SANITATION SERVICES MODEL MANUAL

Report to the
Water Research Commission
by

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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 1997). 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 by means of common inputs and outputs from the latter serving as inputs for the former. The model has thus far been tested in Harrismith.

This manual

This manual is intended to facilitate understanding and use of the Sanitation Services Model. The key assumptions of the model are discussed, the structure and data inputs required are described and the model results are explained.

The manual should be read in conjunction with the manual for the Water Supply Services Model. In the latter manual the philosophy behind the models is described and their potential role in the drafting of Water Services Development Plans is outlined.

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 and the Sanitation Models 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

MODEL PURPOSE AND SCOPE

Purpose of the Sanitation Services Model

The aim of the model described in this manual is to assist the agencies responsible for urban sanitation 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 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.

Scope

The model has been developed for application in urban areas, including small towns situated in rural areas. It is not applicable to rural areas. The model should be applied to each local authority area as a whole, and not to sub-sections in isolation. A metropolitan area should be modelled as a whole if water services are managed at metropolitan level. If sub-structures were to be modelled, then the financial relationship between all sub-structures (and possibly between the sub-structures and the metropolitan council) would need to be ascertained, making the modelling exercise considerably more complicated than modelling the metropolitan area as a whole.

BASIC METHODOLOGY

The user of both the WSSM and the SSM would generally undertake the following steps:

1. Understand the current status quo

The model user must begin by developing a thorough understanding of the current status of service provision in the area being modelled, including its demographic and economic profile, existing service coverage, operating and maintenance expenditure, tariff structure, income and payment profiles, water consumption patterns, etc. Acquiring the necessary information would typically require inputs from the engineering, planning and treasury departments within a local authority. Meaningful use of the model requires that the information is accurate, and it is therefore essential that experienced technical and financial personnel operating at a high level be involved in reviewing and interpreting the data and the model runs.

2. Enter service goals and time-frames

On the basis of existing service levels and coverage, the model user would decide on service level goals and time-frames. Typically, three scenarios would be chosen initially:

- an ambitious scenario seeking to meet political aspirations;
- a financially conservative scenario seeking to minimise impacts on tariff levels; and
- a "medium" scenario.

Ideally, these scenarios should be developed through interaction between the urban area's political representatives and the local authority's technical and financial managers.

The model user would then design three investment programmes to meet the service level goals and time frames.

3. Design income and tariff policy

The next step is to adjust tariff structures and levels as to fit intended tariff policy and to ensure financial viability of the supply agency over the period of analysis (10 years).

4. Assess outputs

The key outputs provided by the model are:

- capital expenditure and sources of capital income;
- recurrent expenditure, income and cash flows;
- tariffs and monthly bills.

These outputs need to be assessed in terms of the financial viability of the agency over the period of analysis, the physical feasibility of the investment programme proposed, the affordability of the tariff levels proposed and willingness to pay, and the political acceptability of the service goals and required tariffs/tariff increases to maintain financial viability.

5. Undertake a sensitivity analysis

The model user may then make adjustments to inputs to determine sensitivities of various parameters on the key model outcomes.

6. Select likely scenario and refine analysis

The next step is to present the three chosen scenarios, together with the sensitivities of the key parameters, to the political representatives and financial and technical managers of the supply agency/local authority. These should then choose the most appropriate investment scenario for further investigation – or, if unhappy with all of them, suggest an alternative.

The data input for the chosen investment scenario should be further refined and various options within this general scenario explored. These more detailed options within the chosen overall scenario would then again be presented to the decision-makers, who would make investment and tariff policy decisions taking this analysis into account.

7. Update model

As new (or more accurate) data become available, the analysis can be further refined. Updating the model at regular intervals (such as every year or two) is also recommended for ongoing monitoring and planning.

LINKING THE WSSM AND THE SSM

The WSSM and the SSM have been designed to be used together. The user should first run the WSSM, and establish an acceptable programme for water supply services. Certain key outputs from this scenario are then used by the SSM, relating to levels of service and consumption. In addition, key demographic and economic inputs must be the same.

The final two output screens of the WSSM contain the data that is required by the SSM. These can be entered into the SSM manually by the user, either by means of entering the values directly or by copying and pasting values in the appropriate input boxes. Alternatively, the user may link the two models, so that changes in the WSSM will automatically be read by the SSM. This however requires a fair degree of familiarity with Excel, and a high capacity computer.

The final outcome of the process will be an investment programme, or a range of programmes, for water supply and sanitation services. The expenditure and income information on each service will however be separately recorded, and the user will need to combine these manually should he/she wish to do so.

MODEL FEATURES

The key focus

The key focus of the model is on the financial viability and sustainability of the sanitation 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 four different types of water supply service for low-income households. 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.

Compatibility with the Water Supply Services Model

The model requests the user to enter the water services provided and the estimated average consumption per connection over the investment period. The investment programme for sanitation service can then be designed in such a way that water supply and sanitation services are compatible.

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 sanitation services. 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 wastewater flows

Wastewater flows are projected for the ten-year period. These projections have the advantage of incorporating, in a consistent manner, predictions of population and economic growth, income levels, levels of service provision for both water supply and sanitation, and changes in water consumption for reasons of price, changes in technology or habit.

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 sanitation 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.

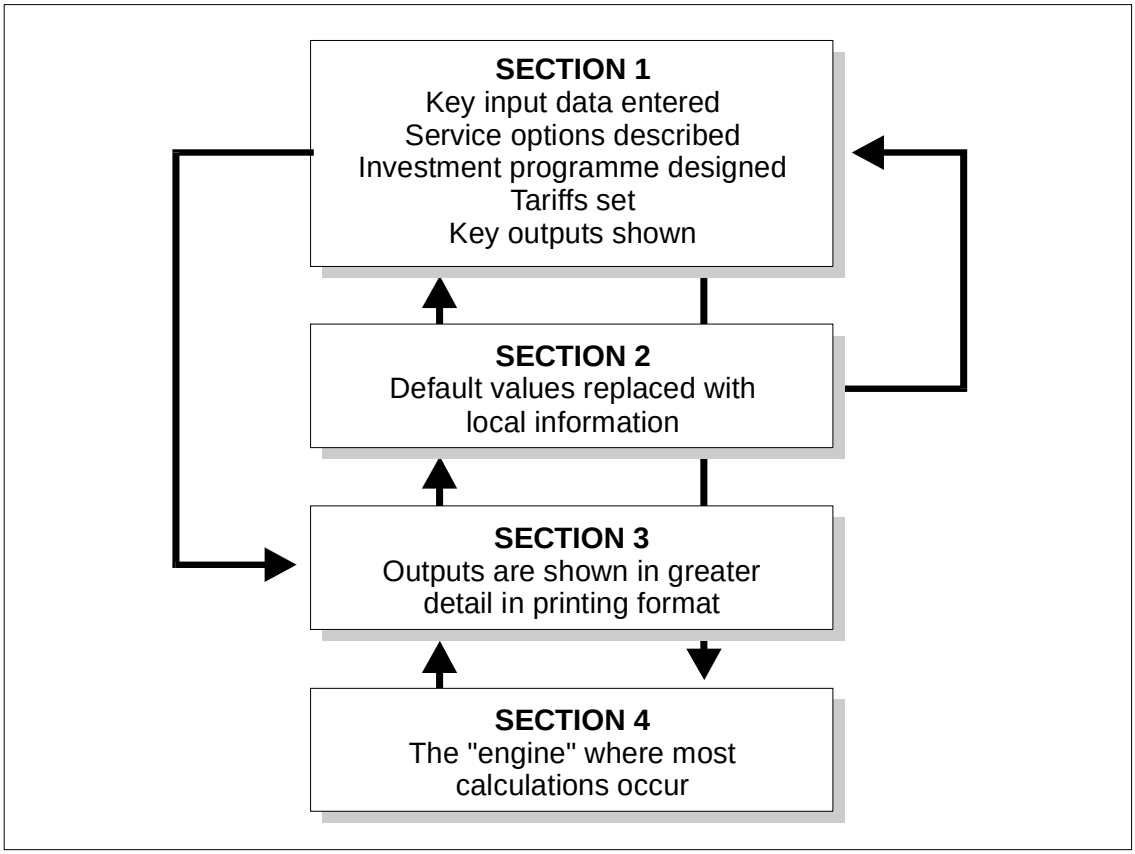

Figure 2: The model structure

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 Sanitation Service Model (SSM) 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 SSM 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.... It is further recommended that copies of the two sheet of data exported from the WSSM are at hand (sheets 3.14 and 3.15 of the WSSM).

WHEN THE INFORMATION TO BE ENTERED IS DERIVED FROM THE WSSM EXPORT SHEETS, THIS IS INDICATED IN CAPITAL LETTERS. These figures may be entered manually, or by means of copying and pasting the values (not formulae – use the "paste special, values" Excel facility). The latter method is recommended in certain instances, which are noted in this manual.

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. Where relevant defaults are supplied in the WSSM but not the SSM, this is indicated.

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/comments 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"(or "Comment"). 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 (AS FOR WSSM).

Type
The type of local authority being modelled – for example, local or metropolitan council (AS FOR WSSM).

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 3.10)

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 (AS FOR WSSM).

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 MUST BE THE SAME AS THAT USED IN THE WATER SUPPLY SERVICES MODEL (WSSM) IF THE MODELS ARE TO BE USED TOGETHER (see sheet 3.14 of the WSSM).

The information entered 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 Module 3 of “Management Guidelines For Water Service Institutions (urban)” (WRC, forthcoming ??)

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/…” in this section).

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 servants' 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 1.6 EXISTING SERVICE PROVISION), these households should be recorded as having an inadequate service.

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 in the WSSM 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 in the WSSM 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 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 1.10 and 1.11 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 in the WSSM correspond to housing subsidy categories.

The model cannot run if there are no consumers in the fourth income category. 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 this category which will translate into one consumer unit.

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 water bills sent out each month, which for metered supplies should correspond to the number of

water meters. (Remember that the number in each category must be the same as the number used in the WSSM).

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 and wastewater flows.

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 is entered in this category.

1.3 The future environment

THE INFORMATION ON THIS PAGE MUST BE THE SAME AS THAT USED IN THE WATER SUPPLY SERVICES MODEL (WSSM) IF THE MODELS ARE TO BE USED TOGETHER (see screen 3.14 of the WSSM). *NO DEFAULT VALUES ARE SUPPLIED IN THE SSM.*

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 in the WSSM 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 in the WSSM 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 in the WSSM = 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 in the WSSM = 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 in the WSSM 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 to be provided are described here. The type(s) of water supply required for each system is(are) also specified (column 2), since this affects the investment programmes allowed (see 1.5 WATER SUPPLY and 1.10 - 1.11 INVESTMENT TARGETS...). Full waterborne sanitation is broken down by income category, because of the differences in wastewater flows, cost and financing arrangements (see screens 2.1, and 2.5 - 2.8).

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.

Non-residential services

The model allows non-residential consumers to receive either waterborne or on-site sanitation (see 1.12 INVESTMENT TARGETS..). The nature of the systems can be described on this screen, and appropriate costs entered in section 2 (screen 2.1 UNIT CAPITAL COSTS FOR INTERNAL SERVICES).

1.5 Water supply : Percentage distribution by service type and metering

ALL THE INPUTS ON THIS SCREEN ARE DERIVED FROM THE WSSM (WSSM screen 3.15). It is recommended that the values are copied and pasted rather than entered manually, for reasons of both efficiency and accuracy. If the user wishes to use the SSM as a "stand-alone" model, it is advised that she/he provide estimates of the data required.

The screen records the water supply services provided over the ten-year investment period. The percentage of residential CUs with each type of service is entered per year. The purpose of this information is to ensure that the sanitation services provided are consistent with water supply services. For example, waterborne sanitation requires an on-site water supply, while in-house water cannot be provided without either waterborne sanitation or a septic tank to dispose of wastewater. Inconsistencies between the investment programmes are shown red on the screens used to design the investment programme for sanitation services (screens 1.10 and 1.11 INVESTMENT TARGETS...). Inconsistencies will not cause the SSM to cease calculation.

Data are entered by service type and metering information. The latter is necessary because of the tariff option provided for charging for sanitation on the basis of water consumption (see screens 1.15 and 1.16 FUTURE TARIFFS..).

For residential CUs, the model calculates the percentages provided with in-house water as the residual. If the calculated percentages differ from those calculated by the WSSM, then either the number of CUs, the distribution of income (screen 1.2) and/or other water supply services have been entered incorrectly. If the sum of services provided to low income households exceeds 100, an error message is displayed. This will not cause the SSM to cease calculations, but will cause errors in the calculation of the discrepancy between water supply and sanitation services (screens 1.10 and 1.11).

The model assumes that all middle and high income CUs are provided with in-house water.

Water supply for non-residential CUs is recorded in two categories in the WSSM, namely on-site and inadequate supplies. The percentages of CUs in the latter category only are requested here. The percentages with on-site supplies are calculated as residuals, but are not displayed on the screen.

1.6 Existing service provision

Residential consumer units

The sanitation services (row) provided to consumer units with each type of water supply service (column) must be entered in the yellow blocks. Only legitimate combinations may be entered.

The second column in the table shows the numbers of CUs with each type of water supply service. These are calculated from the total number of residential consumer units (screen 1.2), and the percentages entered on the previous screen (screen 1.5). For water supply services requiring on-site sanitation, the number of CUs with “other inadequate” services is calculated as the residual. For water supply services requiring waterborne sanitation or septic tanks, the number with full waterborne sanitation is calculated as the residual.

Note that the bucket system is recorded separately from other inadequate services (usually nothing or unimproved pit latrines). This is because of the high running costs associated with the former system that will fall away as alternative systems are provided.

The SSM assumes that unmetered user-defined water supply services (defined in the WSSM) cannot support waterborne sanitation or septic tanks, while metered user-defined options require these services.

If the sum of the entries for each type of water supply service exceeds the total number of consumer units in the second column, a message “check inputs” will appear and the model will not calculate any outputs.

Non-residential consumer units

Water supply service options for these consumers are either "inadequate" or "on-site". Corresponding sanitation services must be entered, as for residential CUs. *The model assumes that all on-site connections are metered, and that "wet" industries must have an on-site supply.*

If the sum of the entries for each type of water supply service exceeds the total number of consumer units in the second column, a message "check inputs" will appear and the model will not calculated any outputs.

1.7 Water consumption and wastewater production

Water consumption (Ml pa)

THIS INFORMATION MUST BE OBTAINED FROM THE WSSM (WSSM screen 3.15). The amount of water sold/used by the agency is recorded for each year. The purpose of this information is to check that current and projected wastewater production is sensible (see "% w/w produced in area as % water used" on this screen, and screens 1.18 and 3.9 and 3.11).

Wastewater produced in (base year)

- **Total wastewater produced**, expressed in Ml per annum. This refers to the total amount of wastewater produced in the area, plus any additional wastewater treated by the service provider that originates outside the municipal boundaries. If the service provider treats only some of the wastewater produced, or none of it, then the total amount produced within the area must be recorded regardless of who actually treats it.
- **% total due to ingress and stormwater.** Some of the wastewater produced in an area is due to leakages of rainwater into the pipes ("ingress") and stormwater that flows into the system, rather than the wastewater flows from water consumers. The user is asked to estimate the percentage of the total that comes from these sources. In the absence of further information, an estimate of 15 percent may be used.
- **% total from outside LA area.** Many service providers treat wastewater from surrounding areas. Here the user is asked to enter the percentage of the total amount treated that comes from outside the LA area (i.e. the area to which the demographic and financial information refers, on screens 1.2, 1.8 and 1.9). Projections of the amount to be treated from outside sources are made on screen 2.10.
- **Total produced by consumers within LA area** (output). This is the total amount of wastewater produced (or treated) *minus* the amount due to ingress and stormwater *minus* the amount imported from outside the LA area. This is the amount that must be compared to the amount of water used in the area.
- **% w/w produced in area as % water used** (output). This output serves as a cross-check of the information entered thus far. It shows wastewater produced by consumers in the area as a percentage of the water used. This percentage should be between 60% and 95%. If it is not, total water consumption and wastewater production inputs must be re-checked and a value outside this range after re-checking must be justified.
- **Total wastewater treated by service provider.** In some areas the service provider (usually the local authority) is responsible for treating all the wastewater produced. In other areas this function is carried out by an outside agency, in the form of either a private company or another local authority. In

yet other situations the service provider is responsible for treating some of the wastewater while an outside agency is responsible for treating the rest. Here the user is asked to specify the total amount treated by the service provider in the base year.

◊ Future responsibility for the treatment of wastewater is set in section 2. The default assumption is that if the service provider is responsible for less than 80% of wastewater treatment in the base year, outside agencies will be responsible for the treatment of additional flows in the future (see screen 2.3). If an outside agency treats less than 20% of the wastewater produced, it will remain treating the base year amount but no more.

Water consumption per CU by service type

THIS INFORMATION MUST BE OBTAINED FROM THE WSSM (WSSM screen 3.15). It is recommended that the values be copied and pasted rather than entered manually, for the sake of both efficiency and accuracy. If the SSM is to be used as a "stand-alone" model, then sensible assumptions need to be made here. Defaults are provided should these be required.

The information to be recorded is the average monthly consumption per CU by service type (kl per month). The purpose of this information is to predict wastewater flows that are derived from water consumption, thus ensuring compatibility between predictions of water consumption and wastewater flows (see screens 2.8).

Note that there is no automatic check in the SSM that these amounts and the total amount of water used, entered at the top of the screen, balance. It is left to the user to ensure that the information entered is sensible.

1.8 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 sanitation 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 three categories of expenditure: **administration** (including overheads and billing); **wastewater and sludge treatment**; and **reticulation and collection.** The purpose of this is to estimate the running costs of each service type with greater accuracy (see screen 2.9 RUNNING COSTS BY SERVICE TYPE).

◊ Defaults are provided for a "typical" service provider and these change with arrangements for treating wastewater.

The **average cost(s) per kl** of wastewater treated by the service provider and by outside agencies respectively are displayed, as calculated by the model. If

these are incorrect, then the amount(s) of wastewater treated and amount(s) spent on treatment are incompatible and need to be checked.

1.8 Accounts (2) – tariffs and income

Income accrued by the service provider from the provision of sanitation services is calculated by the model from the tariffs entered here.

There are many ways in which **tariffs** are levied for sanitation. Including all of these methods would made the model very complicated, and simplification is therefore essential. The categories provided by the model in which tariffs may be entered are as follows:

- **On-site sanitation:** Charges for on-site sanitation may be levied on a Rands per month basis, or per desludging (= load if one load is sufficient to remove the contents of the pit).
- **Waterborne sanitation with an unmetered water supply:** charges are levied as a fixed amount per month per CU (Rands per month).
- **Waterborne sanitation with a metered water supply:** charges may be levied as a fixed amount per month per CU (Rands per month), and/or an amount per kl of wastewater produced. Estimates of the amounts of wastewater produced are set on screen 2.8, and the average monthly bills when volumetric charges are levied are shown in the last column of the table.

The actual tariff structure used by a service provider may differ from the structure provided for in the model. The user needs to estimate the amounts payable in terms of the model's categories. This estimation is assisted by the calculation of the total income due, discussed below (see "total income billed").

Provision is made for **recurrent subsidies** and **other income (**R'000). The latter should include income from services such as clearing blockages, but strictly speaking should exclude income from connection fees for new services since these are accounted for elsewhere (see screen 2.5 HOUSING SUBSIDIES AND CONSUMER PAYMENTS).

Total income billed must agree with the total obtained from financial statements or budgets (less connection fees for new services). 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).

Received income 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 right hand table. For calculation purposes total amount unpaid is more important than the breakdown between the various consumer groups, which may be estimated.

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 (on the sanitation account).

1.9 – 1.12 Investment programme

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

- make provision for new residential consumer units (screen 1.10);
- eliminate the residential backlog and upgrade existing services (screen 1.11); and
- make provision for non-residential consumers (screen 1.12).

1.9 Investment targets (1): new residential consumer units

IT IS ESSENTIAL THAT THE INVESTMENT PROGRAMME PROVIDES SANITATION SERVICES THAT ARE COMPATIBLE WITH WATER SUPPLY SERVICES. IF THE WSSM AND THE SSM ARE USED TOGETHER, THE INVESTMENT PROGRAMME USED IN THE WSSM MUST BE USED TO GUIDE THE PROGRAMME PROVIDED HERE. The investment programme used in the WSSM is shown on sheet 3.14, DATA FOR EXPORT TO SANITATION MODEL, tables 8 and 9.

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.

TO ENSURE COMPATIBILITY WITH WATER SUPPLY SERVICES, THE USER MUST PROVIDE SERVICES SUCH THAT THE SUM OF CONSUMER UNITS PROVIDED WITH VIP AND LOFLOS SYSTEMS CORRESPONDS TO THE PERCENTAGE PROVIDED WITH WATER SUPPLY SYSTEMS THAT REQUIRE ON-SITE SANITATION (COMMUNAL STANDPIPES, YARD TANKS AND UNMETERED USER-DEFINED SERVICES). For example, if 40 percent of new residential CUs are be provided with yard tanks and the remainder with in-house water, then 40 percent can be provided with VIPs or LOFLOS systems and the remainder must receive either waterborne sanitation or septic tanks. Thus a legitimate investment programme would be for example 30 percent VIPs, 10 percent LOFLOS, 5% septic tanks, 25% simple waterborne and 30% full waterborne.

◊ The percentage provided with full waterborne sanitation 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 have full waterborne sanitation (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.

- The most important information is the excess (-shortage) of waterborne sanitation and septic tanks provided per annum. These numbers are shown in red for highlighting purposes. A positive number means that some sites are provided with waterborne sanitation or septic tanks but a water supply service that cannot support them (e.g. yard tanks). Negative numbers mean that some sites have water supply services that require waterborne sanitation or septic

tanks to dispose of wastewater, but have VIPs or LOFLOS systems. If the combinations of water and sanitation are illegitimate, the model will not cease calculations but the investment programme should be altered. It will however sometimes be difficult to reduce the discrepancy in services to zero, and a small discrepancy is acceptable.

- Service levels by type 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(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 sanitation services will have received by the end of the investment period. This is done in the first three rows of the input table. The programme is entered in three categories, depending on the type of water supply services that CUs with inadequate sanitation have in the base year. *If the numbers entered in a row 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/inad., no water" row (i.e. the top row). By the end of the investment period (see "Time frames" below), 10% of CUs currently with inadequate water and sanitation services will have received VIPs, 20% LOFLOS, 5% septic tanks, 30% simple waterborne sanitation and the remaining 35% full waterborne sanitation. The number of CUs involved is shown to the right of the input blocks.

THE PROGRAMME ENTERED MUST CORRESPOND TO THE PROGRAMME FOR WATER SUPPLY SERVICES. For the top row of the table (inadequate water and sanitation), this means that the investment programme must be directly compatible with that for making up the backlog of water supply services (see 1.10 above). For the remainder of the programme compatibility is sometimes more complicated, because of the range of initial combinations of water supply and sanitation services. For example, some CUs served by communal standpipes may have no sanitation, while others may have VIPs. Some CUs with on-site water may be served by the bucket system (inadequate), while others may have LOFLOS systems. Entering an investment programme for these CUs requires a certain amount of trial and error.

Upgrading (B): the next five rows allow the user to enter an upgrading programme for existing CUs. The programme is specified by entering the final percentage distribution of services for CUs currently with the services specified in the column.

Note that "downgrading" is not permitted for model-determined services, for example from full waterborne to simple waterborne. The numbers of CUs in each of the service categories in the base year are displayed to the right of the input table. *THE UPGRADING PROGRAMME MUST BE COMPATIBLE WITH THE PROGRAMME FOR WATER SUPPLY.*

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 full waterborne sanitation. 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 TIME FRAME AND NATURE OF THE PROGRAMME SELECTED MUST BE THE SAME AS THAT USED IN THE WSSM.*

◊ 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 information displayed on screen 1.10 is repeated here.

1.12 Investment targets (3): non-residential

New non-residential CUs

The model allows for on-site and full waterborne sanitation for these CUs. The nature of the on-site system should be recorded on screen 1.4, and the appropriate costs entered on screen 2.1. The numbers involved are displayed on the screen.

◊ The default programme provides all CUs with waterborne sanitation.

Upgrading of institutions, commerce and dry industries

These may be provided with on-site or waterborne sanitation. The numbers involved are displayed on the screen. The user specifies the **time frame** and whether an equal number per annum is provided or the programme occurs along an S-curve.

◊ The default programme provides all non-residential CUs with waterborne sanitation over a ten year period 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 screen 2.1), bulk and collector infrastructure (screens 2.2-2.3), asset replacement (screen 2.4) 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 (5 or 10 years). The sources include borrowing, which is calculated as a residual (see screens 3.3-3.4), capital subsidies (screen 2.5-2.6), once-off capital payments by consumer units (screen 2.5) and current income generated by the service provider from the sale of water (screen 2.11).

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 1.10 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.

1.14 – 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 three screens:

- tariffs for on-site sanitation (screen 1.14);
- tariffs for waterborne sanitation for residential CUs (screen 1.15); and
- tariffs for waterborne sanitation for non-residential CUs (screen 1.6).

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 charges for on-site sanitation at reasonable rates (sceen 1.14) and to do likewise for the fixed monthly component of tariffs for CUs with waterborne sanitation. The volume charges can then be adjusted until the cash flow requirements are met. (This will work, however, only where the bulk of water sold is metered and a significant proportion of income is derived from the volume charges.)

1.14 Future tariffs (1): on-site sanitation

Base year: tariffs for the base year entered on screen 1.9 are displayed here. If there are no CUs with the particular service type, "no CUs" is displayed. Tariffs may be levied in the form of a fixed monthly charge, or a charge when desludging occurs (or both).

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

Year 1: the user enters tariffs for year 1 of the programme 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.

Caution: 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 tariffs.

Caution: 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 tariffs 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 are the average monthly bills for each of the service types, and the estimated monthly costs of providing the services, excluding capital charges (R pm per CU). These may be used to more carefully adjust charges to cost, and to ensure equity in the pricing structure. Average monthly costs are set on screen 2.9.

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.

1.15 Future tariffs (2): waterborne sanitation - residential

Charges for waterborne sanitation are entered as a fixed amount per month when water supplies are unmetered, (Rands per month per CU). When water supplies are metered, a fixed monthly amount and/or an amount per kl of wastewater produced (volume charge) apply. Estimates of the amounts of wastewater produced are set on screen 2.8.

As on the previous screen, the user may enter tariff increases in **nominal or real** terms, and may view future monthly charges in nominal or real terms

"Show average monthly bills?" provides the user with 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 volume charge. In order to view the total bill, a "yes" must be entered into the relevant block. (Default = "no".)

The information displayed on the screen is the same as that displayed on screen 1.14.

Displayed lower down on the screen are (not shown on the print-out):

- the average monthly costs for each of the service types,
- the operating and maintenance cost of the system as a whole (O&M),
- the average historic cost (AHC) of the system, and
- the average price per kl of wastewater treated by service type.

These may be used to more carefully adjust charges to cost, and to ensure equity in the pricing structure.

1.16 Future tariffs (3): waterborne sanitation - non-residential

Charge for non-residential consumers are levied as for residential consumers with waterborne sanitation. The options regarding nominal or real, and viewing monthly bills, are the same as on the previous screen.

The information displayed on the screen is the same as that displayed on screens 1.14 and 1.15.

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

This is an output screen for display purposes, showing:

- annual and cumulative cash flows on the operating account, 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 Wastewater flows

This is an output screen for display purposes, showing:

- The total amount of water used, as entered on screen 1.7.
- Wastewater produced by consumers in the area.
- The total amount of wastewater treated, whether by the service provider or outside agencies. The difference between the amount produced and the amount treated is the amount of ingress and stormwater flowing into the system, and the amount of wastewater treated that originates outside the municipal area.
- The wastewater flow factor, which is the amount of wastewater produced by consumers in the area expressed as a percentage of the amount of water used.

These amounts are shown both graphically and in the table below the graphs. The amount of wastewater produced locally must always be less than the amount of water used, so that the wastewater flow factor is less than 100 percent. The amount treated can however exceed the amount of water used, if wastewater from outside areas is treated and/or if large amounts of stormwater flow into the system.

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

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

For comparability, costs for both on-site and waterborne sanitation should include the costs of the toilet bowl and a comparable structure to house the toilet. These costs should be comprehensive, including overheads, contingency fees etc. and VAT.

◊ 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 Collector and bulk infrastructure capacity requirements

Screens 2.2 and 2.3 deal with collector and bulk infrastructure, comprising collector pipelines, outfall sewers, pump stations and wastewater treatment works. Collection vehicles for on-site sanitation options are also considered here.

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 do not reflect the actual capacity of the system. Actual, existing capacity, which may include surplus capacity, is entered on screen 2.3. The capacity requirements of the various components of the system are used to calculate future requirements, determined on the next screen.

Capacity requirements for collector pipelines are established in the first block. The first column shows the categories of CU, and the second the average wastewater flow 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. An allowance for ingress and stormwater runoff is included in the average daily flow figures shown.

The final column shows the total capacity currently required, by service type, for base year levels of wastewater flow (Ml/day flow). Total capacity requirements are shown in the last row.

Capacity requirements for outfall sewers are established in the second block. The user is asked to enter the capacity required as a percentage of the average daily flow rate.

Pump station 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).

Wastewater treatment works are dealt with in the fourth block. The user specifies the capacity required as a percentage of the average daily flow. The calculated capacity reflects the total necessary to treat the flow from the area. The capacity required by the service provider is displayed on the next screen (screen 2.3).

Collection vehicles for on-site sanitation options are dealt with in the final block. This refers to the vehicles required to suction pits and on-site storage tanks. The vehicles used to collect the contents of buckets are not included because bucket sanitation is not regarded as an acceptable service, and no additional collection capacity will be required in the future.

2.3 Collector and bulk infrastructure costs and expansion programme

On the previous screen the model established the capacity requirements of collector and bulk 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 capacity, as appropriate. Vehicle costs are entered in R thousands per vehicle, along with the average capacity of such vehicles.

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.

◊ The default programme for WWTW assumes that the service provider will be responsible for the provision of new capacity only if it treats 80% or more of the wastewater currently produced in the area. If less than this is treated, an outside agency is assumed to be responsible for additions.

If the service provider has an expansion plan, 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 the shortfall in WWTW capacity includes capacity provided by

outside agencies, and does thus not necessarily mean that new capacity is required.

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 water consumption, and therefore wastewater production, falls as a result of a steep increase in water tariffs. Water consumption per CU, derived from the WSSM, is entered on screen 1.7 WATER CONSUMPTION AND WASTEWATER PRODUCTION, and annual wastewater production is shown on screen 3.11 WASTEWATER PRODUCTION.

Remember that any shortfall in WWTW capacity is automatically assumed by the model to be made up by an outside agency. The user must ensure that a cost is entered for wastewater treatment by an outside agency, otherwise this expenditure will not be recorded (see screen 2.10).

2.4 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 2.11 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 defaults 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 collector 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 screen (screen 2.3).

2.5 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 consumer 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 in informal areas or backyard shacks. The numbers involved are displayed on the screen, along with the number of CUs currently on formal sites with inadequate services (usually buckets).

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 where applicable.

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 and/or capital accounts (see screens 2.11, 3.3 and 3.5).

◊ 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.

Rate of increase in the nominal value of housing subsidies

The nominal value of the capital (housing) subsidies used for sanitation 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.

Non-residential CU payments
No provision is made for subsidies for non-residential CUs, since none are likely to be available in this form.

◊ The default CU payments are the full costs of service provision (see screen 2.1).

Household payments for other upgrading
CU payments for other service upgrading are entered here. No provision is made here for subsidies for the upgrading of services deemed to be adequate.

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

2.6 Capital subsidies: infrastructure grants

Additional capital subsidies may be available for bulk and collector 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 CMIP subsidy is not supposed to be used for waterborne sanitation. The default amount is therefore a rough estimate of the sludge handling facilities required for on-site sanitation in the form of a VIP that is periodically desludged.

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.

◊ The default rate is 50% of the rate of inflation.

B. **A grant provided as a (fixed) percentage of the cost of bulk and collector 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).

2.7 SLUDGE TREATMENT: ON-SITE SANITATION

Introduction
Screens 2.7 and 2.8 deal with the volumes of sludge and wastewater produced per consumer unit. The functions of these screens are threefold:

- A "wastewater balance" is established for the base year.
- Expected changes in the volumes of wastewater produced per CU are entered.
- Where service types are not currently provided, but will be in the future, estimates of likely sludge/wastewater production are made.

Estimate the quantity of sludge produced by CUs with on-site sanitation.
For on-site sanitation, the user estimates the volume of sludge per desludging or, in the case of bucket sanitation, per collection. The next step is to estimate the frequency of desludging and/or collection, in either number of months or times per month depending on the service.

◊ The defaults for the base year are estimates. Note that the defaults for non-residential CUs with inadequate services assume that the bucket system is used.

2.8 Wastewater flows: waterborne sanitation

Establishing a "wastewater balance" in the base year

The first task on this screen is to establish a "wastewater balance" for the base year. It is important to understand how this is done because the model will cease calculations if the balance is out. A "wastewater balance" in essence means that the total amount of wastewater produced, as entered on screen 1.7, can be sensibly allocated to the various consumer groups. This in turn requires that the information on numbers of CUs, service levels and consumption per CU, entered on screens 1.2, 1.6 and 1.7 respectively, is sensible.

For each of the services listed, the user must estimate the percentage of water used that flows into the wastewater stream (i.e. the wastewater flow factor). The wastewater flow factor of commercial and dry industrial CUs is calculated as a residual, and if this factor is not sensible then the "wastewater balance" is out. The upper and lower limits to what is deemed "sensible" can be set by the user in the ***max=*** and ***min=*** input blocks below the table.

The amounts of wastewater discharged per CU are shown in the next column (kl per month per CU). These amounts are calculated as the average monthly water consumption per CU for each type of service, multiplied by the wastewater flow factor.

◊ The default wastewater flow factors for residential CUs are estimates, based on case studies. The defaults for non-residential CUs are rough estimates only, and may be inappropriate for the area under consideration.

If the estimated wastewater flow factors are such that the amount allocated to commercial and dry industrial consumers results in too high or too low a flow factor, the model will cease to calculate. The message "wastewater balance out – model will not calculate" will appear on this screen and on a number of screens in section 1. The calculated value will be shown so that the user is able to see whether too much or too little of the total wastewater produced is allocated to this category of consumers.

Rectifying wastewater balance errors: If the calculated wastewater flow factor for commercial and dry industrial CUs is too high, then the amounts produced by the other categories must be increased by increasing their wastewater flow factors. The converse applies if the wastewater flow factor for commercial and dry industrial consumers is too low (i.e. reduce their wastewater flow factors).

Should sensible adjustments to the wastewater flow factors fail to rectify the problem, then either (1) the total amount of wastewater produced is too large(small) relative to the levels of water consumption per CU entered in section 1 (see screen 1.7), (2) the information on numbers of CUs provided is incorrect (screen 1.2), and/or (3) information on existing service levels is inaccurate (screen 1.6). In essence, wastewater balance errors mean that it is not possible to sensibly allocate the total amounts of wastewater produced to the area's consumer units, given their services and levels of water consumption.

Base year entries for services not provided in the base year

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 simple waterborne sanitation

in the area in the base year, but according to the investment programme these are to be provided in the future.

◊ If no information is provided by the user, the default amounts are used, which are estimates.

Estimating wastewater flows for years 5 and 10 of the investment programme

The next step is to estimate wastewater flow factors for years 5 and 10. Remember that these estimates must be made for the water consumption per CU entered on screen 1.7.

The defaults for year 5 are the consumption estimates for the base year, and for year 10 the estimates for year 5. This applies to all consumer categories except middle and high income CUs.

◊ The defaults for middle and high income CUs are calculated so that the amount of wastewater produced remains unchanged. The reason for this is the assumption that, when significant water savings are made, it is largely outdoor use that is reduced (for gardens and swimming pools[5]).

Other sources of wastewater

The final tasks on this screen are to

- predict the percentage of total wastewater produced/treated due to ingress and stormwater runoff for year 5 and year 10, and
- predict the total percentage of water treated that will come from outside the municipal area (or outside the area to which the information of CUs, income and expenditure relates).

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

2.9 Running costs by service type: base year

The service provider's annual expenditure on the operating account was entered on screen 1.8 ACCOUNTS (1): EXPENDITURE in the major expenditure categories. Each of these amounts was then allocated to the three functions of the service provider, namely administration, treatment and reticulation/collection. 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 full waterborne sanitation for middle-income CUs. These are entered in the first (white) columns of the blocks marked Administration, Reticulation and Treatment respectively. Collection costs for on-site systems are entered as a cost per collection. The resulting average monthly costs are shown in the third column of each block. Total monthly costs are shown in the last column of the table.

◊ The default ratios for administration costs are estimates.

◊ The defaults for collection costs for on-site services other than buckets are the greater of R35 (R50 for non-residential) or 90% of the tariff entered on screen 1.9.

See "Management Guidelines for Water Service Institutions:", Module 5, Annexure 1. (WRC) Project K5/758. Forthcoming.

◊ The default ratios for reticulation costs are based on estimates of the likely pipe length required per site, except in the case of simple waterborne sanitation where maintenance costs are likely to be higher.

◊ The default ratios for treatment costs are based higher for wet industries on the assumption of higher organic loading of their wastewater.

2.10 Running costs by service type: future

This screen deals with future operating costs. Administration, collection and reticulation costs are entered in Rands per CU, while wastewater treatment costs are recorded by means of predicted costs for each year of the investment programme.

Future wastewater treatments costs are entered in the first table. Annual percentage increases are entered for the period under consideration. Increases can be recorded in nominal or real terms, as selected by the user in the input block above the table (default = real).

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 wastewater treatment, which is of interest when a service provider both treats wastewater and uses the services of an outside agency.

◊ The default assumes that the real costs will remain unchanged.

Note that future wastewater treatment costs can be estimated only if there is a cost for the base year. Situations may however arise where a cost is required for later years only - for example if the service provider is currently responsible for all treatment but will need to make use of an outside agency some time in the future. Under these circumstances token amounts of wastewater treated by an outside agency, and expenditure on this service, will need to be entered on screens 1.7 and 1.8 respectively.

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

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

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

◊ The defaults assume that both current average operating costs and the marginal costs entered will remain unchanged over the investment period.

2.11 Other income and expenditure

Other income

The income information entered on screen 1.9 records income from tariffs, recurrent subsidies and “other income” (such as clearing of blockages, sale of treated sludge). Income from tariffs is calculated by the model for the investment period. This screen requires the user to estimate future income from recurrent subsidies and “other” sources.

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 1.8, as determined by the investment programme and changes in costs. 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 other 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 already been recorded as capital expenditure (for example as "other capital expenditure" on screen 2.4), 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.

2.12 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%, 2.5%and 2% 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 1.9), and those for the intervening years are extrapolated. Separate provision is made for on-site sanitation, residential waterborne, non-residential waterborne sanitation 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 on-site services is 5% in year 10. This low non-payment rate implicitly assumes that these services are provided at a rate affordable to low-income CUs.

◊ The default rate for residential waterborne sanitation is calculated for year 10 by comparing monthly bills (screen 1.15) to the maximum payments that can be made by the different income groups, entered on screen 1.12. 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 residential waterborne sanitation, 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 1.12 should be changed and the defaults will automatically adjust.*

◊ The defaults for non-residential CUs with waterborne sanitation 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 11 output SCREENS in formats appropriate for printing. The last two screens (3.10 and 3.11) 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 wastewater production.

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). It also shows the volumes of wastewater/sludge produced, for the base year, year 5 and year 10 (kl per month per CU).
- Table 4 shows the wastewater treatment 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 3.10.

Note that, if the default programme has been used, expenditure on collector and bulk infrastructure is "smooth". 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 2.11).

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 1.9), namely income from tariffs from the 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.[6] Instead of showing staff, general and maintenance expenditure, the model shows this expenditure in the categories "administration, storage and reticulation" and wastewater treatment costs. The other items of expenditure (capital charges, contributions and other expenditure) are the same as those on screen 1.8. "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 "accrued surplus (-deficit)" is the difference between accrued income and expenditure. The "realised surplus (-deficit)" is the accrued 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 2.12) and non-payment rates broken down into various consumer categories.

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[6] 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 their staff, maintenance and general components.

The information shown on this screen is summarised on screen 3.11.

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.

3.8 Monthly bills (nominal)

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

3.9 Wastewater flows (Ml/a)

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

- The amount of sludge produced by on-site sanitation;
- The volume of wastewater produced by residential consumers;
- The volume of wastewater produced by non-residential consumers;
- The total volume produced within the local authority area;
- The amount of wastewater drawn from outside the area;
- The amount of wastewater treated that is due to ingress and stormwater run-off;
- The total amount of wastewater treated; and
- The amount of wastewater treated by the service provider.

TABLE 2 shows the annual percentage changes in these quantities.

TABLE 3 shows the total amount of water used in the area, and the amount of wastewater produced by consumers in the area. The amount of wastewater produced is expressed as a percentage of water used in the last row. This value should lie somewhere between 60 and 90 percent, and if this is not the case then the total amount of water used and/or wastewater produced must be re-checked.

3.10 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, real and summarised nominal).

Other items of information include the name of the town, 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.

3.11 Summary data (operating account)

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

- income, expenditure and cash flows (TABLE 1, real and summarised nominal);
- unit operating costs, and wastewater/sludge treated by service type (TABLE 2);
- monthly bills (TABLE 2);
- wastewater production and total water consumption (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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