WATER RESEARCH COMMISSION

WATER SUPPLY SERVICES MODEL MANUAL

PALMER DEVELOPMENT GROUP

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Report to the
Water Research Commission
by

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WRC Report No. KV109/98
July 1998

Obtainable from:

Water Research Commission
PO Box 824
Pretoria
0001

The publication of this report emanates from a project entitled *Upgrading of water supply investment planning (WIP) model for water services providers*. (WRC Project No K8/294)

ISBN 1 86845 406 1
SET NO 1 86845 408 8

Printed in the Republic of South Africa

PREFACE

Model origin

The Water Research Commission (WRC) appointed Palmer Development Group (PDG) to undertake an institutional and financial review of water supply and sanitation services in the urban areas of South Africa (PDG, 1994). The overall objective of this project was to present information and analysis that could help relevant community leaders and decision-makers to guide and promote the extension of services, to enable all people living in the (urban) areas of South Africa to have adequate and appropriate water supply and sanitation. The project also aimed to facilitate the related processes of financial, institutional and policy changes that the adoption and implementation of relevant strategies would require.

During this project, an investment-tariff model was developed. The purpose of this model was to assist the agencies responsible for water supply in urban areas in the development and evaluation of investment scenarios and tariff policy. This was to be done in the context of the overall goals of eradicating service backlogs as rapidly as possible, whilst maintaining the financial viability of the service.

Model testing and extension

Subsequent to its initial development, Durban Water and Waste expressed interest in using the model and were involved in the testing, further development and extension of the model to include the modelling of sanitation as well as water supply. The revised model was tested and used by a number of water service providers including Durban Water and Waste, Rand Water, Port Elizabeth, Pietermaritzburg and Estcourt.

The water and sanitation model was applied to twenty towns in South Africa during a study commissioned by the Development Bank of Southern Africa (DBSA) to assess the financial viability nationally of alternative residential infrastructure investment programmes (DBSA, 1995a). Similar models for electricity, roads and stormwater and solid waste were developed and used. A consolidated model of all these services was also developed for application on a national scale (DBSA, 1995b). These studies informed the first draft of the Municipal Infrastructure Investment Framework (RSA, 1995).

The Combined Services Model

In early 1996 Palmer Development Group was commissioned by the DBSA to develop more "user-friendly" models for the major urban infrastructural services, namely water, sanitation, electricity, solid waste, roads and stormwater. The outcome of this project was the Combined Services Model, which is a single model that assesses the financial viability to local authorities of alternative residential infrastructure investment programmes in any or all of these services.

To date, the Combined Services Model has been applied to some 30 local authorities in South Africa by DBSA, Palmer Development Group and the Western Cape Provincial Government. The model was used in the subsequent refinement and extension of the Municipal Infrastructure Investment Framework (RSA, 1997a). It was used in two studies by Palmer Development Group, commissioned by the DBSA, the first of which was to identify and quantify the risks associated with investment in municipal infrastructure in South African towns (PDG, 1996). The second study provided an empirical assessment of towns on which the CSM had been run, as part of a broader project to identify factors that impact on investment planning in South African towns (PDG, 1997). The CSM is a useful tool in the development of Integrated Development Plans, which are now statutory requirements for local governments.

The Water Supply Services Model and the Sanitation Services Model

The Water Supply Services Model was developed in 1997 as an updated and extended version of the original investment-tariff water model, incorporating additional variables, allowing for *inflation and making full use of the experience gained in the development* and application of the Combined Services Model. The model has to date been applied in the Winterveld, King William's Town, Harrismith and the (Johannesburg) Southern Metropolitan Substructure.

The Sanitation Services Model is an updated and extended version of the sanitation component of the investment-tariff model. It can be used as a stand-alone model, but is designed for use with the WSSM. The model has thus far been tested in Harrismith and the (Johannesburg) Southern Metropolitan Substructure.

This manual

This manual is intended to facilitate understanding and use of the Water Supply Services Model. It describes the philosophy behind the model, outlines its aims, limitations and key assumptions, describes the structure and data inputs required and explains the model results.

A separate manual describes the use of the Sanitation Services Model.

ACKNOWLEDGMENTS

Funding

The *Water Research Commission* (WRC) provided funding for the initial development of the investment-tariff model and its subsequent testing in Port Elizabeth, Pietermaritzburg and Estcourt. The Commission also provided funding for the development of the current Water Supply Services Model (WSSM) and the Sanitation Services Model (SSM) and, in conjunction with the Development Bank of Southern Africa, the Combined Services Model.

Durban Corporation funded the further development of the initial investment-tariff model and the extension to include sanitation in the model. Assistance was also provided for the development of the current Sanitation Services Model.

The *Development Bank of Southern Africa* provided funding for the development and subsequent updating of the Combined Services Model.

Model development

- The initial investment-tariff model was developed by Rolfe Eberhard of Palmer Development Group.
- The current Water Supply Services Model was developed by Bee Thompson of Palmer Development Group.
- The Combined Services Model was developed by Bee Thompson and Rolfe Eberhard of Palmer Development Group.

The following people contributed towards the development of the model:

- Clive van Horen, of the Energy & Development Research Centre at the University of Cape Town, who had developed a conceptually similar model for the electricity sector and contributed substantially towards the initial concept development and model coding.
- Neil Macleod, Executive Director of Durban Water and Waste, who provided much of the data used in the illustrative model runs and made suggestions for improvements and modifications.
- Andre Roux and Barry Jackson, of the Development Bank of Southern Africa, who provided the initial inspiration and encouragement.
- Ian Palmer, of Palmer Development Group, who provided technical information and much encouragement.
- Burgert Gildenhuys, of the Development Bank of Southern Africa, who provided support and ideas for the development and updating of the Combined Services Model which has been invaluable in the development of the Water Supply Services Model.

CONTENTS

INTRODUCTION

Background

In South Africa it is estimated that about 13% of urban households lack adequate sanitation facilities, and about 11% lack adequate water supplies (RSA 1997a, Annexure 4). The responsibility for making up the backlog in services and meeting new demand has been given to local authorities in terms of the Constitution of the Republic of South Africa of 1996.

Local authorities face a significant two-fold challenge in providing the necessary services to all residents within their areas of jurisdiction:

- developing adequate institutional capacity to implement new investments and to manage all assets in an efficient, fair and accountable manner; and
- ensuring financial viability and long-term sustainability of services provision.

Medium- and long-term financial viability and sustainability of services can only be ensured through proper investment planning in which the operating and maintenance implications of investments, as well as user affordability and willingness to pay, are taken into account.

Water Services Development Plans

In terms of the Water Services Act of 1997, every water services authority is obliged to prepare Water Services Development Plans. The first such plan is to be finalised by December 1998, and thereafter at intervals to be determined by the Minister. A plan should be prepared as part of the preparation of an Integrated Development Plan (IDP), which is required in terms of the Local Government Transition Act of 1993. If no IDP is being prepared, then a Water Services Development Plan must be independently prepared.

The contents of a Water Services Development Plan, as required by the Act, are as follows:

> 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 programme 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;

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 thereof; 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.

A suite of models is available to assist in the preparation of these plans, as illustrated in Figure 1. The Combined Service Model (CSM) is ideally suited to the development of an Integrated Development Plan, while the Water Supply Services Model (WSSM) and the Sanitation Services Model (SSM) are suited to the preparation of a Water Services Development Plan.

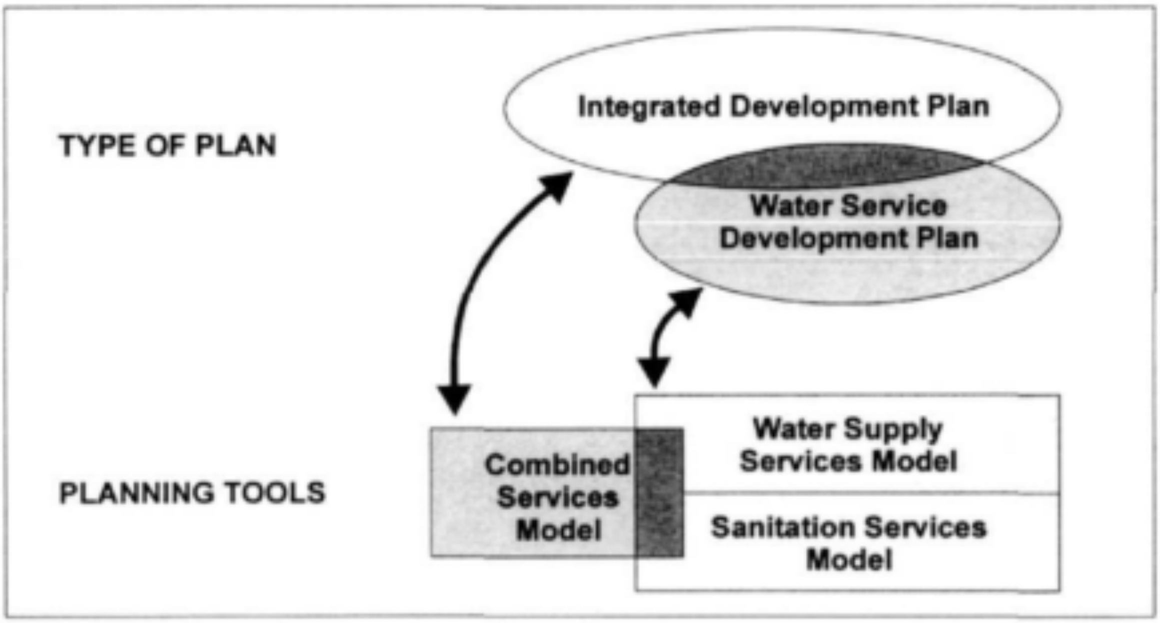

Figure1: Integrated Development Plan, Water Services Development Plans and the Models as planning tools

The relationship between Water Services Development Plans and the Water Services Supply and Sanitation Models is shown below. The column on the left lists the requirements of a plan, while the column on the right shows the way the WSSM and SSM can assist in the planning process.

RELATIONSHIP BETWEEN:

Water Services Development Plans	WSSM and SSM
1. *Current status* • Customer profile • Level of service • Water balance • Finances: expenditure, tariffs etc.	• Sets up structure for capturing information on current status.
2. *The proposed programme* • Consumer and economic growth projections • Time frame • Service level targets	• Systematically assesses implications of alternative growth projections. • Allows service level targets to be tested within different time frames, with emphasis on their financial implications.
3. *Flow and load projections*	• Facilitates projections of water demand and wastewater flows.
4. *Bulk and connector infrastructure*	• Facilitates projections of investment requirements with regard to capacity, timing and cost.
5. *Organisational arrangements* • Water services authority • Service providers and outsourcing • Organisational structure and staff • Training	NA
6. *Costs* • Capital costs • Projected operating costs	• Structures way costs are recorded. • Provides default values for unit costs as a first guess in the absence of local information. • Projects capital and operating costs on an annual basis.
7. *Finance* • Capital finance • Income policy (tariffs) • Operating account	• Allows finance options to be tested. • Allows tariffs to be set to achieve financial targets. • Projects future operating account. • Projects future cash flows.
8. *Affordability to customer*	• Provides affordability check. • Projected cash flows directly linked to affordability.
9. *Water conservation measures*	• Model has elasticity function to allow some testing of impact of tariffs on demand. • Model allows for changes in consumption per consumer over the investment period, to evaluate implications of additional savings on total demand and finances.

Purpose of the Water Supply Services Model

The aim of the model described in this manual is thus to assist the agencies responsible for urban water supply services to undertake the necessary investment planning and analysis. More specifically, its purpose is to evaluate the impact of different investment scenarios and tariff policies on the financial viability of the water service provider. Financial viability is assessed in terms of actual cash flows once ability and willingness to pay have been taken into account.

A major advantage of the model is that it provides a transparent interface between policy-makers and technical and financial personnel in the service agency. In general, policy-setting is the function of policy-makers (political representatives), whereas the determination of policy implications is the task of the technical and financial personnel in the agency itself. The model provides a *transparent tool* to test financial and physical implications of desired policy options, and hence to foster *trust* between policy-makers and the technical personnel.

MODEL FEATURES

The key focus

The key focus of the model is on the financial viability and sustainability of the water supply service. International experience has clearly shown that, where service provision is not financially sustainable, it is the poor who are the major losers. This does not preclude the provision of subsidies from external sources to run the service, but demands that assumptions regarding these be made explicit.

Policy neutrality

With the exception of this basic assumption, the model is policy-neutral - it does not impose any policy choices onto the user, but allows for flexibility to test the implications of alternative policy choices on the financial viability and sustainability of the service.

Many service options and flexible timing

The investment programme allows for the provision of six different types of water supply service for low-income households, two of which can be specified by the user. The upgrading programme can take place over a period of one to ten years. A great deal of flexibility therefore exists in terms of both service options and timing.

Easy to use and transparent

The model itself is easy to use once a certain degree of familiarity has been reached with its structure, input requirements and output format. It comprises a set of spreadsheet pages organised into four sections (see section below), with data input blocks clearly marked.

The model is completely transparent. There are no "black box" calculations. Most of the calculations occur in the "engine" (section 4), which is organised in a logical progression of topics. The user is able to trace every calculation undertaken in the model (although these do at times become rather complicated).

Default values

The model is designed in such a way that an initial run is possible with a minimum of information required. Default values are used when information is not entered by the user.

Essential inputs are entered in the yellow input blocks, and the model cannot run without these. Inputs that replace default values are entered in the white input blocks, and the relevant defaults are shown in blue below or next to the blocks.

Some of the defaults are simply numbers, and these are displayed in bold type. Others are calculated from model data, and are shown in normal type. Where relevant, notes are attached to the defaults explaining their calculation.

Protection against incompatible entries

The model provides a certain degree of protection against nonsensical results due to the use of incompatible data. Major incompatibilities will produce error messages and/or the model will not calculate the outputs. For example, if the total number of serviced residential sites exceeds the number of residential consumer units entered on a previous screen, an error message will appear and the model will not calculate further. If the total amount of water sold by the service provider does not break down into sensible amounts per consumer unit, an error message to this effect will appear on a number of screens and calculations will not be done.

Flexible tariff structure

There are a number of tariff options available. For domestic consumers with metered supplies, water may be charged for as a fixed amount per month, a fixed amount plus a consumption charge, or a consumption charge only. The consumption charge makes provision for a rising (or declining) block rate with three blocks. Unmetered service options are charged a fixed amount per month.

The tariff options for non-residential users with metered supplies include a consumption charge with or without a fixed monthly charge. A fixed monthly charge can be set for each of three categories of users: (a) institutional, (b) commercial and "dry" industrial, and (c) "wet" industrial consumers. The consumption charge applies to all non-residential users. Three variations of this basic structure are available:

- The consumption charge for non-residential users is the same as that set for residential users (including the definition of the blocks).
- *The consumption charge for non-residential users is a fixed amount per kilolitre consumed* (i.e., block rates do not apply).
- Non-residential consumers can be converted to "Residential Unit Equivalents" (RUEs) on the basis of consumption, and each RUE is charged for consumption on the domestic scale. In effect, this option defines block rates for each individual consumer based on their consumption. A fixed monthly charge per RUE (or part thereof) is independently set, and this charge can be used to ensure that non-residential users pay an economic rate for water, should the domestic structure include a low tariff for the first consumption block.

Tariff increases are set by entering the charges for year 1, and the percentage increases (in real or nominal terms) for subsequent years for the various components.

Payment levels linked to services and income levels

Key to the financial viability of the service provider is a low rate of non-payment (bad debts). An important issue is, therefore, the maximum monthly amounts that consumers are willing and able to pay for water. The model explicitly links (residential) non-payment rates to estimated maximum monthly payments for lower-income groups, to minimise the danger of an investment programme seeming to be viable because of unrealistic expectations regarding consumer payments.

Prediction of consumption

Consumption is projected for the ten-year period, broken down into various categories of users (residential, non-residential, municipal) and physical losses. These projections have the advantage of incorporating, in a consistent manner, predictions of population and economic growth, income levels, levels of service provision, responses to the changes in price and changes in consumption for other reasons (such as changes in technology or taste).

Bulk and connector infrastructure expansion

The model can be used to predict when expansion is required in the various components of bulk and/or connector infrastructure.

Nominal and real values

Provision is made in the model for inflation, and outputs are shown in both real and nominal terms. The user is frequently given the option of entering variables in nominal or real terms – when entering tariff increases, for example.

TECHNICAL SPECIFICATIONS

The model was developed using Excel for Windows, and may be run using Excel 5.0 or a later version. It is recommended that the model be run on at least a 66 MHz machine with 8 Mb of RAM. The user requires only a very basic knowledge of the Excel spreadsheet package.

THE MODEL STRUCTURE

The model consists of four sections:

Section 1: This is the interactive section of the model. Essential information is entered and the water supply service options are described. An investment programme is designed. The user then sets annual tariff increases to meet the service provider's cash flow requirements. Key outputs on the capital and operating accounts are shown.

Section 2. The user is requested to enter information to replace the default values that are used in the absence of local information. Replacing default values will affect the outputs in section 1, which can be finalised only once local information has been entered.

Section 3. Output information is presented in greater detail, in formats suitable for printing.

Section 4. This is the "engine" where most of the calculations are conducted. A user would access this section only to trace the model's calculations, if desired.

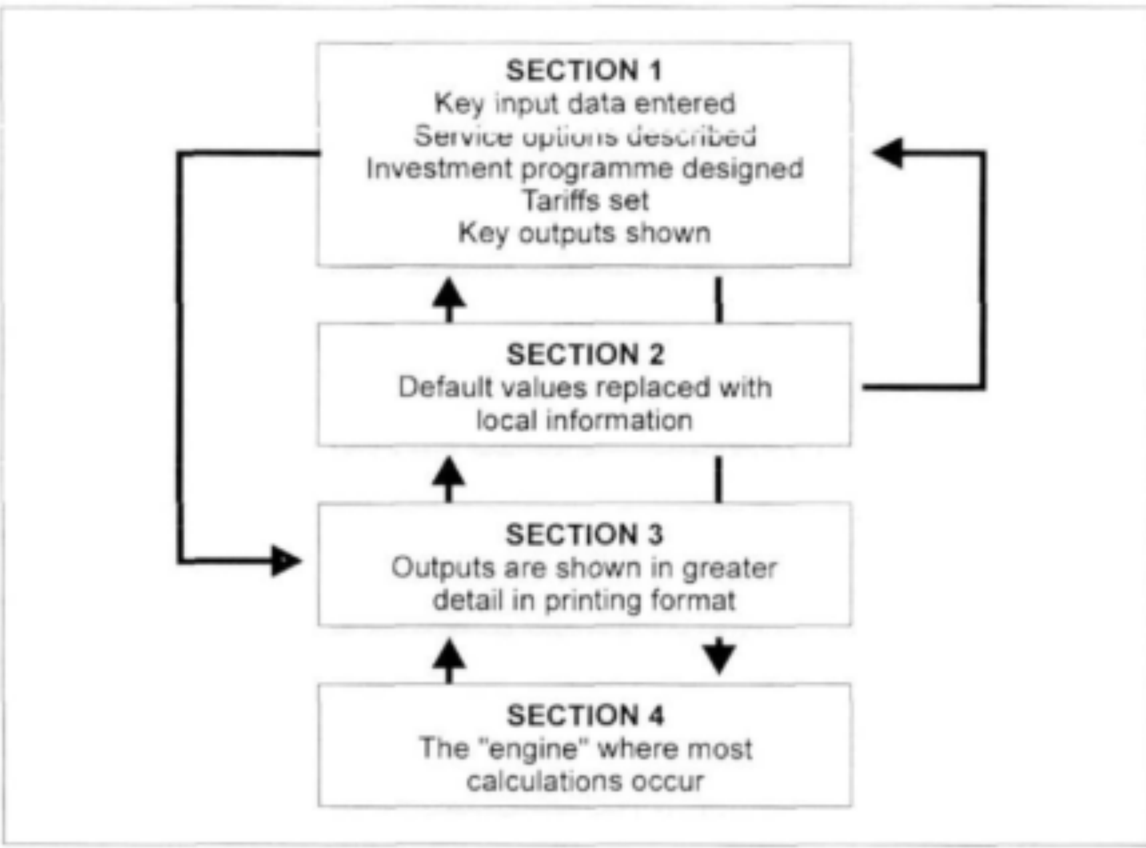

Figure 2: The model structure

MODEL ASSUMPTIONS

- The model assumes the following:
- One agency exercises control over investment and tariff decisions in a discrete urban area [1]
- This agency already provides a service and has proper budgets and financial statements [2]
- There are at least some residential consumers in the higher-income categories, and all consumers in these categories have an in-house water supply [3]
- There is at least some economic activity in the area and there are, therefore, some non-residential consumers.[4]
- The finance required for investment in infrastructure may be obtained from consumer contributions, current revenue and/or subsidies. The balance is borrowed under conditions set by the user of the model. Only one set of conditions however applies, so that no provision is made for borrowing from internal and external sources at different rates.
- The important indicator of viability is the cash surplus/shortfall of the service provider on the operating account once all interest payments/earnings and contributions to funds have been included. Borrowing for capital expenditure is not included in the cash shortfall, but is reflected in the form of the interest and redemption payments arising from the loans.
- The model covers an 11-year period with "Year 0" the current planning year and "Year 1" the first year of planned investment. The backlog of services must be made up by the end of the period.

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1 If more than one agency in fact provides the service, their data can be combined and the model will treat them as a single unit.

2 Should this not be the case, a base year can be "manufactured" by the user. For example, it can be assumed that the agency provides two (high-income) residential users and a single non-residential user with the service. "Manufacturing" data, however, requires a certain level of familiarity with the model so that the consumer unit, consumption and expenditure inputs are compatible.

3 In the case of there being no consumers in the higher-income categories in the area concerned, a single "consumer unit" in each of the higher income categories will suffice and the outputs related to these (such as bills) can be ignored.

4 As above, but for non-residential consumers.

MODEL DESCRIPTION

Section 1
ESSENTIAL INFORMATION, INVESTMENT PROGRAMME AND TARIFF-SETTING

Introduction

The inputs and outputs of the Water Supply Service Model (WSSM) are discussed in this and the following two sections.

It is recommended that the reader have a full printout of sections 1, 2 and 3 of the WSSM at hand when reading this discussion. Note that screens in section 1 are numbered 1.1, 1.2 ...; the screens in section 2 are numbered 2.1, 2.2 ...; and those in section 3 are numbered 3.1, 3.2....

All assumptions are italicised.

Situations under which the model will give error messages or be unable to calculate are italicised and underlined.

Items in sections 1 and 2 that are outputs are indented.

◊ Default values are marked with a diamond.

All data input areas are light grey (essential inputs) or white (inputs with default values) on the printout and yellow or white on the screen.

All numerical inputs are entered as numbers. Where percentages are required, the user enters a number and the model converts this to a percentage.

Sources of information and assumptions made regarding data inputs should be recorded for future reference. This may be done either on paper or on the model itself:

- Data sheets are available for recording this information on paper.
- Data can be entered on the screen by means of notes in the relevant blocks. To insert a note, unprotect the screen if using Excel 7. Place the cursor on the input block and highlight the "Insert" option on the tool bar, then select "Note". A text box will appear. Type in the note, then click on "Add". The note will be recorded and appear on the screen in the form of a red dot. In order to read the note, select "Insert" then "Note" when the cursor is on the block (for Excel 5) or simply place the cursor on the block and the note will appear on the screen (Excel 7 and higher).

1.1 Description

The purpose of the "Description" input page is to identify the area and model user, set the base year and record details unique to the particular run of the model. The user should input:

Local authority
The name of the urban area being modelled.

Type
The type of local authority being modelled – for example, local or metropolitan council.

Run

A unique run number for each run within a particular batch (usually starting at 1). This number is shown on every subsequent screen.

Scenario

A description of the scenario. Details, for example of the service levels to be provided and cash flow targets, can be recorded. It is also useful to make notes of key estimates and assumptions. For example, if the number of households and service levels in certain areas are uncertain, this should be recorded.

The text in this input box is shown on the output sheet Summary 1, which is usually printed out (see SECTION 3: MODEL OUTPUTS, screen 3.12)

Base year

The current planning year (Year 0). If Year 0 is 1997, then the first year of investment will be 1998 and the last year of analysis will be 2007.

Financial years and calendar years generally do not coincide, and the user is therefore asked to enter the financial year to which the planning year refers. The planning year may be recorded as the calendar year in which the financial year either begins or ends, as long as the definition is used consistently. For example, if a financial year runs from 1 July 1996 to 30 June 1997 the planning year may be entered as either 1996 or 1997.

Note that is important to enter a single year (as a number) as the base year, since this input is used to calculate all the "year" displays on subsequent screens.

1.2 The current environment

The information on this page is very important, and should be as accurate as possible. Some of the demographic and income distribution data may however not be readily available and will need to be estimated. For a discussion of how this may be done, see "Consumer Profile and Demand for Services", Module 3, "Management Guidelines for Water Service Institutions (Urban)" (WRC, 1998)

Households and residential consumer units

Total population

The total population of the area concerned. This input is used as a cross-check of household numbers by checking that average household size is sensible (see "People per household/…").

Number of households on formally serviced sites

Households on individual formal sites (excluding backyard shack-dwellers), plus households in flats, plus households in townhouse complexes. Note that this number of households is likely to be greater than the number of residential water meters where blocks of flats and townhouse complexes have bulk meters.

Households living in the backyard shacks, "granny flats" or servant's quarters are not counted as separate units unless they are provided with a separate service by the supply agency (that is, they are separately billed).

Households/individuals living in migrant hostels can be dealt with in various ways, depending on the circumstances.

- If those living in these units are to remain there under existing conditions, then the unit as a whole is best treated as an "institution" (see below).
- If the hostel is to remain a single quarter unit but some families presently living there are to be accommodated elsewhere, the latter should be recorded as "backyard shack dwellers". The hostel must then be recorded as an "institution".

- If the hostel is to be converted to family accommodation, the households involved should be recorded as "households on formally serviced sites". When service information is entered (see 1.5 EXISTING SERVICE PROVISION), these households should be recorded as having a communal water supply.[5]

Hostels attached to educational establishments, military camps, hospitals etc. must be treated as "institutions" (see "Non-residential consumer units").

Number of households in informal settlements

An estimate of the number of households in *all* the informal areas under the jurisdiction of the water service provider must be entered.

Number of households in backyard shacks

The total number of households living in backyard shacks must be entered, including households temporarily accommodated in migrant hostels, as discussed above. If there are areas in which more than one family occupy the main residence, and secondary households are likely to require separate sites, these should also be recorded as "backyard shack" dwellers.

Total households (output)

"Total households" is the sum of the above three entries, and provides an estimate of the total number of households in the area. Note that this number is the number appropriate for services provision, and may differ from the number appropriate for example for poverty and unemployment profiles.

Formal sites required for households in informal areas

The model makes provision for the number of sites required by households in informal areas to differ from the number currently estimated to reside there. A difference may, for example, arise if it is expected that a number of households currently in the informal areas will occupy backyard shacks in the new formal(ised) areas.

◊ The default assumes that all households currently in informal areas require formal sites.

Formal sites required for households in backyard shacks

An estimate needs to be made of the number of backyard shacks that will fall into disuse over the investment period. Remember that all households recorded as "backyard shack dwellers" by virtue of their being currently accommodated in hostels, or living with other families, must be provided with new sites.

◊ The default assumes that 50% of "backyard shacks" will need to be replaced by formal sites.

Total residential consumer units (output)

Total residential consumer units comprise (1) households currently resident on formal sites (as the primary occupiers); (2) households in informal areas for whom formal sites need to be provided; and (3) households currently recorded as resident in "backyard shacks" which are destined to fall into disuse over the investment period (including secondary occupiers of formal dwellings and households temporarily accommodated in hostels).

The difference between the number of households and the number of residential consumer units is thus primarily the number of backyard shacks that are to remain in use by the end of the ten-year period.

People per household/People per consumer unit (output)

These provide a cross-check to see whether population and household/consumer unit information is sensible. If, for example, there are only 2.5 people per household, then

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[5] If the existing infrastructure is to be replaced, then the households can be recorded as having no/inadequate services.

either the population has been underestimated or the number of households overestimated (or both). An average household size exceeding 7 indicates that the estimates of households and/or population may be incorrect.

Residential consumer unit income distribution

Income distribution is critical to an assessment of the viability of an investment programme (see 1.9 and 1.10 INVESTMENT TARGETS). Five categories are provided, *the first three of which are for low-income households who qualify for government subsidies*. The user must define the categories in terms of monthly household income (Rands per month), then enter the percentage of residential consumer units which fall into each category, except the lowest, which is calculated as a residual.

Note that the definition of residential consumer units is important for areas with large numbers of (permanent) backyard shacks, migrant hostels and/or live-in domestic workers. Available information may define each of these as a separate household, which will give a higher proportion of low-income households than is true for residential consumer units as defined here. Data therefore need to be checked for the definition of "households", and adjusted if necessary.

◊ The default income categories correspond to housing subsidy categories.

The model cannot run if there are no consumers in the top two income categories. If there are, in fact, none in the area modelled, token numbers need to be entered (as percentages). For example in an area with 1 000 residential consumer units, 0.001 (=0.1%) may be entered into each of the top income categories which will translate into one consumer unit per category.

Non-residential consumer units

Non-residential consumer units are entered in three categories, namely:

- institutions;
- commercial consumers and "dry" industries; and
- "wet" industries.

The appropriate number for each category is the numbers of bills sent out each month, which for metered supplies should correspond to the number of water meters.

The distinction between these categories may be important for two reasons:

- if the tariffs levied differ between them, currently or in the future; and
- if the pattern of economic growth in the area is likely to result in a change in the relative proportions of these categories of consumers. For example, it may be that "wet" industries are expected to stagnate while "dry" industries will grow at a healthy pace, which has important implications for non-residential water consumption.

If uniform tariffs are to be levied and the composition of the local economy is to remain unchanged, then this categorisation is less important. *The model, however, cannot calculate unless there is a number in the "commercial and dry industrial" category*. The number may be a fraction (e.g. 0.001), but for simplicity it is recommended that one consumer in each of the categories is entered.

1.3 The future environment

Residential and local economic growth

The user is asked to enter a rate of growth in the number of residential consumer units for the base year, year 5 and year 10. The model extrapolates rates for the intervening years.

◊ The default rates are 3.5%, 3.2% and 2.8% for the three years respectively.

Economic growth is similarly entered for the three years, and rates for the intervening years are extrapolated. Rates of growth are separately entered for the three categories of non-residential consumers. This is to allow for changes in the structure of the economy, which, as noted above, can have important implications for water consumption and tariff income. The resulting combined rates of economic growth are shown in the last row of blocks.

◊ The default growth rate is a uniform 3.5% per annum.

(Output): Average rates for the full ten-year period are shown in the column to the right of the input blocks.

Residential Consumer Unit income distribution

Future income distribution is predicted by the model on the basis of the relative rates of economic and household growth. The user can further influence the future distribution pattern by classifying the ability of the local economy to influence income disparities as poor, average or good.

◊ Default = average.

Inflation rate

The inflation rate is entered for the base year, year 5 and year 10, and rates in the intervening years are extrapolated. A separate rate of inflation may be entered for the construction industry.

◊ Default = 10% for all years.

Responsibility for CAPEX

The purpose of this section is to determine how much of the capital expenditure required for internal services is reflected on the service provider's capital budget, and how much of the cost is borne directly by private developers/individuals.

◊ The default assumes that all developments for high income households and non-residential consumers are financed by developers/individuals, while developments for low-income households (which generally qualify for capital subsidies) are the responsibility of the service provider. Expenditure on new and upgraded service provision for low-income households therefore appears as items on the capital expenditure budget of the service providers.

An important assumption is made by the model regarding borrowing for low-income households: it is assumed that, even if these services are provided by developers, any borrowing will need to be done by the service provider. The rationale is that a developer will be unlikely to borrow long-term finance for low-income developments.

1.4 Types of service

Residential services

The types of service available are described here. The type of sanitation system provided with each water connection is also specified (column 2), since this affects water consumption (see 2.9 and 2.10 CONSUMPTION). In-house connections are broken down by income category, because of the differences in consumption, cost and financing arrangements (see screens 2.1, and 2.7 - 2.10).

The income levels for which the services may be suitable are suggested as a guide to users (column 3). This table suggests:

- the services potentially acceptable to consumers in the specified income category and below; and
- the services likely to be affordable to consumers with little or no recurrent subsidisation, after the provision of capital subsidies.

The "service category" shown is a number that corresponds to the income level for which the service is regarded as suitable, from 1 (very low) to 5 (high). These numbers are used in assessing the affordability of the proposed investment programme (see 1.9 and 1.10 TARGETS).

Provision is made for two user-defined service options to be entered in the white input blocks – for example, low pressure in-house water connections. The income level for which these may be suitable must be entered (column 3), and the user needs to specify whether the service types entered are metered or unmetered, by typing a "yes" (metered) or "no" (unmetered) in the relevant input block (column 4). Cost, financing and consumption information must be entered in section 2 (screens 2.1, 2.7, 2.9 and 2.10).

◊ The defaults for the user-defined services assume costs, financing arrangements and levels of consumption as for in-house connections (low-income consumers). They further assume that connections are metered.

Non-residential services
The model assumes that all new services for non-residential consumers are on-site connections.

1.5 Existing service provision

Residential consumer units
The number of consumer units with each type of service must be entered in the yellow blocks. If the user has defined service types, these appear in the last two rows of the table. The total number of residential consumer units is the number calculated on screen 1.2, and the number with no/inadequate services is the difference between this total and the sum of the numbers entered in each of the service categories. The third column shows the percentage of CUs with each type of service (calculated).

The model allocates in-house connections to high-income households first, then to households in the middle-income category. The remainder are allocated to low-income households.

If the sum of the entries exceeds the total number of consumer units entered on screen 1.2, a message "check inputs" will appear and the model will not calculate any outputs.

A message "Backlog must include all h/holds in backyard shacks who need new sites" will appear on the screen if the calculated number of CUs with inadequate services is smaller than the number of households in backyard shacks who need new sites, as entered on screen 1.2. The model will not calculate until this error has been remedied.

If the service information entered is such that households in informal areas must have a service other than communal standpipes, a message to this effect appears on the screen. This is to alert the user, and will not cause the model to cease calculations.

Metering information is entered in the fourth column, where the user is asked to specify the number of connections that are metered in each of the relevant service types. The percentages in the fifth column are the percentages of each service type that is metered.

◊ The default assumes that all connections that can be, are metered.

Entering a larger number of metered connections than connections in any service type will result in an error message and will cause the model to cease calculations.

Non-residential consumer units
Service options for these consumers are either "inadequate" or "on-site". *The model assumes that all on-site connections are metered, and that "wet" industries must have an on-site supply.*

1.6 Water consumption

Macro estimates – current consumption

The agency's current water purchases and sales are recorded here. The first block deals with water purchased and purified, and the second with the use of that water.

Water purchased and purified:

- **Total purified water purchased**, expressed in Ml per annum, for example from a waterboard or an adjacent municipality.
- **Total raw water purchased** or otherwise obtained, in Ml per annum, for the purposes of purification.
- **Total water purified** is the amount of raw water actually purified. A difference between the amount purchased and the amount purified may arise due to losses or the sale of unpurified water, for example to surrounding farmers. *The model does not make provision for sales of unpurified water, however, thus assuming that raw water not purified is lost to the system.*

Water sold and used

Water sold to residential and non-residential consumers must be entered separately. It is important that this information is (at least fairly) accurate, because inaccuracies will lead to incorrect estimates of consumption by the various consumer units. *If the amounts entered cannot be sensibly allocated to specific users, the base-year water balance will be out and the model will not be able to do any further calculations.*

If the water balance for either residential or non-residential consumers is out, a message to this effect will appear on the screen. The balance can be adjusted in section 2 (screens 2.9 and 2.10). If sensible adjustments on these screens do not rectify the problem, it means that the data provided by the user on consumer units, service levels and water sold are incompatible.

Used by service provider (not sold)

This must include water used but not paid for interdepartmentally. (Water paid for is recorded as water sold). Such water may be used for purposes such as fire-fighting and the watering of parks, as well as water provided to consumers free of charge – for example through public standpipes for which households are not billed. If accurate information is not available, an estimate must be made.

Physical water losses (output)
This is the difference between the total amount of purified water used and the amounts sold and used by the service provider. The percentage loss is shown on the right of the input block, and if this percentage conflicts with other estimates the previous inputs on this sheet must be checked.

Current capacity of bulk infrastructure

The capacity, in Ml per day average annual flow, must be entered only if the service provider is responsible for at least some of its own bulk supply.

Macro estimates – projections

Estimates are requested of **average annual rates of growth** of water sold and used, for the first and second five-year periods respectively. The purpose of this is to compare existing forecasts with that linked to the investment programme, and has no effect on the calculated outputs. The estimate appears as a line on a graph on screen 1.18 CONSUMPTION.

◊ The default is the rate of growth predicted by the model.

Estimates of **physical losses** are requested for years 5 and 10 respectively, while those for the intervening years are extrapolated.

◊ The defaults are the lesser of 15% or losses in the base year.

1.7 Accounts (1) – expenditure

The essential inputs on this page are the **amounts spent by the service provider in the base year, in R'000 per annum, in the functional categories shown**. These categories correspond to those recommended by the Institute of Municipal Treasurers and Accountants for local government (IMTA 1994). The information should preferably be obtained from financial statements but, if these are not available or are for some reason unsuitable, budgeted expenditure may be used.

Provision is made for recording expenditure by other departments that are attributable to the water supply service, where costs are not fully charged out within the local authority. These departments include, for example, the Treasury, Office of the Town Clerk and the Town Engineer. Such expenditures must be recorded if the water supply service is to be modelled as an autonomous cost centre. If it is to be modelled as a department within a local authority where surpluses (deficits) are transferred to the rates account, then the required surpluses (deficits) can be modelled as cash surpluses (deficits) when setting tariffs (screens 1.13 - 1.16).

The user is then asked to allocate the amount spent on each item between four categories of expenditure: **administration** (including overheads and sales); **bulk** (i.e. purchase and/or purification costs); **storage** (i.e. reservoirs, water towers etc); and **reticulation**. The purpose of this is to estimate the running costs of each service type with greater accuracy (see screen 2.11 RUNNING COSTS BY SERVICE TYPE).

◊ Defaults are provided for a "typical" service provider and these change with the bulk supply arrangements.

The **average cost per kl** of bulk water purchased is displayed as calculated by the model. If this is incorrect, then the amount(s) of water purchased and amount(s) spent are incompatible and need to be checked.

1.8 Accounts (2) – tariffs and income

Income accrued by the service provider from the sale of water is calculated by the model from the tariffs entered here.

Tariffs are entered as follows:

- **Fixed monthly charges** (Rands per month) for metered and unmetered consumers. If there are no fixed monthly charges for metered consumers, the relevant blocks may be ignored (or enter 0).
- **Consumption charges** for metered **residential** consumers (c/kl). These are entered as block tariffs, allowing for different rates for three different consumption blocks. The blocks are specified by the user on this screen, and are used throughout the model. The charges for each consumption block must then be entered. If there is a constant consumption charge (i.e. water is charged for at the same rate regardless of the amount consumed), then this charge must be entered as the rate for all the consumption blocks. If there are more than three consumption blocks, the user must estimate charges for combined blocks.
- **Consumption charges** for metered **non-residential** consumers. A consumption charge may be entered as a constant charge (c/kl), i.e. a set rate per kl regardless of the amount consumed.

◊ If nothing is entered in the relevant block, the model assumes that the block rates for residential consumers apply.

Other income includes recurrent subsidies and sundry income (R'000). Strictly speaking, connection fees should be excluded to the extent that these are used to finance capital expenditure.

Received income (column 4) refers to cash actually received, with the difference between income billed and the amount received for each category constituting non-payment. The percentage of income not paid is calculated in the last column of the bottom table. The total amount unpaid is more important than the breakdown, which may be estimated.

> **Total income billed** must agree with the total obtained from financial statements or budgets. Should there be a big discrepancy, then consumer unit, service level, consumption and/or tariff information needs to be checked.
>
> The **surplus/(deficit)** under the "total billed" column shows the accrued surplus/deficit (i.e. the total amount due for the year's services less expenditure). The amount shown under the "received" column shows the actual cash surplus/deficit for that year (R'000).

The final input is the **cash reserves** of the service provider at the beginning of the base year, entered as a positive or a negative number (R'000). In its simplest form this refers to the service provider's bank balance.

1.9 – 1.12 Investment programme

An investment programme is designed on three separate screens, which respectively allow the user to

- provide for new residential consumer units (screen 1.9);
- eliminate the residential backlog and upgrade existing services (screen 1.10);
- provide for non-residential consumers (screen 1.11); and
- plan a metering programme for existing residential services (screen 1.11).

1.9 Investment targets (1): new residential consumer units

Service types provided: the user enters the percentages of new low-income CUs to be provided with each type of service (block A). Remember that percentages must be entered as numbers, not in percentage format.

◊ The percentage provided with in-house connections is calculated by the model, and will be 100% in the absence of other inputs. This means that the default investment programme provides all low-income CUs with in-house connections.

If the other entries add up to more than 100 an error message will appear in the "In-house, low income" box and the model will not calculate.

The model assumes that all new middle- and high-income CUs receive metered in-house connections (block B). The numbers involved are displayed on the screen.

Information: various items of information are shown on the screen to help guide the investment programme. These are best viewed after the full residential investment programme has been entered, and are discussed in the next section 1.10.

1.10 Investment targets(2): backlog and upgrading

Services to be provided

Backlog (A): the user specifies the percentage distribution of service types that CUs currently with no or inadequate services will have received by the end of the investment period . This is done in the first row of the input table. *If the numbers entered exceed 100, an error message will appear and the model will not calculate.*

For example, say the user enters 10, 20, 5 and 30 in the "None/inadequate" row (i.e. the top row). By the end of the investment period (see "Time frames" below), 10% of these CUs will have received a communal standpipe service, 20% yard tanks, 5% yard taps with on-site sanitation, 30% yard taps with waterborne sanitation and the remaining 35% an in-house connection. The number of CUs involved is shown to the right of the input blocks.

Upgrading (B): the next seven rows allow the user to enter an upgrading programme for existing CUs. The programme is specified by entering the final percentage distribution of services of CUs currently with the services specified in the column. Note that "downgrading" is not permitted for model-determined services, for example from an in-house connection to a yard tap. The numbers of CUs in each of the service categories in the base year are displayed to the right of the input table.

Once again, error messages will appear if any of the row entries add up to more than 100, and the model will not calculate.

◊ The default programme provides all CUs with in-house connections. For a programme in which no upgrading occurs, the user must enter 100 in the input blocks with (red) borders.

Note that the upgrading programme is for existing consumers only, and the investment programme does not make provision for the subsequent upgrading of new connections.

Time frames

Time frames for making up the backlog (A) and for the upgrading programme (B) are then selected. The user also decides whether the programmes are to provide an equal number of connections per annum, or start off slowly, build up to a maximum by the middle of the period and tail off slowly. The latter is referred to as an S-curve. The time scale can vary between five and ten years for an S-curve, and one and ten years if an equal number of investments are provided per annum.

◊ The default programme assumes that the backlog is made up and upgrading occurs over ten years along an S-curve.

The model cannot calculate the outputs if a time frame of more than ten years is selected, or less than five years along an S-curve.

Information

The following information is provided on this and the previous screen to guide the investment programme:

- Service levels by type and by category after the investment programme for the base year and years 5 and 10.
- The mismatch between services and income levels, where a "mismatch" is deemed to occur when a CU is provided with a service which it would not be able to afford should tariffs reflect costs. This is therefore an indicator (albeit somewhat rough-and-ready) of the extent of cross-subsidisation that will be required and/or the likely non-payment rate and/or cash flow problems.
- Income distribution, which is used to calculate the level of mismatch between services and incomes.
- Capital expenditure and borrowing requirements, in base year Rands (R millions), for the first five years of the programme. These are shown for the first five years only to correspond to the requirements of the Water Services Development Plan.
- The cumulative cash balance of the water service provider in the base year and years 5 and 10. Note that these numbers will change once adjustments have been made to the tariffs. The investment programme alone should not be used to set these.

1.11 Investment targets (3): non-residential and metering programme

New non-residential CUs

The model automatically provides metered on-site connections for these CUs. The numbers involved are displayed on the screen.

Upgrading of institutions, commerce and dry industries

These are also automatically provided with metered on-site connections. The user specifies the **time frame** and whether an equal number per annum is provided or the programme occurs along an S-curve.

Metering programme for residential CUs

The percentages of residential CUs with unmetered connections in the base year are shown in the first column of the table (by service type, as entered on screen 1.5). The user then specifies the percentages of these connections that will be metered by the end of the programme. The time frame and the S-curve/equal number per annum options are entered in the boxes to the right of the percentage table.

◊ The default metering programme provides all (appropriate) connections with meters within five years, distributed along an S-curve.

1.12 Capital requirements

This is an output screen for display purposes, showing the capital requirements in nominal and real terms for a five- and/or ten-year period.

> **CAPEX:** The first table shows capital expenditure for the first five years or the full ten-year period, as specified by the user (default = 10 years), in both nominal (dark green) and real (light green) terms. Total capital expenditure is shown as well as the amounts to be spent by the service provider and private developers respectively. The proportion for which private developers are responsible was entered on screen 1.3.
>
> The graph below the CAPEX table shows capital expenditure for the full ten-year period, broken down into its major components. These are respectively new internal services, internal services to make up the backlog and for upgrading (costs on screens 2.1-2.2), bulk and connector infrastructure (screens 2.3-2.5), asset replacement (screen 2.6) and other expenditure (screen 2.6).
>
> Capital expenditure on the graph may be displayed in nominal or real terms, as specified by the user (default = nominal).
>
> **SOURCES OF FINANCE:** The second table shows the sources of finance for capital expenditure. These are shown in both nominal and real terms, for the period specified by the user. The sources include borrowing, which is calculated as a residual (see screens 3.3-3.4), capital subsidies (screen 2.7-2.8), once-off capital payments by consumer units (screen 2.7) and current income generated by the service provider from the sale of water (screen 2.13).
>
> The graph shows the same information, in either nominal or real terms as specified by the user.
>
> **MISMATCH BETWEEN SERVICES AND INCOME:** the table displayed on screens 1.9, 1.10 and 1.11 is displayed again here for information. It provides a summarised indicator of the services provided by the investment programme relative to income levels, and serves as an indicator of the likely cross-subsidisation required by the programme and/or levels of non-payment and/or cash flow problems.

1.13 – 1.16 Setting tariffs

Setting tariffs to meet cash flow requirements is the final step in the modelling procedure. Tariffs, and the resulting monthly bills, can be used as the final indicators of the affordability of the investment programme. Alternatively, acceptable tariffs can be entered and the resulting cash flows can be used as the indicators.

Tariffs are set on four screens:

- fixed monthly charges for unmetered consumers (screen 1.13);
- fixed monthly charges for metered residential consumers (screen 1.14);
- fixed monthly charges for metered non-residential consumers (screen 1.15); and
- consumption charges (screen 1.16).

Each of these screens displays the service provider's annual net cash flow (for recurrent income and expenditure only), the cash balance at the end of each year, the budgeted surplus/(deficit) and the percentage of accrued income that is unpaid in each year.

Suggested method: a suggested method of setting tariffs to meet cash flow requirements is to set the fixed monthly charges on the first three screens at reasonable rates and then to adjust consumption charges (screen 1.16) until the cash flow requirements are met. (This will work, however, only where the bulk of water sold is metered.)

1.13 Future tariffs (1): unmetered consumers

Base year: tariffs for the base year entered on screen 1.8 are displayed here. If there are no CUs with the particular service type, "no CUs" is displayed.

Nominal or real: the user decides whether future tariffs and tariff increases are to be entered in nominal or real terms.

Year 1: monthly charges for year 1 of the programme are entered by the user for each service category. Remember that, if increases are to be entered in real terms, year 1 charges must be deflated to base year prices.

Years 2 to 10: annual percentage increases that apply to all service categories can then be entered, in nominal or real terms as selected by the user.

> *<u>Caution</u>: ensure that the selection of "nominal" or "real" and the tariff inputs are consistent. For example, selecting "nominal" and entering increases in real terms may result in real decreases in monthly charges.*
>
> *<u>Caution</u>: be very careful when setting year 1 tariffs by means of a formula referencing base year tariffs (e.g. = base year tariffs). If a "no CUs" is copied into a year 1 block the model cannot calculate, even if there are no CUs with this type of service in the future.*

Outputs: the monthly charges for the ten-year period are displayed on the screen by service type. These may be viewed in either real or nominal terms, as determined by the user. (This selection is independent of the way in which tariff increases are entered.)

Also displayed lower down on the screen is the average price per kl (c/kl) of water for each of the service types, and the recurrent cost per kl (c/kl) of providing the water, excluding capital charges. These may be used to more carefully adjust charges to cost, and to ensure equity in the pricing structure. The cost per kl for all service types is summarised in screen 3.10.

Information: Annual net cash flows, year-end cash balances, budgeted surpluses/(deficits) and non-payment rates are displayed. The user is therefore able to directly observe the effects of changing tariffs on these variables.

1.14 Future tariffs (2): monthly charges, metered residential

Monthly charges for metered residential CUs are entered. The method of entering future tariffs is the same as for unmetered CUs, and the screen is a duplicate of screen 1.13 with two exceptions:

- **Show average monthly bills?** The user has the option of viewing either the fixed monthly charges or the total monthly water bill per CU, by service type, for the ten-year period. The total monthly bill includes both the fixed monthly charge and the consumption charge. In order to view the total bill, a "yes" must be entered into the relevant block. (Default = "no".)

- **Price elasticity**. A price elasticity of demand for water is entered here for metered residential CUs, by service type. The price elasticity of demand is a measure of the responsiveness of consumption to changes in the price of water. It measures the percentage change in demand in response to a percentage change in price. Thus, for example, a price elasticity of -0.25 means that for every 1% increase in the price of water, demand will decrease by 0.25%.

  Note that price elasticity is entered as a *negative whole number*, and not in decimal or percentage format. Thus for example, a price elasticity of -0.25 must be entered as -25. The model will automatically read the entry as -0.25. An entry of -0.25 will be read as -0.0025 (or -0.25%).

The information displayed on the screen is the same as that displayed on screen 1.13.

1.15 Future tariffs (3): monthly charges, metered non-residential

Monthly charges for metered non-residential CUs are entered on this screen. The method of entering future tariffs and displaying monthly bills is the same as for metered residential CUs. However, there are three ways in which non-residential CUs can be charged:

- A fixed monthly charge (optional) plus a constant consumption charge (i.e. a constant price per kl regardless of consumption ("constant charge").
- A fixed monthly charge (optional) plus the rising block tariff applicable to residential consumers (entered on screen 1.16) ("block tariff").
- Conversion to Residential Unit Equivalents, which entails a fixed monthly charge plus the rising block tariff applicable to residential consumers, per RUE ("per RUE").

The concept of a **Residential Unit Equivalent** requires further explanation. The rationale behind the concept is that it may be desirable to apply a rising-block tariff to non-residential CUs, but this is difficult to do fairly using the conventional system where more is paid per unit of water the higher the consumption. Using this system, all large users would pay a high average price for water and small users would pay a low average price, regardless of how productively the water was used. This could seriously disadvantage large users, and particularly "wet" industries.

Conversion to RUEs deals with this problem by converting these CUs to equivalent units on the basis of monthly consumption (set by the user). Each RUE is then charged the fixed monthly charge and the residential consumption charges for consumption up to the amount that defines a RUE.

For example, let a RUE be set at 40 kl per month. A CU using 100 kl per month will then be converted to 3 RUEs, two of which consume 40 kl per month and the other, 20 kl. The CU will pay three monthly charges (say R10 per RUE = R30).

Now let the residential consumption blocks be set at 0-10, 11-30 kl and 30+ kl per month at rates of R1, R2 and R3 per kl respectively. The CU will effectively pay R1 per kl for the first 30 kl (3 RUEs x 10 kl), R2 per kl for the next 50 kl (2 RUEs x 20 kl+1RUE x 10 kl) and R3 kl for the last 20 kl (2 RUEs x 10 kl). In effect, this system defines consumption blocks for each non-residential user based on consumption.

The user needs to select the preferred tariff option by entering a 0 (= constant), 1 (= rising block) or 2 (= RUEs) in the **Tariffs for non-residential...** block. If option 2 is selected, the user needs to specify consumption per RUE in the **1 RUE per** block.

◊ The default tariff option is the constant rate per kl, and the default conversion to RUEs is one RUE per 40 kl per month.

Outputs: the effects of selecting different tariff options and amount may be observed firstly by viewing the monthly bills per CU and, secondly, by the effects of different choices on budgeted income and cash flows.

Tables below the information block show the price per kl of water under the different tariff options, as well as the cost per kl of water provision (excluding interest and redemption charges).

1.16 Future tariffs (4): consumption charges

Consumption charges are entered here. Provision is made for a three block rising tariff for residential CUs, and a separate consumption charge for non-residential CUs should the constant consumption charge option be selected.

As in the case of fixed monthly charges, the charges for the **base year** are displayed and the charges for **year 1** of the investment programme are entered in the yellow input blocks under the appropriate year. **Annual increases** for the remaining years are entered separately for each consumption block.

Once again, year 1 tariffs and annual increases can be entered in **nominal or real terms** (default = real) and the user must specify which is being used.

Outputs: consumption charges are shown for all the years in both nominal and real terms.

National Water Supply Regulation guidelines for blocks 1 and 2 tariffs: The National Water Supply Regulations (DWAF 1997) specify:

- (at least) a three-block rising tariff for residential consumption;
- a charge of not more than the operating and maintenance cost of the system for at least the first 5, but not more than the first 10 kl per month per CU (a "lifeline" tariff);
- a charge not less than the average historic cost of the system for the next consumption block up to a maximum of 30 kl per month; and
- a tariff equivalent to the marginal cost of expansion for consumption in excess of 30 kl per month.

The Regulations' maximum tariff for the first consumption block, and the minimum for the second block, are shown in the dark space below the nominal prices per kl for the two blocks respectively. These are calculated by the model based on cost information supplied by the user (or calculated using default values).

An additional input block is to be found to the right of the guideline maximum block 1 tariffs, which asks the user to specify the percentage of the cost of bulk water purchases that represents capital charges to bulk suppliers. This is because calculation of the "lifeline" tariff should exclude all interest and redemption costs.

Message: if a tariff option for non-residential users other than a constant consumption charge has been selected, a message to this effect appears (in red) on the screen. This is to alert the user to the fact that changing these tariffs will have no effect on income or cash flows.

1.17 Net cash flows, non-payment, costs and prices

This is an output screen for display purposes, showing:

- annual and cumulative cash flows (with reference to recurrent income and expenditure only), in both nominal and real terms (table)
- non-payment rates (bottom line of top table)
- budgeted surpluses/deficits (graphic)

- debt-service ratios, which show interest and redemption charges on long-term loans as a percentage of income billed and income received respectively (graphic), and
- cost and income information, in c/kl (bottom table).

Note that the difference between the budgeted and realised surplus on the first graph arises due to non-payment. Non-payment is also the reason for the difference in debt-service ratios depending on whether accrued income or income actually received is used to calculate it.

If the constraint on the debt-service graph is exceeded, it means that the service provider is having to pay more than a prudent amount of income on finance charges and is unlikely to be able to borrow as much as the scenario requires (see Manual notes to screen 2.14).

1.18 Consumption

This is an output screen for display purposes, showing:

- total water use, with both the macro consumption estimates entered on screen 1.6 and the consumption estimated by the model (graphic)
- annual growth in the rate of water consumed and bought/purified by the service provider (graphic), and
- a table showing the amount of water consumed, the amounts bought and/or purified and the physical losses on an annual basis.

Note that differences in the rates of growth of water consumed and bought/purified arise when physical losses change as a percentage of the total.

Section 2
REPLACING DEFAULTS

Introduction

The outputs shown in section 1 use both essential data entered in that section and the values contained in section 2. All inputs in section 2 have default values, and these will be used in the calculations in the absence of other information. However, for greater accuracy these should be replaced wherever local information is available.

2.1 Unit capital costs for internal services: residential

Capital costs for internal (i.e. reticulated) services are entered as a *cost per site* (single residential). Costs for *new services* are entered in the first input column, and for *upgrading* in the next seven input columns.

The model uses these costs for the full ten-year period, inflated only by the inflation rate in the construction industry. Costs should therefore be estimated as the likely average cost of developments over the period.

Costs for communal standpipes, yard tanks and yard taps should include the cost of meters and terminals. Costs for in-house connections should include the costs of the meter and isolating valve, but exclude the costs of on-site plumbing. These latter costs will be included in the cost of the house itself (i.e. the top structure). All costs must be comprehensive, including VAT, overheads, contingency fees etc.

◊ The default costs for new services are in 1997 prices.

◊ The default costs for upgrading are calculated as a percentage of the costs of a new service, and will adjust to the costs for new services entered by the user. For information, the percentages used in the calculations are shown in blue to the right of the input table.

2.2 Unit capital costs for internal services: non-residential

Internal service costs for non-residential consumers are similarly entered as a cost per site. Since all non-residential consumers are assumed to receive on-site water, there are only two costs to be entered for each type of CU, namely that for new services and that for upgrading from an inadequate service.

Given the wide range of sizes and consumption levels of non-residential CUs, it is very difficult to estimate an average cost of internal services per site. For current purposes this is not too serious a problem, however, since *the model assumes that private developers are responsible for financing these services*. This means that the provision of these services will have no capital expenditure or borrowing implications for the service provider. (The implications for bulk and connector infrastructure are dealt with on screens 2.3, 2.4 and 2.5).

◊ The default costs for new services are (fairly arbitrarily) set at the cost of a high income residential connection for institutions and commerce/dry industries, and five times this amount for wet industries. The default costs for upgrading are the costs for new services.

2.3 Connector infrastructure capacity requirements

Screens 2.3 and 2.4 deal with connector infrastructure, comprising (major) pipelines, reservoirs, pumps and water towers.

Screen 2.3 sets out to establish the capacity requirements of the system for the base year level of consumption. Note that these amounts are the requirements for current consumption levels only, and not the actual capacity of the system. Actual existing capacity, which may include surplus capacity, is entered on screen 2.4.

Capacity requirements for pipelines and reservoirs are established in the top block. The first column shows the categories of CU, and the second the average consumption by category in l/day (for information). The user is then asked to specify:

- the **pipeline capacity** required for peak hourly flow, expressed as a percentage of the average daily flow; and
- the **reservoir capacity** required as in terms of numbers of days of storage.

The last two columns show the total capacity currently required, by service type, for base year levels of consumption for pipelines (Ml/day flow) and reservoirs (Ml storage capacity). Total capacity requirements are shown in the last row.

Pump capacity requirements are determined in the next block, by specifying:

- the percentage of average daily flow to be pumped, and
- the average number of hours per day that the pump is used for.

From this information the pumping capacity required for current consumption is calculated (Ml/hour).

Water towers are dealt with in the last block. The user specifies:

- the percentage of average daily flow pumped into water towers; and
- minutes of peak hourly flow for which capacity is required.

From this information the storage capacity of water towers required for current consumption is calculated (Ml capacity).

2.4 Connector infrastructure costs and expansion programme

On the previous screen the model established the capacity requirements of connector infrastructure for current levels of consumption. On this screen it establishes expansion requirements and the total cost of expansion. It does this by requesting information on costs, current capacity and expansion plans.

The **cost of additional capacity** is entered in the top block, in R millions per Ml per day/hour/storage capacity as appropriate.

Current capacity is entered in the first input column of the second block, in the appropriate units.

◊ The default capacity shown is that calculated on the previous screen – i.e. the capacity required for current levels of consumption.

Capacity added in the course of the investment programme is entered in the next ten columns (years shown). The user is guided in this by the default values which appear below each input block, and the last block on the screen which shows the excess or shortfall in capacity for each of the components of the system.

◊ The default programme assumes that only enough capacity is added every year to meet additional consumption requirements. In other words, the default programme assumes a "smooth" provision of capacity with no surplus.

If the service provider has an expansion plan for connector infrastructure, this may be entered on the screen. The relationship between the capacity required and the capacity provided may be seen in the last table on the screen, entitled **Excess/shortfall.** Positive numbers (in black) denote surplus capacity, and negative numbers (in red) denote shortfalls.

Note that it may be possible for surplus capacity to exist even though no capacity is added and there was no surplus capacity in the previous year. This can happen if consumption falls as a result of a steep increase in tariffs, if price elasticities of demand were entered in section 1 (screens 1.14 and 1.15). Annual consumption is shown on screen 3.11 CONSUMPTION.

2.5 Bulk infrastructure costs and expansion programme

This screen allows the user to enter an expansion programme for bulk infrastructure. The addition of cost information allows the model to calculate the cost of the programme.

This screen should be ignored by service providers who purchase purified water from outside agencies only, or who are responsible for some of their own bulk supply but do not intend expanding this capacity.

◊ The default programme is one of no expansion of bulk capacity. The implicit assumption is that additional water requirements will be met by means of purchases of purified water.

Service providers who plan to expand their bulk infrastructure capacity are asked to enter the costs of the four components, in Ml per day additional capacity added. These components are:

- source of supply;
- treatment;
- pumping; and
- transmission.

In the second block the user is asked to specify the capacity requirement for each component in excess of the average annual flow, expressed as a percentage. For example, let the average annual flow in a system be 100 Ml/day. An additional capacity requirement of 20% for treatment works means that the works must be able to deliver 120 Ml/day to cater for variations in demand.

The user enters the expansion programme in the third block, **Current capacity and expansion programme.** This programme should be guided by the last two tables, which show the **Excess/shortfall** in total capacity and the **total capacity required** as if the service provider were responsible for all bulk requirements.

Remember that any shortfall in capacity is automatically assumed by the model to be made up by means of bulk purchases from an outside agency. The user must ensure that a bulk water cost for purified water is entered, however, otherwise this expenditure will not be recorded (see screen 2.12).

2.6 Asset replacement and other capital expenditure

Asset replacement

The model makes provision for annual expenditure on asset replacement linked to the replacement cost of infrastructure existing in the base year. Note that this is actual expenditure, and not provision made for future replacement by contributions to funds. The latter are provided for on screen 2.13 OTHER INCOME AND EXPENDITURE.

It is assumed that expenditure on asset replacement will be for existing infrastructure only, and not for new infrastructure provided during the course of the investment programme.

The user is asked to enter the **replacement value** of the various components of existing infrastructure in the first input column, and annual expenditure on replacement, expressed as a **percentage of the replacement value**, in the second input column. The resulting **expenditure per annum (R'000)**, in base-year Rands, is shown in the last column.

◊ The default replacement value is calculated on the basis of information provided on the number of CUs, the services provided and costs. The percentage inputs are estimates only.

It is recommended that the user adjust the percentage inputs rather than asset replacement values should he/she be unhappy with the amounts to be spent per annum. This does, of course, not apply if recent and reliable estimates are available of the actual replacement value of existing assets.

Other capital expenditure

The user may enter other capital expenditure in this table in R'000 per annum. Entries may be made in nominal or real terms, as specified by the user. Types of expenditure that this table is designed to accommodate include expenditure on the rehabilitation of deteriorated infrastructure, and unusual expenditure such as the construction of a new head office building. The table can also be used to enter expenditure on bulk and connector infrastructure should plans exist or projects already have been initiated. If such entries are to be made, the user must ensure that the costs of any expansion calculated by the model are cancelled out. This is best achieved by entering zeros in the cost input blocks on the relevant screens.

2.7 Capital subsidies for internal services and consumer payments

There are four sources of finance for internal services: consumer payments, capital subsidies, income earned by the service provider, and borrowing by the service provider. On this screen the user is asked to enter payments made and subsidies available per CU.

New residential CUs and elimination of the backlog

Capital subsidies are entered as an amount per consumer unit by service type, in base year Rands. In the current policy environment this subsidy is most likely to be the housing subsidy, which is available to households with incomes below R3 500 per month and which have not previously received state assistance for housing and services. All households to be provided with formal sites would qualify for this subsidy, thus including new households and consumer units currently with inadequate services.[6] No provision is made for subsidies to CUs in the middle- and high-income brackets, because the housing subsidy is not available to them and it is unlikely that another source will be forthcoming.

CU payments are payments made to the developer, whether the service provider itself or a private agency fulfills this role, plus additional connection fees paid to the service provider.

If the sum of the subsidy amount plus the CU payment exceeds the cost of the service provided, the service provider will earn a profit on the connection (capital account). If the sum is smaller than the cost, the balance must be provided by the service provider either in the form of borrowing or by using surpluses generated on the operating (screen 2.13) and/or capital accounts.

◊ The default subsidies for residential CUs in the first three income categories are the differences between the costs of service provision (entered on screen 2.1) and CU payments entered on this screen. The result is that, in the base year, the service provider would make neither a profit nor a loss on these services.

◊ The default payments for residential CUs in the first three income categories are estimations. For higher-income and non-residential CUs they are the full costs of service provision.

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[6] There may be exceptions to this, however, for example if the infrastructure in an area is so badly deteriorated that it effectively provides an inadequate service. But this situation is better dealt with by recording the services as they are meant to be and providing for their rehabilitation on screen 2.6.

Upgrading from standpipes in informal areas

Housing subsidies are likely to be available to households in informal areas which are currently provided with communal standpipes. Should this be the case, the user is requested to enter the **subsidy** amount provided per CU for upgrading, along with the **CU payment**.

◊ The default CU payments are those used for new services, and the default subsidy amounts are calculated in the same manner as for new services. The connection fees are assumed to increase with inflation, while the nominal value of the subsidy increases at a rate specified by the user (see next entry).

The next step is to specify how many such CUs are to be provided with upgraded services. Below the capital subsidy entries, the model displays (1) the total number of CUs currently provided with communal standpipes which are to be upgraded, as determined by the investment programme entered in section 1, and (2) the number in informal areas currently supplied with this service. The user is then asked to specify the number of CUs in informal areas which are to be upgraded.

◊ The default is either the total number of CUs in informal areas with a communal standpipe service, or the total number to be upgraded, whichever is the smaller.

Rate of increase in the nominal value of housing subsidies

The nominal value of the capital (housing) subsidies used for water supply may not increase sufficiently to keep pace with inflation, and if so the real value will decline. The user is asked to specify the nominal rate at which these subsidies are to increase, in percentages per annum.

◊ The default rate of increase is 50% of the inflation rate, which is displayed directly below the input boxes.

It is important to note here that, since CU payments only keep pace with inflation, decreases in the real value of the subsidies will result in the service provider being responsible for raising the additional finance.

Household payments for other upgrading

CU payments for other service upgrading are entered here.

◊ The defaults are the full (internal service) costs of the upgrading, which increase with inflation.

2.8 Capital subsidies: infrastructure grants

Additional capital subsidies may be available for bulk and connector infrastructure, and/or internal services. This screen makes provision for grants to be provided in three ways:

A. **Grants provided in the form of an amount per CU**, for residential CUs that would qualify for housing subsidies in terms of income and existing services (screen 2.7). This matches the Consolidated Municipal Infrastructure Programme (CMIP) grant currently available for bulk and connector infrastructure (see RSA 1997a).

◊ The default grant is an estimate of the amount required to provide a consumer unit in the area with 6 kl per month, or the amount entered by the user in the appropriate block. This amount is calculated on the basis of local costs, and on whether bulk infrastructure is the responsibility of the service provider.

As on the previous screen, for this option the user needs to specify the expected rate of increase in the nominal value of the grant (default = 50% of the rate of inflation).

B. **A grant provided as a (fixed) percentage of the cost of bulk and connector services** for the entire period.

C. **A flat grant**, entered in R'000 per annum. Here the user needs to specify whether the amounts have been entered in nominal or real terms (default = nominal).

2.9 Consumption: unmetered connections

Introduction

Screens 2.9 and 2.10 are very important. They deal with the distribution of consumption by consumer unit, which influences the accuracy of the model's results to an important extent. The functions of these screens are threefold:

- The total amounts of water sold to residential and non-residential CUs respectively, which were entered on screen 1.6 WATER CONSUMPTION, are allocated out to the various categories of CU. The result is an estimated (monthly) consumption pattern by service/consumer type.
- Expected changes in consumption per CU are entered. Only changes other than those in response to changes in price are considered here. (Changes in response to price are calculated by the model, using the price elasticities of demand entered on screen 1.14 and 1.15.)
- Where service types are not currently provided, but will be in the future, estimates of likely consumption are entered.

Estimate the average monthly consumption per consumer unit (unmetered).

For unmetered supplies, the user simply estimates an average monthly consumption per consumer unit for the base year, year 5 and year 10. Estimates for both currently available service types and those to be provided in the future must be entered.

◊ The defaults for the base year are estimates, for residential CUs based on data collected from a variety of studies (see RSA 1997a). The defaults for year 5 are the consumption estimates for the base year, and for year 10 the estimates for year 5.

2.10 Consumption: metered connections

This screen is fairly complex, but it is important to understand how it works. The steps to be taken by the user are as follows:

Step 1

The user's first task is to enter estimates of **average consumption** per CU by service type, in kl per month. This is done in the first column of the "Average consumption" block at the end of the table (cells M11:M22). For example, entering a 20 in the "Yard taps (w/borne san)" row means that the average monthly consumption of residential CUs with metered yard taps and waterborne sanitation is 20 kl in the base year.

◊ The defaults for residential CUs are estimates based on case studies and previous experience (see RSA 1997a). Exceptions are to be found in the two user-specified service types, where the default is the consumption for low-income CUs with in-house water. The defaults for non-residential CUs are rough estimates only, and may be totally inappropriate for the area concerned given the wide range of sizes possible in each of these categories.

If the estimates of average consumption are such that the amount of water left for consumption by high income households is insufficient to allow for a sensible average consumption level, an error message will appear and the model will cease to calculate. A further message "residential water balance out" will appear near the top of the screen, and will also be displayed on most screens in section 1. The same applies if too much water is left for this category.

Similarly for the non-residential sector, if the amount of water left for commerce and dry industry is too low error messages will appear and the model will cease to calculate. (There is no upper limit to average consumption in this category).

The "sensible" minimum average consumption for high-income residential CUs is set in the first input block below the consumption table, "**Minimum permissible average consumption for high income CUs**...". If the default is regarded as not sensible, the user may change this. A sensible maximum is entered in the next block. Should average consumption fall outside these limits and error messages appear as a result, the calculated average consumption will appear on the screen next to these inputs. This is intended to serve as a guide to the user on whether too much or too little water is left for this category of consumers.

The same analysis applies to commercial and dry industrial CUs, except that only a minimum constraint on average consumption applies.

Rectifying water balance errors: If the calculated average consumption for high-income CUs is too high, then average levels of consumption for the other categories of consumer, both metered and/or unmetered, must be increased. If too low, then these other averages must be reduced. If the average for commercial and dry industrial CUs is too low, the averages for the other non-residential categories must be reduced.

Should sensible adjustments to these variables fail to rectify the problem, then either (1) the information on numbers of CUs provided is incorrect (screen 1.2), and/or (2) information on existing service levels is inaccurate (for residential CUs - screen 1.5), and/or (3) information on the total amounts of water sold is incorrect (screen 1.6). In essence, water balance errors mean that it is not possible to sensibly allocate the total amounts of water given as sold to the area's consumer units, given their service levels.

Step 2

Base-year entries must be made for services that are currently not provided, but will be in the future. For example, there may be no yard taps in the area in the base year, but according to the investment programme these are to be provided in the future.

◊ If no entries are made by the user the default amounts are used, which are estimates based on case studies.

Step 3

The next step is to estimate average consumption per CU for each category for years 5 and 10. Remember that these estimates must be made on the assumption of constant real tariffs, and that inputs are required for both currently provided and future service types.

◊ The defaults for year 5 are the consumption estimates for the base year, and for year 10 the estimates for year 5.

Step 4

Having established a water balance for the base year using average levels of consumption, the user is now required to estimate the distribution of consumption for each service type across the three **consumption blocks**. These blocks were defined in screen 1.8 and are displayed on this screen (row 9).

For blocks 1 and 2, the user must enter:

- the percentage of CUs with the particular service that fall into that consumption block (columns C and G); and
- the average level of consumption of consumers in the block (columns E and I).

The percentage of consumers and average consumption are calculated for block 3 as residuals (columns K and L). If there are no CUs with a particular service in the base year, a message to this effect is displayed under the "average consumption" column of block 3 and the user can ignore the relevant row.

If the percentage estimates for blocks 1 and 2 are such that their sum exceeds 100, an "err" will appear in the "% CUs" column of block 3 and the model will be unable to calculate.

If the consumption estimates for blocks 1 and 2 are such that there is not sufficient water left for the average level of consumption of CUs in block 3 to exceed the lower limit, a message *"check" will appear in the "Av cons" column of block 3. This will not cause the model to cease calculations, but the error should be rectified for greater accuracy in calculations.*

Rectifying block distribution errors: Correcting a percentage distribution error requires simply that the sum of the numbers entered for a particular service in blocks 1 and 2 does not exceed 100. For example, if 30% of CUs with yard taps (w/borne san) fall into block 1, then no more than 70% can fall into block 2.

If there is too little water left for CUs falling into block 3, then it will then be necessary to increase the percentage of consumers in the lower consumption blocks, and/or reduce the average consumption in these blocks.

◊ The default percentage distributions of CUs into the consumption blocks are based on default average levels of consumption. Should user-entered averages differ significantly from the defaults, the default percentage distribution may well cause errors.

◊ The default average consumption levels for blocks 1 and 2 are calculated so that they are appropriate for the consumption blocks used.

2.11 Running costs by service type: base year

The service provider's annual expenditure on the operating account was entered on screen 1.7 ACCOUNTS (1): EXPENDITURE in the major expenditure categories. Each of these amounts was then allocated to the four functions of the service provider, namely administration, bulk, storage and reticulation. On this screen the staff, general and maintenance expenditures entered in section 1 are further broken down, and allocated to consumer units by service category. The result is an average cost per CU for the service provided (R per month).

The allocation to CUs by service category is accomplished by means of entering ratios of the likely costs of service provision relative to the cost of an in-house service for middle-income CUs. These are entered in the first (white) columns of the blocks marked Administration, Bulk, Storage, Reticulation respectively. The resulting monthly costs are shown in the third column of each block. Total monthly costs, and total monthly costs excluding bulk supply, are shown in the last two blocks.

At the bottom of the screen the user is also asked to enter the percentage of the administration costs that goes towards meter-reading for a metered in-house connection. This percentage is used in the calculation of the default ratios for Administration.

◊ The default ratios for administration costs are calculated primarily according to whether a service is metered or not, along with other special requirements (such as for yard tanks). Where a service type can be either metered or unmetered, the ratio is the weighted average for metered and unmetered connections (see notes on screen).

◊ The default ratios for bulk costs are based on consumption levels, and for storage on storage capacity required. For most service types the ratios for reticulation costs are based on estimates of pipe length and diameter typically required (see notes on screen for further details).

2.12 Running costs by service type: future

This screen deals with future operating costs. Administration, storage and reticulation costs are entered in Rands per CU, while bulk costs are recorded by means of predicted bulk purchase price(s) for water.

For the **administration, bulk and storage costs**, the user is asked to enter costs per CU per month of a *new* connection, i.e. marginal costs (Rands per month). To guide the user, estimated costs for the base year, i.e. current average operating costs, are displayed in the first column of each block.

◊ Default costs are base-year costs for service types that already exist. For new services, costs are calculated as for base year costs.

The next step is to predict changes in the cost of service provision, in percentages per annum to be entered in nominal or real terms as selected by the user. These changes apply to both new and current operating costs.

Future **bulk costs** are entered in the table at the bottom of the screen. The user must enter annual percentage increase in the cost of purified water and, where applicable, raw water and purification costs. Increase must be in nominal or real terms, whichever was used for annual percentage increases in the table above.

The resulting costs (c/kl) are shown below the input rows, with the cost in the base year imported from screen 1.7. The final row displays the average cost of bulk water, which is of interest when a service provider both purchases purified water and is responsible for some of its own bulk supply.

◊ The default assumes a constant real price in the cost of purchased purified and raw water, and water purification.

Note that future bulk costs can be estimated only if there is a cost for the current year. In situations where a cost is required for later years only - for example if the service provider currently purifies all its own water but will need to purchase purified water some time in the future - token amounts of purified water purchased and expenditure will need to be entered on screens 1.6 and 1.7 respectively.

2.13 Other income and expenditure

Other income

The income information entered on screen 1.8 makes provision for income from the sale of water, recurrent subsidies and "other income" (such as reconnection fees, meter-testing fees, sale of redundant material). Income from the sale of water over the investment period is calculated by the model. This screen requires the user to estimate recurrent subsidies and "other" income over the period.

The amounts received in the base year from these sources are displayed on this screen, and the user is then asked to predict the rate at which each of these is expected to increase/decrease over the period. The rates may be entered in nominal or real terms, as specified by the user. The resulting amounts are shown in the rows beneath the input boxes, in base-year Rands (R'000).

◊ The defaults assume the percentage increases are entered in real terms, and that the real value of income from these sources remains constant.

Other expenditure

The model automatically calculates changes in expenditure in the staff, maintenance and general categories entered on screen 1.7, as determined by the investment programme, consumption levels and changes in bulk water costs and the unit cost of service provision (i.e. efficiency). This screen makes provision for predicting changes in other expenditure items.

A. The most important other item is usually **capital charges**. All new charges arising from the capital expenditure undertaken during the investment period are calculated by the model. The service provider, however, generally has commitments from projects prior to year 1 of the investment programme, and payments on these loans must continue. The amount paid in the base year is displayed on the screen, and the user is asked to estimate how payments on these loans will change. An annual percentage change must be entered in *nominal* terms, and the resulting real value of the repayments is shown in the row beneath.

◊ The default assumes that repayments remain constant in nominal terms, thus decreasing in real terms by the rate of inflation.

B. Provision is made for the user to enter "**other expenditure**" for each of the ten years (in real terms).

◊ The default for each year is the real value of expenditure in the previous year.

C. **Contributions** are shown in the last table on the screen. Expenditure in the base year is shown as a percentage of accrued income or total expenditure, as specified in the fourth column. The user then enters a percentage for the investment period (as a number) for each of these items. The default percentages are shown in the last column.

Of these items of expenditure, contributions to fixed assets is potentially important if the service provider is able to generate a large surplus on the operating account. Such contributions will reduce borrowing, and therefore future capital charges. The user is also asked to specify the percentage of this expenditure that will be used for infrastructure, with the rest spent on smaller items such as vehicles, furniture and office equipment. Note however that if the latter expenditures have been recorded as capital expenditure (for example as "other capital expenditure" on screen 2.6), then the user must enter "100" into the input block.

Contributions to funds are recorded as expenditures but do not feed back into the model.

◊ The default percentages are either standard (recommended) amounts for a medium-sized local authority or, in the case of "replacement provision", the same percentages as in the base year.

2.14 Loans and constraints

The cost of loans for capital expenditure

The user enters the borrowing rate on loans for long-term borrowing for capital expenditure for the base year, year 5 and year 10. The model extrapolates the rates for the intervening years. These rates must be entered in nominal terms, and the model then calculates the real rates. The loan repayment period must then be entered.

◊ The default interest rates are the nominal rates calculated for a real rate of 6% per annum. The default repayment period is 15 years.

Note that only one set of loan conditions is provided for per year. No provision is therefore made for loans from various sources which carry different conditions, for example "internal" (Capital Development Fund) and "external" (market) loans. The user is thus required to estimate an average rate for loans from the various sources for the three years.

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

These rates refer to the cost of short-term borrowing to cover operating account deficits, and returns on cash surpluses generated on this account. Again, rates must be entered in nominal terms for the base year, year 5 and year 10 of the programme.

◊ The default rates are calculated for an 8% real rate for short term loans, and a 5% real return on cash surpluses.

If the service provider is a department within a local authority and transfers surpluses or deficits to the rates account, the user may wish to cancel out these payments/surpluses (by entering "0"s). Whether this should be done or not will depend firstly on the way the local authority is structured and, secondly, on the purpose of running the model. However, if these rates are cancelled out, this must be made explicit when the results of the exercise are assessed.

Constraints on the feasibility of the programme

The debt service ratio

For the purposes of this model, the debt service ratio is defined as the ratio of interest and redemption payments on long-term loans to total income for the year. In other words, it is the percentage of income that needs to be paid out in capital charges. Should this ratio exceed a certain level, it is unlikely that the service provider will be in position to borrow more finance and this would constitute a constraint on the investment programme.

The user enters the debt service ratio above which the service provider will no longer be in a position to borrow to finance capital expenditure. This rate is shown as the blue line on the second graph on screen 1.17. A calculated debt service ratio exceeding this level serves only as a warning to the user, and will not cause the model to cease calculations. The model calculates debt service ratios for both accrued income and income actually received, with the difference representing non-payment.

◊ The default ratio of 25% is fairly generous. Commercial finance institutions are likely to be happy with a rate between 15 and 20%.

Maximum payments by level of income

The user is asked to consider the maximum amounts that CUs in the lower-income categories would be willing and able to pay for water. These amounts are used in the calculation of default non-payment rates on screen 2.15.

◊ The default rates are respectively 3.5%, 3%and 2.5% of average income in each category.

2.15 Future losses: percentage of billed income unpaid

On this screen the user is asked to predict the percentage of billed income that will remain unpaid in years 5 and 10 of the investment programme. Rates for the base year have been calculated (screen 1.8), and those for the intervening years are extrapolated. Separate provision is made for unmetered, metered residential and metered non-residential consumers and other sources of income respectively.

In considering future non-payment rates, it is essential that the affordability of the services offered be considered. If this is not done, the results of the modelling exercise may be seriously distorted: bills for high-income and/or non-residential CUs will be artificially low and/or the cash flow will look artificially healthy.

◊ The default rate for unmetered services is 5% in year 10. This low non-payment rate implicitly assumes that all services that can be metered, such as yard and in-house connections, will be metered by the end of the investment period. The rate in year 5 is the average between the base year and year 10 rates.

◊ The default rate for metered residential services is calculated for year 10 by comparing monthly bills and the maximum payments by income group entered on screen 1.14. The assumption made is that CUs pay as much as they are willing to/can afford, but no more than these amounts. The unpaid amount is the difference between the amount billed and the maximum amount that can be paid. The rate in year 5 is the average between the base year and year 10 rates.

Caution: *The user is advised not to override the defaults for metered residential services, particularly for year 10, unless very good reasons can be given for doing this. If the reason is that low-income consumers can afford to pay more, then the maximum payments entered on screen 1.14 should be changed and the defaults will automatically adjust.*

◊ The defaults for metered non-residential CUs and "Other income" in year 10 are the lesser of 5% or the applicable rate in the base year. The rates for year 5 are calculated as for residential CUs.

Section 3
MODEL OUTPUTS

Section 3 consists of 13 output SCREENS in formats appropriate for printing. The last two screens (3.12 and 3.13) provide summaries of the most important information on the capital and operating accounts respectively. For most purposes print-outs of these will suffice. The other screens provide more detailed information on the investment programme, costs, capital and recurrent expenditure, monthly bills and consumption. These should be printed only as required.

3.1 Service levels & numbers of connections provided (residential)

Three tables are provided, showing:

- the percentage distribution of service types for each year;
- the total number of connections provided by service type over the investment period, differentiating between new and upgraded services; and
- the total number of connections provided by year, with no differentiation between new and upgraded services.

The last two tables may be of use for the purposes of project planning, and in assessing whether the desired number of capital subsidies (housing and CMIP grants) are likely to be forthcoming.

3.2 Unit capital and recurrent costs, capital income and consumption

This screen provides a summary of the most important cost and consumption inputs used in the calculations.

- Table 1 provides information on the unit cost of internal services, and how these are financed, in Rands per CU. Note the declining real value of the capital (housing) subsidy if it fails to keep pace with inflation.
- Table 2 shows the unit costs for bulk and connector infrastructure used.
- Table 3 contains information on the monthly operating costs of the different services, at base year prices and levels of efficiency (see screen 2.12).
- Table 4 shows consumption by service type, for the base year, year 5 and year 10 (kl per month per CU). The combined effects on unit consumption of tariff increases (due to price elasticity) and other changes can be observed for metered supplies.
- Table 5 shows bulk water costs per year for the full period (c/kl).

3.3 Capital requirements (real)

Capital expenditure, capital income and borrowing requirements are shown for each year of the investment programme, in base year Rands (R'000). Totals for the first and second five-year periods are shown in the last two columns of the table.

Capital expenditure and sources of income are broken down into various categories. A summary of this information is provided on sheet 3.12.

Note that expenditure on connector infrastructure frequently displays a reduction, or no expenditure is recorded for a period when the default programme is used (see screen 2.4). This is usually due to a drop in consumption in response to a steep increase in tariffs. Also note that asset replacement expenditure is a constant real amount, which is, of course, a simplification.

"Service provider capex" is the expenditure that will appear on the service provider's capital budget. It excludes internal services that are financed directly by private developers/individuals ("developer capex" - see screen 1.3).

"Consumer payments" includes payments made both to the service provider and to private developers. The amount paid to the service provider each year is the difference between "consumer payments" and "developer capex".

"Current income" refers to expenditure on new infrastructure out of the "contributions to fixed assets" item on the operating budget (see screen 2.13).

The borrowing requirement is total capital expenditure less subsidies, consumer payments and contributions out of current income.

3.4 Capital requirements (nominal)

Screen 3.3 is repeated here, but amounts are shown in nominal terms (i.e. after allowing for inflation).

3.5 Income and expenditure (real)

The income and expenditure flows of the service provider are shown for the base year and the investment period, in base-year Rands.

Accrued income (i.e. income recorded as due) is shown in the categories used in section 1 (screen 1.8), namely income from the sale of water to various categories of consumer, subsidies, and other income.

Expenditure is, however, shown in a different format, due to the way the model calculates future operating costs.[7] Instead of showing staff, general and maintenance expenditure, the model shows this expenditure in the categories "administration, storage and reticulation", bulk purchases and purification. The other items of expenditure (capital charges, contributions and other expenditure) are the same as those on screen 1.7. "Capital charges" includes charges on both inherited loans and those arising as a result of the investment programme. This item does not include charges/returns on short-term loans/surpluses, which are shown in the third-last row of the table, "return on surplus (-cost of deficit)".

Note that no provision is made for depreciation as an accounting item, following local authority convention. Only actual expenditure is shown.

The "budgeted surplus (-deficit)" is the difference between accrued income and expenditure. The "realised surplus (-deficit)" is this budgeted amount less unpaid accounts.

The "annual net cash flow" is the realised surplus (deficit) after interest earned on cash surpluses or paid on short-term loans (usually bank overdrafts).

"Cash balance (year end)" is the sum of the cash balance at the end of the previous year and the current year's net cash flow. It therefore refers to accumulated cash surpluses or deficits, and serves as an important indicator of the viability of the programme. Note that this cash flow refers to the operating account only, and differs from a conventional cash flow statement in that cash flows arising from borrowing on the capital account are excluded.

The screen also shows annual debt service ratios (see screen 2.14) and non-payment rates broken down into various consumer categories.

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[7] Future operating costs are calculated using a Rands per CU amount, which includes staff, maintenance and general expenditures other than those directly related to bulk water. Similarly, purification costs are calculated on a c/kl basis and not broken down into its staff, maintenance and general components.

The information shown on this screen is summarised on screen 3.13.

3.6 Income and expenditure (nominal)

Screen 3.5 is repeated here, but amounts are shown in nominal terms (i.e. after allowing for inflation).

3.7 Monthly bills (real)

Monthly bills are shown for each year, in Rands per month, for the various categories of consumer. Base-year Rands are used.

Bills for non-residential consumers are shown for all the tariff options, and the option selected is displayed on the screen (in words).

3.8 Monthly bills (nominal)

The same information is shown as on screen 3.7, but in nominal terms.

3.9 Cost of providing water by service type (excluding capital charges)

The estimated monthly cost to the service provider of delivering water to consumers is shown here, in Rands per month per consumer unit (base-year prices). These costs include all administration, maintenance, bulk and other running costs, but exclude capital charges.

3.10 Costs per kilolitre of providing water service (excluding capital charges)

Whereas screen 3.9 shows running costs in Rands per consumer unit, this screen shows these costs in terms of cents per kilolitre. These are shown for the system as a whole (TABLE 1) as well as for the various categories of consumer (TABLE 2).

TABLE 1 identifies and quantifies the sources of the gap between the cost of bulk water and the cost of delivering water to consumers.[8] It shows how expenditure per kl is increased firstly by distribution activities, secondly by water losses, and thirdly by interest and redemption payments (capital charges).

TABLE 2 can be of use in relating the cost of water to its price for the different service types. However, it is important to remember that these costs exclude capital charges, water losses and contributions to funds or capital expenditure. The prices paid by at least some CUs must therefore usually exceed the costs shown here by a significant margin if the service provider is to meet its cash flow requirements. The prices of water sold by service type, as well as this cost information, are displayed on screens 1.13-1.15. Should the user require a hard copy of these in conjunction, the relevant parts of the screens may be printed out.

3.11 Consumption (Ml/a) and income (c/kl)

Four tables are provided on this sheet. TABLE 1 shows, in Ml per annum:

- water sold to the various categories of consumers;
- water used by the service provider (not sold, referred to as "municipal water");
- total consumed;
- physical losses;

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[8] In order to do this the user will need to highlight the selected part of the sheet, and select the "File, Print" option from the menu bar. The option to print the selection (not the sheet) will need to be selected.

- total purified water purchased; and
- total water purified.

The last two rows respectively show physical water losses as a percentage of the total amount purchased/purified per year, and the macro estimates of these total.

TABLE 2 shows the annual percentage changes in water consumed and purified/purchased.

The first two rows of TABLE 3 show:

- the cost of bulk water; and
- the total average cost of the system (total expenditure, including all contributions to funds and short-term interest payments/total purchased/purified, in c/kl real).

This may then be compared to the information on income, which includes:

- the average price of water sold (total amount billed/total water sold);
- the income accrued per kl (total income due/total water purchased/purified); and
- income actually received (income actually received/total water purchased/purified).

If income actually received exceeds the total average cost, then the service provider will experience a positive net cash flow, and *vice versa*.

TABLE 4 contains additional information on the macro estimates entered on screen 1.6. This table will not print out automatically, and should the user require a hard copy it will be necessary either to change the page setup or highlight the total area to be printed and select "File, Print, Print selection" from the menu options.

3.12 Summary data (capital account)

This sheet is usually printed out, and contains a summary of the most important input and output information relating to:

- demographics (TABLE 2);
- income distribution (TABLE 3);
- economic growth (TABLE 2);
- service levels (TABLES 4 and 5);
- cost information (TABLES 6, 7 and 8); and
- capital income, expenditure and borrowing requirements (TABLE 1, nominal and real).

Other items of information include the name of the town, the date on which the assessment was done, the person responsible, the run number, and the date on which the model summary sheet was printed (Run date). The description of the scenario entered on screen 1.1 is reproduced here.

3.13 Summary data (operating account)

This sheet is also usually printed out, and contains summary information on:

- income, expenditure and cash flows (TABLE 1, nominal and real);
- unit operating costs, consumption and prices (TABLE 2);
- monthly bills (TABLE 2);
- total consumption and physical water losses (TABLE 3);
- debt service ratios (TABLE 4); and
- non-payment rates (TABLE 4).

The name of the town, assessment date, person responsible and run date are reproduced on this sheet.

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