at this scale in South Africa, but they collectively serve a large portion of the urban population. Consequently, managing them effectively is critically important. Here there may be between 500 and several thousand employees. Separate business units responsible for bulk water, bulk wastewater, water distribution and sanitation are essential. It may also be necessary to create geographic sub-divisions for the management of water distribution and sanitation services.

4.4.2 Influencing the size

There are ways of influencing the size of a service provider, through sub-division (if it is too large) or amalgamation (if it is too small). These issues are discussed by Davey (1992b), who provides a good overview of the issues associated with size and sub-division, in a local government context. Davey does not come to any conclusions but notes some of the risks of either very large or very small local governments.

In South Africa, with the recent establishment of new local government structures, the opportunities for influencing size have passed for the meantime. At this stage the emphasis needs to be directed at getting the existing structures to work properly. However, the amalgamation option needs to be kept in mind – particularly for small towns which are reasonably close together. Each town would keep its service authority role but could set up a single service provider, possibly using a publicly owned company.

4.4.3 Structure within a service provider

The structure within a service provider relates primarily to the way it is sub-divided and the way communication is set up. The intention is, obviously, to create effective arrangements to deliver services. Structure is considered here under the following:

a) Span of control.
b) Functional sub-division.
c) Geographic sub-division.
d) Development-orientated arrangements.
e) Community-based approaches.

a) Span of control and organisational hierarchy

There are numerous forms of organisational structure, but two extremes include a long flat organisation with many departments and fewer levels in the hierarchy of responsibility, and secondly a more compressed structure with fewer departments and more levels – the pyramid form (Craythorne, 1993). Typically a flat organisation allows for better communication between the specialists and the chief executive officer, and allows each specialist more independence.

The two forms of structure have different *spans of control*. This concept is concerned with the number of subordinates that a supervisor should have to deal with. The more

subordinates that have to report to an individual in an organisation the broader will be the span of control. The narrower the span, the steeper the organisational pyramid, the closer is the supervision and the longer the internal lines of communication.

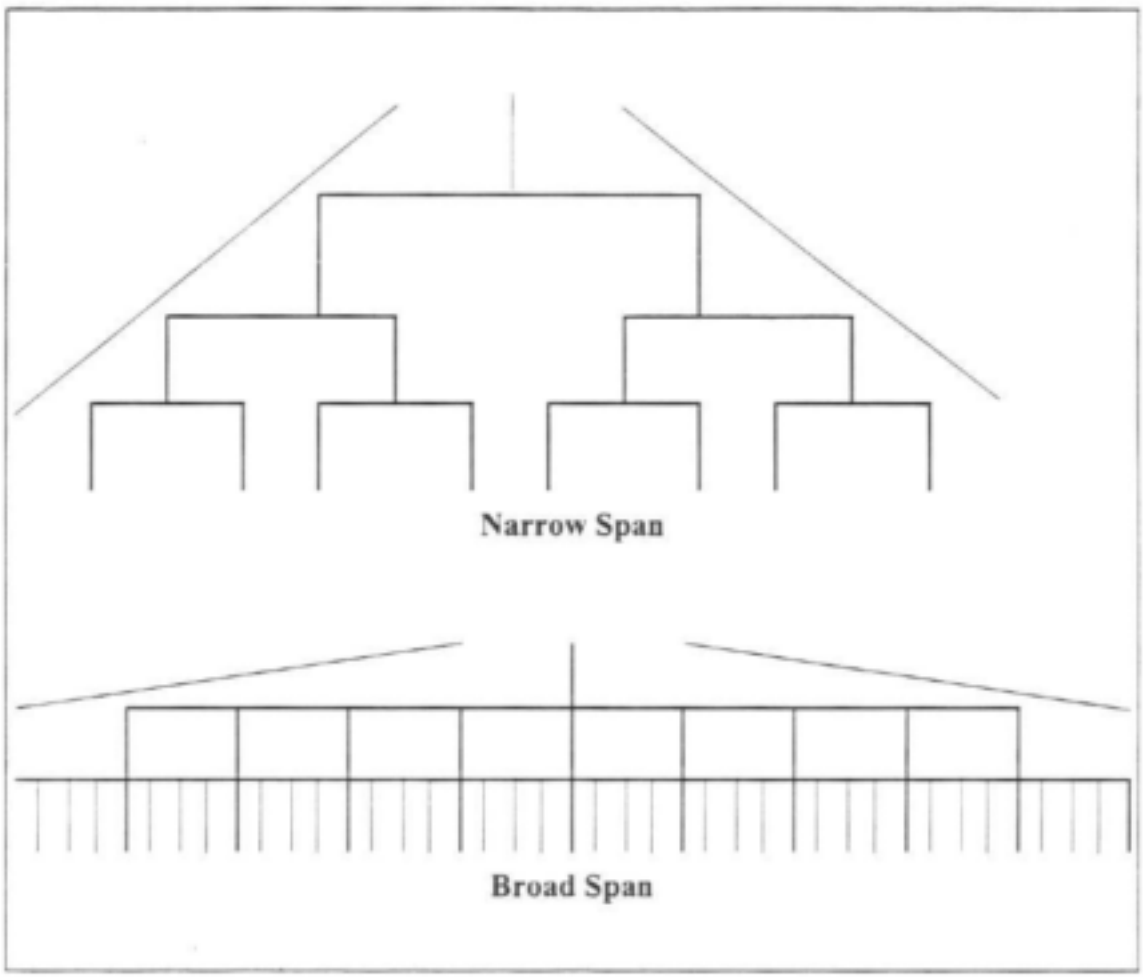


Figure 2: Illustration of span of control

Span of control relates to the way in which an organisation is subdivided into working units and the extent to which relative autonomy of decision-making can be given to these units. If water service provision activities are divided into a few sensibly identified units, with their own management, span of control can be broadened and decision-making expedited.

The broader the span, the fewer the number of levels in the hierarchy. At present there are examples of middle-sized towns (serving about 250 000 people) in South Africa with nine levels; some serving only 100 000 people have eight levels; on the other hand, there are examples of towns in the 200 000 to 300 000 range which have only six levels. Durban Water and Waste is an example of a structure with a particularly broad span of control: it has only six levels. Some organisational theorists argue that the number of levels should not exceed five.

An example of an organisational structure for a middle sized town in South Africa is given in Figure 3.

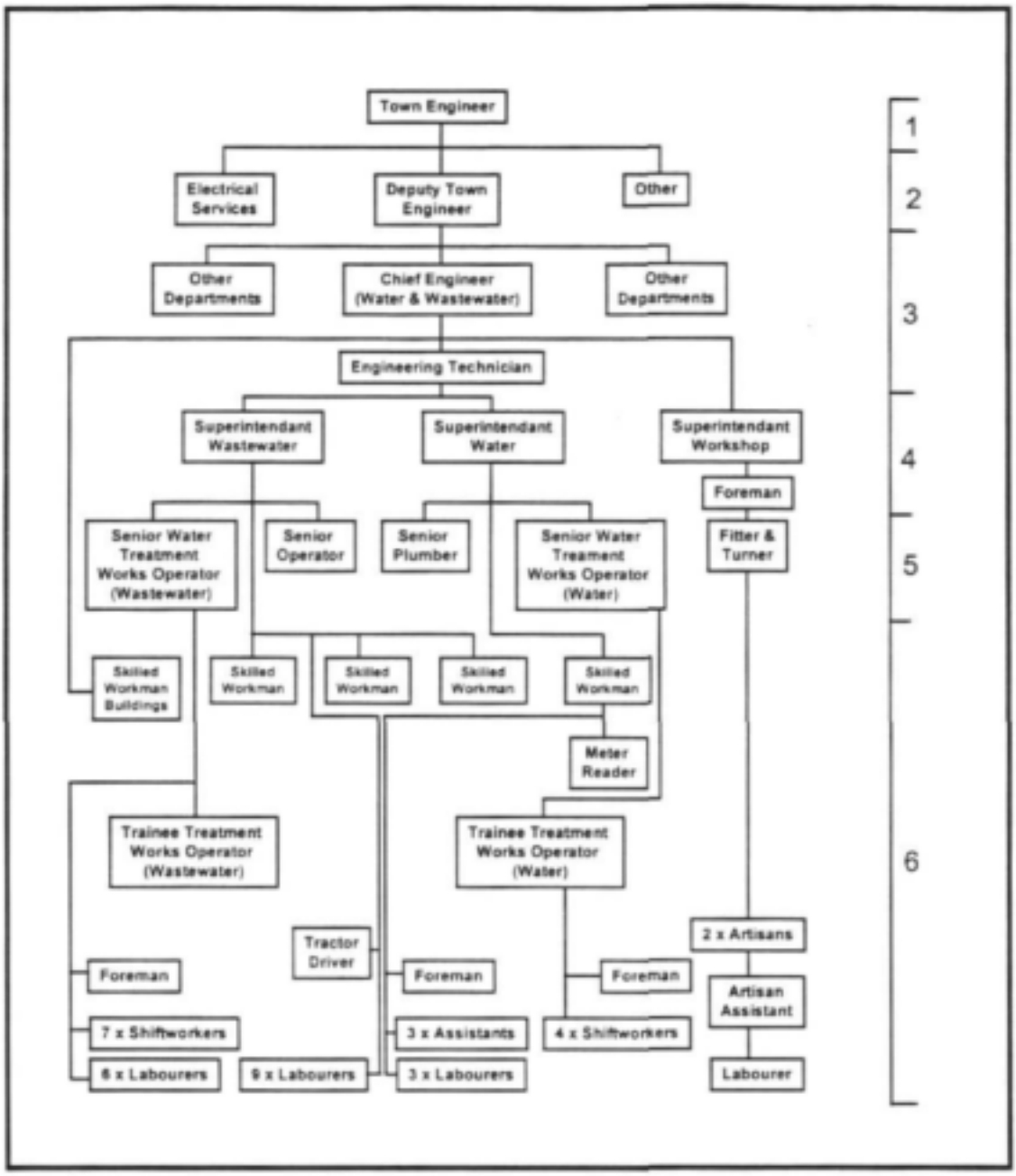


Figure 3: Illustrative organogram for narrow span structure

The structure illustrated in Figure 3 is an example of one with a very narrow span with eight levels in the hierarchy. (The four shift workers for the water treatment works would have to communicate through six levels before they got to the town engineer).

Organisational structure is also strongly related to the categorisation of employees, which are also hierarchical in terms of the level of expertise and responsibilities taken by each category of person. Typically, six categories are identified:

- executive;
- senior management;
- middle management (technical / specialist);
- clerical;

- supervisory / artisan;
- general worker.

These categories are indicated on the organogram in Figure 3.

b) Functional sub-division: separate business units

Functional sub-division relates to the creation of separate units responsible for specific services where the emphasis is on relatively autonomous management and "ring fencing" of accounts. This issue is widely discussed in the literature, generally in a local government context. For example Davey (1992a) and Pasteur (1992), in discussing urban government reform, note the advantages of functional sub-division.

In a water service context, the first level of functional subdivision is to separate the water service as a business unit from the other services performed by a local authority. This process would be generally applicable to medium-sized service providers but is not necessarily best for smaller organisations.

The second stage is to separate water supply and sanitation services and/or to separate bulk services. Each of these separations makes sense as a business unit. In the case of water distribution and sanitation the income to the unit can be clearly defined as the tariffs which are paid by customers of the service. With regard to bulk services, bulk water can be sold to the distributor at a rate per kilolitre while bulk wastewater can be conveyed and treated at volumetric and possibly strength-related rate. These "second-stage" subdivisions are clearly relevant for large service providers and may be important for medium-sized service providers as well.

c) Geographic sub-division: area management vs. utility management

The relevance of geographic sub-division is less clear than that of functional subdivision. The literature makes reference to area management, where a local authority would set up an area-based unit to deal with all municipal services (see, for example, Abbott (1996) and Davey (1992b)). The argument for this is that the customers would have only one place to go with their service concerns, whether these related to roads, water or parks. Based on an international study of local government arrangements, Davey does not see great merit in area management in any but the very largest cities. In essence, area management becomes a process of establishing sub-municipal government and in South Africa this is largely dealt with through the creation of sub-structures within the metropolitan areas.

There is, however, a need for co-ordinating service provision at area level, particularly in under-developed areas when projects are being undertaken. This is dealt with in the next section.

There may also be a need for a service provider to have local offices which are more accessible to customers who may have difficulty travelling long distances. Such offices may represent a move towards area management, with the extent of the move being dependent on how autonomous they are.

d) Development-orientated arrangements

A further area of subdivision which can be created relates to projects. The rationale for this is that the activities related to project implementation are very different from those relating to operations, hence the creation of separate entities to deal with these aspects. This is generally applicable only to larger service providers, as it is only then that organisations tend to have "in-house" staff to deal with projects.

There are also arguments against the establishment of separate project units. These relate primarily to the problems brought about by lack of co-ordination between those who are planning and implementing projects and those who have to operate them.

Burger (1997) discusses various structures to incorporate a project emphasis into local authority structures. He prefaces this with a discussion on a *development orientation* of local authorities; as projects are the visible manifestation of "development", this approach thus becomes particularly important in developing urban areas. Burger proposes the integration of functional activities with development activities in a system shown diagramatically in Figure 4.

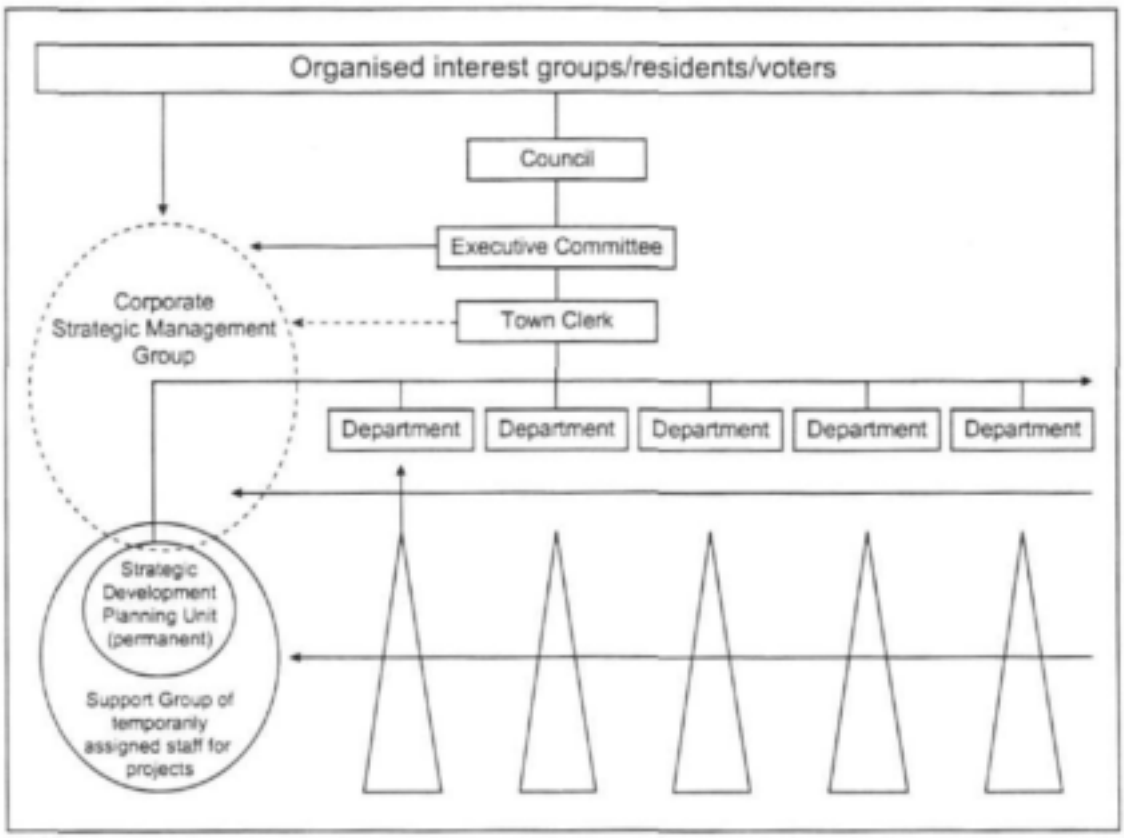


Figure 4: Development oriented management structure
(after Burger)

The arrangements are described by Burger as follows:

- The first component is a corporate strategic management group based on a heavyweight team structure. It comprises a maximum of 15 members, drawn from the senior ranks of the organisation and from influential stakeholders in its task environment. It is important that a number of senior, professionally qualified officials be combined with political and other influential representatives of clients and suppliers. The strategic management group acts as a corporate-level policy-generating body.
- The second component is a strategic development planning unit, consisting of a small core of permanently allocated members with skills in strategic planning, marketing, facilitating, conflict management, negotiations, mediating, evaluating and community relations. This core is not temporary

(as with the heavyweight team structure discussed above), but permanent and managed by an influential senior manager. This group manages a permanent, continuous strategic development planning programme, which may generate or contain various development projects at the operational level. These projects may be implemented or executed through functional or lightweight teams from the functional departments, or by the heavyweight team itself, in which case temporary support staff are "borrowed" from functional departments. The planning unit has approximately six permanent staff. Under no circumstances must the unit be allowed to become a large department permanently. Flexibility and adaptability should remain its most prominent characteristics, and it should grow and shrink according to circumstances.

Clearly the above guidelines are not prescriptive and will have to be informed by local circumstances, but they do provide an indication of the principles of development-focused strategic organisation.

e) Community-based approaches

International experience increasingly highlights the importance of community participation in service provision. This can be seen from the point of view of planning, projects and operations.

In the case of planning, the involvement of communities affected by the plans is necessary and can be accomplished in development-orientated models such as the one proposed by Burger in the previous sub-section. In a more localised context this is dealt with in existing guidelines (PDG 1995a & 1995b).

These guidelines relate also to projects – and planning for them – dealing briefly with the issues associated with community involvement.

Turning to operations, there are examples from the developing world where communities become directly involved in operations associated with water and sanitation systems, with considerable benefit to the overall efficiency of service provision. Perhaps one of the best examples of such an arrangement is the "condominial" sewerage system used in Brazil (Watson,1995). Here communities take a direct role in both the construction and operating of the system, including sewer maintenance. Arrangements such as these clearly affect the organisational structure of a service provider and could be seen as a form of informal contracting out.

4.5 Contracting out services

Section 3.3 of this document dealt with the private sector as a service provider. Briefly, in this model, the private firm would take responsibility for managing the service, including the employment of staff and so on. Further, private sector organisations can be contracted to provide a complete bulk service, where potable water is sold – or wastewater "purchased" – at an agreed rate to service providers who take responsibility for distribution or collection.

The private sector can, however, also be involved in a less comprehensive way, doing part of the work needed. The term often used for this approach is "service contracts" but construction contracts are also included. It needs to be noted that the contracts do not necessarily have to be with the private sector – for example, other public sector bodies could be contracted to provide certain services. Contracts are obviously directly related to the activity concerned and, therefore, the specific options are

discussed in the later sections of this guideline which deal with the specific activities of service providers.

5. GOVERNANCE

This section, and those following, deal more specifically with each of the service provider activities which were identified in Section 4.3.

5.1 Introduction

The term "governance" refers to the manner or system of governing an organisation. In practical terms it involves the arrangements through which the activities of an organisation are directed. In the development context in which water services provision occurs, this includes the arrangements through which the customers participate in decision-making. This is an essential part of good governance and implies a strong sense of accountability by the organisation as a whole, and its leaders in particular, to customers.

There must be clear differentiation between service authority and service provider relationships, as discussed earlier in this guideline. (Governance has already been mentioned from the point of view of the water service authority).

The governance arrangements are defined primarily by the type of organisation: local government, parastatal, private firm or community based organisation. Conventional mechanisms for governance include, for example, the council of a local authority or the board of a company. The people on these boards, councils or committees have two main responsibilities:

- to direct the affairs of the organisation; and
- to ensure that the interests of customers are taken into account.

There is potentially some conflict here which is typical of organisations with developmental responsibilities. Service providers may see the "customer interest" responsibility as conflicting with their own self-interest, particularly in profit-making private organisations. However, mature and well-managed organisations will recognise the congruence of their own interests with those of their customers. If this is not the case, short-term profits may be made at the expense of long-term viability.

5.2 Governance of local authority service providers

While governance remains important for all types of service providers, it is comparatively clear-cut for private and parastatal options. The case of local authority service providers, however, needs specific attention, as there is ambiguity with regard to the role of the council in governing and managing its own Water Service Provider. Practically, the division in a local authority will be between the council, perhaps together with the Town Clerk, acting as service authority, and the water and sanitation departments with their managers, acting as the service provider. The service provider, therefore, does not have separate governance roles in the true sense of the word.

6. Management and Administration

The terms "management and administration" relate to the activities needed to organise the overall functioning of the service provider and include:

- organisation of council, board or committee affairs;

- strategic management;
- water services development or business planning;
- contracts;
- human resources management;
- performance monitoring; and
- reporting.

The organisation of council, board or committee affairs is well covered by local authority and company procedures and is not discussed here. Each of the remaining activities are discussed below:

6.1 Strategic management

Strategy implies anticipation of major changes which affect organisations both internally and externally. Strategic management implies both this anticipation and making the adjustments needed to deal with these changes effectively. This contrasts with a more static approach which is based on the view that things will stay the same. Water service providers, particularly those in South Africa at present, are faced with major change and thus strategic management is particularly important.

The field of management is a complex one and cannot be dealt with adequately in a guideline of this nature. There are, however, a number of good reference works on the topic: Wade Millar (1993) deal with this in the context of a water utility, while Davey (1992b) and Hollis (1994) deal with the broader local government context.

While it needs to be recognised that strategic management is effective only if it is undertaken by the people within an organisation, often outside advice can act as a catalyst and bring new ideas and drive to an organisation. Service providers facing change need to build contacts with others, whether this be other service providers or consultants. There are also some standard tools which can support strategic management. The business plan, discussed in the next section, is one.

6.2 Business planning

The Water Services Bill requires a water services development plan to be prepared by every water service authority. Although it is the service authority and not the service provider which takes direct responsibility for ensuring that a plan is prepared and publicised, the plan guides the affairs of the water service provider in the long term and typically the provider would be directly involved in its preparation. A companion guideline is available for preparing a water services development plan. Here it is necessary to note only that the plan should include:

- the programme to be followed to ensure that all people get water;
- a description of the physical arrangements to be made to provide water;
- the arrangements for financing the proposed programme, dealing both with the capital and operating account; and
- organisational aspects: who will be the service provider and the structure of the organisations.

Within this plan the water service provider should have its own business plan. Further, it needs to be recognised that water services development plans relate only to those organisations providing services directly to customers. Water boards or private sector organisations managing bulk supply also have planning requirements but these would normally be referred to as business plans.

The term "business plan" in a water context should be about the business of providing water services. Thus the emphasis needs to be placed on customers, their demand for services, the right technical solutions, appropriate pricing, marketing and financial viability of the organisation.

It would be expected that the form of the business plan would closely follow that of the water services development plan. The responsibility for preparing this plan normally lies with the chief executive. On the physical or technical side he/she may be assisted by a planning section and on the financial side by the finance section. In the case of small-scale organisations, they cannot normally maintain the expertise to prepare such plans "in house", and reliance needs to be placed either on simple, standardised plans which could be easily prepared or on the services of consultants.

6.3 Contracts

Throughout this guideline emphasis is placed on the options for contracting out services and project-related activities and it is recognised that this approach can bring great benefits. However, the benefits are strongly related to the ability of the service provider to contract properly, to write contracts which properly define the services to be provided and create the right incentives for the contractor to perform well. In fact there are local government models, such as the New Zealand one, where almost all the elements of service provision are contracted out and the local authority management concentrates almost entirely on drafting and monitoring contracts effectively. The ability to contract properly is thus a key success factor for service providers. While legal advice may need to be sought for this it remains the managers' task to deal with the service description and incentive issues in the contract.

6.4 Human resources management

The management of the people in the organisation is obviously a function of primary importance. This includes aspects such as appointments, allocation of responsibilities, training, promotions, salaries, disputes etc. It is neither possible nor necessary to deal with these functions in detail in this guideline, but there are a number of good references on the topic (see Wade Miller (1993); Norris (1992); and Lawrence and Tomaro (1988)).

6.5 Monitoring performance

An important component of good management relates to setting goals for units within the organisation and then monitoring performance against these goals. This is associated with widespread delegation of responsibility and with benchmarking, whereby useful standards are developed over time against which performance can be measured. This can be applied to organisations as a whole or to units within them (see Kingdom *et al* (1996)).

6.6 Reporting

The need for good reporting runs through the whole of an organisation and it is part of all of the activities which are described in the following sections. Here, under the administration activity, two types of reporting need to be mentioned:

- reports prepared for the council, board or committee managing or governing the water service provider;
- reports required by outside organisations, notably the water service authority and national and provincial spheres of government.

The format of these two kinds of reports and the information contained in them may be similar, but the level of detail will vary, with more information required by the board or council of the service provider.

Reporting required by provincial and national government is dealt with in companion modules to this one (Modules 6 and 7). This can also serve as a basis for internal reporting.

7. FINANCE

The term "finance" includes the following:

- On the capital account side:
  - investment planning;
  - raising grant, loan or equity funds;
- On the current account side:
  - budgeting;
  - setting tariffs;
  - sales (billing, collection etc);
  - maintaining accounts.

It is not possible to deal with all these aspects in detail in this guideline, but some of the important aspects are dealt with below.

7.1 Planning investment

The requirements relating to investment-planning relate to the water services development plan and are not discussed here (see companion guideline: "Preparing a water services development plan").

7.2 Raising capital

Typically grant funding originates from provincial or central government and is channelled via the water service authority. However, the service provider would need to identify the need for funds, based on its development plan, and could be requested to prepare the applications for such funding to be passed on to the water service authority. At present the following main options exist for capital grant funding:

- the Municipal Infrastructure Programme (MIP);
- funds from the district council, raised through levies on businesses; and
- housing subsidies.

Options for loan funding to service provider include:

- DBSA; and
- private merchant banks.

A number of other financing sources exist, such as the Independent Development Trust (grant finance), the Infrastructure Finance Corporation (loan finance) and the Local Authorities Loan Fund (loan finance), but they have not been major sources of finance for water service providers to-date or in recent years.

Small amount of grant funds may also be found from international donors and the opportunities for borrowing internationally are opening up, but are subject to Department of Finance approval.

A further important source of capital finance in the case of local authority water service providers, is through each local authority's own capital reserve funds. The aim is for these to be built up by local authorities through provisions made against operating income, for use in capital expenditure projects. The significance of this depends primarily on the financial viability of the local authority and its revenue base.

7.3 Budgeting

Most organisations work on an annual budget cycle and the council, board or committee would have to approve budgets. Typically they are prepared by the treasurer or financial manager. Budget periods include the longer term approach used in water service development planning and short-term year-on-year adjustments based largely on short-term experience.

7.4 Setting tariffs

The tariff which customers need to pay is clearly a crucially important parameter. For this reason it is a key issue to be dealt with in water service development plans where tariffs and the constraints on their increase need to be clearly defined. This aspect is dealt with in a companion guideline (Modules 4 and 5: Water supply and sanitation tariff setting).

7.5 Sales

The term "sales' is used here to include:

- meter-reading;
- billing;
- collection of payments;
- credit control.

The sales activity is strongly dependent on the technology and management arrangements used for dispensing water at the customer interface. This includes:

- metered supply with formal billing;
- prepayment metering both for public standpipe and yard connections;
- yard tanks or orifice-controlled roof tank systems with fixed monthly payments per customer;
- public standpipes run on a concession basis;
- public standpipes with flat rate charges;
- public standpipes with informal *ad hoc* payment arrangements.

Each of the options listed has specific costs that need careful investigation and each requires specific administrative arrangements which are not within the scope of this module. A few points relating to service contracts need to be made, however. There are innovative ways of contracting out sales activities to individuals or small businesses. For example, in Durban a water bailiff is used on a contract basis to manage the yard tank and public standpipe system, including the collection of money. The concession option for public standpipes is also a contracted out activity. Further, the activity of delivering bills and collecting payments door-to-door can be contracted out and has favourable implications for job creation and payment levels.

7.6 Maintaining accounts

A proper accounting system is an essential component of sound management practice. Here the crucial issues are the establishment of a system with cost centres which are useful to managers and the integration of these into good reporting systems. The division into cost centres will depend on the size and nature of the service provider. A guide is given in the table below.

Activities	*Micro*	*Small*	*Medium*	*Large*
Administration and customer relations			X	
– Water supply				X
– Sanitation				X
Finance and sales (treasury)			X	
– Water supply				X
– Sanitation				X
Projects and planning			X	
– Water supply				X
– Sanitation				X
Total all non-operations activities		X		
Operations				
– Water supply: distribution		X	X	X
– Water supply: bulk services		X	X	X
– Sanitation: collection services		X	X	X
– Sanitation: bulk services		X	X	X
Total	X	X	X	X

Note: An X in one column is used to suggest that there should be cost centre for this activity. For example, for a micro service provider only one cost centre is proposed, for the whole water and sanitation system.

In addition to this it may be useful to create separate cost centres for each treatment works, so that costs can be monitored for each. With regard to distribution and collection systems, it may also be necessary to have separate cost centres for specific geographic areas, for similar reasons.

8. PLANNING

The term planning covers a range of activities, including:

- Water services development planning and business planning: this is essentially strategic in orientation and brings together physical, financial, socio-economic and organisational aspects.
- Technical planning: this includes level of service decisions, the way in which the network is to be expanded to serve new customers, the arrangements to provide for bulk and connector services sufficient to provide for the growth in water demand and anticipating rehabilitation requirements. This work is generally done by engineers either within the service provider or consulting to it.
- Operations planning: this refers to the way in which operations are to be organised to run the service in the most effective manner.

In a large organisation there may be separate people carrying out these tasks, although more often the activities are carried out as part of the work done by the chief executive, chief engineer and operations manager respectively. Often consultants are appointed to assist.

All but the larger service providers will need to rely on consultants to carry out the planning of the physical arrangements to provide water. This would generally be done in the form of feasibility studies and master planning reports which would feed into the water services development plan.

9. PROJECTS

The term "projects" encompasses all of the activities needed to provide new infrastructure or rehabilitate existing infrastructure. Thus it includes project management, design, construction and the activities associated with this, such as training of contractors and community interaction over issues which affect them. The "projects" activity varies depending on the nature of the project, which can be divided into the following groups:

- bulk and connector infrastructure;
- new internal infrastructure;
- upgrading of internal infrastructure;
- rehabilitation (asset replacement).

Considering only the immediate impact of the project, rather than the long-term impacts which need to be dealt with under the planning activity, *bulk and connector infrastructure* projects have the least effect on the community. Use of labour-intensive construction and the effects of construction on the people adjacent to the works are the typical factors to be considered.

New internal infrastructure is often a special case, as it is provided together with housing, with developers carrying out the planning, design and construction. In this case the service provider has an influence primarily through the contract with the developer.

Upgrading of internal infrastructure is generally associated with an improvement in level of service. Here the activity is generally confined to the water services sector and the service provider takes a more direct role. Community participation requirements are at their greatest here, as communities are affected by the change in the service they will get as well as disruptions to their living environment.

Finally, with regard to *rehabilitation* the situation is intermediate between the bulk and connector and upgrading cases, with no developer involved.

The process of implementing projects is a complex one and covered by other guidelines (See PDG 1995a and PDG 1995b).

It is notable that, in addition to the role of developers in providing new infrastructure, there are extensive opportunities for contracting out project-related work. In fact it is seldom in South Africa that this work is done "in-house".

10. CUSTOMER RELATIONS

The relationship between service provider and customer is the most important one in the network of relationships which a service provider typically needs to establish (See Figure 1 in Section 2.1 of this module). Here the emphasis must be on providing the customer with the service which has been agreed upon in a way which keeps them satisfied. Obviously the customer has a part to play in paying for the service; given its importance it is evident that the activity of liaising with customers must be given proper attention by service providers.

In terms of the National Water Service Regulations (Section 13), a written contract must exist between the service provider and the customer. Further the water services development plan which defines the obligations of both parties (the nature of the service on the one hand and the amount to be paid for it on the other).

Turning to the mechanisms for maintaining contact between both parties, this would typically involve:

- reactive arrangements such as processes for dealing with complaints effectively; and
- pro-active arrangements such as surveying customers needs and informing them about what is happening.

In addition to these *service provider* activities it needs to be noted that the *service authority* has the responsibility of ensuring that customers are satisfied. This involves:

- monitoring customers to assess the extent to which they are satisfied; and
- resolving disputes between customers and water service providers.

With regard to disputes, these should be dealt with between customer and the service provider as far as possible. Where they are not resolved, however, it has been mentioned previously in this document that there should also be dispute resolution arrangements set up by the service authority. Thus dissatisfied customers would be able to go to the service authority with complaints about the service provider, a process which is outside the customer relations activity of the service provider.

There is considerable literature on "customer relations", much of which relates to well developed cities. In a developing world context the role of such relations becomes more important largely because there are so many unserved or under-served people. Also the technologies used often require more input from the customer.

For all but micro-sized service providers, the following should be seen as a minimum approach for South Africa:

a) A customer relations activity needs to be established. For small service providers this may not require a full-time person, but for all others at least one full-time post would normally be needed.

b) A survey of user attitudes should be carried out at least once every five years by medium and large service providers.

c) A complaints desk and complaints register should be set up. This does not necessarily involve full-time staff, particularly in small service providers, but the activity needs to be delegated to a particular person. Complaints must be recorded and regular reporting of the overall situation with complaints is important. This can then be used as an indicator of performance.

With the inadequacy of the postal service and perhaps lower levels of literacy, innovative ways of relating to customers need to be used. Meetings and the part-time employment of "task teams" can be considered.

11. OPERATIONS

The term "operations" is used to cover the activities required both to operate the service and to maintain it. This is a large topic and includes arrangements to run complex infrastructure such as treatment works. Within the scope of this guideline it is possible to raise only broader issues of importance. As discussed earlier in this guideline, in larger-scale organisations these activities are typically broken down into separate system elements (or cost centres). A typical subdivision would be into bulk water, bulk wastewater, water distribution and sanitation activities. Although it is not necessary that these divisions are created, particularly in smaller service providers, they are discussed separately here.

11.1 Operating bulk water infrastructure

Operating of bulk water supply systems includes the activities relating to:

- water abstraction;
- treatment;
- pumping;
- pipelines;
- control systems.

While small systems using appropriate technology can be reasonably easily operated, larger systems require specialist expertise to run each of the components, notably treatment works.

From the point of view of overall management, the key indicators of efficiency are water quantity, quality and cost: if a sufficient quantity of water is delivered to all customers, with a quality which meets potable water standards, and at a reasonable price, the system can be said to be running efficiently. Conversely, if there is insufficient water provided to meet demand, if the quality is poor or if the price is too high, the system is not performing properly. Measuring the level of performance in relation to these, and other, criteria, in relation to key performance indicators, is a complex matter which is beyond the scope of this module.

Water quality is subject to an SABS standard (SABS 241). In order to maintain the standard a laboratory service is needed for all but micro service providers.

Bulk water supply activities can be contracted out. The most extensive use of private expertise – short of contracting out the whole service – is the use of build-operate-transfer (BOT) contracts for treatment works. Here a contract could be entered into with a private company taking full responsibility for providing the works and treating water to a specific standard, in return for a payment per unit of water treated. Less extensive examples include the contracting out of the operation of a treatment works or just the contracting out of the laboratory service (analysis of samples and water quality reporting).

11.2 Operating bulk wastewater infrastructure

Operating bulk water supply systems includes the activities relating to:

- outfall sewers;
- pump stations;
- treatment works;
- sludge management.

The specific issues associated with operating this infrastructure are beyond the scope of this guideline; a good reference in this regard, however, is: Water Pollution Control Federation (1986) "Plant managers handbook".

Sludge management, often the most troublesome aspect of bulk wastewater systems, is governed largely by the disposal options available. If sludge is to be disposed to land it is covered by a Department of Health guideline. As with bulk water systems, indicators of good performance relate to the quality of treated effluent and unit costs of treatment. The quality-monitoring approaches are common to both water and wastewater systems.

The option of contracting out certain activities is also common to both water and wastewater systems. Sludge management is a special case in South Africa; this has brought some innovative arrangements, for example, selling sludge for brick making or handing over the operation to a fertiliser company.

11.3 Operating distribution systems

11.3.1 Water accounting

Proper accounting of water flows in the distribution system is the most important requirement from a management point of view, as it generates information for sales and for the water audit which, in turn, represents a measure of the efficiency with which the system operates. Requirements relating to the water audit are given in the National Water Supply Regulations (DWAF, 1996) and are also covered in a new SABS Code of Practice (SABS, 1997). The compatibility between these two documents needs to be addressed.

There is a large body of literature on water accounting and unaccounted-for-water (UFW) control, which can be used to supplement the above regulations and code of practice. Jeffcoate and Sarvanapavan (1987) are particularly useful, with an international perspective including the developing country context.

11.3.2 Metering

It is metering which generates the information required for water accounting and thus proper metering is related to proper management. Therefore there are very few situations where the metering of every customer and public standpipe would not be justified. Metering requirements are dealt with in some detail in the National Water Supply Regulations (DWAF, 1996).

11.3.3 Leak detection and pipeline monitoring

Once good water accounting practice is in place it becomes possible to minimise the physical losses of water from the system, from leaks and breaks. There is now a good body of experience in this field in South Africa and contractors who can supply leak detection equipment or provide the full service to locate leaks.

11.3.4 Geographic information systems

The proper operation of larger distribution systems is made easier if a geographic information system is used. This applies to medium and large service providers, but not necessarily to small ones where the complexity and cost of the system may not be justified. For a useful reference with regard to mapping see Pickering *et al* (1993).

11.4 Sanitation: a holistic approach

11.4.1 Education and primary health care

It is the non-technical aspects of service provision which represent one of the major challenges to water service managers in South Africa. This is specifically so with regard to sanitation. Here it needs to recognised that sanitation, to be effective, needs to be based on a strong education and primary health care approach. Where the service provider is within the local authority, strong links are needed between the managers of the technical aspects associated with sanitation and the health officials. If the service provider is separate from the local authority, environmental health care staff need to be employed if the health benefits of investment in infrastructure are to be maximised.

11.4.2 On-site sanitation

On-site sanitation will continue to be a viable sanitation option, particularly on the urban fringe where waterborne sanitation becomes too costly. While much of the responsibility for operating such systems falls to the customer, it is essential that support arrangements are set up by the service provider to deal with:

- education of customers;
- monitoring;
- pit- or tank-emptying.

Education involves an ongoing process of informing people of how their systems work and of how to improve their functioning. Monitoring is a companion process to ensure that sanitation technology is being used properly, but also includes the practical aspect of assessing the sludge levels in tanks or pits so that a proper emptying arrangement can be set up.

With regard to emptying, it is possible for this to be left to the customer to organise, with a charge being levied by the body which does the emptying. However, it is generally preferable for the service provider to set up the arrangements so that emptying can be done in cycles with batches of tanks or pits done at a time. This brings financial benefits to the customer, partly due to economies of scale and partly as they can be charged a small monthly charge for the service instead of a once-off amount.

11.4.3 Bucket systems

Bucket sanitation systems, as operated in South Africa, do not represent an adequate level of service and in many areas are being replaced with better levels of service. Many of these systems exist, however, and they need to be managed properly. Because their maintenance requires the extensive use of labour, it is important to have adequate supervision and oversight over these systems. Their unpopularity, however, means that water service authorities should seek to utilise available sources of subsidy finance to improve those systems as soon as possible.

11.4.4 Wastewater collection

The operation of wastewater collection systems (sewerage) is generally well understood. However, there are new challenges which are associated with the need to reduce capital cost. A good reference with regard to the specifics is: Water Environment Federation (1992) "Wastewater collection systems management". This includes the following topics:

- safety;
- design considerations;
- system maintenance and management;
- pump stations;
- government and community relations;
- construction contracting;
- training.

11.5 Maintenance of infrastructure

The term "maintenance" refers to the year-to-year activities required to keep plant and infrastructure functioning. Some of this is routine maintenance, such as checking oil levels in engines, some requires the replacement of parts on a regular basis and some requires the repair of damaged components. Maintenance needs to be contrasted with "asset replacement' which involves the total replacement of an item of plant or infrastructure.

In its worst form, maintenance involves only a responsive approach to repair damaged items. In its best form a "managed maintenance" approach is used. Here an excellent reference is Wyatt (1989) "Guidelines for maintenance management in water and sanitation utilities in developing countries". This reference has been prepared specifically for the water sector and includes practical procedures. It deals with the following topics:

- introduction to maintenance systems;
- planning and organising maintenance management systems;
- work order systems;
- equipment records;
- materials inventory control;
- monitoring, evaluating, and reporting.

The document includes a list of standard software for maintenance management. Jordaan (1990) is also a useful reference dealing with water supply systems.

There are many elements of a maintenance programme which can be contracted out. Possibly the most widely used is vehicle maintenance. However, overhaul of treatment and pumping equipment, pipeline repair and other activities can also be contracted out.

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WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Module 2

PREPARATION OF A WATER SERVICES DEVELOPMENT PLAN

January 1998

PALMER DEVELOPMENT GROUP

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PREFACE

This module forms part of the series "Management guidelines for water service institutions". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

Executive summary: Introduction to urban services management

Module 1: An introduction to organisational arrangements for water service providers

Module 2: Preparation of a water services development plan

Module 3: Customer profile and demand for services

Module 4: Setting water tariffs

Module 5: Setting sanitation tariffs

Module 6: Reporting procedures for water services

Module 7: Reporting procedures for sanitation services

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The Steering Committee for this project includes the following people:

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Project team

The project team instrumental in developing these guidelines comprised Ian Palmer, Richard Tainton and Bee Thompson, all from Palmer Development Group. Craig Bekker assisted with figures and formatting.

1. INTRODUCTION

1.1 Scope

The government has recently published a Water Services Act (Act 108 of 1997). This module has been prepared to guide water service authorities who are required under the Water Services Act to prepare a Water Services Development Plan (WSDP). It will also be useful to water services providers, who are affected by the plan, and advisors to water service authorities.

The document deals with background issues relating to the plan and the planning process: the reason for having a water services development plan and the processes to be followed in preparing the plan. It then sets out the items to be dealt with in the plan, giving indicators as to how these are to be addressed. However, it does not give a complete methodology for each step to be taken. This is not possible primarily due to the variety of circumstances under which water services need to be provided in South Africa.

Finally this document deals with the use of the plan as a monitoring and regulatory tool.

1.2 Policy framework - the Water Services Act

This module relates directly to the requirements set out in the Water Services Act. The relevant extract from this Act is given below:

> **"Contents of draft water services development plan**
>
> 13. Every draft water services development plan ..... must contain details -
> (a) of the physical attributes of the area to which it applies;
> (b) of the size and distribution of the population within that area;
> (c) of a time frame for the plan, including the implementation program for the following five years;
> (d) of existing water services;
> (e) of existing industrial water use within the area of jurisdiction of the relevant water services authority;
> (f) of existing industrial effluent disposed of within the area of jurisdiction of the relevant water services authority;
> (g) of the number and location of persons within the area who are not being provided with a basic water supply and basic sanitation;
> (h) regarding the future provision of water services and water for industrial use and future disposal of industrial effluent, including -
> (i) the water service providers which will provide those water services;
> (ii) the contracts and proposed contracts with those water services providers;
> (iii) the proposed infrastructure necessary for the water services;
> (iv) the water sources to be used and the quantity of water to be obtained from and discharged into each source;

(v) the estimated capital and operating costs of those water services and the financial arrangements for funding those water services, including the tariff structures;
(vi) any water services institution that will assist the water services authority;
(vii) details of operation, maintenance, repair and replacement of existing and future infrastructure.

(i) of the number and location of persons to whom water services cannot be provided within the next five years, setting out -
(i) the reasons therefor; and
(ii) the time frame within which it may reasonably be expected that a basic water supply and basic sanitation will be provided to those persons; and

(j) of existing and proposed water conservation, recycling and environmental protection measures".

The above requirements form the basis for setting the requirements for development planning.

1.3 Relationship to other guidelines

A WSDP is a comprehensive plan which deals with socio-economic, technical, financial, organisational and environmental issues. Thus, as described in the executive summary, there are clear links to this planning guideline from all of the other modules:

- Module 3: "Customer profile and demand for services", deals largely with socio-economic issues but also deals with several other matters which are essential input to the planning process, notably levels of service and demand projection. Thus this module serves as an introductory module to planning.

- The plan deals with finance and has tariffs as one of its most important elements. The two tariff setting modules (Modules 4 and 5) thus serve as input to the WSDP, dealing as they do with the methodology for setting tariffs.

- Organisational arrangements are part of the WSDP and Module 1 serves as input in this regard.

- The plan generates information which needs to be disseminated. The proposed method for doing this is given in the reporting modules (Modules 6 and 7).

1.4 Relationship to other planning processes

There are other planning processes which affect water services provision. There are also planning processes which are undertaken by local authorities for all services, land development and economic purposes which impact on water service provision.

1.4.1 Water sector planning

There are four planning processes specifically related to the water sector:

Area plans

The term "area" is used by the water sector to mean an area significantly larger than a local council area. Typically it would be at district council scale but it may be larger or smaller depending on what the local water related circumstances are.

An "area plan" is used by the water sector for the plan which covers the social, economic, technical, institutional, financial and environmental aspects associated with providing water and sanitation services in this area. The plan is intended to provide the framework within which water and sanitation projects can be implemented. Area plans have been set up largely for rural areas but they also provide the framework for water services provision in urban areas, particularly smaller towns.

There is currently some uncertainty regarding the relationship between area plans and water service development plans. For example, if a district council is a water service authority it would have to have a water service development plan. In most respects this would be the same as an area plan.

Water resources plans

Water resources plans are prepared at catchment scale to assess the water resources situation and make proposals with regard to the development of these resources. Such plans would feed into area plans at "area scale". From the point of view of the water service authority they also feed into the water services development plan and there is little ambiguity in this regard.

Project plans

The approach to project planning is currently rather different in rural and urban areas. In rural areas the project planning process is currently being promoted by DWAF largely to ensure that Community Water Supply and Sanitation (CWSS) projects are properly implemented and managed. At present they are not strongly linked to a water service authority which is a concern. However, as this is primarily a rural issue, it is not covered here.

In urban areas a project plan would clearly be subservient to a water service development plan. The water service development plan would identify the projects which are needed to expand or improve water services. The project plan would then deal with the specifics of the projects when they are needed.

Bulk services master plans

This planning process has traditionally been used by local authorities in South Africa. Although generally technical in orientation, they would normally start with demand projections which has a non-technical aspect to it. Under the new planning régime the bulk services master plan would be part of the water service development plan, taking demand figures from it and providing input to it on bulk service options and costs.

1.4.2 Local government planning

There are several planning processes followed by local government, including structure planning and Land Development Objectives. But the most important from the point of view of water services development planning is the integrated development planning required by new local government legislation.

Integrated development plans

Integrated development plans (IDP's) are at the heart of planning for service provision by local government. They deal with the social, economic, institutional, financial, technical and environmental issues associated with service provision by a local authority. They also deal with broader issues associated with land development. As such they link with the land development objectives (LDO's) required by the Development Facilitation Act.

A water service development plan fits directly into an integrated development plan. It has the same scale (local authority) and the same overall objective: to promote effective and sustainable service provision to the people in the local authority area. The essential difference is that the WSDP deals with water supply and sanitation services while the IDP deals with all services provided by a local authority.

Ideally a water service development plan would follow an IDP. However, if the WSDP came first it would be possible for it to be integrated into the IDP.

2. WATER SERVICES DEVELOPMENT PLAN - OVERVIEW

2.1 Purpose of a water services development plan

The water service development plan (WSDP) serves a number of purposes:

a) It sets out the way things need to be organised in the future so that water services can be properly provided to all.

b) It is essentially a contract between the people in the area of jurisdiction of the water service authority and the water service authority itself. It describes the various aspects of the service which the authority will arrange to provide so that people know what to expect.

c) It also sets out the basic form of the relationship with others who will be involved with water service provision. In particular it would identify water service providers.

d) The plan also forms the basis for the contract between water service authority and water service provider. The service provider has the responsibility for putting into action what the plan describes.

e) It serves as a basis for monitoring the performance of the water service provider.

f) Finally it is at the heart of the regulatory system. The measurement of performance against plan can be used by the water service authority and by national government as a basis for taking action against water service providers who do not perform properly.

2.2 The WSDP cycle

The process of development planning involves a comprehensive look at all the factors which effect the provision of services. It can best be described as a cycle such as that

shown in Figure 1. This figure also illustrates the links which need to made to the Integrated Development Plan (IDP).

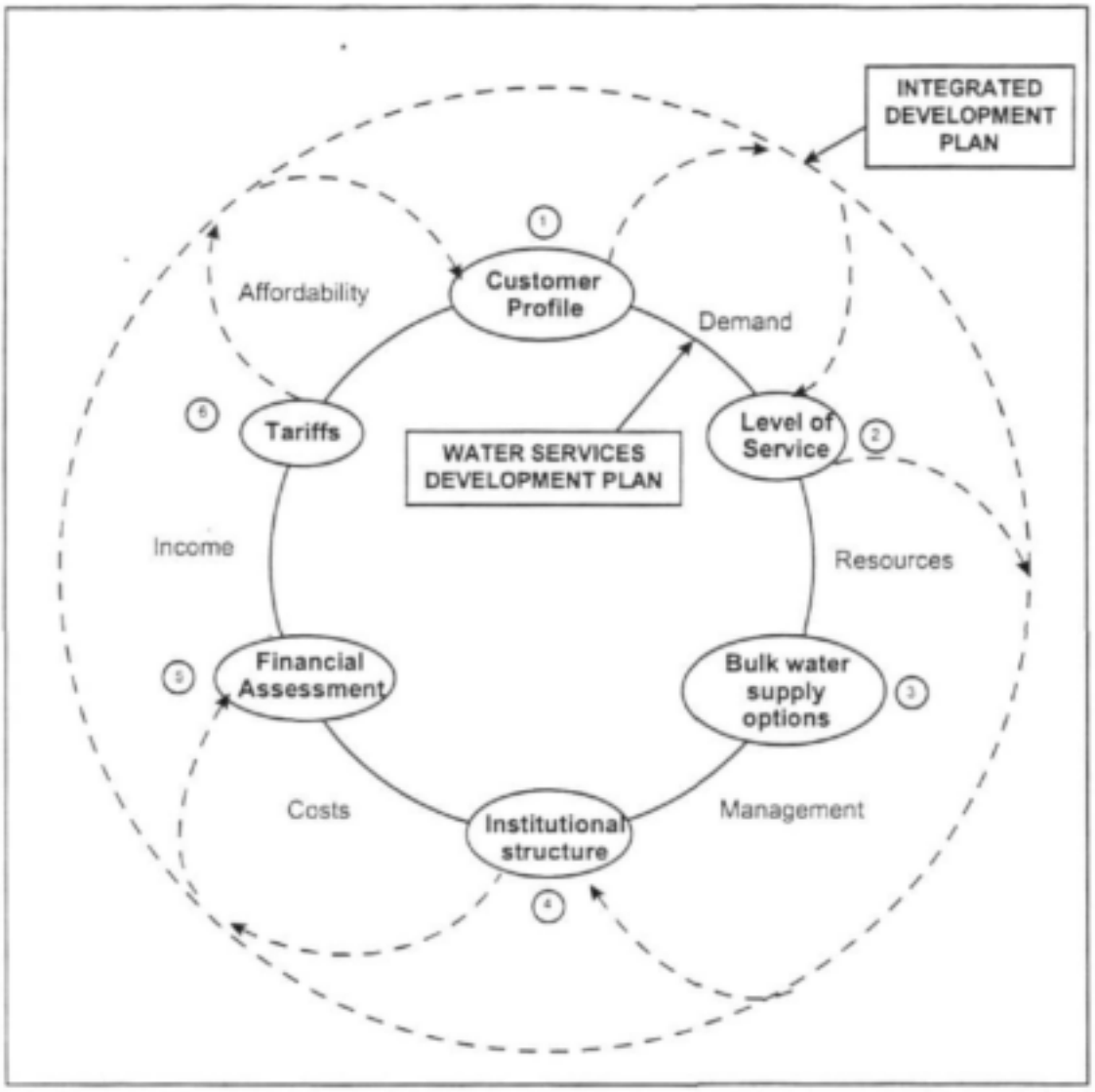


Figure 1: The Water Services Development Planning Cycle

The process starts with an understanding of customer profile and then moves to consideration of technical, institutional, and financial aspects, returning again to the customers where the affordability of the arrangements needs to be dealt with.

The cycle represents an integrated process which avoids the failings of linear processes which have often been used in the past, where planning starts with the technical aspects, proceeds to financial and then deals with the community and institutional aspects as an "add on". If technical arrangements are taken too far early in the process it can be difficult to re-orientate these to produce a sustainable structure.

Each step in the process is dealt with as one of the components of the plan which are described in Section 3. However, it needs to be recognised that initially there is not

one solution emanating from the process. In fact, given the complexities of the cycle, several solutions or options may be generated. These options form the basis for discussions with stakeholders, as described in the following sub-section.

2.3 The planning process

In order to prepare a WSDP a process has to be followed which incorporates the following stages:

a) Data gathering.
b) Assessment of options.
c) Interaction with stakeholders.
d) Preparation of draft plan.
e) Approval of plan by stakeholders.
f) Finalising of plan.
g) Submission of plan to authorities and publishing.

Data gathering It is not possible to list all the data which is required for the plan due to the wide variety of local conditions. However, the data required follows from the outputs which are required from the plan, as described in Section 3. Much of this data may already be available to the Water Service Authority. But typically substantial work needs to be done to gather new information.

Assessment of options The options for the way water services are provided will have infinite variety, considering the complexity of socio-economic, technical, institutional, environmental and financial factors. However, certain options need to be selected for analysis based on the cyclical process described in the previous sub-section. Judgment of the planner will be important here in selecting options which are realistic and useful in workshops with stakeholders. The use of computerised methods based on models is particularly useful here as the analysis is made easier. This is discussed in the following sub-section.

Interaction with stakeholders A plan is only relevant if the people who are affected by it know about it and accept it. Thus the process of interaction with stakeholders in the preparation of the plan is essential. This interaction needs to start at the point when options have been generated so that stakeholders can understand the issues and the implications for them. There is no single method for interaction which will work for all communities. But generally a workshop format would be suitable, with the numbers of workshops and their duration depending on the size of the community, the number of stakeholder organisations and the complexity of the water service options.

The identity of stakeholders will also vary from one place to another. But normally the following would be included:

- The water service authority
- Existing or potential water service providers
- Community based organisations, such as civic associations
- Other government representatives
- NGOs and others representing specific interest groups.
- Organisations representing business interests
- Unions, particularly municipal workers unions.

Preparation of a draft plan Once options have been discussed with stakeholders the plan itself can be prepared in draft form, based on the outline given here in Section 3.

Approval of plan by stakeholders It is essential that stakeholders see the draft plan and accept it before it is finalised. This can be done through a further workshop or through separate interactions with each stakeholder group. It is considered necessary for the plan to be presented to the stakeholders in a meeting format so that the service authority can be sure that people understand it properly.

Finalising the plan Once it is approved the plan can be finalised and it then represents an agreement between the Water Service authority and customers as to what is to be provided.

Submission of plan to authorities and publication The Water Services Act requires that the plan be submitted to various government bodies and notice of its adoption must be published in the provincial gazette. These aspects are discussed in more detail later in this guideline.

2.4 Use of water services models to prepare a WSDP

In the process of analysing the options for providing water services, the use of computerised methods has advantages. Computer models have been developed for this purpose by Palmer Development Group for the Water Research Commission and Development Bank of Southern Africa. These models allow the operating and capital costs associated with level of service decisions to be assessed. They also serve as a "first cut" tariff setting tool which is essential if the affordability of the service to customers is to be assessed. Further the outputs from the models includes long term trends with regard to capital investment, tariffs and water demand.

The water supply services model is in a more advanced stage of development than the sanitation model. It functions with Excel spreadsheet software. The input and output tables from this model are included as an appendix to this guideline to assist those who wish to use the model for planning.

The sanitation model has also updated and translated into Excel spreadsheet format. It is available for those who wish to use it but it is not included with this guideline.

2.5 The plan as a product

Once the plan has been agreed to between local stakeholders it is written down and becomes a product. In addition to the hard copy (paper version) of it there are now other options for making it available electronically. In this form it can be easily transmitted to those that require it and can deal with the electronic format. It is also possible for the plan to be made accessible via the internet, as discussed later in this guideline.

2.6 The plan and reporting requirements

The Water Services Act requires reports to be prepared on the implementation of the plan. In addition Water Service Authorities are required to submit certain information to DWAF regarding water services in their areas. It is proposed that the quantitative

aspects of these two reporting requirements be integrated and a proposed reporting format for water supply and sanitation systems is included with these guidelines as modules 7 and 8. These reporting formats are in essence a summary of the quantitative content of a water services development plan.

The manner of reporting and feedback is discussed later in this guideline. But the reporting format is introduced here so that the reporting requirements can be cross referenced in the next section.

3. THE COMPONENTS OF THE PLAN

The essential information required for each component of the WSDP is described in the following sub-sections. Cross referencing information is given in a box where it is appropriate, as follows:

Reference to relevant table in Water Supply Service Model (see annexure to this Module).
Reference to place where information for reporting regarding water supply can be filled in (See Module 6: Reporting for water)
Reference to place where information for reporting regarding sanitation can be filled in (See Module 7: Reporting for sanitation)

3.1 Current status

3.1.1 Description of area served

In this section the following needs to be included:

a) An A4 map showing the supply area and its sub-division into supply zones.

b) A brief (one page) description of the topography and geotechnical conditions in the area.

3.1.2 The current customer profile

The focus of the Plan is on delivering services effectively to those who need them: the customers. Thus the profile of the customers within the area to be served is of central importance and is the starting point for development planning.

The issues associated with customers, and the methodology to be used in getting a customer profile as discussed in a companion module to this one: Module 3: 'Customer profile and demand for services'. This module deals with demographic issues, the relationship between population and customer units, and household (and hence customer unit) income profile.

The figures which are needed to define the customer profile are:

a) Total population.

b) Numbers of residential customer units.

c) Income profile of residential customer units.

d) Numbers of non-residential customer units.

Water supply services model:	Page 1.2
Reporting for water:	WB 1 & 2
Reporting for sanitation:	SB 1 & 2

3.1.3 Level of service

The next step in preparing the Plan is to address service levels.

The concept of service levels relates to the options which customers can be given with regard to the convenience of the service and hence the amount of water which they can consume. Here there is a range, from unimproved sources of water (rivers, wells etc.) up to house connections where water is reticulated on the plot and in the house to several taps.

Level of service issues are also addressed in Module 3: "Customer profile and demand for services", as described in the Preface of this document.

Both the existing levels of service provided in the service area, and those to be used in the future, need to be identified.

Once the levels of service have been identified the current number of customer units with each type of service needs to be calculated. Also the number of customers (households) who are unserved needs to be given.

Water supply services model:	Page 1.4; 1.5
Reporting for water:	WB 3
Reporting for sanitation:	SB 3

3.1.4 Water balance

The water balance is an important step in the process of understanding the current functioning of a water supply system.

From the point of view of water supply, the methodology for doing this is described in a new (as yet unnumbered) SABS Code of Practice: "Management of potable water distribution systems".

For wastewater flows, the elements of a methodology are contained in Annexure 1 of Module 5: "Setting Sanitation Tariffs".

From the point of view of the Water Services Development Plan the following information is needed:

On the water supply side:

a) Amount of bulk water purchased or, if the bulk system is run by the service provider (authority), the amount of water treated.

b) The amount of water metered, both to residential and non-residential customers.

c) An estimate of the amount of water supplied to authorised, unmetered customers.

d) An estimate of the amount of water which is used by unauthorised customers (illegal connections etc).

e) Water used but not supplied to customers. This is generally that used by the service provider itself.

f) Physical potable water losses [the difference between a) and the total of b) to e)]

On the wastewater side:

a) An estimate of the amount of wastewater collected from customers, both residential and non-residential.

b) An estimate of the amount of stormwater ingress.

c) An estimate of the net loss or gain to the groundwater.

d) Any other influent into the wastewater stream.

e) Metered flow entering the wastewater treatment works or outfall, if no treatment is applied.

In the case of the wastewater flow balance the total of amounts a) to d) should equal e). An iterative process is generally needed to get the balance right.

Water supply services model:	Page 1.6
Reporting for water:	WC 3
Reporting for sanitation:	SC 3

3.1.5 Organic load mass balance

An organic load mass balance needs to be included, using COD (Chemical Oxygen Demand) as a basis.

On the input side the mass balance needs to be made up from COD loads per capita for residential customers and known or estimated organic loads for industrial effluents. Aggregated, this makes up the total organic mass load on the treatment works.

On the output side, the organic load in the treated effluent flow (that which passes into the environment) needs to be estimated, based on efficiency of the treatment works. This needs to meet statutory effluent standards.

3.1.6 Description of existing infrastructure

The existing infrastructure needs to be described, with capacities where necessary, and the age of the infrastructure.

A standard reporting format is described in the companion guidelines Modules 6 and 7.

Reporting for water:	WC & WD
Reporting for sanitation:	SC & SD

3.1.7 Capacity related to current demand

The capacity of the existing systems need to be stated in relation to current demand, in the following categories:

On the water supply side:

a) The yield of the water resource (dam, borehole, spring or stream). Units: million m^3/year.

b) Permit limit for abstraction and allocations.

c) The abstraction arrangements from the resource (raw water pumping, borehole pumping capacity or gravity feed).

A standard reporting format is described in Module 6.

On the sanitation side:

a) Capacity of existing treatment works.

b) Permit limit for discharges.

Water supply services model:	Page 1.6
Reporting for water:	WD
Reporting for sanitation:	SD

3.1.8 Current expenditure

The current expenditure on water services needs to be provided. This needs to be separated into the following cost centres:

a) Bulk water supply (if this part of the service is included).

b) Water distribution (including sales, if possible).

c) Sanitation: collector services.

d) Bulk sanitation.

Within each cost centre, the standard sub-division proposed by the Institute of Municipal Treasures and Accounts (IMTA), "Report on Standardisation of Financial Statements of Local Authorities in South Africa" (5th edition - June 1994) needs to be used.

Water supply services model:	Page 1.7
Reporting for water:	WC 1
Reporting for sanitation:	SC 1

3.1.9 Current tariffs and income

The current tariffs and income need to be provided. With regard to water supply this needs to be in separate categories depending upon whether fixed charges or flow based charges are applied and, if the latter, if rising block rates are applied.

With regard to sanitation the tariff system needs to be stated. If a separate charge is not levied for sanitation this needs to be stated and the source of income stated (generally from rates). Where a separate charge is levied for specific sanitation services (waterborne, on-site etc.) this needs to be stated.

On the income side, the total amount which is billed to customers for each service needs to be stated in addition to which the amount actually received must be given.

Water supply services model:	Page 1.8
Reporting for water:	WC 1 & 2
Reporting for sanitation:	SC 1 & 2

3.2 The proposed programme

3.2.1 Economic and household growth projections

The key factor affecting the proposed programme for providing customers with water services in the future is the projected growth in the numbers of customers. From the point of view of residential customers, this is directly related to household growth in the service area.

It is also important to assess the trends with regard to household income as this will affect the ability of households to afford water services. This trend is related to the economic growth trends for the area.

Economic growth trends also affect the non-residential customer unit growth, particularly growth in commercial and industrial water demand and associated wastewater flow discharges.

Methods for projecting household and economic growth are given in Module 3.

Water supply services model:	Page 1.3
Reporting for water:	WB 1
Reporting for sanitation:	SB 1

3.2.2 Time frame

The time frame for the planning process needs to be set. This should be at least 5 years. However, infrastructure provision is by nature long term, and, therefore, it may be necessary to do longer term planning. The factors which affect this are discussed in Module 3.

3.2.3 Service level targets

The most crucial of all decisions relating to development planning is the level of service to be provided to customers in the future. This has a major impact on the capital and operating cost of providing the service and hence on the long term viability of service provision. If service levels are set too high the customers who receive them will not be able to afford to pay for them and are likely to default on their payments which will in turn, impact on the viability of the service provider.

A financial analysis is needed to assess whether service levels provided in the future will be affordable. Tools are available for doing this analysis and the methodology for doing this is (using the computer models) consistent with the approach put forward in this guideline.

As a starting point the types of service to be offered to customers needs to be considered. This is discussed in Section 3.1.3.

Then targets need to be set for providing people with specific service levels. This is done in four categories:

a) New households: Here the percentage of new households to be provided with specific levels of service needs to be given.

b) Current backlogs (those households who are currently not adequately served): Here again the percentage to be provided with services at specific levels needs to be given and the time frame for eradicating backlogs needs to be stated.

c) Upgrading (those who currently have adequate services but who are to be upgraded to a higher level): The percentage of customer units at a current level who are to be upgraded to a specified new level needs to be given, together with the time frame.

d) Non-residential customer units.

Water supply services model:	Page 1.9-11
Reporting for water:	WB 3
Reporting for sanitation:	SB 3

3.3 Flow and load projections

3.3.1 Water demand

With the current total water demand known (See Section 3.1.4) and the targets set for providing specific levels of service (Section 3.2), the average annual water demand for each year of the planning period can be calculated.

Methods for doing this, based on customer unit growth and rate of consumption per customer unit are given in Module 3.

On to this needs to be added the flows to be used by the service provider itself and projected physical losses. This gives the projected total bulk water supply requirement.

3.3.2 Wastewater flow and loads

Having the projection of water used by customer units with different service levels, the wastewater flows can be estimated. The organic load (measured as Chemical Oxygen Demand) produced by all customers also needs to be estimated.

The total flow and organic load are the primary indicators of the bulk conveyance and wastewater treatment capacity required.

Aspects of wastewater flow and load estimation are dealt with in Module 5.

Water supply services model:	Page 2.9; 3.11
Reporting for water:	WC 3
Reporting for sanitation:	SC 3

3.3.3 Sludge management

The total dry mass of sludge produced needs to be projected, the type of sludge stated and the method for disposing of it given. (The Department of Health has statutory guidelines for this). It is important to differentiate between sludge from the treatment process and sludge which is taken from the pits or digesters of on-site sanitation systems.

3.4 Bulk and connector infrastructure

3.4.1 Proposed expansion to water supply infrastructure

Based on the total projected water demand figures, the capacity of the existing infrastructure can be assessed. If it is not adequate to deal with the flows over the planning period, provision needs to be made for expanding the infrastructure. This needs to be done on the basis of a master planning study for the water supply which investigates options on the basis of their technical suitability and cost. This is a specialist activity but a pre-feasibility methodology for doing this is contained in the water supply services model (See Annexure to this module, pages 2.4 and 2.5).

The information required is described in Module 6 and 7.

Water supply services model:	Page 2.3; 2.5
Reporting for water:	WF
Reporting for sanitation:	SF

3.4.2 Sources of raw water

The raw water sources and the projected annual withdrawals need to be stated.

3.4.3 Proposed expansion to sanitation infrastructure

The process for dealing with sanitation infrastructure is similar to that proposed for water supply. However, in this case organic loads need to be dealt with as well as flows. Treatment works capacity needs to be measured in terms of both these criteria.

3.4.4 Return flows

The projected return flows and flow quality need to be given, together with the water body (river of aquifer) to which they are to be returned.

3.5 Organisational arrangements

3.5.1 Water service authority

The activities of the water service authority are identified in the Water Services Act, 1997, and in Module 1.

In the Water Services Development Plan, the identity and capacity of the service authority need to be given. In doing this a clear distinction needs to be made between service authority and service provider functions. This is particularly the case where the water service authority is the same organisation as the service provider.

Assuming the service authority is the local government for the area, which will often be the case in urban areas, the council bears the primary responsibility for monitoring the service provider. However, in doing this they may delegate some responsibility to officials who carry *water service authority* responsibilities. These officials represent the capacity of the service authority outside the council.

With regard to capacity, the following information needs to be given:

a) Name of councillors or sub-committees responsible for water service issues.

b) Name and position of any officials who have *service authority* functions.

3.5.2 Identity of water service providers

The following information is to be given:

a) The names of organisation(s) acting as water service provider(s).

b) If there is more than one organisation, the areas served by each need to be identified.

c) The date on which the water service provider was appointed.

3.5.3 Bulk service providers

Where separate bulk service providers are used these need to be identified with:

a) The names of organisation(s).

b) Description of the service.

c) The date on which the bulk service provider was appointed.

3.5.4 Arrangements with neighbouring municipal areas

A service provider appointed by a particular service authority may provide services in more than one municipal area. If this is the case the neighbouring municipalities where services are provided need to be identified, together with the number of customer units who are provided with services there.

It needs to be noted that Plan does not relate to this other area; development plans are specific to the water service authority area. Nevertheless this information is needed as a measure of other commitments of the service providers and of the extent of sharing between neighbouring authorities.

It also needs to be noted that this does not relate to private or parastatal service providers who may have wide ranging service provision responsibilities. Only those in contiguous neighbouring municipalities are relevant here.

3.5.5 Contracting out: service contracts

The issue of "contracting out" is discussed in Module 1 where the difference between handing over full responsibility for running the service (as a service provider) is contrasted with handing over responsibility for particular activities (service contracts).

Service contracts also need to be contrasted with those associated with project activity: planning, design and construction. In the case of service contracts they tend to be ongoing contracts where the service is provided by the contractor year after year.

The Plan needs to include a list of service contracts anticipated over a five year period, with the name of each contractor given, together with the value of the contract per year.

3.5.6 Contracting out: planning, design and construction

With regard to project activity, the extent to which planning, design and construction is done by contract rather than "in house" needs to be given, based on an estimate of the relative value of the work at market rates.

Note that the term "planning" includes feasibility studies and master planning activity.

3.5.7 Organisational structure and staffing levels

The structure of the service provider needs to be given in the form of an organogram, identifying numbers of people responsible for each function.

With regard to staffing levels, breakdown into activities and staff grading categories is required. The extent of breakdown into activities is dependent on the size of the service provider and a guide is given in the table below (the size categories are described in Module 1):

Table 1: Suggested breakdown for reporting staff numbers

Activities	Micro	Small	Medium	Large
Administration and customer relations			X	
- Water supply				X
- Sanitation				X
Finance and sales (treasury)			X	
- Water supply				X
- Sanitation				X
Projects and planning			X	
- Water supply				X
- Sanitation				X
Total all non-operations activities		X		
Operations				
- Water supply: distribution		X	X	X
- Water supply: bulk services		X	X	X
- Sanitation: collection services		X	X	X
- Sanitation: bulk services		X	X	X
Total	X	X	X	X

Note: Where an X appears opposite an activity it is recommended that staff numbers are reported separately for the activity concerned.

Projected trends in staffing levels also need to be given for the next five years. This shows the projected changes of the number of people to be employed, by employment grade.

With regard to staff grading systems, most public service providers use particular grading systems for staff. Non-public service providers are not constrained in this regard. For purposes of consistency, five staff grading categories are proposed as follows:

a) Executive and senior management.

b) Middle management.

c) Clerical.

d) Supervisory or artisan.

e) General workers.

The grading system needs to take account of the size of the service area and the level of experience and qualifications of the staff. However, the grading systems in use by some municipalities can be unduly prescriptive and restrictive; e.g. the grading system used by the "Industrial Council for Local Authority Undertaking of the Cape Province" makes use of 24 staffing levels and 15 grades of local authority. Staff quotas are specified according to staff level and local authority grade. This can sometimes lead to complications with staff members "out growing" a service area or difficulties with attracting experienced personnel. Simplifying the system into five broad staff categories (as above), coupled with greater flexibility for service providers would clarify the reporting and improve the situation.

3.5.8 Training programmes

Given the importance of building capacity, and the role which training plays, the Plan needs to include information on training provisions. Here accredited training

programmes need to be identified, together with the number of person days of training per year provided for, over a five year period.

Reporting for water:	WG
Reporting for sanitation:	SG

3.6 Costs

Costs need to be calculated for proposed future expansion of the water supply system, dealing with both capital and operating costs. The methodology to be used can be flexible but reference can be made to Modules 4 and 5 for further information on cost analysis of service providers. (It should also be noted that Boutek, CSIR are developing a standardised costing methodology).

3.6.1 Capital costs

Capital costs need to be estimated for new infrastructure, upgrading and for asset replacement. The methodology requires that these be calculated separately for internal, connector and bulk infrastructure.

With regard to *internal services*, capital costs need to be estimated on a per-customer-unit basis for different levels of service. This needs to be done for newly serviced customer units and for upgrading of existing customer units.

Capital costs for *bulk and connector services* also need to be estimated based on the proposals for extending these services.

Finally capital costs need to be estimated for *asset replacement* of internal, connector and bulk infrastructure.

Water supply services model:	Page 2.1-2.5
Reporting for water:	WB 4 & 5
Reporting for sanitation:	SB 4 & 5

3.6.2 Projected operating costs

Projections of operating costs are needed, based on the proposed programme and proposed organisational arrangements. The starting point is the current operating costs (See Section 3.1.8).

The first step is to allocate the existing operating costs to customer units to get a per-customer-unit operating cost which will vary with the level of service provided. Various methods are available, from very simple to fairly complex. A relatively simple method is used in the water supply services model (See Annexure, page 2.12). A fairly complex method for water supply is described in the Annexure to Module 4: 'Setting water tariffs'. A method for sanitation costs is described in Module 5: 'Setting sanitation tariffs'.

The next step is to predict future costs per customer unit for the different types of customers. Costs per unit may change due to increases or decreases in the efficiency of service provision, and/or if input costs rise relative to the general inflation rate. For example, the cost per unit of bulk water purchased may increase in real terms. Future costs will also depend on future levels of consumption (see Modules 4 and 5).

The final step is to calculate total operating costs. This is a function of the estimated unit costs and the projected numbers of customer units in each category.

Water supply services model:	Page 2.11-12
Reporting for water:	WB 2
Reporting for sanitation:	SB 2

3.7 Finance

3.7.1 Investment programme

Having the proposed programme, and the capital costs of each infrastructure element to be provided, an investment programme can be calculated.

3.7.2 Capital finance

Sources of capital are needed to finance the programme, which include:

a) Housing subsidies, for internal services for new customer units where households earn less than R3 500 per month.
b) MIP subsidies for bulk and connector services and for upgrading.
c) Other *ad hoc* grants which may become available.
d) Payments by households in the non-subsidised housing category.
e) Own funds of the service provider.
f) Loans.

All of these sources need to be considered and assigned to funding the year by year capital requirements identified in the investment programme.

Water supply services model:	Page 3.3
Reporting for water:	WB 7
Reporting for sanitation:	SB 7

3.7.3 Income policy (tariffs)

Income is based on tariffs charged to customers of services and on subsidies received.

The service authority needs to have an income or tariff policy stating where it will raise recurrent income from, how tariffs are to be set for different customer groups and levels of service, and actual tariff levels.

Further, it is important to project trends in tariffs as this is the key constraint to be applied to a service provider. Methodologies are available for doing this (See water supply and sanitation services models, for example).

Water supply services model:	Page1.13;1.15
Reporting for water:	WC 2
Reporting for sanitation:	SC 2

3.7.4 Operating account

Annual expenditure can be estimated from costs. This, together with annual income, makes up the operating account. The operating account figures need to be given for the current year and projected into the future.

Other information which is needed is the debtors (unpaid accounts) and net cash flow.

(See Page 2.11 to 2.15 of water supply services model).

Water supply services model:	Page 2.11-2.15
Reporting for water:	WC 1
Reporting for sanitation:	SC 1

3.7.5 Sales arrangement

Sales arrangements includes:

a) Meter reading
b) Billing
c) Collection of payments
d) Credit control

Information needs to be provided on each of these aspects, including:

a) Type of metering to be used (credit or prepaid) for each level of service.
b) Type of billing system (separate for water services, combined, creative styles).
c) Method of sending bills (mail or hand delivery).
d) Arrangements for payment collection (offices or door-to-door)
e) Number of customer units per payment collection point.
f) Credit control arrangements (action taken to collect debts).

3.8 Affordability to customers

The key element of the water services development plan is the assessment of affordability of the service to customers. This needs to be done by relating the amount customers are to be charged for water services in relation to their household incomes (See Module 3 for a discussion on willingness to pay for services).

The water services development plan needs to include information on the average household income of communities provided with specific levels of service and average bill for water services per household. The percentage of household income paid on water services needs to be given.

Water supply services model: Page 1.9-10

3.9 Water conservation aspects

The plan needs to include information on water conservation measures, including:

a) Methods applied.

b) Amount spent on conservation.

c) Impact on reducing water use and wastewater discharges.

4. MONITORING ARRANGEMENTS

It has been mentioned in the introductory section of this guideline that the WSDP is not intended only for internal planning purposes. One of its most important uses is as a communications tool to allow customers in the area to assess the service they are receiving or will receive in future. Further it serves to communicate what is planned to other spheres of government and to neighbouring water service authorities. The need for other spheres of government to have this information relates to their monitoring and regulatory obligations. Thus the plan is central to the monitoring process.

4.1 Submitting the plan

The Water Services Act requires the WSDP to be submitted to the following bodies:

- Department of Water Affairs and Forestry
- National Department of Constitutional Development
- Provincial administration
- Neighbouring water service authorities.

In addition the plan must be available for inspection at the offices of the water service authority and must be obtainable at a nominal fee.

In order to make the plan as widely accessible as possible the intention of DWAF is to require water service authorities to make the plan available on the internet. At this stage it is required that all large service authorities undertake to do this.

4.2 Local level monitoring

Local level monitoring takes place in two ways:

- The individual customers can use the plan to monitor the performance of the water service authority. This may be done by civic bodies who are carrying out this task on behalf of all customers or groups of customers. It may also be done by individuals who wish to know when they are to get services or have their service level upgraded.
- Monitoring of water service providers who are contracted to the water service authority with the WSDP as a basis for describing the service provision responsibilities of the service provider. In this situation the WSDP serves as a benchmark for measuring the performance of the service provider.

4.3 National level monitoring

At national level DWAF is primarily responsible for monitoring water service authorities with regard to water service provision. However, given the fact that there are likely to be over 500 water service authorities in the country it will not be possible for this level of monitoring to be very intensive. But a national body is best placed to collect information and establish monitoring criteria: key performance indicators and benchmarks. This is best done by measuring the performance of a large number of service authorities.

In order for a national level monitoring system to be effective, it is essential that information is fed into it in standard format and kept relatively simple. The reporting approach proposed at this stage is described in Section 4.4.

The monitoring arrangement has two parts to it:

- Reporting back on key performance indicators based on national statistics so that service authorities can assess themselves in relation to these statistics. This is essentially a process to establish benchmarks.
- Identifying individual water service authorities who are not performing well. DWAF would also need to do this in relation to performance indicators and certain benchmarks.

4.4 Reporting requirements

Reporting with regard to WSDPs has three components to it:

a) The submission of the WSDP itself, which is discussed in Section 4.1.
b) The submission of the summarised quantitative information from the WSDP to DWAF.
c) Annual updates with regard to quantitative information.
d) Written annual reports.

Reports (a) and (d) will be used primarily by local stakeholders. Reports (b) and (c) will be used primarily by DWAF, but with the processed information fed back to service authorities and the public.

The outline of report (a) is given in Section 3.

Reporting requirements for reports (b) and (c) are dealt with in modules 6 and 7 of this guideline series.

Finally, with regard to report (d) the report would include the quantitative information requested in report (c) together with:

- Reasons why the actual performance deviates from plan.
- Proposed measures to be taken to make improvements if performance is worse than planned.

4.5 Establishing key performance indicators

At this stage key performance indicators are not established for water service provision. A process will need to be set up to do this, preferably together with benchmarking. It is best for this to be done on the basis of information actually collected from water service authorities.

5. THE PLAN AS A REGULATORY TOOL

Having the plan and using it to assess performance will go a long way towards improving performance. However, ultimately the Water Services Act provides for the WSDP to be used as a regulatory tool. This implies that legal action can be taken by customers against the water service authority. Finally the Minister of Water Affairs may institute action against water services authorities who do not perform adequately.

ANNEXURE

THE PDG WATER SUPPLY SERVICES MODEL

Water Supply Services Model (v1.0)

A predictive model of the expenditures, consumption and cash flows associated with the provision of water supply services in urban areas

funded and owned by the

Water Research Commission

P.O. Box 824

Pretoria 0001

Tel (012) 330 0340 Fax (012) 331 2565

developed by

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SECTION 1

KEY INPUTS, DECISIONS AND OUTPUTS

THE FOLLOWING SCREENS REQUIRE THE USER TO :

INPUT ESSENTIAL DATA;
DESIGN AN INVESTMENT PROGRAMME;
SET HOUSEHOLD BILLS

KEY OUTPUTS ARE SHOWN

Water Supply Services Model (v1.0)

A predictive model of the expenditures, consumption and cash flows associated with the provision of water supply services, illustrating the basic trade-offs between service levels, monthly bills and subsidies.

1.1 DESCRIPTION

Local authority: Smalltown

Type:

RC = Regional Council
LC = Local Council
MC = Metropolitan Council
MS= Metropolitan sub-structure

Run: 1L (=1,2,3 etc.)

Scenario

Base year: 1998 **that reflects the figures for financial year:** 1997/8

Assessment by: Clive van Horen **Date** (dd/mm/yy) 1-Feb-98
Capacity:

1.2 THE CURRENT ENVIRONMENT

Households and residential consumer units

Total population	50,072	
Households and residential consumer units		
Number of households on formally serviced sites	8,281	(excluding backyard shack dwellers)
Number of households in informal settlements	823	
Number of households in backyard shacks	0	
Total households	**9,104**	
Formal sites required for hhs in informal areas		823 = number of households
Formal sites required for hhs in backyard shacks		- = 50% of households in backyard shacks
Total residential consumer units	**9,104**	**= all actually/potentially billed households**
People per household	5.5	
People per consumer unit	5.5	

Residential CU income distribution

	from (R pm)	to (R pm)	%
very low	0	800	30
low	801	1,500	30
low-middle	1,501	3,500	20
middle	3,501	5,000	10
high	5,001	more	10
	R 0	R 800	100
	R 801	R 1,500	
	R 1,501	R 3,500	

Non-residential consumer units

Number of institutions	54
Commerce and "dry" industries	307
Number of "wet"industries	10

1.3 THE FUTURE ENVIRONMENT

Residential and local economic growth

Predict the rates of growth in the years indicated (% pa) :

Rate of growth in year:	1998	2003	2008	average
Residential CU growth	2.5	2.5	2.5	2.5%
Growth in: - institutions	1.0	1.0	1.0	1.0%
- commerce/dry industry	1.0	1.0	1.0	1.0%
- wet industry	1.0	1.0	1.0	1.0%
Local economic growth	1.0	1.0	1.0	1.0%
Residential CU growth	3.5	3.2	2.8	
in value added - institutions	3.5	3.5	3.5	
- commerce/dry industry	3.5	3.5	3.5	
- wet industry	3.5	3.5	3.5	

Residential CU income distribution

Ability of the local economy to reduce income disparities:

poor/average/good (-1,0,1) 0

Future income distribution:

	Yr. 0	Yr. 5	Yr. 10
very low	30	33	37
low	30	29	28
low-middle	20	19	19
middle	10	9	8
high	10	9	7
average income (R/Cu pm)	2,140	1,988	1,847

Inflation rate

Rate in year (% pa):	1998	2003	2008
General inflation rate	8.0	6.0	6.0
In construction industry	8.0	6.0	6.0
general inflation rate	10	10	10
construction	8	6	6

Responsibility for CAPEX

% of CAPEX on internal services for which the service provider is responsible:

0%	% for high income developments
100%	% for low income developments
0%	% for non-residential developments

1.4 TYPES OF SERVICE

Residential services

TYPE OF SERVICE:	with SANITATION SYSTEM	SUITABLE FOR INCOME LEVEL	service category	DESCRIPTION
None/inadequate				No service; unreliable supply; >200m from homestead; <25l pc /day
Communal standpipes	on site (e.g. VIP or LOFLOS)	very low	1	A reliable supply of clean drinking water within 200m of the homestead
Yard tanks	on site (e.g. VIP or LOFLOS)	very low	1	Piped water supply to tank on site, filled periodically (eg once per day)
Yard taps (on-site san)	on site (e.g. VIP or LOFLOS)	low	2	Piped water supply to tap on site, coupled with on-site sanitation
Yard taps (w/borne san)	waterborne/septic tank	low-middle	3	Piped water supply to tap on site, coupled with waterborne sanitation
In-house				Piped water supply to house with multiple taps, waterborne sanitation
In-house, low income	waterborne/septic tank	low-middle	3	consumption typically in the region of 18-24kl per month
In-house, middle income	waterborne/septic tank	middle	4	consumption typically in the region of 20-30kl per month
In-house, high income	waterborne/septic tank	high	5	consumption typically exceeds than 30 kl per month
			3	
			3	
Will new 0	**connections be metered? (yes/no)**			**yes**
Will new 0	**connections be metered? (yes/no)**			**yes**

Non-residential services

	Notes
All institutions, commercial consumers and industries receive on-site connections.	

1.5 EXISTING SERVICE PROVISION

Residential consumer units

Description of service provided:	Residential consumer units with services described		Number of connections with water meters		
WATER	Number	%	Number	%	
None/inadequate	358	4%			
Communal standpipes	845	9%			
Yard tanks		0%			
Yard taps (on-site sanitation)	4,151	46%		100%	4,151
Yard taps (waterborne sanitation)	959	11%	0	0%	959
In-house	2,791	31%		100%	2,791
In-house, low income	970	11%	970	100%	
In-house, middle income	910	10%	910	100%	
In-house, high income	910	10%	910	100%	
0		0%		0%	
0		0%		0%	
TOTAL	9,104				

Non-residential consumer units

WATER	Institutions	"Dry"	"Wet"	
None/inadequate			na	assumed not metered
On-site	54	307	10	assumed metered

Households in informal areas with services (e.g. communal standpipes)	465

1.6 WATER CONSUMPTION

Macro estimates - current consumption

	1998		
Total purified water purchased		Ml per year	
Total raw water purchased/used	**2,642**	Ml per year	
Total water purified	**2,599**	Ml per year	
Total purified water used	**2,599**	Ml per year	
Total water sold to residential consumers	**1,512**	Ml per year	(purified water only)
...to non-residential consumers	**468**	Ml per year	(purified water only)
Total water sold	**1,980**	Ml per year	(purified water only)
Used by service provider (not sold)	**100**	Ml per year	(including water provided free of charge to consumers)
Physical water losses	**519**	Ml per year = **20%**	of purified water used
Current capacity of bulk infrastructure	**8**	Ml per day average annual flow	(ignore if no bulk)

Macro estimates - projections

Expected increase in (% per annum):	**years 1-5**		**years 6-10**		
Total water sold		6.3%		% per annum	1.8%
Used by service provider (not sold)		2.5%		% per annum	2.5%

Physical losses in years 5 and 10 (% of total water bought/purified)

in year 5	**in year 10**	
		% of total water bought/purified
15.0%	15.0%	

1.7 ACCOUNTS (1) - EXPENDITURE

Note : It is important for predicting future costs that expenditure is allocated to the correct categories

R '000 pa	Total R '000	Percentage of total allocated to: Administration		Bulk		Storage		Reticulation	
Staff costs	**929**	**20%**	186	25%	232	**20%**	186	35%	325
General expenses	**1,036**								
of which ... bulk water (raw)	*370*	0%	*0*	100%	*370*	0%	*0*	0%	*0*
... bulk water (purified)		0%	*0*	100%	*0*	0%	*0*	0%	*0*
... other expenditure	*666*	**20%**	*133*	20%	*133*	**20%**	*133*	40%	*266*
Repairs and maintenance	**221**	**5%**	11	20%	44	**20%**	44	55%	121
Capital charges	**649**	**10%**	65	30%	195	**20%**	130	40%	260
Contributions to fixed assets		**10%**	0	30%	0	**20%**	0	0%	0
to capital development fund	**40**	**10%**	*4*	30%	12	**20%**	*8*	40%	16
to replacement provision		**10%**	0	30%	0	**20%**	0	0%	0
to other funds	**41**	**10%**	4	30%	12	**20%**	8	40%	17
Other expenditure	**0**	**10%**	0	30%	0	**20%**	0	0%	0
TOTAL	**2,916**	**14%**	403	**34%**	999	**17%**	509	**34%**	1,005

Average cost per kl of raw bulk water purchased in **1998** **14** c/kl

Average cost per kl of purified bulk water purchased in **1998** **0** c/kl

1.8 ACCOUNTS (2) - TARIFFS AND INCOME

Fixed monthly charges (Rands pm)

Rands per month	unmetered	metered
None/inadequate		na
Communal standpipes	13.20	na
Yard tanks		na
Yard taps (on-site san)		13.20
Yard taps (w/borne san)	13.20	13.20
In-house, low income		13.20
In-house, middle income		13.20
In-house, high income		13.20
0		
0		
institutions		0.00
Commerce and dry		36.00
Wet industries	na	200.00

Block tariffs (c/kl)

Block definitions

	from	to	kl/month
Block 1	0	10	10.0
Block 2	10.1	20	30.0
Block 3	20.1	more	

Block tariffs		
Block 1	128	c/kl
Block 2	136	c/kl
Block 3	136	c/kl

Non-residential consumption charge

140 c/kl

per consumer =	R 0	per RUE of	30	kl/month
per consumer =	R 10	per RUE of	30	kl/month
per consumer =	R 12	per RUE of	30	kl/month

	TOTAL BILLED		RECEIVED		% NON-PAYMENT
Unmetered	286	7%	114	3%	60%
Metered residential	2,876	72%	2,589	74%	10%
Metered non-residential	812	20%	804	23%	1%
Recurrent subsidies		0%	-	0%	0%
Other income		0%		0%	0%
TOTAL	3,974	100%	3,507	100%	12%
SURPLUS/(DEFICIT)*	1,058		591		

Accumulated cash reserves at beginning of 1998

R '000 -500

0

INVESTMENT PROGRAMME

THE FOLLOWING 3 SCREENS ALLOW THE USER TO DESIGN
AN INVESTMENT PROGRAMME
AND CALCULATES THE ASSOCIATED CAPITAL EXPENDITURE AND SOURCES OF FINANCE.

1.9 INVESTMENT TARGETS : (1) NEW RESIDENTIAL CONSUMER UNITS

A. % of new CUs with incomes below R 3,500 pm to be provided with :									
Communal standpipes		%	=	0	in first 5 years,	0	in second 5 years	0
Yard tanks		%	=	0	in first 5 years,	0	in second 5 years	0
Yard taps (on-site sanitation)		%	=	0	in first 5 years,	0	in second 5 years	0
Yard taps (waterborne sanitation)	100	%	=	1,162	in first 5 years,	1,318	in second 5 years	0
In-house, low income	0	%	=	0	in first 5 years,	0	in second 5 years	0
0		%	=	0	in first 5 years,	0	in second 5 years	0
0		%	=	0	in first 5 years,	0	in second 5 years	0
	100%							
B. All new residential Cus with incomes > R 3,500 pm provided with in-house water:								
number of connections =				35	in first 5 years,	35	in second 5 years	0
Total connections for new households =				1,196	in first 5 years,	1,354	in second 5 years	

SERVICE LEVELS AFTER INVESTMENT PROGRAMME (all residential CUs)								CAPITAL EXPENDITURE	
Service	none	s/pipe	Yard tanks	Y/taps(os)	Y/taps(wb)	In-house	0%	0%	R millions (real), yrs 1-5
Category	0	1	1	2	3	3,4,5	3	3	BORROWING 5
%hhs in yr 0	4%	9%	0%	46%	11%	31%	0%	0%	CAPEX 11
% hhs by yr 5	0%	0%	0%	0%	73%	27%	0%	0%	CUMULATIVE CASH BALANCE
% hhs by yr 10	0%	0%	0%	0%	75%	25%	0%	0%	R' 000 (real)

MISMATCH BETWEEN SERVICES AND INCOMES	Yr 0	Yr 5	yr 10	Yr 0 81
% res CUs with category 3 and very low/low incomes:	1%	63%	65%	Yr 5 894
% res CUs with category 2 and very low incomes:	17%	0%	0%	Yr 10 756

INCOME DISTRIBUTION	very low	low	low-middle	middle	high
year 5	33%	29%	19%	9%	9%
year 10	37%	28%	19%	8%	7%

SERVICES BY CATEGORY	None	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Cat. 5
1998	4%	9%	46%	21%	10%	10%
year 5	0%	0%	0%	82%	9%	9%
year 10	0%	0%	0%	84%	8%	8%

0

1.10 INVESTMENT TARGETS : (2) BACKLOG AND UPGRADING

A. Enter the percentages of residential consumer units currently with inadeqate services to be provided with the services shown in the rows.

B. Enter the percentages of residential CUs to be upgraded from (column) to (row). (Row total = 100%)

From / To	s/pipe	Yard tanks	Y/ taps(on-s)	Y/ taps(wb)	In-house	0	0	CUs currently with service		
A. None/inadequate				100	0			358	4%	of total
B. Communal standpipes				100	0			845	9%	of total
Yard tanks				100	0			0	0%	of total
Yard taps (on-site san)				100	0			4,151	46%	of total
Yard taps (w/borne san)				100	0			959	11%	of total
In-house, low income					100			970	11%	of total
0					0	100		0	0%	of total
0					0		100	0	0%	of total

Time-frame for making up the backlog (A)	5	years	Upgrading services (B)	5	years 10

Do you wish the programmes to provide an equal number of investments per year, or to be distributed along an S-curve?

(0=S-curve, 1=equal number pa)	Backlog (A)	1	0	Upgrading services (B)	1	0

SERVICE LEVELS AFTER INVESTMENT PROGRAMME (all residential CUs)

Service	none	s/pipe	Yard tanks	Y/ taps(on-s)	Y/ taps(wb)	In-house	0%	0%
Category	0	1	1	2	3	3,4,5	3	3
%hhs in yr 0	4%	9%	0%	46%	11%	31%	0%	0%
% hhs by yr 5	0%	0%	0%	0%	73%	27%	0%	0%
% hhs by yr 10	0%	0%	0%	0%	75%	25%	0%	0%

MISMATCH BETWEEN SERVICES AND INCOMES

	Yr 0	Yr 5	yr 10
% res CUs with category 3 and very low/low incomes:	1%	63%	65%
% res CUs with category 2 and very low incomes:	17%	0%	0%

CAPITAL EXPENDITURE

R millions (real), yrs 1-5

BORROWING	5
CAPEX	11

CUMULATIVE CASH BALANCE

R' 000 (real)

Yr 0	81
Yr 5	894
Yr 10	756

INCOME DISTRIBUTION

	very low	low	low-middle	middle	high
year 5	33%	29%	19%	9%	9%
year 10	37%	28%	19%	8%	7%

1.11 INVESTMENT TARGETS : NON-RESIDENTIAL AND METERING PROGRAMME

New non-residential consumers

All new institutions, commercial consumers, dry and wet industries are provided with on-site water :

institutions :	3	in first 5 years,	3	in second 5 years
commerce and dry industries :	16	in first 5 years,	16	in second 5 years
wet industries :	1	in first 5 years,	1	in second 5 years

Upgrading of institutions, commerce and dry industries

All institutions, commerical consumers and dry industries are provided with on-site water :

Time-frame for making up the backlog: 5 years (10)

Do you wish the programmes to provide an equal number of investments per year, or to be distributed along an S-curve?

(0=S-curve, 1=equal number pa): 0 (0)

institutions :	0	in first 5 years,	0	in second 5 years
commerce and dry industries :	0	in first 5 years,	0	in second 5 years

Metering programme for residential Cus

% of current CUs metered:	1998	after metering programme	
Yard taps (on-site san)	100%		100%
Yard taps (w/borne san)	0%		100%
In-house	100%		100%
0	0%		100%
0	0%		100%

Time frame: 5 (10)

S-curve (=0) or equal pa (=1): 1 (0)

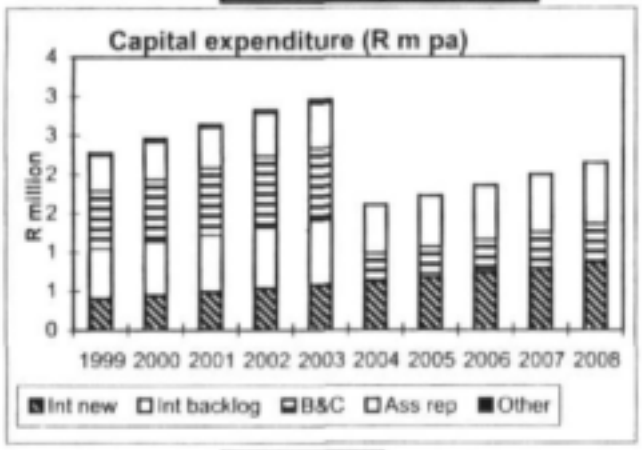
Note : all new connections assumed metered

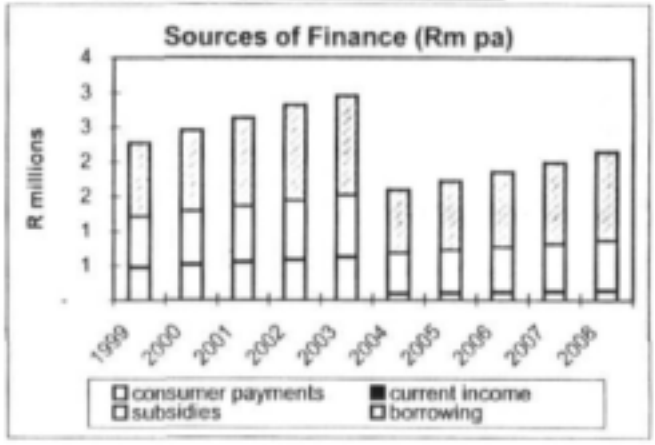
Water Supply Services Model (v1.0) Smalltown 1L Base year = 1998

1.12 CAPITAL REQUIREMENTS shown for a 10 year period (5 or 10) 10

	Real	
TOTAL CAPEX	R 16	(R millions)
by Service provider	R 16	(R millions)
by developers	R 0	(R millions)

Borrowing	R 8	(R millions)
Subsidies	R 5	(R millions)
CU payments	R 3	(R millions)
Current income	R 0	(R millions)





show real? [ ] (yes = real) no

MISMATCH BETWEEN SERVICES AND INCOMES

	1998	2003	2008
% res CUs with category 3 and very low/low incomes:	1%	63%	65%
% res CUs with category 2 and very low incomes:	17%	0%	0%

TARIFF SETTING

THE FOLLOWING 3 SCREENS ALLOW THE USER TO SET TARIFFS TO MEET CASH FLOW REQUIREMENTS

1.13 FUTURE TARIFFS (1) : UNMETERED CONSUMPTION

Step 1 : Enter the monthly charge for 1999 (Rands per consumer unit per month)

Step 2 : Enter the annual percentage increase in the monthly charges for the succeeding years.

Tariffs and % increases may be entered in nominal or real terms. **Nominal (=1) or real (=0)?** 0 0

Rands per month	1998	1999	% pa 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
None/inadequate	0.0	0.0	0	0	0	0	0	0	0	0	0	0
Communal standpipes	13.2		0	0	0	0	0	0	0	0	0	0
Yard tanks	no CUs		0	0	0	0	0	0	0	0	0	0
Yard taps (on-site san)	no CUs		0	0	0	0	0	0	0	0	0	0
Yard taps (w/borne san)	13.2	13.2	13	13	13	13	13	13	13	13	13	13
In-house, low income	no CUs	13.2	13	13	13	13	13	13	13	13	13	13
In-house, middle income	no CUs	13.2	13	13	13	13	13	13	13	13	13	13
In-house, high income	no CUs	13.2	13	13	13	13	13	13	13	13	13	13
0	no CUs		0	0	0	0	0	0	0	0	0	0
0	no CUs		0	0	0	0	0	0	0	0	0	0
Institutions	no CUs		0	0	0	0	0	0	0	0	0	0
Commerce and dry	no CUs		0	0	0	0	0	0	0	0	0	0

view in real (=0) or nominal (=1) terms? 0 0

(Rm, real)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual net cash flow		0.6	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Cash balance (year end)	-0.5	0.1	0.5	0.7	0.8	0.9	0.8	0.8	0.7	0.7	0.7	0.8
Budgeted surp/(-deficit)		1.1	0.7	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2
% non-payment		12%	9%	8%	7%	7%	6%	6%	5%	5%	5%	4%

1.14 FUTURE TARIFFS (2) : MONTHLY CHARGES, METERED RESIDENTIAL

Step 1 : Enter the monthly charge for year 1 (Rand per consumer unit pm)
Step 2 : Enter the annual percentage increase in the monthly charges for the succeeding years.
Tariffs and % increases may be entered in nominal or real terms. Nominal (=1) or real (=0)? | | 0

Rands per month	fixed charge 1998	fixed charge 1999	1998	1999 % pa	2000	2001	2002	2003	2004	2005	2006	2007	2008	Price elasticity	
Yard taps (on-site san)	13.2	13.2	24	24	24	24	24	0	0	0	0	0	0	-20.00	Yard taps (on-site san)
Yard taps (w/borne san)	no CUs		0	18	18	18	19	19	19	19	19	19	19	-20.00	Yard taps (w/borne san)
In-house, low income	13.2	13.2	33	33	33	33	33	33	33	33	33	33	33	-20.00	In-house, low income
In-house, middle income	13.2	13.2	42	42	42	42	43	43	43	43	43	43	43	-20.00	In-house, middle income
In-house, high income	13.2	13.2	79	79	79	79	80	80	80	80	80	80	80	-20.00	In-house, high income
0	no CUs		0	0	0	0	0	0	0	0	0	0	0		0
0	no CUs		0	0	0	0	0	0	0	0	0	0	0		0

Show average monthy bills? (Rands pm) yes | yes/no no | view in real (=0) or nominal (=1) terms? | 0

(Rm, real)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual net cash flow		0.6	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Cash balance (yr end)	-0.5	0.1	0.5	0.7	0.8	0.9	0.8	0.8	0.7	0.7	0.7	0.8
Budgeted surp/(-deficit		1.1	0.7	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2
% non-payment		12%	9%	8%	7%	7%	6%	6%	5%	5%	5%	4%

1.15 FUTURE TARIFFS (3) : MONTHLY CHARGES, METERED NON-RESIDENTIAL

Step 1 : Enter the monthly charge for year 1 (Rand per consumer unit pm)
Step 2 : Enter the annual percentage increase in the monthly charges for the succeeding years.
Tariffs and % increases may be entered in nominal or real terms. Nominal (=1) or real (=0)? 0 | 0

Rands per month	fixed charge 1998	fixed charge 1999	1998	1999 % pa	2000	2001	2002	2003	2004	2005	2006	2007	2008	Price elasticity	Rands per month
Institutions - constant charg	0.0	0.0	42	42	42	42	43	43	43	43	43	43	43	-20.00	Institutions - constant charge
Commerce&dry - constant	36.0	36.0	184	184	184	184	188	187	187	187	187	187	187	-20.00	Commerce&dry - constant
Wet industry - constant cha	200.0	200.0	900	900	900	900	921	918	917	917	917	917	917	-20.00	Wet industry - constant charge
Institutions - block tariff	0.0	0.0	40	40	40	40	41	41	41	41	41	41	41	-20.00	Institutions - block tariff
Commerce&dry - block	36.0	36.0	179	179	179	179	183	182	182	182	182	182	182	-20.00	Commerce&dry - block
Wet industry - block tariff	200.0	200.0	879	879	879	879	899	896	896	896	896	896	896	-20.00	Wet industry - block tariff
Institutions, per RUE	0.0	0.0	40	36	36	36	37	36	36	36	36	36	36	-20.00	Institutions, per RUE
Commercial&dry, per RUE	10.2	10.2	177	171	171	171	174	172	172	172	172	172	172	-20.00	Commercial&dry, per RUE
Wet industrial, per RUE	12.0	12.0	867	858	858	858	872	866	866	866	866	866	866	-20.00	Wet industrial, per RUE

Show average monthy bills? (Rands pm) yes | yes/no no | view in real (=0) or nominal (=1) terms? | 0

Tariffs for non-residential : constant = 0, rising block=1, RUEs = 2 | 0 | 1 RUE per 30 kl pm | 40

(Rm, real)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual net cash flow		0.6	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Cash balance (yr end)	-0.5	0.1	0.5	0.7	0.8	0.9	0.8	0.8	0.7	0.7	0.7	0.8
Budgeted surp/(-deficit)		1.1	0.7	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2
% non-payment		12%	9%	8%	7%	7%	6%	6%	5%	5%	5%	4%

1.16 FUTURE TARIFFS (4) : CONSUMPTION CHARGES

Nominal (=1) or real (=0)? 0 | 0

Block 1	0	to	10	kl per month									
				2000	2001	2002	2003	2004	2005	2006	2007	2008	
% increase pa	1998	1999	1999										
Price (c/kl,real)	128	128	128	128	128	128	128	128	128	128	128	128	
Price (c/kl, nominal)	128		138	148	158	168	178	189	200	212	225	238	
O&M cost of system (c/k,real)		104	104	105	105	104	104	103	103	102	102	101	50 % bulk cost capital
Block 2	10	to	20	kl per month									0
% increase pa						3.0							
Price (c/kl,real)	136	136	136	136	136	140	140	140	140	140	140	140	
Price (c/kl, nominal)	136		146	157	168	184	195	206	219	232	246	260	
Average historic cost (c/kl,real)		139	144	146	146	147	148	147	146	146	145	145	
Block 3	20	kl per month and above											
% increase pa						3.0							
Price (c/kl,real)	136	136	136	136	136	140	140	140	140	140	140	140	
Price (c/kl, nominal)	136		146	157	168	184	195	206	219	232	246	260	

Non-residential constant consumption charge												
% increase pa						3.0						
Price (c/kl,real)	140	140	140	140	140	144	144	144	144	144	144	144
Price (c/kl, nominal)	140		151	161	172	189	200	212	225	239	253	268

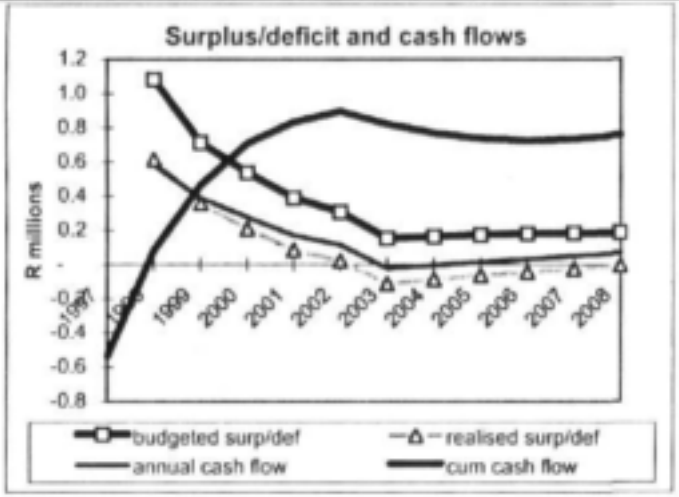
(Rm, real)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual net cash flow		0.6	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Cash balance (yr end	-0.54	0.1	0.5	0.7	0.8	0.9	0.8	0.8	0.7	0.7	0.7	0.8
Budgeted surp/(-deficit)		1.1	0.7	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.2	0.2
% non-payment		12%	9%	8%	7%	7%	6%	6%	5%	5%	5%	4%

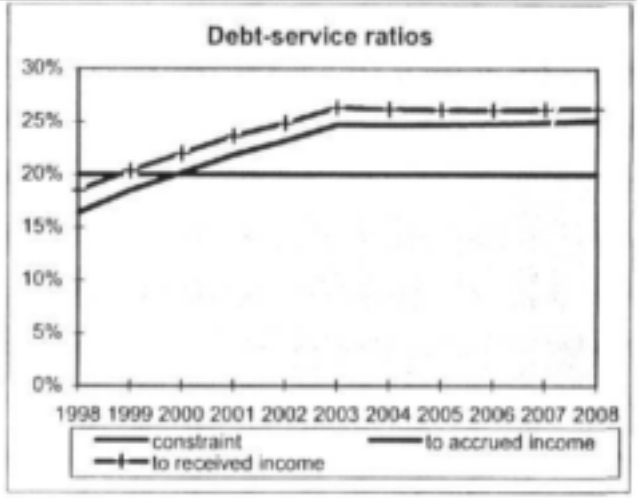
view in real (=0) or nominal (=1) terms? 0 0

1.17 NET CASH FLOWS, NON-PAYMENT, COSTS AND PRICES

ANNUAL AND CUMULATIVE NET CASH FLOW (R millions pa)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Annual, real	0.58	0.39	0.27	0.17	0.11	-0.02	-0.01	0.01	0.03	0.05	0.07
Cumulative, real	0.08	0.46	0.71	0.83	0.89	0.82	0.77	0.73	0.72	0.73	0.76
[illegible]											
[illegible]											
% non-payment	12%	9%	8%	7%	7%	6%	6%	5%	5%	5%	4%





show real? yes (yes = real) no

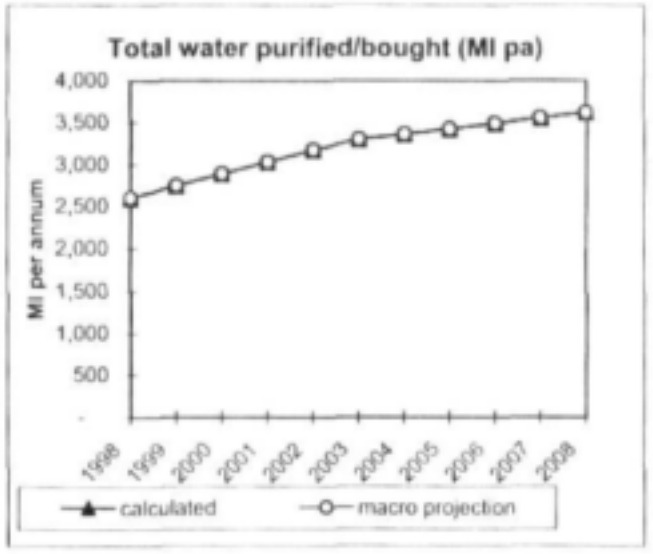
COST OF WATER AND INCOME PER KILOLITRE SOLD (c/kl)

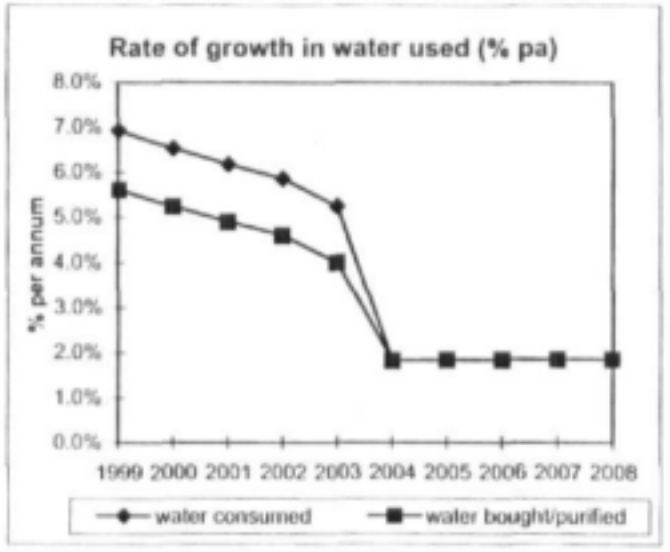
c/kl	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bulk water cost	30	31	33	33	33	34	33	33	32	32	31
Average total cost of water	113	117	120	121	123	125	125	124	124	124	123
Average price water sold of	191	176	168	162	158	153	153	152	152	152	151
Received income/kl	134	131	129	127	127	125	125	125	125	125	125

Note : Received income is less than the price of water sold per kl due to non-payment, municipal water (not sold) and physical losses

inex graf

1.18 CONSUMPTION





TOTAL WATER CONSUMED AND TOTAL PURIFIED/BOUGHT (calculated)

Ml pa	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
consumed	2,080	2,224	2,369	2,515	2,663	2,802	2,854	2,906	2,960	3,015	3,071
bought/purified	2,599	2,745	2,889	3,030	3,170	3,297	3,357	3,419	3,482	3,547	3,614
Physical losses	20%	19%	18%	17%	16%	15%	15%	15%	15%	15%	15%

con graf

SECTION 2

ENTER OWN DATA

THE FOLLOWING SCREENS ALLOW THE USER TO REPLACE DEFAULT VALUES WITH INFORMATION SPECIFIC TO THE AREA CONCERNED.

2.1 UNIT CAPITAL COSTS FOR INTERNAL SERVICES : RESIDENTIAL

Cat.	Type of service	1 New services (R per CU)	2. Upgrading from ("Type of service" column) to (row): s/pipe	Yard tanks	Y/ taps(on-s)	Y/ taps(wb)	in-house	0	0
0	None/inadequate	**na** **na**	R 900	R 1,200	R 1,400	R 1,600	R 1,800	R 1,800	R 1,800
1	Communal standpipes	**R 900**		R 840	R 1,050	R 1,280	R 1,620	R 1,620	R 1,620
1	Yard tanks	**R 1,200**			R 980	R 1,200	R 1,530	R 1,350	R 1,350
2	Yard taps (on-site san)	**R 1,400**				R 320	R 720	R 360	R 360
3	Yard taps (w/borne san)	**R 1,600**					R 540	R 360	R 360
3	In-house, low income	**R 1,800**						R 360	R 360
4	In-house, middle income	**R 2,100**							
5	In-house, high income	**R 2,400**							
3	0	**R 1,800**	R 180	R 480	R 700	R 880	R 1,260		R 900
3	0	**R 1,800**	R 180	R 480	R 700	R 880	R 1,260	R 900	

2.2 UNIT CAPITAL COSTS FOR INTERNAL SERVICES : NON-RESIDENTIAL

Enter an estimated average cost for internal services :

Type of consumer	New services (R per CU)	Upgrading (R per CU)
Institutions	R 2,100	250 R 2,100
Commerce and dry industry	R 2,400	250 R 2,400
Wet industry	R 12,000	

Metering costs

Cost of providing meters:

Type of service	Cost (R per CU)	
Yard taps (on-site sanitation)		**R 150**
Yard taps (waterborne sanitation)		**R 150**
In-house		**R 200**
0		R 200
0		R 200

2.3 CONNECTOR INFRASTRUCTURE CAPACITY REQUIREMENTS

Capacity requirements for Pipelines and reservoirs	Average daily consumption l/CU/day	Pipelines: Capacity required for peak hourly flow as % av daily flow		Reservoirs: Capacity required as number of days of storage		Total capacity currently required Pipelines Ml/day	Reservoirs Ml storage
None/inadequate	33		250%		2.00	0	0
Communal standpipes	132		**250%**		**2.00**	0	0
Yard tanks	197		**100%**		**1.10**	0	0
Yard taps (on-site san)	263		**300%**		**2.50**	3	3
Yard taps (w/borne san)	460		**300%**		**2.50**	1	1
In-house, low income	493		**350%**		**2.50**	2	1
In-house, middle income	723		**350%**		**3.00**	2	2
In-house, high income	1,599		**350%**		**3.00**	5	4
0	592		350%		2.50	0	0
0	66		350%		2.50	0	0
Institutions	986		**350%**		**3.00**	0	0
Commerce&dry industry	3,467		**250%**		**2.50**	3	3
Wet industry	16,438		**250%**		**2.50**	0	0
Used by municipality	262		**250%**		**2.50**	1	1
				Total capacity required		**18**	**15**

(Ml/day flow / Ml storage capacity)

Pumps	% of average daily flow to be pumped		**40%**	Ml/hour capacity required
	average number of hours per day pump in use		**8.0**	**0**
Water towers	% of average daily flow pumped into water towers		**40%**	Ml storage capacity required
	Minutes of peak hourly flow for which capacity required		**30**	**4**

2.4 CONNECTOR INFRASTRUCTURE COSTS & EXPANSION PROGRAMME

Cost of additional capacity					
Pipelines (Rm/Ml/day)		R 0.2	Reservoirs (Rm/Ml additional storage capacity)		R 0.4
Pumps (Rm/Ml/hr)		R 0.1	Water Towers (Rm/Ml additional storage capacity)		R 0.2

Connector infrastructure expansion programme											
	Current	Capacity (Ml/day peak flow) added in (year):									
Pipelines	capacity	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Ml/day											
	18	1.2	1.2	1.2	1.2	1.2	0.4	0.4	0.4	0.4	0.5
Reservoirs		Capacity (Ml/day storage) added in (year):									
Ml storage											
capacity	15	1.0	1.0	1.0	1.0	1.0	0.4	0.4	0.4	0.4	0.4
Pumps		Ml/hour pumping capacity added in (year):									
Ml/hour											
capacity	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water towers		Capacity (Ml/day storage) added in (year):									
Ml storage											
capacity	4	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1

Default programme : sufficient connector capacity provided to meet annual requirements on year-by-year basis

Excess/shortfall											
Pipelines	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reservoirs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pumps	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Water towers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

2.5 BULK INFRASTRUCTURE COSTS & EXPANSION PROGRAMME

Cost of bulk infrastructure (R million per Ml/day additional capacity)

Source of supply		Treatment		Pumping		Transmission	
	R 0.9		R 1.2		R 0.5		R 0.3

Capacity requirements : % additional capacity required (additional to Ml/day average annual flow)

Source of supply		Treatment		Pumping		Transmission	
	10%		20%		30%		40%

Current peak capacity and expansion programme

Ml/day peak capacity		Current capacity	Capacity (Ml/day) added in (year): 1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Source of supply	9											
Treatment	10											
Pumping	10											
Transmission	11											

Default programme : no bulk infrastructure provided (purified water assumed purchased from outside agency)

Excess/shortfall (Ml/day peak capacity)											
Source of supply	3	2	2	1	1	0	0	0	(0)	(0)	(0)
Treatment	3	2	2	1	1	0	0	0	(0)	(0)	(0)
Pumping	3	2	2	1	1	0	0	0	(0)	(0)	(1)
Transmission	3	3	2	2	1	0	0	0	(0)	(0)	(1)

Average annual flow and total capacity required

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Ml/day av annual flow	6	6	6	7	7	8	8	8	8	8	8
Total Ml/day capacity required											
Source of supply	6	7	7	8	8	8	9	9	9	9	9
Treatment	7	7	8	8	9	9	9	10	10	10	10
Pumping	7	8	8	9	9	10	10	10	11	11	11
Transmission	8	9	9	10	10	11	11	11	11	12	12

2.6 ASSET REPLACEMENT & OTHER CAPITAL EXPENDITURE

ASSET REPLACEMENT	Replacement value of existing infrastructure (R millions)		Annual asset replacement % replacement value %		R '000 pa (real)
Internal reticulation					
residential		R 14		1.0%	R 139
non-residential		R 1		1.0%	R 10
Connector infrastructure					
pipelines		R 4		0.5%	R 18
reservoirs		R 6		0.5%	R 31
Bulk infrastructure					
Source of supply	5.0	R 8		0.5%	R 25
Treatment	7.0	R 12		1.5%	R 105
Pumping	3.5	R 5		2.0%	R 70
Transmission	2.0	R 3		1.0%	R 20
Other infrastructure				0.5%	R 0
TOTAL					**R 417**

OTHER CAPITAL EXPENDITURE

R,000 per year — **Will the amounts be entered in nominal (=1) or real (=0) terms?** 0

Description	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Rehabilitation										
TOTAL	0	0	0	0	0	0	0	0	0	0

2.7 HOUSING SUBSIDIES AND CONSUMER PAYMENTS

New residential CUs and elimination of backlog

Rands per CU	Housing subsidy		CU payments	
Communal standpipes		R 900		R 0
Yard tanks		R 1,150		R 50
Yard taps (on-site san)		R 1,300		R 100
Yard taps (w/borne san)		R 1,400		R 200
In-house, low income		R 1,446	354	R 500
In-house, middle income	na		354	R 2,100
In-house, high income	na		354	R 2,400
0		R 1,446		R 354
0		R 1,446		R 354
Institutions	na			R 2,100
Commerce and dry industries	na			R 2,400
Wet industries	na			R 12,000

Upgrading (from s/pipes, informal areas)

	Housing subsidy		CU payments	
s/pipes	na			
Yard tanks		R 790		R 50
Y/taps os		R 950		R 100
Y/taps wb		R 1,080		R 200
In-house		R 1,266	354	R 354
roof tank		R 1,266	354	R 354
other 2		R 1,266	354	R 354
	845	CUs to be upgraded from s/pipes		
	465	CUs with s/pipes in informal areas		
465		CUs in informal areas to be upgraded		
Institutions				R 250
Commerce and dry industries				R 250
Wet industries			na	

Enter the rate at which you expect the nominal value of housing subsidies to increase (% pa)

1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
8%	7%	7%	6%	6%	6%	6%	6%	6%	6%	= inflation rate in construction industry
4%	4%	3%	3%	3%	3%	3%	3%	3%	3%	= 50% of the inflation rate

Household payments for other upgrading

Rands per consumer unit

From \ To	s/pipe	Y/tank	Y/tap(os)	Y/tap(wb)	In-house	0	0
Communal standpipes				354	354		
Yard tanks				354	354		
Yard taps (on-site san)				354	354		
Yard taps (w/borne san)							
In-house, low income							
0							
0							

Defaults are fees as for new connections

2.8 CAPITAL SUBSIDIES - INFRASTRUCTURE GRANT

Infrastructure grants may be provided in three ways:

A. **Rands per CU qualifying for housing subsidy R** 500 R 312 policy : R3 000/hh for all bulk and connector infrastructure

Enter the rate at which you expect the nominal value of this B&C subsidy to increase (% pa)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
B&C											
	8%	7%	7%	6%	6%	6%	6%	6%	6%	6%	= inflation rate in construction industry
	4%	4%	3%	3%	3%	3%	3%	3%	3%	3%	= as housing

and/or **B.** **% of cost of bulk and connector infrastructure** **%** 0

and/or **C.** **Flat grant in thousands of Rands per annum (R '000)**

Source	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0

Have these amounts been entered in nominal or real terms? 0 = nominal, 1 = real

2.9 CONSUMPTION : UNMETERED CONNECTIONS

Estimate the average monthly consumption per consumer unit (kl/month):

	Consumption in 1998	Expected consumption by 2004	2009	
None/inadequate	**1.0**	1.0	1.0	kl/month
Communal standpipes	**4.0**	4.0	4.0	kl/month
Yard tanks	**6.0**	6.0	6.0	kl/month
Yard taps (on-site sanitation)	**10**	10	10	kl/month
Yard taps (waterborne sanitation)	11 **15**	11	11	kl/month
In-house, low income	**22**	22	22	kl/month
In-house, middle income	**32**	32	32	kl/month
In-house, high income	**52**	52	52	kl/month
0	**22**	22	22	kl/month
0	**22**	22	22	kl/month
Institutions	**12**	12	12	kl/month
Commerce and dry	**12**	12	12	kl/month

2.10 CONSUMPTION : METERED CONNECTIONS

Step 1 : Enter the average consumption of all consumer units by service type (kl/CU per month).
Step 2 : Estimate what the average consumption would be by years 5 and 10 respectively if tariffs were constant (real).
Step 3 : Enter the %'s of CUs in blocks 1 and 2, and the average consumption of CUs in these blocks.
Step 4 : Where service types are currently not offered but will be in the future, enter estimates of consumption.

	Block 1			Block 2			Block 3		Average consumption (kl/CU/month)					
kl/month	0 to 10 kl			10.1 to 20 kl			20.1 more							
RESIDENTIAL	% CUs	Av cons	kl	% CUs	Av cons	kl	% CUs	Av cons kl	1998	2004	2009	1998	2004	2009
Yard taps (on-site san)	65%	5		32%	12		3%	30				8	8	8
Yard taps (w/borne san)	50%	5		40%	15		10%	no CUs	14	14	14	12	14	14
In-house, low income	20%	5		70%	15		10%	35	15			18	15	15
In-house, middle income	10%	5		70%	15		20%	55	22			25	22	22
In-house, high income	2%	5		40%	15		58%	73	49			na	49	49
0	20%	5		70%	15			no CUs				18	18	18
0	20%	5		70%	15			no CUs	2			18	2	2
NON-RESIDENTIAL	%	Av cons		%	Av cons		%	Av cons kl						
Institutions	10%	5		70%	15		20%	95				30	30	30
Commerce&dry industry	10%	5		60%	15		30%	320	105				105	105
Wet industry	0%	5		0%	15		100%	500				500	500	500
Conversion of non-residential consumers to Residential Unit Equivalents (RUEs)								1 RUE per		30	kl per month			

Minimum permissible average consumption per CU for high income CUs (used as check)	25
Maximum permissible average consumption per CU for high income CUs (used as check)	300
Minimum permissible consumption per CU for commerce and dry industry (used as check)	5

2.11 RUNNING COSTS BY SERVICE TYPE : BASE YEAR

Allocation of base year expenditure - staff, general and repairs and maintenance

Estimate the ratios of costs in relation to the cost of providing in-house water to middle income consumer units
The average amounts spent per consumer unit per month on the four functions are then calculated from the totals entered in section 1 (screen "acc1 ex")

	Administration		Bulk		Storage		Reticulation		Total cost	Total cost
	ratio	R pm	ratio	R pm	ratio	R pm	ratio	R pm	R pm/consumer	without bulk
None/inadequate	0.0	0.0	0.0	0	0.0	0.1	0.1	0.8	1	1
Communal standpipes	0.7	2.2	0.2	2	0.1	0.5	0.5	4.0	8	7
Yard tanks	1.2	0.0	0.3	0	0.1	0.0	2.0	0.0	0	0
Yard taps (on-site san)	1.0	3.2	0.4	3	0.3	1.3	0.7	5.6	13	10
Yard taps (w/borne san)	0.7	2.2	0.6	5	0.5	2.3	0.8	6.4	16	11
In-house, low income	1.0	3.2	0.7	6	0.6	2.5	0.8	6.4	18	12
In-house, middle income	1.0	3.2	1.0	8	1.0	4.4	1.0	7.9	24	16
In-house, high income	1.0	3.2	2.2	19	2.2	9.8	1.2	9.5	41	23
0	1.0	0.0	0.8	0	0.7	0.0	0.8	0.0	0	0
0	1.0	0.0	0.1	0	0.1	0.0	0.8	0.0	0	0
Institutions	1.0	3.2	1.4	12	1.4	6.0	1.0	7.9	29	17
Commerce&dry industry	1.0	3.2	4.8	41	4.0	17.7	1.5	11.9	73	33
Wet industry	1.0	3.2	22.7	193	18.9	83.7	5.0	39.7	320	127
Municipal water	0.0	0.1	0.4	3	0.3	1	2	12	17	13

% of administration costs to metering of service for in-house connections **30%**

2.12 RUNNING COSTS BY SERVICE TYPE : FUTURE

Step 1. Estimate year 1 monthly operating costs per consumer unit for new connections by service type (R pm).

Step 2. Predict changes in administration, storage and reticulation costs per consumer unit (% change pa)

Step 3. Predict changes in the price of purchased water and the cost of treating water (% pa)

% changes to be entered in nominal (=1) or real (=0) terms? 0 0

Rands per CU per month	Administration existing	Administration new	Storage existing	Storage new	Reticulation existing	Reticulation new	Total	% change pa (real)
Communal standpipes	2.2	0.6	0.5	0.5	4.0	4.0	5	0
Yard tanks	0.0	3.8	0.0	0.4	0.0	15.9	20	0
Yard taps (on-site san)	3.2	3.2	1.3	1.3	5.6	5.6	10	0
Yard taps (w/borne san)	2.2	3.2	2.3	2.3	6.4	6.4	12	0
In-house, low income	3.2	3.2	2.5	2.5	6.4	6.4	12	0
In-house, middle income	3.2	3.2	4.4	4.4	7.9	7.9	16	0
In-house, high income	3.2	3.2	9.8	9.8	9.5	9.5	23	0
0	0.0	3.2	0.0	3.0	0.0	6.4	13	0
0	0.0	3.2	0.0	0.3	0.0	6.4	10	0
Institutions	3.2	3.2	6.0	6.0	7.9	7.9	17	0
Commerce&dry industry	3.2	3.2	17.7	17.7	11.9	11.9	33	0
Wet industry	3.2	3.2	84	84	40	40	127	0
Municipal water - single "consumer unit" therefore only % change pa to be entered :							17	% pa change in use of water

Predicted rates of increase in the cost of bulk water purchases and the cost of treating water (% pa)

% increase pa	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
purified water purchased (% pa)	na											0% pa (real)
purchased purified water (c/kl - real)	0	0	0	0	0	0	0	0	0	0	0	
raw water purchased (% pa)	na	10.0	10.0	10.0	10.0	10.0						0% pa (real)
cost of raw water (c/kl - real)	14	15	17	19	21	23	23	23	23	23	23	
cost of purifying water (% pa)	na											0% pa (real)
cost of purifying water (c/kl - real)	16	16	16	16	16	16	16	16	16	16	16	
cost of own purified water (c/kl - real)	30	31	33	34	36	38	38	38	38	38	38	
average cost of water (c/kl - real)	30	31	33	33	33	34	33	33	32	32	31	

2.13 OTHER INCOME & EXPENDITURE

Other income R thousands

Recurrent subsidies in the base year = R 0 thousand = R 0 per CU classified as "very poor".

Other income accrued in the base year = R 0 thousand

Enter the rate(s) at which you expect these sources of income to increase (-decrease) (% pa)

% changes to be entered in nominal (=1) or real (=0) terms? 0

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
Subsidies											0% pa, nominal
Other income											0% pa, real
Subsidies	0	0	0	0	0	0	0	0	0	0	**(R'000, real)**
Other income	0	0	0	0	0	0	0	0	0	0	**(R'000, real)**

Other expenditure R thousands

Capital charges in the base year = R 649 thousand

Enter the rate(s) at which you expect payments on existing loans to increase (-decrease) (% pa, nominal)

Source	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	
											0% pa, nominal
	603	563	527	495	467	441	416	392	370	349	(R'000, real)

Estimate future contributions and other expenditure items as follows:

Expenditure item	1998	Future		
Contributions to fixed assets	0.0%		% accrued income	1.0%
to capital development fund	1.0%		% accrued income	2.0%
to replacement provision	0.0%		% accrued income	0.0%
to other funds	1.0%		% accrued income	1.0%
Other expenditure	0.0%		% total expenditure	0.0%

% contributions to fixed assets on infrastructure 20%

2.14 LOANS & CONSTRAINTS

The cost of loans for capital expenditure

Rate in year (% pa) :	1998	2003	2008				Real rate of defaults:
Nominal interest rate =				14.5%	12.4%	12.4%	6%
Real interest rate =	6.0%	6.0%	6.0%				
Repayment period (years) :				15			

The cost of short term loans (returns on cash surpluses)

Estimate the cost of short term borrowing and interest on short term deposits

Rates in year:	1998	2003	2008				Real rate of defaults:
Short term overdraft rate :				16.6%	14.5%	14.5%	8.0%
Real rate:	8.0%	8.0%	8.0%				
Short term deposit rate :				13.4%	11.3%	11.3%	5.0%
Real rate:	5.0%	5.0%	5.0%				

Constraints on the feasibility of the programme

Debt service ratio

Debt service ratio (interest&redemption / income, %)	20.0	25.0%

Maximum payments by level of income (Rands per month)

	from (R pm)	to (R pm)	R pm	
very low	0	800	15	14
low	801	1,500	25	35
low-middle	1,501	3,500	50	63

2.15 FUTURE LOSSES : % BILLED INCOME UNPAID

Predict the percentage of billed income that will remain unpaid in years five and ten :

	1998	2003	2008	2003	2008
Unmetered	60%			33%	5%
Metered residential	10%			8%	5%
Metered non-residential	1%			1%	1%
Other income	0%			0%	0%

In estimating residential non-payment, the affordability of the levels of services provided must be taken into account. The following information for year 10 is of relevance to metered residential services :

A. RESIDENTIAL CONSUMER UNITS WITH (METERED) ON-SITE CONNECTIONS AND W/BORNE SANITATION IN YEAR 10.

65% of residential CUs currently have category 3 services but earn less than R 1,500 per month.

By year 10 these consumers will be able to afford an average payment of R 19 per month.

This payment amounts to 96% of the average monthly bill of R 20

If these consumers were to pay as much as they can afford, then non-payment would amount to 2% of total billed residential income.

B. RESIDENTIAL CONSUMER UNITS WITH (METERED) YARD TAPS AND ON-SITE SANITATION IN YEAR 10.

0% of residential Cus have category 2 services but earn less than R 801 per month.

By year 10 these consumers will be able to afford an average payment of R 15 per month.

This payment amounts to 0% of the average monthly bill of R 0

If these consumers were to pay as much as they can afford, then non-payment would amount to 0% of total billed residential income.

C. OTHER NON-PAYMENT

Some allowance should be made for non-payment for other reasons. This may be assumed to be 3% of total billed residential income for metered supplies by year 10.

SECTION 3
OUTPUTS

THE FOLLOWING SCREENS SHOW THE MODEL OUTPUTS IN GREATER DETAIL

3.1 SERVICE LEVELS & NUMBERS OF CONNECTIONS PROVIDED (residential)

TABLE 1 DISTRIBUTION OF TYPES OF SERVICE

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
none/inadequate	4%	3%	2%	1%	1%	0%	0%	0%	0%	0%	0%
Communal standpipes	9%	7%	5%	3%	2%	0%	0%	0%	0%	0%	0%
Yard tanks	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Yard taps (on-site sanitation)	46%	36%	26%	17%	8%	0%	0%	0%	0%	0%	0%
Yard taps (waterborne sanitation)	11%	24%	37%	49%	61%	73%	73%	74%	74%	75%	75%
In-house, low income	11%	10%	10%	10%	10%	9%	9%	9%	9%	9%	8%
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
0	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
In-house, middle income	10%	10%	10%	5%	5%	9%	9%	9%	9%	9%	8%
In-house, high income	10%	10%	10%	5%	5%	9%	9%	8%	8%	8%	8%
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

TABLE 2 CONNECTIONS PROVIDED - upgrading and new services, years 1 - 10 (total)

Numbers of residential consumer units upgraded from (column service) to (row service) :

From \ To	s/pipe	Yard tank	Y/ taps(on-s)	Y/ taps(wb)	In-house	other 1	other 2
None/inadequate	0	0	0	358	0	0	0
Communal standpipes	na	0	0	845	0	0	0
Yard tanks	na	na	0	0	0	0	0
Yard taps (on-site san)	na	na	na	4,151	0	0	0
Yard taps (w/borne san)	na	na	na	na	0	0	0
In-house	na	na	na	na	na	0	0
roof tank	0	0	0	0	0	na	0
other 2	0	0	0	0	0	0	na
Total provided - upgrades	**0**	**0**	**0**	**5,354**	**0**	**0**	**0**
Total provided - new	**0**	**0**	**0**	**2,480**	**70**	**0**	**0**

TABLE 3 CONNECTIONS PROVIDED - upgrading and new services, year by year

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Communal standpipes	0	0	0	0	0	0	0	0	0	0	0
Yard tanks	0	0	0	0	0	0	0	0	0	0	0
Yard taps (on-site san)	0	0	0	0	0	0	0	0	0	0	0
Yard taps (w/borne san)	1,291	1,297	1,303	1,309	1,315	250	257	264	271	278	7,834
In-house, low income	0	0	0	0	0	0	0	0	0	0	0
In-house, middle & high income	7	7	7	7	7	7	7	7	7	7	70
roof tank	0	0	0	0	0	0	0	0	0	0	0
other 2	0	0	0	0	0	0	0	0	0	0	0
Total	**1,298**	**1,304**	**1,310**	**1,316**	**1,322**	**258**	**264**	**271**	**277**	**284**	**7,904**

Water Supply Services Model (v1.0) Smalltown 1L Base year = 1998

3.2 UNIT CAPITAL AND RECURRENT COSTS, CAPITAL INCOME AND CONSUMPTION

TABLE 1 INTERNAL SERVICES : CAPITAL COSTS, SUBSIDIES &PAYMENTS.

	Capital costs Rands / CU (real)		Subsidies and payments (R/CU, real) housing subsidy (real value)			payments
	new internal services	meters existing connections	1998	2003	2008	real value, all years
Communal standpipes	900	na	900	766	663	0
Yard tanks	1,200	na	1,150	978	847	50
Yard taps (on-site san)	1,400	150	1,300	1,106	958	100
Yard taps (w/borne san)	1,600	150	1,400	1,191	1,032	200
In-house, low income	1,800	200	1,446	1,230	1,066	354
In-house, middle income	2,100	200	na	na	na	354
In-house, high income	2,400	200	na	na	na	354
0	0	0	0	0	0	0
0	0	0	0	0	0	0
Institutions	2,100	with upgrading	na	na	na	2,100
Commerce&dry industry	2,400	with upgrading	na	na	na	2,400
Wet industry	12,000	metered	na	na	na	12,000

TABLE 2 CAPITAL COSTS: BULK AND CONNECTOR

Bulk infrastructure (R millions)		
Source of supply	**na**	Rm/Ml/day additional capacity
Treatment	**na**	Rm/Ml/day additional capacity
Pumping	**na**	Rm/Ml/day additional capacity
Transmission	**na**	Rm/Ml/day additional capacity
Connector infrastructure (R millions)		
Pipelines	**0.2**	Rm/Ml/day additional capacity
Reservoirs	**0.4**	Rm/Ml storage capacity
Pumps	**0.1**	Rm/Ml/hr pumping capacity
Water towers	**0.2**	Rm/Ml storage capacity

TABLE 3 OPERATING COSTS BY SERVICE TYPE (R per CU per month, base year)

	Administration, storage and reticulation			Purification&bulk purchase	
	existing connections unmetered	metered	new connections	current average	unmetered metered
None/inadequate	1	5	na	0	na
Communal standpipes	5	5	5	1	na
Yard tanks	0	5	0	0	na
Yard taps (on-site san)*	9	10	10	3	2
Yard taps (w/borne san)*	0	0	12	0	0
In-house, low income*	11	12	12	7	4
In-house, middle income*	15	16	16	10	7
In-house, high income*	22	23	23	15	14
0	0	0	0	0	0
0	0	0	0	0	0
Institutions	0	17	17	0	9
Commerce&dry industry	0	33	33	0	31
Wet industry	5	127	127	0	149

*Costs shown for metered connections only.

TABLE 4 CONSUMPTION BY SERVICE TYPE (kl per CU pm)

	kl/m in 1998		kl/m in 2003		kl/m in 2008	
	unmetered	metered	unmetered	metered	unmetered	metered
None/inadequate	1	na	0	na	0	na
Communal standpipes	4	na	0	na	0	na
Yard tanks	0	na	0	na	0	na
Yard taps (on-site san)*	10	8	0	0	0	0
Yard taps (w/borne san)*	0	0	0	14	0	14
In-house, low income*	22	15	0	15	0	15
In-house, middle income*	32	22	0	22	0	22
In-house, high income*	52	49	0	48	0	48
0	0	0	0	0	0	0
0	0	0	0	0	0	0
Institutions	0	30	0	30	0	30
Commerce&dry industry	0	105	0	105	0	105
Wet industry	0	500	na	498	na	498

TABLE 5 BULK WATER (c/k)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
purchased purified	0	0	0	0	0	0	0	0	0	0	0
raw water	14	15	17	19	21	23	23	23	23	23	23
cost of purification	16	16	16	16	16	16	16	16	16	16	16
average cost bulk water	30	31	33	33	33	34	33	33	32	32	31

3.3 CAPITAL REQUIREMENTS (real)

R thousands 1998 Rands	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	TOTAL yrs 1-5	TOTAL yrs 6-10
CAPITAL EXPENDITURE	**R thousands**											
Internal services - new residential	368	377	386	396	405	416	426	436	447	458	1,932	2,183
Internal services - new non-residential	10	10	10	10	10	10	10	10	11	11	49	52
Internal - backlog and upgrading	597	597	597	597	597	0	0	0	0	0	2,983	0
metering programme	29	29	29	29	29	0	0	0	0	0	144	0
Connector infrastructure	688	693	699	704	666	242	248	254	259	265	3,450	1,268
Bulk infrastructure	0	0	0	0	0	0	0	0	0	0	0	0
Asset replacement	417	417	417	417	417	417	417	417	417	417	2,087	2,087
Other	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL CAPEX	**2,108**	**2,123**	**2,137**	**2,152**	**2,124**	**1,085**	**1,102**	**1,118**	**1,134**	**1,151**	**10,644**	**5,590**
service provider CAPEX	2,084	2,098	2,113	2,127	2,099	1,059	1,076	1,093	1,110	1,127	10,522	5,465
developer CAPEX	24	24	25	25	25	26	26	25	25	24	123	126
SUBSIDIES	**R thousands**											
Housing subsidy	492	483	475	468	462	289	289	288	287	287	2,378	1,440
Infrastructure grant	186	182	179	176	174	103	103	103	103	102	897	514
Other subsidies/grants	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL SUBSIDIES	**677**	**665**	**654**	**644**	**635**	**393**	**392**	**391**	**390**	**389**	**3,275**	**1,954**
CONSUMER PAYMENTS	443	444	445	447	448	63	64	66	67	68	2,227	328
CURRENT INCOME	8	8	8	8	9	9	9	9	9	9	41	45
BORROWING REQUIREMENTS												
TOTAL BORROWING	**980**	**1,006**	**1,030**	**1,053**	**1,032**	**621**	**637**	**652**	**668**	**685**	**5,101**	**3,263**

3.4 CAPITAL REQUIREMENTS (nominal)

R thousands (current Rands)	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	TOTAL yrs 1-5	TOTAL yrs 6-10
CAPITAL EXPENDITURE	R thousands											
Internal services - new residential	396	435	476	519	563	612	665	722	784	852	2,388	3,635
Internal services - new non-residential	10	11	12	13	14	15	16	17	18	20	61	86
Internal - backlog and upgrading	642	688	735	782	829	0	0	0	0	0	3,676	0
metering programme	31	33	35	38	40	0	0	0	0	0	177	0
Connector infrastructure	741	800	861	922	925	356	387	420	455	493	4,249	2,112
Bulk infrastructure	0	0	0	0	0	0	0	0	0	0	0	0
Asset replacement	449	481	514	547	580	615	652	691	732	776	2,571	3,465
Other	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL CAPEX	**2,269**	**2,448**	**2,633**	**2,821**	**2,951**	**1,598**	**1,720**	**1,850**	**1,990**	**2,141**	**13,122**	**9,298**
service provider CAPEX	2,243	2,420	2,603	2,789	2,917	1,560	1,680	1,808	1,946	2,095	12,971	9,090
developer CAPEX	26	28	30	32	34	38	40	42	43	45	151	208
SUBSIDIES	R thousands											
Housing subsidy	529	557	585	613	641	426	451	476	504	533	2,924	2,390
Infrastructure grant	200	210	221	231	242	152	161	170	180	190	1,103	853
Other subsidies/grants	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL SUBSIDIES	**729**	**767**	**805**	**844**	**883**	**578**	**612**	**647**	**684**	**723**	**4,028**	**3,243**
CONSUMER PAYMENTS	477	512	549	586	623	93	100	109	118	127	2,746	546
CURRENT INCOME	8	9	10	11	12	13	14	15	16	17	51	75
BORROWING REQUIREMENTS	R thousands											
	1,055	**1,160**	**1,269**	**1,380**	**1,434**	**914**	**994**	**1,080**	**1,172**	**1,273**	**6,298**	**5,434**

3.6 INCOME AND EXPENDITURE (nominal)

R thousands pa	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
INCOME (accrued)												
Unmetered, residential		286	131	105	75	40	0	0	0	0	0	0
Unmetered, non-residential		0	0	0	0	0	0	0	0	0	0	0
Metered, residential		2,876	3,200	3,544	3,908	4,350	4,746	5,119	5,521	5,956	6,426	6,933
Metered, non-residential		812	882	955	1,030	1,134	1,209	1,294	1,386	1,484	1,588	1,700
Recurrent subsidies		0	0	0	0	0	0	0	0	0	0	0
Other income		0	0	0	0	0	0	0	0	0	0	0
TOTAL		**3,974**	**4,213**	**4,604**	**5,013**	**5,523**	**5,955**	**6,413**	**6,907**	**7,440**	**8,014**	**8,634**
EXPENDITURE												
Admin, storage and reticulation		1,390	1,579	1,783	2,002	2,235	2,481	2,687	2,910	3,152	3,414	3,698
Bulk - purification of own		773	920	1,090	1,237	1,388	1,554	1,647	1,746	1,851	1,962	2,080
Bulk - purchase of purified		0	0	0	0	0	0	0	0	0	0	0
Capital charges		649	779	928	1,095	1,279	1,471	1,581	1,705	1,843	1,996	2,166
Contributions to fixed assets		40	84	92	100	110	119	128	138	149	160	173
to capital development fund		0	42	46	50	55	60	64	69	74	80	86
to replacement provision		0	0	0	0	0	0	0	0	0	0	0
to other funds		41	42	46	50	55	60	64	69	74	80	86
Other expenditure		0	0	0	0	0	0	0	0	0	0	0
TOTAL		**2,893**	**3,447**	**3,984**	**4,534**	**5,122**	**5,744**	**6,172**	**6,637**	**7,143**	**7,692**	**8,288**
Budgeted surplus (-deficit)		**1,080**	**766**	**619**	**478**	**401**	**211**	**241**	**270**	**297**	**322**	**345**
Unpaid accounts (-)		-467	-384	-380	-375	-375	-368	-372	-373	-373	-370	-364
REALISED SURPLUS(-DEFICIT)		**613**	**382**	**239**	**103**	**26**	**-157**	**-130**	**-103**	**-76**	**-48**	**-19**
Return on surplus (-cost of deficit)		-32	35	78	105	122	124	121	122	125	133	144
Annual net cash flow		581	417	317	209	148	-34	-9	18	49	84	125
CASH BALANCE (year end)	**-500**	**81**	**498**	**815**	**1,024**	**1,172**	**1,138**	**1,129**	**1,147**	**1,197**	**1,281**	**1,406**

DEBT-SERVICE RATIO	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
capital charges/accrued income	16%	18%	20%	22%	23%	25%	25%	25%	25%	25%	25%
capital charges/received income	19%	20%	22%	24%	25%	26%	26%	26%	26%	26%	26%

NON-PAYMENT	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
% of total accrued income unpaid	12%	9%	8%	7%	7%	6%	6%	5%	5%	5%	4%
% of unmetered income unpaid	60%	55%	49%	44%	38%	33%	27%	22%	16%	11%	5%
% of metered residential income unpaid	10%	10%	9%	9%	8%	8%	7%	7%	6%	6%	5%
% of metered non-residential income unpaid	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%

3.7 MONTHLY BILLS (Real)

Unmetered connections (Rands per month, real)

Residential	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
None/inadequate	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Communal standpipes	R 13	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Yard tanks	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Yard taps (on-site san)	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Yard taps (w/borne san)	R 13	R 13	R 13	R 13	R 13	R 0	R 0	R 0	R 0	R 0	R 0
In-house, low income	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
In-house, middle income	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
In-house, high income	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Non-residential											
Institutions	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Commerce&dry industry	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0

Metered connections (Rands per month, real)

Residential	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Yard taps (on-site san)	R 24	R 24	R 24	R 24	R 24	R 0	R 0	R 0	R 0	R 0	R 0
Yard taps (w/borne san)	R 0	R 18	R 18	R 18	R 19	R 19	R 19	R 19	R 19	R 19	R 19
In-house, low income	R 33	R 33	R 33	R 33	R 33	R 33	R 33	R 33	R 33	R 33	R 33
In-house, middle income	R 42	R 42	R 42	R 42	R 43	R 43	R 43	R 43	R 43	R 43	R 43
In-house, high income	R 79	R 79	R 79	R 79	R 80	R 80	R 80	R 80	R 80	R 80	R 80
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Non-residential	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Tariff option selected :	**Constant tariffs**										
Institutions - constant	R 42	R 42	R 42	R 42	R 43	R 43	R 43	R 43	R 43	R 43	R 43
Commerce&dry - constant	R 184	R 184	R 184	R 184	R 188	R 187	R 187	R 187	R 187	R 187	R 187
Wet industry - constant	R 900	R 900	R 900	R 900	R 921	R 918	R 917	R 917	R 917	R 917	R 917
Institutions - block tariff	R 40	R 40	R 40	R 40	R 41	R 41	R 41	R 41	R 41	R 41	R 41
Commerce&dry - block	R 179	R 179	R 179	R 179	R 183	R 182	R 182	R 182	R 182	R 182	R 182
Wet industry - block tariff	R 879	R 879	R 879	R 879	R 899	R 896	R 896	R 896	R 896	R 896	R 896
Institutions, as RUEs	R 40	R 36	R 36	R 36	R 37	R 36	R 36	R 36	R 36	R 36	R 36
Commercial&dry, as RUEs	R 177	R 171	R 171	R 171	R 174	R 172	R 172	R 172	R 172	R 172	R 172
Wet industrial, as RUEs	R 867	R 858	R 858	R 858	R 872	R 866	R 866	R 866	R 866	R 866	R 866

3.8 MONTHLY BILLS (Nominal)

Unmetered connections (Rands per month, nominal)

Residential	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
None/inadequate	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Communal standpipes	R 13	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Yard tanks	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Yard taps (on-site san)	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Yard taps (w/borne san)	R 13	R 14	R 15	R 16	R 17	R 0	R 0	R 0	R 0	R 0	R 0
In-house, low income	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
In-house, middle income	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
In-house, high income	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Non-residential											
Institutions	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Commerce&dry industry	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0

Metered connections (Rands per month, nominal)

Residential	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Yard taps (on-site san)	R 24	R 25	R 27	R 29	R 31	R 0	R 0	R 0	R 0	R 0	R 0
Yard taps (w/borne san)	R 0	R 20	R 21	R 23	R 25	R 26	R 27	R 29	R 31	R 33	R 35
In-house, low income	R 33	R 35	R 38	R 41	R 43	R 46	R 49	R 52	R 55	R 58	R 62
In-house, middle income	R 42	R 46	R 49	R 52	R 56	R 59	R 63	R 67	R 71	R 75	R 80
In-house, high income	R 79	R 85	R 91	R 97	R 105	R 111	R 118	R 125	R 132	R 140	R 148
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0	R 0
Non-residential	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
Tariff option selected :	**Constant tariffs**										
Institutions - constant	R 42	R 45	R 48	R 52	R 56	R 60	R 63	R 67	R 71	R 75	R 80
Commerce&dry - constant	R 184	R 198	R 212	R 226	R 246	R 260	R 278	R 292	R 310	R 329	R 348
Wet industry - constant	R 900	R 968	R 1,038	R 1,109	R 1,207	R 1,275	R 1,351	R 1,432	R 1,518	R 1,609	R 1,706
Institutions - block tariff	R 40	R 43	R 46	R 49	R 54	R 57	R 60	R 64	R 67	R 71	R 76
Commerce&dry - block	R 179	R 192	R 206	R 220	R 239	R 253	R 268	R 284	R 301	R 319	R 338
Wet industry - block tariff	R 879	R 946	R 1,014	R 1,083	R 1,179	R 1,245	R 1,319	R 1,399	R 1,482	R 1,571	R 1,666
Institutions, as RUEs	R 40	R 39	R 42	R 44	R 48	R 51	R 54	R 57	R 60	R 64	R 68
Commercial&dry, as RUEs	R 177	R 184	R 197	R 210	R 227	R 240	R 254	R 269	R 285	R 302	R 321
Wet industrial, as RUEs	R 867	R 923	R 990	R 1,057	R 1,142	R 1,203	R 1,276	R 1,352	R 1,433	R 1,519	R 1,610

Water Supply Services Model (v1.0) Smalltown 1L Base year = 1998

3.9 COST OF PROVIDING WATER BY SERVICE TYPE (excluding capital charges - R per CU pm, rea)

Unmetered connections	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
None/inadequate	1	1	1	1	1	0	0	0	0	0	0
Communal standpipes	6	6	6	6	6	0	0	0	0	0	0
Yard tanks	0	0	0	0	0	0	0	0	0	0	0
Yard taps (on-site san)	0	0	0	0	0	0	0	0	0	0	0
Yard taps (w/borne san)	14	14	15	15	15	0	0	0	0	0	0
In-house, low income	0	0	0	0	0	0	0	0	0	0	0
In-house, middle income	0	0	0	0	0	0	0	0	0	0	0
In-house, high income	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
Institutions	0	0	0	0	0	0	0	0	0	0	0
Commerce&dry industry	0	0	0	0	0	0	0	0	0	0	0
Metered connections											
Yard taps (on-site san)	12	13	13	13	13	0	0	0	0	0	0
Yard taps (w/borne san)	0	16	16	17	17	17	17	16	16	16	16
In-house, low income	17	17	17	17	17	17	17	17	17	17	17
In-house, middle income	22	22	23	23	23	23	23	23	23	23	22
In-house, high income	37	38	38	39	39	39	39	38	38	38	38
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
Institutions	26	27	27	27	27	27	27	27	27	27	26
Commerce&dry industry	64	66	67	68	68	68	68	67	66	66	65
Wet industry	275	282	290	292	294	296	292	289	286	284	281

Water Supply Services Model (v1.0) Smalltown 1L Base year = 1998

3.10 COSTS PER KILOLITRE OF PROVIDING WATER SERVICE (excluding capital charges) (c/kl)

TABLE 1 COST PER KILOLITER OF WATER PURCHASED/PURIFIED, SOLD AND USED (c/kl, real)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Distribution costs (administration,storage, reticulation and bulk)											
Average cost of bulk water	30	31	33	33	33	34	33	33	32	32	31
Expenditure per kl sold, used & lost	83	85	86	87	87	88	88	87	87	86	86
Expenditure per kl water sold&used	104	109	110	109	108	108	107	107	106	106	105
Total costs, including all interest and redemption, contributions and other expenditure											
Total expenditure per kl sold, used & lost	113	117	120	121	123	125	125	124	124	124	123
Total expenditure per kl sold & used	141	144	146	146	147	148	147	146	146	145	145

TABLE 2 COST OF PROVIDING WATER BY SERVICE TYPE, EXCLUDING CAPITAL CHARGES AND PHYSICAL LOSSES (c/kl, real)

Unmetered	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
None/inadequate	123	124	126	126	126	0	0	0	0	0	0
Communal standpipes	158	160	161	162	162	0	0	0	0	0	0
Yard tanks	0	0	0	0	0	0	0	0	0	0	0
Yard taps (on-site san)	0	0	0	0	0	0	0	0	0	0	0
Yard taps (w/borne san)	129	131	132	133	133	0	0	0	0	0	0
In-house, low income	0	0	0	0	0	0	0	0	0	0	0
In-house, middle income	0	0	0	0	0	0	0	0	0	0	0
In-house, high income	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
Institutions	0	0	0	0	0	0	0	0	0	0	0
Commerce&dry industry	0	0	0	0	0	0	0	0	0	0	0
Metered											
Yard taps (on-site san)	156	157	159	159	160	0	0	0	0	0	0
Yard taps (w/borne san)	0	116	118	118	118	119	119	118	118	117	116
In-house, low income	110	112	113	114	114	115	114	113	113	112	112
In-house, middle income	101	102	103	104	104	105	104	104	103	103	102
In-house, high income	76	77	79	79	80	81	80	79	79	78	78
0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0
Institutions	87	88	90	90	91	92	91	90	90	89	89
Commerce&dry industry	61	62	64	64	64	65	65	64	63	63	62
Wet industry	55	56	58	58	59	59	59	58	58	57	56

3.11 CONSUMPTION (Ml pa) AND INCOME (c/kl)

TABLE 1 CONSUMPTION, PHYSICAL LOSSES AND TOTAL PURCHASED/PURIFIED (Ml per annum)

Unmetered	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Residential	171	137	103	69	34	0	0	0	0	0	0
Non-residential	0	0	0	0	0	0	0	0	0	0	0
Total unmetered	**171**	**137**	**103**	**69**	**34**	**0**	**0**	**0**	**0**	**0**	**0**
Metered											
Residential	1,345	1,516	1,688	1,862	2,036	2,205	2,248	2,293	2,339	2,388	2,435
Non-residential	468	473	477	482	487	489	494	499	504	509	514
Total metered	**1,813**	**1,989**	**2,166**	**2,344**	**2,523**	**2,694**	**2,743**	**2,793**	**2,843**	**2,898**	**2,949**
Municipal water*	96	98	101	103	106	108	111	114	117	120	123
Total consumed	**2,080**	**2,224**	**2,369**	**2,515**	**2,663**	**2,802**	**2,854**	**2,906**	**2,960**	**3,015**	**3,071**
Physical losses	519	521	520	515	507	495	504	513	522	532	542
Total purchased/purified	**2,599**	**2,745**	**2,889**	**3,030**	**3,170**	**3,297**	**3,357**	**3,419**	**3,482**	**3,547**	**3,614**
Total purified water purchased	0	0	0	110	250	377	437	499	562	627	694
Total purified	2,599	2,745	2,889	2,920	2,920	2,920	2,920	2,920	2,920	2,920	2,920
% physical losses	**20%**	**19%**	**18%**	**17%**	**16%**	**15%**	**15%**	**15%**	**15%**	**15%**	**15%**
Macro est of purified/purchased	2,599	2,745	2,889	3,030	3,170	3,297	3,357	3,419	3,482	3,547	3,614

* * Municipal water* here excludes water provided provided directly to consumers free of charge, which is included in the unmetered consumption category.

TABLE 2 ANNUAL PERCENTAGE CHANGES IN CONSUMPTION AND TOTAL PURIFIED/PURCHASED (% pa)

Calculated	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Residential	9.0%	8.3%	7.8%	7.3%	6.5%	2.0%	2.0%	2.0%	2.0%	2.0%
Non-residential	1.0%	1.0%	1.0%	1.0%	0.5%	1.0%	1.0%	1.0%	1.0%	1.0%
Municipal water*	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Total consumed	**6.9%**	**6.5%**	**6.2%**	**5.9%**	**5.2%**	**1.8%**	**1.8%**	**1.9%**	**1.9%**	**1.9%**
Total purified/purchased	**5.6%**	**5.2%**	**4.9%**	**4.6%**	**4.0%**	**1.8%**	**1.8%**	**1.9%**	**1.9%**	**1.9%**

* * Municipal water* here excludes water provided provided directly to consumers free of charge, which is included in the unmetered consumption category.

TABLE 3 AVERAGE COSTS, PRICES AND INCOME OF SYSTEM (c/kl - real)

Average cost of bulk water	**30**	**31**	**33**	**33**	**33**	**34**	**33**	**33**	**32**	**32**	**31**
Total average cost	**113**	**117**	**120**	**121**	**123**	**125**	**125**	**124**	**124**	**124**	**123**
Average price of water sold	191	178	168	162	158	153	153	152	152	152	151
Income accrued/kl (all water)	153	144	140	137	136	133	132	132	131	131	131
Income received/kl (all water)	**134**	**131**	**129**	**127**	[illegible]	**125**	**125**	**125**	**125**	**125**	**125**

3.12 SUMMARY DATA 1 (Capital account)

Town	Run	Base yr	Assessed by	Assessment date	Run date
Smalltown	1L	1998	Clive van Horen	1-Feb-98	20-Mar-98

Scenario

TABLE 1 CAPITAL ACCOUNT : CAPITAL EXPENDITURE, CAPITAL INCOME AND BORROWING REQUIREMENTS (R thousands)

Real	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Year 1-5	Year 6-10
Capital expenditure	2,108	2,123	2,137	2,152	2,124	1,085	1,102	1,118	1,134	1,151	10,844	5,590
of which by service provider	2,084	2,098	2,113	2,127	2,099	1,059	1,078	1,093	1,110	1,127	10,522	5,465
Capital subsidies	677	665	654	644	635	393	392	391	390	389	3,275	1,954
Consumer payments	443	444	445	447	448	63	64	66	67	68	2,227	328
Exp from current income	8	8	8	8	9	9	9	9	9	9	41	45
Borrowing	980	1,006	1,030	1,053	1,032	621	637	652	668	685	5,101	3,263
Nominal												
Capital expenditure	2,269	2,449	2,633	2,821	2,951	1,568	1,720	1,850	1,990	2,141	13,122	9,298
of which by service provider	2,243	2,420	2,603	2,789	2,917	1,569	1,680	1,808	1,946	2,095	12,571	9,096
Capital subsidies	729	767	805	844	883	578	612	647	684	723	4,028	3,243
Consumer payments	477	512	549	586	623	93	100	109	119	127	2,748	548
Exp from current income	8	9	10	11	12	13	14	15	16	17	51	75
Borrowing	1,055	1,160	1,269	1,380	1,434	914	994	1,080	1,172	1,273	6,298	5,434

TABLE 2 NUMBERS OF CONSUMER UNITS AND AVERAGE GROWTH RATES

	1998	2003	2008	Av % pa	Year 1-5	Years 6-10
Residential	9,104	10,300	11,654		2.5%	2.5%
Institutions	54	57	60		1.0%	1.0%
Commercial and "dry"	307	323	339		1.0%	1.0%
"Wet" industrial	10	11	11		1.0%	1.0%
Local average economic growth rate					1.0%	1.0%

TABLE 3 INCOME DISTRIBUTION

	1998	2003	2008
very low	38%	33%	37%
low	30%	29%	28%
low middle	20%	19%	19%
middle	10%	9%	8%
high	10%	9%	7%

TABLE 4 RESIDENTIAL SERVICE LEVELS

	none	s/pipe	Yard tanks	Y/ taps(on-s)	Y/ taps(wb)	In-house	0%	0%
Category	0	1	1	2	3	3.4.5	3	3
1998	4%	9%	0%	46%	11%	31%	0%	0%
2003	0%	0%	0%	0%	73%	27%	0%	0%
2008	0%	0%	0%	0%	75%	25%	0%	0%

TABLE 5 MISMATCH : SERVICES VS INCOMES

% of consumers with service categories and incomes:	1998	2003	2008
3/low,very low	1%	63%	65%
2/very low	17%	0%	0%

TABLE 6 UNIT COSTS : INTERNAL SERVICES, SUBSIDIES AND CONSUMER PAYMENTS

	Capital costs Rands / CU (real)		Subsidies and payments (R/CU, real) housing subsidy (real value)			payments real value, all years
	new internal services	metering programme	1998	2003	2008	
Communal standpipes	900	na	900	766	663	0
Yard tanks	1,200	na	1,150	978	847	50
Yard taps (on-site san)	1,400	150	1,300	1,106	958	100
Yard taps (w/borne san)	1,600	150	1,400	1,191	1,032	200
In-house, low income	1,800	200	1,446	1,230	1,066	354
In-house, middle income	2,100	200	na	na	na	354
In-house, high income	2,400	200	na	na	na	354
0	0	0	0	0	0	0
0	0	0	0	0	0	0
Institutions	2,100	with upgrading	na	na	na	2,100
Commerce&dry industry	2,400	with upgrading	na	na	na	2,400
Wet industry	12,000	metered	na	na	na	12,000

TABLE 7 UNIT COSTS : BULK AND CONNECTOR

Bulk infrastructure (R millions)		
Source of supply	na	Rm/Ml/day additional capacity
Treatment	na	Rm/Ml/day additional capacity
Pumping	na	Rm/Ml/day additional capacity
Transmission	na	Rm/Ml/day additional capacity
Connector infrastructure (R millions)		
Pipelines	0.20	Rm/Ml/day additional capacity
Reservoirs	0.40	Rm/Ml storage capacity
Pumps	0.10	Rm/Ml/hr pumping capacity
Water towers	0.20	Rm/Ml storage capacity

TABLE 8 Inflation and borrowing rates for long term loans

	1998	2003	2008
general inflation rate	8%	6%	6%
inflation in construction	8%	6%	6%
nominal borrowing rate	14.5%	12.4%	12.4%

3.13 SUMMARY DATA 2 (Operating account)

Town	Run	Base yr	Assessed by	Assessment date	Run date
Smalltown	1L	1998	Clive van Horen	1-Feb-98	20-Mar-98

TABLE 1 OPERATING ACCOUNT : INCOME, EXPENDITURE AND CASH FLOWS (R thousands)

Real	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Accrued income		**3,974**	**3,915**	**3,991**	**4,069**	**4,214**	**4,286**	**4,355**	**4,424**	**4,496**	**4,569**	**4,643**
of which sale of water		*3,974*	*3,915*	*3,991*	*4,069*	*4,214*	*4,286*	*4,355*	*4,424*	*4,496*	*4,569*	*4,643*
Expenditure		**2,893**	**3,203**	**3,454**	**3,681**	**3,908**	**4,134**	**4,191**	**4,252**	**4,317**	**4,385**	**4,458**
Surplus (deficit)		**1,080**	**712**	**537**	**388**	**306**	**152**	**164**	**173**	**179**	**183**	**186**
Non-payment (bad debts)		(467)	(357)	(329)	(304)	(286)	(265)	(252)	(239)	(225)	(211)	(196)
Return on surplus (-cost of deficit)		(32)	33	67	85	93	89	82	78	75	76	77
Annual net cash flow		**581**	**388**	**275**	**169**	**113**	(24)	(6)	12	30	48	67
CASH BALANCE (year end)	(538)	**81**	**463**	**707**	**831**	**894**	**819**	**767**	**735**	**723**	**730**	**756**
Nominal												
Accrued income		*3,974*	*4,213*	*4,604*	*5,013*	*5,523*	*5,955*	*6,413*	*6,907*	*7,440*	*8,014*	*8,634*
of which sale of water		3,974	4,213	4,604	5,013	5,523	5,955	6,413	6,907	7,440	8,014	8,634
Expenditure		*2,893*	*3,447*	*3,984*	*4,534*	*5,122*	*5,744*	*6,172*	*6,637*	*7,143*	*7,692*	*8,288*
Surplus (deficit)		*1,080*	*766*	*619*	*478*	*401*	*211*	*241*	*270*	*297*	*322*	*345*
Non-payment (bad debts)		*(467)*	*(384)*	*(380)*	*(375)*	*(375)*	*(368)*	*(373)*	*(373)*	*(373)*	*(370)*	*(364)*
Return on surplus (-cost of deficit)		*(32)*	*35*	*78*	*105*	*122*	*124*	*121*	*122*	*125*	*133*	*144*
Annual net cash flow		*581*	*417*	*317*	*209*	*148*	*(34)*	*(9)*	*18*	*49*	*84*	*125*
CASH BALANCE (year end)	*-500*	*81*	*498*	*815*	*1,024*	*1,172*	*1,138*	*1,129*	*1,147*	*1,197*	*1,281*	*1,406*

TABLE 2 UNIT COST, CONSUMPTION, BILLS AND PRICE OF WATER BY SERVICE TYPE

	Cost (R/CU pm, real) (excluding capital charges)			Consumption (kl/CU pm) kl/month per CU			Monthly bills (R pm, real) R per month per CU			Price per kl c/kl		
	1998	2003	2008	1998	2003	2008	1998	2003	2008	1998	2003	2008
None/inadequate	1	0	0	1	0	0	0	0	0	0	0	0
Communal standpipes	6	0	0	4	0	0	13	0	0	330	0	0
Yard tanks	0	0	0	0	0	0	0	0	0	0	0	0
Yard taps (on-site san)*	12	0	0	8	0	0	24	0	0	294	295	295
Yard taps (w/borne san)*	14	17	16	0	14	14	13	19	19	120	134	134
In-house, low income*	17	17	17	15	15	15	33	33	33	219	221	221
In-house, middle income*	22	23	22	22	22	22	42	43	43	193	195	195
In-house, high income*	37	39	38	49	48	48	79	80	80	162	165	165
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
Institutions	26	27	26	30	30	30	40	41	41	133	136	136
Commerce&dry industry	64	68	65	105	105	***	179	182	182	169	173	173
Wet industry	275	296	281	500	498	498	879	896	896	176	180	180

*Values shown for metered connections only

TABLE 3 TOTAL CONSUMPTION (Ml per annum)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total consumed	2,080	2,224	2,369	2,515	2,663	2,802	2,854	2,906	2,96	3,015	3,071
Total purchased/purified	2,599	2,745	2,889	3,030	3,170	3,297	3,357	3,419	3,4\2	3,547	3,614
% physical losses	20%	19%	18%	17%	16%	15%	15%	15%	15%	15%	15%

TABLE 4 DEBT SERVICE RATIOS AND NON-PAYMENT

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
capital charges/accrued income	18%	18%	20%	22%	23%	25%	25%	25%	25%	25%	25%
capital charges/received income	19%	20%	22%	24%	25%	26%	26%	26%	26%	26%	26%
% of total accrued income unpaid	12%	9%	8%	7%	7%	6%	6%	5%	5%	5%	4%

WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Module 3

CUSTOMER PROFILE AND DEMAND FOR SERVICES

January 1998

PALMER DEVELOPMENT GROUP

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PREFACE

This module forms part of the series "Management guidelines for water service providers". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

Executive summary: Introduction to urban services management

Module 1: An introduction to organisational arrangements for water service providers

Module 2: Preparation of a water services development plan

Module 3: Customer profile and demand for services

Module 4: Setting water tariffs

Module 5: Setting sanitation tariffs

Module 6: Reporting procedures for water services

Module 7: Reporting procedures for sanitation services

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The Steering Committee for this project includes the following people:

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Project team

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1. INTRODUCTION

1.1 Aim

Central to the functioning of an effective water service provider is accurate information on the amount of water currently provided to customers, and informed projections of the amounts to be provided in the future. Similarly for sanitation, it is necessary to have an accurate understanding of current services and an idea of future service requirements.

While most local authorities have good information on service provision within their pre-1994 areas of jurisdiction, the situation in the old Black Local Authority (BLA) and ex-homeland areas is often less certain. Additional uncertainty is added by the large informal settlements, where services are required but little is generally known about the demographics or the demand for services in the areas concerned.

The aim of this module is to suggest ways in which service providers can gain an accurate understanding of the current situation, and make informed projections regarding future requirements.

1.2 Information requirements

The demographics of an area, combined with its economic structure, is the basic determinant of both current and future demand for water and sanitation services. It is therefore essential that the service provider gain a good understanding of the current demographic and economic situation and be in a position to make informed projections of future trends. The demographic and service information required to assess the current situation includes:

- the current population;
- the number of households;
- the number of residential customer units (some of which may consist of more than one household);
- the incomes of these residential customer units;
- the number and type of non-residential customer units;
- current levels of service;
- current consumption;
- the demand for services, in terms of willingness to pay for the services desired; and
- knowledge, attitudes and practices around water supply and sanitation.

The information required to make sensible projections of future requirements includes projections of:

- population growth and
- economic growth, which are the major determinants of
- growth in the number of customer units;
- changes in the income levels of residential customer units;
- the demand for services and levels of service provided to residential customer units;
- changes in consumption per customer unit (residential and non-residential) due to the changes in price;

- the effects of water metering programmes;
- changes in consumption per customer unit due to changes in technology and/or knowledge, attitudes and practices;
- changes in consumption per customer unit due to conservation measures; and
- weather patterns and climate.

2. CURRENT POPULATION

2.1 Settlement types

An understanding of a town's demographic and service profile usually requires distinguishing between dwellings located on formal plots and those in informal areas. Strictly speaking, a *formal plot* is one which is part of an approved township plan, has been surveyed and has title registered in the name of a legal entity (e.g. an individual, company or local authority). There are likely to be some ambiguous situations, where suburbs have been formally laid out with sites given numbers and allocated to particular individuals households but where tenure has not been registered. This arrangement was prevalent in the late 1980s and early 1990s on projects developed by the former provincial administrations. Under such circumstances the plots would, nevertheless, be considered as "formal". As the new housing subsidy policy in South Africa is associated with tenure delivery to the beneficiaries, it is likely that the occurrence of such situations will decline.

Informal settlements can be divided into two groups:

- illegal settlement or squatting; and
- traditional settlements.

Where people have settled illegally (squatting) there is obviously no professionally planned layout, no survey and no registration of title. Often there are also land ownership difficulties – possibly with the landowner unwilling to allow the land to be transferred to people occupying illegally, or with the land assigned to uses other than residential. There are, however, often strong arguments for recognising the right of people to stay in these settlements permanently; land registration, ownership and servicing then needs to be dealt with *ex post facto*.

In the case of traditional settlements, people have been living permanently on land allocated to them via traditional processes, often mediated by tribal leaders. Typically the right to occupy is defined by a 'permission to occupy' issued by the chief. Such rights are not centrally registered and can be taken away by the chief.

Many of the new urban local councils have had traditional settlements incorporated into them. Providing security of tenure, housing and services for these settlements is thus a major task facing local authorities.

2.2 Existing sources of information on population size

Information on the populations of towns is available from a number of sources, of varying degrees of reliability depending on the source and the area concerned. The most important of these are listed below, followed by a discussion of methods that a service provider may use to estimate the size of the current population.

In general, for most towns information on the old "white", "coloured" and "Indian" formal areas is reliable and accessible, if at times somewhat dated. The reliability of existing population estimates in the old (formal) BLA areas is more uncertain, given

the extent of overcrowding and backyard shacks in many of these areas, the reluctance in the past of people to admit to the presence of so-called "illegals", and the movement of people out of these overcrowded townships to informal settlements (see Giliomee and Schlemmer, 1985). For a variety of reasons, including rapid growth and difficulties in gaining access to areas, population estimates for informal areas tend to be outdated and unreliable.

a) ***The national census***. The most comprehensive information available is from the national census, and most other demographic estimates (other than local surveys) rely on it as a base. Until the detailed results of the 1996 census are available and have been evaluated, however, the 1991 census is too outdated to be recommended as a reliable source for service providers. It may nevertheless be advisable to make use of 1991 census figures and make sensible projections as an initial source and a check against other estimates. The growth rates used for updated population estimates by organisations such as the Development Bank of Southern Africa (DBSA) or the Bureau for Market Research (BMR) at UNISA should be used unless there are good reasons to use locally determined rates. Once the detailed results of the 1996 census are available they should be used as a first source.

b) ***Current estimates based on the 1991 census***. Organisations such as DBSA and BMR estimate population size by applying growth factors to 1991 census data (e.g. DBSA 1991). These are, however, usually done by magisterial district rather than disaggregated into individual local authority areas. Urban and non-urban areas are separately recorded. The value of this source of information to service providers therefore depends on the size of area concerned: if it is the only or by far the dominant urban area in the district then these figures may be useful. The populations of smaller urban areas, however, cannot be extracted from these sources.

c) ***Voter registration information***. The most recent national source of information – before the results of the 1996 census become available – is 1995 voter registration data. This information is somewhat problematic in that only eligible voters were recorded. This means, firstly, that the number of people below the age of 18 needs to be estimated on the basis of typical age ratios which may lead to errors. Secondly, unregistered adults are excluded, so that in an area with, for instance, a significant population of illegal immigrants, use of this source will lead to an underestimate. Thirdly, registration in an area did not necessarily mean that the person lives there; including such voters plus dependants would lead to an overestimate. Despite these problems, in the absence of more reliable information, voter registration can provide a relatively up-to-date first estimate of population size. A major advantage of this information is that it includes people in both formal and informal areas.

d) ***Local area studies.*** In some areas local universities, government departments, management consultants or other bodies have made recent population estimates. Housing surveys are frequently a valuable source of information. For example, Vista University conducted a study of housing and infrastructure in towns in the Eastern Cape in 1995-1996 which included population estimates (Horn et al 1996). In 1996 the Department of Town and Regional Planning at the University of the Free State conducted a study of the population in the Bloemfontein-Botshabelo-Thaba Nchu region (Krige 1996). In certain local substructures in Gauteng estimates for 1995 and 1996 were available from three sources: local authority

estimates, the Gauteng Health Department, and estimates made by management consultants.

It is worth investigating alternative sources and evaluating them for soundness. If more than one estimate is available they should be compared. Where estimates differ greatly (which is often the case)[1] they must be treated with caution. Informed judgements are required to evaluate the relative accuracy of the different estimates, and it may be advisable for the service provider to make its own estimates and/or conduct a survey.

2.3 Service provider estimates and surveys.

If the service provider is to make its own population estimate, it is important that this be done in as scientific a manner as is feasible. A statistically valid survey would provide the best information, but this may not always be possible. A method of estimating the current population by means of a combination of available data and surveys is discussed below. The purpose is to provide some ideas on how to set about estimating the size of the current population. The method described was recently used in the Durban Metropolitan area.

The first step in assessing the current population of an area is to list the formal and informal settlements for which the service provider is responsible and determine their *boundaries*. This information should be readily available for formal areas. For informal areas local knowledge will frequently suffice, and it is recommended that the assistance of people who live and/or work in these areas be obtained. In some cases aerial photographs may be necessary to verify information.

The size of the *population* then needs to be determined. Possibly the easiest way to so this is by obtaining dwelling counts and household sizes for all settlements in the study area. An estimate of the population in each settlement/area is then determined as follows:

(no. of dwellings) x (average household size) = population estimate

The population of the area as a whole can then be calculated by adding the populations of each settlement or area.

An alternative approach would be to estimate numbers and household sizes of different types of dwellings (see Table 1). These would then be aggregated to obtain the population of the area as a whole.

In formal areas *dwelling counts* can usually be obtained from local authorities and township administrators. However, in areas where reliable information is not available (as in the informal areas), surveys may be required. These may need to include the use of aerial photography as a base for identifying dwellings. Dwellings should be categorised according to a typology which is simple, representative and agreed to by all parties concerned. An example of typology, adapted from that used by the Durban Metropolitan Council, is shown in Table 1.

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[1] For example, estimates of the 1995 population in a metropolitan substructure in Gauteng varied between 360 300 and 725 800.

Table 1: Dwelling typology used by the Durban Metropolitan Council (adapted)

Domain	*Dwelling typology*	*Definition of dwelling type*
Formal	Suburb	House, flat, residential institution (eg university residence)
Formal	Township	House, residential institution (eg hostel)
Informal	Infill single	Single shack, close to formal dwelling and other land uses.
Informal	Infill backyard	Single shack, occur in backyards of formal dwellings.
Informal	Rows of rooms	Shack rooms joined together.
Informal	Peripheral cluster	Single shacks grouped together, one path to cluster. Small scale agriculture.
Informal	Peripheral single	Single shacks, edge to formal areas.
Peri-urban	Cluster	Single dwellings grouped together, more than 50% square shape. Agricultural activity.
Peri-urban	Single	Single square or round dwellings. Agricultural activity.
Peri-urban	Traditional homestead	Traditional dwellings, clustered into a homestead. Agricultural activity.

Note: "Peri-urban" refers to informal areas with signficant agricultural activity in evidence.
Source: Adapted from Breetzke and Wright, 1996

Table 2: Average weighted household sizes for the Durban Metropolitan Area

Domain	*Typology*	*Stratum*	*1995 mean weighted household size*
Formal	Township house	African	5.3
	House/flat	Coloured	4.3
	House/flat	Indian	4.4
	House/flat	White	3.0
		Average formal	**4.3**
Informal	Infill single	Total	4.1
	Infill backyard	Total	3.7
	Rows of rooms	Total	5.0
	Peripheral single	Total	4.8
	Peripheral cluster	Total	6.0
		Average informal	**4.7**
Peri-urban	Peri-urban single		7.0
	Peri-urban cluster		6.5
	Peri-urban traditional homestead		5.9
		Average peri-urban	**6.2**

Notes:

1. "Peri-urban" refers to informal areas with signficant agricultural activity in evidence.
2. See section 5.1 for an example of how a weighted average is calculated.

Source: Breetzke and Wright, 1996

The *household size* is the number of persons per dwelling. In the past, surveys of household size tended to be restricted to only certain spatial areas or to focus on specific population groups (Breetzke and Wright, 1996). To obtain an accurate population estimate, however, estimates of household size for all settlement types

across the whole area of jurisdiction are necessary. An example of average household sizes is given in Table 2 for the Durban Metropolitan Area. Note that the average formal and informal rates are weighted averages, where the weights are the proportions of African, Coloured, Indian and White dwellings respectively.

As can be seen from the example in Table 2, the formal, informal and peri-urban residential areas may have differing household sizes. In the formal areas a possible future trend towards lower household sizes has been identified, caused partly by wealthier extended families breaking up due to increased geographical mobility, and partly by declining population growth rates. The breaking up of extended families will have the effect of an increase in the demand for housing and services.

In the informal areas the findings of the Durban Metropolitan Area survey confirm a pattern identified in the early 1990s of approximately five persons per dwelling. In peri-urban areas, which are usually traditional areas and where a significant amount of agricultural activity is still in evidence, household sizes were found to be greater than in both informal and formal areas.

It is worth noting that, in the survey of the Durban Metropolitan Area, household sizes were found to be significantly lower than expected for almost all types of dwelling. This highlights the importance of conducting at least some form of investigation rather than relying on anecdotal evidence and conventional wisdom.

2.4 Setting up a database

It may be well worth a local authority's while to set up a database of local information to serve as a reliable source. The database should be updated and monitored at regular intervals. Public disclosure of the information is recommended, to allow for refinement of the population figures and community boundaries through the input of specialised local knowledge and to promote its use as a common basis for planning and policy decisions. This is of particular significance for the development of a strategic plan for spatial development in the study area, because strategic planning for the provision of services and social and engineering infrastructure can be more complementary given a common demographic and spatial base.

3. CURRENT HOUSEHOLDS

For the service provider the number of households is even more important than the number of people in its area of jurisdiction. The household is the basic building block for socio-economic analysis, as it functions as an economic unit. Simplistically, a household consists of one or more breadwinners and a number of dependants who share the income. In an uncomplicated world, each household would live in a separate dwelling unit on a separate plot, and receive and pay for the relevant service as an individual unit. The real situation is, however, far more complicated. For example, in many formal townships more than one family unit resides on a plot, either sharing the house or in backyard shacks. In informal areas it is possible that a single family unit is spread over a number of dwelling units and would share a single house if one were available. The presence of migrant workers in hostels, lodgers and live-in domestic servants further complicates the picture: for some purposes it makes sense to treat each as a separate household, but from the point of view of service provision this would not be sensible.

Data on numbers of households are generally available from the same sources as population data. Another source worth mentioning is the NELF database which is

maintained by the National Electricity Regulator (NER). Household information, however, tends to be rather dated and needs to be verified against local estimates.

If there is up-to-date information available on the numbers of households in an area, it is important to determine how these are defined. For instance, if lodgers and live-in domestic workers are recorded as individual households, the number of households will be greater and the average household size lower than if they were included as part of larger households. For the service provider it may make sense to alter original data to conform to a definition that is more sensible for the purpose of service provision; for example, lodgers and live-in domestic workers should be included as part of the households in which they reside.

If local surveys are conducted to establish population sizes by means of dwelling counts, these will probably serve as fairly good estimates of the number of households in each area. Greater accuracy would, however, be achieved by establishing how many of these units house more than one household who would separate, given the opportunity, and to what extent households in informal areas currently occupy more than one dwelling unit but would move onto a formal plot as a single unit should plots be made available. It would also be useful to know how many backyard shacks are essentially extensions of the family home. The purpose of this information is to establish the number of "functional units" within the service provider's area of jurisdiction, since it is largely with these units that the service provider must interact. The information will also be useful in projecting future growth, as discussed later in this report.

3.1 Household size

An important determinant of consumption within a household is its size: larger households will tend to use more water and produce more waste than small ones. There are, of course, economies of scale associated with the use of these services – for example, more dishes are washed with the same water and family members may share bathwater, so that water consumption is not directly proportional to household size. Household income, levels of service and climatic factors also play a major role in water consumption (see section 7). Information on household size in the different areas and types of dwellings is, nevertheless, important to a proper understanding of the current situation.

Sources of information may include:

- local surveys which, if conducted along the lines described in this report, should provide accurate and up-to-date information on household sizes;
- in the absence of survey data it would probably be worth tapping local sources of information such as clinics, schools, churches, social work offices, NGOs and civic movements within the various areas; and
- as a last resort, "typical" household sizes for different types of dwellings may be used, such as those shown in Table 2.

4. INCOME DISTRIBUTION

It is of vital importance that a service provider have a fairly accurate idea of residential income levels within its area of jurisdiction. Residential income impacts heavily on the amount of water likely to be used as well as affordability and willingness to pay. Thus current high levels of non-payment in certain areas may be due to lack of affordability. In addition, the income distribution profile of a town is important in assessing how appropriate the tariff structure is – for example, are poor households paying more for their water than better off ones? To what extent are poor households being cross-subsidised?[2]

Income levels are also critical to the planning of services provision. Firstly, where there is a backlog it is important to have a good idea of the incomes of the relevant households, as well as the capacity of other customers to provide cross-subsidies, to ensure that the services to be provided will be financially sustainable. Secondly, both housing subsidies for internal services and "top structure" and the Consolidated Municipal Infrastructure Programme (CMIP) grant for bulk and connector infrastructure are provided on the basis of income. For these reasons future income distribution also needs to be projected along with population growth, and this is dealt with in section 11 below.

Because of the link between capital subsidies and income, it is advisable for service providers to use the income categories applicable to the allocation of housing subsidies. It is also advisable to provide at least two categories for households with incomes above the subsidy cut-off level (currently R3 500 per month) due to the wide range of consumption levels within this group. Suggested income categories are given in Table 3.

Table 3. Suggested income categories

Income category
Less than R800 per month
R800 – R1 500 per month
R1 500 – R3 500 per month
R3 500 – R 5 000 per month
More than R5 000 per month

Note: All households qualifying for housing subsidies qualify for CMIP grants for bulk and connector infrastructure.

Reliable information on income distribution is currently likely to be even more difficult to find than estimates of population size or number of households. Income is recorded in the national census, and the 1996 census may be a good source when the results become available. The results of the last (1991) census are now too old to be of much value other than a first rough estimate of income among the "white", "coloured" and "Indian" populations.[3] More recent estimates of income distribution have been

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[2] The National Water Supply Regulations of February 1997 make provision for a certain degree of subsidisation of residential customers with low consumption levels. Tariff structures and cross-subsidisation are dealt with in Module 4 of this series ("Setting water tariffs").

[3] Remember that income categories would need to be adjusted for inflation. For example, at an average inflation rate of ten percent between 1991 and 1997, the category of income R500 to R800

made by various research organisations, for example a national survey conducted by the South African Labour and Development Research Unit at the University of Cape Town during 1993/4 (SALDRU, 1994). Information such as this is generally at a national or regional level, however, and can serve only as a very rough guide to income distribution in a particular local authority area.

The best source of information would be a well constructed and carefully executed local survey. However, this is unlikely to be practical for most service providers and alternative strategies need to be devised. One such would be to combine information on dwelling types with local information on typical income levels in each type and area. Such local information could be sought from the same sources as information on occupancy levels, namely schools, clinics, churches, social workers and NGOs working within the areas, as well as credit agencies such as banks, building societies and loan agencies for some areas.

Alternatively, or in addition, a rough approximation may be arrived at by using property values. The argument for this is that the developer selling the property assesses the income of the household purchasing it (or receiving it if it is fully subsidised) and the value of the property is closely related to household income. This link between household income and property value is, however, not always a good guide. There can be a mismatch where households with comparatively low incomes live in relatively high value properties, which is most likely to occur in the old BLA townships where in the past houses were allocated on administrative grounds.

5. CUSTOMER UNITS

5.1 Residential customer units

A large proportion of the service provider's interaction with the population for the purposes of residential service provision will be through households as the functional units. However, not all households provided with services interact directly with the service provider:

- Backyard shack dwellers make use of the services delivered to the plot and, from the point of view of the service provider, all households residing on the plot form a single customer unit.
- The same applies where more than one household reside in a single dwelling unit.
- Tenants in multiple dwelling units (such as blocks of flats and townhouse complexes) are often not individually metered and billed by the service provider. The body owning the complex is billed and pays the provider, and must then make its own arrangements to recover payment from the tenants. This may be in the form of water bills if individual units are measured, but is more often in the form of a monthly levy or part of the rental payment.

The term "customer unit" is used to describe the individual units to which services are delivered. A customer unit is the property or dwelling unit which is supplied with the service either directly or indirectly via intermediaries. Intermediaries are those persons or bodies who interact directly with the service provider and on-sell water, such as owners of multiple dwelling units.

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in the 1991 census would need to be adjusted to R890 to R1 420 in 1997 Rands (= 1991 prices X 110% to the power 6, rounded)

The number of residential customer units in an area is made up of the following:

- all single formal residential plots, occupied and used for residential purposes;
- all individual flats and townhouses; and
- dwellings in informal areas.

The sizes of the various residential customer units are important because of the consumption implications. Given that some customer units comprise more than one household, it may be necessary to adapt the relevant household information on household sizes. Specifically, households sharing a service should be combined to form a single customer unit. For example, if the average household size of backyard shacks is 3.5 and that of formal dwellings in a township is 4, then the combined average household size of formal plots with backyard shacks is 7.5. If 60 percent of the plots in a particular township have backyard shacks, the weighted average household size for the township would be:

$$(60\% \times 7.5) + (40\% \times 4) = 6.1$$

Strictly speaking, old-age homes, university residences, school and migrant hostels, etc are residential customer units. They range widely in size and consumption, however, and it is therefore easier to treat them as institutional customer units along with educational establishments, churches, sports clubs etc. as discussed below.

5.2 Non-residential customer units

Four types of non-residential customer unit may be identified:

- institutional customer units such as schools, clinics, hospitals, churches and day care centres;
- commercial customer units, such as shops and offices;
- "dry" industrial customer units – that is, industries not using water as part of their "core" processes; and
- "wet" industrial and service customer units – industries and services that use water in their "core" processes, such as the manufacture of beverages, fruit canning, textile dying, laundries and car washes.

The reason for identifying these different categories of non-residential customers is that the amounts of water used per employee or unit of value added will differ significantly. This means firstly that the price of water will have different effects on their costs and it may be necessary to provide differentiated tariff structures. Secondly, predicting future consumption is likely to be more accurate if the different types of non-residential customers are dealt with separately (see section 10.3 below).

When classifying these customers there are likely to be a number of ambiguous cases: for instance, should a hairdressing salon be classified as a "wet" or as a "dry" customer unit, or should a sports club be classified as an institutional or a commercial customer unit, or even a "wet" unit? These decisions need to be made at the local level, with due regard for water consumption patterns and the possible effects on economic viability of increases in the price of water. It is, however, important is that a consistent approach be adopted.

Probably the best source of information on non-residential customers is water bills, with each billed unit classified as a customer unit. It may, however, not be possible to differentiate between the different types of customers from this information. Should this be the case, information should be available from the rates account on the

numbers of institutions and "wet" industries and service establishments (once the service provider has decided which enterprises should be thus classified). These can then be subtracted from the total number of non-residential water bills issued to give an estimate of the number of commercial and "dry" industrial customer units.

An alternative approach would be to separate out "large" and "small" users, and assume that large users are "wet" industries or services. This approach is, however, problematic and may lead to inaccuracies in projections of future consumption because some "wet" customers may nevertheless be comparatively small users (such as laundries and hairdressers), while some "dry" customers may be large users (such as a large shopping mall with a single water meter).

Billing data will of course exclude (some) informal non-residential customer units, such as churches, daycare centres and perhaps some retail outlets in informal areas. These should be included even though their current consumption may be small, because they form part of the backlog of service provision. Information on the numbers and characteristics of these establishments is unlikely to be readily available, and will probably need to be estimated on the basis of local knowledge.

6. TYPES AND LEVELS OF SERVICE

Having established the number of customer units, the next step is to link these units to water and sanitation services.

6.1 Service typology

There are many different types of water and sanitation services, as shown in Table 4. The different types are generally associated with different degrees of convenience to the user, which classifies them as representing different levels of service. Generally, higher levels of service offer greater convenience and result in higher levels of consumption. For example, it is more convenient to obtain water from a yard tap than a communal standpipe, and levels of consumption per household are therefore generally higher when yard taps are provided. It is even more convenient to have water on tap inside the home, and this service is generally associated with even higher levels of consumption. In the case of sanitation, waterborne systems are more convenient to the user than on-site options but generate greater amounts of waste to be processed. Higher levels of service are usually more costly to provide and to use, and may therefore be affordable only to higher-income groups unless lower-income groups are subsidised.

Table 4 lists a number of types of water and sanitation services, along with an indication of the level of service that each provides and the income categories for which they may be acceptable. Some of these services are described as "not acceptable" for all categories, because they do not provide a level of service that ensures adequate health and safety. It is important to note that, when selecting services, the acceptability of a particular service will depend firstly on the technical possibilities in the area concerned, secondly on the willingness of customers to pay for services, and thirdly on the potential for cross-subsidisation so that higher services may be afforded by the town as a whole. In the fourth place, services cannot be properly selected unless those concerned have a good understanding of what each entails in terms of both its technical and financial characteristics. With reference to the sanitation options, on-site sanitation may not be technically appropriate in some areas due to high residential densities, soil conditions and/or a high water tables. There

would, however, appear to be disagreement over the point at which on-site options become technically unacceptable.

It is important to point out that the "level" is different to the "standard" of a service. The standard refers to the technical quality of the service concerned: the way that it is designed, built, operated and maintained. For example, a Ventilated Improved Pit (VIP) toilet may represent a basic service level, but it should nevertheless be provided to a good standard. Thus it should be comfortable to use, well built and properly operated (MIIF, 1997).

Table 4. Service typology, levels and income brackets for which services may be acceptable

Service type	*Service level*	*Income groups for which service may be acceptable*
Water supply		
Unreticulated source: well, borehole, spring or river	not acceptable in urban areas	none
Communal standpipe	basic	very low
Yard tank	basic/intermediate	very low & low
Yard tap (may be metered or unmetered)	intermediate	very low, low & medium
House connection (multiple taps, may be metered or unmetered)	high	all
Sanitation		
Unimproved pits, buckets or nothing	not acceptable	not applicable
Ventilated Improved Pit (VIP) toilets	basic	very low & low
Low Flow On Site (LOFLOS) systems, including aqua-privies	basic	very low & low
Simple waterborne sanitation (sewered), including shallow sewerage options and septic tank effluent drainage (STED) system	intermediate	very low, low & medium
Septic tanks	intermediate/high	all (in suitable areas)
Full waterborne sanitation	high	all

Note: very low = <R800 per month, low = R800-R1 500 per month, medium = R1 500-R3 500 per month, high = >R3 500 per month

6.2 Water

The water services that are appropriate for urban areas as identified in Table 4 are described below.

6.2.1 Communal standpipes

The basic level of services is a communal standpipe located within 200 meters of any dwelling in the settlement. This provides a water supply conforming with RDP standards and the White Paper of the Department of Water Affairs. While communal standpipes may be held to represent an adequate service, providing an acceptable balance between cost on the one hand and convenience and health benefits on the other, there are difficulties with providing this service:

- Most households, particularly those earning above R800 per month, want yard connections and are willing to pay for them.

- There are difficulties in getting people to pay for publicly provided communal water supplies. While there are options for retailing water from communal water points (kiosks, concessions, etc, see Module 4), these are expensive to operate and raise the cost of water considerably. They are also administratively burdensome. Prepayment metering may, however, render this option financially and administratively more acceptable (CSIR 1997).
- Communal standpipes are seen by communities to be inequitable, as those who are closer to the standpipe have a more convenient service and will tend to use more water. If a flat rate is levied some households will be paying more per kilolitre for their water than others.

For the above reasons, it is proposed that more emphasis be placed on individual connections. In some areas, however, it may not be possible to provide these to all households in a short space of time due to the cost and/or capacity constraints, and communal standpipes remain an option.

An argument can be made for not charging for water from conventional communal standpipes in a town that can afford to fully subsidise this service. The argument revolves around the expense involved in billing, the difficulties in collecting payment for what is perceived as an "unfair" service and the poverty of most of the households using these facilities. It may cost the service provider more to charge for the service (while experiencing a high level of non-payment) than simply not to charge at all, while free water from standpipes can provide a valuable form of "social security" to a town's poorest households. It will, however, be important in such circumstance to guard against abuse, such as illegal connections to nearby households and filling large containers for vending in areas not supplied with water.

A new technology currently being tested in South Africa is pre-payment water dispensers. Should these prove cost-effective they will provide a better option than conventional standpipes, because they reduce the unfairness of the system and eliminate the problems of non-payment and abuse. A number of pilot projects are currently underway, for example with Rand Water in the Winterveld and Modderspruit and in a number of other areas with the Umgeni and Magalies Water Boards.

6.2.2 Yard tanks

A typical yard tank system involves the provision of a single 200 litre tank on each plot. The tank is filled every day from the reticulation, via a manifold, by a water bailiff employed by the service provider. The water bailiff also collects payments from people at the start of the month, either in the form of cash or tokens purchased at designated outlets. A charge is levied at a fixed rate per month per tank, and more than one tank can be installed on a plot, if required. If payment is not received the connection to the tank on the plot is turned off and the tank is not refilled.

Yard tanks have been applied successfully in the Durban Metropolitan Area, offering a number of benefits:

- a simple cost recovery approach;
- transferring a substantial portion of the cost to the individual connection which makes the costing system more equitable and transparent; and
- constraining consumption to levels which people can afford.

6.2.3 Yard taps

More conventionally, a yard connection is made to a single tap on the plot. This may be a (private) standpipe or, where waterborne sanitation is provided, a tap on the wall of the toilet, perhaps with a washing facility included. There are situations where the supply is not metered and people are charged a flat rate, regardless of how much they consume. There are difficulties with this approach, however: it is inequitable, it is difficult to collect flat rate charges and it is hard to run proper water accounting systems. Therefore it is proposed that, as a matter of policy, yard connections should be metered and people should be charged based on the quantity of water used.

Where waterborne sanitation is not provided, particular attention needs to be applied to sullage disposal. Water ponding at a standpipe can cause health problems. Thus where the soil is relatively impermeable, soakaways need to be provided.

6.2.4 House connections

The highest level of water supply is a house connection with multiple taps. Metering is advisable, to allow use-related charges to be made for consumption, which is likely to be relatively high.

6.3 Sanitation

6.3.1 Ventilated Improved Pit Latrines (VIPs)

The VIP has evolved in Southern Africa over the last twenty years and is by far the most widely applied improved sanitation technology in the rural areas of the region. The system prevents contact with faeces directly and indirectly via vectors such as flies. A properly designed VIP is also odour free. It is robust, easy to build and a natural progression for rural communities, the majority of whom presently use unimproved pits latrines. VIPs may often also be appropriate in urban fringe areas where settlement densities are lower and the cost of water-reticulated options comparatively high (WRC 1993b).

6.3.2 Low flow on-site sanitation options (LOFLOS)

There are a group of technologies which fit in to this category, including the aqua-privy, recent adaptations of the aqua-privy and pour-flush systems. They are characterised by a flush volume of one litre or less with on-site soakaways of some sort (WRC 1993b). Pour-flush systems, widely used in India for example, have not been used in South Africa – the new adaptations of the aqua-privy are best known here. These do not have a good track record, not because of their concept but because they have often been badly designed and put in without proper management arrangements. There was a stage about three to five years ago where the previous provincial administrations installed thousands of "aqua-privies" where either the pedestal, tank or soakaway were under-designed (see WRC 1993c). The technology remains an option but is unlikely to be widely selected.

6.3.3 Composting systems

There are new developments in the field of composting latrines in South Africa. These have merit in that a useful by-product is produced on-site (compost). They are however comparatively costly and need evaluation, particularly to ascertain whether people will accept them.

6.3.4 Septic tanks

This is an on-site option where a normal toilet, often together with grey water from the house, flushes to a tank which discharges to a soakaway. Flush volumes are conventional (6 to 15 litres). Septic tank systems are widely used in South Africa in urban and rural areas – for example, the upper-income area of Hillcrest in Durban uses them. Reasonably large sites are necessary.

6.3.5 Simple waterborne systems

The term "simple waterborne" has been introduced mainly as a contrast with the standard which was applied previously in South Africa where sewers were laid in road reserves, at comparatively large depths, with minimum diameters of 150 mm, generous minimum gradients and 60m intervals between manholes. These sewers generally discharge to complex wastewater treatment works.

The best example of a "simple" system is the Brazilian "condominial" where people take responsibility for reticulating their own houses, laying sewers at shallow depths and with comparatively flat gradients. This is not applied in South Africa, but over recent years there have been innovations with "midblock" sewers running on individual sites at the back of the property, with 100m manhole intervals. Here depths are shallower and connections to the toilet often shorter.

The Septic Tank Effluent Drainage (STED) system could also be included in the "simple" category. This has also been called "small-bore " or "solids-free" sewerage. A septic tank (or aqua-privy tank) is needed on the site and the effluent from the tank flows to the sewer. Because the solids content in the sewer is comparatively low, the sewers can have smaller diameters and be laid to flatter grades without manholes. Also, some treatment takes place in the tank, and the load on a treatment works is therefore lower. The term "simple" is perhaps a misnomer here : not only are tanks required on the sites but a reticulated system, treatment works and sludge handling system are needed.

Finally "simple" systems can be associated with low technology treatment options, such as ponds or engineered wetlands (WRC 1993b). These are generally only suited to smaller systems, perhaps up to 20 000 people (although the city of Gaborone, which has a population in the order of 100 000, has relied on pond systems for decades).

6.3.6 Full waterborne sanitation

From a reticulation point of view this is the traditional standard described in the last subsection. Although there is not necessarily an association between reticulation and treatment technology, conventional systems would typically use biofilter or activated sludge treatment technology. The trend in South Africa is strongly towards activated sludge, as better quality can be obtained and there is now the option to remove phosphorus biologically.

6.4 Health, environmental and institutional considerations

6.4.1 Health

Substantial improvements in health conditions can result if better water and sanitation services are provided (NIEP, 1996). There is, however, evidence which suggests that the major benefit comes from the "first step": going to a basic level of service from nothing or from an inadequate level, providing the service is properly operated (Van Derslice and Briscoe, 1995). Evidence also suggests that the health impacts of water

and sanitation services are greatly enhanced by appropriate education campaigns (RSA 1996, Almedom et al, 1997). These campaigns should impart an understanding of the causes of disease and teach suitable hygienic practices. Simple measures such as washing hands after going to the toilet, and storing water in clean containers can have markedly beneficial effects. An argument can be made for making health education programmes an essential pre-requisite of water and sanitation programmes, to ensure that the maximum health benefit is derived from the provision of services.

6.4.2 Environmental impact

There are negative environmental impacts associated with greater use of water, but these are small given the amount of water which poorer people use even when they have access to water on-site. Environmental considerations should not prevent people being provided with higher levels of service for water.

The issue of environmental impact of sanitation systems is complex. It is not possible to "prove" that one type of sanitation system is better from an environmental point of view than another. There are local situations where the environmental constraints will favour certain technological solutions but there is no "right answer " globally (WRC 1993d). On-site systems can cause ground water contamination, which in turn can pose serious health problems. However, if ground water is not used for drinking purposes, then the risk to health of contamination from on-site sanitation is greatly reduced. Furthermore, it may be more cost-effective to treat the ground water for drinking purposes or import water from elsewhere than provide waterborne sanitation. Waterborne systems may also present contamination problems. For example, in the 1995/96 environmental report of Umgeni Water, the major problems with water quality in their catchment were associated with waterborne sanitation systems. This is a good catchment for study as people use both on-site and waterborne systems. Similar conclusions have been drawn for the Upper Rietspruit catchment (WRC 1993e). The bottom line is that any sanitation system that has not been properly designed and/or managed is likely to cause environmental problems.

6.4.3 Institutional requirements

The extent to which water supply arrangements are effective depends substantially on the institutional arrangements set up to manage the service. Where capacity is lacking, community relations are poor, and/or management is weak there are frequently problems with the water supply service.

With regard to management of sanitation systems there is a range of requirements relating to the technology selected. At the one extreme, full waterborne sanitation systems require a high level of management capacity, both to keep reticulation systems clear and to run treatment works. South Africa has some infamous examples of badly managed systems where the health and environmental consequences have been serious. If phosphorus removal is required, the operation of treatment works requires a high standard of operator and this cannot be assured in all cases. At the other extreme, VIP systems are simple to operate and, in rural areas particularly, can be run by communities with limited support from local government.

6.5 Identifying current services provision and service backlogs

Customer units need to be classified in terms of the services provided. The purpose of this is, first, to quantify the backlog of service provision to facilitate investment planning. Secondly, projections of future service requirements are likely to be more reliable if customer units are broken down into groups with similar characteristics

(Billings and Jones, 1996), and one of the most important characteristics is the level of service provided. Since most non-residential customers will be supplied with high levels of service, the focus here is on residential customer units. There may, however, be some institutions and businesses with lower levels of service (or none), particularly in informal areas, and where this is the case these need to be included in the backlog of service provision.

The types of services provided to residential customers are generally linked to types of housing, which in turn tend to be correlated with income levels. Table 5 shows the links between housing and services types typical in South Africa.

Table 5: Housing and associated service types typical to South African towns

Plot	*House*	*Level of service: water supply*	*Level of service: sanitation*
Formal plot	Formal: single house: value > R50 000	House connection, multiple taps	Typically waterborne sanitation, possibly septic tank
	Formal: single house: value R15 000 – 50 000	House connection (multiple taps) or yard tap	Typically waterborne sanitation, possibly bucket, septic tank or LOFLOS
	Formal: multiple dwellings, typically flats or townhouses	Typically connection to each housing unit	Typically waterborne sanitation
	Formal single house with informal "backyard shack"	Typically house connection; may be yard tap or communal	Typically waterborne sanitation, possibly bucket, septic tank or LOFLOS
	Informal: single house	Typically yard tap; may be public stand-pipe or house connection.	Waterborne, bucket or on-site sanitation
	Informal: group of houses	As above	As above
Informal	Formal: single house	Typically public standpipe (reticulated or borehole); may be yard tap or house connection.	Typically unimproved pit, may be other on-site or waterborne
	Informal: single house	Inadequate or public standpipe	Typically unimproved pit, may be other on-site
	Informal: group of houses	As above	As above

A fairly simple method of recording service provision in a town is to identify areas and record the number of residential sites/customer units within each of these having a particular type of service. An example for water provision in a fairly small town is shown in Table 6. The information required is generally available from the service authority (frequently the town engineer). In obtaining this information, it is important to bear in mind the need for agreement by all parties on the areas included and the numbers of customer units involved.

Table 6. Recording water provision by level of service (residential customer units)

Area	*In-house*	*Yard tap*	*Yard tank*	*Communal standpipe <200 m*	*Tanker service*	*None*
High income	2 000	0	0	0	0	0
Middle income	4 500	0	0	0	0	0
Old "white", low income	1 500	0	0	0	0	0
Old "coloured"	6 400	700	0	0	0	0
Ex-BLA, area 1	8 000	3 000		400	0	0
Ex-BLA, area 2	0	1 400	450	3 700	0	0
Informal 1	0	0	0	0	150	2 000
Informal 2	0	0	0	0	0	8 500
Total	**22 400**	**5 100**	**450**	**4 100**	**150**	**10 500**

7. CONSUMPTION

7.1 Water consumption

Levels of water consumption among residential customer units depend on a number of factors, the most important of which are discussed below.

a) Service levels are a major factor in determining consumption, with higher levels of service generally associated with greater consumption due to the greater convenience of use.

b) Levels of income are also strongly correlated with water use. Consumption tends to rise along with levels of income, as more water-using appliances are used, gardens become a factor and/or get bigger, swimming pools become a factor, and, depending on the tariff structure, customers become less concerned about water bills due to their decreasing proportion of household expenditure.

c) The size of a customer unit will obviously have an effect on the amount of water used. As previously mentioned, there are economies of scale within a household in the use of water, so that the consumption of a household with six people is unlikely to be double the consumption of an otherwise similar household of three. Water consumption will, nevertheless, be greater when households are larger. Where residential customer units include a main house and one or more independent dwelling (a backyard shack, for example), water consumption is likely to be high for the type of service and level of income, because some economies of scale experienced within a household will be lost, such as shared washing water.

d) The type of dwelling unit will affect the level of consumption. In particular, consumption will on average be higher for otherwise similar households living in houses rather than in flats and townhouses, because of the larger amounts used for gardens and swimming pools in the former (see Module 5, annexure 1).

e) Consumption tends to be higher when connections are not metered. Evidence from the United States of America shows that consumption drops significantly when water meters are installed (Billings and Jones, 1996).

f) In areas where water is metered but bills are not paid and payment is not enforced, consumption levels are likely to be higher.

g) To the extent that the price of water affects the amount consumed (see section 12.3), consumption levels are likely to be higher in areas where the price of water is low than in areas where they are high.

Table 7 indicates ranges of consumption levels likely to be associated with different types of service and, for in-house connections, levels of income. The ranges shown are indicative only, and are based largely on water consumption data from a number of South African towns (MIIF, 1997 Annexure 4, Malan *et al*, 1983 and WRC, 1996). The ranges are for customer units consisting of single households, and may be higher for plots with backyard shacks.

Table 7. Typical ranges of residential water consumption by service type and income level for customer units consisting of single households (kl per month)

Type of service and income level	*Consumption range (kl per month)*
In-house, high income	more than 30 kl
In-house, medium income	more than 25 kl
In-house, low income	12 – 30 kl
Yard tap – waterborne sanitation	8 – 20 kl
Yard tap – on-site sanitation	5 – 15 kl
Yard tank (for maximum of two tanks per site)	4 – 12 kl
Communal standpipe	2 – 6 kl

Note: These ranges are intended as indicative only.
Sources: Malan et al (1983), MIIF (1997) Annexure 4, WRC (1996). Also see Module 5 annexure 1.

Water consumption by non-residential customer units varies widely, and there are no "typical" ranges as for residential units. Consumption depends not only on the type of activity, but also the size of the customer unit. Most non-residential customer units are likely to be metered, however, so that consumption patterns should be available.

Actual consumption for all metered customer units should be readily available from the service provider. Consumption for unmetered connections will need to be estimated on the basis of "typical" levels, adjusted for customer unit size and in such a way that, when the amounts consumed by each individual customer unit are added up, the amount tallies with bulk estimates.

Consumption information is useful firstly in developing a good understanding of how water is currently used and, secondly, in projecting future demand. Future residential demand will depend to a significant extent on the income and service level profile of customer units, so that an adequate understanding of current consumption patterns by service type and income level is important. Furthermore, if conservation strategies are to be adopted and/or the price of water substantially increased, their effects on future demand will depend on how much is currently being consumed by whom.

7.2 Sanitation

The demand for sanitation services is closely linked to water consumption: where water is provided in-house, a waterborne sanitation system is required to remove wastewater. Some yard taps are similarly accompanied by waterborne sanitation. In

general, the more water that is used within the home the more wastewater produced, although this needs to be modified by outdoor usage. Table 8 gives an indication of the percentages of residential water used that flow into the wastewater stream when in-house water and waterborne sanitation are provided, alongside the amounts of wastewater produced.

Table 8. Wastewater from residential in-house water connections

	High income		*Middle income*		*Low income*	
	house	*flat*	*house*	*flat*	*house*	*flat*
% water to wastewater	50%	95%	65%	95%	80%	95%
wastewater (kl pm)	30	30	20	20	16	16

Source: Adapted from Module 5 annexure 1

On-site sanitation systems do not produce a wastewater flow that needs to be treated off-site. However, the service provider must have the facilities to periodically desludge the systems, and a certain amount of external treatment capacity is required to treat this sludge.

The production of wastewater from non-residential customer units depends on the nature and size of the customer. Most commercial, "dry" industrial and institutional customers without grounds probably display water:wastewater ratios similar to those of households in flats (see Table 8). When there are gardens, the proportion of water consumed flowing into the wastewater stream will probably be closer to that of a middle-income household on a suburban plot. The amounts of wastewater produced by "wet" customers will depend firstly on the amounts of water purchased and, secondly, on the water content of the final products. For example, a significant proportion of the water purchased by a plant producing soft drinks will be included in the final product, while most of the water used by a textile-dyeing factory will flow into the wastewater stream. A service provider will need to establish the nature of non-residential users in its area, with particular attention paid to large water users and "wet" customers.

An important aspect of non-residential wastewater that needs to be considered is the extent to which it is polluted. Developing an understanding of which users produce this type of waste is important both for a thorough understanding of current demand and for future planning.

8. WILLINGNESS TO PAY

8.1 The importance of assessing willingness to pay

In virtually all urban areas of South Africa there is currently a backlog of services provision, and decisions need to be made about how and when to provide the necessary services. New households are also being formed and these need to be catered for. It is important that services are provided in such a manner that the service provider remains financially viable, and the willingness of customers to pay for services is therefore of crucial importance. As noted by Rogerson (1997), one of the key reasons for the failure of water projects in developing countries is lack of understanding of the demand for the service. Assumptions are made about the percentages of household income that customers will be willing to pay for water, but these are seldom empirically verified. Incorrect assumptions can have undesirable

consequences. Firstly, households may not make (full) use of the services provided and continue to use alternative sources because the payment is regarded as too high. This can have adverse consequences in terms of both public and private health and safety. It may also result in under utilised infrastructure and therefore financial difficulties for the service provider. Secondly, households may be unwilling to pay for what they regard as an inferior service when they would be willing to pay more for greater convenience – for example they may be willing to pay for yard connections but not communal standpipes. Thirdly, if it is possible, households may make full use of the service but be unwilling to pay for it because they regard the payments as unfair. Fourthly, customers may be unwilling to pay if payment is regarded as unnecessary because there are no social, legal or technical sanctions to non-payment (PDG 1997).

8.2 Factors affecting willingness to pay

A distinction needs to be drawn between "need" and "demand". In essence, a "need" or "felt need" reflects what people would like to have. "Demand", or "effective demand" reflects what they are actually willing to pay for. The difference arises due to the problem of limited resources: households are not able to meet all their needs and must make decisions on how to allocate their resources to best advantage. There are many factors that affect a household's willingness to pay for a service; some of the most important of these are given below, as discussed in Evans (1992).

- *Level of service* – the lowest (and cheapest) level of service is not always the most marketable; for example, customers may be prepared to pay for yard taps but not communal standpipes.
- *Standard of service* – if the service is unreliable people will not be willing to pay.
- *Perceived benefits* – people will be willing to pay only if the perceived benefits are worth the cost. Agencies and communities may not have the same perceptions regarding benefits, for example health benefits. There may also be important differences within communities, particularly where some stand to gain more than others from a particular service. An understanding of customer perceptions is crucial to the successful running of water supply and sanitation services.
- *Relationship to production* – customers may be willing to pay more if the service provided can be used for revenue-generating activities such as gardening and livestock-watering.
- *Level of income* – if the charge is beyond the means of the customers they will not be able to pay;
- *Price* – people will not be willing to pay for a service if the price is regarded as too high, particularly if an alternative is available. The price must to be seen in relation to the cost of other services, such as electricity, schooling or health care, as well as levels of income. A balance needs to be struck between covering the costs of running the service and what people are willing to pay.
- *Opportunity cost of time* – the more time that is saved in collecting water and the greater the perceived value of this time, the greater will be the willingness to pay;
- *Other or existing sources* – where existing sources are considered acceptable it is unlikely that customers will be willing to pay for a new service.

- *Reputation of service agency* – that is, the credibility of the service provider, and its ability to deliver and be seen to be doing so.
- *Transparency of financial management* – this is closely linked to the reputation of an agency and is ultimately a matter of trust. Information on how the service is priced and how customers' contributions are used should be easily accessible.
- *Community cohesion* – factional conflicts within the local community may lead to a lack of co-operation from some sectors of the community.
- *Policy environment* – if people perceive that other communities are not paying for services they will be reluctant to pay; thus the policy adopted needs to be clearly formulated and communicated and consistently implemented.
- *Perception of ownership and responsibility* – people may be unwilling to pay for a service if they believe that the system belongs to an external body, such as the government. Non-acceptance of ownership and responsibility can be symptomatic of problems with the implementation of the project, inadequate consultation, or dissatisfaction with the level and type of service.
- *Institutional framework* – willingness to pay may be influenced by the perceived legitimacy and openness of the institution(s) responsible for service provision.
- *Socio-cultural factors* – such as beliefs in relation to natural and basic resources, spiritual beliefs associated with water sources, and perceptions of water quality (what constitutes good water) may influence willingness to pay.

8.3 Measuring willingness to pay

There are two basic methods of estimating willingness to pay: the indirect and the direct.

8.3.1 The indirect method

The first indirect method involves an analysis of what other customers in similar situations are paying (Evans, 1992; Rogerson, 1996). The advantages of this method are that information is drawn from actual practice and is readily available. The major disadvantage, however, relates to the fact that no two communities are exactly alike, and differences (for instance in income, perceptions and available alternatives) make it potentially misleading to draw comparisons. Furthermore, the approach is essentially "top down": decisions are being made for the community on the amounts that they will be "willing" to pay, rather than their being asked.

A second indirect approach is the use of proxy measures, such as the use of case studies of water-vending to provide indictors of willingness to pay. These studies can provide important indicators on the value which people give to water and the upper limits of their willingness to pay in term of both total amounts spent and unit costs. Where vending occurs within the community to be served this information can be of particular value. It needs to be borne in mind, however, that where alternative sources exist the poorest households may make no or only very limited use of water-vendors. Their willingness to pay will therefore not be adequately captured by water-vending studies. In addition, poor households may purchase less water from vendors than the amount regarded as the necessary for a minimum acceptable standard of health; for these households vending studies provide an indication of willingness to pay in terms of amounts spent rather than unit costs.

8.3.2 The direct method

This method is sometimes referred to as the "contingent valuation" method (Evans, 1992; Rogerson, 1996). Until the late 1980s it was generally regarded as unreliable, but with improved methodology it is now at the "cutting edge" of international research on willingness to pay (Rogerson, 1996). Essentially "contingent valuation" consists of a household survey in which interviewers pose questions in the context of a hypothetical market. It involves asking customers what they would be prepared to pay in the future for improved services. The problem with this is that often answers to direct questions are misleading because the hypothetical questions are not taken seriously, or there are perceived advantages to giving false answers. The method is thus vulnerable to bias in three basic areas:

- *Hypothetical bias* – which refers to problems the customer may have in conceptualising the questions of the interviewer.
- *Strategic bias* – the respondent may think he/she can influence the provision of services in his/her favour by not answering the questions truthfully.
- *Compliance bias* – the respondent may give answers which are influenced by his/her desire to please the interviewer.

These major sources of bias can, however, be addressed (Rogerson, 1996; Evans, 1992). Firstly, where the hypothetical service is not well known to the community information can be provided through pictures, films and discussions so that the nature of the service is clear. Secondly, it is possible to assess the magnitude of strategic bias through use of a variety of techniques. Thirdly, through careful recruitment and training of interviewers compliance biases can be minimised.

The direct method is in practice far more subtle than bluntly asking people to name a price for future water and sanitation services. A technique which has gained acceptance in recent years (Evans, 1992) is the "bidding game". There are a number of variations of this method, but all involve a process of negotiation between the respondent and the interviewer. The game involves moving up and down a range of possible prices for particular types and standards of service until a level is reached at which the respondent agrees to pay a particular price and no more. The basic form of the bidding game is to ask: "If you were required to pay X per month for a connection, would you choose to connect to the system or would you prefer to use an alternative source?" Each household is asked this question across a range of tariffs with the sequencing of bids starting at the extremes and then converging inwards; for example, if the prescribed values were R5, R10, R20, R50, R70 and R100, the order would be: R5, R100, R10, R70, R20 and R50. The bid is closed with an open-ended final bid query. From this process it is possible to get an indication of the level of demand for improved services and the relative demand for the different levels of service.

Contingent valuation surveys are labour-intensive and thus relatively expensive. However, compared to the investment required for most piped water systems the cost of the survey is likely to be relatively small considering the information acquired. An assessment of willingness to pay should be an inherent part of project planning and design, and surveys are the most effective way to do this.

8.4 Target groups for survey

Whatever method is used, it is important to direct the survey at the right people. To determine this target group it may be first necessary to find out who in the household will actually be responsible for paying the bill. Often it is assumed that "the

household" will pay, with men assumed to be the principle providers. Frequently, however, it is women who bear the responsibility for both collecting and paying for the water. Surveys that do not take this into account and target the wrong group will produce misleading results.

8.5 Community participation and partnerships in surveys

The greater the distance between the researcher and the subjects of research the greater the likelihood of misleading results. An approach in which the community is involved in not only providing answers but also in posing questions, analysing the data produced and agreeing on practical solutions is more likely to produce accurate results (Evans, 1992).

9. THE CUSTOMER-SERVICE PROVIDER INTERFACE

Establishing hypothetical willingness to pay is one thing, but effecting and maintaining this willingness is another. It was mentioned in section 8.2 above that factors such as the reputation of the service agency, accountability and perceptions of legitimacy, ownership and responsibility are likely to have an impact on willingness to pay. A recent study by Palmer Development Group focusing on the Masakhane Campaign highlights the most important factors currently of relevance in South African towns (PDG 1997). The purpose of the study was to gather information regarding the progress of the Campaign by means of case studies, and interpret the information "to ascertain factors which have an impact on the success or failure of local authorities as service providers".

Lessons from the study were divided into five main groups:

- delivery
- communications
- payments
- structures
- politics.

At the risk of over-simplification, it was found that effective service providers had established good (two-way) communication between officials, councillors and customers; that this was backed up by efficient delivery of affordable services and adequate maintenance of existing infrastructure; and that clear and accepted mechanisms were in place to penalise those who can afford to pay, but do not do so.

On the issue of communication, it was pointed out that the most valuable measures are those that create effective channels for communication flows, bearing in mind that the pre-1994 structures may be regarded with mistrust or simply be unable to deal with the issues that local authorities face from their "new" customers. Thus, for example, regular ward and community meetings may be used, and/or "complaints clerks" sent into an area instead of relying on a "complaints desk" or "hotline". It was also pointed out that community structures need to be included, in view of their standing in the eyes of the community.

The report highlights the importance of imparting to people an understanding of what the council does, what the actual costs of service provision are, and how payments are used. Participation in drawing up the budget has proved a useful method for gaining acceptance of financial and capacity constraints and the budget itself.

There is a need for communication to be backed by effective service delivery, but capacity and budget constraints limit the potential for "quick fixes". The "quick fix" approach also carries the danger of inadequate planning and the delivery of services that cannot be sustained. In delivering services two important issues were identified, namely increasing options and making a visible impact. The first refers to providing communities with full information regarding alternative services and their cost and convenience implications (see section 6 above), and then permitting them to select appropriate services. With regard to the second, there are some fairly effective and comparatively cheap measures that can be taken in the short term to improve service delivery and create confidence. For example, good operating and maintenance practices can improve service delivery significantly in previously neglected areas. In some towns very effective waste-collection services have been initiated using local labour and contractors. This use of local resources is in itself a valuable contribution, since it not only stimulates local economic development but also increases understanding of the services delivered and the visibility of the service provision process.

Before enforcing payment, the report points out that to gain people's trust a local authority must:

> show that it is capable of accounting and proper financial management. This implies that they are capable of drawing up accurate and understandable bills, delivering them to customers and ensuring there are convenient places for people to pay.

It was found that special provisions are needed for those who simply cannot afford to pay for services. These generally entail registering with the local authority for special payment dispensation, subject to verification of the household's financial status.

The case studies did not identify any organisational structures particularly well suited to effective service delivery, but came to the conclusion that a variety of structures could work. It did, however, identify the importance of motivated and competent people with vision and strategy, who are willing to take risks and make unpopular decisions where appropriate.

Local politics can disrupt local development and service delivery. For example, new political leadership might exploit people's dislike of punitive measures following non-payment and a failure to deliver on (unrealistic) election promises. The report concludes that the best weapon against this is transparency in service delivery, and openness and honesty about what can be delivered. It was found that development proceeded best in towns where development was prioritised over political affiliations.

10. PROJECTIONS OF FUTURE DEMAND

Providing water and sanitation services requires that projections be made of future demand, no matter how crude the methods used may be. The simplest method is to estimate current per capita consumption and project future demand on the basis of this and population growth:

demand in year Z = (population in year Z) x (estimated per capita consumption)

This approach assumes that the future will be much like the past except that there will be more people. In some circumstances this simplifying assumption may be acceptable, but where circumstances affecting consumption are changing the use of

this method will lead to serious forecasting errors. In South Africa this method is likely to lead to errors for the following reasons:

- The amalgamation of local authorities and the growth of informal settlements mean that the customer profile of urban service providers has changed in the recent past and will continue to do so in the future.
- The recently adopted national approach to the use of water, which involves both ensuring affordable water to all households and encouraging conservation among larger users, has far-reaching implications for tariff structures and, largely because of this, consumption patterns.

As pointed out by Billings and Jones (1996), forecasting errors can be costly. For instance, servicing the debt on an overbuilt facility can be burdensome. Customers will be required to make higher payments than would otherwise have been necessary, and the financial viability of the service provider may be jeopardised. On the other hand, underestimating the demand for water or miscalculating peak flow requirements can result in water shortages which will impose costs on customers and damage the reputation of the service provider.

10.1 Types of forecasts

Proper planning requires decisions that involve short, medium and long term projections. Table 9 shows the major applications of each of these planning horizons.

Table 9. Types of forecasts and major applications

Forecast type	*Time range*	*Application*
Short term	1 to 2 years	Operations planning and revenue forecasting
Medium term	2 to 10 years	Treatment and distribution investments, setting rates, conservation programmes
Long term	more than 7 years	Raw water supply, overall capacity decisions

Source: Billings and Jones (1996)

Forecast errors tend to increase as the forecast period increases, so that long-term forecasts are likely to be the least reliable and require periodic adjustment. The shorter the period the more easily accuracy can be achieved, and short-term forecast errors arise mainly due to the unpredictability of human behaviour and the weather. Medium-term forecasts are crucial to planning, but are difficult to make accurately because they must allow for a changing customer base, changing economic conditions, changing technology, variable weather patterns and responses to conservation campaigns and/or price increases, all of which are difficult to predict beyond a year or two.

10.2 Forecasting techniques

There are many different forecasting techniques, from very simple informal methods to sophisticated formalised ones. Most methods involve the use of per capita or per customer unit use rates. The differences lie in the extent to which changes in these use rates are predicted, and the degree of disaggregation between customers.

There are significant benefits to be derived from formalised forecasting techniques. Firstly, assumptions are made explicit and open to scrutiny. Secondly, formalised forecasts rely on actual historical data rather than beliefs, and the exercise can lead to a deeper understanding of the factors that drive current demand. Thirdly, formalised

techniques reduce the danger of forecasting capacity being lost for a significant period due to the departure of key employees.

The major techniques used are discussed below (Billings and Jones, 1996).

10.2.1 Per capita and other unit use coefficient approaches

These approaches involve predicting future demand on the basis of per unit consumption and the growth rate of the units selected. The most common form is the already discussed method of forecasting by means of per capita consumption and expected population growth. An alternative method is to disaggregate customer units into different types, establish consumption per unit and predict the growth rate of each type. The types most commonly used are residential, commercial, industrial and public (municipal) customers. This method is more accurate than the first, but assumes a substantial degree of continuity in consumption patterns within each customer type.

Another approach is to link future water use to land-use patterns. A certain rate of consumption is assigned to residential, commercial, industrial and public land respectively and future consumption is estimated on the basis of land-use plans. This approach is appropriate only where land-use patterns are strictly adhered to and the characteristics of the different customer types remain more or less unchanged.

10.2.2 End-use models

End-use forecast models predict future use on the basis of extensive detailed information of water use by customers. For example, residential use is built up from information on water used for bathing, toilet flushing, washing, etc for a "typical" family. A similar approach is possible for industrial water use. The accuracy of this type of model is likely to depend firstly on how many classes of customer units are identified (with more likely to yield greater accuracy than few), and on how changes in use per customer unit are catered for in response to variables such as price increases and conservation strategies. There is also a danger that the consumption built up for a "typical" customer unit is not, in fact, an accurate reflection of use.

10.2.3 Extrapolation

Extrapolation encompasses a wide variety of techniques such as simple time trends, exponential smoothing and other more complicated methods. Their basic assertion is that the future can be predicted on the basis of the past, and the method is valid only to the extent that the future will be like the past. In South Africa this method is likely to be inappropriate at present for the same reasons that simple projections on the basis of per capita consumption are inappropriate – namely the comparatively recent amalgamation of local authorities, the growth of informal settlements, and the recently adopted national focus on water conservation.

10.2.4 Causal/structural models

Per capita and other unit use models have been criticised for ignoring socio-economic factors, such as changes in the characteristics of customer classes and changes in the behaviour of individual customer units in response to factors such as price increases and changes in technology. A typical causal/structural model would divide customer units into a number of classes with similar characteristics and predict the future water use of each of these on the basis of growth, changes in income, responses to price increases, responses to changes in technology and other relevant factors. In a situation

where structural changes are occurring, causal/structure models are likely to provide more accurate forecasts than unit use, end use or extrapolation models.

10.3 Implementation

As a first step, rough estimates can be made, based on available information and simple calculations. Past trend and current use should be carefully studied and the major variables in future use identified. It is generally advisable to deal with the different types of customer units separately, since the factors affecting residential and non-residential consumption and municipal use differ somewhat. Projections for each category can then be made using the most appropriate technique. For example:

- For residential customers, causal/structural models are likely to be the most appropriate, since changes in the profile of this group in terms of income levels, service levels and consumption patterns need to be taken into account.
- For institutional, commercial and "dry" industrial customers, the consumption unit use approach may be adequate. Past consumption will need to be established and projections made of business growth. If there are likely to be significant changes, however, for example in the price of the service or the composition of the group, it will be necessary to allow for responses to these.
- The unit use approach may be appropriate for "wet" customers, as long as the structure of this sector remains stable in terms of both composition and consumption. If there are a limited number of large users in the area, it may be well worth while to establish what their future plans are in terms of both growth and the use of water in their production processes.
- Municipal use may be projected simply on a per capita basis. However, the impact of water conservation measures and/or a changing customer profile may need to be taken into account.

One of the key decisions to be made is the extent to which data should be disaggregated (Billings and Jones, 1996). On the one hand, the *principle of composition* applies: disaggregation adds precision by separating out customers with similar characteristics. Future demand can be more accurately predicted by dealing separately with each group. On the other hand, the *principle of noise* needs to be considered: the smaller the group the more likely there are to be forecasting errors because of the random element in human behaviour. The trick is, then, to identify the balance between these principles. As Billings and Jones point out, however, greater accuracy is likely to be achieved by dealing with smaller groups with similar characteristics rather than large groups with marked dissimilarities.

The next step is to formalise the calculations in such a way that they can be scrutinised, revised and repeated in later years. This may be done either by developing a model or by making use of one already developed for the purpose.[4]

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[4] Two such models have been developed by Palmer Development Group. The first, developed with the assistance of the Water Research Commission and Durban Water and Waste, includes both water and sanitation services. The second is a more recent and more detailed model for water supply only.

11. PROJECTING THE NUMBER OF CUSTOMER UNITS

Projecting consumption involves two key variables, namely the future number of customer units and the consumption per unit. Customer unit growth in turn depends primarily on two (interrelated) factors, namely population growth and economic growth.

11.1 Population growth

Population growth is a function of the birth and death rates in the area concerned, modified by migration into and out of the area. In estimating population growth a number of approaches are possible.

11.1.1 Extrapolation

If records of past growth are available, these may be projected into the future (the extrapolation method). However, for South African towns this method may be misleading due to the "unnatural" patterns of urbanisation in the past (see Giliomee and Schlemmer, 1985). The elimination of influx control, combined with capital intensification in the agricultural sector, led to very rapid growth in many towns in the old "white" South Africa during the latter half of the 1980s and the early 1990s. Projecting this rate of growth into the future is likely to lead to overestimates of population growth. On the other hand, growth rates during the 1960s and 1970s were artificially low in most "white" South African towns and artificially high elsewhere.

11.1.2 Using existing national or other estimates

A second method involves using projected population growth rates for all South African urban areas, by province or for towns of a similar size to the one in question. Such estimates are available from the Development Bank of Southern Africa, the Centre for Development Enterprise, and the Demographic Information Bureau for example. This approach is preferable to the first, but may miss important local factors such as proximity to a border or the closing down of a mine.

11.1.3 Constructing a local rate

A third approach is to construct a growth rate that takes local circumstances into consideration. The first step would be to divide the population into groups with similar socio-economic characteristics and to estimate birth and death rates for each of these, probably with reference to appropriate national rates such as those available from the Development Bank of Southern Africa. The rate of population growth before migration can then be calculated for the town.

The next step would be to estimate the extent of in- and out- migration. This is likely to be more difficult, and requires consideration of factors that may attract people to the area, and factors that may encourage people to leave. The economic growth rate of the town in relation to the growth rate in surrounding areas is likely to be of importance here, with people likely to be attracted to areas of greater (perceived) economic opportunity. "Push" factors in operation in surrounding areas also need to be considered, such as structural changes in agriculture and on-going violence.

11.2 Household and residential customer growth

The household growth rate will be the same as the population growth rate if the average size of households remains unchanged. An increase in average household size will result in a household growth rate below that of the population, while a reduction

in average household size will have the opposite effect. If there are reasons to believe that the average size of households will change significantly in the forecast period, then the household growth rate should take this into account. For example, housing shortages may mean that there are large numbers of extended families living together which are likely to separate as more housing becomes available. The household growth rate will then exceed the population growth rate. Conversely, if growth is expected to be concentrated in groups with larger families, the household growth rate will be below the population growth rate.

The rate of growth of residential customer units is likely to be similar to household growth except in areas with high concentrations of backyard shacks. Where backyard shacks exist due to housing shortages, it is possible that the number will be reduced over the years as more housing becomes available. For each backyard shack that is replaced by an independent site a new customer unit is formed. This source of customer unit growth can be fairly substantial in towns with high proportions of backyard shacks, and must be taken into account.

Another potential source of discrepancy between household and customer unit growth lies in the transition from informal to formal settlements. For example, two or more units currently identified as separate customer units in an informal settlement may jointly occupy a single formal site. Some may become backyard shack dwellers while others join to form an extended family unit. It will probably be fairly difficult to predict this type of effect, and in the absence of information to the contrary it is probably safest to assume that each dwelling in an informal settlement will form a separate customer unit when formal sites are provided to replace informal settlements.

12. PROJECTING ECONOMIC GROWTH AND INCOME DISTRIBUTION

The local economy impacts on consumption in three important ways:

- Comparatively strong economies tend to attract new people, and this directly creates new customer units.
- Growing local economies are associated with greater commercial and industrial activity. This generally translates into greater demand for water and sanitation services by these categories of customers.
- A growing economy is likely to mean increased household income for at least some residents. This, in turn, allows the benefiting households to consume more. Both the rate of growth and the distribution of its benefits will therefore have an impact on the demand for services.

Poor economic performance will mean little growth, or even a decline, in the demand for services from non-residential customers, and may also result in a slow or negative population growth. Depending on conditions in surrounding areas and the mobility of the population, however, poor economic performance may be accompanied by a slow or negative growth in the number of wealthier households but a growing number of poor households. The consequences for the area will be serious, particularly if services are provided that poorer customer units cannot afford to pay for: while the number of customer units requiring cross-subsidisation increases, the ability of the local economy to provide these decreases. In planning for the provision of new residential infrastructure, the relative rates of economic and customer unit growth therefore need to be carefully considered.

The nature of economic growth also has important implications for future residential consumption and the affordability of the services provided. Growth that is concentrated in capital-intensive industries, and/or requires primarily high level skills, will mean relatively few additional employment opportunities for unskilled labour. This means that relatively few poor households will benefit, and the effect of growth will be more to raise the number and/or average incomes of better-off households than to decrease poverty. Growth that involves comparatively large numbers of people with no or less sophisticated skills, on the other hand, will increase the incomes of a larger number of relatively poor households.

12.1 Estimating economic growth

Local economic growth is not easy to estimate, but the following process can be followed:

Step 1: Find historic trends in economic growth for the magisterial district concerned, based on Gross Geographic Product (GGP) figures. This information is readily available from Central Statistical Services or the Development Bank of Southern Africa. The figures in real terms (that is, adjusted for inflation) need to be used.

Step 2: Find indicators of economic growth for the specific area, such as the growth in electricity consumption by non-residential customers and changes in metropolitan or district council income from levies.

Step 3: Relate these figures to the growth in Gross Domestic Product (GDP) for the country as a whole to determine how the economy in the service area has grown in the past in relation to the national economy. This could also be done for the province in which the area falls.

Step 4: Establish the availability of land for the development of new industry and business, since this is a prerequisite for expansion. Planning guides such as Structure Plans should be consulted.

Step 5: Assess the extent to which local economic conditions are likely to change, with reference to both the business cycle and structural changes. For example, approach major local businesses and/or business organisations to ascertain production and expansion plans and likely new investments. There may be well advanced plans for establishing large industries in the area, and/or a programme of small businesses development. The impact on the economy can be assessed by comparing the size of the product (value added) which the activities will generate to that of existing value added.

Step 6: In order to project growth for a period of longer than two-to-three years, the multiplier effects and potential linkages of investment/expansion plans need to be investigated. For example, if a new holiday resort is to be built, will local contractors be employed? Will the local retail industry be in a position to meet the demand from new holiday makers or will these benefits be felt in an adjacent (larger) town? To what extent might small business, such as home-baking, curio manufacture or vehicle repairs be stimulated? Also, if the area is part of one of the government's Strategic Development Initiatives (SDIs) it can perhaps be assumed that economic growth will accelerate within a year or so.

Step 7: Find economic growth projections for the economy as a whole, urban and rural areas, provinces and any others that may be available. Projections are made by the Department of Finance,[5] the South African Reserve Bank, private economic

[5] Projections are contained in the policy document "Growth, Employment and Redistribution" (GEAR).

consultants, private financial institutions, and international organisations such as the World Bank. Estimates may differ widely and are always based on a number of assumptions that are open to criticism. They will nevertheless provide some idea of the expected performance of the wider economy and serve as benchmarks against which to assess projections of local economic growth.

Step 8: On the basis of historical trends, changes in local conditions and projections for the wider economy, predict economic growth rates for perhaps two-to-five-year periods. The further into the future projections are made the greater the uncertainty, but planning for service provision demands a longer time horizon than three years, and economic growth needs to be factored in. It is preferable that the assumed economic performance of the area be explicitly stated rather than implicit in the projections of demand for services.

Step 9: Remember that municipal rates and taxes can have an impact on economic growth. Firstly, discretionary expenditure by residential customers on other goods and services will be reduced by increases in municipal payments, which will affect the level of demand. Secondly, marginal business may be rendered insolvent by steep increases. Thirdly, increases may affect the location of new businesses, or even stimulate existing establishments to relocate to areas with lower rates and taxes.

12.2 Estimating income distribution

Future income distribution depends on the relative rates of economic and population growth, combined with the distributive nature of that growth. Other redistributive measures taken locally or nationally also need to be taken into account, such as state pensions, child care grants, and employment in public works programmes. Predicting future income distribution is a complicated and imprecise process. However, as in the case of economic growth, projections of demand involve assumptions about future income distribution, and it is best that these be made explicit.

The simplest assumption to make is that income distribution will remain unchanged over the forecast period. If predicted economic and residential customer unit growth rates are similar, this is probably a fairly realistic assumption. Since rapid economic growth is likely to attract more people to the area, it is unlikely that economic growth will greatly exceed customer unit growth for a prolonged period unless this is a national phenomenon. On the other hand, very poor performance may see an exodus of households. Without well substantiated reason to believe the contrary, an assumption of unchanged income distribution is therefore probably the safest.

13. PROJECTING CONSUMPTION PER CUSTOMER UNIT

Once the number of customer units has been estimated, the average consumption per unit in each category of customers needs to be projected. The first task is to decide on the categories of customer units. It is recommended that residential customers be separated by level of service and income, both of which affect levels of consumption. Since lower levels of service are likely to be linked to particular income categories, only customer units with high levels of service need to be subdivided into income categories.

Non-residential customer units also need to be categorised according to consumption characteristics. Table 10 provides examples of categories for residential and non-residential customer units.

Table 10. Suggested categories of customer units

Residential customer units		*Non-residential customer units*
Water	***Sanitation***	***Water and sanitation***
1. None/inadequate	1. Bucket, unimproved pit, chemical, none	1. All non-residential, inadequate service
2. Communal standpipes	2. Ventilated improved pit	2. Institutional
3. Yard tanks	3. LOFLOS	3. Commercial and "dry" industrial
4. Yard taps	4. Simple waterborne	4. "Wet" industrial
5. In-house: income <R3 500 pm	5. Full waterborne: income <R3 500 pm	
6. In-house: income R3 500-R 5 000 pm	6. Full waterborne: income R3 500-R5 000 pm	
7. In-house: income >R5 000 pm	7. Full waterborne: income >R5 000 pm	

13.1 Levels/types of service

Future levels/types of service need to be established in order to project future consumption. An investment programme therefore needs to be decided upon that will provide for new customer units and meet targets in terms of making up the backlog. In deciding on an investment programme, levels of income and customer willingness to pay need to be taken into account. In particular, the affordability of the proposed programme to the area concerned, allowing for an appropriate degree of cross-subsidisation, needs to be carefully considered. In general, the poorer the area the less cross-subsidisation possible and the more closely service levels need to be linked to what households are willing to pay for services.

13.2 Income levels and distribution

The demand for services tends to increase with the income of a household. Rising income means more money to spend on services and less concern about the amounts to be paid, greater use of water-using equipment such as washing machines, more gardens and more swimming pools. If income levels in an area increase, then one would expect average levels of consumption to increase accordingly. The extent of this increase will depend on whose incomes have risen, since increases in demand per customer unit tend to be proportionately greater at lower levels of income. Future consumption will also depend on whether increases in income are accompanied by an upgrading of services to higher levels. Falling average incomes will have an effect on consumption by increasing the proportion of low-income (and presumably low-consumption) customer units. Average consumption within each category may also decline, if, for example, there is a rising proportion of destitute households.

13.3 Responses to changes in the price of the service[6]

If services are charged for in such a way that increases in consumption result in increases in monthly bills, there is potential for consumption to change in response to changes in the price of the service offered. Thus where water is metered and charged for according to the amount consumed, consumption patterns may be influenced by

[6] This section draws heavily on Billings and Jones (1996).

changes in price. There are a number of basic tariff structures. For water the most common are:

- fixed monthly rates (for unmetered consumption);
- a fixed monthly charge and a consumption charge; the consumption charge may increase, decrease or remain constant as the amount consumed increases – these are respectively referred to as increasing, decreasing and constant block rate schedules;
- a fixed monthly charge and a consumption charge for water used exceeding a certain amount; and
- consumption charges only (increasing, decreasing or constant block-rate schedules).

The most commonly used structures for a waterborne sanitation service are:

- a fixed monthly charge, often linked to the value of the property or an estimate of the volume of wastewater to be treated; and
- a percentage of the water bill.

Since wastewater flows are not metered, it is not possible to charge amounts for waterborne systems directly linked to wastewater production. For on-site sanitation systems (such as septic tanks, VIPS and LOFLOS options) there is usually a set fee per month or per load for removal of the sludge.

When water is charged for on a block rate system, there is generally a tendency for consumption to decrease as the price of water increases and *vice versa*. In economic terms, water consumption is price-elastic. The price-elasticity of demand is a measure of the responsiveness of demand to changes in price, and is calculated as follows:

price elasticity of demand = (% change in demand) / (% change in price)

The degree of responsiveness depends on a number of factors, the first being the tariff increase in relation to the expected rate of inflation: only if customers perceive the increase to be above the inflation rate will they respond by reducing demand. It is thus the perceived *real* increase that is of importance. The second factor is the extent of the increase: dramatic increases are more likely to prompt water-saving changes in behaviour than small changes, since the potential effects on monthly bills of the former are more significant. Thirdly, the response will vary between residential customer units depending on income levels: the higher the level of income the smaller the share of household expenditure on water and the less significant the saving becomes to the household. Fourth, if an increase in tariffs forms part of a water conservation campaign and is accompanied by a publicity campaign and other measures (see box 1 and 13.6 below) the response is likely to be greater than if tariffs are increased on their own.

In estimating the effects of an increase in the price of water, the time scale is important. In the short term, water savings can be made by reducing certain forms of use such as garden-watering and washing pavements and cars. In the longer term, new appliances may be purchased that use less water than older models (such as dishwashers and washing machines), water-saving devices may be installed (low-flow shower heads, drip irrigation systems and dual flush toilets, for example), and new buildings may include fixtures that use less water. In industry, new technologies may be adopted that result in less water used per unit of output. It is also possible that

short-term savings will be short-lived if the price increases are fairly modest: after the shock of the initial price increase has worn off, the "hassle factor" of changed behaviour may outweigh the value to the household of the financial savings.

Box 1 ***CASE STUDY***

A live "case study" of the combined effects of steep increases in tariffs and the initiation of a water conservation campaign is currently in progress in Hermanus. The tariff increases were effected by the introduction of a rapidly rising block-rate schedule. Early indications suggest a 25 percent saving in water used for the first four months of the campaign, which has been ascribed largely to the steep tariff increases (personal communication with town engineer). It will be interesting to follow the permanence of these savings – as the "shock" wears off on the one hand, but on the other as new water-saving devices and technologies can be introduced (see 13.6 below, DWAF 1997 and Urban Management, Vol. 28 nos. 4&5).

Projections of the demand for water and, by implication, sanitation services should allow for changes due to changes in the price of water. Failure to do this will have the effect of overestimating both the amount of the service to be provided and the revenue received. Projecting these changes is, however, no simple matter – partly for technical reasons, but mainly because it is very difficult to predict human behaviour. The "technical" problem may be illustrated as follows:

> Assume a new tariff structure is introduced that increases the price of 20 kl of water per month by 20 percent and of 50 kl of water per month by 200 percent. Using a price elasticity of demand of -0.3 (-30%) the prediction is that a customer using 20 kl per month will reduce this by 6 percent (30% x 20%) to 18.8 kl per month. On the other hand a customer using 50 kl per month is predicted to reduce consumption by 60 percent to 20 kl per month.

A six percent reduction may be realistic, but a 60 percent reduction is clearly not. The problem is that specific elasticities are valid only for very small changes in price.

For large price changes the concept of price-elasticity can be used by calculating a series of responses to small increases. This will, however, be fairly complicated. When tariff structures are to be changed and/or the price of water dramatically increased for at least some users, as a first round estimate it may be adequate to predict saving per customer unit simply on the basis of predicted amounts saved per month for the different categories.

When price increases are large, their effects on real income and therefore economic growth potential need to be taken into consideration. As discussed in section 12.1, large increases may reduce the discretionary expenditure of households thus reducing their demand for other good and services. This effect will however be minimised by the introduction of a tariff structure that penalises "luxury" consumption only, since this expenditure is discretionary and, for high income households, payment for water is only a small component of the household budget. Steep increase in the price of water for non-residential customers may cause some marginal businesses to go insolvent. It may also affect the location of new business developments, although this is likely to be of importance mostly to "wet" industries.

13.4 Metering programmes

Evidence suggests that water consumption is significantly lower when the service is metered, compared to an unmetered supply (Billings and Jones, 1996). The effects on

consumption of programmes to install water meters therefore need to be taken into account. Enforcing payment in areas where this is currently not the case and non-payment levels are high may also have an effect on consumption. Both enforcement programmes and potential effects on consumption should be considered.

13.5 Changes in technology and customer preferences

There has for many years been an international trend towards developing domestic devices and industrial equipment that use less water. A developing country like South Africa imports technology, and this trend is therefore evident here as well. Replacing old equipment may, therefore, have the coincidental effect of reducing water use by the customer units involved. Increases in the price of water are likely to reinforce this trend.

Where there are large industrial water users in the area, it may be worth approaching them to establish whether there are any plans for installing new equipment or adopting new processes that use water more efficiently. Should this be the case, the potential effects on the effluent flow should also be investigated.

Demand projections should also take into consideration changes in customer "tastes" that affect water consumption. For example, if saunas and lawns, requiring large amounts of water, become fashionable among the wealthy, the additional water used should be taken into consideration.

13.6 Conservation programmes

Projections need to include the possible effects of water conservation programmes. There is comparatively little recorded experience to draw on in attempting to make these predictions (Billings and Jones, 1996). A few points may, however, be usefully made:

- Conservation campaigns are likely to be more successful if they are multifaceted – for example, publicity campaigns, tariff increases and retrofit programmes.
- Responses may be short-lived as people slowly revert back to "normal" behaviour. This response is typical to drought-related conservation measures, and may occur if the campaign is perceived as an emergency measure.
- Reverting back to pre-campaign consumption patterns is less likely to occur when water prices and the pricing structure are such that high levels of consumption are penalised.
- Other permanent measures can also reduce slippage, such as building regulations that require new structures to be fitted with water-saving devices.
- Non-residential users may be able to respond only with a time lapse, when they need to replace equipment and can install more water-efficient devices.

The Hermanus "case study" referred to in box 1 may in the years to come provide very useful information on the long-term effects of water conservation campaigns. This campaign involves a 12-point plan including the introduction of a steeply rising block tariff (including a "lifeline" tariff), an assurance of supply tariff, the clearing of alien vegetation, school water audits, water loss management, a retrofit programme, water-wise gardening, water-wise food production, the introduction of pre-paid water and electricity meters, a communication programme, informative billing and the passing of by-laws to enforce certain measures in the National Water Regulations such as restriction on the watering of gardens and control over the design of new

developments (DWAF 1997). The campaign was introduced in 1996, and it is envisaged that the full programme will be implemented within 3 years.

13.7 Weather and climate

The amount of water consumed and the peak flow factors in an area are fundamentally influenced by climate and, in the short term, the weather. These factors will be automatically included in projections if future consumption per customer unit is based on historical trends of a representative nature. Three qualifications however need to be made.

- If the historical data being used to estimate current usage are drawn from an unusually hot, cold, dry or wet period, predictions of future use must be adjusted to reflect a more "normal" weather pattern.
- For areas with highly variable weather patterns it may be sensible to provide alternative scenarios that depend on temperature and rainfall, particularly for short-term forecasts.
- If very long-range forecasts are being made, the forecaster may wish to include changes in climate due to global warming – although this phenomenon is fraught with uncertainly and the best way to take account of the effect is probably by modelling different scenarios.

14. CONCLUSION

The effective provision of water and sanitation services requires a thorough understanding of the current situation and well informed projections of future requirements. In essence, two pieces of information are required for each year: firstly the number of customer units; and, secondly, the demand of each unit for the services.

Since each individual unit cannot be treated separately, it is necessary to define groups of customers with similar characteristics. Two major groups may be identified, namely residential and non-residential customers. These should then be further subdivided on the basis of consumption patterns. It is recommended that residential customer units be classified in terms of levels of service and income, while non-residential customers be functionally classified according to their status as institutions, "dry" or "wet" industries. Public, or municipal consumption must also be taken into account.

The number of residential customer units depends on the population size and the way people are organised into functional units consuming and paying for the services – hence "customer units". The number of non-residential customer units depends on the size and nature of the local economy. Future planning therefore requires, first and foremost, projections of residential customer units and local economic growth.

Consumption per unit depends on a number of factors. For residential customer units the most important of these are levels of service and income levels. Non-residential consumption is far more variable than residential and depends on both the size and the nature of the customer unit concerned.

In order to project future consumption a number of variables need to be taken into consideration. First and foremost, the number and composition of customers needs to be predicted. Changes in income levels and distribution, investment programmes providing new services and the nature of business expansion (or contraction) are therefore of central concern.

Changes in consumption per customer unit then need to be considered. These changes may be induced by changes in the price of water, changes in technology, changes in "tastes" and water conservation measures. Climate and weather exert a significant influence on consumption patterns, and need to be taken into account when interpreting historical data and when projecting demand.

The bottom line of any water and sanitation service is the need to cover costs. The willingness of customers to pay for the services provided is therefore of critical concern. Given the high costs of most reticulated water and sanitation systems and the wide differences in income levels, perceptions and priorities in South Africa, it would be well worth a service provider's while to establish what services its potential customers are willing to pay for. Many a project has failed in developing countries due to the failure to properly ascertain customer demand. This is not to say that households should not be provide with services if they can afford nothing, or only very little: health and moral considerations demand that a certain minimum standard be provided to ensure an acceptable level of health and safety and it is the responsibility of the service provider to ensure this provision. But service providers should not presume to know what customers want, because this can result in costly mistakes.

Demand can be projected for different time periods, and short-, medium- and long-term projections are required for different aspects of planning for the provision of services. Any planning involves projections, no matter how simplistic. Formalising and systematising the process has significant advantages in terms of accuracy, transparency, and continuity.

To conclude, in order to ensure that all the residents of South African are provided with adequate water and sanitation services in as short a time as possible, it is critically important that services are provided effectively, efficiently and in such a manner that they are financially sustainable. In order to do this, proper planning is essential. Proper planning in turn requires a thorough understanding of the current customer profile and well considered projections of future demand.

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WATER RESEARCH COMMISSION

Management guidelines for water service providers (urban)

Module 4

SETTING WATER TARIFFS

January 1998

PALMER DEVELOPMENT GROUP

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PREFACE

This module forms part of the series "Management guidelines for water service providers". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

Executive summary: Introduction to urban services management

Module 1: An introduction to organisational arrangements for water service providers

Module 2: . Preparation of a water services development plan

Module 3: Customer profile and demand for services

Module 4: Setting water tariffs

Module 5: Setting sanitation tariffs

Module 6: Reporting procedures for water services

Module 7: Reporting procedures for sanitation services

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Project team

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1. Introduction

1.1 Context

The water sector in South Africa is in the process of significant change that reflects both the new democratic dispensation and the growing concern about water resources. The Department of Water Affairs and Forestry (DWAF) has been active in producing policy which is reflected in its White Papers of 1994 and 1997 (DWAF, 1994; 1997), the National Water Supply Regulations of 1997 (DWAF, 1997a) and the proposed Water Services Bill (RSA, 1997b). These policy and legislative initiatives have direct implications for tariff-setting at the local authority level. For example, the proposed Water Services Bill states that "no water service institution may use a tariff which is substantially different from any prescribed norms and standards" (Chapter II, 10. 4). Prescribed norms and standards for residential water tariffs are set out in the National Water Supply Regulations of 1997 (henceforth "Regulations").

1.2 Aims

This module, which has been written specifically with DWAF policy and the Regulations in mind, aims to provide a set of guidelines for water service providers at the municipal (i.e third tier) level. The intention is to assist them in establishing an appropriate tariff structure and determining the tariff levels for the retail of water within their area of supply. Broad guidelines are provided on how to go about setting tariffs that comply with the Regulations and meet the threefold purpose of:

- promoting affordable access
- meeting revenue requirements, and
- promoting the efficient use and conservation of water.

1.3 Scope

The focus of the guidelines is on residential tariff structures, reflecting the emphasis of the recent national policy initiatives of DWAF. Little detailed policy and research work has been undertaken in South Africa in recent years on the determination of appropriate tariff structures and levels for non-residential customers. Hence only preliminary comments pertaining to these are made in this guideline.

Tariffs at the municipal level are the focus of the discussion. The relationship between first, second and third tier providers is not considered, where the *first tier* refers to nationally owned and operated dams and irrigation schemes, *second tier* to regional distributors such as water boards and *third tier* to municipal level distributors. There are a number of important issues between the tiers that need to be dealt with regarding the pricing of bulk water and the allocation of surplus finance. However there is little clarity as to how these matters are to be dealt with and it is beyond the scope of this guideline to deal with them.

1.4 Outline

The report is structured in the following way:

- *Concepts.* The following issues and concepts which directly inform the process of tariff determination are discussed: (1) who should pay for water and why? (2)

equity (fairness); (3) financial viability and subsidies; and (4) efficient use and conservation.

- *Principles.* A set of principles for the establishment of tariffs is proposed, based on an interpretation of national water policy in its current form.
- *Tariff structures.* An outline of possible tariff structures related to different types of water service is given, setting out the basic rationale and the advantages and disadvantages of each.
- *Cost classification and allocation.* The Regulations require that tariff levels are related to the actual costs of service provision. This section outlines and discusses the relative merits of different methods of determining and allocating costs. One method of allocating costs is discussed in detail in Annexure 1.
- *Present tariff policy in South Africa.* An interpretation of present policy is presented and discussed. An alternative interpretation based on a different method of cost allocation is also given and the implications discussed.
- *Guidelines for setting tariffs.* Based on the foregoing discussion, recommended guidelines for setting tariffs are given.
- *Affordability, willingness to pay and enforcement.* The guidelines end with a discussion of issues, a proper understanding of which is essential to the success of any tariff strategy.

2. CONCEPTS

2.1 Who should pay for water?

In the terminology used by economists, water is both a "public" and "private" good or commodity.[1] The "public" nature of water means that a portion of both the benefits and costs associated with the use and/or misuse of water have impacts on a community or society as a whole. For example, the provision of adequate supplies of potable water to all households in an area has public health benefits which go beyond the benefits to the individual households supplied with water. The "private" nature of water means that a portion of the benefits and costs are directly related to the individual use of water.

The implications of this for water-pricing are, broadly speaking, that part of the costs should be borne by society as a whole through some form of tax-transfer process, and part should be borne by customers themselves. This logic is in keeping with the current policy of subsidising the capital cost of water services for poor households and for implementing "life-line" tariffs (see section 6). The current policy is also guided by a desire to alleviate poverty and effect a redistribution of income.

Finding the appropriate balance between public (taxes) and private (customer tariffs) funding of water supply systems is one of the key challenges of developing an appropriate water tariff policy. The balance depends not only on perceived public benefits relative to private benefits of service provision, but also on society's desire to alleviate poverty and effect a redistribution of income.

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[1] The interpretation of the terms "public" and "private" used here do not follow the strict definitions used in economics, but are intended to convey a more general meaning which incorporates the concept of externalities arising from the differences between private and public costs and benefits.

The relative weight placed on public and private sources of revenue for the water supply system will largely depend on society's understanding of the concept of fairness.

2.2 Fairness

Few would dispute the notion that a tariff structure must be fair. However, there is often disagreement concerning the meaning of "fairness" in practice. There are two separate but related notions of fairness:

a) *"Horizontal fairness"*: each individual in the same circumstance must be treated in the same way. According to this view, customers who receive the same service should pay the same amount for the service. For example, a household in Soweto with a house connection using 25 kl of water per month should pay the same monthly charge as a household in Sandton using an equal amount of water. The notion of horizontal fairness is sometimes used to argue that all households should pay the full cost of service provision, as this is the only charging structure which would guarantee complete horizontal fairness.

b) *"Vertical fairness"* or *equity*: it is fair to treat households with different incomes or wealth differently where the existing distribution of income in society is highly unequal, since a highly unequal distribution of income is unfair. This notion underlies, for example, a progressive income tax system in which households with a higher income pay proportionately more income tax than poorer ones. The argument may also be applied to water tariffs, by saying that it is fair to structure tariffs in such a way that poor households (who tend to be small users) pay less per kilolitre of water used than rich ones.

South Africa is characterised by a highly unequal distribution of income and it is therefore important that both notions of fairness are addressed in a water tariff policy. The new policies of DWAF place a strong emphasis on equity, and water service providers will be required to reflect this emphasis in the development of local tariff structures and in the setting of tariffs.

The concept of (vertical) equity supports the assertion that a portion of water should be provided free, or at a subsidised rate, to poor households. The approach adopted by the Department, as expressed in the Regulations, is that tariffs should be set in such a way that (poor) customers using a small amount of water make contributions towards the direct operating costs of service provision only, while (wealthier) customers using larger amounts of water bear the full burden of capital charges and contributions to funds to make provision for expansion of the capacity in the future. (An alternative approach might be to link payments more directly to affordability and/or willingness to pay and subsidise the provision of water to poor households. The cost of the subsidies could be covered through payments by wealthier customers or by means of inter-government grants.)

Within the context of national policy, the weight of emphasis placed on the respective notions of fairness will be determined ultimately by the local water service provider. The governance structure of the service provider together with the nature of its relationship with its customers (both the served and unserved in its area of supply) will influence the final outcome.

It is important that all parties concerned understand and agree on the notion of "fairness" used in setting tariffs. Perceptions of unfairness will lead to disaffection

and may result in resistance to payment which may in turn jeopardise the financial viability of the service provider.

2.3 Financial viability and subsidies

Long-term financial viability of the service provider is an essential prerequisite for the sustainable provision of water services to customers. The precondition for financial viability is that operating revenues exceed operating expenditure by a margin sufficient to allow for the payment of capital charges (i.e. interest and redemption on loans). Operating revenues include recurrent subsidies received, and the greater the proportion of capital expenditure financed by means of capital subsidies, the smaller will be the capital charges. Ideally, provision should also be made for future asset replacement as well as capital investment in new capacity by contributing to funds. Using savings to finance capital expenditure will reduce capital charges in later years.

Although financial viability of water service providers does not imply that all costs are fully paid for by customers, it is government policy that water service providers should be financially self-reliant within a clearly defined and constrained subsidy environment.

The national subsidy environment is described in Section 6.1.

2.4 Efficient use and conservation

South Africa is a water-scarce country and it is becoming significantly more costly to develop new water sources to meet additional demand. In this context, competition for the use of existing water resources will increase, with a consequent impact on the price of water. Greater efficiency in the way in which water is used and water conservation will become more important in the future. The proposed new National Water Tariff Policy seeks to anticipate these changes (DWAF, 1997).

The Water Tariff Policy concentrates on the first (national) tier, proposing a new tariff schedules for (untreated) water from government water schemes and introducing a water resource cost (the cost of the water itself over and above the infrastructure cost) which reflects the relative scarcity of water on a water catchment or system basis. The direct impact of these policies on third-tier (municipal) water service providers will be higher bulk water prices. The possiblity of providing first tier water free of charge for essential human consumption has however also been raised, which should soften the impact of conservation pricing on bulk water prices, particularly for service providers in poorer areas.[2]

In addition to the direct impact of changes in the first-tier water tariff, third tier water service providers will be required to implement third-tier tariffs which encourage water conservation and greater efficiency in water use.

3. TARIFF POLICY PRINCIPLES

The South African Constitution and the National Water Tariff Policy Review (DWAF, 1997) provide the basic principles governing national policy on water tariffs at the third tier. The following is a summary of these principles:

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[2] There is however as yet no clarity regarding the mechanism through which the differentiated price for water from national schemes is to be passed down to third tier providers.

- *Governance and the policy process.* The National Water Services Bill, National Water Supply Regulations and related guidelines will control pricing at the second and third tiers in a way which is consistent with national water policy.
- *Water is a social as well as an economic good and is essential for human life.* Water resource management and pricing policy cannot be considered in terms of economic objectives alone.
- *Constitutional right.* All residents in South Africa have the right of access to a certain basic amount of water necessary for maintaining personal health and hygiene. Pricing policy should promote this right by subsidising basic access, whilst nevertheless providing incentives for water resources to be used efficiently, by ensuring that all other water is ultimately priced at its economic scarcity value.
- *Cost recovery, efficiency, conservation, equity.* Pricing at the second and third tiers must be consistent with the principles of cost recovery, efficiency in water use and conservation, and equitable access to basic water services.
- *Equity and access.* The most important contribution to equity comes from policies ensuring access to basic services for all South Africans.
- *Life-line tariffs – third tier.* The principle of life-line tariffs at the third tier is supported.
- *Life-line tariffs – first tier support.* In order to support the implementation of life-line tariffs at the third tier, it has been proposed (DWAF, 1997) that an amount of water equivalent to that required to meet basic human needs will be made available free of charge at the first tier level (i.e. from government schemes).
- *Subsidy targeting.* Where subsidies are implemented, they should favour the poor, be equitable, be clearly targeted and transparent.

4. TYPES OF TARIFF STRUCTURES

4.1 Introduction

The type of tariff structure used is partly dependent on the nature of the service provided,[3] as, for example, unmetered supplies cannot be charged on the basis of the amount of water consumed. Notwithstanding this constraint, the choice of tariff structure is wide. Options available for each type of service are discussed below.

4.2 Communal supplies

4.2.1 Unmetered

It is very difficult to apply a water tariff structure to communal standpipes in a fair and effective way. For this reason, communal standpipes are often unmetered. Where they are not metered, the tariff option is limited to some (fairly arbitrary) fixed monthly charge levied on customers living in the area. The charge is arbitrary because the amount of water supplied is not measured and an estimate of average consumption per household must be made. For these reasons, as well as reasons of equity (see Section 2.2) and willingness to pay (see Section 8), in large urban areas where it is affordable, water from public standpipes is often made available at no financial cost to the customer.

[3] For a fuller explanation of the various possible types of water service, see Module 4.

4.2.2 Metered

Where communal standpipes are metered, the range of tariff options is increased (although difficulties are associated with all of the options):

- ***Uncontrolled, fixed average bills.*** The amount of water supplied at each standpipe is not controlled in any way (households can use as much or as little water as they wish), but the total amount of water supplied in any given period can be measured. In this context, a fixed periodic (usually monthly) charge can be set based on the basis of the actual average amount of water consumed per household accessing the standpipe (or group of standpipes).

  COMMENT: This charging arrangement is both approximate and unfair. It is approximate because it cannot be known for certain which households make use of which standpipes, and unfair because it is almost certain that households in close proximity to the standpipe will use more water than those living further away.

- ***Controlled, water bailiff (standpipe attendant or "privatised standpipe").*** Water from controlled standpipes can be rationed and/or sold by a water bailiff. A "privatised standpipe" entails the provision of communal standpipes on residential sites so that the occupants become the attendants. Various financial arrangements can apply.

  COMMENT: These arrangements are typically expensive (defeating the objective of providing a low cost and affordable supply), administratively burdensome and can lead to conflict (see CSIR, 1997; PDG, 1994b; PDG, 1994d; Rivett-Carnac 1989). Further reference to these arrangements is made in section 7.1.4.

- ***Pre-payment meters.*** New technologies are being developed which have the possibility of reducing unfairness as well as administration and billing costs through making use of automated pre-payment systems (for example: key pads, coins, coupons, credit cards). These are currently being tested in a number of areas, and are discussed further in section 7.1.4.

  COMMENT: These technologies are new and, although promising, are not yet fully tested (see CSIR 1997).

4.3 Individual connections

4.3.1 Unmetered

- ***House connections and yard taps.*** The range of tariff options for unmetered individual connections is limited. Consumption must be estimated[4] and some average or estimate used as a basis for billing individual households.

  COMMENT: Although such tariff structures are widely used where individual connections are not metered, they have at least two definite disadvantages: (1) households have no incentive to save water as the charge is not directly related to the amount of water consumed by each household; and (2) any tariff chosen may be perceived to be unfair as households consuming less water may be required to pay the same amount as households consuming more water.

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[4] This can be done using a number of criteria: (1) total consumption into area in a specified period divided by the number of households, (2) plot size, (3) property value, (4) household size. Each method has disadvantages.

- ***Yard tanks (pressure controlled)***. The amount of water supplied is constrained by significantly reducing the water supply pressure.

  COMMENT: For this service option, a fixed monthly fee is more equitable, as the total amount of water available is constrained and usage between households is likely to be much more equal than in the case of house and yard connections.

- ***Yard tanks (with bailiff)***. Here payment can be directly linked to the amount of water consumed because the amount of water supplied to each customer can be controlled and measured.

  COMMENT: This system has successfully been applied in the Durban Metropolitan Area. There is, however, a danger of high labour costs making it expensive to operate thus defeating the objective of a low-cost and affordable water supply option.

4.3.2 Metered

A wide range of tariff options are available for individual metered connections:

- ***Fixed periodic charge only***. Unrelated to amount of water consumed. (See unmetered individual connections above).
- ***Consumption charge only***. A consumption-related charge. The consumption charge may increase, decrease or remain constant as the amount consumed increases.
- ***Two-part tariff***. A fixed periodic charge and a consumption-related charge. This is a commonly used structure and is discussed below.
- ***A life-line tariff***. A zero or subsidised charge for the first X amount of water consumed in a given period, with or without a fixed periodic charge.
- ***Variations on the theme***. A number of variations on the above theme are possible. For example, a fixed periodic charge and a consumption related charge for water use exceeding a set amount.

There are a number of ways in which consumption charges may be levied: (Beecher *et al*, 1991; Billings and Jones, 1996):

- ***Uniform or constant consumption related charge***, where each unit of water consumed is charged for at a constant rate.
- ***Increasing block rates***, where charges are set for consumption blocks on a rising scale.
- ***Decreasing block rates***, where charges are set for consumption blocks on a decreasing scale.
- ***Seasonal tariffs***, where prices are higher during high-use seasons (usually summer) or when water is scarce (as during drought periods).
- ***Differentiation by use***, for example, separate indoor and outdoor rates, where different charges are levied for indoor and outdoor use. If this system is to be used there should ideally be different water meters for the different uses (for example, outdoor usage is separately metered).
- ***Sliding scale***, where the price per unit of all water consumed increases as the total consumption (per specified period) increases.

- ***Spatial pricing***, where more is charged for water in areas that are more expensive to serve.

4.4 Two-part tariff structures – a discussion

4.4.1 Fixed periodic (monthly) charges

The economic rationale behind the two-part tariff is that certain costs are "fixed", in that they do not vary with the level of consumption, while "variable" costs are directly related to the amount consumed. The argument is that tariff structures should reflect this by allowing the fixed component to cover the "fixed" costs and the consumption charges to cover "variable" costs. In conventional economic theory "fixed" costs are associated with the costs of providing the infrastructure, while "variable" costs are those incurred while operating and maintaining the system[5] (Gildenhuys, 1993). However, in practice the division between "fixed" and "variable" costs is not that clear cut, as some "variable" costs are only weakly related to consumption. In addition, in the longer term some infrastructure costs will be affected by the amount used by each customer – for example, high levels of consumption may necessitate a dam and/or new treatment plant, which would not have been necessary for many years had unit consumption been lower. It thus becomes a matter of judgement what costs to define as "fixed" and what as "variable" and therefore how to structure tariffs.

In practice the following costs have been identified as providing the rationale for the fixed component of a two-part tariff (PDG 1994b):

- Certain administrative costs are incurred per connection regardless of the amount of water consumed.
- Certain or, some may argue, all capital costs are unrelated (or weakly related) to water consumption.
- Maintenance costs may also be weakly related to consumption, especially where demand is highly seasonal.

Further arguments in favour of the fixed charge component of a two-part tariff are:

- These charges provide revenue stability especially where demand is highly seasonal.
- This charge may be seen to be "fair" in the sense that customers pay their (allocated) share of the fixed costs of service provision.

COMMENT: The assertion of fairness is open to dispute, firstly because the classification of costs as "fixed" and "variable" and the allocation to the different types of customers is a matter of judgement.[6] Secondly, these charges may result in a regressive tariff structure with small (poor) customers paying a higher average price for water than large (rich) customers. The larger the fixed component of the tariff, the more regressive the structure is likely to be. When balancing the advantages and disadvantages of a fixed charge it must be remembered that it can only be "fair" for customers to pay the full costs of service provision when the distribution of income is "fair", that is, vertical equity considerations have to be taken into account. As discussed above, where there are large disparities in income a strong case can be made

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[5] Costs are discussed in sections 5.2 and 5.3.

[6] Allocating costs to different types of customers is dealt with in section 5.

for the cross-subsidisation of poorer customers, whether by local wealthier ratepayers, larger water users or from national sources in the form of inter-government grants.[7]

4.4.2 Consumption-related charges

As discussed above, the basic rationale underlying the consumption-related charge in a two-part tariff is that a portion of the cost of service provision is directly related to the amount of water consumed. In its simplest form the consumption charge is a constant amount per unit of consumption. More sophisticated structures also exist, and most consumption related charges are variations of constant, increasing or declining block-rate structures. These are illustrated in Table 1.

Table 1: Constant, increasing and declining block rates

Consumption blocks (kl per month)	*Charge (Rands per kl)*		
	constant rates	*increasing block rates*	*decreasing block rates*
0-10 kl	R2.00	R1.00	R2.50
10-30 kl	R2.00	R2.50	R2.00
30-80 kl	R2.00	R3.80	R1.80
more than 80 kl	R2.00	R6.00	R1.00

Each tariff structure is discussed in turn.

a) A *constant charge* per kilolitre regardless of the amount consumed (that is, a constant block-rate structure) is fairly common in South Africa. This structure has the advantage of being relatively easy for the service provider to administer and for customers to understand. The same tariff can be applied to both residential and non-residential customers. It does not, however, permit the cross-subsidisation of poor by wealthy customers and provides only limited incentives to reduce water consumption compared to a rising block rate.

b) A *rising block rate* means that the first stipulated amount of water consumed is charged for at a low rate, the next amount is charged for at a higher rate, the next at an even higher rate, and so forth. In the example of the rising block rate schedule given in Table 1, a customer using 85 kl of water per month would pay R1.00 per kl for the first 10 kl used, R2.50 per kl for the next 20 kl, R3.80 per kl for the next 50 kl and R6.00 per kl for the remaining 5 kl. The total water bill would be R280. The calculation is shown in Table 2.

Table 2: Illustrative calculation of rising block tariff

		Unit cost per kl		*kl consumed in block*		*Total cost for amount consumed in that block*
Cost of first 10 kl	=	R1.00	x	10 kl	=	R10
Cost of next 20 kl	=	R2.50	x	20 kl	=	R50
Cost of next 50 kl	=	R3.80	x	50 kl	=	R190
Cost of last 5 kl	=	R6.00	x	5 kl	=	R30
Total consumption and cost				**85 kl**	**=**	**R280**

[7] For example, in Hermanus, vertical equity considerations have been taken into account in their fixed monthly charges by setting a fairly high fixed monthly "availability" charge of R40 per "economic" residential unit, and lower rates of R10 and R2 for poor "sub-economic" and "indigent" households respectively.

A major advantage of the progressive (rising) block-rate tariff structure is that it shifts the financial burden of system capacity expansion from small to large users. Under a uniform tariff structure, all users (both large and small) contribute in equal proportion to their consumption to system capacity expansion. Under a progressive block-tariff structure, large users (especially those engaged in luxury, superfluous or wasteful consumption) are required to contribute significant amounts to capacity expansion costs.

This tariff structure has two additional advantages: (1) it discourages wasteful, luxurious and superfluous consumption and hence plays an important role in encouraging greater efficiency in water use and water conservation; and (2) it reduces the costs of service provision to small users (by reducing the necessary finance contribution to fund capacity expansion) and hence facilitates cross-subsidies and the affordability of life-line tariffs.

The disadvantages of this type of structure include the greater complexity of administration and the potential for customer confusion. These are, however, fairly minor problems that are relatively easily overcome (PDG, 1994b). A more significant problem concerns the prejudice to large customers who are required to pay the high rates for most of their water, for example industries and multiple residential units with single meters. To prevent this it may be necessary to charge them on a constant block-rate schedule or to define different blocks (see Section 7.2.2).

c) A *declining block rate* schedule is unfair to small customers in that more is paid per kilolitre at low levels of consumption than at high levels. The incentive to conserve water is reduced compared to an increasing block-rate schedule. The structure is based on the rationale that there are economies of scale in the provision of water, so that large, particularly non-residential customers, should pay less per unit consumed. This approach, however, neither acknowledges the future costs of capacity expansion nor permits any cross-subsidisation from large to small users and is not recommended.

4.4.3 Variants of the two-part tariff

A fixed monthly charge plus a consumption charge for water use exceeding a set amount is a variant of an increasing block-rate schedule where the first block is priced at zero. If the fixed amount is modest, at least for low-income customers, this will essentially provide a "lifeline" tariff for the first consumption block. The disadvantage of this system is that customers are motivated to use at least the amount of water provided in the first block since, in the eyes of the customer, this has been "paid for" in the fixed charge. If the block is set at a relatively small amount of no more than 10 kl per month this is not a major disadvantage. The larger the block, the more serious the disadvantage.

4.5 Development fees

Development fees are charges to cover the costs of the development of the local reticulation system and sometimes include the cost of connecting to the existing bulk water network. The cost of developing the bulk water supply network is usually not included as this cost is normally recovered through the bulk water tariff (consumption related charge). Development fees are usually once-off payments. They could, however, be levied as periodic fees. Periodic development fees can also be levied to cover the cost of major upgrading and/or replacement costs related to the local

reticulation network. Development fees may be wholly or partly subsidised in the interests of vertical equity. The capital subsidies currently available to low income households discussed in section 6.1 may be used for this purpose. Alternatively, development costs can be recovered through the consumption related charge. Development levies may be added to the consumption charge for certain (new) areas. Alternatively, the development costs can be borne by all customers which means that existing customers cross-subsidise new customers.

4.6 Connection fees

Connection fees are charges to cover the cost of individual customers connecting to the local reticulation network. For obvious reasons, these charges are usually only applicable to individual connections (yard tanks, yard taps and house connections). These fees are usually levied as a once-off charge. Alternatively, new customers wanting to connect to the system could be asked to pay a deposit and the remaining fee over a specified period. Interest may or may not be charged in such an arrangement. Connection fees may be wholly or partly subsidised in the interests of vertical equity. As in the case of development fees, the capital subsidies currently available to low income households discussed in section 6.1 may be used for this purpose. Alternatively, connection fees can be recovered through the consumption related charged either through an individualised levy or pooled across all customers (cross-subsidised).

5. THE (FINANCIAL) COSTS OF SERVICE PROVISION

5.1 Introduction

Two different concepts of cost need to be distinguished: economic cost and financial cost. Financial cost refers to money actually spent, whereas economic cost is a far broader concept and reflects the value to society of the activity in question. The economic cost takes into consideration the fact that prices do not always reflect true scarcity value – for example due to government subsidies. It also takes into account the presence of "externalities", which are costs or benefits that arise which do not carry a (direct) financial cost or benefit to the provider. For example, building a dam might flood inhabited areas and carry very heavy costs for those displaced, but these are unlikely to be borne by the provider unless substantial compensation payments are made. Alternatively, the provision of clean water can have external benefits in the form of improved health but these benefits will not accrue to the service provider (see Squire and Van der Tak, 1988).

To the service provider – as opposed to society – the important cost is simply the financial cost of constructing and operating the necessary infrastructure. "External" costs and benefits do not impact on its operations until they are translated into financial costs (for example, compensation) or savings (for example, less time off due to illness). Similarly it is of no concern to the provider that prices do not always reflect true scarcity value: for example, if a project is financed by means of a low-interest loan then it is those payments that are of concern, not the payments that would need to be made if the cost of the loan reflected the true scarcity value of savings in the economy as a whole. The term "costs" in this report, therefore, refers simply to financial costs, and not the true economic costs of service provision.

The costs of service provision must be known to the service provider for three reasons: (1) to determine revenue requirements and thus to set tariffs in such a way

that financial viability is ensured; (2) to meet the requirements of the National Water Supply Regulations which specify that the costs of service provision must be used to guide tariffs (this is also in the interests of fairness and transparency); and (3) as a basis for predicting future costs, which is important for achieving tariff stability and financial sustainability in the longer term.

5.2 Classification of costs to the service provider

Three kinds of costs may be identified: average historic costs, replacement costs and marginal costs. Each is discussed in turn.

5.2.1 Average historic costs.

These are the costs already incurred and include operating and maintenance costs plus interest and redemption payments on past investments.[5] The average historic cost (AHC) per unit of water is therefore calculated as follows:

AHC = (Capital Interest and redemption payments + O&M) / water supplied

It is important to note that calculations of average historic cost will vary depending on the extent to which the initial capital is subsidised and the conditions against which capital was borrowed (interest rate and repayment period). The simple example of AHC calculations given below illustrates this:

> ***Example:*** If R0.5 million was paid for a dam 10 years ago, it costs R10 000 to maintain and operate the dam each year, and the dam supplies 100 000 m^3 per year, then the AHC would be: (1) If the dam was paid for in cash, then AHC = 10 c/kl (the O&M cost only). (2) If the dam was subsidised by 30% and the rest of the money for the dam was borrowed at a fixed interest rate of 15% and repaid over a period of 30 years, then AHC = 63 c/kl. (3) If all the money for the dam was borrowed at a fixed interest rate of 15% and repaid over a period of 30 years, then AHC = 86 c/kl. (4) If all the money for the dam was borrowed at a fixed interest rate of 15% and repaid over a period of 20 years, then AHC = 96 c/kl". (Squire and Van der Tak, 1988)

This example illustrates the fact that when the initial capital expenditure has been subsidised the AHC reflects a subsidised cost and water will be under-priced from the perspective of the economy as a whole. New borrowing at an unsubsidised rate can result in the a dramatic increase in unit costs. When using AHC to set residential tariffs for the second consumption block as required by the Regulations, it may therefore be sensible to estimate more realistic capital charges and charge economically more realistic rates. Surplus funds can then be used to subsidise other services in poorer communities and/or be retained in a fund for future expansion.

5.2.2 Replacement costs

When infrastructure reaches the end of its economic life it needs to be replaced, and these costs are referred to as the replacement costs. This expenditure is financed either by means of loans or by drawing on accumulated capital reserves. One of the reasons for making regular contributions to reserves is, therefore, to make provision for asset replacement.

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[5] Operating and maintenance costs and interest and redemption charges are discussed in Section 5.

5.2.3 Marginal costs

The marginal cost is the cost that would be incurred to produce an additional unit of water. There are two kinds of marginal cost: the short-run marginal cost, which is the cost incurred by producing an additional unit while keeping productive capacity constant, and the long-run marginal cost which relaxes the condition of constant productive capacity. The cost of most interest here is the long-run marginal cost. Capacity generally needs to be expanded at irregular intervals and at a fairly high (construction) cost. The expansion can be financed by means of borrowing, drawing on accumulated reserves, subsidy finance or a combination of these. Borrowing, whether from external sources or the local authority's own capital funds (see section 5.3.3), gives rise to a flow of interest and redemption payments. These payments, along with the additional operating and maintenance costs of the new infrastructure, are experienced by the service provider as the marginal costs.

5.3 Expenditure

Service providers (or the local authorities of which they form a part) need to prepare budgets and financial statements every year that account for both expenditure and income. Expenditure is generally broken down in two ways. The first breakdown allows one to identify operating and maintenance costs, capital charges and 'contributions to funds' for the system as a whole. The second separates the system into its functional components – for example, administration, bulk supply and reticulation. Table 3 shows the standard breakdown of expenditure recommended by the Institute for Municipal Treasurers and Accountants (IMTA 1994). Also shown is the type of expenditure and cost each item represents.

Table 3: Breakdown of expenditure

Expenditure item	*Type of expenditure*	*Type of cost*
Salaries, wages and allowances	Operating and maintenance	Historic cost
General expenses, including bulk water, electricity and chemicals	Operating and maintenance	Historic cost
Repairs and maintenance	Operating and maintenance	Historic cost
Interest and redemption payments	Capital-related	Historic cost
Contributions to fixed assets[1]	Capital-related / Operating and maintenance[1]	Historic cost
Contributions to stabilisation funds, e.g. tariff stabilisation fund	Operating and maintenance	Historic cost (smoothing fluctuations in expenditure to stabilise tariffs)
Contributions to capital funds	Capital-related	Contribution to replacement & marginal costs

Note: 1. "Fixed assets" can include small items such as computers, furniture and vehicles as well as major capital items such as reservoirs and pipelines. The acquisition or replacement of small equipment that does not extend the useful life of major facilities may be classified as operating and maintenance expenditure.

5.3.1 Fringe operating and maintenance expenditures

Operating and maintenance (O&M) expenditures are those expenses incurred by the service provider while providing a water service to customers. O&M expenses include items such as:

- salaries and wages;
- benefits paid to staff;
- power (electricity);
- rent;
- insurance;
- chemicals;
- general overheads;
- vehicle running costs; and
- inter-departmental charges – that is, support services rendered by the municipality to the water service provider or vice versa, such as computer facilities, meter reading and billing, or office rental.

Expenditure on small equipment that does not extend the useful life of major facilities should be classified as O&M expenditure.

O&M expenditures are estimated in the annual budgets of municipalities/service providers. Actual expenditure is recorded in the financial statements. Unfortunately, the financial statements of local authorities may not reflect a breakdown by type of expenditure separately for each department. This information should nevertheless be readily available.

When the service provider is a municipal department, some of the expenditures incurred in providing the service may be recorded as the expenditure of another department. For example, when the treasury is responsible for billing, this expenditure may be reflected as a treasury expense which is not charged to the water services department. Computer services may be rendered to the local department without this being recorded as an expense. The extent to which this is the case will depend on the conventions used within the local authority, and in particular the extent to which interdepartmental services are charged to the departments concerned. It is important, however, that all the relevant expenses are included when estimating O&M expenditure, since failure to do so will result in an incorrect estimate of the (financial) cost of providing the service.

Some small capital-related expenditures may be included in the O&M budget.

When using past O&M budgets to predict future expenses, care should be taken that these budgets reflect extraordinary expenditures in a fair manner, for example large non-recurring items such as the painting of reservoirs.

5.3.2 Capital-related expenditure

Capital-related expenditures are the annual expenditures that arise from financing capital projects. Capital projects include the replacement of existing facilities, normal extensions and improvements, and new works. These may be financed by means of loans, subsidies, capital reserve funds and/or current revenue. Annual contributions to capital reserve funds may also be classified as a capital-related expenditure.

- *Subsidies.* For extensions and new works, capital grants and subsidies from national government may be an important source of finance. The current national subsidies framework is described in Section 6.1.

- *Loan finance.* Most major capital improvements and replacements that are not covered by capital subsidies must be financed by means of loans, stock issues or private equity finance.

If possible, it is best to equate the loan period to the economic life of the facility. The debt-service component becomes an annual expense and consists of interest and redemption payments on loans outstanding. Current interest and redemption payments on past loans are reflected in the accounts of the local authorities/ service providers, and the schedule of future payments on these will be known to them. In order to estimate future interest and redemption payments, a schedule of capital expenditure is required along with an indication of the sources of finance and loan conditions (i.e. the interest rate and redemption period). The annual costs (interest and redemption) of the new loans can then be calculated and added to the payments on existing loans to obtain a stream of future payments.

Issues related to financing capital investment in water supply are discussed in more detail in "Capital investment in the urban water and sanitation sector – some issues" (PDG 1994a).

5.3.3 Contributions to funds

Contributions to funds are separately recorded in the accounts of the water service provider.

Capital Development Fund

The most important fund for local authorities in South Africa is the Capital Development Fund. Its purpose is to accumulate capital reserves for the purchase of equipment, asset replacement, improvement and expansion of infrastructure. Departments within the local authority borrow from this fund and repay the loans with interest. The interest rate has in the past frequently been set below the market rate, but it has long been recommended that market-related rates be used (Croeser Working Group, 1982). The Fund operates under stringent rules – for example, no less than a prescribed percentage of income may be saved in the Fund in any one year, it may not be used to finance recurrent expenditure and a certain proportion of the interest accumulated on reserves must be paid annually into the current income account of the local authority(Croeser Working Group, 1982). Given their function, annual contributions to these funds are classified by the service provider as capital related expenditure.

Tariff stabilisation

This fund is designed to prevent large fluctuations in tariffs and/or cash flow due to fluctuating expenditures. For example, a tariff stabilisation fund allows a service provider to respond over a number of years to an increase in the price of bulk water. These contributions are, therefore, essentially O&M expenditures, even though they are not necessarily spent during the period under review.

5.4 Expenditure by functional component of a water supply service

The method of determining tariffs stipulated in the Regulations requires only that the O&M and capital-related expenditures for the system *as a whole* are known. However, more sophisticated methods are available that enable the expenditures associated with service provision to be estimated for the different types ("classes") of customers. Tariffs can then be seen in relation to the actual (financial) costs of service provision and the degree of cross-subsidisation can be more accurately estimated (see section 6.2.5). These methods involve allocating expenditure to the different types of

customers, and in order to do this expenditure must first be allocated to the functional components of the system. A typical breakdown of functional components is shown in Table 4 and Figure 1.

Table 4: Classification of the components of water supply systems

Major component	*Constituent components*
Bulk infrastructure	Water source Pumping/Abstraction Transmission Treatment
Connector infrastructure	Storage Connector pipelines
Internal services	Reticulation Customer services
Overhead expenditure	Planning Administration

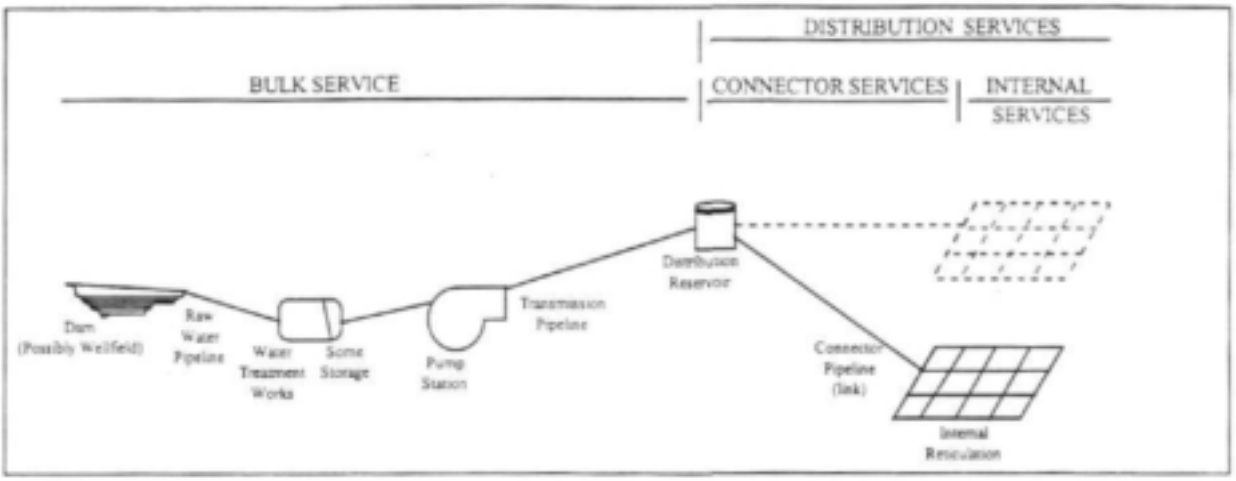
Expenditure is then broken down as follows:

- *Bulk costs* are the expenditures related to the source of supply, raw and treated water pumping, water treatment and transmission mains. Where a service provider purchases purified water the only bulk cost will be the cost of purchased water.
- *Connector service costs* are those associated with the distribution reservoirs and the connector mains.
- *Internal service costs* refer to expenditures relating to reticulation infrastructure and customer services including meter reading and billing. Fire service costs are included in this category.
- *Overhead expenditure* includes planning and design as well as general administration. This expenditure can be allocated to the bulk, connector and reticulation categories on the basis of their estimated shares in the total.

Each of the components involves operating and maintenance expenditures, capital charges and contributions to funds and fixed assets, except where all purified water is purchased from an outside supplier, in which case only operating and maintenance expenditure applies to the bulk service.

In the accounts of the water service departments of many local authorities no differentiation is made between connector and internal service costs. A split is, however, useful for the accurate allocation of expenditure to different types of customers. In addition, some administration and customer service costs may be reflected as expenditures of other departments (for example, Treasury), and as previously noted it is important that these costs be fully accounted for when estimating the costs of service delivery.

Figure 1: Classification of the components of water supply systems



Source: "Costing of water supply systems (draft)". *Evaluation of water supply to developing urban communities.* Working Paper. (PDG 1994c).

Expenditure can be allocated to the functional components of the water supply service in varying degrees of detail. Table 5 provides a relatively simple breakdown for the water department of a local authority which is responsible for its own bulk infrastructure and for which billing is done by the Treasury department.

Table 5: Simple allocation of expenditure to functional components (for "Town A")

R thousands	*Bulk services*	*Connector services*	*Internal reticulation*	*Admin. & consumer services*	*Total*
Staff costs	370	350	200	0	920
Bulk water purchase	0	0	0	0	0
Other general expenses	471	70	60	57	658
Repairs and maintenance	126	54	90	80	350
Share of other department costs	2	12	1	100	115
Contributions to stabilisation funds	0	0	10	0	10
Total O&M expenditure	**969**	**486**	**361**	**237**	**2 053**
Interest and redemption	1 264	1 300	398	0	2 962
Contributions to capital funds and fixed assets	15	18	9	1	43
Total O&M and capital-related expenditure	**2 248**	**1 804**	**768**	**238**	**5 058**

A more detailed analysis would involve (1) breaking down the major components of the water supply system into sub-categories as shown in Table 4, and (2) making allowance for *average* and *peak* consumption and the timing of peaks. An analysis at this level of detail is provided in Annexure 1.

6. WATER TARIFF POLICY IN SOUTH AFRICA

A breakdown of costs is necessary to apply the National Water Supply Regulations of 1997 on residential tariffs. Before discussing these regulations and showing how tariffs can be calculated on the basis of cost, the national subsidy framework and regulations on metering are briefly discussed.

6.1 The national subsidy framework

As at July 1997, the following capital subsidies were available for water provision at the third tier and were predominantly (though not exclusively) focused on urban areas:

- ***Housing subsidy***. A (locally determined) portion of the national housing subsidy is available for local neighbourhood reticulation (i.e. internal service) costs for all services including water supply. The housing subsidy is a once-off capital grant for households with incomes below R3 500 per month who have not previously received state assistance to acquire (residential) property. An amount of up R15 000 per household is made available, depending on household income. The subsidy is provided by the Department of Housing and allocated by the Provincial Housing Boards.
- ***Bulk and connector infrastructure subsidy***. A once-off grant (of up to R3 000 per household with incomes below R3 500 per month) is available for bulk and connector infrastructure and can be used for water treatment works, reservoirs, major pipelines and pump stations. This subsidy is associated with the Consolidated Municipal Infrastructure Programme, located in the Department of Constitutional Development.

These two subsidies are intended to provide new residential infrastructure for low-income households and the rehabilitation of deteriorated or damaged infrastructure in previously neglected areas. These subsidies should make a significant contribution toward the capital cost of water infrastructure development in low-income communities.

The following additional operating subsidy has been proposed:

- ***Bulk water subsidy***. A noted in section 2.4, it is proposed in the National Water Tariff Policy document (DWAF, 1997b)[5] that a portion of bulk water be made available from the first tier (government water schemes) at no charge. This amount is for basic human needs and is calculated on the basis of 25 litres per person per day.

Various other subsidies in the form of inter-governmental grants between central, provincial and local governments have been made available in the past. The national government is in the process of restructuring the system, and in the future it is likely that only the subsidies noted above will be available for the urban water sector. It is almost certain that DWAF will require water service providers to be financially viable within this framework of subsidies, and tariffs will therefore have to be set so as to generate sufficient income to cover all remaining costs.

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[5] This document has no legal status.

6.2 Metering

The presence or absence of metering impacts significantly both on the types of tariff structures that can be applied (see section 4) and the incentives for customers to use water efficiently and without wastage. A further advantage of metering is that it greatly facilitates effective water management by the service provider: it enables accurate water balances to be calculated thus facilitating programmes aimed at reducing leakage and unaccounted-for water.

The Regulations state that:

> All water supplied to a customer by the Municipality shall pass through a meter or other measuring device for the purpose of measuring the quantity of water consumed. (Part II 26 (1))

With reference to on-site connections that can be metered, the Regulations specify that:

> The Local Authority shall require the installation, at the owner's expense, of a meter to each dwelling unit.... (Part II 27 (7))

Clearly the aim is to provide for all water used to be accurately measured in the interests of good water management. The regulation governing on-site connections does not apply to existing dwelling units, however, since the Regulations also state that:

> No owner shall be required to comply with these regulations by altering a water installation ... which was installed in conformity with any laws applicable immediately before the date of commencement of these regulations.... (Part II 2 (3))

Therefore, where individual connections are currently not metered and the Municipality wishes to install meters, it may need to finance this itself.

6.3 Residential tariffs

6.3.1 The 1994 White Paper

The policy of the Department of Water Affairs and Forestry as stated in the White Paper of 1994 is "that all customers of potable water must contribute to the cost of their water supplies" (DWAF, 1994). A clear distinction is drawn, however, between operating and maintenance costs on the one hand, and capital charges on the other. Poor households with low levels of consumption are expected to contribute towards operating and maintenance costs only.

6.3.2 The Regulations

Following the broad policy of the 1994 White Paper, the tariff structure for residential customers set down in the Regulations (DWAF 1997a) is a three block rising tariff which involves a "lifeline" tariff and a determination of block charges on the basis of the costs of service provision.

The Regulations require that residential tariffs for potable water be structured as follows:

a) a "lifeline" tariff for a quantity of water of not less than 5kl per customer per month...

b) a tariff based on historical costs for any quantity of water consumed in excess (of the "lifeline" block) up to a maximum of 30kl per customer per month;

c) tariffs based on the marginal cost of supplying water for any quantity ... in excess of (30kl per month).

Marginal costs are defined in the 1994 White Paper as "the present day cost of the latest or next augmentation scheme" (DWAF, 1994: 25).

The Regulations specify further that:

> The 'lifeline' tariff *shall not exceed* the tariff calculated by dividing the budgeted operating and maintenance costs for any financial year by the estimate of the quantity of water sold.... (own emphasis)

Fixed monthly charges receive no mention in the Regulations, and the implication is that these should be avoided. The implicit assumption is that all costs should be treated as "variable" and none as "fixed". Since block 2 rates fully cover capital related and O&M costs while block 3 rates (in most cases) exceed this level, revenue requirement should be met while providing a "lifeline" tariff, encouraging water saving and avoiding the regressive features of a fixed monthly charge.

In order to fully understand the residential tariff structure specified in the Regulations an understanding of the costs of service provision is necessary. These have been discussed in Section 5.

6.3.3 Illustration of Regulation-based tariffs

As indicated above, the National Water Supply Regulations specify a three-block rising tariff for residential water with the lowest block representing a "lifeline" tariff. The "lifeline" tariff should be no greater than:

(total O&M costs) / (total water sold)

The block 2 tariff should be based on historic costs and block 3 on marginal costs.

Tariffs for "Town A", whose expenditure is given in Table 5, can be calculated with the additional information on water sold and capacity expansion shown in Table 6:

Table 6: Information for Town A required to calculate tariffs

Total O&M expenditure	2.053	R million
Total capital related expenditure	3.005	R million
Total O&M and capital-related expenditure	**5.058**	**R million**
Total water sold in year	2 182	Ml
Annualised cost[10] of capacity expansion	6.100	R million per annum
Capacity of new infrastructure	1 403	Ml per annum

Residential tariffs may then be calculated as follows:

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[10] The annualised cost is the annual interest and redemption payable, contributions to asset replacement funds and the O&M expenditures incurred by the new scheme.

Table 7: Illustrative calculation of residential tariffs for Town A

Block 1 tariff (0-10 kl per month) (life-line)	= R2 053 000 / 2 182 Ml	= R0.94 /kl
Block 2 tariff (10-30 kl per month)	= R5 058 000 / 2 182 Ml	= R2.32 /kl
Block 3 tariff (> 30 kl per month)	= R6 100 000 / 1 403 Ml	= R4.35 /kl

These block rates may also be used to set tariffs for unmetered supplies, such as communal standpipes and yard tanks. In order to do this, consumption needs to be estimated. Assuming consumption for communal standpipes, yard tanks and unmetered yard taps of respectively 4kl, 6 kl and 11 kl per month per customer unit[11], monthly charges can be calculated as follows:

Table 8: Illustrative calculation of tariffs for other service levels in Town A

Communal standpipes	4 kl x R0.94/kl	R3.76	per customer unit per month
Yard tanks	6 kl x R0.94/kl	R5.64	per customer unit per month
Unmetered yard taps	(10 kl x R0.94/kl)+(1kl x R2.32/kl)	R11.7	per customer unit per month

These tariffs and monthly bills exclude fixed monthly charges, which are not dealt with in the Regulations. Should the local authority wish to apply fixed charges, these will need to be set at low levels for poorer households so as not to violate the concept of a "lifeline" tariff.[12]

6.3.4 Comments on the regulations and the above illustration

- *Simplicity is attractive.* The simplicity of the method advocated in the regulation and illustrated above is attractive. The data requirements are not onerous (with the exception of estimating marginal cost – see below) and the tariff structure achieves the objective of improving equity by cross-subsidising between large (read wealthy) and small (read poor) customers).
- *Calculation of marginal costs.* Accurate long-run marginal costs are difficult and costly to estimate, and are, in any event, fairly subjective (Beecher *et al*, 1991). Nevertheless, a rough estimate can usually be obtained without great expense which should be adequate for the purposes of the tariff structure advocated here.
- *Marginal costs approximate historic costs.* Where marginal costs are close to or below average historic costs,[13] the rationale for a third block falls away. In this case, the second block would have to be set at such a level as to cover the costs of the life-line tariff cross-subsidy. If politically feasible, a third block could still be implemented for the purposes of increasing the cross-subsidy burden for very

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[11] The term "customer units" is used in preference to households to allow for the fact that more than one household can occupy one property, for example where there are backyard shacks. This issue is discussed in some detail in Module 3 (section 5).

[12] See footnote 6 for an example of a differentiated fixed monthly charge as currently applied in Hermanus.

[13] This will be the case where water resources are abundant and/or cheap to develop.

large customers and encouraging conservation. Surpluses generated can be used to subsidise other services.

- *Small proportion of block 3 users.* In very poor areas (for example, the Winterveld), where a very small proportion of customers have a consumption which falls into block 3, the contribution towards the cross-subsidy from block 3 will be small. In this case, the second block will have to be set at a rate which contributes more significantly to the cross-subsidy than would be the case in other areas. In some cases, this tariff may have to be set at a very high rate and it may be difficult to get customer acceptance for this tariff as it may not be affordable. This raises two issues: either the boundary of the water service provider has been inappropriately drawn (because it is not feasible for the service provider to be financially self-sufficient), or it is necessary for customers to receive an addition "special case" subsidy.
- *Basis of the life-line tariff calculation.* The Regulations state that the life-line tariff should not *exceed* that amount which would recover the O&M costs of the service. Service providers are free to set the life-line tariff at a lower rate – though most are likely to set it at the O&M recovery rate. There are two interpretations of the O&M-based life-line tariff calculation. The most common interpretation is likely to be that total O&M costs are those costs reflected in the service provider's financial statements. A second interpretation (which is likely to be less common but is a stricter interpretation of the concept of operation and maintenance), is that the true O&M cost is the total O&M cost reflected in the financial statements of the service provider *less* the capital component of the bulk water purchased. For example, if a water service provider purchases water from a water board and the water board's financial statements reflect that 60% of its total costs are capital costs and 40% operating and maintenance costs, then the purchase cost of bulk water must be multiplied by a factor of 0.4 and the O&M cost of the service provider adjusted accordingly. That is, the true O&M cost is equal to the total of the "non-bulk water purchase O&M items" plus 40 percent of the total bulk water purchase cost. The Regulations do not explicitly state which method of O&M calculation should be used. The difference between the two methods may be significant as illustrated in the next point and some clarity on this issue is needed.
- *Sensitivity to bulk water supply arrangements.* If O&M costs do not exclude the capital cost component of bulk water, then "lifeline" tariffs will be sensitive to bulk supply arrangements. Where a service provider purchases purified water this expenditure is experienced as an operating cost, and this is the way it is reflected in the financial statements. However, the capital charges associated with bulk infrastructure will be built into the price paid for the purified water. For this service provider O&M expenditure will be high relative to capital charges and the "lifeline" tariff will be high relative to the tariff block 2 as well as to tariffs in an area responsible for its own bulk infrastructure. To illustrate this, consider town B (based on an actual town):

Total water sold (1996)	= 32 270 Ml
Total O&M expenditure (1996)	= R49.203 million
Total expenditure (1996)	= R56.410 million

Using the formula given in the Regulations, tariffs for blocks 1 and 2 will be:

"Lifeline" tariff	= (R49.203 million) / 32 270 Ml	= R1.52/kl
Block 2 tariff	= (R56.410 million) / 32 270 Ml	= R1.75/kl

This contrasts with the example for Town A (also based on an actual town), where the service provider is responsible for its own bulk infrastructure and the tariffs are R0.94/kl and R2.32/kl respectively.

Note that the above calculations do not take into account the bulk water subsidy for basic human needs – that is, free first-tier water calculated on the basis of 25 litres per person per day. This would further reduce the "lifeline" tariff.

- *Inefficient water service providers.* Inefficiencies in the provision of water will lead to high O&M costs, which will in turn translate into higher "lifeline" tariffs than if the service provider were to operate efficiently. This could, for example, lead to a situation where small (poor) water users are financing high salaries and wasteful use of equipment.
- *Transparency of cost allocation.* To the extent that the "lifeline" tariff is meant to cover O&M costs of the service, this method of calculation can be misleading. The implicit assumption is that the cost per kilolitre is the same for all customers in a system. This is however not necessarily true (see Table 9). For example, there are certain administrative costs associated with meter reading and billing that are relatively fixed and do not vary with consumption. Communal standpipes may require more maintenance expenditure per kilolitre dispensed than other services. Some services require large amounts of storage and flow capacity in connector infrastructure due to "peaky" consumption patterns, while services such as yard tanks are specifically designed to reduce peak demand. The capital and O&M costs associated with connector infrastructure therefore differ between the different services in terms of cost per kilolitre sold. Furthermore, if a local authority sells a significant proportion of its water to one or a few large bulk purchases, the O&M costs per kilolitre for the system as a whole will be significantly lower than the O&M costs of services to residential customers.
- *Cross-subsidisation not explicit.* Given the foregoing, calculating costs and tariffs as set out in the Regulations implies that the full extent of cross-subsidisation is not made explicit. This is not necessarily a major disadvantage, but is in conflict with the general policy principle of transparency in the allocation of subsidies.
- *Fixed monthly charges.* The Regulations do not deal with fixed monthly charges, and the implication is that these should be avoided. The absence of such a charge can, however, be a problem in some towns. In holiday towns where demand is very seasonal, for example, many houses stand empty for a number of months of the year and water consumption is minimal, but this increases dramatically during the holiday period. Without a fixed monthly charge owners would be paying only the "lifeline" tariff out of season in spite of the large amount of capacity that their in-season demand requires. This capacity carries capital charges and has O&M requirements. Without fixed monthly charge it would be difficult for the service provider to meet its revenue requirements, and the fairness of the tariff structure would be compromised.

  As discussed in section 4.4.1, revenue stability in all towns and the "fairness" of customers contributing towards the fixed costs of service provision are further arguments that can be raised in favour of a fixed monthly charge. The "fairness" of

such a charge must however be balanced against the "unfairness" of large disparities in income and wealth and, if used, these charges would need to differentiate between different income groups.

6.3.5 Allocating costs to customer categories and the implications for tariffs

Estimating the actual costs of service to the different types of customers has two major benefits. Firstly, this is necessary if the principle of transparency in the provision of cross-subsidisation is to be adhered to. Secondly, estimates are essential for accurate projections of the recurrent costs associated with the provision of new services.

There are a number of ways in which costs can be allocated to different customers. A relatively sophisticated method involves separating the functional components of the system into base and extra capacity requirements (see Annexure 1). Annual costs are then allocated to each of the components using sensible allocation factors. The next step is to allocate the costs of each of these sub-components to the different types of customers. The result is a monthly O&M and capital cost per kilolitre by type of customer. A variation of this method and a worked example are presented in Annexure 1. The method is based on an American Water Works Association procedure (AWWA, 1983), adapted to take into account the different types of residential services provided in South Africa and the capital subsidy environment.

A simpler allocation of costs to types of customers is the water supply planning model (see Module 2). The O&M costs of town B were allocated using the model and the results are presented below.

The principles employed to allocate O&M costs are as follows:

a) Administration and customer service costs are allocated to customer units depending primarily on whether these are metered and/or billed.

b) Bulk costs are allocated on the basis of average annual daily consumption.

c) Connector costs are allocated according to required storage capacity.

d) Reticulation costs are calculated on the basis of pipe length per customer unit.

The costs are calculated in such a way that total annual O&M expenditure is accounted for.

The results of this process for town B are shown in Table 9 and Table 10 and shows O&M expenditure per customer unit per month for the different types of service by function. Note that administration (including customer service) costs are fairly similar regardless of consumption levels. Also note the differences in relative costs between the service types. For example, administration and reticulation costs are fairly high for yard tanks compared to yard taps, but storage costs are far lower because of the nature of this service which avoids peak demand on the system.[14]

[14] Service options are discussed in Module 4.

Table 9: Monthly O&M costs by service type and water service function

	Consumption	Administration	Bulk	Storage	Reticulation	Total
	kl/month	R/CU/month				
Communal standpipes (unatttended)	4.0	4.2	4.7	0.3	1.6	**11**
Yard tanks (with bailiff)	6.0	6.7	7.0	0.3	5.4	**19**
Yard taps (on-site sanitation)	8.0	5.6	9.3	0.8	2.2	**18**
Yard taps (w/borne sanitation)	14.0	5.6	16.3	1.5	2.6	**26**
In-house, low income	20.0	5.6	23.3	2.1	2.6	**34**
In-house, middle income	30.0	5.6	35.0	3.7	3.2	**48**
In-house, high income	75.0	5.6	86.9	9.3	3.8	**106**
Institutions	90	7.3	105	11.2	3.2	**126**
Commerce & "dry" industry	115	5.6	134	11.9	4.8	**156**
"Wet" industry	800	11.2	933	83.1	16.0	**1 043**

Note: for an explanation of the different types of service see sections 6.1 and 6.3. and Module 3.

Table 10 compares total costs with monthly bills when the latter are calculated using the "lifeline" and block 2 tariffs (AHC) calculated according to the formula supplied in the Regulations. The cost and price per kl of water are also shown. Bills for non-residential customers are calculated using the block 2 tariff plus 20 percent. The purpose of this table is to show that a very different picture of O&M costs is provided by a disaggregated process of cost allocation compared to calculating an average cost per unit of water sold for the service as a whole. The O&M costs per kl of water sold differ significantly between service types and economies of scale are in evidence. A "lifeline" tariff calculated on the basis of average O&M costs for the system as a whole is therefore likely to imply cross-subsidisation of O&M expenditure to customers with lower levels of service and low monthly consumption.

Table 10: Comparison of O&M costs and monthly bills by service type

	Consumption	*Total cost O&M*	*Total bill based on block tariffs1*	*Av. cost O&M*	*Av. price block tariff*
	kl/month	*R/CU/month*	*R/CU/month*	*R/kl*	*R/kl*
Communal standpipes (unattended)	4	11	6	2.70	1.52
Yard tanks	6	19	9	3.23	1.52
Yard taps (on-site sanitation)	8	18	12	2.25	1.52
Yard taps (w/borne sanitation)	14	26	22	1.85	1.59
In-house, low income	20	34	33	1.68	1.64
In-house, middle income	30	48	50	1.58	1.67
In-house, high income	75	106	262	1.41	3.50
Institutions	90	127	189	1.41	2.10
Commerce & "dry" industry	115	156	241	1.36	2.10
"Wet" industry	800	1043	1,678	1.30	2.10

Note: 1. The block tariffs used to determine the monthly bills are calculated according to the formula given in the Regulations.

6.3.6 Discussion

The objective of contrasting the method of tariff determination advocated in the Regulations with the costs by customer category derived from a cost allocation method is *not* to recommend the cost allocation method as a preferred alternative. Rather, the cost allocation process shows the degree of cross-subsidisation achieved by the tariff structure recommended by the Regulations, rendering them more transparent. This level and method of cross-subsidisation is implicitly endorse by the Regulations on the basis that it reduces income inequality and hence is equitable.

Secondly, the cost allocation exercise draws attention to the issue of vertical equity across water supply areas. An area dominated by small (low-income) customers is likely to experience higher O&M costs per unit of water sold than a wealthier area, other things being equal. Customers with the same service and level of consumption will pay more in the poor area than the wealthier one *simply because of where they live*, and not because of any discrepancy in the cost of providing the particular services in question. In order to minimise this problem, the boundaries of water supply areas need to be carefully drawn and attention may need to be given to providing subsidies to areas of predominantly poor households.[15]

A third objective of the exercise is to draw attention to the discrepancy between costs and tariffs for the purposes of projecting future expenditure and therefore revenue requirements. Where the proportion of small customers is set to increase, O&M expenditure per unit of water sold will increase, *ceteris paribus*, and the "lifeline" tariff calculated according to the regulations will need to rise in real terms. In effect,

[15] Note that this is an entirely different issue to costs differing between areas due to difference in the cost of bulk water supply.

the extent of cross-subsidisation per unit of water sold to small users will decrease as the proportion of these customers increases.[16]

6.4 Non-residential tariffs

No guidelines are provided for tariff structures for non-residential users in the regulations.

7. GUIDELINES FOR SETTING TARIFFS

7.1 Residential tariffs

When setting tariffs the Water Service Regulations need to be complied with. Interpreted broadly, these specify at least three tariff blocks on a rising schedule such that:

a) a "lifeline" tariff is charged for no less than 5kl and no more than 10kl of water per customer unit per month, and set at a rate *which does not exceed* the *true* O&M expenses (that is, using a strict interpretation of O&M expenses applied to both bulk water and distribution – see section 6.2.4);

b) for consumption in excess of 10kl and up to 30 kl per customer unit per month a charge is levied that covers *at least* the average historic cost (AHC) of providing the water;

c) all water consumed in excess of 30 kl per month is charged for at a higher rate, taking into account the need for conservation and the economic, social and environmental costs of capacity expansion.

7.1.1 The "lifeline" tariff

Note that the Regulations provide only for a *maximum* "lifeline" tariff. There is nothing to prevent a service provider charging a rate below the maximum where this is feasible, or even providing a certain minimum amount free of charge. Lower life-line rates or free water will provide a valuable form of social security for the very poor and can have major advantages in terms of health and customer goodwill. This goodwill can in turn impact on the willingness of customers to pay their bills. If the first basic amount of water were to be free, it would, however, be important that the amount be strictly limited and that water meters be read and customers correctly billed for additional use. The issue of payment for water is a controversial one, but a case can be made for the need for at least some form of payment, on the grounds that payment can help to instil a sense of value in the commodity and strengthen a community's requirement for accountability on the part of the water service provider.

However, as indicated previously, there may be (rare) circumstances in some urban areas where additional subsidies to support the life-line tariff may be necessary. No mechanism has been developed whereby such circumstances can be evaluated and appropriate criteria used for the determination of a suitable subsidy.

7.1.2 Setting tariffs for higher consumption blocks

Water service providers not only need to comply with the Regulations concerning residential tariffs, but need to ensure that their revenue requirements are met. These revenue requirements should include provision for asset replacement and a capital

[16] Projecting demand is dealt with in Module 4.

reserve fund for future capacity expansion. Therefore, tariff rates for consumption in excess of the "lifeline" amount and, in particular, in excess of 30kl per month need to be set in such a way that revenue requirements are met. Rates for non-residential customers also need to be set bearing revenue requirements in mind. These may be used to help subsidise "lifeline" rates, although this will be a local decision.

When setting rates for the higher blocks, the effects of increases in the price of water on consumption need to be taken into account. Significant increases are likely to result in reduced consumption, which will impact on the operating costs, the revenue received and future capital costs.[17]

7.1.3 Fixed monthly charges

The Regulations make no provision for fixed monthly charges. Fixed charges are regressive in the sense that they result in a higher average cost per unit of water bought at low levels of consumption than at high levels. For areas in which there is only a normal seasonal variation in demand, this characteristic of a fixed charge may outweigh any advantages in terms of revenue stability. However, as previously discussed, in towns with large seasonal variations (such as holiday towns) both revenue stability and fairness suggest the need for a fixed monthly charge. The capacity that exists to cater for in-season demand needs to be financed and maintained even when not in use, and it stands to reason that those who use the capacity need to cover these costs. This applies to both residential and non-residential customers whose demand is highly seasonal, such as the owners of holiday homes, hotels and certain forms of food-processing.

In setting fixed monthly charges it is advisable to differentiate between customer groups so as to reduce the regressive nature of such charges. For example, a minimal or no charge could be levied for yard taps and similarly for in-house connections in poor areas or, if administratively possible, for all residential customer units with incomes below a certain level.[18] Within the non-residential sector the fixed monthly rates for highly seasonal customers could be higher than those for all-year-round customers, at least during the months of low consumption.

7.1.4 Charging for standpipe water

International and local experience suggest that recuperating the costs of standpipe supplies in urban areas is notoriously difficult (PDG 1994b). Charges are normally levied on a flat rate based on average consumption. This is inequitable since small users pay the same amount as large users and households close to the standpipes are better located to use (and abuse)[19] the service. Bills are not related to use and so there is no incentive to save water by turning taps off properly, reporting leaks etc.

Water can be charged for by providing standpipe attendants. Local and international experience, however, suggests that this significantly raises the cost of distribution, is administratively burdensome and can lead to conflict, while standpipe attendants earn very little (CSIR 1997; PDG, 1994b; PDG, 1994d; Rivett-Carnac 1989). Charging a high price for this water would be inequitable since it is the poorest who would be

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[17] See Module 4.

[18] See footnote 8 regarding fixed monthly charges in Hermanus.

[19] Abuse can take the form of "private connections" into the standpipe, exercising monopoly control over the standpipes and using the water for vending purposes in areas without supplies (PDG, 1994).

making use of the service. The service could be subsidised, but this would defeat the purpose of cost recovery since it may well be cheaper for the service provider simply not to charge for standpipe water.

The use of pre-payment water dispensers is an option that is currently being tested in South Africa. For example, Rand Water is currently running pilot projects in the Winterveld and Modderspruit to evaluate their feasibility. A number of pilot projects are also in progress with the Umgeni and Magalies Water Boards. Indications thus far are that these systems can significantly improve the efficiency of service provision by reducing billing and administration costs, reducing non-payment, and improving the information available to management. The durability and resistance to vandalism of the systems however remain to be seen. If these systems prove cost-effective it may be a sensible approach (see *CSIR, 1997*).

In the interests of equity, and given the problems outlined above, service providers might be advised to provide on-site connections in urban areas to the extent that this is financially viable, in the form of metered yard taps, house connections or yard tanks, as appropriate.[20] International research and local anecdotal experience suggests that customers are far more willing to pay for individual connections than for water from communal standpipes (PDG, 1994b; Evans, 1992). Where standpipes are used, the most sensible approach for service providers who can afford it may be to provide the water free of charge or at a highly subsidised rate.[21]

Where payments for water from communal standpipes are necessary, flat monthly rates are, at this stage, probably the best option, subject to the outcome of the trials with pre-payment dispensers. These rates should be determined together with the community after careful assessment of willingness to pay for the service.[22] It is also important that structures be in place to minimise abuse and wastage.

7.1.5 Multiple residential units

The Regulations specify that new dwelling units in single occupancy must be fitted individually with water meters (Part II, 27 (7)). Existing multiple-dwelling units, such as blocks of flats and townhouse complexes, are, however, frequently served by a single meter and individual units are charged a set rate to recover the owner's payment to the service provider. The introduction of a rising block tariff will be unfair to households in such accommodation if the bulk of the water consumed is charged for at high rates. Possibly the simplest way to deal with this situation would be to charge multiple-residential units on a constant block-rate schedule. However, this would be unfair because households in multiple dwelling units would pay more for water in the lowest block and less for "luxury" consumption than households in single units. Small customers would be at a disadvantage and large customers at an advantage compared to their single unit counterparts.

An alternative, and fairer, method would be to define consumption blocks for each multiple unit in such a way that the separate units are treated as if separately metered.

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[20] The issue of service levels, costs, payments and acceptability are discussed in Module 4.

[21] This unfortunately raises the issue of equity between rural and urban areas. While it may be feasible to provide free water from communal supplies in many urban areas, this is unlikely to be the case in rural areas.

[22] Methods of assessing willingness to pay are discussed in Module 4.

The blocks would depend on the number of dwelling units in the complex. For example, assume that the tariff schedule for single residential units is as follows:

Block 1 = 0 – 10 kl, cost = R1.00/kl
Block 2 = 10-30 kl, cost = R2.00/kl
Block 1 = > 30 kl, cost = R4.00/kl

The schedule for a block of flats with 20 individual units would be:

Block 1 = 0 – 200 (10 x 20)kl, cost = R1.00/kl
Block 2 = 200-600 (30 x 20) kl, cost = R2.00/kl
Block 3 = > 600 kl, cost = R4.00/kl

The total bill would then be the same as the bill for 20 separately metered units together consuming the recorded amount, and it would then be up to the owner to charge tenants fairly. This system has the additional advantage of providing an incentive for the owner to encourage water conservation. This method of charging is based on residential unit equivalents (RUEs).

7.2 Tariffs for non-residential customers

7.2.1 Classification of customer types

Non-residential users comprise a range of different establishments. The convention adopted in the guideline series (see Module 3) is to classify these as follows:

- *Institutional customers* such as schools, clinics, hospitals and churches.
- *Commercial customers*, for example, services, wholesale and retail activities.
- Non-water-intensive *"dry" industrial customers*, that is, industries that do not use water intensively.
- Water-intensive *"wet" industrial* and other *customers*, that is, industries and economic activities that use water in their manufacturing or "core" processes, such as the beverages, fruit canning and laundry industries.

The Treasurer's Task Team of the Finances Committee of the Major Urban Areas Association (Major Urban Areas Association, 1996) recommended a constant block rate structure for non-residential customers. However, in selecting the most appropriate structure and determining the actual rates for different types of non-residential customers in a particular area, a number of issues need to be taken into consideration.

7.2.2 Factors to consider in setting non-residential tariffs

- **Responsibility for average historic costs**
  The non-residential sector as a whole must cover at least the full cost of service provision, including contributions to stabilisation and capital reserve funds. The average price of water should therefore be at least the average historic cost (AHC) of service provision.
  The simplest method of calculation is that stipulated in the Regulations for the second block for residential tariffs, as follows:

(Total O&M costs + total capital related costs) / (total amount of water provided)

If a differentiated tariff is to be adopted based on costs, the cost of providing the service to each category needs to be assessed (see Table 9 and Table 10).

- **Responsibility for future capacity expansion**
  To the extent that non-residential use is responsible for capacity expansion, the price these customers pay for water should be higher than the current AHC. Some of the surplus generated should be saved in a fund for future expansion and some may be used to cross-subsidise small residential customers.

- **Economic growth**
  The potential impact of water tariff increases on economic stability and growth needs to be assessed. This applies particularly to sunk investments in productive capacity in "wet" industries. In general, it is unlikely that tariff increases will have a marked impact on the economic viability of "dry" industry and other commercial activity where the cost of water represents a very small share of input costs. The location of new industrial development, especially water-intensive industries, should be based on the marginal cost of capacity expansion (DWAF, 1986).

- **The need to encourage conservation**
  Ideally, non-residential tariffs should be so structured as to encourage conservation (as is the case for residential tariffs). A rising block rate schedule is an effective way of structuring tariffs to encourage conservation. The application of a rising block rate to non-residential customers is, however, complicated by the diversity of size, water consumption patterns and the productivity of water use. The application of a rising block rate schedule along the lines of the residential tariff schedule may be unfair, because large customers would pay a higher average price for their water while small customers would pay a lower price regardless of how productively the water was used. The steeper the increase in the block rates, the more unfair the system would be. One way of dealing with this problem would be to define blocks for each class of non-residential customers and, in the case of "wet" industries, for each individual industry. In order to do this, sensible methods would need to be devised. This could prove to be fairly time-consuming, and the process would need to be understood and accepted as fair by all parties concerned.

  An alternative method that has been applied is to convert non-residential customers to "residential unit equivalents" (RUEs) on the basis of consumption[23]. For example, let a RUE be set at 40kl per month. An industrial customer using 400kl would be converted to 10 RUEs for that month. Using the illustrative residential tariffs for Town A show in table 7, this consumer would than effectively pay R0.94/kl for the first 100kl (Block 1 rate), R2.32/kl for the next 200kl (Block 2 rate) and R4.35/kl for the last 100kl (Block 3 rate). Since it would not be sensible to charge this consumer at the "lifeline" rate for the first 100kl, it would be necessary to levy a fixed charge per RUE of, say R20 per month. This would effectively increase the price of the first block to R2.94/kl.

[23] This system is currently used in Hermanus and was introduced as part of the Water Conservation Campaign.

The tariffs structure recommended by the Treasurers Task Team of a constant block rate schedule would be much simpler to implement and administer. It would, however, be likely to have a smaller effect on water conservation than a rising block tariff.

- **Revenue requirements**
  In practice, the rate for block 3 of the residential schedule and the rates for non-residential customers will need to be set with reference to the revenue requirements of the service provider. Sufficient income will need to be generated to subsidise the "lifeline" block and make provision for contributions to capital reserve funds, and decisions will need to be made regarding the proportions of this income to be obtained from the residential and non-residential sectors respectively.

8. AFFORDABILITY, WILLINGNESS TO PAY AND ENFORCEMENT

The issue of willingness to pay is discussed in some detail in the module "Customer profile and demand for services". Suffice it here to say that there are many factors affecting willingness to pay, of which price is only one. Price is, however, important, and in setting tariffs cognisance must be taken of how rates compare to those for other services, what the tariffs mean in terms of monthly bills, what alternatives there are to the services offered and what income levels prevail in the area concerned. An understanding of local perceptions regarding the service and the "fairness" of the payments required is equally important. In South Africa a range of other factors affect willingness to pay, and non-payment has indeed virtually reached the status of a "culture" in some communities. Recreating a "culture" of payment will require a range of actions such as proper communication between service providers and communities, enforcement of sanctions, upgrading the quality of service provision and more. But setting tariffs that are seen by all parties as "fair" is an essential component of the process.

9. GENERATING AND USING SURPLUSES

Most local authorities generate a surplus on their water services account, and use this to subsidise the provision of other services. The question arises as to what an acceptable surplus is, and to what use this may be put.

An investigation during the mid 1980's found that the surpluses generated varied between local authorities, and averaged around 10 percent. No legislation or guidelines have however been formulated regarding an acceptable level of surplus, nor the specific uses to which this surplus may be put (personal communication with Mr H. Venter, past president of the Institute of Municipal Treasurers and Accountants)[24].

The question of course arises regarding the extent to which increases in the price of bulk water will affect the ability of the service provider to generate a surplus (see section 2.4). Alternatively, or in addition, a certain amount of the surplus might need to passed on to first tier providers for water resource development. Unless service providers are willing to increase their prices fairly significantly - and customers are

[24] The accounting principle applied is that the surplus is transferred to the Rates and General account, and disbursed from there.

willing to pay the higher prices - they may find themselves unable to generate surpluses from water to the extent that was possible in the past.

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WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Annexure 1

A "COST-OF-SERVICE" BASED METHOD FOR SETTING WATER SUPPLY TARIFFS IN SOUTH AFRICA

January 1998

PALMER DEVELOPMENT GROUP

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1. INTRODUCTION

1.1 Methodology

This annexure describes a procedure for setting tariffs based on the cost of service provision. The intention is to describe a method for determining the various cost components of a water supply service so that tariff related decisions can be made in a transparent manner and the extent of cross-subsidisation is apparent.

The procedure involves the following steps (see Figure 1):

- collection and analysis of billing and budgetary data;
- allocation of annual expenses to the functional cost components;
- distribution of the component costs to the various customer classes in accordance with their requirements for service;
- design of water tariffs for each class of customer.

1.2 Sources

Much of the information used to compile this module has been drawn from manuals published by the American Water Works Association (AWWA). The method adopted here for allocating and distributing costs closely follows the methodology presented in these manuals. A number of adaptations have been made to suit the South African situation, however, particularly with regard to the categorisation of the components of water supply systems, the separation of residential customers into distinct groups by service type, and the introduction of the concept of the "equivalent customer". The final step of tariff determination applies the policy on water tariffs of the Department of Water Affairs and Forestry as expressed in the White Paper of 1994 (DWAF, 1994). The data used for the calculations are drawn from an actual South African town.

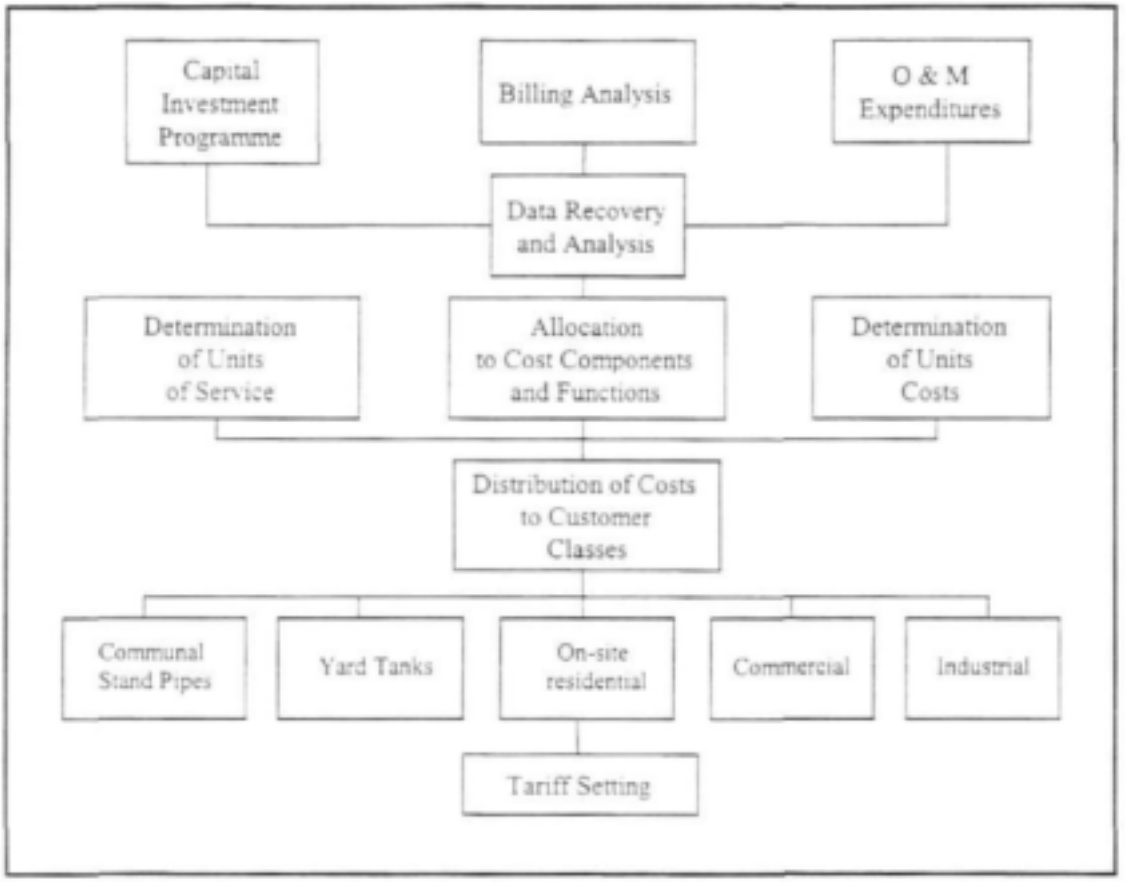
2. DATA REQUIREMENTS

The information required to determine tariffs includes data relating to the following:

- types of customers;
- service levels of the different types of customers;
- numbers of customers in each category;
- size of water meter (if any) serving each customer
- the monthly levels of consumption for each customer including estimates of consumption for unmetered connections; and
- the costs of providing the water service.

The accuracy of tariffs is dependent on the quality and detail of the available data. The more detailed the data set the more accurately tariffs can be set to reflect the cost of service incurred by the various customer groups. The data from such an analysis serves as the basis for the development of effective and equitable tariff structures. Generally the above data can be obtained from a summary and analysis of all bills issued by the water service provider over a certain period, as well as its annual budgets and financial statements. Estimates of the consumption of unmetered connections may not be readily available, but will need to be made.

Figure 1: Schematic of tariff-setting procedure



2.1 Water consumption data

The water bills issued by a water service provider for a particular historical period provide valuable information on the number of customers billed and the consumption patterns of metered customers. Estimates of the consumption of unmetered customers need to be made with reference to both local knowledge concerning consumption patterns and the total amount of water used by the service provider. Specifically, estimates must be made in such a way that the following holds true:

metered water sold + unmetered water provided + water lost in distribution = total water used

The period of analysis should preferably be at least a year and should ideally coincide with the fiscal year of the water service provider so that the results derived from the billing analysis can be correlated with the figures in the financial statements. The year selected should be representative of average consumption levels and preferably not a year in which water usage was abnormally high or low, due to climatic or other conditions.

Consumption data should then be organised into consumption blocks so that consumption patterns may be observed. It is essential to do this if a block rate tariff schedule is to be designed. Table 1 provides an example of consumption data for residential customers. From this information both the distribution of consumption patterns across residential customers and seasonal factors may be observed. Similar tables are required for other customers.

Table 1: Summary sheet of water consumption of residential customers

Consumption Block (kl/mnth)	Number of Bills per Consumption Block													Total Bills per mnth
	0-5	6-10	11-15	16-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	>100	
Jul	3 727	1 153	922	574	652	268	134	72	58	23	21	17	116	7 621
Aug	4 247	1 227	802	511	453	154	76	37	29	20	12	6	163	7 574
Sep	3 757	1 197	869	566	619	259	117	64	49	37	13	17	172	7 564
Oct	2 891	1 262	994	656	815	377	210	114	70	53	34	25	233	7 501
Nov	2 830	891	856	702	903	475	278	182	106	82	64	49	316	7 418
Dec	2 161	817	856	724	1 043	620	420	245	218	106	104	60	367	7 374
Jan	1 543	638	789	870	1 208	819	551	344	245	144	90	85	412	7 326
Feb	2 135	714	702	699	990	643	436	301	225	176	136	77	501	7 234
Mar	2 336	890	858	739	937	614	343	216	145	119	88	59	394	7 344
Apr	2 035	1 107	1 079	785	1 034	518	350	200	123	77	50	44	337	7 402
May	2 441	1 013	941	699	981	529	316	166	134	91	67	41	319	7 419
Jun	3 275	1 252	1 022	665	724	303	148	79	66	32	23	18	130	7 607
Average No. of Bills per month	2 782	1 013	891	683	863	465	282	168	122	80	59	42	288	7 449
Total No. of Bills per annum	33 378	12 161	10 690	8 190	10 359	5 579	3 379	2 020	1 468	960	702	498	3 460	89 384

3. COSTS

In order to set tariffs according to the cost of service provision for each customer, a detailed set of data relating to costs needs to be prepared.

3.1 Test year

Cost analysis requires the choice of a test year or test period which is the annualised period for which costs are to be analysed and rates established. The test year may be a historical year, a future year, or a mixture of the two. The choice of an appropriate test year is often controversial because it involves a trade-off between the certain nature of historic costs and the speculative nature of future costs. Accounting theory may be more compatible with historic data, while economic theory – marginal-cost pricing in particular – is forward-looking.

Once revenue requirements are established for the test year of choice, the next step in tariff-setting is to allocate the costs associated with those requirements to particular functional areas and to customer classes.

4. ALLOCATION OF SERVICE COSTS

Cost-allocation involves the assignment of costs to components and functions of the water department. The costs are allocated according to the extent that they can be attributed to their origins, but there is always an element of subjectivity in this procedure. Thus the results of any cost-allocation process cannot be considered objective, but is necessary if tariffs are to based on the costs of service provision.

4.1 Methods of cost of service allocation

There are many different methods for allocating the costs of a service provider. Methods which allocate costs on the basis of the capacity requirements of the various users are called fully allocated methods (AWWA, 1991). There are essentially three approaches:

- the peak responsibility method;
- the non-coincidental peak method;
- the average and excess demand method (which is really a combination of the two previous methods).

a) The peak responsibility method

This method is based on the allocation of costs according to customers' responsibility for the system peak demand. The method accounts for the costs associated with the magnitude and timing of peak demand, but does not take account of average demand. Thus there is no capacity cost assigned to off-peak users.

A criticism of this method is that there is a potential for shifting peaks as large customers re-schedule their demand patterns to avoid high tariffs. Another criticism is that off-peak customers are presumed not to affect capacity requirements or capacity costs, which is not always true – for example, more off-peak capacity is required to allow for off-peak customers than would be needed for routine system maintenance.

b) The non-coincidental peak method

This method allocates costs on the basis of customer contribution to the peak demand, but do not take into account the timing or the average demand. The cost-allocation basis is therefore each customer class's contribution to the sum of maximum demands

for all customer classes. Thus, as with the peak coincidental method, the method does not account sufficiently for the costs incurred by off-peak demand. Also, because the timing aspect of peak demand is not recognised but rather the sum of each customer class's maximum demand, the allocation of peak costs are, at best, an approximation of the origin of peak costs. An example of this type of method is the commodity-demand method which is described in detail in AWWA's manual on water rates (AWWA, 1983).

c) Average and excess demand method

This method is based on the non-coincidental peak methodology and allocates costs on the basis of both demand and consumption. Thus it recognises the contributions of both peak and average demand to capacity costs but ignores the timing of demand in the allocation of costs. The costs allocated on the basis of average demand represent the minimum revenue necessary for cost recovery for delivery of a uniform service. The average-excess demand method has been selected here because it recognises both peak and average demand.

4.2 Cost-allocation procedure

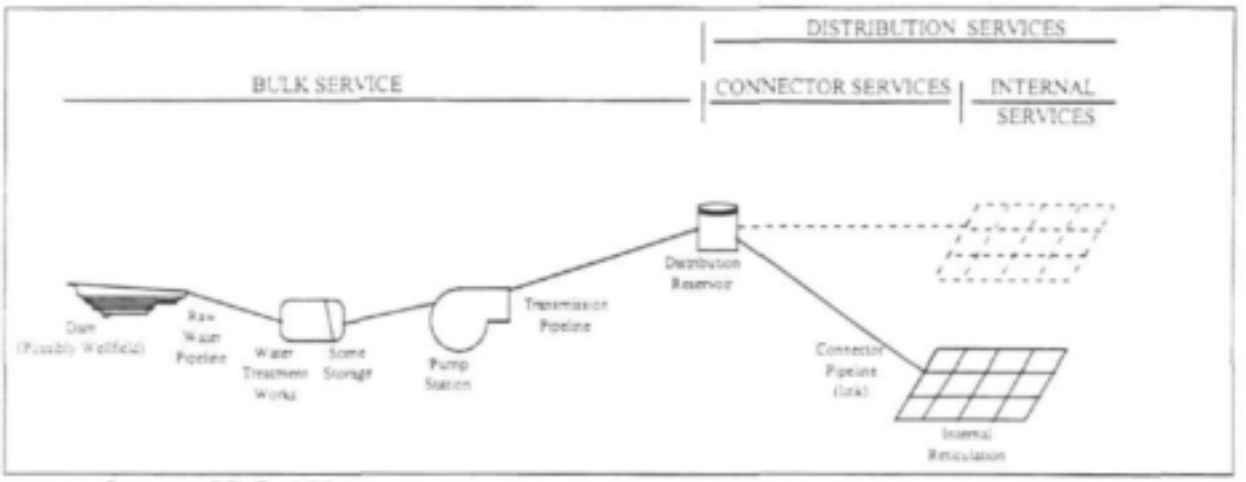
The first step in allocating costs is to categorise the costs according to functional components of the water system:

- water source;
- pumping;
- transmission;
- treatment;
- storage;
- connector pipelines;
- reticulation;
- customer accounting;
- planning and design; and
- administration.

These costs can be aggregated into the following categories (see Figure 2):

- bulk costs;
- connector service costs;
- internal service costs;
- customer costs;
- fire service costs.

Figure 2: Classification of the components of water supply systems



Source: PDG, 1994.

Bulk costs are the costs related to the source of supply, raw and treated water pumping, water treatment and transmission mains; *connector service costs* are those associated with the distribution reservoirs and the connector mains; and *internal service costs* are costs relating to reticulation infrastructure. *Customer costs* relate to metering, billing, collections and customer service; *fire service costs* are the costs associated with meeting the flow requirements to fight fires.

4.2.1 Cost allocation to bulk, connector and internal service functions

Bulk costs, connector service and internal service costs are further divided into base-capacity costs and extra-capacity costs. *Base-capacity costs* are costs that are incurred in providing a water supply service at the annual average demand conditions. *Extra-capacity costs* are costs associated with meeting demand in excess of the annual average demand, and include operation-and-maintenance expenses and capital costs related to meeting peak demands.

The allocation to base-capacity and extra-capacity components is done on the basis of the annual average flow rate, the annual maximum daily flow rate and the annual maximum hourly flow rate. For example, if a system has an *annual average flow* rate to *maximum daily flow rate* ratio of 1:1.54 and an *annual average flow* rate to *annual maximum hourly flow rate* ratio of 1:2.22, then facilities designed to meet maximum-day requirements may be allocated 65 percent (1/1.54) to the base-capacity cost component and 35 percent (0.54/1/54) to the maximum-day extra-capacity cost component. Facilities designed to meet maximum-hour requirements would be allocated 45 percent (1/2.22) to base-capacity cost and 55 percent (1.22/2.22) to the maximum-hour extra-capacity cost. This is a simplistic procedure but is used here as more theoretically sound procedures are too complex.

a) Bulk costs

All costs related to the source of supply, bulk pumping facilities, water treatment facilities and transmission infrastructure are categorised as bulk costs. Costs associated with the source of supply are allocated entirely to the base-capacity cost component, as such facilities are sized to meet annual supply requirements in total, whether or not variations in daily needs are experienced. If the source of supply includes a groundwater supply, a portion of the costs for source of supply may be

allocated to maximum-day or maximum-hour extra-capacity, depending on the basis of design or consumption characteristics associated with the borehole supply.

Chemical costs due to water treatment processes tend to vary directly with water consumption and are thus assigned directly to the base-capacity cost component. Other costs related to water treatment (excluding chemical costs) are allocated on the basis of the maximum-day extra-capacity component.

Power costs (especially for pumping) are allocated principally to the base-capacity cost component. The cost of power to satisfy peak demand should be allocated to the extra-capacity component to the degree that it varies with average pumping requirements. In Tables 4 and 5, pumping power is allocated 10 percent to the maximum-day extra-capacity cost component in recognition of this factor, with the balance of power costs (90 percent) being allocated to base-capacity cost. The extent to which power costs are allocated to the extra-capacity cost component depends on the variation in electricity demands incurred in pumping and the electricity tariff structure applicable to pumping.

Any other bulk or connector costs (other than customer-related costs) are allocated to cost components on the basis of the design extra-capacity requirements of each facility – for example, costs associated with the transmission supply mains are allocated on the basis of the maximum-day extra-capacity component.

b) Connector service costs

Connector service costs are those associated with the distribution reservoirs and the connector mains. Water-towers, if used, and the pumping costs associated with them are included here. Costs relating to the connector mains are allocated on the basis of maximum-hour extra-capacity. Water-tower costs are also allocated according to maximum-hour extra-capacity costing, as their main function is to provide for the peak hourly demand requirements of the system. Distribution reservoir costs are allocated to maximum-day extra-capacity, as design is based on peak daily demand. Reservoirs also provide an element of system reliability, and thus the base-capacity cost component should be assigned a small portion of the costs of such facilities. The percentage factor used in the allocation of distribution reservoir costs is largely dependent on engineering judgement and the operating characteristics of the reservoirs in each particular system. In the example given in Tables 4 and 5 reservoir costs are allocated on the basis of 90:10 (maximum-hour: base-capacity).

c) Internal service costs

Costs related to internal services are made up of salaries and wages, repairs and maintenance, general expenses, meters and services expenses, and fire service expenses. The first step in allocating these costs to the internal service costs is to identify the costs attributable to the customer (meters and services component) and fire service cost functions and allocate them accordingly. The allocation is made on the basis of some reasonable factor derived from the service records of the water department, such as maintenance records of person-hours spent on servicing meters and fire-hydrants, or the number of employees assigned to each function. Costs directly attributable to meters and fire hydrants are allocated directly to their respective cost functions.

The remaining costs are allocated to the Internal Service Base- and Extra-capacity components. This allocation is made on the basis of maximum-hour capacity because reticulation facilities are designed to meet the maximum hour requirements.

4.2.2 Cost allocation to the billing and collecting cost function

Billing and collecting (mainly meter reading) costs form part of the Customer Service Cost Function. The allocation of costs to this function is especially significant if a municipality is considering a fixed service charge for customers (discussed in further detail in section 6.3.2). All expenses directly related to customer billing and collecting are allocated directly to the customer cost function. The meters and services component of this cost function is derived from the costs associated capital outlay for the meters and with servicing the meters.

4.2.3 Cost allocation to the fire service cost function

Fire service costs are those associated with meeting the servicing and capacity requirements to fight fires. A portion of the reticulation costs, administration costs and planning and design costs are allocated to this cost, as discussed in previous and following sections. Any costs that are directly attributable to fire hydrants are allocated to the fire service cost component.

4.2.4 The allocation of general overhead costs to cost functions

General overhead costs are costs associated with administration and planning and design. These costs are associated with all the cost functions and need to be apportioned on a logical and representative basis. If data are available on the value of office buildings, furniture and equipment, vehicles, and other general plant, an analysis of the apportionment of these assets to the functional components of the system can be used as the basis for allocating general overhead costs (i.e. planning and design and administration costs), excluding salaries and wages and fringe benefits. Salaries and wages are allocated on the basis of their apportionment to cost functions.

4.3 Worked example

The cost-allocation procedure discussed above is illustrated in Tables 3 and 4. A matrix of the allocation factors used is given at the bottom of each table.

Table 2: Allocation of operation and maintenance costs to functional components

Item	TOTAL	BULK		CONNECTOR		INTERNAL SERVICES		CUSTOMER COSTS		FIRE
		Base Capacity	Capacity: Max Day	Base Capacity	Capacity: Max Hour	Base Capacity	Capacity: Max Hour	Meters & Services	Billing & Collecting	SERVICE
Source of Supply										
Salaries,Wages and Allowances	74 064.00	74 064.00								
General Expenses	539 142.00	539 142.00								
Repairs and Maintenance	15 286.00	15 286.00								
Pumping										
Salaries,Wages and Allowances	0.00	0.00	0.00							
General Expenses	0.00	0.00	0.00							
Repairs and Maintenance	0.00	0.00	0.00							
Purchased Power	0.00	0.00	0.00							
Water Treatment										
Salaries,Wages and Allowances	296 256.00	192 566.00	103 690.00							
General Expenses	156 568.00	101 769.00	54 799.00							
Repairs and Maintenance	56 144.00	36 494.00	19 650.00							
Chemicals	275 000.00	178 750.00	96 250.00							
Transmission Mains	55 000.00	35 750.00	19 250.00							
Connector Service										
Distribution Storage	50 000.00			5 000.00	45 000.00					
Connector Mains	80 000.00			36 000.00	44 000.00					
Reticulation										
Salaries,Wages and Allowances	549 980.00					192 493.00	302 489.00	0.00		54 998.00
General Expenses	179 750.00					62 913.00	98 863.00	0.00		17 975.00
Repairs and Maintenance	13 870.00					4 855.00	7 629.00	0.00		1 387.00
Meters and Services	80 000.00							80 000.00		
Hydrants	0.00									0.00
Customer Accounting										
Meter Reading and Collection	56 500.00								56 500.00	
Uncollectable Accounts	42 000.00								42 000.00	
Administration										
Salaries,Wages and Allowances	260 000.00	26 000.00	13 780.00	26 000.00	13 780.00	26 000.00	23 400.00	50 960.00	71 760.00	8 320.00
General Expenses	884 180.00	88 418.00	46 861.54	88 418.00	46 861.54	88 418.00	79 576.20	173 299.28	244 033.68	28 293.76
Repairs and Maintenance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	3 663 740.00	1 288 239.00	354 280.54	155 418.00	149 641.54	374 679.00	511 957.20	304 259.28	414 293.68	110 973.76
Allocation Factors										
Source		1	0							
Maximum Day Designed Facilities		0.65	0.35							
Maximum Hour Designed Facilities				0.45	0.55					
Pumping		0.9	0.1							
Chemical		1	0							
Distribution Storage				0.1	0.9					
Reticulation						0.35	0.55	0		0.1
Planning and Design		0.1	0.053	0.1	0.053	0.1	0.09	0.196	0.276	0.032
Admin : Salaries & Benefits		0.1	0.053	0.1	0.053	0.1	0.09	0.196	0.276	0.032
Admin : Other		0.08	0.04	0.08	0.04	0.07	0.09	0.2	0.38	0.02

Table 3: Allocation of capital-related costs to functional components

Item	TOTAL	BULK		CONNECTOR		INTERNAL SERVICES		CUSTOMER COSTS		FIRE
		Base Capacity	Capacity: Max Day	Base Capacity	Capacity: Max Hour	Base Capacity	Capacity: Max Hour	Meters & Services	Billing & Collecting	SERVICE
Source-of-Supply Plant:										
Interest & Redemption	1 195 468.00	1 195 468.00								
Contributions to Funds		0.00								
Contributions to Capital Outlay		0.00								
Pumping plant:										
Interest & Redemption		0.00	0.00							
Contributions to Funds		0.00	0.00							
Contributions to Capital Outlay		0.00	0.00							
Treatment Plant										
Interest & Redemption	68 312.00	44 402.80	23 909.20							
Contributions to Funds	15 030.00	9 769.50	5 260.50							
Contributions to Capital Outlay	1 500.00	975.00	525.00							
Transmission Mains										
Interest & Redemption		0.00	0.00							
Contributions to Capital Outlay		0.00	0.00							
Connector Services										
Interest & Redemption	606 640.00			60 664.00	545 976.00					
Contributions to Capital Outlay				0.00	0.00					
Reticulation										
Distribution Network										
Interest & Redemption	350 000.00					122 500.00	192 500.00	0.00		35 000.00
Contributions to Funds	37 200.00					13 020.00	20 460.00	0.00		3 720.00
Contributions to Capital Outlay	12 500.00					4 375.00	6 875.00	0.00		1 250.00
Meters										
Interest & Redemption	2 000.00							2 000.00		
Contributions to Capital Outlay								0.00		
Fire Hydrants										
Interest & Redemption	2 500.00									2 500.00
Contributions to Capital Outlay										0.00
General Admin:										
Interest & Redemption		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Contributions to Funds	1 430.00	114.40	57.20	114.40	57.20	100.10	128.70	286.00	543.40	28.60
Contributions to Capital Outlay		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	2 292 580.00	1 250 729.70	29 751.90	60 778.40	546 033.20	139 995.10	219 963.70	2 286.00	543.40	42 498.60
Allocation Factors										
Source		1	0							
Maximum Day Designed Facilities		0.65	0.35							
Maximum Hour Designed Facilities				0.45	0.55					
Pumping		0.9	0.1							
Chemical		1	0							
Distribution Storage				0.1	0.9					
Reticulation						0.35	0.55	0		0.1
Planning and Design		0.1	0.053	0.1	0.053	0.1	0.09	0.196	0.276	0.032
Admin : Salaries & Benefits		0.1	0.053	0.1	0.053	0.1	0.09	0.196	0.276	0.032
Admin : Other		0.08	0.04	0.08	0.04	0.07	0.09	0.2	0.38	0.02

5. DISTRIBUTION OF COSTS TO CUSTOMER CLASSES

5.1 Introduction

In the previous section, costs were allocated to the functional components of the water service provider. In order to set tariffs to equitably recover these costs from the users of the system, the proportion of the responsibility that each customer bears for the costs assigned to each component needs to be determined.

5.2 Customer classes

For the purposes of tariff-setting the ideal would be to assign cost responsibility to each individual customer. This would be inordinately time consuming, however, and may not even be possible. A reasonable assessment of cost responsibility can be determined for classes of customers with similar water consumption characteristics while treating large customers with unusual service requirements separately. The criteria for classifying customers into customer classes include:

- service characteristics, e.g. water treated or not; bulk supply or household supply; and
- demand patterns, e.g. peak demands – daily and seasonal, levels of consumption.

5.2.1 General classes

The four principal customer classes typical of most water utilities are (AWWA, 1991):

- *Residential*: One-family dwellings, (usually physically separate) and multi-family apartment buildings.
- *Commercial*: Non-residential, non-industrial business enterprises, typically offices, shops, hotels, etc.
- *Industrial*: Manufacturing and processing establishments.
- *Institutional*: Governmental customers, including schools, parks, and other public buildings, (sometimes grouped together with commercial customers).

These customer classes can be further divided into sub-classes. For example, in South Africa residential customers can be divided according to the level of service (see "Customer profile and demand for services"):

- standpipes;
- yard tanks;
- yard taps;
- house connections.

5.2.2 Customers purchasing bulk water

Water is sometimes sold in bulk to certain customers (such as a neighbouring municipality or a large industry or a mine). Treated water is provided in most cases, but on occasion raw water is provided.

5.2.3 Fire-protection service

Fire-protection service is different from other types of water service, because the service provided is mainly of a standby nature. In other words, the service entails a readiness to deliver relatively large quantities of water for short periods of time at any of a large number of points in the water distribution system, while the total annual quantity of water delivered is relatively small.

Table 4: The number of "equivalent customers" attributable to the various customer classes

Consumer	Type of Consumer Unit	Number of Consumer Units	Cost factor*	Equivalent Consumers	Total Equivalent Consumers
Residential					
Stand-pipes	household	410.0	0.3	123.0	123.0
Yard-tanks	household	161.0	0.7	112.7	112.7
House connections					
Single dwelling <500 m^2	household	500.0	1.0	500.0	
Single dwelling >500 m^2	household	86 784.0	1.5	130 176.0	130 176.0
low-rise	household	900.0	1.0	900.0	
high-rise	household	1 200.0	0.8	960.0	1 860.0
Commercial					
Small		176.0	1.0	176.0	
Other					
hotels	rooms	300.0	0.3	90.0	
camp/caravan sites	sites	150.0	0.2	30.0	
office floor space	100 m^2 floor space	100.0	1.0	100.0	396.0
Industry	30 kl/month water use	10.0	10.0	100.0	100.0

* Source PDG, 1994

5.3.5 Fire service costs

The units of service used to assign costs to the fire protection component are the maximum-day and maximum-hour flow rates, expressed in Ml/day, required to provide for a flow for fire-fighting of four consecutive hours on any one day.

5.3 Units of service

In order to set tariffs according to the cost of service delivery, the costs of the different components of the system must be allocated to the respective customer classes. Responsibility for each component may be expressed in terms of the number of *units of service* required by each class. Units of service need to be determined to both equitably reflect the cost responsibility of customer classes and be available or determinable from the local municipality's standard data base. The units of service for the respective cost components that have been used in the worked example given in Table 8 are discussed in the following paragraphs.

5.3.1 Bulk and connector costs

The units of service used to distribute the costs associated with bulk and connector services are the annual water consumption figures for each class in Megalitres (Ml). Both average daily and peak flow demands are used.

Base-capacity costs are the costs that would be incurred in supplying water at perfect load factor (that is, at a continuous, uniform rate), without costs incurred in providing extra plant capacity for variation in the consumption rate beyond a uniform rate. Thus the unit of service for the allocation of base-capacity costs is the total annual water consumption per customer class.

Extra capacity costs for maximum-day and maximum-hour services are incurred in providing facilities to furnish water at varying rates above the average. Extra-capacity costs are determined using the average consumption rate in mega-litres per day (Ml/day) as a function of a maximum-day or maximum-hour extra-capacity factor, expressed in terms of the percentage of the class maximum-day consumption as to the average annual consumption; for example, if a customer class maximum-day consumption is 2.5 times its average rate, it is said to have a maximum-day extra-capacity factor of 250 percent. This yields the maximum consumption level in (Ml/day). Extra-capacity is then the difference between maximum consumption level (expressed as total capacity in Table 8) and average consumption rate.

5.3.2 Internal service costs

The unit of service used for the distribution of costs associated with internal costs to customer classes is based on the number of "equivalent customers" per class (see Table 6). The number of "equivalent customers" is derived by applying a cost factor to each customer based on the level of service, size of property and nature of costs provided. The cost factor used in each case has been based on ratios derived from the results of a study done on the cost of the various levels of service for water supply systems (PDG, 1994).

5.3.3 Customer meter and service costs

Distribution of the costs associated with meters and services to customer classes is made on the basis of the equivalent meter cost factors. The number of equivalent meters per customer class is determined by applying a factor to each meter based on it's size (see Table 7).

5.3.4 Customer billing and collecting costs

The unit of service is the total number of bills rendered to the respective customer classes per annum.

Table 5: Determination of equivalent meters

Meter Size (mm)	Equivalent Meter
20	1
25	1.4
32	1.8
50	2.9

Customer Class	Water Meter Size (OD mm)	No. of Meters	Conversion Factor	No. of Equivalent Meters	Total EMs per Customer Class
Residential					
Standpipes	20	0	1	0	0
Yardtank	20	0	1	0	0
House-connection					
single dwelling	20	5020	1	5020	5020
Multi-dwelling	32	200	1.8	360	
	50	0	2.9	0	360
Commercial					
Small	20	170	1	170	
	25	0	1.4	0	
	32	0	1.8	0	170
Other	20	10	1	10	
	25	35	1.4	49	
	32	10	1.8	18	77
Industrial	32	3	1.8	5.4	
	50	7	2.9	20.3	25.7

Table 6: Units of service

Customer Class	Base Capacity		Maximum Day			Maximum Hour			Equivalent Consumers	Equivalent Meters & Service	Bills
	Annual Use (kl)	Average Rate (kl/d)	Capacity Factor (%)	Total Capacity (kl/d)	Extra Capacity (kl/d)	Capacity Factor (%)	Total Capacity (kl/d)	Extra Capacity (kl/d)			
Retail Service:											
Residential											
Stand-pipes	21 714	59	100	59	0	250	148	89	123	0	4 920
Yard-tanks	14 412	39	100	39	0	200	78	39	113	0	1 944
House connections	1 885 977	5 167	250	12 918	7 751	400	20 668	15 501	132 036	5 380	89 384
Commercial	57 121	156	200	312	156	325	507	351	396	247	2 402
Industrial	201 000	551	150	827	276	200	1 102	551	100	26	670
Fire Protection	0	0		150	150		900	900			
Total	2 180 223	5 972		14 305	8 333		23 403	17 431	132 768	5 653	99 320
Bulk Sales	1 800	5	200	10	5	325	16	11		20	0
Total System	2 182 023	5 977		14 315	8 338		23 419	17 442	132 768	5 673	99 320

5.4 Unit costs

To calculate the costs attributable to each customer class the unit costs for each component of the system need to be determined first. Unit costs are determined by dividing the amounts of the annual operation-and-maintenance and capital costs apportioned to the system components (obtained from Tables 4 and 5), by the respective total system units-of-service (obtained from Table 8). For example, the operation-and-maintenance base-capacity unit cost for bulk costs (R 0.59 per kl in Table 9) is calculated by dividing the allocated base-capacity operation-and-maintenance expense (R1 288 239 in Table 9) by the total base-capacity component units of service (2 182 023 kl/annum). Similarly for the unit costs of the other cost functions/components.

5.5 Allocation of costs to customer classes

The costs attributable to the various customer classes are a function of the unit costs (Table 9) and the number of units of service assigned to each class for each component of the system (Table 8). From these figures the total operation-and-maintenance costs and the total capital costs can be determined and subsequently the total cost per customer class (see Table 9). The total cost of service given in Table 9 represents the costs to be recovered from the respective classes of customer. The breakdown of costs by function and customer class enables the service provider to set tariffs that are closely linked to the costs of service provision.

Table 7: Determination of unit costs of service

Customer Class	Base Capacity		Maximum Day			Maximum Hour			Equivalent Consumers	Equivalent Meters & Service	Bills
	Annual Use (kl)	Average Rate (kl/d)	Capacity Factor (%)	Total Capacity (kl/d)	Extra Capacity (kl/d)	Capacity Factor (%)	Total Capacity (kl/d)	Extra Capacity (kl/d)			
Retail Service:											
Residential											
Stand-pipes	21 714	59	100	59	0	250	148	89	123	0	4 920
Yard-tanks	14 412	39	100	39	0	200	78	39	113	0	1 944
House connections	1 885 977	5 167	250	12 918	7 751	400	20 668	15 501	132 036	5 380	89 384
Commercial	57 121	156	200	312	156	325	507	351	396	247	2 402
Industrial	201 000	551	150	827	276	200	1 102	551	100	26	670
Fire Protection	0	0		150	150		900	900			
Total	2 180 223	5 972		14 305	8 333		23 403	17 431	132 768	5 653	99 320
Bulk Sales	1 800	5	200	10	5	325	16	11		20	0
Total System	2 182 023	5 977		14 315	8 338		23 419	17 442	132 768	5 673	99 320

Table 8: Allocation of costs to customer classes

Customer Class	BULK		CONNECTOR		INTERNAL SERVICES		CUSTOMER COSTS		Direct	Allocation of O&M	Allocation of Capital	Total Cost of Service
	Base Capacity	Capacity Maximum Day	Base Capacity	Capacity Maximum Hour	Base Capacity	Capacity Maximum Hour	Meters & Services	Billing & Collecting	Fire Protection Service	Cost of Service	Cost of Service	per Customer Class
Inside-Town												
Unit Costs of Service (R/unit)												
O&M	0.59	42.49	0.07	8.58	2.82	3.86	53.64	4.17				
Capital Costs	0.57	3.57	0.03	31.31	1.05	1.66	0.40					
	(kl)	(kl/d)	(kl)	(kl/d)	per EC	per EC	per equiv.	per bill	R/year	R/year	R/year	R/year
Residential												
Stand-pipes												
Units of Service	21 714	0	21 714	89	123	123	0	4 920				
O&M Costs	12 820.00	0.00	1 546.00	764.00	347.00	474.00	0.00	20 523.00		36 474.00		
Capital Costs	12 446.00	0.00	606.00	2 786.00	130.00	204.00	0.00				16 172.00	52 646.00
Yard-tanks												
Units of Service	14 412	0	14 412	39	113	113	0	1 944				
O&M Costs	8 509.00	0.00	1 026.00	335.00	318.00	435.00	0.00	8 109.00		18 732.00		
Capital Costs	8 261.00	0.00	402.00	1 221.00	119.00	187.00	0.00				10 190.00	28 922.00
House connections												
Units of Service	1 885 977	7 751	1 885 977	15 501	132 036	132 036	5 380	89 384				
O&M Costs	1 113 481.00	329 339.00	134 282.00	132 989.00	372 619.00	509 131.00	288 560.00	372 847.00		3 253 248.00		
Capital Costs	1 081 042.00	27 657.00	52 619.00	485 270.00	139 219.00	218 757.00	2 168.00				2 006 732.00	5 259 980.00
Commercial												
Units of Service	57 121	156	57 121	351	396	396	247	2 402				
O&M Costs	33 724.00	6 628.00	4 067.00	3 011.00	1 118.00	1 527.00	13 248.00	10 019.00		73 342.00		
Capital Costs	32 741.00	557.00	1 594.00	10 988.00	418.00	656.00	100.00				47 054.00	120 396.00
Industrial												
Units of Service	201 000	276	201 000	551	100	100	26	670				
O&M Costs	118 670.00	11 727.00	14 311.00	4 727.00	282.00	386.00	1 378.00	2 795.00		154 276.00		
Capital Costs	115 213.00	985.00	5 608.00	17 249.00	105.00	166.00	10.00				139 336.00	293 612.00
Fire-Protection Service												
Units of Service	0	150	0	900	0	0						
O&M Costs	0.00	6 373.00	0.00	7 721.00	0.00	0.00			110 973.76	125 067.76		
Capital Costs	0.00	535.00	0.00	28 175.00	0.00	0.00			0.00		28 710.00	153 777.76
Total Inside-Town Allocated Cost of Service										**3 661 139.76**	**2 248 194.00**	**5 909 333.76**
Outside-Town												
Unit costs	1.28	46.77	0.10	46.15	4.09	5.84	54.12	4.18				
Wholesale												
Units of Service	1 800.00	5.00	1 800.00	11.00	0.00	0.00	20.00	0.00				
Cost of Service	2 301.00	234.00	188.00	508.00	0.00	0.00	1 082.00	0.00				4 313.00
Total Allocated Cost of Service	**2 539 208.00**	**384 035.00**	**216 249.00**	**695 744.00**	**514 675.00**	**731 923.00**	**306 546.00**	**414 293.00**	**110 973.76**			**5 913 646.76**

6. TARIFF-SETTING

6.1 Tariff-setting procedure

Once the revenue requirements of the municipality (or annual cost of service) have been determined, the tariff-setting process entails selecting the tariff blocks and then determining the tariff for each block.

6.1.1 Selection of tariff blocks

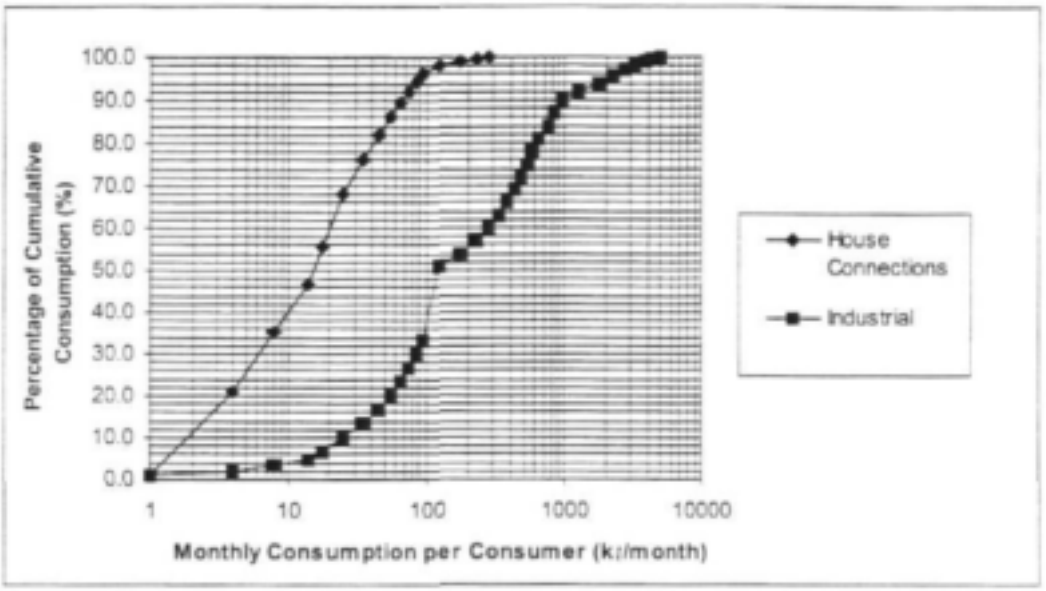
The selection of tariff blocks in Table 10 have been made on the basis of the recommendations contained in the White Paper (DWAF, 1994) and the specifications of the Water Supply Regulation (DWAF, 1996). Tabled alongside each block is the corresponding consumption of each of the customer classes, which must be determined from an analysis of water consumption data for metered customers. Thus for example, the relevant consumption per tariff block for residential customers with metered connections is shown in column (b) of Table 2.

Table 9: Determination of tariff blocks

Tariff Block (kl/month)	Customer Class Consumption (kl/month)			Total Consumption to Tariff Block for all bills (kl/month)
	Metered Residential	Commercial	Industrial	
First 6	397 464	9 988	3 350	410 802
6+ to 30	882 473	27 638	16 750	926 861
Over 30	606 040	19 495	180 900	806 435
Total	1 885 977	57 121	201 000	2 144 097

An alternative method for the selection of tariff blocks is to use cumulative consumption curves. To construct the curves, the percentage of cumulative consumption is plotted against monthly consumption levels on a semi-log graph. The graph should yield an "S"-curve. Cumulative consumption curves for each of the customer classes to be charged a volume-related tariff should be constructed, preferably on the same graph for comparative purposes. The blocks can then be selected on the basis of the average monthly consumption which corresponds to the 90 percentile of each customer class (see Figure 3). This is the method suggested by the American Water Works Association.

Figure 3: Cumulative consumption curves



6.1.2 Calculating tariffs

Tariffs in Table 11 have been set in accordance with the recommendations of the White Paper (DWAF, 1994) Specifically, they have been set in such a way that unmetered customers pay the full costs of O&M expenditure allocated to them, and the block 1 tariff is the average O&M cost per kilolitre for metered residential and commercial customers. It has been assumed that commercial customers are billed on the same basis as metered residential customers, while industrial and bulk customers and the fire protection service are billed in such a way that each covers the full costs of service provision but does not provide any surplus for cross-subisidisation.

a) Flat-rate tariff

Customers with a level of service for which it is not possible to charge a volume related charge are charged a flat rate – for example, customers with a communal stand-pipe service or yard-tanks. As can be determined from Table 11, the flat rate for these customers is calculated using the operation and maintenance costs allocated to their customer class. The capital-related costs of their service are transferred to the larger customers for cost recovery from their tariffs (see column 11, Table 11). Thus a degree of cross-subsidisation occurs. Thus, the flat rates relevant to stand-pipes and yard-tanks are calculated by dividing the allocated operation and maintenance costs for the respective classes (column 5, Table 11) by the annual water consumption in each block (column 4, Table 11). The flat rate applicable to customers with stand-pipes and yard-tanks is given in column 8, Table 11.

Table 10: Tariff-setting

1	2	3	4	5	6	7	8	9	10	11	12
Tariff	**Customer Class**	**No. of Consumer Units**	**Annual Water Consumption in each block**	**Allocated O&M Cost of Service**	**Allocated Capital Cost of Service**	**Allocated Total Cost of Service**	**Proposed tariff**	**(units)**	**Revenue Under Proposed Tariff**	**Revenue Transferred from Lifeline Customer Classes**	**Average Unit Cost**
		no.	kl/year	R/year	R/year	R/year			R/year	R/year	R/kl
Flat Rate	Stand-pipes	410	21714	36 474.00	16 172.00	52 646.00	7.41	R/month	36 474.00	-16 172.00	1.68
	Yard-tanks	161	14412	18 732.00	10 190.00	28 922.00	9.70	R/month	18 732.00	-10 190.00	1.3
Rising Block	Metered residential & Commercial										
	First 6 kl/mnth		410 802				1.68	R/kl	690 884.31		
	6+ to 30 kl/mnth		926 861				2.68	R/kl	2 483 993.83		
	Over 30 kl/mnth		806 435				3.19	R/kl	2 571 319.61	26 362.00	
	Total	7808	2 144 097	3 605 933.76	2 221 832.00	5 746 197.76			5 746 197.76	0.00	

b) Volume-related charge

The rates for the tariff blocks selected in section 6.3.1. are calculated as follows:

First 6 kl per month

This block is the "lifeline" block. The rate is thus calculated on the basis of the total allocated operation and maintenance costs for the relevant customer classes; i.e. residential metered on site connections and commercial. More specifically the calculation is the allocated operation and maintenance costs in column 5, Table 11 divided by the total annual consumption for the classes of residential house-connections and commercial, in column 4, Table 11.

6+ to 30 kl per month

The rate for this block is calculated on the basis of the recovery of average cost of service. The rate is therefore the total cost of service allocated to the volume-charged customer classes (column 7, Table 11) divided by the total annual consumption for these classes, (column 4, Table 11).

Over 30 kl per month

The rate for this block is set in such a way that it subsidises the capital-related costs of the standpipe and yard-tank service and the lifeline tariff block, in addition to recovering the average cost of service allocable to the customers of this block. The rate is calculated as follows:

the total cost of service allocated to the volume-charged customer classes (column 7)
plus
the total capital-related costs transferred from the stand-pipe and yard-tank service (see column 11)
minus
the revenue generated by the first two blocks (see column 10)
divided by
the total annual consumption over 30 kl per month (column 4)

c) Fixed service or availability charge

Some water service providers may wish to charge a fixed service charge or an availability charge in addition to a volume-related charge. As discussed in the text, the charge is designed to cover the fixed costs of the water service water department and may be especially desirable in holiday towns which have a large percentage of the households they serve standing empty for most of the year.

An example of how a fixed charge designed to cover billing and meter reading costs may be calculated is given in Table 12. The unit costs for each of the customer services are determined in Table 8. The total costs are a function of the unit cost and the equivalent meter and service ratio.

Table 11: Determination of fixed component of the tariff

Fixed Charge according to Meter Size	Unit Cost	Equivalent Meter and Service ratio	Cost (R)
20mm service charge			
Meters and service related costs	4.5	1	4.50
Billing and collecting related costs	4.17		4.17
Total			8.67
25mm service charge			
Meters and service related costs	4.5	1.4	6.30
Billing and collecting related costs	4.17		4.17
Total			10.47
32mm service charge			
Meters and service related costs	4.5	1.8	8.10
Billing and collecting related costs	4.17		4.17
Total			12.27
50mm service charge			
Meters and service related costs	4.5	2.9	13.05
Billing and collecting related costs	4.17		4.17
Total			17.22

7. CLOSURE

This annexure has illustrated a method of allocating service costs to different classes of customers with a greater degree of accuracy than the simpler methods used in the Regulations and shown in section 6.2 of the main text. The purpose is to enable tariffs to be set with a greater degree of transparency regarding cross-subsidisation. With detailed cost-allocation it is possible to specify both the degree and the source of this subsidisation.

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WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Module 5

SETTING SANITATION TARIFFS

January 1998

PALMER DEVELOPMENT GROUP

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PREFACE

This module forms part of the series "Management guidelines for water service providers". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

Executive summary: Introduction to urban services management

Module 1: An introduction to organisational arrangements for water service providers

Module 2: Preparation of a water services development plan

Module 3: Customer profile and demand for services

Module 4: Setting water tariffs

Module 5: Setting sanitation tariffs

Module 6: Reporting procedures for water services

Module 7: Reporting procedures for sanitation services

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Project team

The project team instrumental in developing these guidelines comprised Ian Palmer, Richard Tainton and Bee Thompson, all from Palmer Development Group. Craig Bekker assisted with figures and formatting.

1. INTRODUCTION

1.1 Context

The water sector in South Africa is in the process of significant change that reflects both the new democratic dispensation and the growing concern about water resources. The Department of Water Affairs and Forestry (DWAF) has been active in producing policy which is reflected in its White Papers of 1994, 1996 and 1997 (DWAF, 1994; RSA, 1996; DWAF, 1997), the National Water Supply Regulations of 1996 (DWAF, 1996) and the Proposed Water Services Bill (RSA 1997). These policy and legislative initiatives have direct implications for tariff-setting at the local authority level. For example, the proposed Water Services Bill states that "no water service[1] institution may use a tariff which is substantially different from any prescribed norms and standards" (Chapter II, 10. 4). Although prescribed norms and standards are set out in the National Water Supply Regulations of 1996 (henceforth "Regulations") for (residential) water tariffs, no such norms and standards have been proposed for sanitation. Beyond setting out some basic principles and outlining subsidy policies, the National Sanitation White Paper does not address the issue of sanitation tariffs.

Sanitation service authorities and providers are responsible for providing safe and adequate sanitation services to all residents within their municipal areas. In order to do this on a sustained basis, sanitation service authorities will need to establish effective management systems and generate local revenue from the services provided. The implementation of effective and equitable tariff structures is key to ensuring the sustainability of service provision in the future.

1.2 Aims

This module aims to provide a set of guidelines for sanitation service providers to assist them in establishing an appropriate tariff structure and determining the tariff levels for the retail of sanitation services within their jurisdiction. The module discusses the different types of tariff structure that may be applicable to alternative types of sanitation systems. It then describes a procedure for setting tariffs based on the cost of service provision. The intention is to describe a method for determining the various cost components of a sanitation service so that tariff-related decisions can be made in a transparent manner and the extent of cross-subsidisation is apparent.

1.3 Scope

The emphasis of the report is on tariffs for residential waterborne sanitation systems; some preliminary guidelines for residential on-site sanitation systems and non-residential waterborne sanitation systems are also given. The module is primarily aimed at small-to-medium urban water service providers, and may not necessarily be applicable to larger utilities such as metropolitan structures or district councils.

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[1] The draft Water Services Bill (RSA, 1997) defines "water services" as pertaining to water and sanitation systems. Where there is a need to differentiate between the two, the bill proposes that the term "water supply services" be used for water systems and "sanitation services" for sanitation systems.

1.4 Outline

The report is structured in the following way:

- ***Principles***. Some principles for the establishment of tariffs are proposed based on an interpretation of national water and sanitation policy in its current form.
- ***Tariff structures***. An outline of possible tariff structures related to different types of sanitation service is given, setting out the basic rationale and the advantages and disadvantages of each.
- ***Cost allocation methods***. This section outlines and discusses the relative merits of different methods of determining and allocating costs.
- ***Cost-causative method.*** This section contains a detailed description of a method of expenditure analysis which may be relevant in setting sanitation tariffs in South Africa.
- ***Guidelines for setting tariffs***. Based on the foregoing discussion, guidelines for setting sanitation tariffs are given.

1.5 Sources

Much of the information used to compile this module has been drawn from manuals published by the American Society of Civil Engineers (ASCE), the American Public Works Association (APWA) and the Water Pollution Control Federation (WPCF). The method adopted here for allocating and distributing costs closely follows the methodology presented in these manuals. A number of adaptations have been made to suit the South African situation, particularly with regard to the categorisation of the components of sanitation systems, the separation of residential customers into distinct groups by service type, and its application to the analysis of on-site sanitation services.

2. TARIFF POLICY PRINCIPLES

In developing a tariff policy, the National Sanitation Policy White Paper (RSA, 1996) and the Department of Constitutional Development and Local Government recommend the following principles (MIIF, March 1997):

- *Self-financing at local level*: Services should be self-financing at a local and regional level, within the framework of subsidies from national government.
- *Affordability*: The setting of tariffs should take household affordability into account, within the context of targeted subsidies to the poor.
- *Fairness*: Tariff policies should be fair. Individuals or groups of individuals should not be discriminated against and all people should be treated equitably. (See discussion on "fairness" in Module 5.)
- *Payment in proportion to the amount consumed*: In general, and as far as is practically possible, customers should pay in proportion to the amount of the service they consume, with customers who consume more of the service paying more than those who consume less.
- *No services provided directly to an individual property or dwelling should be made available free of charge:* In general, all households who get services delivered to their homes – typically water, waterborne sanitation, electricity and

road access – should pay some charge, often set at the operating and maintenance costs of the services consumed. Exceptions to this should only be made for indigent households.

- *Sustainability*: Tariff policies that are reliant on unsustainable subsidies will mean that essential maintenance of infrastructure is not carried out and that there will be inadequate services in the future.
- *Efficient allocation and usage of resources*: Tariff policies should help to facilitate the efficient usage and allocation of scarce resources (both renewable and non-renewable), taking into account resource quality and degradation.
- *Economic development*: Tariffs applied to mining, industrial and commercial enterprises should take into account their impact on economic development. Negative impacts could affect employment, lowering overall levels of affordability and increase pressure on the sustainability of urban services. Economic development must also be balanced against the conservation and sustainability of the physical environment.
- *Transparent subsidies*: Any subsidies which exist must be transparent (visible and understood by all those affected).
- *Financial viability of the local service agencies*: It is essential that the service agencies remain financially viable, as failure to ensure this will result in the lack of sustainability of the services.
- *Local determination of tariff levels*: In general, unless cost structures are similar (as is the case in the electricity industry, for example), tariffs for urban services need not be uniform over a wide geographic area.
- *Minimum level of service considerations and financial viability*: The financial viability of the service agency will be highly sensitive to the defined minimum acceptable level of service.
- *Consistent tariff enforcement*: A consistent policy should be implemented whereby failure to pay (correctly) billed amounts for services results in the consumer's service being restricted or suspended.
- *Separate tariff*: A separate tariff should be calculated for sanitation services and will vary according to the level of service provided.
- *Payment of operation and maintenance costs*: All households should pay at least the full operating and maintenance costs of the services consumed.
- *Life-line tariff*: Provision should be made for a life-line tariff for poorer people who use little of the service, but should cover at least the operating and maintenance costs of the service consumed. Tariffs should be progressively more expensive for large customers.

With reference to these principles, the following points should be borne in mind:

- It is important that all parties concerned understand and agree on the notion of "fairness" used in setting tariffs. Perceptions of unfairness will lead to disaffection and may result in resistance to payment which may in turn jeopardise the financial viability of the service provider.

- Tariffs should reflect the cost of service and thus systems such as on-site technologies, which have lower recurrent costs than waterborne systems, should have lower tariffs.
- Sanitation tariffs for poor households should not exceed tariffs for wealthier households and preferably should be substantially less.
- Sanitation tariffs should include a life-line component and be progressive in nature – that is, favour redistribution of income between wealthy and poor households
- Sanitation tariffs should be separately identifiable, that is, they should not be pooled in a general property tax. (Note: this does not preclude sanitation tariffs being charged as part of a property tax, but requires that it be clearly identified as a separate part of the tax).
- Tariffs should promote the conservation of water and the environment

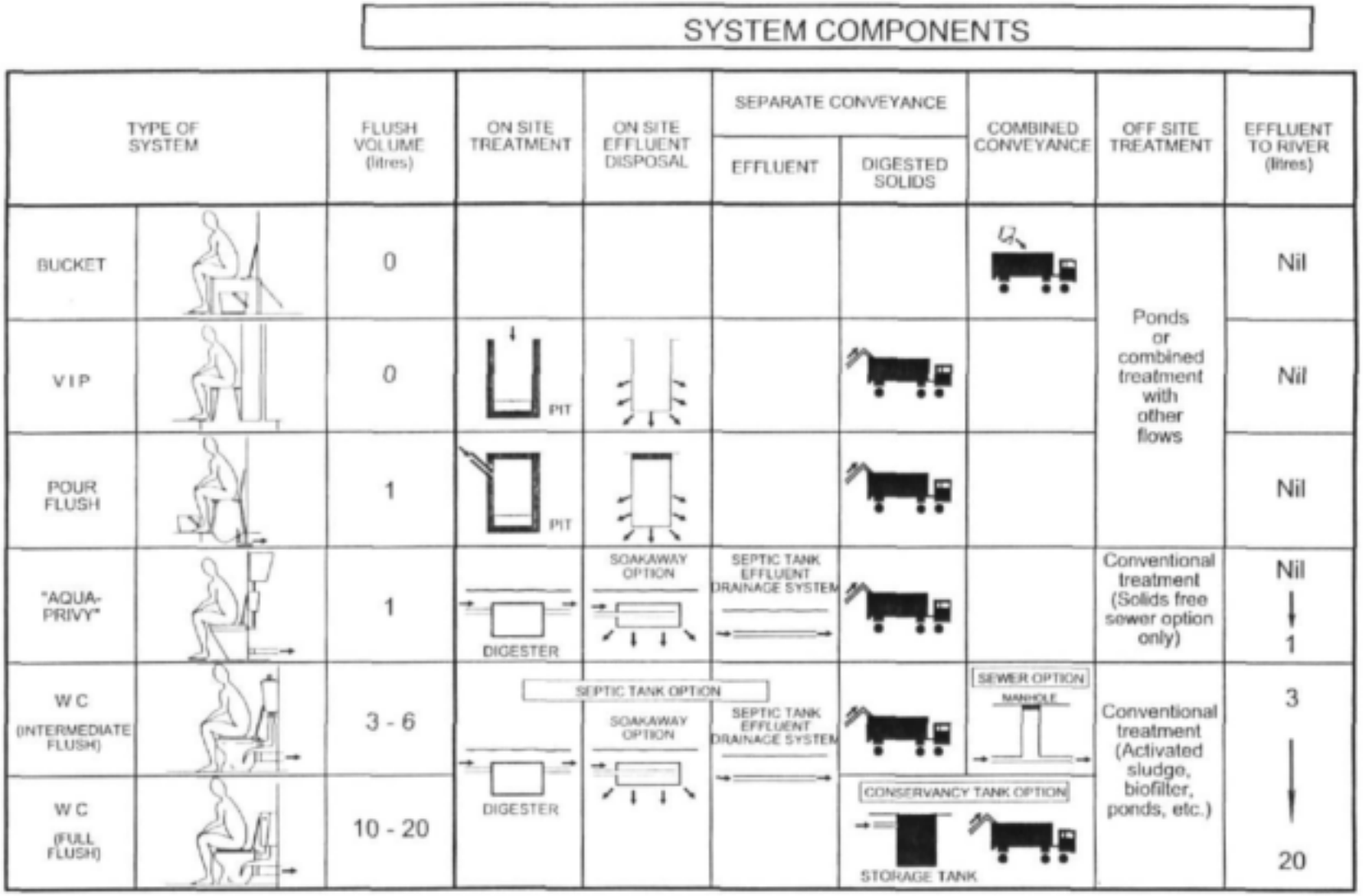
3. TYPES OF TARIFF STRUCTURES

3.1 Introduction

The type of tariff structure used depends on the type of service being provided and the nature of the customer. The wide range of service types available was discussed in detail in Module 3. A diagram showing the broad categories of service types and their components is given in Figure 1. The nature of the service to a customer or group of customers is of particular significance when designing sanitation tariffs. For example, industrial users (who may produce a far more toxic effluent than residential users) will place greater demands on the treatment works than residential users; and customers with on-site sanitation should bear no responsibility for sewer costs. Therefore, when considering an appropriate tariff structure it is useful to consider the following separately (Bahl et al, 1992):

- residential and commercial customers with waterborne sanitation;
- residential customers with on-site sanitation; and
- industrial customers.

Figure 1: Type of service options



3.2 Residential customers with waterborne sewerage

3.2.1 Methods of determining tariffs

In general, the tariffs for waterborne sanitation services to residential users may be calculated in one or more of the following ways (PDG, 1994):

- based on the actual costs of service provision;
- based on property rates;
- based on the total water bill;
- based on water consumption and treatment costs;
- based on some physical characteristic; and

Each is discussed in turn in the following sections.

a) Based on actual costs

This type of tariff would be based on the direct demands that a user places on the wastewater system, which is in turn related to the volume and strength of wastewater discharged into the wastewater system. The actual measurement of these parameters (at least for residential users) is impractical, however, because reliable wastewater meters to measure volume, and sampling equipment to measure the strength of the wastewater are prohibitively expensive. Hence a tariff structure based on actual costs is not feasible and some other method must be chosen.

b) Charges based on property rates

Basically the method is to set the tariff according to an appropriate percentage of the value of the property. Thus:

sanitation tariff = X % of the property value

where the value of X is a constant for the service area.

Sanitation tariffs included in, or linked to, property rates are commonly used in South Africa. Although this is largely an historical heritage, whereby the majority of local authority income was derived from property taxes, the method has a strong rationale and is still appropriate and applicable today.

The primary rationale underlying a property tax-based charging system for wastewater is that it is a progressive tariff in which wealthy households pay proportionately more towards the costs of the wastewater system than do poor ones. The economic argument behind this is two-fold: firstly, because adequate universal sanitation provision produces positive community health-related externalities, sanitation provision to poor households should be subsidised; secondly, where income distribution is highly unequal, progressive tariff structures contribute towards greater income equality which is desirable.

A secondary advantage is that the tariff is simple and cheap to administer provided a property tax system is already in place and adequately administered. A further advantage is that the tariff system provides a means of collecting a financial contribution from undeveloped or unserviced areas in a community that will benefit from the future availability of the wastewater system (Bahl et al, 1992) as well as from plots which have the option of connecting but have chosen not to connect.

The main disadvantage is that the tariff is not directly related to costs.

Property rates-based charges may be combined with a volume-related servite charge (assessed on the basis of water consumption, for example) in order to match revenues with costs in a more equitable manner.

c) Based on total water bill

This system of wastewater charging is used in many countries (Bahl et al, 1992). The method entails a wastewater surcharge which is set according to an appropriate percentage of the water bill. Thus,

wastewater charge = X % of the water bill

where the value of X may differ for different housing types, reflecting real cost differences.

The rationale for the charge is that the cost of the wastewater service is related to the amount of water consumed and that the total water bill provides a proxy for the amount of wastewater produced. The linkage between sanitation service costs and water bills may be weak, however. The advantage of the system is that it is simple and cheap to administer, provided that an adequate water billing system is in place.

d) Based on water consumption

A refinement of the above method is to base sanitation charges on the amount of water consumed. Thus,

wastewater charge = (water consumed) x (factor) x (wastewater tariff)

where the factor is an estimate of the average percentage of water consumed that is returned to the sewer system (set for each housing/economic consumer type) and the wastewater tariff is the unit cost of wastewater conveyance and treatment (expressed as c/kℓ of the total billable volume of wastewater).

If this tariff method is combined with a fixed monthly charge (which is related to fixed overhead and other costs), then the tariff structure has the advantage of being more closely linked to actual costs. This method of charging cannot be used effectively where water consumption is not metered.

e) Based on some physical characteristic

Tariffs may be based on some physical characteristic such as plot size or the length of the plot frontage. The rationale for this types of charge is that the cost of reticulation is related to these measurements. There are circumstances in which such a charging structure may make sense; in general, however, such a system of charging is arbitrary and therefore not recommended.

3.2.2 Types of tariff structures

The above methods of calculating sanitation tariffs can be combined in three ways: (1) a fixed monthly charge, (2) a variable charge only- related to consumption, and (3) a fixed charge and a consumption (i.e. variable) charge.

a) Fixed monthly charge only

The sanitation service can be billed as a fixed monthly charge which may vary between customers but which does not vary each month. The actual charge can be calculated in a number of ways as described above. The most common fixed charge would be a property tax-based charge in which the amount paid each month is a function of the property value of each consumer. Alternatively, the fixed charge may

be calculated by dividing the total consumer related costs by the number of customers (see Table 13).

b) Variable charge only

A variable charge is a monthly charge that varies with consumption, and is calculated according to a set tariff structure. This type of charge could be levied based on, for example, a percentage of the water bill or on the amount of water consumed. In this case, no fixed charge is levied.

c) Fixed monthly charge and a variable charge

A fixed monthly charge may be combined with a variable charge. This structure enables costs to be more closely related to charges. In this type of tariff structure, the fixed charge component may be related to fixed costs which do not vary between consumer classes (for example, administration and capital charges), and the variable cost may be related to an estimate of the volume of wastewater produced and the cost of treating the wastewater.

d) Fixed charge and a rising block variable charge

This form of tariff is similar to the structure described in paragraph (c) above, except that volume rates increase as consumption rises. This structure would facilitate the inclusion of a lifeline component to the tariff, which would be applicable where water consumed is less than the set minimal amount (e.g. less than 5 kℓ per month), determined on the basis of an amount that is considered affordable to low income families. For example, town "A" charges a fixed tariff of R15 per bill which is related to its administrative and customer service costs. On top of this charge the town applies a rising block volume rate as shown in Table 1.

Table 1: An example of a rising block volume rate

Monthly water consumption	Sanitation volume tariff
0 - 5 kℓ	85% x consumption x 10c/ kℓ
5 - 10 kℓ	85% x consumption x 35c/ kℓ
10 - 30 kℓ	65% x consumption x 45c/ kℓ
more than 30 kℓ	40% x consumption x 55c/ kℓ

From the table it can be seen that the there are four tariff blocks - based on water consumption. Each block has a different tariff which is determined on the basis of an estimate of the wastewater produced in each water consumption category (see Annexure 1) and a differentiated volume rate.

Life-line tariffs

All of the tariff structures mentioned above can incorporate a life-line component. Some examples are given below:

- *Property value-based charges:* properties below a certain value can be exempt from sanitation charges, or have subsidised sanitation tariffs levied.
- *Fixed charges:* properties in defined socio-economic areas could be exempted from sanitation charges, or have subsidised sanitation tariffs levied.

- *Water bill-based charges:* if a life-line tariff is implemented for water, then a sanitation tariff which is linked to the water tariff will automatically include a life-line component (see Module 5)
- *Water volume-based charge:* a life-line sanitation tariff can be levied where less than a specified amount of water is consumed.
- *Property size-based fixed charge:* properties smaller than a certain size can be exempted from sanitation charges or have a subsidised sanitation tariff levied.

3.2.3 Development and connection fees

Although a direct service charge system or a rates-based charge are usually the primary means of obtaining operating revenues, other charges unrelated to water-use are sometimes used to supplement the primary revenue sources. These include charges such as connection fees and sewer charges - to cover initial capital expenditure, (see Module 5, sections 4.5. and 4.6.)

3.2.4 Recommended tariff structure

Currently there is no legal impediment in South Africa for a service authority to structure its sanitation tariffs as it sees fit. Any combination of the types of tariffs described above can be used. Most authorities in the country use property rates-based methods. Worldwide, however, the trend is towards volume-based tariffs.

When considering tariff structures it should be noted that waterborne sanitation is more expensive than on-site sanitation systems which provide an equal health benefit. Customers who opt for this system should therefore be willing to pay towards the cost of connecting to the network and at least a significant portion of the full ongoing operation and maintenance costs of the system.

3.3 Residential customers with on-site systems

3.3.1 Types of on-site sanitation systems

There is a wide range of on-site sanitation systems which may be provided by sanitation authorities: including septic tanks, low flow on-site sanitation systems (LOFLOS) and ventilated improved pit latrines (VIPs). Each system has particular cost implications for the service provider. When considering an appropriate tariff structure it is useful to divide the on-site systems into two broad categories:

- *wet on-site methods*: methods that require water for flushing, such as pour flush latrines, LOFLOS and septic tanks; and
- *dry on-site sanitation methods*: methods that do not need water, such as VIPs.

3.3.2 Types of tariff structures

For on-site sanitation systems two types of tariff structures are possible:

- a *fixed monthly tariff* based on an estimate of the operations costs (to the service provider), say over ten years, calculated on a monthly basis. The operations costs are primarily related to pit emptying and sludge disposal and treatment; or
- a *periodic fee* linked to each episode of pit-emptying.

The advantage of the monthly charge is that it is likely to be more affordable than the periodic fee. The disadvantage is that customers see no direct link between the monthly payment and the service received.

3.3.3 Development charges

If the monthly tariff is based on the recovery of operations costs only, then the development charge would need to ensure the recovery of the capital development cost of the on-site systems. For low-income households this development charge can be offset by subsidies from the service authority and/or central government: there are currently a number of subsidies available from central government for low income households for the development of basic infrastructure. These are discussed in Section 4.

3.4 Tariffs for institutions and commercial users

In general, the characteristics of wastewater produced by commercial customers and institutions such as government, schools, and so on, are similar to those of residential wastewater. Therefore it is probably best to apply the same tariffs as for residential users (see section 3.2.), unless there is reason to suspect that large amounts of pollutant load are being discharged into the general sewer system – for example, separate tariffs may be applicable to hospitals requiring additional or specialised treatment of their wastewater.

Tariffs should ensure full cost recovery, including both operating costs and capital charges (i.e. average historic cost - for more information see Module 5).

For schools with on-site sanitation, arrangements for pit-emptying and sludge disposal are crucial for the success of the systems and contingencies for the regular maintenance of these systems need to be made. This includes methods for cost recovery. A periodic fee is probably the most appropriate in this instance.

3.5 Tariffs for industry

Large industry and mining activities which emit substantial quantities of effluent need to bear the costs they impose on the wastewater system, particularly in respect of the additional treatment requirements that may be necessary for receiving toxic industrial effluent. For this reason, many municipalities monitor large industries closely by metering and intermittent sampling. Special effluent charges are applied to users who discharge effluent into the wastewater system which is either in excess of a prescribed minimum or has a strength or quality greater than standard domestic effluent.

As in the case of commercial and institutional customers, the basic minimum principle for sanitation tariffs for industry and mining should be full cost recovery. These tariffs should be based on an appropriate combination of volumetric flow and biological / chemical loads. From an economic efficiency point of view, it would be desirable to price wastewater flows from commerce and industry at the long-run marginal cost[2].

Marginal cost pricing is applicable in this context because industry location decisions should be based on correct pricing signals. The development of industries generating large amounts of wastewater should be in areas with low long-run *marginal costs* for wastewater conveyance and treatment. Because the marginal costs of sewage treatment may be much higher than current average historical costs in some areas, it may not be feasible to implement a policy of marginal costing in the short term.

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[2] The marginal cost is the cost that would be incurred to produce an additional unit of water. There are two kinds of marginal cost: the short-run marginal cost, which is the cost incurred by producing an additional unit while keeping productive capacity constant, and the long-run marginal cost which relaxes the condition of constant productive capacity.

Present tariff policies developed by the larger city councils in South Africa for industrial effluent are generally sound. Most of them set industrial tariffs according to a formula prescribed in the local bylaws. These formulae vary from municipality to municipality but are generally structured to account for the additional costs of receiving and treating wastewater due to excessive volume, COD load or suspended load of the effluent received.

An example of a formula used for trade effluent charges is given below (Durban Metro Wastewater Management, Nov 1996):

$$A = X + V(C/R) + Z(B/S)$$

where:

- "A" is the additional charge applicable to trade effluent (Rands per kℓ)
- "X" is the prescribed rate for the conveyance and preliminary treatment of sewerage
- "V" is the prescribed rate for the treatment of standard domestic effluent having a prescribed COD value.
- "R" is the prescribed COD value for standard domestic effluent.
- "Z" is the prescribed rate for the treatment of standard domestic effluent having a prescribed settleable solids value.
- "S" is the prescribed settleable solids value for standard domestic effluent.
- "C" is the measured COD of the trade effluent (milligrams per litre)
- "B" is the measured volume of settleable matter to the nearest millimetre.

An in-depth review of industrial effluent structures in South Africa is beyond the scope of this module and is the subject of another research project recently undertaken for the Water Research Commission (WRC, Project K5/854).

3.6 Other sources of income

Other practices that may supplement revenue are:

- the sale of processed wastewater sludge as a soil supplement;
- selling the final effluent for irrigation purposes or for large-scale cooling of industrial facilities, such as an electric power generating plant;
- renting certain equipment, such as portable pumps, on an hourly or daily basis;
- selling of laboratory and testing services, equipment maintenance services, or acceptance of sewage and sludge from outside the system's normal jurisdictional service area; and
- plants that employ anaerobic processes may have the capability to sell excess methane gas or to generate electric power.

4. THE COSTS OF SERVICE PROVISION

4.1 Introduction

There are essentially two different types of cost, namely economic cost and financial cost. Financial cost refers to money actually spent, whereas economic cost is a far broader concept and reflects the value to society of the activity in question To the service provider the important cost is the financial cost of constructing and operating the necessary infrastructure, and the term "costs" in this report refers simply to financial cost or expenditure[3].

The costs of service provision must be known to the service provider for three reasons: (1) to determine revenue requirements and thus to set tariffs in such a way that financial viability is ensured; (2) to ensure fairness and transparency in setting tariffs; and (3) to predict increases in future tariffs – which is important for achieving tariff stability and financial sustainability in the longer term.

4.2 Expenditure

Service providers are required to prepare budgets and financial statements every year accounting for both expenditure and income. Expenditure is commonly broken down further into operating and maintenance expenditure, capital charges and "contributions to funds" for the system as a whole. These categories are discussed further in the following sections:

4.2.1 Operation and maintenance expenditures

Operation and maintenance (O&M) expenditures are those expenses incurred by the service provider in the provision of a sanitation service to the customer. Typical O&M expenses associated with a municipal sanitation service are shown in Table 2 overleaf.

[3] These concepts were discussed in more detail in Module 5 of this series.

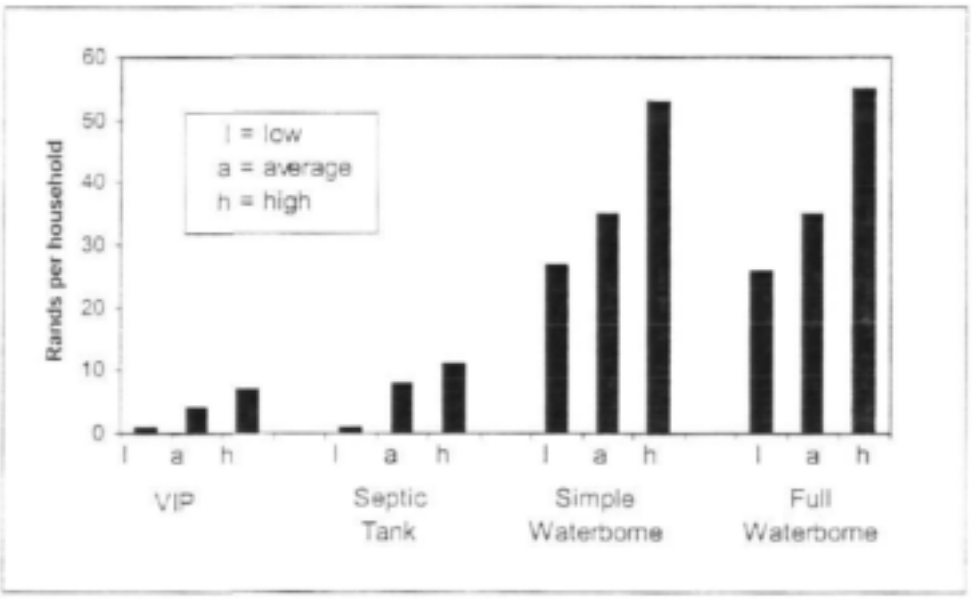
Table 2: The O&M expenses of a typical wastewater utility

On-site expenses	*Collection system*	*Wastewater treatment expenses*	*Accounting and collecting expenses*	*Consumer service expenses*	*Administrative and general expenses*
• Pit emptying • Tanker service • Sludge handling • General repairs and maintenance • Education and public awareness	• Operation supervision • Operation labour • Operation supplies and expenses • Maintenance of sewer lines • Inspection of sewer connections • Pumping (lift station) labor • Power for pumping • Pumping station supplies and expenses • Maintenance of pumping station structures and equipment • Transportation • Insurance on pumping facilities	• Operation supervision • Labour • Power • Chemicals • Fuel • Maintenance of structures and equipment • Transportation • Sludge disposal • Insurance on plant structures and equipment.	• Meter reading • Strength sampling • Consumer billing • Accounting • Collections • Cashiers • Payment processing	• Consumer enquiries • New service requests and billing enquiries • Education and capacity building	• Administrative salaries • Other general office salaries • General office supplies and expenses • Special services (engineering, legal) • Employee insurance • Vehicle insurance • Other employee costs (workman's compensation) • Special requirements of grant programmes • Miscellaneous general expenses.

O&M expenses will differ depending on the nature and level of service provided; that is, the expenses incurred in providing a waterborne service will be different from those incurred for an on-site service.

Figure 2 shows a comparison of the O&M expenditure for different levels of service. From the figure it can be seen that the O&M expenditure for a waterborne service is an order of magnitude more expensive than for a ventilated improved pit-latrine (VIP).

Figure 2: O&M Expenditure for different levels of service



Source: DCD, March 1997

a) Waterborne

O&M expenditure for a waterborne service includes costs associated with salaries and wages, billing, transmission, accounting, treatment, pumping, and general overheads. Some of these expenses are directly related to the quantity of wastewater produced (such as transmission, pumping and treatment expenses) and are termed "variable expenditure". Other expenses (such as personnel, administration and consumer service expenses) need to be paid regardless of the amount of wastewater treated and may be called "fixed expenditure".

According to this classification, fixed expenditures are those expenses that remain relatively unchanged for a certain period o time(e.g. a year), such as sewer-cleaning and administration. Variable expenditure changes with fluctuations in volume or strength of wastewater treated, such as power used for pumping. A characteristic associated with a waterborne sanitation service is the high fixed expenditure relative to variable expenditure. A feature of this high *fixed: variable expenditure* ratio is that larger customers will have a lower unit cost than smaller customers – in other words the unit cost of wastewater treatment will decrease for increasing consumption.

b) On-site sanitation

O&M expenditure for on-site sanitation systems is generally lower than that associated with waterborne systems. The costs are mainly associated with emptying a

pit or digester, sludge-handling, clearing blockages, repairing breakages, and general maintenance (PDG, 1995). The local municipality usually provides certain of these services, particularly pit-emptying and sludge-handling. It is important that proper management arrangements are established, otherwise the costs of on-site services can become prohibitive. Issues which need consideration are:

- *The size of the pits:* Smaller pit sizes may reduce the initial capital expenditure of building the latrines, but will have the effect of increasing the O&M expenditure because they will need to be emptied more often.
- *Access to individual sites*: Access to sites for pit-emptying can be a problem in dense settlements. Constraints such as gradient and position of the latrines on the erven are also important factors to note when planning for pit-emptying operations.
- *High COD concentration of sludge:* The sludge from on-site toilets has a high COD concentration in relation to sewage. If on-site sludge is treated at the same facility as a town's waterborne sewage then arrangements should be made to ensure that the capacity of the plant is sufficient to cope with the additional organic load.
- *Sludge handling:* The procedure for dealing with sludge from pits and tanks may vary from the more conventional methods such as the use of anaerobic and aerated ponds, to the use of intermediate technology such as composting which can substantially reduce the sludge treatment costs.
- *Education programmes:* Education and community awareness programmes are important components of a sustainable service. If they are neglected pits are often used for solid waste disposal.

4.2.2 Capital-related expenditure

Capital-related expenditures are the annual expenditures that arise from financing capital projects. These depend on the total implementation costs of projects and the financial arrangements used to fund them.

a) Sources of capital finance

Capital projects may be financed by means of loans, subsidies, capital reserve funds and/or current revenue. Annual contributions to capital reserve funds may also be classified as a capital-related expenditure. Common finance arrangements used by service providers in South Africa are:

Loans

Asset replacements and new works are commonly financed from loans. These result in recurrent costs in the form of interest and redemption payments which are determined in relation to the origin of the loan and the loan conditions (i.e. the interest rate and the loan period). Ideally the loan period should be the same as the economic life of the facility.

Capital reserve funds

Most municipalities in South Africa operate a fund (i.e. the Capital Development Fund) to which they contribute annually in order to accumulate capital reserves for the purchase of equipment, asset replacement, improvement and expansion of infrastructure. Departments within the municipality are then able to borrow from this fund and repay the loans with interest. These are referred to as "internal" loans,

whereas loans from outside agencies are referred to as "external" loans. Contributions to this fund are separately recorded in the accounts of the sanitation service provider and are classified as capital-related expenditure.

Current revenue or operating income
The costs of routine purchases of small capital items and the replacement of existing items may be financed from current revenue. A sanitation service provider may need to purchase equipment many times throughout the year to ensure continued operation. Equipment purchases include such items as typewriters, desks, calculators, microcomputers, and pneumatic handtools. Normally these items are not recorded in financial statements as a part of operation and maintenance expense; instead, they are capitalised and the cost spread over the useful life of the asset.

Capital subsidies from government, such as. district council grants
Capital grants from national government are increasingly a source of capital finance to sanitation service providers. The three main sources of grant finance available at present in South Africa are as follows:

- The Consolidated Municipal Infrastructure Programme's (MIP) bulk and connector grant (of up to R3 000 per household) is a once-off grant for the installation of a basic level of service and thus can only be used for infrastructure such as sludge handling facilities. Wastewater treatment works are explicitly excluded.
- A portion of the Housing Subsidy is available for internal services – the portion available is usually determined by the local authority and depends on household income – up to R15 000 per household is available, of which a portion can be used for land and internal services costs, including on-site latrines or sewerage.
- A subsidy is available from DWAF for the construction of on-site latrines – currently this is set at R600 per household and is targeted at the rural areas.

b) Components of capital expenditure for waterborne systems
Capital-related expenditure for a waterborne service is associated with:

- the construction of *new works*, such as sewerage networks, pumping stations and treatment plants, where no previous infrastructure existed (i.e. "greenfields" development);
- *asset replacement* of ageing equipment and plant to keep systems functioning properly;
- *upgrading* of infrastructure to provide a higher level of service; and
- routine *capital purchases*.

This capital can either be financed from subsidies from government, loans or capital reserve funds.

c) Components of capital expenditure for On-site sanitation systems
The capital-related expenditure for on-site sanitation services is related to finance for new works, asset replacement or the upgrading of the following:

- the installation and construction of the on-site units;
- the purchase of pit emptying equipment and vehicles;

- the construction of facilities and/or the purchase of plant for sludge treatment and handling;
- environmental monitoring.

For new works, the installation and construction costs of internal infrastructure can be financed from the housing subsidy; and the pit emptying equipment and sludge handling facilities from MIP. Asset replacement and upgrading projects are not eligible for this funding and are usually financed from loans or capital reserve funds.

5. COST ALLOCATION METHODS FOR EXPENDITURE ANALYSIS

5.1 Introduction

For the purposes of budgeting and preparing financial statements the O&M and capital-related expenditures for the system as a whole, need to be recorded. However a more detailed analysis of expenditure is usually required in order to set tariffs so that the expenditures associated with service provision can be determined for the different types (classes) of customers. Tariffs can then be set in relation to actual financial costs of service provision Furthermore, it is then possible to more accurately estimate the degree of cross-subsidisation between types of customers.

Cost allocation involves the assignment of expenditure according to the extent to which it can be attributed to its origin or cause. Expenditure can then be allocated to the components and functions of the sanitation system from whence it can be apportioned to the different types of customers. In order to adequately analyse the expenditure of a sanitation service, however, an understanding of the factors which affect the size and nature of the expenditure is necessary; these are briefly discussed in the following section.

5.2 Factors affecting costs

The main factors which affect the expenditure of a sanitation service provider (for both waterborne and on-site services) are:

5.2.1 Waterborne

- *Number and type of customers*: relates to billing and administrative costs;
- *potential customers/service*: relate to the cost of extra capacity in the system for the use of future customers;
- *average volume of wastewater per customer*: relates to pumping, chemical, and other operating costs ;
- *peak volume of wastewater:* relates to conveyance and treatment costs and the sizing of these facilities;
- *area of the collection system:* major factor in the capital costs of a service and, to a lesser extent, the operational and maintenance costs;
- *site conditions:* relate to capital costs associated with the design and construction of the system;
- *density of housing served by the collection system:* relates to capital costs of system because in general the more dense the settlement, the more economical the sewerage will be;
- *wastewater strength*: relates to the treatment costs; and

- *infiltration/inflow volumes:* relate to costs associated with system capacity and are proportional to both customer class flows and the number of customers.

5.2.2 On-site sanitation

- *Water supply arrangements:* relate to the viability of wet sanitation systems, which in turn relate to the capital costs;
- *type of toilet:* relates to the capital cost and the maintenance costs;
- *location of toilet:* relates to the maintenance cost
- *site conditions*: have a bearing on the capital cost of the design and construction of the system;
- *availability of land*: relates to the type of system feasible for the locality of the scheme;
- *public perception*: relates to community acceptance of more economical systems; which in turn relates to the affordability of the community and to awareness and capacity-building costs;
- *size of holding pits*: has a bearing on the capital cost but can have serious implications for maintenance costs – for example, smaller pits mean more frequent emptying is required;
- *building specifications*: relate to construction costs;
- *haulage distance for pit-emptying operations*: relate to maintenance costs;
- *density of housing*: an extremely dense settlement may require specialised equipment for pit-emptying operations, which has a bearing on the capital costs of connector facilities and the maintenance costs; and
- *number of potential customers.*

5.3 Methods of expenditure allocation

There are a number of different methods available for analysing the costs of a sanitation service utility. No one method can be considered the best or most cost reflective. Some of the more commonly used methods are (WPCF Task Force, 1984):

- functional cost method;
- fixed-variable cost method;
- design cost-causative method.

A brief description of these methods follows.

5.3.1 Functional cost method

This is the simplest approach. Expenditure is allocated on the basis of the components of the sanitation service provided, for example:

- consumer service;
- internal reticulation;
- connector infrastructure;
- bulk infrastructure.

A typical breakdown of functional components is shown in Table 3 and Figure 4.

Figure 3: Classification of the components of a waterborne system

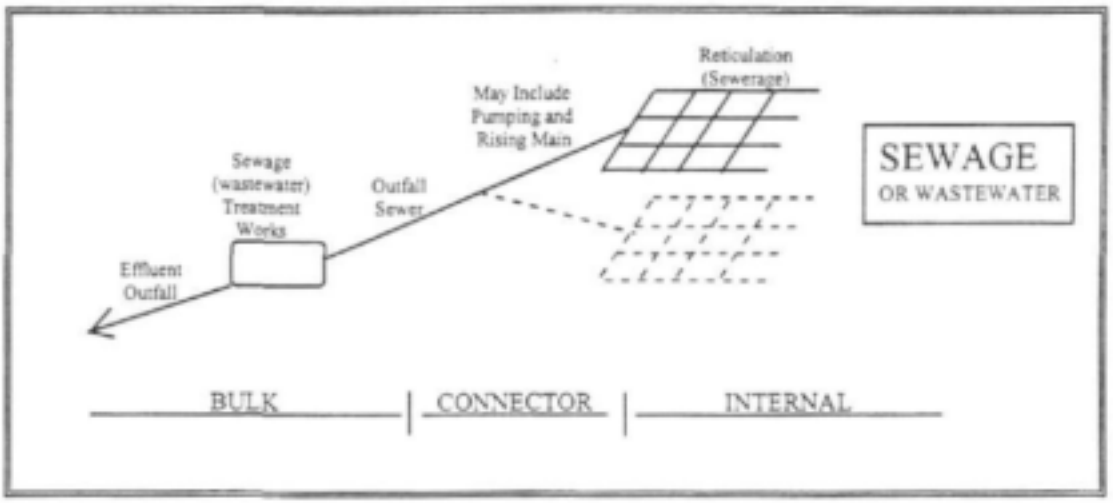


Table 3: Classification of the components of sanitation systems

Major component	*Constituent components*	
	Waterborne	*On-site*
Bulk infrastructure	Sludge disposal Effluent outfall Wastewater treatment	Sludge disposal Sludge treatment
Connector infrastructure	Pumping Outfall sewer	Vacuum tanker service Batch composting facility
Internal services	Sewerage reticulation Consumer services	Household latrines Consumer services
Overhead expenditure	Planning Administration	Planning Administration

Expenditure is then broken down as follows:

- *Bulk costs* for a waterborne service are the expenditure related to the treatment, effluent and sludge disposal; for an on-site service they relate to expenditure on sludge treatment and disposal.
- *Connector service costs* for waterborne service are those associated with the outfall sewer, transmission and the pumping main; and for on-site: pit-emptying service and intermediate sludge storage.
- *Internal service costs* refer to internal sewerage reticulation and consumer services costs; and for on-site they refer to the cost of building household latrines and consumer awareness and support programmes.
- *Overhead expenditure* includes planning and design as well as general administration. This expenditure can be allocated to the bulk, connector and reticulation categories on the basis of their estimated shares in the total.

Each of the components involves operations and maintenance and capital-related expenditure.

The functional cost method provides a relatively simple breakdown of a sanitation service providers expenditure. However, it does not recognise expenses associated

with peak flows. More detailed analyses that allow for such differentiation are possible with either the functional cost method or the cost causative method. These are discussed in the following sections.

5.3.2 Fixed-variable cost method

With this method, expenditure (both operating and capital) is categorised as either fixed or variable,[4] and is then further divided into system components:

- the collection system
- treatment plant
- billing and consumer costs
- administration

These component-related expenses are then allocated to the various consumer classes on the basis of composite allocation factors determined from the characteristics which most affect the expenditure of a particular system component. For example, the variable expenditure of the collection system is allocated to consumer classes based on an allocation ratio determined from the composite responsibility for average daily billable flow adjusted for daily infiltration volumes of each of the customer groups. Similarly, allocation ratios are developed for the allocation of other component-related expenses to consumer classes.

An advantage of this method is that because expenditure is divided into fixed and variable categories the impact on revenues of significantly changing volumes is shown. In addition the minimum level of revenue required, based on fixed expenditure needs, can be more easily determined with respect to each consumer class. A disadvantage, however, is that the fixed-variable expenditure procedure requires the use of detailed data in the derivation of the allocation factors for assigning expenses to consumer classes. The unavailability of such information may discourage use of this procedure. It is also not well suited to the analysis of on-site service expenditure.

5.3.3 Design cost-causative method

The design cost causative method is the most commonly used and is the method of expenditure analysis used to illustrate tariff-setting procedure in this module. It allocates capital and O&M expenditure to cost-causative elements of the sanitation system and then distributes these costs to consumer classes on the basis of their responsibility due to their specific service requirements. The distribution of total cost of service to consumer classes is done by first identifying the type of service and the consumer category. Next the units of service for each consumer class is determined. The unit costs for each system component can then be calculated, based on the total units of service for each system component and the total O&M and capital-related expenditure. Cost responsibility is then distributed to the various consumer classes based on the unit costs determined in the previous step and the units of service previously assigned to the consumer classes.

The method thus provides a direct way of apportioning cost responsibility to customers, and a sufficiently detailed analysis of the cost structure of a sanitation

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[4] As defined in section 4.2.1, fixed expenditure refers to those expenses that remain relatively unchanged for the year, and variable expenditure are expenses that change with fluctuations in volume or strength of wastewater treated.

service provider for tariff-setting purposes. It is discussed in more detail in the next section.

6. THE COST-CAUSATIVE METHOD FOR ALLOCATING SANITATION SERVICE EXPENDITURE

6.1 Introduction

The cost-causative method of expenditure allocation consists of the following key steps:

- collection and analysis of billing and budgetary data;
- allocation of annual expenses to the system components and cost functions; and
- distribution of the component costs to consumer classes.

A description of the method follows.

6.2 Data requirements

An important first step in analysing service costs for tariff-setting purposes is to collect the necessary data. The accuracy of the cost of service analysis depends on the quality and detail of the available data. The type of data required relates to the cost causing factors listed in section 5.2. and the expected cost of providing the service. In general, these data can be obtained from the billing records of the service provider and the annual budgets and financial statements of the municipality or service authority. The data collected should be representative of a typical 12-month time period for which the tariffs are to be in effect. The year selected should be representative of average consumption levels and preferably not a year in which wastewater discharges were abnormally high or low. Another approach is to base the cost analysis on data projected from a survey of historic records of the service provider. The review period could cover two, or even five, years.

6.3 The allocation of costs to system components

Once all available data are available the expenses are classified according to O&M and capital-related expenditure and then categorised according to system components. Following this, the expenditure associated with each of the system components is apportioned to the cost-causative functions:

- volume (relates to average wastewater flow);
- capacity (relates to peak flow);
- wastewater strength; and
- consumer services.

The degree to which expenses are apportioned to these functions is determined by the extent to which the component of the system (such as internal reticulation) relates to the cost functions (such as volume, capacity, strength and consumer services). The procedure for the allocation of both O&M and capital-related expenditure is explained in more detail in the following sections.

6.3.1 Allocation of capital-related expenditure

An example of the cost allocation procedure is given in Table 4. The capital costs of service are determined from a schedule of capital expenditure and are allocated to cost-causative functions based on the factors which are most responsible for causing

them (discussed in section 5.2. of this module). The procedure for waterborne and on-site systems is dealt with separately.

Table 4: An example of the allocation of capital-related expenditure

SYSTEM COMPONENTS	TOTAL CAPITAL RELATED COSTS	COST FUNCTION			
		Volume	Capacity	Strength	Consumer
On-site					
Tanker service asset replacement	125 515	n/a	n/a		125 515
Extension to sludge handling facilities	26 552	n/a	n/a	26 552	
Development of 300 new VIPs	82 461	n/a	n/a		82 461
General Admin	22 376	n/a	n/a	6 265	16 111
Total Onsite capital-related costs	256 903			32 817	224 086
Waterborne					
Internal Reticulation	527 861				527 861
Connector					
Outfall Sewers	208 285		208 285		
Pumping Stations	3 104		3 104		
Bulk					
Treatment Plants	290 860	61 081	34 903	194 876	
General Admin	45 110	2 707	10 375	8 120	23 908
Total Waterborne capital-related costs	1 075 220	63 787	256 667	202 996	551 770
Total	1 332 123	63 787	256 667	235 813	775 856

a) Waterborne

From Table 4 it can be seen that the expenditure associated with *internal reticulation* (e.g. lateral sewers, local collector sewers and manholes), which is proportional to the size of the wastewater system, is allocated to the *consumer* cost function. Expenditure associated with *connector infrastructure*, such as those expenses related to outfall sewers and pumping stations, are allocated to the *capacity* cost function because they are usually designed to meet maximum rates of flow.

The *inlet works of the treatment plant*, (facilities providing for screening, grit removal and flow-measuring) are designed to meet maximum hydraulic flow requirements, so the capital expenditure related to these items is allocated to the *capacity* cost function. The *primary and secondary settling tanks* are designed according to the flow rate through the treatment plant, and their related expenditure is therefore allocated to the *volume* cost function.

Reaction tanks (bio-filters, aeration basins) and *sludge-handling facilities* (thickeners, presses, digestors and circulators) are designed on the basis of COD and suspended solids loadings and their related capital expenditure is assigned to the *strength* cost function. Design of chlorination facilities is based on the maximum wastewater flow to ensure that all flows are properly chlorinated. Therefore capital expenditure associated with the *chlorinators and the chlorine contact chamber* are allocated to the *capacity* cost function. *Pumping facilities* within the treatment plant are assigned to the *capacity, volume or strength* cost functions depending on the design criteria.

Capital expenditure associated with *treatment plant administration* and *general facilities* is allocated to the cost functions in proportion to the overall ratio of investment in the system components of the treatment plant. If this information is not available, the following allocations, taken from an analysis of typical all-in construction costs for wastewater treatment plant, can be used for a breakdown of the capital-related costs associated with the treatment plant.:

Table 5: Breakdown of treatment works capital costs

System component	*% of total capital investment*	*Cost function*			
		Volume	*Capacity*	*Strength*	*Consumer*
Inlet works	5		5		
Reaction tanks	37			37	
Settling tanks	21	21			
Chlorination	7		7		
Sludge handling	30			30	
Cost allocation ratio	**100**	**21**	**12**	**67**	**0**

Source: Palmer Development Group, 1993

Where a sanitation system makes use of *tankers* as intermediate storage in the handling of its wastewater, the associated costs should be allocated to the *capacity* cost function, as such facilities are designed to handle maximum peak loads.

General system facilities, such as administrative offices, laboratories, vehicles, work equipment and workshops are considered support elements to the rest of the system. The capital costs associated with such facilities are allocated to cost functions in proportion to overall allocation of investment in other facilities, and the number of waterborne customers compared to onsite customers.

If this information is not available the following assumed proportions can be used:

Table 6: Breakdown of capital investment for a typical wastewater system

System component	*% of total capital investment*	*Cost function*			
		Volume	*Capacity*	*Strength*	*Consumer*
Collector sewers	53				53
Outfall sewers	19		19		
Inlet works	2		2		
Reaction tanks	10			10	
Settling tanks	6	6			
Chlorination	2		2		
Sludge handling	8			8	
Allocation ratio for general capital costs	**100**	**6**	**23**	**18**	**53**

Source: Palmer Development Group, 1993

b) On-site

For the expenditure related to on-site services the following apply:

- *pit-emptying expenses*, which would include tanker service replacement and batch composting facilities, are proportional to the number of customers served, and are thus allocated to the *customer* cost function;
- expenditure associated with *sludge treatment* and *handling facilities* would be allocated to the *strength* cost function; and
- *latrine development* expenditure should be apportioned to the *customer* cost function.

General administration expenditure is to cost functions in proportion to overall allocation of investment in facilities associated with this expenditure, and the number of onsite customers compared to waterborne customers (see Table 4).

6.3.2 Allocation of operation and maintenance expenditure

O&M expenditure is a major part of a sanitation service provider's total expenditure. An example of the allocation O & M costs is shown in Table 7.

Table 7: Allocation of operation and maintenance expenditure (example)

SYSTEM COMPONENTS	TOTAL O&M EXPENDITURE	COST FUNCTION			
		Volume	Capacity	Strength	Consumer
Onsite Sanitation Services					
Vacuum tanker Service	124 400				124 400
Sludge treatment and handling	115 000			115 000	
Community awareness programme	80 000				80 000
Customer Billing	28 146				28 146
Administrative and General	75 915			50 104	25 811
Total O&M Costs - Onsite	423 460			165 104	258 357
Waterborne					
Internal Reticulation	185 000				185 000
Outfall Sewers	90 210		90 210		
Pumping Stations	4 400	1 100	3 300		
Conservancy Tank	231 482		231 482		
Treatment Plants					
Inlet Works	79 460	79 460			
Reaction Tanks	326 660			326 660	
Setting Tanks	88 290	88 290			
Tertiary Treatment	97 115	97 115			
Sludge Handling	238 375			238 375	
General	52 970	16 950		36 020	
Customer Billing	80 650				80 650
Administrative and General	217 529	34 805	93 537	54 382	34 805
Total O&M Costs - Waterborne	1 692 141	317 720	418 529	655 437	300 455
Total O&M Costs	2 115 601	317 720	418 529	820 540	415 909

Source: (WPCF et al, 1984)

Most O&M expenditure, for both waterborne and on-site services, can be allocated in a similar manner to the way capital-related expenditure was allocated in the previous section; for example, O&M expenses associated with the *internal sewer reticulation* are allocated to the *consumer* cost function, as was done in the case of capital expenditure. Similarly, expenditure related to the *outfall sewers* is assigned to the

capacity cost function; and for on-site sanitation services, *vacuum tanker service* expense is allocated to the *consumer* cost function and *sludge treatment* expenses are allocated to the *strength* cost function. This is not always the case, however; the following O&M expenditure is allocated differently:

- For on-site sanitation services, community awareness and education programmes are allocated to the customer cost function.
- Pumping expenses are not allocated entirely to the capacity cost function. This is because the power costs for pumping vary principally with the volume of wastewater pumped, but other pump-station O&M expenditure is related to peak flows. Therefore, in the example, 25% of the annual pumping expenditure is assumed to be related to power costs and is allocated to the volume cost function, and the remaining 75% of pumping expenditure is allocated to the capacity cost component.
- O&M expenditure associated with the *inlet works and chlorination facilities* at the treatment plant is more dependant on the volumes of wastewater handled than the peak flow rates and is therefore allocated to the *volume* cost function, and not the capacity cost function as was done with capital-related expenditure.
- Expenditure relating to *treatment plant administration and general* activities is allocated to cost functions in proportion to the ratio of expenditure on the other components of the treatment plant, less costs for chemicals and power. If the information required for a detailed breakdown of the treatment plant operation and maintenance costs is not available, an assumed proportional breakdown of the expenditure may be used as is given in Table 8, which was compiled based on typical operations at an activated sludge treatment works..

Table 8: Typical % proportion of O&M costs for an activated sludge treatment works

System component	*Operating staff*	*Maintenance*	*Electricity*	*Chemicals*	*Total % cost breakdown*
Inlet works	15	6	5	5	9
Reaction tanks	20	42	80	5	37
Settling tanks	10	17	5		10
Tertiary treatment	10	3		60	11
Sludge handling	35	27	10	30	27
General and Administration	10	5			6
Overall % of total cost	40	30	20	10	100

Source: Estimates based on experience in the field (Ian Palmer)

From this table, a ratio for allocating general and administration expenditure to cost functions can be derived. In this case it is *32:68* to *volume:strength* cost functions

- *Consumer billing* costs are directly proportional to the number of customers served and are thus allocated to the *consumer* cost function in full.
- Expenditure relating to *general and administrative* operations or overheads is allocated to cost functions in proportion to the ratio of expenditure on the other components of the whole system.

Once the O&M and capital-related expenditure has been allocated to system components and cost functions, it is possible to determine the level of costs attributable to each customer class. This process of distributing expenditure to customers is discussed in the following section.

6.4 Distribution of costs to customer classes

The method for distributing the total cost of service to customers comprises four steps:

- classification of customers into categories or customer classes;
- the determination of the units of service for the system;
- the determination of the unit cost of service; and
- the distribution of costs to customer classes.

6.4.1 Classification of customer classes

In meeting individual customer needs, the service provider incurs a number of costs that must be recovered. Ideally, the service provider would want to recover the cost that each individual customer incurs on the system from that customer. This is impractical, however, because of the numbers of customers usually served and it would require direct measurement of wastewater volume and strength from every customer (discussed in section 3.2.1). Therefore, customers are usually categorised into groups which have similar service requirements who can be served at similar costs to the utility.

Customers are primarily classified as residential, commercial, and industrial. Further classification of these main categories is common, however, and is discussed in the following sections.

a) Residential customers

Residential customer identification and classification is principally based on service type, level of service and affordability. Types and levels of service levels and the income categories for which they may be acceptable are discussed in detail in Module 3.

Table 9: Service typology, levels and income brackets for which services may be acceptable

Service type	*Level of service*	*Income groups for which service may be acceptable*
Unimproved pits, buckets or nothing	not acceptable	not applicable
Ventilated improved pit (VIP) toilets	basic	very low & low
Low flow on site (LOFLOS) systems, including aqua-privies	basic	very low & low
Simple waterborne sanitation (sewered), including shallow sewerage options and septic tank effluent drainage (STED) system	intermediate	very low, low & medium
Septic tanks	intermediate/high	all (in suitable areas)
Full waterborne sanitation	high	all

Note: very low = <R800 per month, low = R800-R1 500 per month, medium = R1 500-R3 500 per month, high = >R3 500 per month

provides a summary of these issues.

Residential customers can be further divided into sub-groups as follows:

- households with dry on-site sanitation systems, such as VIPs;
- households with low flush on-site sanitation systems (LOFLOS);
- households with septic tank on-site sanitation systems;
- low-income single family dwellings with water-borne sanitation, including septic tank effluent drainage (STED) systems;
- middle-income single-family dwellings with water-borne sanitation;
- high-income single-family dwellings with water-borne sanitation;
- multi-family dwellings with water-borne sanitation.

b) Commercial customers

Commercial customers are generally made one class, although a variety of businesses are included – such as motels, hotels, restaurants, and general retail establishments. However, customers such as shopping centres and small industries might be separately identified and classified as large commercial.

c) Industrial customers

Industries are generally made one class but include a variety of economic activities, including:

- manufacturing;
- mining;
- power generation;
- transport activities; and
- construction.

Industrial customers typically involve some type of manufacturing or process facility and generally differ from commercial customers in terms of volume contributed and/or the pollutant content of their wastewater discharge.

The most important group for most municipalities is manufacturing. Sometimes the process used does not require water, in which case the factory would be categorised as "dry" industry. Any industry which produces more than 150 kℓ per month of wastewater is required by law (Water Act, 1956) to apply for a permit from DWAF. It may therefore be sensible to use this as an appropriate level above which industries are classified as "wet".

6.4.2 Units of service

Once customers have been classified into classes, the service costs can be distributed to each class on the basis of their proportionate responsibility that each class bears for the costs. This is determined by first identifying an appropriate unit for each cost function (wastewater volume, capacity, strength, and customer services) that is representative of the cost-causing agent for each component of the system. Once this is done units of service attributable to each customer class for each component are determined. An explanation of the procedure used for the determining the units of

service for each cost function follows, and an example of the procedure is shown in Table 11.

a) Volume

The volume cost function relates to the average annual flow of wastewater of the sanitation service. As such it is not applicable to the analysis of on-site service costs, and in this example it is only of significance to customers with waterborne sanitation.

Wastewater volume is made up of two components, namely consumer-contributed flow, and infiltration/inflow of groundwater and stormwater into the sewers through defective pipes, pipe joints, connections, roof leaders, manhole covers, area drains, etc. The contributed wastewater flow (shown in Table 11) is the annual wastewater discharge of each customer class that enters the system. It is common practice to use metered water data to estimate contributed wastewater volume units of service from residential customers. In this case, allowance should be made for the water used for lawn irrigation, car-washing, or other purposes, which is not discharged into the waterborne system. This is done by the use of a wastewater return factor which will vary for the different residential customer classes. The wastewater return factor is the percentage of the metered domestic water that is returned to the waterborne sanitation system. Typical wastewater return factors for different customer classes in South Africa are given in Table 10. The data were determined from the water balance analysis in Annexure 1 of this module.

Table 10: Typical wastewater return factors for residential customers with waterborne sanitation

Consumer class	*Typical wastewater return factors (%)*		
	*10 % multi dwelling**	*20 % multi dwelling*	*30 % multi dwelling*
Residential – low income	85	87	88
Residential – middle income	67	70	73
Residential – high income	44	50	56

*The percentage of multi-dwellings refers to the proportion of residential customers living in multi-dwellings (or high- or low-rise flats) in comparison with single dwellings.

The return factors used to determine the contributed wastewater flow in Table 11 correspond to those in the "10% multi-dwelling" column in Table 10.

The second component of the total wastewater volume reaching the treatment plant is infiltration/inflow. In the example given in Table 11, it is estimated that 20% of the total flow reaching the treatment plant per year is attributable to infiltration/inflow. In practice this figure should be based on available studies and comparisons between average day volumes and average night flows received at the treatment works.

b) Capacity

As with the volume cost function, the capacity cost function is not used to analyse on-site service because it relates to wastewater flows. System capacity costs depend on the estimated peak flow rates for both wastewater and infiltration/inflow water attributable to each customer class. In the example an estimate of the peak flow units of service was determined by adding the average daily flow rate of contributed wastewater and double the average daily flow rate for infiltration/inflow water.

c) Strength

The strength cost function is relevant to the analysis of both waterborne and on-site sanitation services. The unit of service used to determine responsibility of each consumer class for the strength of wastewater or sludge is the daily organic load as measured by the chemical oxygen demand (COD). The units of service for customers with a waterborne service are based on an estimate of average COD concentrations and contributed volume for each class. For customers with on-site sanitation, units of service are calculated using COD load per capita and the number of people served per consumer class. Typical COD concentrations and average COD load per capita figures for residential and commercial customer classes in South Africa are given in Table 12.

From the table it can be seen that the COD load per capita is generally lower for on-site sanitation systems than for waterborne. This is primarily due to the digestion of sludge that occurs in most on-site systems. It is also noteworthy that the wastewater strength concentrations for low-income waterborne customers is higher than that of high income customers. This can be attributed to the dilutionary effect that the sullage (wastewater from washing machines, dish-washers, etc) has on the sewage.

Table 11: Units of service

Item	Units	Residential						Commercial	Industrial	TOTAL SYSTEM
		Onsite: Septic	Onsite: LOFLOS	Onsite: dry	Waterborne: low income	Waterborne: middle income	Waterborne: high income			
Wastewater Volume	kl/year									
Contributed	kl/year	n/a	n/a	n/a	162 640	328 059	419 212	48 552	180 000	1 138 464
Infiltration/Inflow	kl/year	n/a	n/a	n/a	32 528	65 612	83 842	9 710	36 000	227 693
Total Wastewater Volume	kl/year				195 168	393 671	503 055	58 263	216 000	1 366 157
Wastewater Capacity										
Contributed	kl/day	n/a	n/a	n/a	446	899	1 149	133	493	3 119
Infiltration/Inflow	kl/day	n/a	n/a	n/a	178	360	459	53	197	1 248
Total Wastewater Capacity	kl/day				624	1 258	1 608	186	690	4 367
Strength										
COD	kg/yr	27 959	6 990	12 505	97 584	196 836	251 527	29 131	108 000 [a]	702 573
Consumer										
Bills	number	9 670	4 452	15 490	45 539	22 980	12 487	2 402	670	104 020

[a] Includes 3600 kg from surcharge consumers

Table 12: Typical COD loadings of wastewater digestor/pit sludge entering a treatment works

Consumer class	*Typical COD concentrations (mg/l)*	*Typical COD load per capita (grams COD/person/day)*
Residential – on site – dry	-	16
Residential – on site – wet	-	20
Residential – low income	1200	80
Residential – middle income	800	100
Residential – high income	600	150
Commercial	1000	-

The figures in Table 12 compare favourably with a survey conducted in the city of Belo Horizonte, Brazil (Campos et al, 1996). The survey determined BOD concentrations for residential customers to be in a range of 472 mgBOD/l for middle-income households to 249 mgBOD/l high-income households. The equivalent COD concentrations are determined by doubling the BOD concentrations (pers. com. Mark Wentzel, UCT Civil Engineering Department), and thus the range for COD concentrations is 498 mgCOD/l for high-income households and 944 mgCOD/l for middle-income households.

d) Customer service

The number of monthly bills per customer class are the units of service used to determine responsibility for customer related costs. This data is obtained from the billing records of the wastewater department.

6.4.3 Unit costs

Unit costs are calculated by dividing each cost component for operations and maintenance and capital-related costs by respective total units of service derived in Table 11. For example, in Table 13 the volume unit cost for the operation and maintenance costs of waterborne customers of R0.23 per kℓ (line 15 in the table) is calculated by dividing the allocated volume operation and maintenance cost of R 317 720 (line 14) by the total volume component units of service of 1 366 157 kℓ of wastewater per year (line 12 in the table). Similar calculations are made to determine the unit costs for the other cost functions of operation and maintenance, and capital-related costs.

Total unit costs of service for waterborne and onsite services for each cost function are given separately. These totals are the summation of the unit costs for O&M and capital-related costs for either onsite or waterborne services, and are given on lines 10 and 19 of the Table 13, respectively.

Table 13: Unit cost of service

Line No.	ITEM	TOTAL COST	COST FUNCTION			
			VOLUME	CAPACITY	STRENGTH	CUSTOMER
1	System Units of Service		kl	kl/day	kg COD	bills
2	**Onsite Services**					
3	Number of units		n/a	n/a	47 453.47	29 912.00
4	Operation & Maintenance Expense					
5	Total (R/year)	423 490.29	n/a	n/a	165 103.61	258 356.67
6	O&M Unit Cost (R/unit/year)		n/a	n/a	3.48	8.72
7	Capital Related Costs					
8	Total (R/year)	256 903.25	n/a	n/a	32 817.37	224 085.88
9	Capital-related unit cost (r/unit/yr)		n/a	n/a	0.69	7.57
10	**Total Unit Costs of Onsite Services**		n/a	n/a	**4.17**	**16.29**
11	**Waterborne Services**					
12	Number of units		1 356 157	4 367	683 079	84 078
13	Operation & Maintenance Expense					
14	Total (R/year)	1 692 141.00	317 720.04	418 529.47	655 436.85	300 454.64
15	O&M Unit Cost (R/unit/year)		**0.23**	**95.85**	**0.96**	**3.57**
16	Capital Related Costs					
17	Total (R/year)	1 075 220.20	63 787.14	256 667.48	202 995.81	551 769.79
18	Capital-related unit cost (r/unit/yr)		**0.05**	**58.78**	**0.30**	**6.56**
19	**Total Unit Costs of Waterborne Services**		**0.28**	**154.62**	**1.26**	**10.14**

6.4.4 Distribution to customer classes

The costs of service for each customer class can now be determined. This is done by multiplying the *unit cost of service* for each cost function by the *units of service* for each customer class. An example of this is shown in Table 14 overleaf.

The table provides the analyst with the financial costs (borne by the sanitation service provider) of providing each of the customer classes with a sanitation service. With this information it is possible to structure tariffs to recover the revenue requirements induced by each of the customer classes in a transparent manner.

Table 14: Distribution of costs of service to customer classes

ITEM	VOLUME	CAPACITY	STRENGTH	CONSUMER	TOTAL
Name of Units	(kl)	(kl/d)	(kg COD)	(bills)	
Onsite sanitation Services					
Operation & Maintenance Expense					
Unit Costs of Service (R/unit)			3.48	8.72	
On Site - Dry					
Units of Service			12 505	15 490	
Allocated Cost (R)			43 508	135 146	178 654
On Site - LOFLOS					
Units of Service			6 990	4 452	
Allocated Cost (R)			24 319	38 842	63 162
On Site - Septic					
Units of Service			27 959	9 670	
Allocated Cost (R)			97 277	84 368	181 645
Total O&M Allocated Cost			165 104	258 357	423 460
Capital Related Costs					
Unit Costs of Service (R/unit)			0.69	7.57	
On Site - Dry					
Units of Service			12 505	15 490	
Allocated Cost (R)			8 648	117 219	125 867
On Site - LOFLOS					
Units of Service			6 990	4 452	
Allocated Cost (R)			4 834	33 690	38 524
On Site - Septic					
Units of Service			27 959	9 670	
Allocated Cost (R)			19 335	73 177	92 512
Total Allocated Capital-related Cost			32 817	224 086	256 903
Waterborne Services					
Operation & Maintenance Expense					
Unit Costs of Service (R/unit)	0.23	95.85	0.96	3.57	
Waterborne - low income					
Units of Service	195 168	624	97 584	45 539	
Allocated Cost (R)	45 389	59 791	93 635	162 735	361 550
Waterborne - Middle Income					
Units of Service	393 671	1 258	97 584	22 980	
Allocated Cost (R)	91 554	120 603	93 635	82 119	387 912
Waterborne - High Income					
Units of Service	503 055	1 608	251 527	12 487	
Allocated Cost (R)	116 993	154 113	241 349	44 623	557 078
Commercial					
Units of Service	58 263	186	29 131	2 402	
Allocated Cost (R)	13 550	17 849	27 953	8 584	67 935
Industrial					
Units of Service	216 000	690	108 000	670	
Allocated Cost (R)	50 234	66 173	103 630	2 394	222 431
Total O&M Allocated Cost	317 720	418 526	560 202	300 455	1 596 906
Capital Related Costs					
Unit Costs of Service (R/unit)	0.05	58.78	0.30	9.56	
Waterborne - low income					
Units of Service	195 168	624	97 584	45 539	
Allocated Cost (R)	9 113	36 667	29 000	298 854	373 634
Waterborne - Middle Income					
Units of Service	393 671	1 258	97 584	22 980	
Allocated Cost (R)	18 381	73 961	29 000	150 808	272 150
Waterborne - High Income					
Units of Service	503 055	1 608	251 527	12 487	
Allocated Cost (R)	23 488	94 512	74 748	81 947	274 695
Commercial					
Units of Service	58 263	186	29 131	2 402	
Allocated Cost (R)	2 720	10 946	8 657	15 763	38 087
Industrial					
Units of Service	216 000	690	108 000	670	
Allocated Cost (R)	10 085	40 581	32 095	4 397	87 159
Total Allocated Capital-related Cost	63 787	256 667	173 500	551 770	1 045 725
Total Allocated Cost of Service	381 507	675 197	931 623	1 334 667	3 322 994

7. USING ALLOCATED COSTS TO SET SANITATION TARIFFS

7.1 Introduction

With the cost of service to each of the customer classes known, it is possible to set tariffs to recover costs and make the necessary adjustments to ensure that they are affordable to all customers, in a transparent manner. The cost allocation procedure will be of assistance in setting tariffs regardless of the tariff structure used (see section 3.2 and 3.3).

7.2 Tariff design

There is a growing trend internationally to structure sanitation tariffs based on a fixed charge and a single volume charge for all levels of use. The use of cost of service data in determining tariffs with this structure is shown in Table 15.

Table 15: An example of the development of a cost of service tariff

	Name of Units	Units	Unit cost	Total
Customer Service Charge				
Total Customer Related Costs				
Onsite	Rands	29612	16.29	482 442.55
Waterborne	Rands	84078	10.14	852 224.43
Total				1 334 666.98
Number of Bills	bills			113690
Service Charge (Rands/bill)				11.74
Onsite Service Tariffs				
Onsite Service Charge - Dry				
Wastewater Strength	kg COD	12505	4.17	52 155.98
Number of Bills				15 490
Charge (Rands/bill)				3.37
Onsite Service Charge - LOFLOS				
Wastewater Strength	kg COD	6990	4.17	29 153.00
Number of Bills				4 452
Charge (Rands/bill)				6.55
Onsite Service Charge - Septic tanks				
Wastewater Strength	kg COD	27959	4.17	116 612.00
Number of Bills				9 670
Charge (Rands/bill)				12.06
Waterborne Tariffs				
Volume	kl	1138464	0.28	317 922.65
Volume related Infiltration/Inflow	kl	227693	0.28	63 584.53
Capacity	kl/day	3119	154.62	482 283.52
Capacity related Infiltration/Inflow	kl/day	1248	154.62	192 913.41
Wastewater Strength	kg COD	632025	1.26	794 273.18
Total Volume Related Costs (R)				1 850 977.29
Total Billable Volume				1 138 464
Volume Charge (Rands/kl)				1.63
Strength Surcharge				
COD (Rands/kg)				1.26

The fixed charge generally recovers customer-related costs, which include a portion of general and administrative costs. For waterborne systems the fixed charge will also include those costs associated with meter reading, billing, and collection. For on-site systems it will include the costs of pit-emptying and community awareness programmes aswell as the administration costs.

The volume charge for a waterborne service consists of five components, namely: volume costs, infiltration/inflow volume costs, capacity costs, infiltration/inflow capacity costs and wastewater strength costs. For an on-site service there is no volume charge; but in its place a strength charge could be implemented which relates to the

costs of sludge treatment and handling. Table 15 develops a set of charges for customer, onsite service levels, and waterborne volume and strength related services.

7.3 Tariff-setting example: full cost recovery per customer

An example of the tariff implications of these charges for a family of five people in each of the customer classes follows:

7.3.1 Onsite-dry level of service

Based on the customer and strength service charges developed for an on-site (dry) service in Table 15, the following tariff would be applicable for a family of five with a VIP. (Note that the methodology would be applicable to other forms of on-site dry systems such as composting toilets).

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	11.74	1	11.74
Strength service charge	per bill	3.37	1	3.37
Monthly sanitation tariff				**15.11**

7.3.2 Onsite-LOFLOS

Based on the customer and strength service charges developed for a LOFLOS service in the Table 15, following tariff would be applicable for a family of five with LOFLOS:

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	11.74	1	11.74
Strength service charge	per bill	6.55	1	6.55
Monthly sanitation tariff				**18.29**

7.3.3 Onsite - Septic Tanks

Based on the customer and strength service charges developed for a septic tank service in Table 15, the following tariff would be applicable for a family of five with a septic tank system:

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	11.74	1	11.74
Strength service charge	per bill	12.06	1	12.06
Monthly sanitation tariff				**23.80**

7.3.4 Waterborne – low income

For the case of a low-income family of five with a waterborne sanitation service, their average monthly wastewater contribution to the system would be approximately 12 kℓ

per month (see Table 9 in Annexure 1). Based on the customer service and volume charges developed in Table 15, the following tariff would be applicable:

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	11.74	1	11.74
Volume charge	per kl waste-water per mnth	1.63	12	19.51
Monthly sanitation tariff				**31.25**

7.3.5 Waterborne – middle income

A middle income family with a waterborne service contributes an average of 17 kℓ of wastewater per month (from Table 9, Annexure 1) to the sanitation system. This yields the following tariff:

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	11.74	1	11.74
Volume charge	per kl waste-water per mnth	1.63	17	27.64
Monthly sanitation tariff				**39.38**

7.3.6 Waterborne – affluent

A high-income family with waterborne sanitation contribute an average of 28kℓ of wastewater per month (Table 9, Annexure 1). Based on the customer service and volume charges developed in Table 15, the monthly tariff would be:

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	11.74	1	11.74
Volume charge	per kl waste-water per mnth	1.63	28	45.52
Monthly sanitation tariff				**57.26**

7.3.7 Industrial and commercial customers

Table 15 shows a simplified case where large customers discharging effluent into the wastewater system with COD levels in excess of the of the standard domestic range (which in this example is between 0.4 and 2.5 kg COD per year) pay a surcharge for every kg COD above the upper limit of this range. The surcharge is related to the unit cost for strength related costs as determined in Table 15. The strength surcharge in this case is R1.37 per kg COD per year. For example an industry producing 60 kℓ of wastewater per month with a strength of 1750 mg COD/l (a total of 10.5 kg COD per month), will have the following tariff:

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	11.74	1	11.74
Volume charge	per kl waste-water per mnth	1.63	60	97.55
Strength surcharge	per kg COD in excess of 2.5 kg	1.26	8	10.05
Monthly sanitation tariff				**119.34**

7.4 Tariff setting example - differentiated cost recovery by customer class

Once a preliminary assessment of the tariffs has been made, it is possible to make amendments to the tariff structure to ensure that tariffs are affordable to all customers. For example, a lifeline component could be introduced for dry onsite sanitation customers by subsidising the capital-related costs of the service. This would result in the following tariff (from the example in 7.3.1.):

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	4.92	1	4.92
Strength service charge	per bill	2.81	1	2.81
Monthly sanitation tariff				**7.72**

The unit cost of R4.92 per bill is the O&M unit cost which can be determined from the data in Table 13. The same could be done for customers with LOFLOS (see example in section 7.3.2), thus:

Type of charge	Units of charge	Unit charge (R/unit)	No.of Units	Tariff (R)
Customer service charge	per bill	4.92	1	4.92
Strength service charge	per bill	5.46	1	5.46
Monthly sanitation tariff				**10.38**

If the above subsidies are to be carried by the rest of the customers, in this particular example, it would result in the customer service charge increasing from R11.74 to R13.19 per bill (an increase of R1.45 per month), and the strength surcharge increasing from R1.26 to R1.28 per kℓ.

7.5 Closure

When setting sanitation tariffs the basic principles as outlined in the National Sanitation Policy White Paper (RSA, 1996) need to be complied with. These were discussed in section 2 of this module. In summary the broad principles are that tariffs should:

- promote affordable access;

- meet the revenue requirements of the service provider; and
- promote efficient use and the conservation of water.

In setting tariffs, cognisance must be taken of how rates compare to those for other services, what the tariffs mean in terms of monthly bills, what alternatives there are to the services offered and what income levels are in the area concerned. Furthermore, if tariffs are to be acceptable to the majority of consumers then the service provider must ensure that there is proper communication between service providers and communities, enforcement of sanctions, upgrading of the quality of service provision and more. But setting tariffs that are seen by all parties as "fair" is an essential component of the process.

The primary purpose of the examples in this module is to illustrate a procedure for cost analysis and tariff-setting. The data used in the examples was obtained from a survey of twenty towns in South Africa (PDG, 1994). The figures should, however, only be considered as indicative of typical sanitation service costs in a small town in this country in 1993, and are not intended to be definitive.

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WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Annexure 1

RESIDENTIAL WATER BALANCE ANALYSIS

January 1998

PALMER DEVELOPMENT GROUP

ANNEXURE

1. RESIDENTIAL WATER BALANCE ANALYSIS

1.1 Introduction

Residential water use accounts for between 55% and 70% of the total urban water demand of most towns and cities in South Africa (PDG, 1993). Not all water used for residential purposes enters the wastewater system, however; in general, only water used indoors flows into the sewer.

The term "water balance" used in the title of this section is in reference to the process of determining the amount of wastewater discharged into the sewerage system from the consumption patterns of domestic water received by the respective household. In other words, this section analyses available data for the residential end uses of water to allow understanding of the relationship between water in and wastewater out for the various customer classes existing in South Africa.

1.2 Typical consumption levels for indoor water appliances and fixtures

1.2.1 WC systems

The average nominal flush volume for flush toilets in South Africa is between 11 and 13 litres (CSIR, 1983). The following table presents typical water consumption figures relating to wc's.

Table 1: Daily per capita consumption figures for WC's

Type of WC	*Conventional*	*Intermediate*	*Economy*
Flush volume (litres)	13	9	6
No. of flushes per person per day	4	4	4
Total consumption per person per day (litres/person/day)	52	36	24

Source: CSIR, 1983

1.2.2 Personal cleansing

a) Baths

Table 2: Volumes of water associated with domestic baths

Baths: Nominal length	*Ave total volume capacity (litres)*	*Volume (litres) at depth:*		
		100mm	*150mm*	*300mm**
1800mm	205	56	89	197
1700mm	180	49	79	184
1400mm	130	40	65	150

Source: CSIR, 1983

* Extrapolated volumes from data determined for depths of 150mm, 100mm and 80mm.

b) Wash basins

Table 3: Volumes of water associated with wash basins

Wash basin	*Ave total volume capacity (litres)*	*Use per person per day*	*Ave daily consumption per person (litres/person/day)*
Large	10	1	10
Medium	7.7	1	7.7
Small	3	1	3

Source: CSIR, 1983

c) Showers

Table 4: Volumes of water used in domestic showers

Type of Shower	*Volume (litres) of water used* at flow pressure of:*		
	15 kpa	*100 kpa*	*300 kpa*
High flow	55	125	220
Intermediate flow	35	87.5	150
Economy flow	5	20	37.5

Source: CSIR, 1983

*Based on a showering time of five minutes

1.2.3 Household appliances

a) Washing machines and dish washers

Table 5: Typical volumes of water used by washing machines and dishwashers

Type of appliance	*Ave volume per use (litres)**	*Use per day*	*Ave volume per day (litres/day)*
Washing machine	110	0.75	82.5
Dishwasher	54	0.8	43.2

Source: CSIR, 1983

Most cleansing appliances on the market today have adjustable cycles to save water which on average are capable of a 50% reduction in water consumption. However, this has not been taken into account in Table 5 because it is assumed that the economy cycle on those washing machines that have them is not often used.

b) Taps and faucets

Taps run to waste, (e.g. to rinse hands or vegetables or to allow for the hot water from the geyser to come through), can constitute up to 2% of the total household's water consumption (AWWA, 1993). The amount of water run to waste depends on the flow rate from the tap which depends on the type of tap used and the flow pressure of the system.

A half-open wash basin tap (12mm) at an intermediate flow pressure of 50kPa will typically have a flow rate of between 7 and 20 l/min, and a fully open bath tap

(20mm) will have a flow rate of between 19 and 64 l/min at the same flow pressure (CSIR, 1983).

1.2.4 Leaks and drips

Leaks and drips can account for a significant proportion of household water – for example, a survey of cistern leakage in an office block in Pretoria (CSIR, 1983) found that, on average, 4.6% of the cisterns leaked at an average rate of 26.7 l/hr, which means a daily wastage of 640 litres of water per cistern. Typically leaks and drips account for about 5% of the average household's consumption (AWWA, 1993)

1.2.5 Drinking and cooking

Water used for drinking and cooking is assumed to be between 3-5 litres per person per day.

1.3 Typical levels of external domestic water consumption

1.3.1 Garden watering

A survey of domestic water consumption in Port Elizabeth and Cape Town conducted by Malan, Simpson and Moore (CSIR, 1983) found that garden watering accounted for between 25-37% of total consumption for middle-income households, and between 13 and 37% for low-income households. This is similar to the figures for garden watering from the United States of 25-30% of total household consumption (AWWA, 1993).

The average amount of water necessary to maintain a conventional garden is 30mm per week, (pers com, Frans Smit, a garden irrigation expert). A water-wise garden using indigenous plants can manage with 10mm per week. If it is assumed that garden-watering takes place for seven months of the year (30 weeks) for the average household, conventional gardening would require 900 l/m^2/year, water wise gardening would require 300 l/m^2/year. These figures compare with a survey conducted in California, USA (CDWR, 1976) which found that conventional gardening required 1880 l/m^2/year, and water economy gardens required 720-960 l/m^2/year.

1.3.2 Swimming pools

Loss of water from a swimming pool takes place in the following ways:

- evaporation;
- splash;
- filter backwash;
- leakage;
- periodic replacement of entire contents.

The amount of water needed to maintain a swimming pool in Pretoria was monitored by Malan, Simpson and Moore (CSIR, 1983) over a period of about one year. The swimming pool chosen was a small-medium-sized pool (49kℓ capacity). The results of the programme showed that the pool required 115 litres of water per day on average, excluding periodic replacement of the water. If the contents of the pool were to be replaced every five years this would require an additional amount of 27 l/day. Thus, the total amount of water required to maintain a pool of this size is 142 l/day. The following table was compiled on the basis of these figures:

Table 6: Volume of water required to maintain a swimming pool

Size of swimming pool (kl)	Ave daily volume of water required for maintenance (litres)
30	87
55	160
72	209

1.3.3 Other Uses

Other outdoor uses include:

- car washing: up to 5% of total household consumption;
- driveway cleaning: up to 2% of total household consumption.

1.4 Residential water end uses for typical consumer categories

Table 7 makes use of the data prepared in the preceding sections to estimate the water consumption patterns for different consumer categories, based on the following assumptions:

- The average number of people per household for the different customer classes has been assumed to be four people per household for affluent and middle-income house-holds and five people per household for township households.
- The area of garden under irrigation has been assumed to be 40% of the total erf size for affluent; 30% for middle-income households, and 20% for township houses.
- The daily WC consumption data per household has been determined from the total daily per capita consumption values given in Table 1. Low-income consumers are attributed with nine litre cisterns and an average of three flushes per person per day. Other consumer classes are assumed to have 13 litre cisterns and flush on average four times per person per day.
- For water consumed for purposes of personal cleansing it is assumed that where both showering and bathing facilities exist, two in every four people will bath and one in every four will shower. To calculate the daily consumption attributable to personal cleansing the per capita quantities of water consumed for baths from Table 2 are multiplied by a factor of 0.5 and the quantities for showers from Table 4 are multiplied by a factor of 0.25. Where only bathing facilities exist it is assumed that five people will share three baths per day.
- Affluent consumers are assumed to have large baths (1800mm in length) and on average fill the bath to 300mm. Middle-income consumers are assigned baths of 1700mm in length on average and fill their baths to 150mm. For other consumers it is assumed that they have baths 1400mm in length and fill each bath to 100mm in depth on average (see Table 2 for the volumes of water associated with the above assumptions).
- For hand basins it is assumed that affluent consumers use ten litres per person per day, middle income users 7.7 ℓ/person/day and low-income consumers use three ℓ/person/day, (see Table 3).
- For the volume of water consumed by showering it is assumed that only affluent and middle-income single dwelling consumers have showering facilities. Affluent single-dwelling consumers have high-flow shower heads at intermediate pressure

(150kPa) and the other consumer classes with showers have intermediate-flow shower heads at an standard pressure of 15 kPa (see Table 4).

- For washing machines it is assumed that the economy cycle, (which cuts water consumption of the machine by half), is used for 80% of the time.
- For those consumers that do not have washing machines it is assumed that a volume of double that determined for a small bath (see Table 2) is used twice a week for clothes washing by hand. This means an average figure of 23 ℓday/household is used per household.
- For those consumers that do not have dish washers it is assumed that a volume of double that determined for a medium basin (see Table 3) is used daily for dish washing by hand, i.e. 15.5 ℓ/day/household.
- The average amount of water allowed to flow to waste from taps for affluent and middle-income consumers was estimated by assuming a flow of 15 ℓ/min for one minute a day is allowed to run to waste per person (see section 1.2.3). For low-income consumers a flow of 7 ℓ/min is assumed.
- The amount of water lost to leakage was estimated to be 10 5% of total household consumption for each consumer group (AWWA, 1993).
- The average amount of water used for garden watering was determined for single dwelling customer classes. For affluent consumers it is assumed that garden watering takes place for six months of the year. 30% of the consumers in this group use water-wise methods; and 10% do not water their gardens at all. For middle-income consumers it is assumed that 40% of consumers water their gardens and garden watering occurs for five months of the year. For low-income consumers it is assumed that 30% of consumers water their gardens for five months of the year, (see section 3.1. for volumes of water associated with garden watering).
- 50% of affluent households have swimming pools and 40% of middle-income households have swimming pools. The volume of water used to maintain swimming pools for each customer class was determined from Table 6 and assuming that those affluent households with pools had large pools, and those middle-income households with pools had medium-sized pools, (see Table 6).
- 5% of total household consumption for all consumers has been allowed for other uses not identified in the end uses given below.

Table 7: Determination of residential water consumption

		Average Daily Consumption for the Customer Classes (litres/household/day):					
		Formal - Affluent Suburb		Formal - Middle Income Suburb		Formal - Township Suburb	
		House	Flat	House	Flat	House	Flat
Ave no. of people per household		4	4	4	4	5	5
Average Size of Erf		2200	0	1100	0	500	0
Average garden size under regular watering (m^2)		880.0	0.0	330.0	0.0	100.0	0.0
Water End Uses	Toilet	208	208	208	208	180	180
	Bath	394	394	158	158	120	120
	Wash Basin	40	40	31	31	15	15
	Shower	125	125	35	35	0	0
	Washing machine	50	50	50	50	23	23
	Dish Washer	43	43	16	16	16	16
	Faucets	60	60	60	60	35	35
	Leakage	20	14	11	9	6	6
	Drinking and Cooking	20	20	16	16	15	15
	Garden Watering	1 402	0	245	0	56	0
	Swimming Pool	105	0	64	0	0	0
	Other Uses	10	7	6	4	3	3
Total Daily Consumption per household (l/day)		2 475	960	899	586	468	412
Total Daily Consumption per Person (l/person/day)		619	240	225	147	117	103
Equivalent Monthly Consumption per Household (l/month)		74	29	27	18	14	12

Table 8 presents the data from table 7 in the form of a percentage of the total daily household consumption.

Table 8: Percentage distribution of residential water consumption

		% of Water End Uses of Total Average Daily Consumption for the Customer Classes:					
		Formal - Affluent Suburb		Formal - Middle Income Suburb		Formal - Township Suburb	
		House	Flat	House	Flat	House	Flat
Ave no. of people per household		4	4	4	4	4	4
Average garden size under regular watering (m^2)		880	0	330	0	100	0
Water End Uses	Toilet	8	22	23	35	38	44
	Bath	16	41	18	27	26	29
	Wash Basin	2	4	3	5	3	4
	Shower	5	13	4	6	0	0
	Washing machine	2	5	6	8	5	6
	Dish Washer	2	4	2	3	3	4
	Faucets	2	6	7	10	7	8
	Leakage	1	1	1	2	1	1
	Drinking and Cooking	1	2	2	3	3	4
	Garden Watering	57	0	27	0	12	0
	Swimming Pool	4	0	7	0	0	0
	Other Uses	0	1	1	1	1	1
Total %		100	100	100	100	100	100

1.5 Estimate of wastewater production per consumer category

Wastewater production per customer is associated with internal household consumption and thus the following end uses:

- toilet;
- bath;
- wash basin;
- shower;
- washing machine;
- dish washer;
- faucets;
- leakage.

The data from Table 7 was used to estimate the wastewater production for the different customer classes.

Table 9: Estimate of wastewater production per consumer category

	Average Daily Wastewater Production for the Customer Classes					
	Formal - Affluent Suburb		Formal - Middle Income Suburb		Formal - Township Suburb	
	House	Flat	House	Flat	House	Flat
Daily Volume of water flowing to sewer (litres/household/day)	939	933	568	566	395	394
% Wastewater Production of Total Consumption	38	97	63	97	84	96
Equivalent Monthly Consumption per Household (kl/month)	28	28	17	17	12	12

The above figures compare favourably with the results of a survey conducted by Malan, Simpson and Moore (CSIR, 1983) which found that the mean external consumption of 480 houses in Pretoria on erven between 900 and 1000m^2 was 55% of

total consumption. Figures for Port Elizabeth and Cape Town were 33% and 25% respectively. Thus the amount of water flowing to the sewer was between 45% and 75% for the houses surveyed. The percentage of total water consumption flowing into the sewer for houses given in Table 9 range from 38% to 84%.

Research in the USA (AWWA, 1993) determined indoor residential water use for single family homes to be between 60 and 70% of the total household water consumption, which equates with the figure of 62% for affluent houses in Table 9.

The results of estimates of residential consumption patterns in Cape Town (Singles, 1991) are shown in Table 10.The estimates were based on factors for internal residential consumption derived from a survey of quarterly consumption data for boarding houses, hotels and flats in Sea Point (a fairly built-up area). The factors were then applied to data for the whole of Cape Town. The amount of water used for gardening and external use was then determined to be the difference between the factorised base flow and the actual consumption figure.

Table 10: Results of a survey by Cape Town City Council

Water end use	*% of total consumption*
Gardening	35
Bathing	19.5
Drinking and cooking	3.3
Toilet flushing	29.2
Laundry and dishes	13
Total %	100

Source: Singles, 1991

The estimates prepared in Table 7 and Table 8 put into the above format for comparative purposes, are as follows:

Table 11: Results of water balance analysis

	% of Water End Uses of Total Average Daily Consumption for the Customer Classes *:					
	Formal - Affluent Suburb		Formal - Middle Income Suburb		Formal - Township Suburb	
	House	Flat	House	Flat	House	Flat
External use	61	1	35	1	13	1
Bathing	23	58	25	38	29	33
Drinking & Cooking	1	2	2	3	3	4
Toilet Flushing	9	23	24	37	40	45
Laundry &Dishes	6	16	14	21	16	18
Total %	100	100	100	100	100	100

The figures for single-dwelling middle-income houses in Table 11 compare fairly closely with the results of the survey conducted by the Cape Town City Council.

1.6 Conclusion

Although the consumption levels for domestic appliances and fixtures has been comprehensively dealt with by Malan, Simpson and Moore in their research into "water economy measures for water distribution systems in urban areas", data relating

to the typical profiles of the various consumer groups in South African urban areas, particularly with respect to low-income households, is limited. Thus this analysis has had to make some fairly general assumptions in this regard (see section1.4.) to complete the analysis.

The water and wastewater usage patterns of low-income households in urban areas is an area which requires urgent research. In the interim this analysis provides estimates of the of the quantities of wastewater discharged by the various residential consumer classes.

1.7 References

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WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Module 6

REPORTING PROCEDURES FOR WATER SERVICES

January 1998

PALMER DEVELOPMENT GROUP

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PREFACE

This module forms part of the series "Management guidelines for water service providers". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

Executive summary: Introduction to urban services management

Module 1: An introduction to organisational arrangements for water service providers

Module 2: Preparation of a water services development plan

Module 3: Customer profile and demand for services

Module 4: Setting water tariffs

Module 5: Setting sanitation tariffs

Module 6: Reporting procedures for water services

Module 7: Reporting procedures for sanitation services

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1. Introduction

1.1. Scope

A standardised reporting procedure for water and sanitation service providers was identified as a high priority in a country-wide survey of local authorities' water and waste research needs (Palmer Development Group, 1995). Reporting on water services is considered important for the management needs of both local authorities and national government structures. Information emanating from regular standardised reports could assist local authorities (or water service authorities) in managing service provision more effectively, while at national government level the monitoring of water and sanitation service provision countywide would be facilitated. Thus the topic goes well beyond the needs of local service providers: it relates to the overall process of performance monitoring and regulating service authorities. It also relates to standardised information gathering processes which will facilitate future research.

This module suggests a procedure for reporting on water supply services.

1.2. Aim

The new Water Services Act requires reporting by the water service authority, partly in the form of the water services development plan itself, and partly relating to the implementation of the plan (See clauses 15 and 18). Proposals regarding the form of this reporting are discussed in Module 2 which deals with water services development plans, in Section 4.4. Four reporting components are identified:

a) The submission of the WSDP itself.
b) The submission of the summarised quantitative information from the WSDP to DWAF and other stakeholders.
c) Annual updates with regard to quantitative information.
d) Written annual reports.

In this module the aim is to deal with items b) and c), but only for water supply services (sanitation services are dealt with in Module 7).

As mentioned in the introduction to this module, the reporting is intended to be useful both internally, to the management structures of the service provider, and externally to other stakeholders including higher levels of government, e.g. the Department of Water Affairs and Forestry (DWAF). The reporting is structured in a way which promotes easy monitoring of water service institutions through, firstly, providing sufficient information to define the key elements of a water services development plan and, secondly, to measure performance against this plan.

The intention of such monitoring at both local and national levels, is to enhance the management efficiency of both water service authorities and the water service providers appointed by them. One way this can take place is through the use of the information to develop a standardised set of performance indicators for comparative purposes.

Further, the information can be used to determine the resource and institutional support needs of the water service institutions.

1.3. Relationship To Other Guidelines

The module is part of a management guideline series for water and sanitation service institutions prepared for the Water Research Commission by Palmer Development Group. The modules prepared to date are:

Introduction of urban services management

Module 1:	Organisational arrangements for water service providers
Module 2:	Preparation of a water services development plan
Module 3:	Customer profile and demand for services
Module 4:	Setting water tariffs
Module 5:	Setting sanitation tariffs
Module 6:	Reporting procedures for water services (this module)
Module 7:	Reporting procedures for sanitation services

Much of the information required is discussed in these other modules. Reference is made to them where appropriate rather than providing detailed discussions here.

1.4. Definitions

Definitions are given in Module 1 and are not repeated here.

2. Reporting procedure for WSDP data

2.1. The proposed system

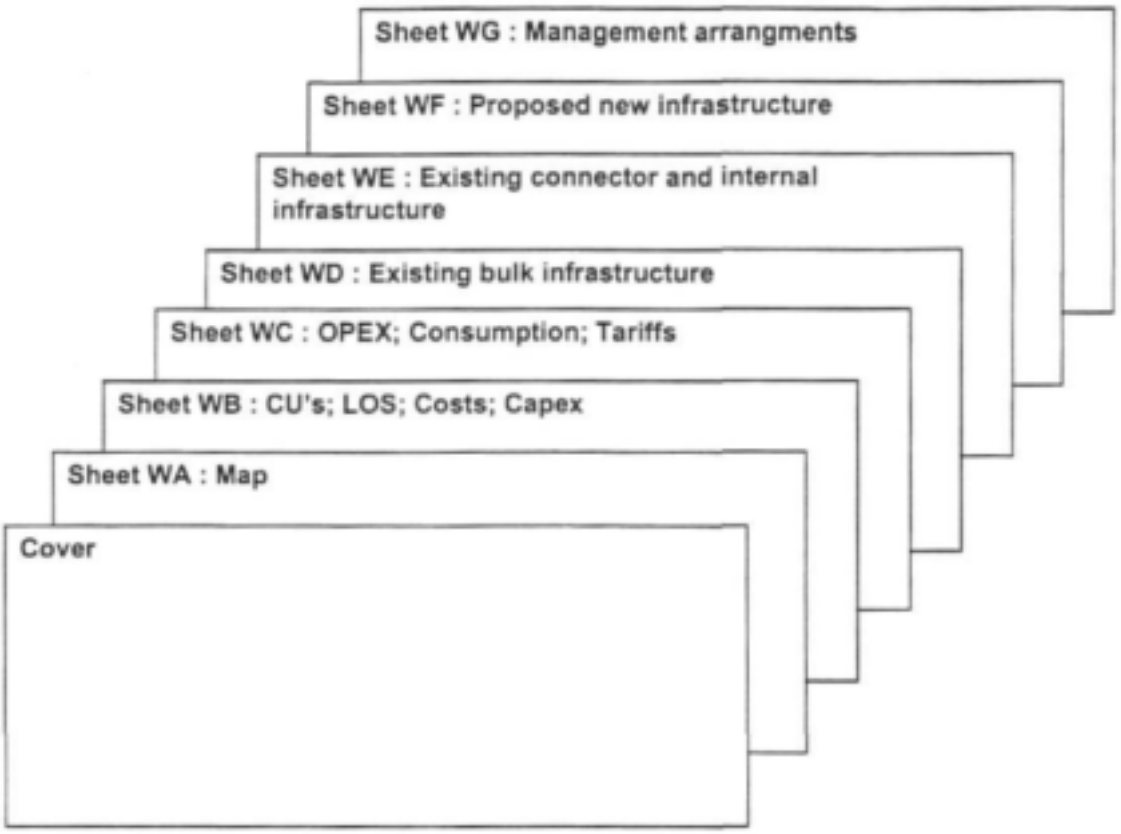
The system of reporting proposed in this module consists of an information data set to be prepared by water service authorities. In doing this they would typically require information from water service providers appointed by them to actually carry out the provision of water supply services. It is in the form of a computer spreadsheet which is written at present in Microsoft Excel 7 for Windows 95.

The electronic format is intended to simplify the transmission and recording of information and facilitate the analysis of the data, for example to get performance indicators using a compatible computer spreadsheet model. One communication channel would be between the water service authority and DWAF and this could take place by means of diskettes or e-mail, depending on the resources of the service provider.

2.2. Structure

The data set is divided into seven component data sheets (see figure 1 below). A print-out of data sheets comprising the spreadsheet is provided in Annexure 1 of this report. Each data sheet and its component tables are described in more detail in the following section.

Figure 1: Components of the Reporting for Water data set



2.3. The data requirements of Reporting for Water

The data requirements for each of the data sheets making up the WSDP data reporting system are explained in this section. An example of each of the data sheets is given in Annexure 1 and should be read in conjunction with the following explanations.

a) Sheet WA: Map

This sheet requires a map showing the supply area and its sub-division into supply zones. The map should include the major components of the water supply system and should be of an appropriate scale and not larger than A4 size. It is recognised that larger scale and more detailed mapping is needed but the A4 map is selected for this report only to provide an overall picture.

b) Sheet WB: CU's, LOS, Costs, Capex

The title of this sheet is an abbreviation of the following:

- Customer Units (CU's),
- Types of Service (TOS)[1],
- Unit costs for components of the water system (Costs), and
- Capital expenditure (Capex).

[1] Types of service are discussed in Module 3.

The first line of this sheet requires the water service authority to fill in the name of the town being reported on, the base year for the data and the date of reporting.

A description of the data required for each table on the data sheet follows:

Table 1: Numbers of Customer Units and Average Growth Rates

The first four data fields of this table (viz. Residential, Institutional, Commercial and "dry", and "Wet" Industrial) refer to the categories of customers to be reported on. The numbers of customer units in each customer class in the base year (1996), and projections of the numbers in 5 years time (2001) and in ten years time (2006) must be stated here (see Module 3 for an explanation of these terms).

The customer categories listed in table 1 are defined as follows :

- *Residential* - all single formal residential plots, occupied and used for residential purposes; all individual flats and townhouses; and dwellings in informal areas. Second dwellings are counted separately only if the have their own water meter and are separately billed, otherwise they form a single customer unit with the main house.
- *Institutional* - such as schools, clinics, hospitals and churches.
- *Commercial* - Non-residential, non-industrial business enterprises, typically offices, shops, hotels, etc.
- *"Dry" industrial* - Industries that do not make use of water as part of their "core" processes
- *"Wet" industrial* - Industries and services that use water in their "core" processes, such as the manufacture of beverages, fruit canning and laundries.

The last line item of table 1 requires a projection of the local average economic growth rate. Suggestions for determining this are provided in Module 3.

Table 2: Percentage income distribution for residential customers

Table 2 requires the percentage distribution of residential customer units across income categories. The income categories are defined in terms of the total monthly incomes per household. The first three categories are defined to coincide with those used for housing subsidy allocations.

The percentage of residential customer units in each income category is required for the base year, the fifth and tenth years respectively (i.e. 1996, 2001 and 2006 in the example). Methods for estimating income distribution are discussed in Module 3.

Table 3: Residential Service Levels

Table 3 is concerned with the provision of services to residential customer units. The first line requires a description of existing services in terms of the percentages of customer units with each of the service types described. In lines 2 and 3 the percentages of households with the described services are to be projected for years 5 and 10 respectively. These percentages should be derived from the investment programme which should be part of the town's Water Services Development Plan (see Module 2). The service types used are described in more detail in Module 3.

Table 4: Unit Costs: Internal service costs, subsidies and Customer payments

Table 4 deals with the capital cost of internal services, housing subsidy finance and once-off capital payments by customer units for the provision of the infrastructure.

- The first column lists the customer categories and types of residential services to be reported on.
- The next section (headed "Capital Costs") requires the entry of a cost per customer unit for new developments in the service area (column headed "new internal services"). Cost must be separately entered for the different service types, in base year Rands
- The third section is for data on housing subsidies. The three columns under the heading "Housing Subsidy" refer to the amount (in Rands) of each housing subsidy that will be used to finance internal water infrastructure. Amounts need to be shown for each type of service. Since the housing subsidy may not keep pace with inflation, the anticipated real (base year Rand) amount to be used for internal water infrastructure needs to be projected for years 5 and 10 respectively.
- The column headed "payments" refers to the amount to be paid by each customer unit in connection fees and development charges, or any other form of up-front capital payment. The amounts must be entered in base year.

Table 5 : Unit Costs - Bulk and Connector

In Table 5, a cost must be entered for each of the components shown in the table in million Rands per Ml per day of capacity added to the system, or per Ml storage or pumping capacity added, as appropriate. These costs can be obtained by dividing the (anticipated) total cost of recent, past or planned projects (adjusted for inflation to base year Rands) by the total capacity of the new works or extensions.

Table 6: Inflation and borrowing rates for long term loans

The first line in Table 6 requires the inflation rate in the base year, and the projected rates in years 5 and 10. It is important that these projections reflect the rates used in Table 7 if information is entered in nominal terms.

The second line requires an estimate of the current average borrowing rate for internal loans, and projections of this rate for years 5 and 10. The third line requires an estimate of the current average borrowing rate for external loans, and projections of this rate for years 5 and 10. Rates must be entered in nominal terms, i.e. the rates actually charged. Note that changes in the inflation rate relative to borrowing rates will affect real borrowing rates (i.e. the rates net of inflation).

Table 7: Capital Account

Data on the capital expenditure, capital income and borrowing requirements are provided for in this table in units of one thousand Rands for the base year and a projected ten year period (base year = year 0). An explanation of the data fields in Table 1 follows:

- *"Real or nominal"* - amounts for each year may be entered in real terms (base year Rands) or nominal terms (current Rands, i.e. taking inflation into account) for each year, and it is necessary to specify whether real of nominal values are being used. It

is recommended that real values be used as far as possible, and certainly after the first five year period.

- *"Capital Expenditure - bulk"* - refers to the total planned capital expenditure for the each year by the service provider on bulk infrastructure. Actual expenditure in the base year is to be entered in the first column.
- *"Capital Expenditure - connector"* - refers to the total planned capital expenditure for the each year by the service provider on connector infrastructure. Actual expenditure in the base year is to be entered in the first column.
- *"Capital Expenditure - reticulation"* - refers to the total planned capital expenditure for the each year by the service provider on reticulation systems. Actual expenditure in the base year is to be entered in the first column.
- *"Capital Expenditure - other"* - refers to the total planned capital expenditure for the each year by the service provider on other items including metering programmes, asset replacement and other items such as vehicles. Actual expenditure in the base year is to be entered in the first column.
- *"Capital subsidies"* - is the portion of capital expenditure to be financed by means of subsidies and grants, the most important of which are the housing subsidy and the CMIP grant for bulk and connector infrastructure.
- *"Customer payments"* - the portion of capital expenditure financed by means of connection fees, development charges and any other once-off capital payments made by customer units.
- *"expenditure from current income"* - refers to capital expenditure financed out of income derived from tariffs and other recurrent income.
- *"Borrowing: capital development fund"* - refers to the portion of capital expenditure financed by means of borrowing from the municipality's or the Water Service Provider's capital development fund (if any).
- *"Borrowing: external"* - refers to the portion of capital expenditure financed by means of borrowing from external sources such as the Development Bank of South Africa and commercial lending institutions.

The last two columns *"Year 1-5"* and *"Year 6-10"* refer to the amounts for each line item corresponding to the first five years and the last five years respectively, of the projection period for which data is required.

c) Sheet WC: Opex, Consumption, Tariffs

This data sheet concerns operational expenditure, levels of consumption and tariffs. It consists of four tables. The data requirements for each table are largely self-evident, however in some cases further explanation is necessary as is given below:

Table 1: Operating Account

Most of the data required for Table 1 is self explanatory. The information should be given in thousands of Rands for the base year and over a projected ten year period. The following is of note:

- *"Accrued income"* - refers to the total income billed or expected to be received by the service provider in the form of reconnection fees, interest from capital reserve funds etc. for the corresponding year. Connection and development fees for new developments must however be excluded because these have already been accounted for (Table 4, Sheet WB). For the year preceding the base year (1995 in example), only the year-end cash balance needs to be entered.

- *"..of which the sale of water"* - refers to income accrued from total water sales to customers of all types, viz. residential, institutional, commercial, industrial and bulk sales to other service areas.

- *"Expenditure"* - is broken down into components which conform with the reporting requirements as recommended by the Institute of Municipal Treasurers and Accountants (IMTA, 1994).

- *"Annual net cash flow"* - is calculated as follows:

  Accrued surplus(deficit) *minus* Non-payment = *Annual net cash flow*

- *"Cash balance (year end)"* - is the accumulated cash balance at the end of each year. It is calculated for year Y by adding the accumulated balance at the end of year X to the annual net cash flow in year Y.

Table 2: Unit Cost, Consumption, Bills and Price of Water by Service Type

The data requirements of Table 2 are considered self explanatory except for the column "Cost (R / CU pm, real)". This column requires estimates of the operating and maintenance costs of services provision including the cost of bulk water purchases. Capital charges are excluded. Methods for determining these costs are discussed in Module 5 (main report and annexure). Projections are required of unit costs for years 5 and 10 (in base year Rands). Changes in units costs may be affected by changes in efficiency, bulk water costs or other input costs, for example.

Table 3: Total Consumption (Ml per annum) and Bulk Water Cost (c/kl)

Table 3 is self evident except where bulk water is derived from sources owned by the Water Service Provider. In this case the average cost of bulk water needs to be calculated. Where bulk water is purchased from an external bulk service provider (such as a Water Board) the cost of bulk water is simply the price paid per kilo-litre.

Table 4: Debt Service Ratios and Non-Payment

The following is of note in Table 4:

- *"capital charges/accrued income"* - is the ratio of
  (total interest and redemption costs) : (total accrued income)

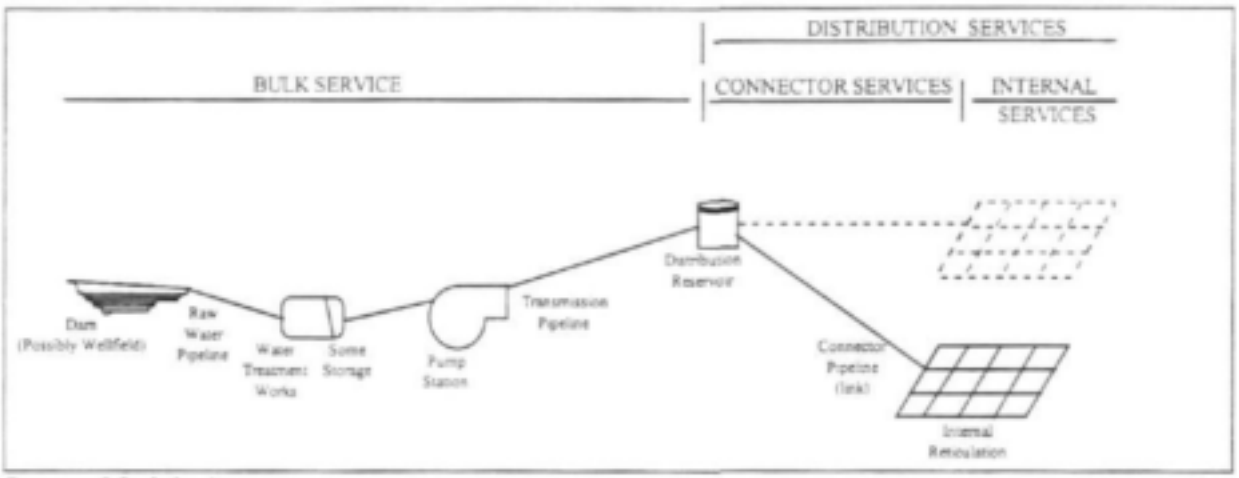
- *"capital charges/received income"* - is the ratio of
  (total interest and redemption costs) : (total accrued income less non-payment)

- *"% of total accrued income unpaid"* - is the percentage of billed income not received and not likely to be received in the near future (bad debts). Note that this refers to the total *amount* of income unpaid, and not the *number* of unpaid bills.

d) Sheet WD: Existing Bulk Infrastructure

The information required for this data sheet relates to a description of the physical bulk infrastructure facilities in the water service area. The differentiation between bulk, connector and internal infrastructure is discussed in Module 5. This differentiation of system components is summarised in Figure2.

Figure 2: Classification of the components of water supply systems



Source: Module 4

As with Sheet WC, much of the information required to complete each table is self-explanatory. However where further explanation is considered necessary, it is provided in the following sections:

Table 1: Surface Water Sources

- *"Category"* - refers to the reservoir category.
- *"Allocation"* - refers to the allocation in terms of an Abstraction permit or Water Court Order.
- *"Safe yield"* - refers to the sustainable yield of the water source determined from an analysis of hydrological data.
- *"Storage capacity"* - relates to dams, and refers to the total staorage capacity of the facility.

Table 2: Wellfields

- *"Safe yield"* - refers to the sustainable safe yield of the borehole determined after pump testing the hole.
- *"Type of Engine"* - refers to the engine driving the borehole pump is powered by diesel, electricity or solar energy. Further information such as the name of the manufacturer, and the model of the engine can also be filled in here.
- *"Type of Pump"* - refers to the make and type of pump used.

Table 3: External Sources

As the name suggests, external sources are bulk water sources supplied to the service provider from outside the water service area, e.g. from a Water Board.

The *"type of source"* refers to whether the origin of the external source is one of the following:

- Surface
- Groundwater
- Purified
- Raw
- Other

The *"Allocation"* field refers to the abstraction granted by agreement in m^3 per year.

Table 4: Other Sources

Other sources are sources within the water service area other than conventional surface water (e.g. dams and rivers) and groundwater sources.

The *"Type of Source"* field requires a description of the source, for example:

- Desalination
- Effluent re-use
- Rain-water harvesting

The *"Total yield"* field is for the total estimated yearly yield in m^3 per year.

The information requirements for Tables 5 and 6 are self evident and do not require further explanation.

Tables 5 and 8: Treatment Works and Process Used

Tables 6 and 7 (a), (b) and (c) relate to a description of the processes and facilities used for the treatment of potable water. The sheet allows for 3 different treatment works.

The data fields are compatible with the national database for water treatment plants compiled by the Water Research Commission. The following is relevant to data fields in the table:

- *"Pre-treatment"* - refers to the process in use e.g. identify either aeration, pre-oxidation, roughing filter or specify any other process.
- *"Coagulation and flocculation"* - specify type of coagulant used and the method of flocculation.
- *"Sedimentation/settling"* - specify the number, size and type of tanks.
- *"Dissolved air flotation"* - specify type of system and the number and size of the tanks.
- *"Filtration"* - specify either slow sand filtration, rapid sand filtration, pressure sand filtration or diatomaceous earth filtration; and the number of filters.
- *"Stabilising and softening"* - specify method and chemicals used.

- *"Chemical oxidation"* - specify ozonation or any other method used.
- *"Disinfection"* - specify method
- *"Tertiary treatment"* - specify type of process, e.g. activated carbon.
- *"Other treatment processes"* - refers to other processes used such as biological treatment, reverse osmosis (membranes), ion-exchange or electrodialysis or any other.

Tables 6 and 7: water quality

The water quality figures in these tables need to be based on averages for the previous year also averaged for the different treatment works.

Other tables

The data fields in Tables 9, 10 and 11 are considered self-evident and no further explanation is provided here.

e) Sheet WE: Existing Connector and Internal Reticulation Infrastructure

The information required for Data Sheet WE is related to a description of the physical connector and internal infrastructure facilities which exist in the water service area. Much of the information required to complete each table is self-explanatory, but where further explanation of the data requirements is necessary, it is provided below:

Table 1: Reservoirs & Water Towers

The data field *"Type"* refers to the type of material used to construct the reservoir, e.g. reinforced concrete, brick and mortar, ferro-cement, etc.

Table 5: Bulk Water Meters

The data fields in Table 5 require the following information:

- *"Size"* - specify size in millimetres, e.g. 40mm, 100mm or any other size.
- *"Type"* - refers to the type and manufacturer of the bulk meters in use e.g. semi-rotary disc (SRD), turbine, propeller, combination or any other type.

The information required to complete the tables describing internal infrastructure (Tables 6 and 7) is considered to be sufficiently clear from the data field headings.

f) Sheet WF: Proposed New Infrastructure

The data in this sheet is related to future plans for the upgrading of existing and the construction of new water supply infrastructure, including bulk, connector and internal components of the system.

Further information on the data fields (where relevant) is provided below:

Water source

- *"type of source"* - specify whether the proposed future source is surface, groundwater, purified, raw or any other type of source.

- *"origin of source"* - specify whether internal or external.

Treatment

- *"upgrading/new works"* - state whether installation will relate to new works or the upgrading of existing works.

Connector main

- *"diametric range"* - state into which diametric category the weighted average pipe diameter fits, i.e. 50mm to 100mm, 100mm to 200mm, 200mm to 400mm or greater than 400mm.

Reservoirs

- *"number"* - refers to the number of reservoirs to be built in the corresponding year.

Reticulation

- *"New infrastructure"* - refers to greenfields development - i.e. infrastructure installed where none existed before.
- *"Reticulation upgrading"* - relates to the length of pipe installed as part of a project to upgrade existing infrastructure to facilitate higher service levels in the service area.
- *"Asset replacement"* - relates to the length of pipe installed as part of a project to replace ageing or damaged pipe.

g) Sheet WG: Management Arrangements

The information required for Data Sheet WG is related to the institutional and staffing arrangements of the water service authority and water service provider for the area.

3. Reporting procedure for annual data update

As mentioned at the start of this module, a second type of report is necessary to enable the implementation of the water service development plan to be monitored on an annual basis.

Certain key pieces of information have been selected for this report to facilitate easy assessment of progress in relation to plan. This information is identified in Table 1. The intention is for this report to be prepared by water service authorities on an annual basis and submitted to key stakeholders, including DWAF.

Table 1: Annual reporting information

Information to be reported: water supply	Plan		Actual	
Number of new customers provided with a service in past year:				
- Public standpipes within 200 metres of dwelling				
- Yard tank or yard tap				
- House connection				
Number of customers provided with upgraded service in past year.				
Capital expenditure over past year (Rm)				
Current tariff				
- Fixed monthly charge (low and high)				
- Tariff per kilolitre (c/kl) (lowest and highest block)				
Change in employment over past year (No employees)				

4. Closure

The module presents a set of data to be reported by water supply service providers for internal management purposes and for national monitoring purposes. The data set has been designed to identify key information relating to development plans, to conform with the regulations of the new Water Services Act, and also to identify key information which can be used to monitor performance in relation to the plan.

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WATER RESEARCH COMMISSION

MANAGEMENT GUIDELINES FOR WATER SERVICE INSTITUTIONS

MODULE 6

ANNEXURE 1

REPORTING PROCEDURE FOR WATER SUPPLY SERVICES
DATA SHEETS

January 1998

PALMER DEVELOPMENT GROUP

Reporting for Water

Sheet WA: Map

Sheet WD: Existing Bulk Infrastructure

Table 1: Surface Water Sources

Dam or river name	River name	Safe yield of source (m3/year)	Storage capacity (m3)	Category (I to Water Act)	Allocation

Table 2: Wellfields

Regional b/hole no	Topographical Co-ordinates	safe yield (l/sec)	Type of pump	Type of engine	Power rating (kW)	Installation date

Table 3: External Sources

Name of Supplier	Type of Source	Allocation (m3/year)

Table 4: Other Sources

Name of Source	*Type of Source*	Total yield (m3/year)

Table 5: Treatment works statistics

Name of Treatment Plant	Treatment works "A"	Treatment works "B"	Treatment works "C"
Area served			
Capacity (kl/hr or Ml/day)			
Population Supplied			
Year when plant was built			
Year and type of any modifications and/or upgrading			

Table 6: Quality of Raw Water

Turbidity		Iron (mg/l as Fe)	
pH		Manganese (mg/l as Mn)	
Colour (units/Hazen)		Flouride (mg/l as F)	
Alkalinity (mg/l as CaCO3)		Nitrate (mg/l)	
Calcium (mg/l as Ca)		Sulphate (mg/l as SO4)	
Magnesium (mg/l as CaCO3)		Chlorides (mg/l as Cl)	

Table 7: Quality of Treated Water

Turbidity		Iron (mg/l as Fe)	
pH		Manganese (mg/l as Mn)	
Colour (units/Hazen)		Flouride (mg/l as F)	
Alkalinity (mg/l as CaCO3)		Nitrate (mg/l)	
Calcium (mg/l as Ca)		Sulphate (mg/l as SO4)	
Magnesium (mg/l as CaCO3)		Chlorides (mg/l as Cl)	

Table 8: Treatment Process Used:

	Treatment works "A"	Treatment works "B"	Treatment works "C"
Pre-Treatment			
Co-agulation and Flocculation			
Sedimentation/Settling			
Dissolved Air Flotation			
Filtration			
Stabilising and softening			
Chemical oxidation			
Disinfection			
Tertiary treatment			
Other treatment processes			

Table 9: Length of Bulk Main (in kilometers):

Diametric range (mm)	Steel	Glass Reinforced Plastic (GRP)	Ductile iron	Reinforced concrete	Prestressed concrete	Asbestos cement	P V C	HDPE	Other
50<Dia<100									
100<Dia<200									
200<Dia<400									
Dia>400									

Table 10: Age and Maintenance of Bulk Main :

Age in years	Age < 10	10 < Age < 20	20 < Age < 30	30 < Age < 50	Age > 50
Percentage installed pipeline in age categories (%)					
No. of pipe breakages (pipe leaks repaired) last year					

Table 11: Pump stations:

Name/no. of pump station	Capacity of Station (l/s)	type of pumps	No. of duty	standby units	Age of equipment

Reporting for Water

Sheet WC: Opex; Consumption; Tariffs

Town	Base yr	Run date
	1996	

TABLE 1 OPERATING ACCOUNT : INCOME, EXPENDITURE AND CASH FLOW (R thousands)

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Real or Nominal?		na	base year										
Accrued income		na											
of which sale of water		na											
Expenditure:	*Staff*	na											
	General	na											
	Repairs & Maintenance	na											
	Interest & Redemption	na											
	Fixed assets	na											
	Contributions to funds	na											
	SUB-TOTAL	na											
Surplus (deficit)		na											
Non-payment (bad debts)		na											
Annual net cash flow		na											
CASH BALANCE (year end)													

TABLE 2 UNIT COST, CONSUMPTION, BILLS AND PRICE OF WATER BY SERVICE TYPE

Customer Category	Cost (R /CU pm, real) (excluding capital charges)			Consumption (kl/CU pm) kl/month per CU			Monthly bills (R pm, real) R per month per CU			Price per kl c/kl		
	1996	2001	2006	1996	2001	2006	1996	2001	2006	1996	2001	2006
None/inadequate												
Communal standpipes												
Yard tanks												
Yard taps (on-site san)												
Yard taps (w/borne san)												
In-house, low income												
In-house, middle income												
In-house, high income												
Other residential service level												
Institutions												
Commerce&dry industry												
Wet industry												

TABLE 3 TOTAL CONSUMPTION (Ml per annum) and BULK WATER COST (c/kl)

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total consumed (Ml pa)											
Total purchased/purified (Ml pa)											
Average cost of bulk water (c/kl)											

TABLE 4 DEBT SERVICE RATIOS AND NON-PAYMENT

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Capital charges/accrued income											
Capital charges/received income											
% of total accrued income unpaid											

Reporting for Water

Sheet WB: CU's; TOS; Costs; Capex

Town	Base yr	Run date
	1997	

TABLE 1 NUMBERS OF CUSTOMER UNITS AND LOCAL ECONOMIC GROWTH RATES

	1996	2001	2006
Residential Institutions Commercial and "dry" "Wet" industrial			
Local average economic growth rate			

TABLE 2: INCOME DISTRIBUTION (%)

Monthly Income (R/month)	1996	2001	2006
< R800 pm R800-R1 500 pm R1 500-R3 500 pm R3 500 - R5 000 pm > R5 000 pm			

TABLE 3 RESIDENTIAL SERVICE TYPES (% DISTRIBUTION)

	none	s/pipe	Yard tanks	Y/ taps(on s)	Y/ taps(wb)	In-house	Other
1996							
2001							
2006							

TABLE 4 UNIT COSTS : INTERNAL SERVICE COSTS, SUBSIDIES AND CONSUMER PAYMENTS

	Capital costs Rands / CU (real)		Subsidies and payments (R/CU, real) housing subsidy (real value)			payments
	new internal services	metering programme	1997	2001	2006	real value, all years
Residential ecustomer units						
Communal standpipes						
Yard tanks						
Yard taps (on-site san)						
Yard taps (w/borne san)						
In-house, low income (<R3 500)						
In-house, middle income			na	na	na	
In-house, high income			na	na	na	
Other residential service level						
Institutions			na	na	na	
Commerce&dry industry			na	na	na	
Wet industry			na	na	na	

TABLE 5: UNIT COSTS : BULK AND CONNECTOR

Bulk infrastructure (R millions)	
Source of supply	Rm/Ml/day additional capacity
Treatment	Rm/Ml/day additional capacity
Pumping	Rm/Ml/day additional capacity
Transmission	Rm/Ml/day additional capacity
Connector infrastructure (R millions)	
Pipelines	Rm/Ml/day additional capacity
Reservoirs	Rm/Ml storage capacity
Pumps	Rm/Ml/hr pumping capacity
Water towers	Rm/Ml storage capacity

Table 6 : Inflation and borrowing rates for long term loans

	1996	2001	2006
general inflation rate			
nominal borrowing rate - internal loans			
nominal borrowing rate - external loans			

TABLE 7 CAPITAL ACCOUNT : CAPITAL EXPENDITURE, CAPITAL INCOME AND BORROWING REQUIREMENTS (R thousands)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Year 1-5	Year 6-10
Real or nominal ?	base year												
Capital expenditure:													
Capital expenditure- bulk													
Capital expenditure- connector													
Capital expenditure- reticulation													
Capital expenditure- other													
Sources of finance :													
Capital subsidies													
Consumer payments													
Exp from current income													
Borrowing :													
Capital Development Fund													
External													

Sheet WE: Existing Connector and Internal Reticulation Infrastructure

a) Connector Infrastructure

Table 1: Reservoirs & Water Towers

Name/Number of Reservoir	Capacity (m3)	Type	Age (years)

Table 2: Local pump stations:

Name/number of pump station	Capacity of Station (l/s)	Power rating (kW)	type of pumps	No. of duty	standby units	Age (yrs)

Table 3: Length of Connector Main (in kilometers):

diametric range (mm)	Steel	Glass Reinforced Plastic (GRP)	Ductile iron	Reinforced concrete	Prestressed concrete	Asbestos cement	P.V.C	HDPE	Other
50<Dia<100									
100<Dia<200									
200<Dia<400									
Dia>400									

Table 4: Age of Connector Main :

Age in years	Age < 10	10 < Age < 20	20 < Age < 30	30 < Age < 50	Age > 50
Percentage of total installed pipeline in each of the corresponding age categories (%)					

Number of pipe breakages (pipe leaks repaired)	

Table 5: Bulk Water Meters:

Size (mm)	Type	Total Number	Age (yrs)

b) Internal Reticulation

Table 6: Length of Internal Reticulation network (in kilometers):

diametric range (mm)	Steel	Glass Reinforced Plastic (GRP)	Cast iron	Reinforced concrete	Prestressed concrete	Asbestos cement	P.V.C	HDPE	Other
50<Dia<100									
100<Dia<200									
200<Dia<400									
Dia>400									

Table 7: Age of Internal Reticulation network :

Age in years	Age < 10	10 < Age < 20	20 < Age < 30	30 < Age < 50	Age > 50
Percentage of total installed pipeline in each of the corresponding age categories (%)					

No. of pipe breakages (pipe leaks repaired) last year	

Reporting for Water

Sheet WF: Proposed New Infrastructure

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Water Source											
name of source											
type of source											
origin of source											
projected yield (m3/year)											
Treatment											
upgrading/new works											
additional capacity (m^3/day)											
Bulk Main											
diametric range (mm)											
material											
length (m)											
Pump stations											
additional capacity (m^3/day)											
Reservoirs											
number											
total additional capacity (m^3)											
Connector Main											
diametric range (mm)											
material											
length (m)											
Reticulation (length of pipe - meters):											
New infrastructure											
Upgrading											
Asset replacement											

Reporting for Water

Sheet WG: Management Arrangements

Table 1: Water Service Authority:

Name of Authority		
Separate Council / Sub-committee (if used)		
Responsible Councillors	Responsible Officials	
	Name	Position

Table 2: Water Service Provider:

Name	Area Served	Date Appointed

Table 3: Bulk Service Provider:

Name	Description of Service	Date Appointed

Table 4: Project Related Contracts:

	Percentage	
	Contract	In-house
Planning		
Design		
Construction		

Table 5: Service Contracts:

Description of Service	Name of Contractor	Value of Contract per Year (next 5 years)				
		1997	1998	1999	2000	2001

Table 6: Staff:

Name of Grading System:							
		Number of Employees					
	Post Norm Grade	Executive and Senior Management	Middle Management	Clerical	Supervisory or Artisan	General Worker	Total
Finance and Administration							
Finance and Sales (treasury)							
Projects and Planning							
Operations							
Bulk Services							
Distribution Services							
Total (current year)							
Projection of total in five years time	2002						

Table 7: Training:

Training (projected number of person days over next 5 years)						

WATER RESEARCH COMMISSION

Management guidelines for water service institutions (urban)

Module 7

REPORTING PROCEDURES FOR SANITATION SERVICES

January 1998

PALMER DEVELOPMENT GROUP

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PREFACE

This module forms part of the series "Management guidelines for water service providers". The primary aim of the series is to assist those involved in providing retail services in the water and sanitation sectors to manage these services effectively and efficiently by making available relevant and practical information. The focus of the guidelines is on urban areas.

The guideline series consists of the following modules:

Executive summary: Introduction to urban services management

Module 1: An introduction to organisational arrangements for water service providers

Module 2: Preparation of a water services development plan

Module 3: Customer profile and demand for services

Module 4: Setting water tariffs

Module 5: Setting sanitation tariffs

Module 6: Reporting procedures for water services

Module 7: Reporting procedures for sanitation services

Acknowledgements

The management guideline series forms part of a Water Research Commission-funded project titled "The establishment of a research framework for local authorities and the preparation of the first part of a series of management guidelines for water and waste departments in local authorities." (Project K5/758).

The Steering Committee for this project includes the following people:

Mr J Bhagwan	Water Research Commission
Dr GR Backeberg	Water Research Commission
Ms J Burke	Johannesburg Metro Council
Mr DQ Ramsay	Southern Peninsula Metro Local Council
Mr NA Macloed	Durban Water and Waste
Mr CJ Francis	Newcastle TLC
Mr B Jackson	Development Bank of Southern Africa
Mr H Muller	Department of Water Affairs and Forestry
Ms L Colvin	Department of Water Affairs and Forestry
Mr Z Nofumela	Department of Constitutional Development

The project team is indebted to the steering committee for their valuable input in assisting to meet the objectives of the project, and gratefully acknowledge their contribution. The support and finance provided for the project by the Water Research Commission is acknowledged and sincerely appreciated.

Project team

The project team instrumental in developing these guidelines comprised Ian Palmer, Richard Tainton and Bee Thompson, all from Palmer Development Group. Craig Bekker assisted with figures and formatting.

1. Introduction

1.1. Scope

A standardised reporting procedure for water and sanitation service providers was identified as a high priority in a country-wide survey of local authorities' water and waste research needs (Palmer Development Group, 1995). Reporting on water services is considered important for the management needs of both local authorities and national government structures. Information emanating from regular standardised reports could assist local authorities (water service authorities) in managing service provision more effectively, while at national government level the monitoring of water and sanitation service provision countywide would be facilitated. Thus the topic goes well beyond the needs of local service providers: it relates to the overall process of performance monitoring and regulating service authorities. It also relates to standardised information gathering processes which will facilitate future research.

This module suggests a procedure for reporting on sanitation services.

1.2. Aim

The new Water Services Act requires reporting by the water service authority, partly in the form of the water services development plan (WSDP) itself, and partly relating to the implementation of the plan (See clauses 15 and 18). Proposals regarding the form of this reporting are discussed in Module 2 which deals with water services development plans, in Section 4.4. Four reporting components are identified:

a) The submission of the WSDP itself.
b) The submission of the summarised quantitative information from the WSDP to DWAF and other stakeholders.
c) Annual updates with regard to quantitative information.
d) Written annual reports.

In this module the aim is to deal with items b) and c), but only for sanitation services (water supply services are dealt with in Module 6).

As mentioned in the introduction to this module, the reporting is intended to be useful both internally, to the management structures of the service provider, and externally to other stakeholders including higher levels of government, e.g. the Department of Water Affairs and Forestry (DWAF). The reporting is structured in a way which promotes easy monitoring of water service institutions through, firstly, providing sufficient information to define the key elements of a water services development plan and, secondly, to measure performance against this plan.

The intention of such monitoring at both local and national levels, is to enhance the management efficiency of both water service authorities and the water service providers appointed by them. One way this can take place is through the use of the information to develop a standardised set of performance indicators for comparative purposes.

Further, the information can be used to determine the resource and institutional support needs of the water service institutions.

1.3. Relationship To Other Guidelines

The module is part of a management guideline series for water and sanitation service institutions prepared for the Water Research Commission by Palmer Development Group. The modules prepared to date are:

Introduction of urban services management

Module 1: Organisational arrangements for water service providers
Module 2: Preparation of a water services development plan
Module 3: Customer profile and demand for services
Module 4: Setting water tariffs
Module 5: Setting sanitation tariffs
Module 6: Reporting procedures for water services
Module 7: Reporting procedures for sanitation services (this module)

Much of the information required is discussed in these other modules. Reference is made to them where appropriate rather than providing detailed discussions here.

1.4. Definitions

Definitions are given in Module 1 and are not repeated here.

2. Reporting procedure for WSDP data

2.1. The proposed system

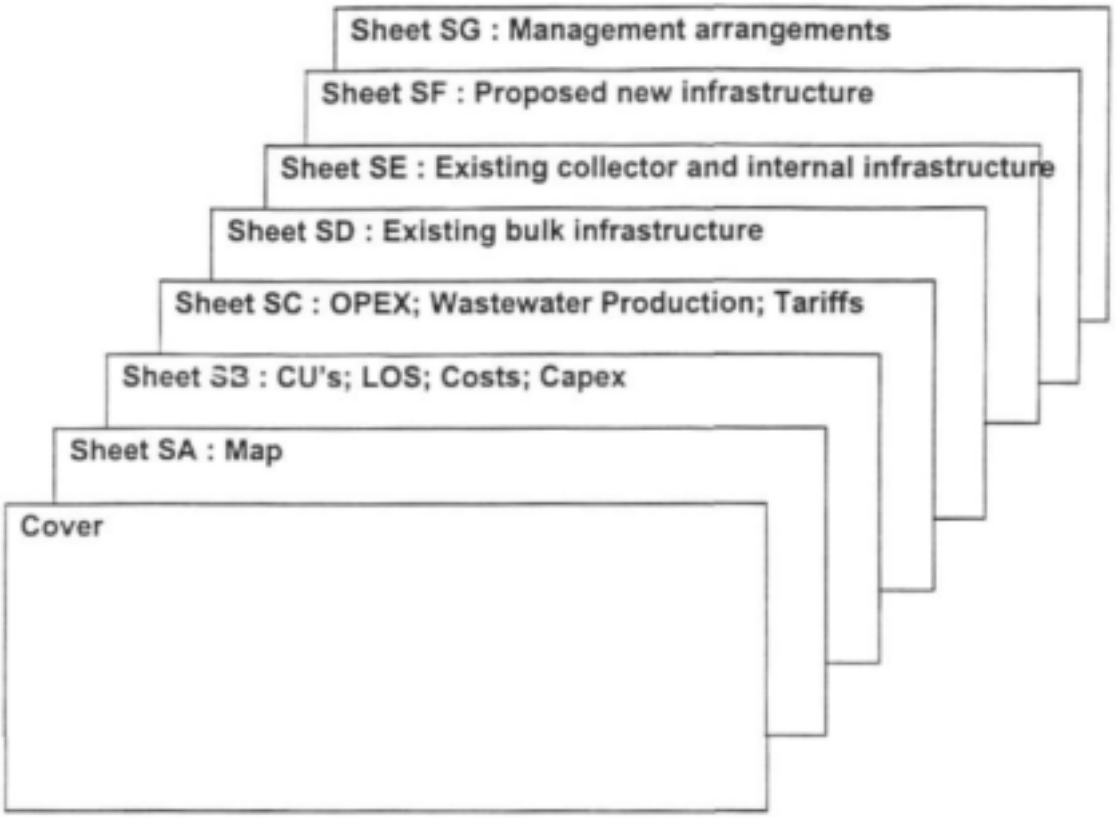
The system of reporting proposed in this module consists of an information data set to be prepared by water service authorities. In doing this they would typically require information from water service providers appointed by them to actually carry out the provision of sanitation services. It is in the form of a computer spreadsheet which is written at present in Microsoft Excel 7 for Windows 95.

The electronic format is intended to simplify the transmission and recording of information and facilitate the analysis of the data, for example to get performance indicators using a compatible computer spreadsheet model. One communication channel would be between the water service authority and DWAF and this could take place by means of diskettes or e-mail, depending on the resources of the service provider.

2.2. Structure

The data set is divided into seven component data sheets (see figure 1 below). A print-out of data sheets comprising the spreadsheet questionnaire is provided in Annexure 1 of this report.

Figure 1: Components of the Reporting for Sanitation data set



Each component data sheet is described in more detail in the following section.

2.3. Data requirements

An example of each the data sheets is given in Annexure 1 and should be read in conjunction with the following. In some cases (especially for Data Sheets SB and SC) the data fields of this module are similar to the ones in Module 6: "Reporting Procedures for Water Supply Services".

a) Sheet SA: Map

This sheet requires a map showing the water service authority area and its sub-division into sanitation zones. The map should include the major components of the sanitation system and should be of an appropriate scale and not larger than A4 size. It is recognised that larger scale and more detailed mapping is needed but the A4 map is selected for this report only to provide an overall picture.

b) Sheet SB: CU's, TOS, Costs, Capex

The title of this sheet is an abbreviation for the following:

- Customer Units (CU's),
- Type of Service (TOS)[1],

[1] Types of service are discussed in more detail in Module 3 of this Management Guidelines series.

- Unit costs for components of the sanitation system (Costs), and
- Capital expenditure (Capex).

The first line of this sheet is for the name of the service area being reported on, the base year of the data and the date reporting. The base year is usually the previous or the current year, depending on the availability of service and financial data.

A description of the data requirements for each table follows:

Table 1: Numbers of Customer Units and Average Growth Rates

The first four data fields of this table (viz. Residential, Institutional, Commercial and "dry", and "Wet" Industrial) refer to the categories of customers to be reported on. The numbers of customer units in each category in the base year (1996), and projections of the numbers in 5 years time (2001) and in ten years time (2006) need to be provided. Suggested methods for estimating future numbers are provided in Module 4.

The customer categories are defined as follows :

- *Residential* - all single formal residential plots, occupied and used for residential purposes; all individual flats and townhouses; and dwellings in informal areas. Second dwellings are counted separately only if they are separately billed, otherwise they form a single customer units with the main house.
- *Institutional* - such as schools, clinics, hospitals and churches.
- *Commercial* - Non-residential, non-industrial business enterprises, typically offices, shops, hotels, etc.
- *"Dry" industrial* - Industries that do not make use of water as part of their "core" processes
- *"Wet" industrial* - Industries and services that use water in their "core" processes, such as the manufacture of beverages, fruit canning and laundries.

The last line item of table 1 requires a projection of the local average economic growth rate. Suggestions for determining this are provided in Module 3.

Table 2: Percentage income distribution

Table 2 requires the percentage distribution of residential customer units across income categories. The income categories are defined in terms of the total monthly incomes per household. The first three categories are defined to coincide with those used for housing subsidy allocations.

The percentage of residential customer units in each income category is required for the base, 5th and 10th years respectively (i.e. 1996, 2001 and 2006 in the example). Methods for estimating income distribution are discussed in Module 3.

Table 3: Residential Service Levels

Table 3 is concerned with the provision of services to residential customer units. The first line requires a description of existing services in terms of the percentages of customer units with each of the service types described. In lines 2 and 3 the

percentages of households with the described services are to be projected for years 5 and 10 respectively. The service types used are described in Module 3.

Table 4: Unit Costs: Internal services, subsidies and customer payments

Table 4 deals with the capital cost of internal services, housing subsidy finance and once-off capital payments by customer units for the provision of the infrastructure.

- The first column lists the customer categories and types of residential services to be reported on.
- The next section (headed "Capital Costs") requires the entry of a cost per customer unit for new developments in the service area (column headed "new internal services"). Cost must be separately entered for the different service types, in base year Rands.
- The third section is for data on housing subsidies. The three columns under the heading "Housing Subsidy" refer to the amount (in Rands) of each housing subsidy that will be used to finance internal sanitation infrastructure. Amounts need to be shown for each type of service. Since the housing subsidy may not keep pace with inflation, the anticipated real (base year Rand) amount to be used for sanitation infrastructure needs to be projected for years 5 and 10 respectively.
- The column headed "payments" refers to the amount to be paid by each customer unit in connection fees and development charges, or any other form of up-front capital payment. The amounts must be entered in base year Rands.

Table 5: Unit Costs - Bulk and Collector

A cost must be entered for each of the components shown in the table in the units given in the table as appropriate. These costs can be obtained by dividing the (anticipated) total cost of recent past or planned projects (adjusted for inflation to base year Rands) by the total capacity of the new works or extensions.

Table 6: Inflation and borrowing rates for long term loans

The first line requires the inflation rate in the base year, and the projected rates in years 5 and 10. It is important that these projections reflect the rates used in table 7 if information there is entered in nominal terms.

The second line requires an estimate of the current average borrowing rate for internal loans, and projections of this rate for years 5 and 10. The third line requires an estimate of the current average borrowing rate for external loans, and projections of this rate for years 5 and 10. Rates must be entered in nominal terms, i.e. the rates actually charged. Note that changes in the inflation rate relative to borrowing rates will affect real borrowing rates (i.e. the rates net of inflation).

Table 7: Capital Account

Data on the capital expenditure, capital income and borrowing requirements are provided for in this table in units of one thousand Rands for the base year and a projected ten year period (base year = year 0). An explanation of the data fields in Table 7 follows:

- *"Real or nominal"* - amounts for each year may be entered in real terms (base year Rands) or nominal terms (current Rands, i.e. taking inflation into account) for each year, and it is necessary to specify whether real of nominal values are being used. It is recommended that real values be used as far as possible, and certainly after the first five year period.

- *"Capital Expenditure - bulk"* - refers to the total planned capital expenditure for the each year by the service provider on bulk infrastructure. Actual expenditure in the base year is to be entered in the first column.

- *"Capital Expenditure - collector"* - refers to the total planned capital expenditure for the each year by the service provider on collector infrastructure. Actual expenditure in the base year is to be entered in the first column.

- *"Capital Expenditure - internal"* - refers to the total planned capital expenditure for the each year by the service provider on internal services including reticulated and on-site systems and equipment. Actual expenditure in the base year is to be entered in the first column.

- *"Capital Expenditure - other"* - refers to the total planned capital expenditure for the each year by the service provider on other items including asset replacement and items such as vehicles. Actual expenditure in the base year is to be entered in the first column.

- *"Capital subsidies"* - refers to the portion of capital expenditure to be financed by means of subsidies and grants, the most important of which are the housing subsidy and the CMIP grant for bulk and connector infrastructure

- *"Customer payments"* - the portion of capital expenditure financed by means of connection fees, development charges and any other once-off capital payments made by customer units.

- *"Expenditure from current income"* - refers to capital expenditure financed out of income derived from service charges and other recurrent income.

- *"Borrowing: capital development fund"* - refers to the portion of capital expenditure financed by means of borrowing from the municipality's or the Sanitation Service Provider's capital development fund (if any).

- *"Borrowing: external"* refers to the portion of capital expenditure financed by means of borrowing from external sources such as the Development Bank of South Africa and commercial lending institutions.

The last two columns *"Year 1-5"* and *"Year 6-10"* refer to the amounts for each line item corresponding to the first five years and the last five years respectively, of the projection period for which data is required. Note that the base year is referred to as year 0.

c) Sheet SC: Opex, Consumption, Tariffs

This data sheet is for information relating to operational expenditure, levels of wastewater production and tariffs or charges in the service area. It consists of four tables. The data requirements for each table are largely self-evident, however in some cases further explanation is necessary and is provided below:

Table 1: Operating Account

The data in Table 1 should be given in thousands of Rands for the base year and over a projected ten year period. The following data fields are explained further:

- *"Accrued income"* - refers to the total income billed or expected to be received by the service provider in the form of reconnection fees, interest from capital reserve funds etc. for the corresponding year. Connection and development fees for new developments must however be excluded because these have already been accounted for (Table 4, Sheet SB). For the year preceding the base year (1995 in example), only the year-end cash balance needs to be entered.

- *"..of which revenue from tariffs or rates"* - refers to income accrued from customers' payments for sanitation services. This includes all customer categories, viz. residential, institutional, commercial, industrial and bulk sales to other service areas.

- *"Expenditure"* - is broken down into components which conform with the reporting requirements as recommended by the Institute of Municipal Treasurers and Accountants (IMTA, 1994).

- *"Annual net cash flow"* - is calculated as follows:

  Accrued surplus(deficit) *minus* Non-payment = *Annual net cash flow.*

- *"Cash balance (year end)"* - is the accumulated cash balance at the end of each year. It is calculated for year Y by adding the accumulated balance at the end of year X to the annual net cash flow in year Y.

Table 2: Unit Cost, Wastewater Production, Bills and Price of Water by Service Type

The data requirements of Table 2 are considered self explanatory except for the column "Cost (R / CU per month - real)". This column requires estimates of the operating and maintenance costs of services provision including the cost of wastewater treatment. Capital charges are excluded. Methods for determining these costs is discussed in Module 6. Projections are required of unit costs for years 5 and 10 (in base year Rands). Changes in units costs may be affected for example by changes in efficiency or treatment costs.

Table 3: Total Flow (Ml per annum) and Bulk Sanitation Cost (c/kl)

If an outside agency treats the wastewater, the cost is simply the price paid per kl. If the service provider is responsible for treatment, the cost per kilolitre is the

(total costs of wastewater treatment) / (volume treated during the period)

To determine the total cost of wastewater treatment the share in total costs of this operation needs to be calculated. A method for determining this is provided in the Module 5.

Table 4: Debt Service Ratios and Non-Payment

The following is of note in Table 4:

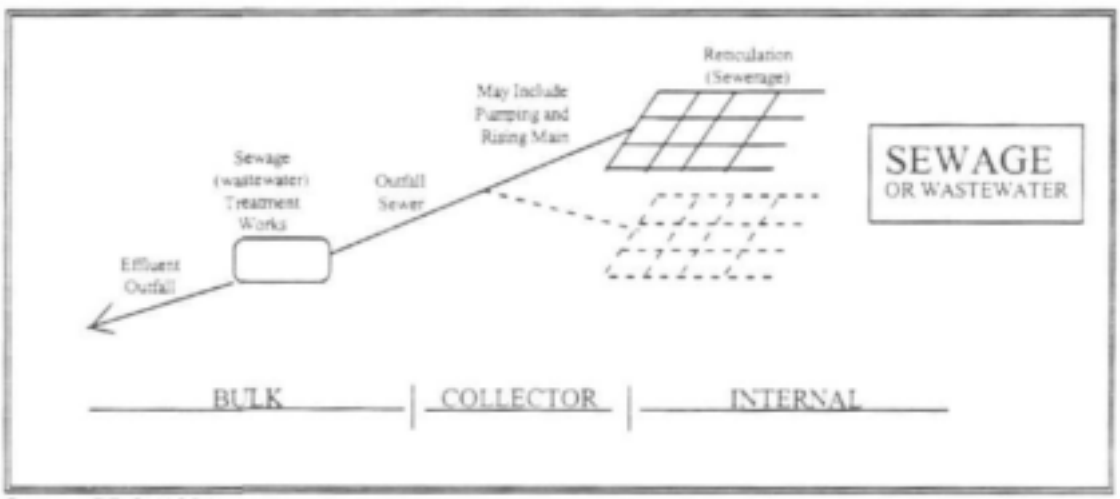
- *"capital charges/accrued income"* - is the ratio of
  (total interest and redemption costs) : (total accrued income)
- *"capital charges/received income"* - is the ratio of
  (total interest and redemption costs) : (total accrued income less non-payment)

"% of total accrued income unpaid" - is the percentage of billed income not received and not likely to be received in the near future (bad debts). Note that this refers to the total *amount* of income unpaid, and not the *number* of unpaid bills.

d) Sheet SD: Existing Bulk Infrastructure

The information required for this data sheet relates to a description of the physical bulk infrastructure facilities in the sanitation service area. The classification of bulk, connector and internal infrastructure is discussed in the Module 4 and 6, and is summarised below in Figure 2.

Figure 2: Classification of the components of sanitation supply systems



Source: PDG (1994).

As with Sheet SC, much of the information required to complete this data sheet is self-explanatory. However where further explanation is considered necessary, it is provided in the following sections:

Table 1 and 3: Treatment works and process

These tables relate to a description of the processes and facilities used for the treatment of wastewater.

The data required relates to a description of the existing sewage (wastewater) treatment facilities and processes in the service area, with provision made for information to be given for each works. The data fields are compatible with the classification procedure used by current legislation.

The following is relevant to data fields in the tables:

Table 1

- *"Classification of Works"* - refers to the classification of the wastewater treatment plant in terms of Schedule II of the Regulations pertaining to section 12A of Water Act, 1956 (Act 54 of 1956).
- *"Sewage Concentration (mg/l COD)"* - refers to the average COD concentration of sewage flowing into the works - specify COD level if possible or whether the concentration is above or below 700 mg/l COD.

Table 3

- *"Preliminary treatment"* - refers to the process in use.
- *" Primary Sedimentation"* - specify the number, size and type of tanks.
- *"Anaerobic digestion"* - specify type of system and the number and size of the tanks.
- *"Sludge drying beds"* - specify the number and total capacity in m^3
- *"Oxidation ponds"* - specify capacity and and number.
- *"Biofilters and biodiscs"* - specify type of system and number of filters.
- *"Activated sludge"* - specify method
- *"Tertiary treatment"* - specify type of process.
- *"Maturation Ponds"* - specify number and capacity.
- *"Chlorination"* - specify process
- *"Sludge treatment"* - specify type of process
- *"Nutrient removal"* - specify process if other than activated sludge or bofilters.

Table 2

This table requires limited information to be reported on effluent quality. The information needs to be reported as averages for all discharges from all treatment works over the year. In calculating the average the values for each discharge need to be weighted based on the flow being discharged.

Other tables

The data fields in Tables 4, 5 and 6 are considered self-evident and no further explanation is provided here.

e) Sheet SE: Existing Collector and Internal Infrastructure

The information required for Data Sheet SE involves a description of the physical collector and internal infrastructure facilities which exist in the sanitation service area, including on-site sanitation facilities and equipment. The information requirements of the data fields in this sheet are self-explanatory.

f) Sheet SF: Proposed New Infrastructure

The data in this sheet is related to future plans for the upgrading of existing and the construction of new sanitation infrastructure, including bulk, connector, internal and on-site infrastructure. Note that this is the physical counterpart of the financial data on capital expenditure provided in Sheet SB, Table 1. The information on internal and on-site infrastructure must accord with the percentage distribution of service types provided in Sheet SB, Table 4.

Additional information on the data fields is provided below:

- *"upgrading/new works"* - state whether installation will relate to new works or the upgrading of existing works. "Internal sewerage upgrading" - relates to the length of reticulation sewers installed to upgrade existing infrastructure to higher service levels.
- *"Outfall sewer - diametric range"* - state into which diametric category the weighted average pipe diameter fits, e.g. less than 200mm, 200mm to 400mm, 400mm to 800mm or greater than 800mm.
- *"Collector sewer - diametric range"* - state into which diametric category the weighted average pipe diameter fits, e.g. less than 200mm, 200mm to 400mm, 400mm to 600mm or greater than 600mm.
- *"Internal sewerage - New infrastructure"* - refers to greenfields development - i.e. infrastructure installed where none existed before.
- *"Internal sewerage - upgrading"* - relates to the length of sewer installed as part of a project to upgrade existing infrastructure to facilitate higher service levels in the service area.
- *"Internal sewerage - Asset replacement"* - relates to the length of reticulation sewers installed to replace ageing or damaged pipe.

g) Sheet SG: Management Arrangements

The information required for Data Sheet SG is related to the institutional and staffing arrangements of the sanitation service authority for the area.

3. Reporting procedure for annual data update

As mentioned at the start of this module, a second type of report is necessary to enable the implementation of the water service development plan to be monitored on an annual basis.

Table 1: Annual reporting information

Information to be reported: sanitation	Plan		Actual	
Number of new customers provided with a service in past year:				
- On site sanitation				
- Intermediate sanitation				
- Full waterborne sanitation				
Number of customers provided with upgraded service in past year.				
Capital expenditure over past year (Rm)				
Current tariff				
- Fixed monthly charge - if used (low and high)				
- % of water bill - if used (low and high)				
Change in employment over past year (No employees)				

Certain key pieces of information have been selected for this report to facilitate easy assessment of progress in relation to plan. This information is identified in Table 1. The intention is for this report to be prepared by water service authorities on an annual basis and submitted to key stakeholders, including DWAF.

4. Closure

The module presents a set of data to be reported by water supply service providers for internal management purposes and for national monitoring purposes. The data set has been designed to identify key information relating to development plans, to conform with the regulations of the new Water Services Act, and also to identify key information which can be used to monitor performance in relation to the plan.

5. References

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WATER RESEARCH COMMISSION

MANAGEMENT GUIDELINES FOR WATER SERVICE INSTITUTIONS

MODULE 7

ANNEXURE 1

REPORTING PROCEDURE FOR SANITATION SERVICES
DATA SHEETS

January 1998

PALMER DEVELOPMENT GROUP

Reporting for Sanitation

Sheet SA: Map

Reporting for Sanitation

Sheet SB: CU's; TOS; Costs; Capex

Town	Base yr	Run date
	1995	

TABLE 1 NUMBERS OF CUSTOMER UNITS AND LOCAL ECONOMIC GROWTH RATES

	1996	2001	2006
Residential Institutions Commercial and "dry" "Wet" industrial			
Local average economic growth rate			

TABLE2: INCOME DISTRIBUTION (%)

	1995	2001	2006
< R800 pm R800-R1 500 pm R1 500-R3 500 pm R3 500 - R5 000 pm > R5 000 pm			

TABLE 3 RESIDENTIAL SERVICE TYPES (% DISTIBUTION)

	Unimproved pits, buckets or nothing	Ventilated Improved Pit (VIP) latrines	Low Flow On-site (LOFLOS) systems, incl aqua-privies	Septic tanks	Simple waterborne sanitation* (sewered)	Full waterborne sanitation (sewered)
1995						
2001						
2006						

* excluding shallow sewerage options and septic tank drainage (STED) systems

TABLE 4 UNIT COSTS : INTERNAL SERVICES, SUBSIDIES AND CUSTOMER PAYMENTS

	Capital costs	Subsidies and payments (R/CU, real)			
	Rands / CU (real) new internal services	housing subsidy (real value) 1995	2001	2006	payments real value, all years
Unimproved pits, buckets or nothing					
Ventilated Improved Pit (VIP) latrines					
Low Flow On-site (LOFLOS) systems					
Simple waterborne sanitation					
Full waterborne sanitation, low income					
Full waterborne sanitation, middle income		na	na	na	
Full waterborne sanitation, high income		na	na	na	
Institutions		na	na	na	
Commerce&dry industry		na	na	na	
Wet industry		na	na	na	

TABLE 5: UNIT COSTS : BULK AND CONNECTOR

On-site sanitation (R)	
Pit emptying service	R/pit
Sludge handling	R/m³/day handling capacity
Waterborne sanitation (R)	
Pumping	R/kW pumping capacity
Outfall sewers	R/m³/day design capacity
Treatment	R/m³/day design capacity
Effluent disposal (e g marine outfall)	R/m³/day design capacity

Table 6: Inflation and borrowing rates for long term loans

	1995	2001	2006
general inflation rate			
nominal borrowing rate			

TABLE 7 CAPITAL ACCOUNT : CAPITAL EXPENDITURE, CAPITAL INCOME AND BORROWING REQUIREMENTS (R thousands)

	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Year 1-5	Year 6-10
Real or nominal ?	base year												
Capital expenditure:													
Capital expenditure- bulk													
Capital expenditure- collector													
Capital expenditure- internal													
Capital expenditure- other													
Sources of finance :													
Capital subsidies													
Consumer payments													
Exp from current income													
Borrowing :													
Capital Development Fund													
External													

Sheet SC: Opex; Consumption; Tariffs

Town	Base year	Run date

TABLE 1 OPERATING ACCOUNT : INCOME, EXPENDITURE AND CASH FLOW (R thousands)

		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Real or nominal ?		na	base year										
Accrued income		na											
of which revenue from tariffs or rates		na											
Expenditure:	*Staff*	na											
	General	na											
	Repairs & Maintenance	na											
	Interest & Redemption	na											
	Fixed assets	na											
	Contributions to funds	na											
	SUB-TOTAL	na											
Surplus (deficit)		na											
Non-payment (bad debts)		na											
Annual net cash flow		na											
CASH BALANCE (year end)													

TABLE 2 UNIT COST, WASTEWATER PRODUCTION AND BILLS OF SANITATION SERVICES BY CUSTOMER TYPE

	Cost (R /CU pm, real) (excluding capital charges)			Wastewater Production (kl/CU pm) kl/month per CU			Monthly bills (R pm, real) R per month per CU		
	1996	2001	2006	1996	2001	2006	1996	2001	2006
Unimproved pits, buckets or nothing									
Ventilated Improved Pit (VIP) latrines									
Low Flow On-site (LOF LOS) systems									
Simple waterborne sanitation									
Full waterborne sanitation, low income									
Full waterborne sanitation, middle income									
Full waterborne sanitation, high income									
Institutions									
Commercial/dry industry									
Wet industry									

TABLE 3 TOTAL WASTEWATER FLOW (Ml per annum) and TREATMENT COST (c/kl)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total Wastewater Flow to Treatment Works(Ml pa)											
Average cost of Wastewater Treatment (R/Ml)											

TABLE 4 DEBT SERVICE RATIOS AND NON-PAYMENT

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
capital charges/accrued income											
capital charges/received income											
% of total accrued income unpaid											

Sheet SD: Existing Bulk Infrastructure

Table 1: Treatment works

Name of Treatment Plant:			
Name of Treatment Plant			
Classification of Works			
Design Capacity (Ml/day)			
Sewage Concentration (mg/l COD)			
Year when plant was built			
Year and type of any modifications and/or upgrading			

Table 2: Effluent quality

Parameter	Ave value
COD (mg/l)	
Ammonia (mgN/l)	
Nitrate (mgN/l)	
Phosphates (mgP/l)	
E. Coli (Count per 100 ml)	

Table 3: Treatment Process Used

Name of Treatment Plant:			
Preliminary Treatment			
Primary Sedimentation			
Anaerobic digestion			
Sludge drying beds			
Oxidation ponds			
Biofilters or biodiscs			
Activated sludge			
Tertiary treatment			
Maturation ponds			
Chlorination			
Sludge treatment			
Nutrient Removal			

Table 4: Length of Outfall Sewer (in kilometers):

Diametric range (mm)	Vitrified Clay	Glass Reinforced Plastic (GRP)	Concrete	Asbestos cement	P.V.C	HDPE	Other
less than 200							
200<Dia<400							
400<Dia<600							
Dia>600							

Table 5: Age of Outfall Sewer :

Age in years	Age < 10	10 < Age < 20	20 < Age < 30	30 < Age < 50	Age > 50
Percentage installed pipeline in age categories (%)					

Table 6: Pump stations:

Name/no of pump station	Capacity of Station (l/s)	type of pumps	No. of duty	standby units	Age of equipment

Sheet SE: Existing Collector and Internal Infrastructure

a) Collector Infrastructure

Table 1: Length of Collector Sewers (in kilometers):

Diametric range (mm)	Vitrified Clay	Glass Reinforced Plastic (GRP)	Concrete	Asbestos cement	P V C	HDPE	Other
less than 200							
200<Dia<400							
400<Dia<600							
Dia>600							

Table 2: Age of Collector Sewers

Age in years	Age < 10	10 < Age < 20	20 < Age < 30	30 < Age < 50	Age > 50
Percentage installed pipeline in age categories (%)					

Table 3: Pump stations

Name/no. of pump station	Capacity of Station (l/s)	type of pumps	No. of duty	standby units	Age of equipment

b) Internal Infrastructure

Table 4: Length of Internal Sewers (in kilometers):

Diametric range (mm)	Vitrified Clay	Glass Reinforced Plastic (GRP)	Concrete	Asbestos cement	P V C	HDPE	Other
50<Dia<100							
100<Dia<200							
200<Dia<400							
Dia>400							

Table 5: Age of Internal Sewers

Age in years	Age < 10	10 < Age < 20	20 < Age < 30	30 < Age < 50	Age > 50
Percentage installed pipeline in age categories (%)					

Table 6: Pump stations:

Name/no. of pump station	Capacity of Station (l/s)	type of pumps	No. of duty	standby units	Age of equipment

c) On-site Sanitation Facilities and Equipment

Table 7: Bulk and Collector Facilities and Equipment

Pit Emptying make and model of tankers number of tankers	
Sludge Handling (specify method)	

Table 8: Internal Facilities and Equipment

Type of Latrine	Number of Latrines
Ventilated Improved Pit	
LOFLOS	
Septic Tanks	

Reporting for Sanitation

Sheet SF: Proposed New Infrastructure

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Wastewater Treatment											
upgrading / new works											
Additional capacity (Ml/day)											
Pump stations											
Additional capacity (m^3/day)											
Outfall Sewer											
diametric range (mm)											
Collector Sewer											
diametric range (mm)											
Internal Sewerage (length of sewer pipe in metres):											
New infrastructure											
Upgrading											
Asset replacement											
On-site Sanitation (specify number of latrines):											
Ventilated Improved Pit Latrines											
LOFLOS											
Septic Tanks											

Sheet SG: Management Arrangements

Table 1: Sanitation Service Authority:

Name of Authority		
Separate Council / Sub-committee (if used)		
Responsible Councillors	Responsible Officials	
	Name	Position

Table 2: Sanitation Service Provider:

Name	Area Served	Date Appointed

Table 3: Bulk Service Provider:

Name	Description of Service	Date Appointed

Table 4: Project Related Contracts:

	Percentage	
	Contract	In-house
Surveying		
Design		
Construction		

Table 5: Service Contracts:

Description of Service	Name of Contractor	Value of Contract per Year (next 5 years)				
		1997	1998	1999	2000	2001

Table 6: Staff:

Name of Grading System							
		Number of Employees					
	Post Norm Grade	Executive and Senior Management	Middle Management	Clerical	Supervisory or Artisan	General Worker	Total
Finance and Administration							
Finance and Sales (Treasury)							
Projects and Planning							
Operations							
Bulk Services							
Collector Services							
Total (current year)							
Projection of total in five years time	2002						

Table 7: Training:

Training (projected number of person days over next 5 years)						