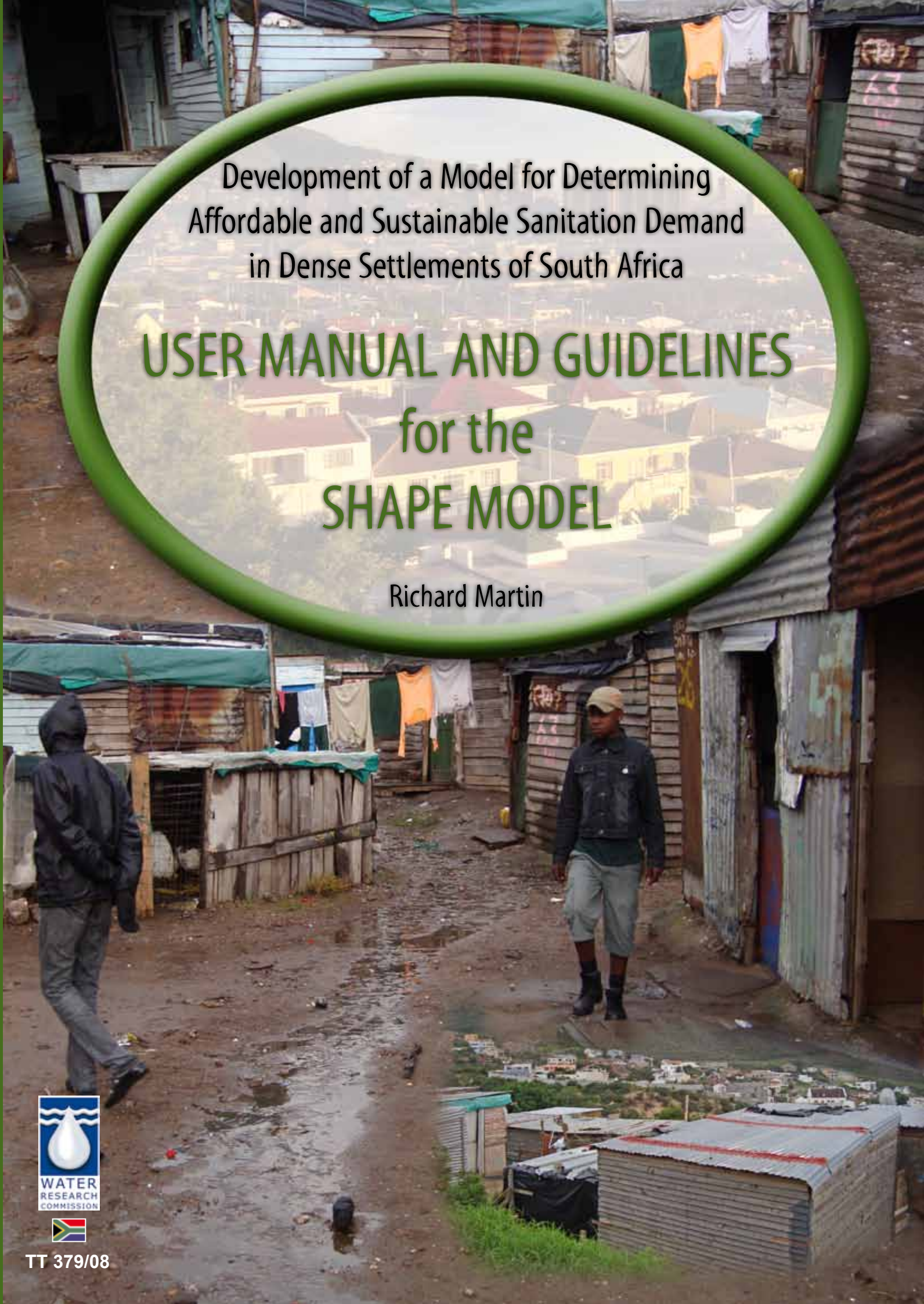

Development of a Model for Determining Affordable and Sustainable Sanitation Demand in Dense Settlements of South Africa

USER MANUAL AND GUIDELINES for the SHAPE MODEL

Richard Martin

WATER RESEARCH COMMISSION

TT 379/08

DEVELOPMENT OF A MODEL FOR DETERMINING AFFORDABLE AND SUSTAINABLE SANITATION DEMAND IN DENSE SETTLEMENTS OF SOUTH AFRICA

USER MANUAL AND GUIDELINES

for the

SHAPE MODEL

(Sanitation and Housing Applied Priorities Enquiry) Model

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This report forms a set with WRC Report No 1664/1/09 and serves as the User Manual and Guidelines for the SHAPE Model software which is available on the WRC website

http://www.wrc.org.za/ResearchReports/ProjectSoftware/SHAPE

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The Sanitation and Housing Applied Priorities Enquiry (SHAPE) Model

1. The Need

Housing costs are made up from an immense number of variables. These include the land, the servicing of the land (which will vary depending on the size of the erf, and the standard and type of servicing provided), the number of rooms, and the standard of fittings, finishes and services. In addition there are the costs of the overheads, such as contractor's profits, professional fees, selling and administration costs, and many more. The equation would not be complete unless we deduct any subsidy paid by the Government and calculate capital repayments at prevailing interest rates and add Local Authority service charges and rates to arrive at the net cost of a house per month.

Selecting a house that meets the spatial needs of one's family which is also affordable is impossible for everyone in the low income strata. It is paradoxical that in spite of this fact such a high percentage – if not all – expenditure on housing solutions for the poor is made without consultation with the users. Demands for better housing are part of the normal currency of politics, and often a specific target is used in slogans, for example the four room house. But while the slogan may present a laudable target it is often unattainable from the economic point of view, and people must have the right to choose what they want.

Crude measures of cost are often used by developers and other for estimates, for example a square metre cost for housing, and a fixed sum for a serviced erf. The apparent precision of these estimates hides the crude basis on which the calculations are made, and prevents anything more than a token involvement in decisions on the housing package.

What is needed is a model that presents the costs in such a way that any variable may be considered in real time, so that beneficiaries may make informed decisions. This is what the SHAPE Model does. Before describing it in detail, we shall briefly describe some of the antecedents of the model and the ways in which it has proved effective.

2. Background

The methodology on which the concept is based goes back many years. Early attempts to obtain consumer reaction to housing options included an analogue computer in 1972 in Zambia, and a model using weighted symbols for walls, windows and services in 1973. In 1984 a 1:20 model was developed in Kenya which comprised building elements (such as walls, roofs, windows, etc.) the mass of each of which was indirect proportion to their cost. Thus, when a design had been built in model form, it was possible to obtain the cost by simply weighing the model. A further, and very much simplified version was designed as a survey tool for use in Botswana. This incorporated models of rooms at 1:100 which could be carried in a

special briefcase. These models were not weighted, but corresponding prices were given for each element which could be added up quite simply to arrive at a gross cost. In all these situations it was found remarkable that even though people are always appalled at the actual cost of building they quickly come to terms with it and begin to engage in the difficult process of working out what their minimum solution would be.

The computerised model described here is a further refinement of the concept. It was first used in Kenya and later developed into a much more powerful tool in South Africa. It is very quick, very accurate and very flexible, and ideally would be used linked to drawings of the solution selected. The model has since been adapted for use specifically as a means for testing community preferences in sanitation. This report explains how to use the model.

The SHAPE model is an adaptation of this work to meet the needs of a study which focuses on sanitation.

3. Applications

3.1 House and Sanitation Costs

The basic objective is to allow the user to specify their sanitation preferences within the context of a global cost for the housing solution. Many studies of sanitation preferences exist, but the decisions which are taken in such cases are inevitably limited by the fact that only one component in the total package of housing preferences is being studied. For all income groups, but most particularly for the poor, there the trade-offs between stand size and servicing, house size, and standard of fittings and finishes. The value of this model is that, for the first time, as far as we are aware, a comparatively accurate estimate of the actual cost of all components allows such a trade off to be made. Moreover, due to the user-friendly interface, it does not require prior training. Indeed, experience has shown that even illiterate people quickly grasp the concepts.

The computerised model presented here is based on the concept of all-inclusive prices that may be used in a component form to obtain an aggregate price.

Thus we may obtain a price for a single room, for two rooms, any number of rooms, etc. Obviously serviced areas such as kitchen and bathrooms are more expensive for their size than non-serviced areas. For electricity there is a connection cost and a wiring cost for each room. In addition, there is the monthly charge. All of these costs can be represented in graphical form, in model form and in electronic form. The costs are presented in monthly form – which is the way that people think about housing expenditure – and are totally inclusive. That is to say, they include not only all construction costs (including professional fees, interest during construction, facilitation costs, administration of sales and conveyancing, etc.), but also monthly service charges and rates.

Sanitation is a major factor in such decisions, and the model allows comparison in the cost-in-use of six different sanitation solutions. In other words the user is not required to evaluate the relative capital and running costs – the model incorporates monthly amortisation of capital costs as well as water consumption, etc., thus allowing all costs to be presented as a single monthly outgoing.

Two problems arise in practice when trying to apply the model. The first is the diversity that can emerge from a group: for example a person with a large family might prefer to go for space as an absolute priority, and minimise expenditure on services, while a person in the same income group who has no family will prefer the convenience of good services and will not treat space as an overriding objective. To serve both these needs on contiguous erven is impractical, so there must inevitably be clustering of those with similar objectives. Thus the model can be used to channel those with similar needs into similar projects or parts of projects. In this context the original objective of the Goldev project's Housing Clubs[1] is a useful concept that is capable of further development. This was that each group of 20 families would determine the layout, internal servicing and, possibly, house design within their "Club". The strength of this concept is that it provided a structure within which diversity could be managed. In this respect it echoes the system used in the Lusaka Squatter Upgrading Project, where it was applied with great success in the overspill areas, where each group of 25 families was free to prepare its own layout. The concept gains added practicality if the housing is built under the control of the householder, either by self-help or small contractor.

The second problem is that of understanding the choices. No one can pretend that working with a computer is either user-friendly or communicative. Therefore, as a start, the model should be supported by cardboard – or similar – models that illustrate the type of solutions being chosen.

3.2 Land use

In the consultation process, there are usually two stages. The first is what might be considered the strategic stage: looking at the needs of the majority of beneficiaries who are hoping to obtain housing on the site. This will give guidance on servicing standards and land use. The second stage is a refinement of relationship to both design and cost.

Given the present pricing policy of land, the advantages to society and the urban economies of high densities are not reflected in the cost of the land itself and the on-site servicing. Until a system is introduced to intervene in some way, there is not a strong economic incentive to reduce erf size. However, a reduction in erf size has another consequence: it increases the number of families that may be housed on a given piece of land. All the above arguments apply in even stronger terms to multi-storey development.

[1] This was undertaken as a collaboration between Planact and USAID's Community and Urban Services Project, 1994

The model therefore has a second application: it calculates the land use requirements for a given site, including all land uses applicable to a community of a specific size. Thus, when a community or its leaders are considering erf size, they may quickly see how many families can be accommodated for a given erf size.

Both types of information are difficult to carry in one's head, and so a quick and easy print out system is essential, so that each decision can be recorded on paper, and, if necessary, referred back to.

4. How it works

The starting point for any realistic assessment of sanitation and housing demand must be the amount of money available for housing, and subsequent decisions should all be referred back to that commitment. Therefore, whether the model is being used by a person or a group of people, it is essential to think very carefully about the question of affordability.

Once this has been done, the model asks a series of questions, which will be discussed in detail below. These try to follow the natural progression of thought of most people when it comes to housing: for example to start off with the number and type of rooms, and progress through detail on the house to the erf size and servicing details. Throughout the process the total capital cost and monthly cost of the solution proposed are displayed on the screen. At any time the person can change to previous decisions, or may decide to do several quite different ones just to see what the results are, and then compare the print-outs.

The costs displayed are based on construction costs supplied by a quantity surveyor, engineer, or other knowledgeable person. The method for making these inputs is described in detail in a special section on that matter below. But they do not only include construction costs per se: they include all construction overheads such as professional fees, sales and transfer costs, and monthly service charges and rates. The beneficiary may select rental or purchase, which will also affect the level of monthly cost.

Once a satisfactory solution has been arrived at, a final print out can be made, together with a schedule of payments. This will show the bond payments, service charges and maintenance at current rates. Obviously in the case of bond repayments the current interest rates are used, but alternative print-outs can be quickly generated using other rates.

The model has been used successfully in three ways.

The most detailed and effective method for individual consultations is to work with the client on the computer. However, many people are intimidated by computers and find it easier to visualise the options by means of models. The scales of about 1:50 or 1:20 have been found to be effective. In such circumstances the computer is used to obtain the costs quickly and effectively and to print out the results.

The second option is to work with groups who can debate the options and arrive at consensus regarding their requirements as far as, for example, sanitation and road standards are concerned.

The third option which has been used with success is to use a miniature model kit as the basis for individual interviews. In such cases the computer is not used, but limited choice costed options are used which can be added by the interviewer.

Basic Data

What is your name?	Duncan	
What is your occupation?	Security Guard	
How many adults live in your household (including yourself)?	1	
How many children?	2	
How much do you earn a month?	R1,500.00	
How much do you spend on housing each month?	R200.00	13.33%
How much do you spend on service charges for water, rubbish removal etc?	R60.00	4.00%
How much can you afford to spend on housing and service charges together, every month?	R370.00	24.67%
Do you want to buy or rent?	○ Rent ◉ Buy	

5. A step-by-step description of the model

Important Note
Before using the model, it is essential that the costs and site data are checked by a professional to ensure that they are correct.

For users unfamiliar with using computers, instructions regarding how to use this program are given in Appendix 1.

5.1 MAIN MENU PAGE

When the file is loaded it automatically goes to the Main Menu. Using the mouse, place the little hand over the top bar "Finances" and click the left hand button.

5.2 FINANCES PAGE

Opposite you will find a reproduction of the Finances Page, and all other pages will be reproduced in connection with a description of how to use them.

1. Place the cursor (which will be in the form of a " + " symbol) over the top right hand cell, click the mouse, and type in the person's name and then press the "enter" key. (The reason for typing in the person's name is that it is used in the final print-out, which will be given to the enquirer, which gives a sense of achievement to him or her.)

2. Once the name has been typed and entered, the "entry box" will move down to the next cell, in which you should enter the person's occupation.

3. Type in the person's monthly income. Most people are shy of revealing their income, but this is an essential component in the decision regarding how much to spend on housing. If the person does not want to reveal his or her income, it is sufficient to record an amount for monthly housing expenditure – see the next box. (However, please note that the feature called "Optimise Model" requires that income be entered if it is to be run). When entering the income simply type in the numbers: the program will not accept an entry that has the R symbol before the numbers.

4. The next box asks for the current monthly rental or bond payment. Make sure that the person understands the question properly,

5. This question is asking for the amount that the person spends on service charges each month. Make sure that the person understands the question properly, and then type in the response.

6. Now ask the person whether he or she can afford to spend any more. If the reply suggests a figure that is very much higher than before, you should ask him or her to think about it carefully, and consider the need to budget for school fees, transport, hire purchase payments, etc. Make sure that this figure is carefully considered.

This is the most important single entry in the model, as people will always be inclined to shift the goal posts of expenditure when they realise how different their expectations are from their means to meet them. For example they always want more than they can afford, and in grappling with that issue will, in an act of self-deception, convince themselves that they can spend more than they can truly afford. This initial target should therefore be treated with great respect. The percentage of the target met is included in the print-outs, for information.

7. The entry box will now move down to the "Rent" or "Buy" box. There will be a black circle in one of them, indicating that this is the option currently selected. When the person has decided the answer, and that answer is different from the one already selected, move the cursor over the bar. It will change to a little hand when it is over the circle. Now click the mouse and the dot will move to the selected choice.

8. At the bottom of the page there are three bars: "Optimise Model", "House Design", and "Return to Main Menu".

The "Optimise Model" bar helps the person by proposing a solution that is affordable within very broad limits, based on the person's stated salary.

There are advantages and disadvantages of using the "Optimise Model" bar. The advantage is that the person is starting with a cost figure that is within his or her affordable range, and therefore he can see relatively quickly what the impact is of making changes. It is also likely to make the process quicker.

The disadvantage is that it may influence the person to adopt a specific solution without a full consideration of the choices, which will ultimately lead him or her to feel that he has been cheated, or that the decision is not truly valid.

Which approach to adopt should be considered in the light of the type of respondent beneficiary, but in general it may be considered preferable.

To select the "Optimise Model" move the cursor until it is over the bar and click the mouse. The cursor will now change from a hand to an hourglass, indicating that the computer is calculating: this process will take anything from 10 to 60 seconds. Once it has finished, the page will automatically change to House Design.

If you do not want to "Optimise Model", move the cursor to the House Design bar, and click the mouse.

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The Sanitation Menu

What sort of sanitation would you like?

Improved, ventilated pit latrine	◉
Improved, ventilated double pit latrine	○
Composting pit latrine	○

Shared water tap	◉
Individual water tap	○

Conventional sewers	○
Small bore shallow sewers	○

Piped water, with toilet and shower in one room	○
Piped water, with toilet and shower in separate rooms	○
Piped water, with bathroom incl bath, wc and basin	○

Gross Capital Cost	**R41,645**	
Nett Monthly Payment	**R87**	**5.81%**

5.3 SANITATION PAGE

The selections on this page need to be made with care, as they have major financial implications. The most important distinction is between on-site sanitation, and waterborne sanitation. The costing is applied in such a way that the following costs are included:

On-site sanitation

There are three choices:

- The standard ventilated pit latrine
- The double pit latrine
- The composting latrine

If any of these selections is made, the following are included:

- The structure itself, together with the pit.
- The cost of an individual or shared water connection (as specified), and monthly water charges based on the level of water consumption associated with the supply selected.

Since on-site sanitation does not require water to operate, the user can choose whether to use a standpipe for his/her water supply, or whether to go for a higher cost solution – an individual water tap on the stand.

Waterborne Sanitation

There are two choices:

- Small bore sewers
- Conventional sewers

When waterborne sanitation is selected, the following costs are activated:

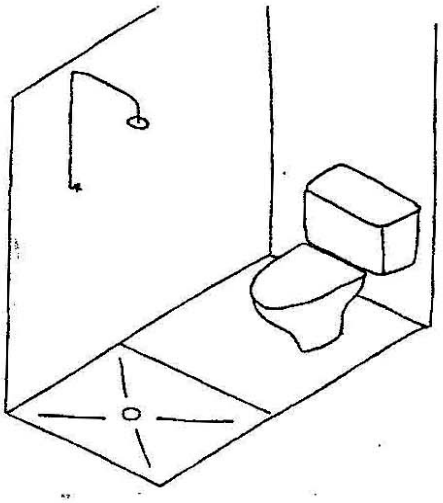
- A sewer is provided, and monthly costs for sewerage treatment are included
- A water connection is provided, and monthly costs for water consumption are included
- The cost of all fittings, together with the drain to the sewer and inspection chamber
- The cost of the pipe work
- The cost of the room(s) in the house (including doors and windows, of course) together with finishes as specified for the other rooms in the house.

One choice may be made from the five alternatives offered. Please note that the rooms are the standard minimum room sizes for the type of facility offered.

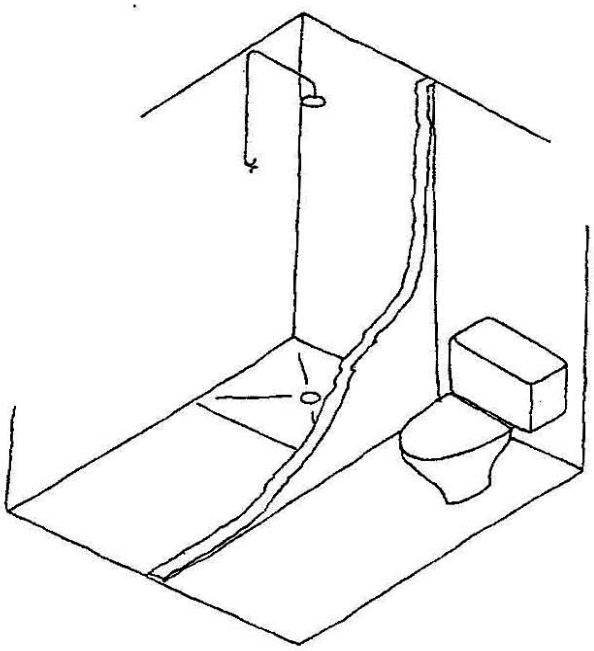
Sanitation Extras Menu

Do you want a w.c. in separate room? (must have bathroom)	☐
Do you want a shower in separate room? (must have bathroom)	☐
Do you want a kitchen sink? (must have piped water)	☐
Do you want a basin in the bedroom? (must have piped water)	☐

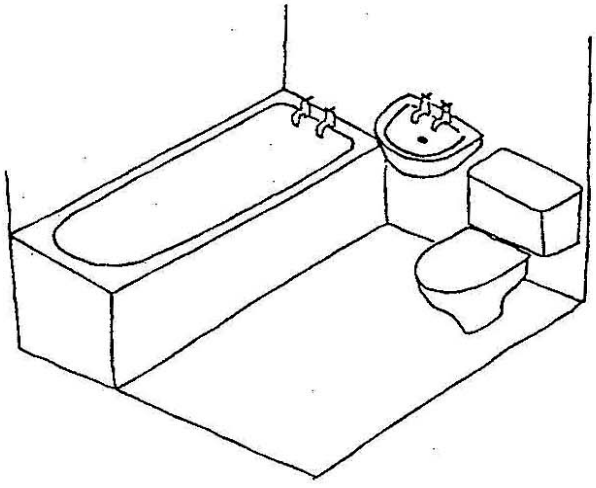
Gross Capital Cost	**R41,645**	
Nett Monthly Payment	**R87**	**5.81%**



Toilet and shower in one room



Toilet and shower in separate rooms



Bathroom including bath, WC and basin

Sanitation Extras

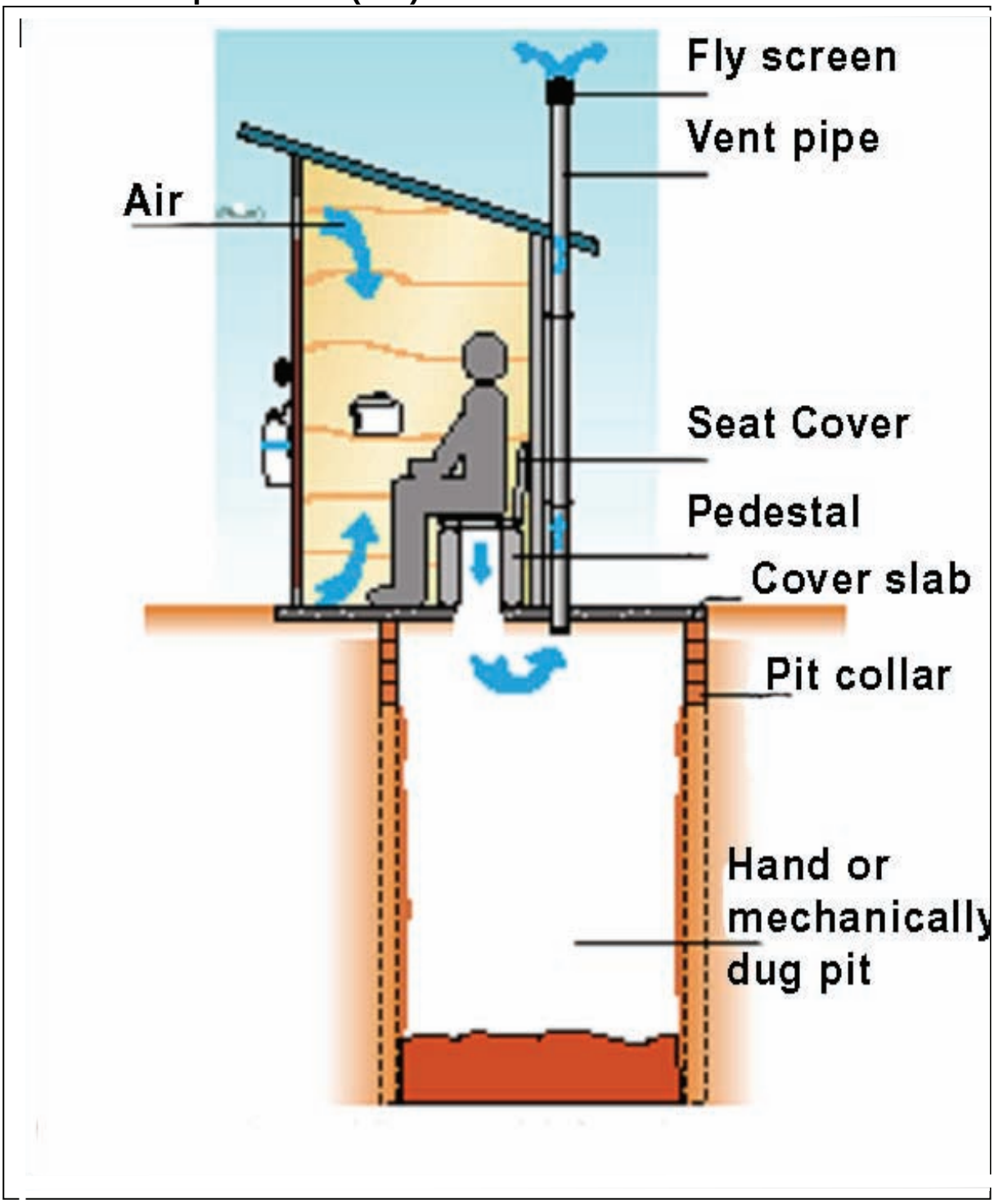
After the selection has been made from the first five options, there are "optional extras", as shown in the copy of the menu on the opposite page. Following this are arrangements for improved services which are self explanatory. It is possible to choose all or any of them, but there are pre-conditions which are noted.

Illustrations of Sanitation Options

On the following pages are illustrations of the sanitation options which have to be explained to the participant(s) in some detail so that they can make informed decisions. These illustrations are taken from the following publication:

Department of Water Affairs and Forestry, (undated) *Sanitation is Dignity: Sanitation Technology Options*. DWAF, Pretoria, South Africa.

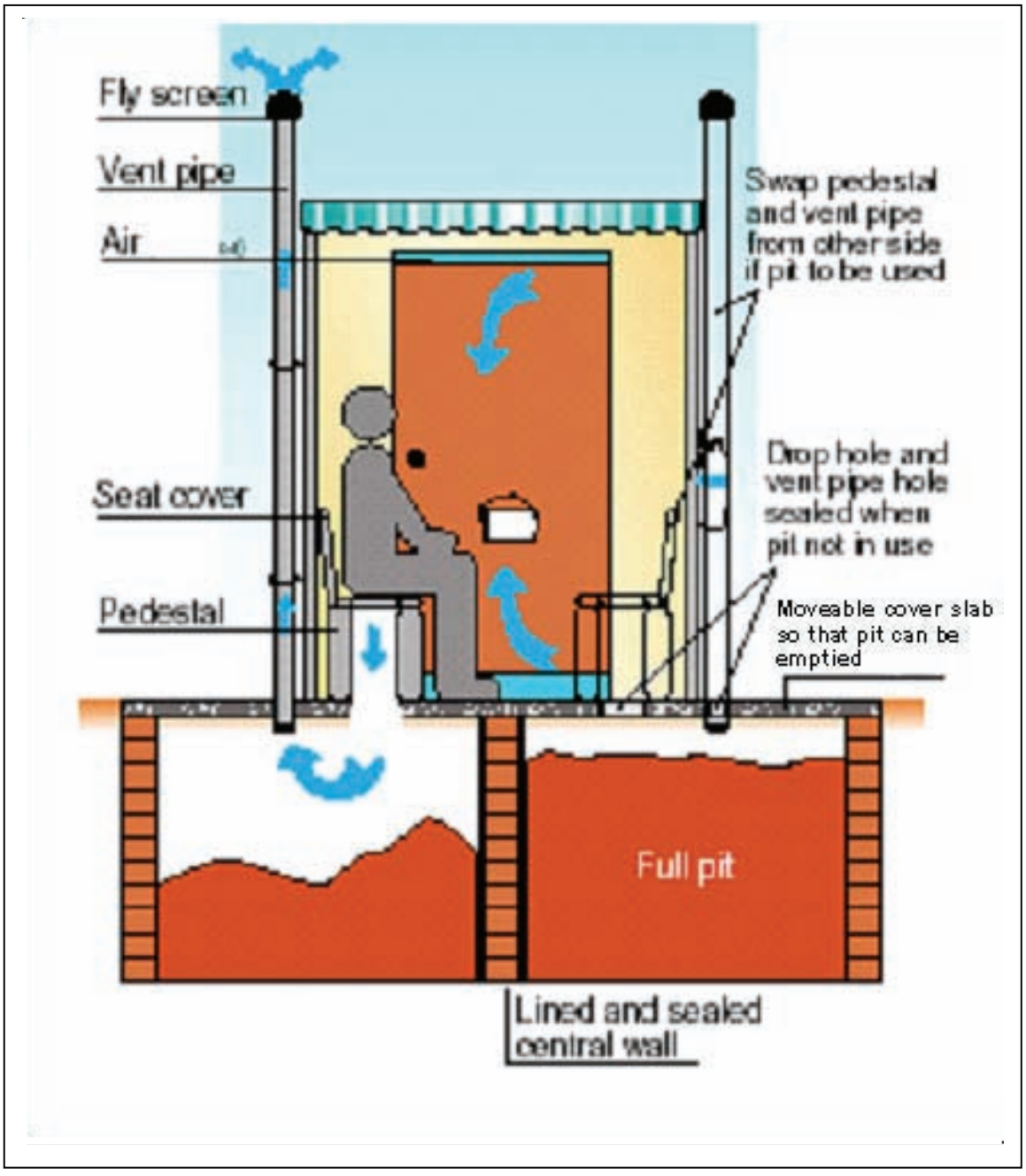
Ventilated Improved Pit (VIP) Toilet



Consumer responses: Widely used in rural and peri-urban areas of SA. Excellent for the bottom of the range. Affordable to the poorest.
Application requirements: No water or sewer networks needed. Suitable in arid and semi-arid areas (most of South Africa).

Capital cost: R5 500
Maintenance cost R250 p.a.

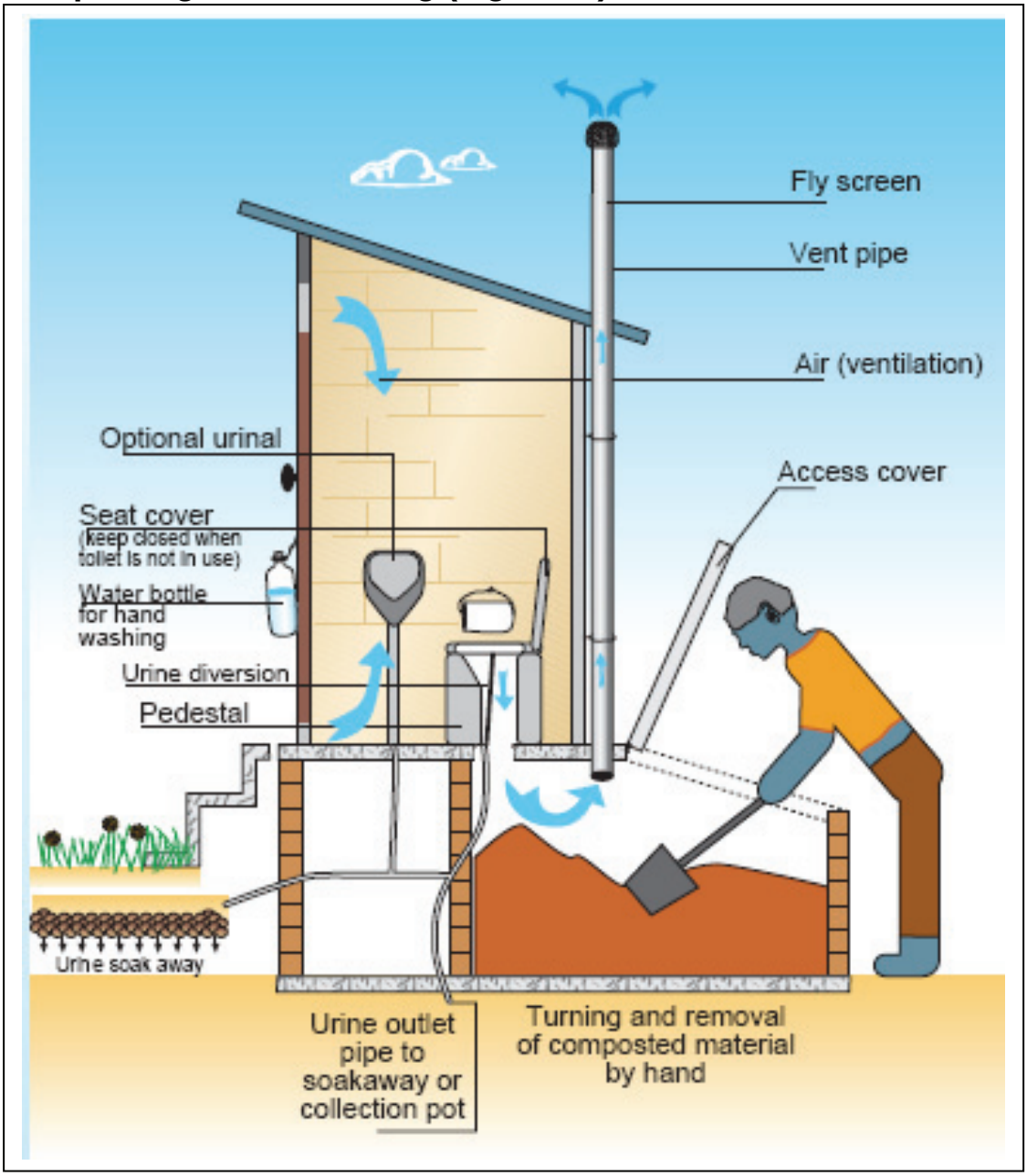
Ventilated Improved Double Pit (VIDP)



Consumer responses: Excellent for the bottom of the range. Affordable to the poorest. Emptying the full pit is not always acceptable to consumers.
Application requirements: No water or sewer networks needed. Suitable in dry conditions and where soil conditions make deeper excavations for a single pit infeasible.

Capital Cost R6 000
Maintenance R150 p.a.

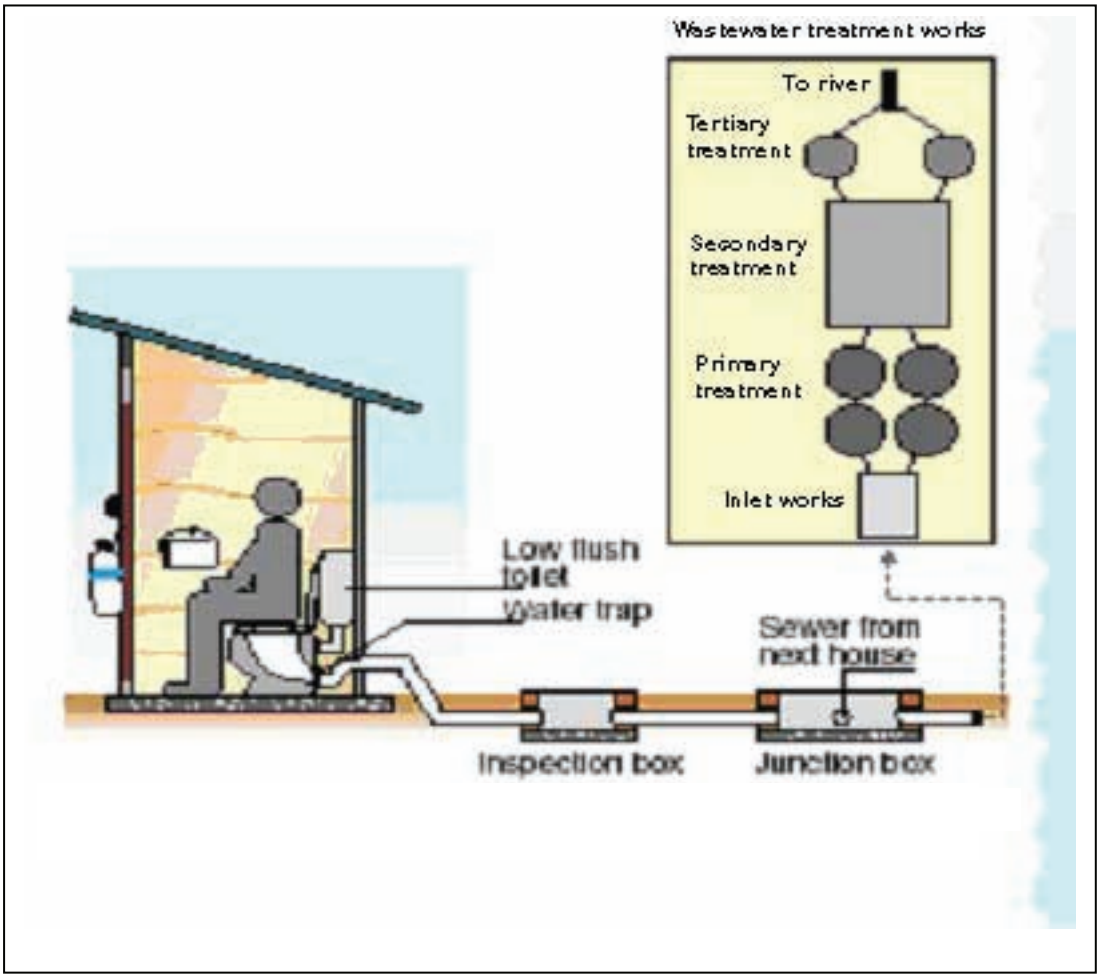
Composting or desiccating (e.g. UDS) toilet



Consumer responses: Not in wide use in SA yet – still being monitored and tested. More expensive than VIPs.
Application requirements: No water or sewer networks needed. If moisture is not kept separate and controlled, this toilet may become malodorous. A bit sensitive to handle.

Capital cost R7 500
Maintenance R650 p.a.

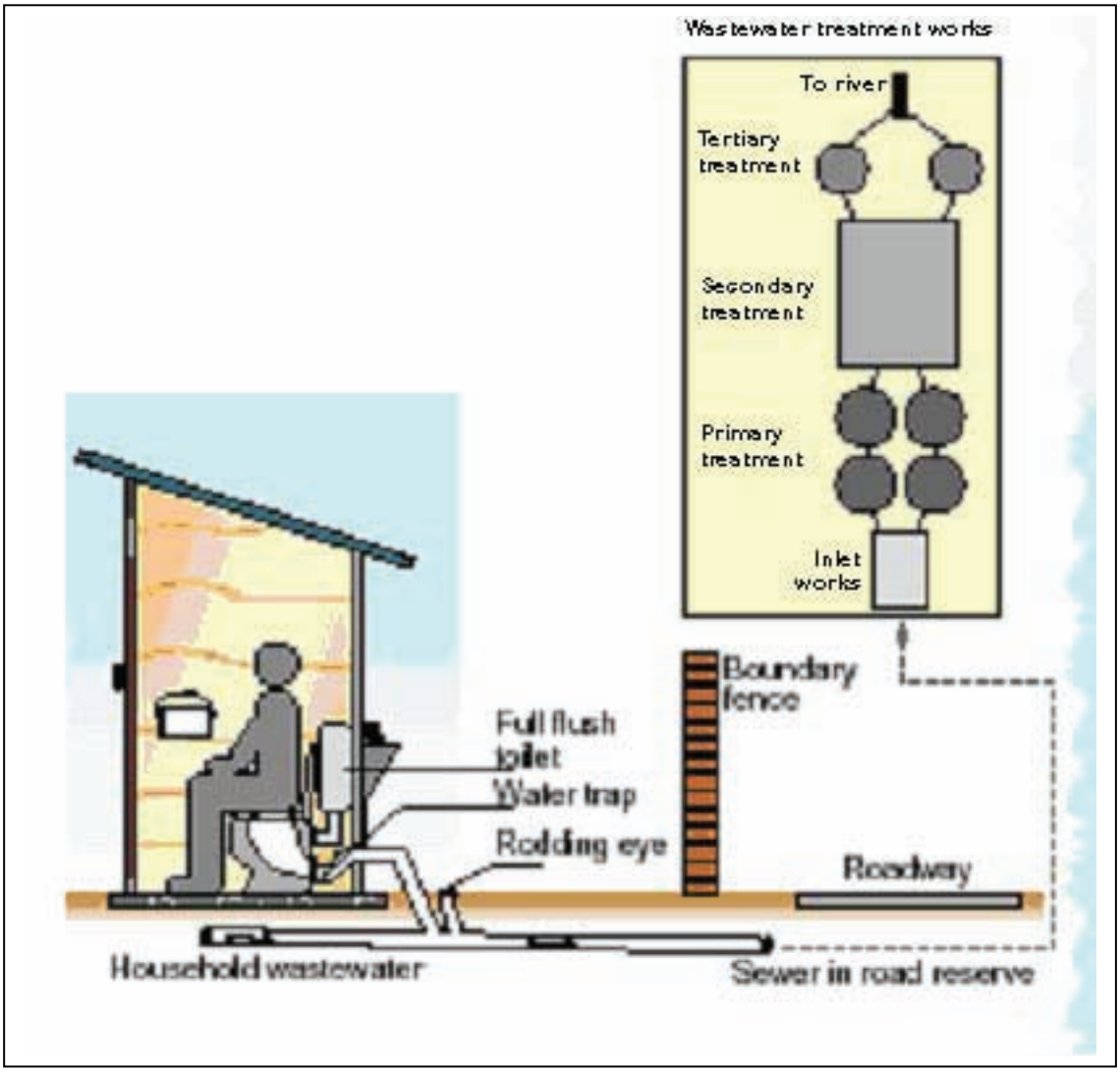
Shallow waterborne sewerage system



Consumer responses: A new concept in South Africa.
Application requirements: Water and sewer reticulation networks are needed as well as wastewater treatment plants. Shallow pipes may break due to external loads, despite much cheaper costs than full conventional waterborne systems.

Capital cost R4 500
Maintenance R600 p.a.

Full conventional waterborne sewerage system:



Consumer responses: Top of the range. The aspiration of most South Africans, although not affordable to many.
Cost recovery sometimes problematic. Application requirements: Both water and sewer networks are needed, as well as wastewater treatment plants. Very costly. Health consequences of failure of wastewater treatment plants are enormous in comparison with failure of dry, on-site sanitation systems.

Capital cost R10 250
Maintenance R1 100 p.a.

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Housing Design Menu

Describe the sort of house you need by listing the rooms that you want and saying how big you want them:

Room (Bathroom, shower and w.c. are selected on the Sanitation screen)	Select	Length m	Width m
Living Room	☑	4.00	3.00
Bedroom 1	☐	3.00	3.00
Bedroom 2	☐	3.00	3.00
Bedroom 3	☐	3.00	3.00
Bedroom 4	☐	3.00	3.00
Kitchen	☐	3.00	3.00
Dining Room	☐	3.00	3.00
Balcony or Stoep	☐	3.00	1.50

Gross Capital Cost	**R41,645**	
Nett Monthly Payment	**R87**	**5.81%**

5.4 HOUSE DESIGN PAGE

This page allows the person to choose the size and number of rooms. The first step is to click down the select column. Boxes which have an "x" in them have already been selected. If the person does not wish to select that option clicking on the "x" will remove it. Where the box is currently empty, it may be selected by clicking over it with the mouse, at which stage an *"x"* will appear.

By clicking down the "Select" column one is choosing which rooms to include in the house. It will be noticed that each time a selection is made, the figures at the bottom of the page "Gross Capital Cost" and "Nett Monthly Payment" will change.

It is possible to change the dimensions to suit the needs of the customer, but normally it is better not to go into detail at the first try. Cardboard models with furniture in them to give a sense of scale are useful in assisting in this process. It should be noted that the model will accept any dimension, (e.g. 2.85 m) and not just whole units of metres.

It will be noticed that there is no mention of bathrooms, toilets or showers. These are selected on a separate page.

Balconies and verandahs may also be included. At this stage it may be noted that it is possible to specify that some of the rooms should be provided in the form of a slab only, or slab and roof: this is done on the next page. On this page what is selected is the ultimate size of the house: the various cost savings techniques are applied as a separate exercise.

Meanwhile it will be noticed that a capital cost figure and monthly charge appear on the bottom of the page. Each time a room is selected, the figure will change. Until the house has been designed in its entirety these figures do not mean much, though if the "optimise model" procedure has been adopted they will be a comparatively satisfactory guide. For example, if one has optimised the model, or is on a second iteration of the process, one can quickly see how much is added to the cost by adding or enlarging a room.

When this page has been selected, click the bar called "Savings" to turn to the next page.

Savings Menu

Would you like this to be a normal house, with all walls and roofing - no savings ?	◉
Would you like this to be a one room house, with slab and roof ?	○
Would you like this to be a one room house and slab ?	○
Would you like the external walls, roof and slab only ?	○
Would you like the external walls and roof but no slab ?	○
Would you like this to be a slab and toilet block only ?	○

There are 1 internal doors. How many do you want?	1

Gross Capital Cost	R41,645	
Nett Monthly Payment	R87	5.81%

5.5 SAVINGS PAGE

This page offers several alternative ways of saving cost.

It should be noted that if the person has a/ready selected a very small house, most alternatives on this page will be of little relevance.

It is recommended that this page be skipped the first time around: it can be returned to when all other choices have been made.

The principle of each alternative is described below, and should be carefully explained, with assistance from the illustration on the next page which shows how the savings are calculated.

There are six choices, as illustrated on the next page.

1. This is the "normal house" with no savings. (Top left hand side of the illustration on the next page).

2. "One room house with slab and roof"

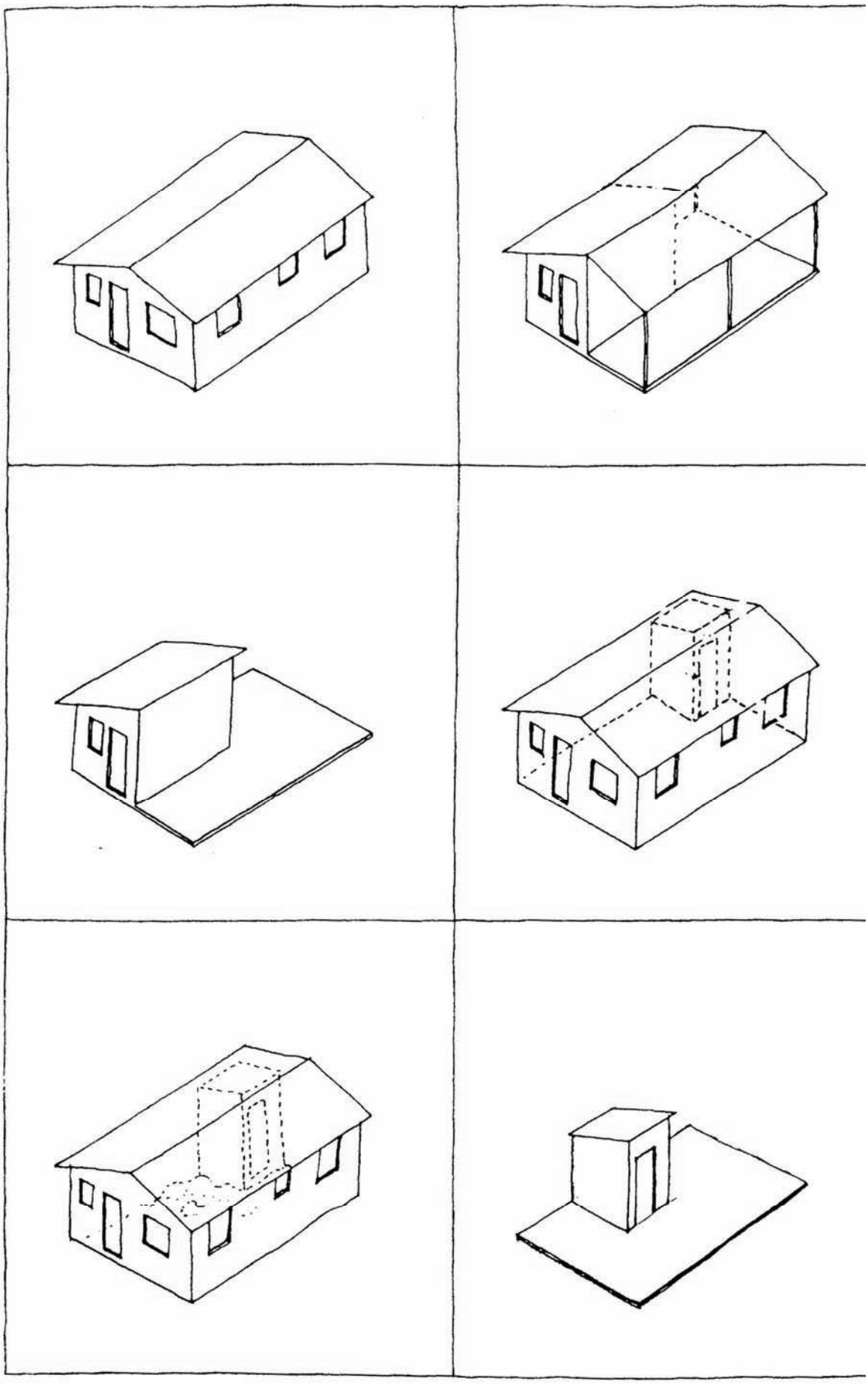
This is what is commonly called a "core house", and is illustrated in the top right hand side of the illustration overleaf. Assuming that, for example, a four room house has been selected on the previous page, by selecting this option we omit the walls and windows of all rooms except one, and the toilet accommodation. The foundations for walls not built at this stage are included underneath the slab. If the house is already only one room and we attempt to remove it, an error message pops up in red below.

3. "One room house and slab"

This option is the same as the above, but leaves out the roof over all rooms except one. This is illustrated in the left hand middle picture over.

4. "External walls, roof and slab only"

This option omits all internal walls to make what is sometimes called a "shell house". All windows and external doors, as well as the toilets and/or bathroom (if they have been selected) are retained, as well as any finishes that have been selected, such as plaster and paint. Foundations for the omitted walls are included under the slab. This is illustrated in the right hand middle picture over.



5. "External walls and roof but no slab"

This is the same as the above, but omits the slab as well as the foundations of internal walls. This is illustrated in the bottom left picture opposite.

6. "Slab and toilet block only"

This is the same in principle as option 2 above, but has no habitable rooms, and is illustrated in the bottom right picture opposite.

Finally, there is the opportunity to leave out some internal doors. The number of doors included in the selected option is stated in the text in the box, and will vary depending on the design proposal. The number requested is entered in the box on the right. The number must either be lower than that stated, or the same. If the number is larger that the maximum number required, an error message will appear.

Finishes and Electrical Services Menu

Do you want the Outside Walls Plastered?	☐
Do you want the Inside Walls Plastered?	☐
Do you want Ceilings?	☐
Do you want the Outside Walls Painted?	☐
Do you want the Inside Walls & Ceiling Painted?	☐
Do you want PVC Floor Tiles?	☐

Do you want Electricity?	☐
Do you want hot water? (must have electricity)	☐

Gross Capital Cost	**R41,645**	
Nett Monthly Payment	**R87**	**5.81%**

5.6 FINISHES AND ELECTRICITY PAGE

Any combination of these selections may be made. Boxes with an "x" in them indicate that that choice has been selected. To de-select, click over the "x" with a mouse. To select those without an "x", also simply click over the square with the mouse.

If electricity is selected, the model includes the cost of the electrical connection as well as the wiring and fittings to all rooms that have been selected. It also includes the cost of monthly charges for electricity used.

If hot water in selected, the following costs are included:

- The cost of hot water piping to all fittings specified, namely shower, sink, wash hand basin or bath.
- The cost of the geyser and its electrical connection to the distribution board.

Building and Erf-Type Menu

In what type of house or flat do you want to live?

Detached house in township or suburb		◉
Semi - detached house in township or suburb		○
Terrace (Row) house in township or suburb		○
Two storey house in township or suburb		○
What erf (stand) size do you want?	Frontage :	8.00m
(Erf size is calculated automatically for flats)	Depth :	20.00m
Flat in the centre of town (10 storeys)		○
Flat at the edge of town (3 storeys)		○

Number of Units	1,463	
Gross Capital Cost	R41,645	
Nett Monthly Payment	R87	5.81%

5.7 BUILDING AND ERF TYPE PAGE

This page gives the options with regards to built form. The first four choices all stand in their own erf, and are appropriate for individual tenure. The other two are flats.

The customer should be shown drawings of the different options, so as to make sure that he or she understands what they are.

The choice of the unit and the width of the erf are closely linked, and should be made with an understanding of the issues. Guidance on this is given below, in relation to each alternative. It should be noted that the depth of the erf is unaffected by the house type selected.

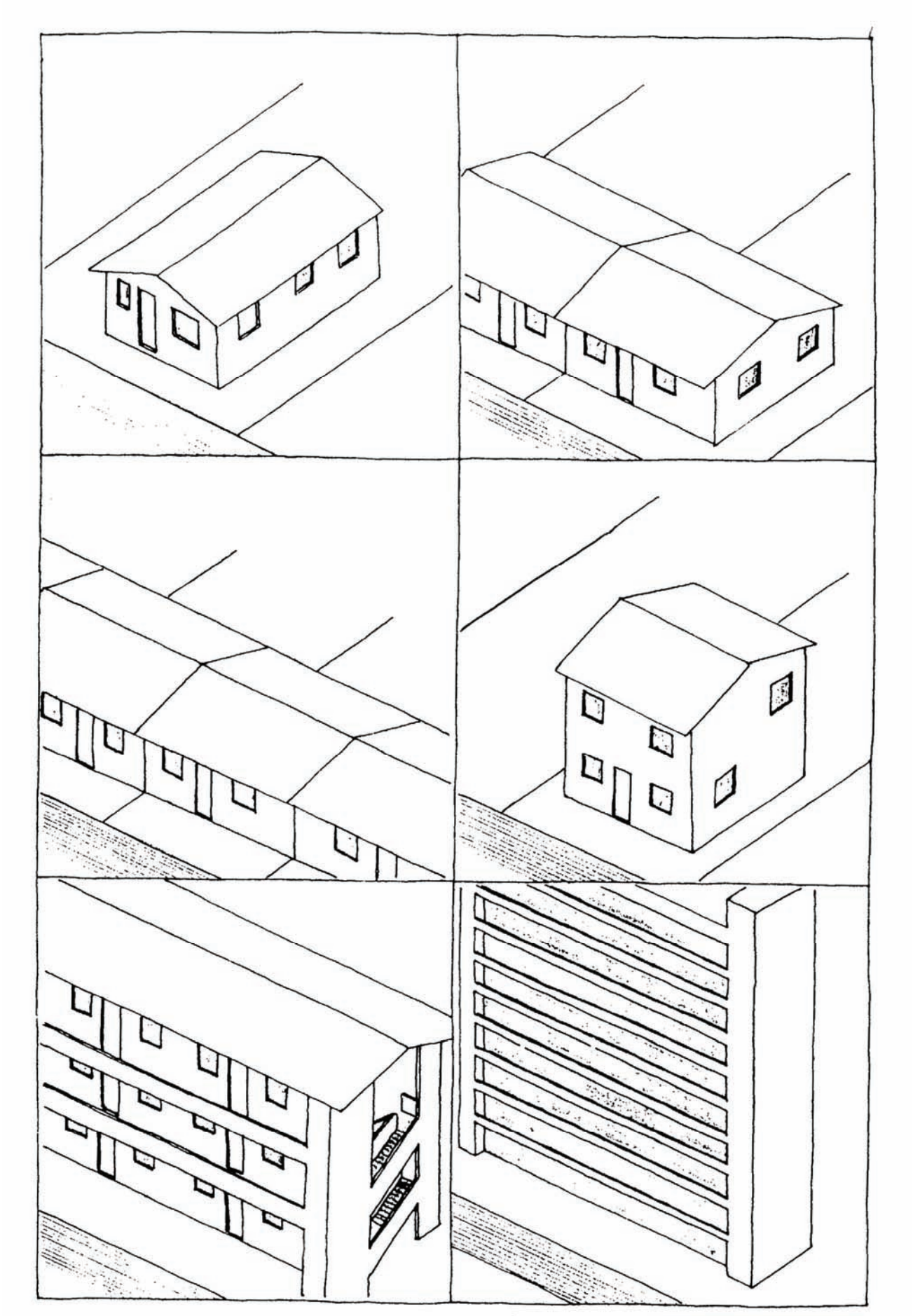
1. Detached House (top left picture on the next page)
This is the normal house unattached to any other, and standing in its own erf. The minimum size of the erf will be related to the design of the house, but clearly must be larger than any others to provide at least one metre each side of the building. Thus, assuming a normal minimum width of the house itself as about 6.5 metres, the erf should be at least 8.5 wide. The more normal minimum for this solution, however, is 10 metres.

2. Semi-Detached house (top right picture on the next page).
The cost of construction of this is reduced by the fact that it shares one wall with the neighbouring unit. This also permits a saving in the size of the erf: 8 metres is quite practical for this solution.

3. Terrace (Row) house (middle left picture on the next page)
The cost of this is further reduced by the fact that it shares two walls with the neighbouring unit. The erf size is fixed by the width of the unit, and is therefore not an option that the customer can select.

(In the event that the customer does make an entry into the box displaying the width of the erf the program will disregard it if a terrace house has been selected.)

4. Two storey house (middle right picture on the next page)
This is designed to be a free-standing unit, which is appropriate in two conditions:
– where the house is at least 50 square metres (thus giving a "footprint" of 25 square metres) and preferably more; and where, due to high land prices or similar factors there is a need for high density.



This is generally a more expensive solution, for the following reasons:
– It is necessary to have a staircase, which is an expense not required in a single storey building.
– The building technology required is more complex: for example reinforced concrete upper floor, and the need for scaffolding when building the upper floor.

The next choice concerns the erf size. This has an important impact on the cost of services and the consumption of land. The effect of changing the erf size can be seen in the cost figures displayed at the foot of the page, as well as the number of stands or erven that can be accommodated on a given site if all the units are identical. (A discussion of the land-use aspects of housing projects and how the model calculates these is given below).

For obvious reasons the erf size for flats is not entered by the customer: This is calculated automatically.

The last two options are for flats. It will be noticed that there is a substantial cost difference between the two solutions.

This can be explained by:

3-storey flats (bottom left picture)
The cost here is based on the following design assumptions:

- Shared staircases
- Balcony access to individual flats
- Reinforced concrete frame with masonry infill.

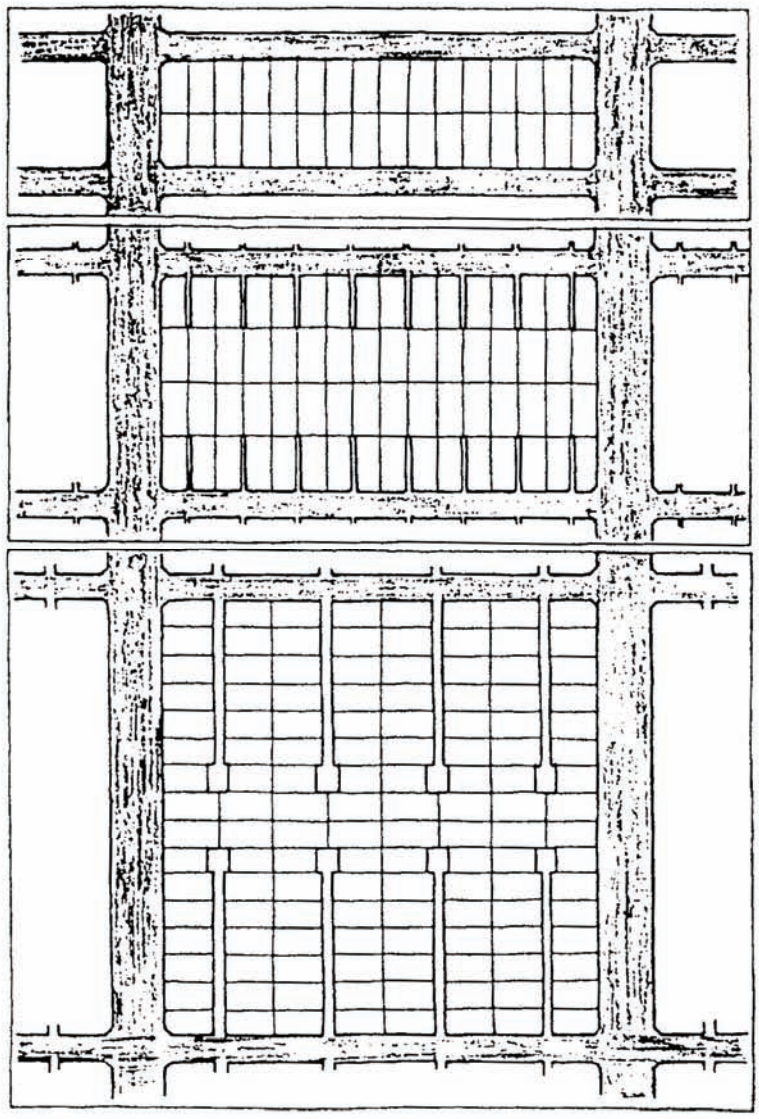
10-storey flats (bottom right picture)

- As above, but with lifts providing the vertical circulation.
- Car parking provided in the basement.

Roads, Layout Type and Lighting Menu

Width of access to front of erf?	Very narrow (3m) (pedestrian way)
How should it be finished?	Nothing
Width of roads serving your area	Normal (16m)
How should they be finished?	Nothing
Which type of block layout do you want?	Conventional: 2 erven deep
Which lighting option do you want?	Tower lighting

Number of Units	**1,463**	
Gross Capital Cost	**R41,645**	
Nett Monthly Payment	**R87**	**5.81%**



Conventional

Double block

Super block

5.8 ROADS, LAYOUT TYPE AND LIGHTING PAGE

In this page, the options are presented in the form of little pull-down menus.

Selections must be made for all five types of choice.

It should be explained what the terms mean. Put very simply, the access being selected in the top box ("Width of access to front of the erf") is the road from which one gets access to the house, which typically runs down the long end of the block. The term "road" has been avoided, as this access may take the form of a pedestrian way.

The other access ("width of roads serving your area") is that which runs down the end of the block. This is illustrated in more detail on the following page.

Below each question on the width of the access is a question on the standard of finish. The term finish is slightly misleading, as it actually refers more to the type of construction. That is to say, the option "nothing" means that the road reserve is established at the width selected, but no construction work takes place on the road or access way. Discretion must be used here, as in soft clayey soils, for example, it will not be practical to have no road finish, whereas on sites with gravelly soils this is quite acceptable.

The next question has major implications for land use and cost (and changes will be noticed in the data on the bottom of the page), particularly if comparatively wide roads have been selected. It offers the possibility of selecting either a conventional road layout (the most expensive option, and the top illustration opposite), or a double depth block (middle illustration), with the rear erven reached by a pedestrian way between the two erven in front, and the "superblock" which is eight erven deep (bottom illustration). It should be noted that the erf dimensions of the front erven in double and superblocks will be reduced by the need for the pedestrian access.

The question about lighting is self explanatory.

Fencing and Walling Menu

Decide the type of fencing/walling around your stand:

Type of fencing/walling?	Nothing

Decide where you want the fencing/walling:

Fencing/Walling at front of stand?	☐
Fencing/Walling at back of stand?	☐
Fencing/Walling down sides of stand?	☐

Gross Capital Cost	**R41,645**	
Nett Monthly Payment	**R87**	**5.81%**

5.9 FENCING AND WALLING PAGE

There are two types of fencing and one type of walling that can be selected from a little pull-down menu. If any fencing or walling is selected, then the three options must be selected below to indicate where the walling fencing or walling is required.

Once this has been done, the beneficiary may select the location of the fencing or walling.

This is the last page, following which the user may choose to obtain a print-out. This is done by returning to the Main Menu, by clicking on the bar at the bottom of the page. On the Main Menu will be found another bar entitled Print.

Inevitably the first package of choices does not exactly suit the needs of the user, usually because the solution is too expensive. Also, there may be an interest in finding out the impact of changes, e.g. a trade-off between larger rooms and better finishes.

The user should therefore be encouraged to make as many choices as he or she needs to do in order to arrive at a satisfactory solution. It is often useful to print out the choices at the end of each attempt (see below for instructions on how to do this). The role of the operator here is not to guide the person. However, it is really important that the user does not arrive at a solution that is obviously too expensive, and the operator should do everything possible to persuade the user to be realistic in this regard. The boxes at the base of the page can be used to move from one page to the next, in either direction.

Therefore, each time a person has run through the questions, the operator should ask him or her whether he or she would like to try again, and only when the person says that he or she is satisfied should the exercise be treated as completed.

Summary for Duncan

Finances	
Income per month	R1,500
Desired Monthly Payment	R370
Rent or Buy	Buy

House Design	
Living Room	No
Bedroom 1	No
Bedroom 2	No
Bedroom 3	No
Bedroom 4	No
Kitchen	No
Dining Room	No
Balcony or verandah	No

Savings (Omission of Walls/Roof)	Normal House - no omissions
Number of Internal Doors (max = 1)	1

Finishes and Electricity	
Plastered Walls	No
Ceilings	No
Paint on Walls and Ceilings (if any)	No
PVC Floor Tiles	No
Electricity	No

Sanitation	
Basic Sanitation	Improved, ventilated, pit latrine with shared tap - Shared Water Tap
Hot Water	No
Additional w.c. in separate room	No
Additional shower in separate room	No
Kitchen sink	No
Wash hand basin in bedroom	No

Building and Erf Type	
Selected House/Flat type	Detached house
Erf size if House chosen	Frontage: 8m Depth: 20m

Roads, Layout Type and Lighting	
Width of access to front of stand	Very narrow (3m) (pedestrian way)
Finish	Nothing
Width of roads serving the area	Normal (16m)
Finish	Nothing
Layout Type	Conventional: 2 erven deep
Lighting	Tower lighting

Fencing/Walling	
Type of Fencing/Walling	Nothing
Fencing/Walling at front of stand?	No
Fencing/Walling at back of stand?	No
Fencing/Walling down sides of stand?	No

Summary of Costs	
Land	R3,974
House	R30,604
Services	R2,931
Capital cost	R41,645
Bond payment without subsidy	R488
Gross Payment	R575
Subsidised payment	R87
% of income	5.81%
% of target expense	23.55%

5.10 REPORT

Either as soon as the person has completed the first run though the model, or at any stage, a print-out can be obtained. This can be done very quickly and easily, provided the computer is connected to a printer.

To obtain a print-out, return to the Main Menu, and click on the panel labelled "Print Summary".

The page will now change and will show a reduced version of the page. On small screens the cursor will look like a magnifying glass. To read any part of the report, simply position the cursor over the text and click, and the text will be displayed at a readable size.

To print, click on the word "print" at the top of the page. To return to the menu without printing click over the word "Close" at the top of the page.

An example of the print-out is shown opposite.

Financial Data Report

Land Price (Rand per square metre)	R15.00
Deposit (% of gross capital cost)	0.00
Bond Rate (Annual % for purchase)	13.00
Interest Rate (Annual % for renting)	12.00
Number of Years (for purchase)	20

Nett Monthly Payment	R87
Gross Bond/Rent Cost:	(R37,481)
Gross Cost including service charges and maintenance:	R93,969

5.11 FINANCIAL DATA

Once this stage has been reached, a Table showing monthly payments and the gross costs may be printed out. Different Tables have been prepared for buying and renting.

The buying Table is based on the bond rate (i.e. interest rate for the loan) and period. These are entered on the screen. In addition, for completeness, a sum has been included for service charges (which are included in all calculations of gross monthly cost produced by the program), and which are specified in the Table; as well as an allowance for maintenance. This increases at the projected rate of inflation.

Enquirers may want to find out the impact of borrowing short term money (which usually carries a higher interest rate) as compared to a conventional Bond. The program allows this to be entered and immediately printed out, giving the total expenditure as well as the annual and monthly rates for comparative purposes. Other factors such as inflation rates may also be changed as required.

Calculations on the rental Table are obviously more speculative, as there are several factors that affect rent levels which are primarily commercial decisions. The most important one is the rate of return that the investor is expecting, and the second one is the rate of annual increase of the rent. In addition it is customary for rent to include two components: the rate of return on the capital invested, and the cost of operating and maintaining the building - the so-called "Ops Costs". In other respects the Table follows the layout of the purchase Table.

Examples of both Tables are given overleaf.

Estimates of Cost - Renting

Estimate of total costs: renting: first twenty years				
Inflation rate%	10.00		Services charges	
Initial yld (rent)	12.00	(% rate annually on capital)	Water	
Low rise ops	0.60	(Rand/sm/month)	Sewage	
High rise ops	3.00	(Rand/sm/month)	Electricity	
Maintenance	3.00	(% of gross capital cost p.a.)	Refuse removal	10
Cost of house	41,645		Street lighting	
Subsidy	54,975		Administration costs (sum)	10
Subs. cost	(13,330)	(less capital subsidy)		
Deposit (%)		(% of gross capital cost)	Rates	
Deposit (R)			Annual %	2.00
Cap to be repaid	(13,330)		Amount pd	69
Total rent				
Gross payment	65,209			

Schedule

Year	Rent	Service Charge	Ops Costs
1		1,046	93
2		1,150	102
3		1,265	112
4		1,392	124
5		1,531	136
6		1,684	149
7		1,853	164
8		2,038	181
9		2,242	199
10		2,466	219
11		2,712	241
12		2,984	265
13		3,282	291
14		3,610	320
15		3,971	352
16		4,368	388
17		4,805	426
18		5,286	469
19		5,814	516
20		6,395	568
Totals		**59,893**	**5,316**
		Gross Cost	**65,209**

Estimates of Costs - Buying

Estimate of total costs: buying				
Inflation rate%	10.00		**Services charges**	
Bond rate p.a.	13.00		Water	
No.of years	20		Sewage	
Maintenance	3.00	(% of gross capital cost p.a.)	Electricity	
Cost of house	41,645		Refuse removal	10
Subsidy	54,975		Street lighting	
Subsidised cost	(13,330)	(less capital subsidy)	Administration costs (sum)	10
Deposit (%)		(% of gross capital cost)		
Deposit (R)			**Rates**	
Capital to be repaid	(13,330)		Annual %	2.00
Total: Bond	(37,481)		Amount pd	69
Gross payment	93,969			

Schedule

Year	Bond	Service Charge	Maintenance
1	(1,874)	1,046	1,249
2	(1,874)	1,150	1,374
3	(1,874)	1,265	1,512
4	(1,874)	1,392	1,663
5	(1,874)	1,531	1,829
6	(1,874)	1,684	2,012
7	(1,874)	1,853	2,213
8	(1,874)	2,038	2,435
9	(1,874)	2,242	2,678
10	(1,874)	2,466	2,946
11	(1,874)	2,712	3,240
12	(1,874)	2,984	3,565
13	(1,874)	3,282	3,921
14	(1,874)	3,610	4,313
15	(1,874)	3,971	4,744
16	(1,874)	4,368	5,219
17	(1,874)	4,805	5,741
18	(1,874)	5,286	6,315
19	(1,874)	5,814	6,946
20	(1,874)	6,395	7,641
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
Totals	**(37,481)**	**59,893**	**71,557**
		Gross Cost	**93,969**

Land Use Data

Site size (Ha)	40.00
Undevelopable area (Ha)	4.00
Other reservations (Ha)	0.00
Servitudes (Ha)	0.00
Complexity Factor %	20.00
Percentage of smaller stands	12.00
Percentage area reduction	25.00
Percentage of larger stands	15.00
Percentage area increase	20.00

5.12 LAND USE

An important part of the decision regarding erf size is the impact that it has on the number of units that can be accommodated on a specific site. The layout (single, double-or super-block) and road widths also have an important effect. It is obviously of great interest to community groups to have access to this information.

In order to make this as accurate as possible, the program allows for data on the actual site to be entered on the land-use page. This will allow quite accurate calculations to be made.

If there is insufficient information on a site, clicking on the bar labelled "use typical site" loads the data for a site of the characteristics.

When using this fictitious site, although the actual number of erven to be produced will have no significance, it allows the user to have a feel for the relative impact of changing the erf sizes, road widths or layout characteristics. This can be the basis for a useful discussion in a workshop situation about land use matters.

There are three stages in using this page:

Stage 1
Set up the data for the site

Information must be completed in respect of all items on the query list.

The terms used are:
Site size: This is the gross area measured within the boundaries.
Undevelopable area: This refers to parts of the site that cannot be developed such as rivers and their banks/floodplains; very steep or rocky areas, areas of very bad soils, etc. The program will use these undevelopable areas as public open space, and only if more is required to provide the necessary area, will so called "developable area" be used for that purpose.
Other reservations: This is land required for purposes not listed in the land use tables given below, such as an industrial area.
Servitudes: These are servitudes already in existence for utilities/rights of way, etc.
Complexity factor. This is an estimate of the amount by which the cost of servicing will exceed those that would be incurred if the site were a rectangle and could be serviced entirely with straight pipes and no wasted land or pipe work. Thus, if the figure 30 is entered here, the program will calculate that 30% more pipe work will be required, and the cost of servicing will increase correspondingly.

Once all these figures have been entered, the number of erven displayed in the relevant pages in the model will be comparatively accurate.

Land Usage Summary

Site specific variables	Hectares	Square m.
Site size (Ha)	40.00	400,000
Undevelopable area	4.00	40,000
Other reservations		
Servitudes		
Total deductibles	4.00	40,000
Area for development	36.00	360,000

Facilities provided and other planning data			
Type	Number	Area/unit	Gross Area
Primary Schools	2	28,000	48,000
High School		48,000	
Creche	6	1,000	6,000
Local Shops	110	50	5,500
Neighbourhood shops	12	900	10,800
Central shops		20,000	
Community Centres	5	600	3,000
Houses of worship	11	600	6,600
Clinics	1	1,000	1,000
Park and undevelopable (s.m.)			40,000
Gross residential area			279,100
Total			400,000

No of stands		1,463
Average stand dimensions		
Frontage	8	
Depth	20	
Area	160	
Gross density (ppha)		183
Gross density (dwellings/ha)		37
Net density (ppha)		262
Net density (dwellings/ha)		52

At this stage, the user may return to the Main Menu, and print out the land use Table, disregarding the options presented at the base of the page. An example is shown opposite.

Stage 2
It will be seen that the number of community facilities and the land that is required to house them has been calculated.

Numbers are calculated on the basis of the population figures, so the greater the number of erven the greater the number of facilities.

Certain anomalies will be noticed when using this part of the program. This is caused by the fact that large land users such as schools may be required when the population increases. Thus, when erf sizes are reduced, for example, in some cases the number of erven may actually be reduced as well, as the number has reached the stage where another school is required, and therefore the land that would have been available for housing has had to be allocated to a school. There are programming methods to overcome this problem, but it has not been considered worth the expense in this context.

Stage 3
A useful third stage is to develop alternative erf sizes and get a feeling for how these will affect the overall balance of the project.

Mix of Stand Sizes

Illustrative alternatives - mix of stand sizes

Input variables	
Percentage of small stands	12
Percentage area reduction	25
Percentage of larger stands	15
Percentage area increase	20

Constant proportion

No. of stands	Frontage	Depth	Area	Total Area
234	6.93	17.32	120.00	28,086
1,068	8.00	20.00	160.00	170,854
183	8.76	21.91	192.00	35,107
			Total	234,046

Constant depth

No. of stands	Frontage	Depth	Area	Total Area
234	6.00	20.00	120.00	28,086
1,068	8.00	20.00	160.00	170,854
183	9.60	20.00	192.00	35,107
			Total	234,046

The program is devised in such a way as to permit three different erf types, and to prepare a print out of land uses and number of erven.

The user may decide to have any percentage of erven larger or smaller than the one selected on the "Building Type and Erf" page, and then obtain a print out showing the impact that this will have on overall numbers and land use.

The program changes the area of the erf, which is printed out in two ways on the Table. The upper Table assumes that the shape of erven will stay constant (that is to say the ratio between the length of the front boundary and the side boundary); the lower Table assumes a constant depth. In both cases the consequent dimensions are given. An example is given opposite.

There is no limit imposed by the program on the degree to which the erven can be larger and smaller than those selected, so clearly discretion is required when using this facility. For example, if erven of 100 square metres had been selected, reducing the size by 50% might be impracticable.

The importance of this facility is once more to demonstrate that larger and smaller sizes have an impact of land use, and the data can be used in workshops to obtain consensus on the mix of the stands.

If questions are asked regarding the cost of the stands, this can be obtained by going to the "Building and Erf Type" page and entering the stand sizes: an instant response regarding the gross monthly cost will then be obtained. If more detail is required, once the erf size has been entered, then a print-out should be obtained which will indicate the land and services costs for the erf size specified.

Assumptions					
Password for Calculations	SMM				
Maximum Pmt as % of Income	25.00%				
Minimum Room Width	0.90m				
Minimum Habitable Room Area	8.00sqm				
Initial Models	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Lowest Income Required	R0	R1,000	R1,500	R2,000	R2,500
Living Room Yes (1) or No (0)	1	1	1	1	1
Living Room Length (m)	3.00m	4.00m	4.00m	4.00m	4.00m
Living Room Width (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 1 Yes (1) or No (0)	0	0	1	1	1
Bedroom 1 Length (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 1 Width (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 2 Yes (1) or No (0)	0	0	0	1	1
Bedroom 2 Length (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 2 Width (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 3 Yes (1) or No (0)	0	0	0	0	0
Bedroom 3 Length (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 3 Width (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 4 Yes (1) or No (0)	0	0	0	0	0
Bedroom 4 Length (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Bedroom 4 Width (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Kitchen Yes (1) or No (0)	0	0	0	0	0
Kitchen Length (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Kitchen Width (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Dining Room Yes (1) or No (0)	0	0	0	0	0
Dining Room Length (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Dining Room Width (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Balcony or verandah Yes (1) or No (0)	0	0	0	0	0
Balcony or verandah Length (m)	3.00m	3.00m	3.00m	3.00m	3.00m
Balcony or verandah Width (m)	1.50m	1.50m	1.50m	1.50m	1.50m
Savings Option (1 to 3)	1	1	1	1	1
Plaster Outside Walls Yes (1) or No (0)	0	0	0	0	0
Plaster Inside Walls Yes (1) or No (0)	0	0	0	0	0
Ceilings Yes (1) or No (0)	0	0	0	0	0
Paint Outside Walls Yes (1) or No (0)	0	0	0	0	0
Paint Inside Walls and Ceilings Yes (1)	0	0	0	0	0
PVC Floor Tiles Yes (1) or No (0)	0	0	0	0	0
Electricity Yes (1) or No (0)	0	0	0	1	1
Sanitation (Type 1 to 5)	1	1	1	1	4
Hot water Yes (1) or No (0)	0	0	0	0	0
Separate w.c. Yes (1) or No (0)	0	0	0	0	0
Separate shower Yes (1) or No (0)	0	0	0	0	0
Kitchen sink Yes (1) or No (0)	0	0	0	0	0
Basin in bedroom Yes (1) or No (0)	0	0	0	0	0
Building Type (1 to 6)	2	1	1	1	1
Stand frontage (m)	8.00m	10.00m	10.00m	10.00m	12.00m
Stand depth (m)	16.00m	20.00m	20.00m	20.00m	25.00m
Front access width (Type 1 to 5)	1	1	2	2	3
Front access finish (Type 1 to 3)	1	1	2	2	2
Service roads width (Type 1 to 4)	3	3	3	3	3
Service roads finish (Type 1 to 3)	1	1	2	2	3
Lighting (Type 1 to 4)	2	2	2	2	2
Block Layout (Type 1 to 3)	3	3	3	3	3
Fencing/Walling (Type 1 to 4)	1	1	1	1	1
Front Fencing Yes (1) or No (0)	0	0	0	0	0
Back Fencing Yes (1) or No (0)	0	0	0	0	0
Side Fencing Yes (1) or No (0)	0	0	0	0	0
Land Use Default Settings					
Site size (Ha)	40.00				
Undevelopable area (Ha)	4.00				
Other reservations (Ha)	0.00				
Servitudes (Ha)	0.00				
Complexity Factor %	20.00				
Percentage of small stands	12.00				
Percentage area reduction	25.00				
Percentage of larger stands	15.00				
Percentage area increase	20.00				

5.13 OTHER FACILITIES

5.13.1 Assumptions

Clicking on this bar on the main menu will take the user to a "Password Validation" dialogue box. The password is currently set as SMM (Capital letters). When the password has been entered the page will appear. It is presented in the form of a spreadsheet, and it may be necessary to scroll upwards to reach the beginning.

An example of the current assumptions is reproduced opposite. It will be seen that there are a few very general assumptions (i.e. the minimum width of room, and maximum percentage of income) but the majority of the data concerns the basis for the models that are offered under the "optimise model" system. These assumptions do not have to be changed in the normal course of events, but if cost figures have been changed dramatically in the main spread sheet, it will be necessary to change these figures too.

There are two ways in which this can be done. The easiest method is to increase the income levels, thus the cut off level for Option 2 would change from R1,500 to R1,800, for example. The problem with this method is that it reduces the meaning of the option offered to the lowest income group, as it will cover a wide range.

A better alternative, but one which requires more time is to adjust the mix offered for each income group in such a way as to produce a solution that is appropriate for that income group. There may be an element of trial and error in this process. The easiest way of doing this is to do it within the main body of the model, make a note of the preferred options, and then enter them all together in the assumptions page.

5.13.2 Calculations

Clicking on the calculations bar activates a password dialogue box. The password is SMM (Capital letters), and the same cautions must be exercised regarding the use of case in entering it.

Once the password has been accepted, the spreadsheet is then displayed. The method of entering and changing data on the spreadsheet is discussed in detail in Appendix 2.

6. The Specialist Variables

A very large number of variables are incorporated into the model prior to it being interrogated by the public.

These are as follows:

6.1 The site: land price, size, slope of ground, foundation conditions (i.e. difficult soils such as expanding clay, collapsing sand, rock). Completing these items should be done on the advice of an experienced professional, as some of them have important cost implications.

6.2 Planning and building regulations: size of block, maximum number of storeys for walk-up flats and car parking requirements for multi-storey housing.

6.3 Professional fees: chargeable fees for surveyors, conveyancers, planners, engineers, architects, quantity surveyors; supervision costs, i.e. resident engineer and clerk of works.

6.4 Developer's overheads: Community facilitation costs, marketing costs, overheads.

6.5 Monthly charges

These include rates, water and sewerage charges, refuse removal and street lighting. In the case of sectional title or rented property it includes operating costs, which are charged per square metre.

There is also a provision for a change in the VAT rate, and factors to adjust for price escalation, the location of the project, etc.

6.6 Subsidy system

The model incorporates three types of subsidy system. As presently in use, it is adapted to the system of capital subsidies based on income. The size of the subsidy and the income cut-off data are found in cells G105-G112.

For policy development purposes, and so as to have flexibility to respond to potential policy changes, other types of policy are also embedded in the model and can be used if required. These are:

- The interest rate subsidy. For example, if the subsidy reduces the rate of interest by 2% this is entered into the model as such and all calculations of monthly repayments will reflect this fact. This is entered in cell B206.
- The monthly income subsidy. Under this system, an amount is stipulated by which the amount to be repaid monthly is reduced by a fixed sum. If this is entered into the model all calculations of monthly repayments will reflect this fact. This is entered in cell B208.

The subsidies are not mutually exclusive and can be combined.

7. Basic Cost Inputs

The cost inputs for the model are divided into two categories:

- building
- civil engineering.

7.1 Civil engineering

The cost data for civil engineering is based on the successful tender for a job of a similar magnitude. Since engineering costs increase with the size of the site, due to the necessity to use larger pipe sizes for greater populations, size is quite important. Other factors such as the complexity of the site layout, price escalation, changing the VAT level, etc. are also accommodated so as to permit a fair estimation of the price levels that would be obtained if the job was to be tendered. This is the type of estimate that any experienced engineer or quantity surveyor would do in estimating any job.

Water and sewers require different diameters for different locations in the network. In the case of sewers, they also require rodding eyes, Inspection chambers and manholes. In water systems there are valves and valve chambers, thrust blocks and other fittings. Instead of trying to undertake a design of the scheme which will identify precise numbers of such features and fittings, the model uses the average cost per unit length of the pipes and all fittings. This is obtained quite simply by arithmetical division from the bill of quantities. Over and above the gross cost per unit length of pipe work, there is excavation, backfill, etc., which is estimated from costs from the bills, using average depths as dictated by site conditions. Electricity and security lighting costs are estimated in the same way.

Before costing sewers the model looks for whether a WC has been included. If so, it adds in the cost of main sewers and connection between the housing unit and the sewer. Likewise, if individual plot connection and/or WC have been specified the model adds in the cost of the water connection and meter (if specified).

Roads are calculated on a rate basis. The width of residential roads is established by the participant/ beneficiary, from which actual quantities can be calculated. Stormwater drainage can be specified to different standards and is calculated accordingly.

7.2 Building costs

These are based on bills of quantities from a recent job of a similar magnitude, and use all rates exactly as included in a bill.

The model calculates the length of the foundations, the size of the slab, the amount of walling, etc., and calculates the costs from this. Roof overhangs are based on values inserted by a specialist based on conditions prevailing in the region or on the site.

8. The algorithms: how the model works

8.1 Estimating the lengths of pipes and wires

Lengths of pipes are calculated on the following basis. It is assumed that the pipes will serve two stands for each unit length of a stand width. For example if the stand width has been specified as 12 m, a length of 12 m is required to serve two stands (which are back to back), and thus 6m is required for each stand. To this is added half the width of the road if it has been specified that piped services will be run in the road reserve. In addition to this the potion of the distributor pipe which runs at right angles to the block is included, by taking the total depth of the block and the road frontage, and dividing that by the total number of stands in the block.

8.2 Road lengths

These are calculated using the same logic.

8.3 Calculating the building quantities

The model makes certain assumptions about the way the building is designed. The basic assumption is that a spine wall runs through the centre of the building, if it is more than one room wide.

The design of the house will always attempt to maximise the amount of shared walling between the rooms. Thus when there are two rooms, one wall will be shared between them. When a third room is added, two walls will be shared. When a fourth room is added, a total of four walls will be shared (see diagram). When sanitary facilities are included, these will always have their own lobby for privacy of one metre in width (see diagram).

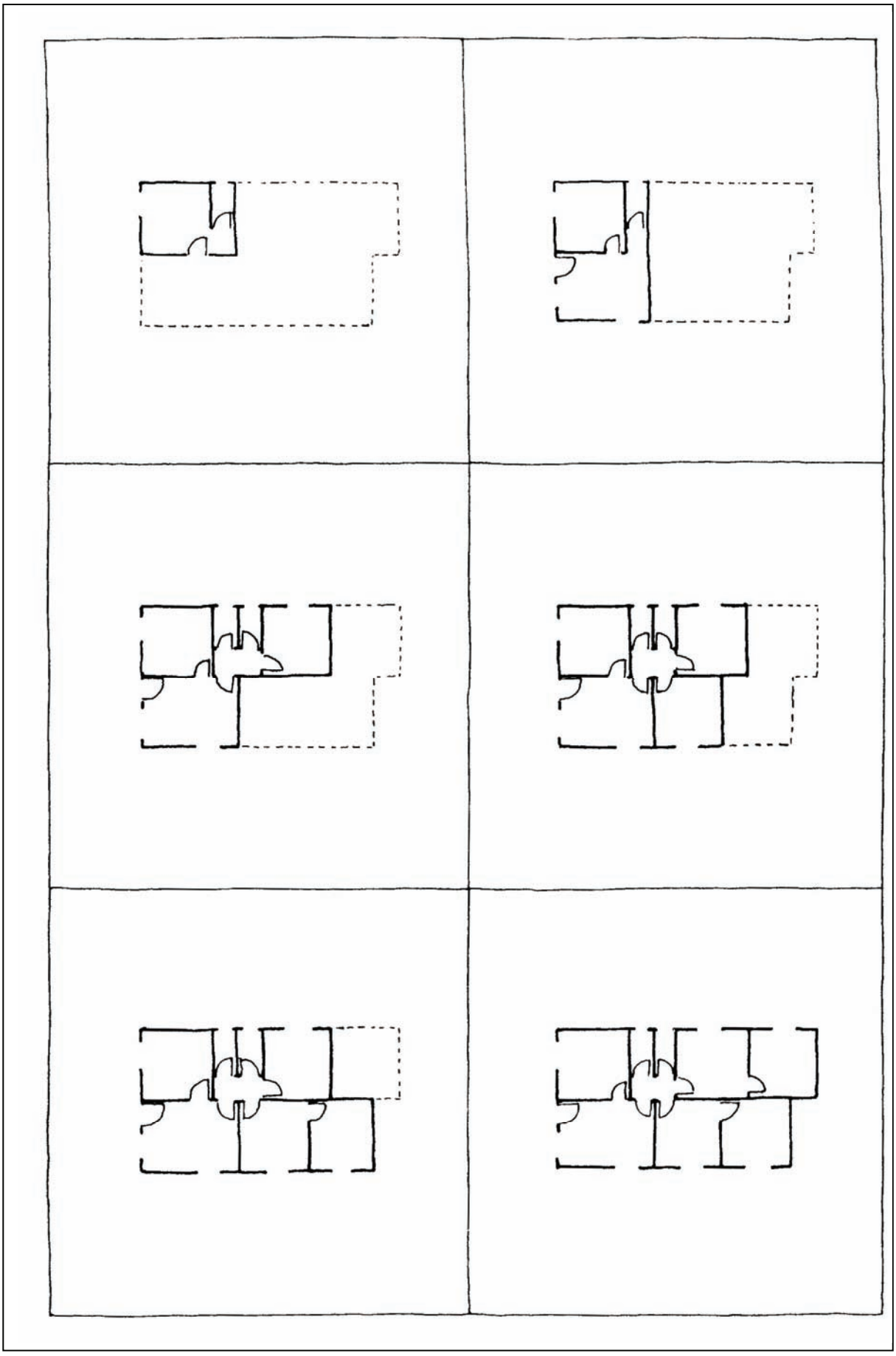
The model provides one door per room, though the participant can specify an extra door for the "back" door.

It estimates the size of the windows by dividing a room area by 10 (i.e. 10% of floor area), and then looking for the nearest larger window size that is available from a standard range.

8.4 The impact of built form

Where a two storey house is selected, the model splits the accommodation between the two floors, and adds in the area required for a staircase, and the cost of it and associated balustrades. It calculates the size of the upper floor on the basis of 50% of the habitable space, and the roof size on the gross "footprint" of the dwelling (i.e. including staircase) plus the specified roof overhang.

When flats are selected, the model assumes that walk-up flats will be provided to an upper limit that can be specified in terms of the number of storeys. This will be based on local regulations. In such cases the design assumes a single staircase at the end, or in the middle of the block, from which access to the flats is by open balcony.



The sequence in which rooms are added to the notional design

In the case of higher buildings, the model adds the cost of the lift to that of the staircase, and assumes car parking has to be provided in the form of a multi-storey car park.

9. How to apply the results

Clearly, actual designs will not necessarily follow the stereotype that the model is based upon, but this does not preclude a wide number of variations without loss of accuracy.

In the case of building there are clearly different degrees of efficiency in terms of design. The model is based on a high efficiency system, and the drawing opposite illustrates the basic logic which the model uses in assembling the consumer's choices into a notional design. Clearly the dimensions of the rooms will affect the nature of the design, but the model must make assumptions regarding the amount of shared walling between rooms. These assumptions follow the design shown opposite. For example, all four rooms must be measured for the first room. Addition of a second room only requires three walls. A third room requires a further three walls, while the fourth room only needs two walls, etc. Circulation space is provided with the toilet and shower compartments. Otherwise circulation is through the non-bedrooms, namely Living Room, Kitchen and Dining Room.

The house is placed with the roof ridge running at right angles to the road. This permits expansion forwards and backwards, unconstrained by the side boundaries.

In the case of planning layouts, the type of design has been illustrated in connection with the roads selection page of the model. While these designs lack all finesse, they may be adapted in a number of creative ways without loss of the accuracy of the costing. The one variable that is usually affected in developing appropriate layouts, especially in the superblock system, is the erf depth. This, however, is a factor that does not loom large in people's perception of their usable space, and considerable variations may be used without loss of amenity.

APPENDIX 1
How to use the program

Guidance for those not familiar with the use of computers or Excel.

Loading
The program is written in Excel. Version 5.0c or later must be used. The file name is SHAPE model.xls. The program is loaded by double clicking on the Excel icon in the windows page.

Entering data
There are four types of entry. One requires a choice of a number of alternatives options. In this case the entry looks like a bar. There will be a black circle in one of them, indicating that this is the option currently selected. When the person has decided the answer, and that answer is different from the one already selected, move the cursor over the bar. It will change to a little hand when it is over the circle. Now click the mouse and the dot will move to the selected choice.

The second is a square box in which selections can be made by clicking, at which stage an "x" will appear in the box. In these entries it is possible to select any number of boxes - in other words these are not exclusive options. Boxes which have an "x" in them have already been selected. If the person does not wish to select that option clicking, on the "x" will remove it.

The third is where data is required to be typed in. In this case the cursor takes the form of a "+". Data is entered by positioning the cursor over the cell and typing the entry, followed by pressing the "Enter" key.

Anything you enter will overwrite what was in the cell previously.

If you make a mistake, you can either press the "Esc" key abort the entry, or use the backspace key which erases the entry from right to left. If you have already pressed "Enter", you can delete the entry by pressing the "Delete" key.

When entering Rand amounts, do not type an R before the numbers: the program will insert this automatically.

Lastly, there are cases where the choices cannot all be displayed due to lack of space, and a pull-down sub-menu is used. This is activated by moving the cursor until it turns into a hand, and then clicking the mouse. The option required is then selected by placing the cursor hand over it and clicking the mouse.

Printing Reports
There are four report pages available.

1. Summary of all house and erf design selections and the associated costs (designated "Print Summary" on the Main Menu).

2. Renting or Buying Cost Reports. (Accessed from the Main Menu)

3. Land Use. (Accessed from the Land Use page)

4. Stand mix. (Accessed from the Land Use page)

The method of printing these is the same in each case.

- Make sure that the computer is connected to a printer, and is set up for that printer.

- Click on the respective "Print" panel on the page noted above.

- The text of the report will appear in the page in a miniature format. On small screens this will be unreadable, but if required it can be displayed larger by using the mouse to place the cursor (which looks like a magnifying glass) over the text and clicking the left mouse button. The text will now change to a readable size. You may scroll up and down the page by using the arrow keys on the keyboard.

- To print the report, move the cursor over the word "Print". It will be noticed that it changes from a magnifying glass to an arrow. Now click the left mouse button. The page will now print.

  If you simply want to look at the data without printing it, when you wish to return to the menu move the cursor over the word "Close" at the top of the page and click.

APPENDIX 2

How to enter the cost data

1. From the main menu click on the panel "Calculations"

2. The program will ask for the password. Type "SMM" (without the inverted commas). Password entry is "case sensitive", which means that it will not accept "smm" or "Smm". If it rejects your entry, simply click on "Calculations" again.

3. The calculations sheet will now be displayed.

4. Before going any further, save the sheet in its present form. To do this, open the File Menu by clicking on "File" at the top left hand side of the page, then click on "Save As". When the dialogue box appears asking for a new file name use an easily distinguishable name such as Tempmod. You may now return to the job of entering data.

5. The sheet is entry protected, and before any entries can be made it must be de-protected. To do this go to the "Tools" menu, and click on "protection", and the click on "unprotect".

6. It is now possible to change any cell on the sheet. Clearly this must be done with **extreme caution,** and before making any entry in a cell **it is essential to check whether the cell contains a formula or simply a value.** Only cells with value contents should be changed, as entering a value where a formula used to be will impair the integrity of the worksheet.

7. Mistakes can happen. If you are conscious of the fact that you have entered a value over a formula, but you have not yet pressed Enter, you may avoid making the entry by pressing the Esc key. If, however, you have already entered it you have two choices: either you do not save the file on exit from the program, in which case all the other entries you might have made will be lost; or else you can make a note of the cell concerned and re-enter the formula from your back-up file, made as described in paragraph 4 above. Please note that some cells have very complicated formulae, and this could be more time-consuming than it sounds.

8. The cells where values may be entered are restricted to the following:

Parts of Column G: Site data and professional fees

Column I Building cost data

Column S Civil engineering cost data.

Column Z Additional cost data.

Columns AX, AY and AZ: Land use data

9. Construction cost data

Special mention should be made of the methodology by which building cost data can be entered into the model.

9.1 Building Cost data

The principle used in the building cost data is that items are entered direct from the Bills of Quantities of the lowest tender for a suitable job. This can be done very quickly and simply, by simply scrolling down the column where these entries are made, and changing the cost figures. For obvious reasons cost data should be taken from a project that is as similar in scale and conditions as possible to typical projects on which the model will be applied. However, since there are ways in which costs can be manipulated, it is possible to adjust them to suit the conditions. The program has adjustment factors for the size of project, the location, and inflation. So price taken from a large project with a simple layout in Gauteng may be adjusted for a small project taking place a year later on a constricted site in a rural area, as each of these aspects has an adjustment factor. These factors are found in cells G62-G64.

It is wise when entering data to also make a note of the tender location and date so that these adjustments can be made intelligently.

Once the cost figures have been entered, the model integrates them, and uses them as modular items. For example the cost of a door includes the door itself, the frame, hinges and lock, all labour required to fit it, and any painting associated with the door. The cost of the wall that is displaced by installation of the door is subtracted. No entries should be made in the T calculation columns where this integration of the data takes place.

9.2 Civil Engineering

Entries for civil engineering works are based on a different approach. This is because, with sewers and water mains there are a number of variables dictated by the design itself, which cannot be considered in a program of this nature. These are the diameter of the pipes - the larger the project, the higher the proportion of large diameter pipes; and the fittings (in water reticulation) and manholes (for sewers).

The program integrates these items at the entry stage, by requiring only the entry of the total length of pipework, which can always be obtained from the Bills; and the

total cost of both pipework and fittings or manholes. These figures are then grossed and reduced to an average cost per linear metre. While this is a fictional device, it has been found to work very reliably in practice.

When entering the costs and quantities from Bills, it is possible to use the spreadsheet as a calculator: i.e. each individual quantity can be entered into the cell, thus generating a string of numbers separated only by + signs. The value of this is that it provides a checkable record of the numbers that have been entered, as well as saving time.

Roads are calculated in the same way as building costs, i.e. by simply taking the rates from Bills. The program then calculates unit costs by calculating the quantities of the type of road specified by the user, and then multiplying them at the quantities derived from the erf sizes and road widths.

As in the case of building contracts the prices may be adjusted for the size of project, the location, and inflation. These factors are found in cells G56-G58.

The cells into which data entry can be made are reproduced on the following pages. Those cells which have an X through them should not be used as they contain a formula. That is to say that the value that is displayed in the cell has been generated from another source in the spreadsheet.

	F	G
1	1	
2		
3	PROFESSIONAL INPUTS	
4	(For "yes" enter 1,	
5	for "no" enter 0)	
6	Land price/sq m (in Rand)	10 F
7		
8	SOILS	
9	Founds: No. of 200mm courses below slab	2
10	Heaving clays	0
11	Collapsing sands	0
12	Rock (%)	0
13	Other (% extra for foundation)	0
14		
15	SPECIAL SUBSIDY	
16	(Soils/location) (Y=1,N=0)	0
17		
18	TOPOGRAPHY	
19	% slope	2
20		
21	STORMWATER DRAINAGE	
22	Surface	1
23	Surface, lined	0
24	Underground	0
25	% Culverted crossings	0
26		
27	WATER meter required	1
28		
29	LAYOUT	
30	Approximate number of stands	1463 F
31	Block length (number of stands)	20
32	Block width (number of stands)	2 F
33	Site complexity factor (% extra)	10 F
34		
35	LOCATION OF SERVICES	
36	Block centre	0
37	Street	1
38		
39	MULTI STOREY VARIABLES	
40	No of flats/lift per floor	10
41	No. of flats/stair per floor	4
42	Car park spaces/unit (in garage)	1.30
43	Gross area per car (sm)	22
44		
45	CONSTRUCTION DETAILS	
46	Thickness external walls (mm)	150
47	Thickness internal walls (mm)	100
48	Roof Overhang (m)	0.50
49	Wall height (eaves)	2.80
50	Wall height (ridge)	3.75
51	Use roof trusses (Y=1,N=0)	0

	F	G
53	COST ADJUSTMENTS	
54	Cost basis	
55	Civils contract	%
56	Inflation factor over input prices	0
57	Locational vartn from input(+/-%)	0
58	Scale var. from input prices (+/-%)	0
59	Contract period (months)	12
60		
61	Building contract	
62	Inflation factor over input prices	0
63	Locational vartn from input (+/-%)	0
64	Scale var. from input prices (+/-%)	0
65	Contract period (months)	12
66		
67	FEES	
68	Topographical Survey (Ha)	8000
69	Land survey/erf	700
70	Conveyancing/unit	700
71	Town planning/ha	700
72	Architectural (%)	2
73	Quantity surveying (%)	1
74	Civil engineering (%)	3
75	Structural engineering (%)	0
76	Structural fees applicable? (Y=1, N=0)	0
77	Project management (%)	1
78	RE monthly salary (civils)	9000
79	COW monthly salary (building)	8000
80	No of community liaison staff	1
81	Period of employment (months)	15
82	Community liaison staff monthly salary	3000
83	Overhead rate for site staff (%)	30
84		
85	VAT rate (%)	14
86		
87	DEVELOPER'S SALES COST AND PROFIT	
88	Profit (%)	2
89	Sales costs (%)	0
90		
91	OPERATIONAL COSTS	
92	Low rise (excl rates,wtr, ele) (R/sm)	0.6
93	High rise (excl rates,wtr,ele) (R/sm)	3
94		
95	UTILITIES AND TAXES	
96	See column CM	
97		
98	DEPOSITS (Sum)	
99	Water	600 F
100	Electricity	300 F
101		
102	FINANCE TERMS	
103	Loan term etc - see column BV	
104	Bridging finance interest rate	19
105	Lowest subsidy income limit (R per month)	800
106	Amount (R)	54975
107	2nd lowest subsidy income limit (R per month)	1500
108	Amount (R)	54975
109	Middle subsidy limit (R per month)	2500
110	Amount	54975
111	Upper subsidy limit (R per month)	3500
112	Amount	54975
113	Max product price (R)	200000
114	Soils/location subs. (%)	15

	H	I
1	Date of tender	Sept 2007
2	BUILDING	ENTER
3	BASIC RATES	RATES HERE
4	Total cost of contract, exc VAT	5236931
5	P & G	759355
6		
7	Site clearance/sm	8
8	Reduce levels/cm	36
9	Excavate trenches/cm	90
10	Excavate under apron slabs/sm	9
11	Scarify and compact under slab/sm	12
12	Make up levels/cm	60
13	Excavate in rock	250
14	Concrete	
15	In foundations/cm	900
16	Power float slab/sm	14
17	Framework to slab edge/lm	36
18	100 mesh reinforcing/sm	30
19	Cement conc in paving/sm	140
20	Formwork to ends of paving/lm	15
21	4Y10 reinforcing bar/lm	9
22	Walling	
23	90mm conc block wall	110
24	140mm conc block wall	145
25	190mm block wall	180
26	90 mm brick wall	120
27	190mm brick wall	240
28	Brickforce	2
29	Bagging/sm	12
30		
31	Extras on walling	
32	Wire roof ties/unit	9
33	Precast concrete cills/lm	65
34	Extra for U-block/lm	120
35		
36	Roofing	
37		
38	Roof truss	160
39	Length of truss	8
40	38 x 50mm wall plate/m	10
41	38 x 114 runners	20
42	38 x 114 bracing	20
43	50 x 76 purlins	21
44	50 x 76 blocking	21
45	10 x 230mm bargeboard	28
46		
47	Corrugated iron roofing/sm	115
48	Ridge capping/lm	65
49	Concrete tiles/sm	80
50	Concrete ridge/lm	70
51	A/c sheeting	125
52	A/c ridge	80
53		

	H		I
54	Doors		
55	Meranti panel door 812 x 2030mm		1200
56	Hollow core door 812 x 2030mm		130
57			
58	Frames		
59	Meranti door frame		276
60	Meranti quadrant/lm		12
61	Steel door frame, 90mm wall		120
62	Steel door frame, 140mm wall		165
63			
64	Ironmongery		
65	Pair 100mm hinges		80
66	2 lever lockset		160
67	Cylinder mortice lockset		210
68	Rubber door stop		15
69	3 x 38 mm water bar		48
70	Gutter/lm		65
71	Downpipe/lm		60
72			
73	Windows		
74	(H X W)mm		
75	NE1		
76		1	108
77		1	
78	NE2		
79		1	164
80		1	
81	NC2		
82		1	306
83		1	
84	NC4		
85		1	306
86		2	
87	ND510		
88		2	410
89		1	
90	ND511		
91		2	445
92		2	
93			
94	Burglar bars/sm		90
95			
96	PLASTER		
97	One coat plaster		32
98			
99	Reveals/lm		12
100	Gypsum plasterbd, inc branderg		86
101	Glazed tiles/sm		160
102			
103			
104	Plumbing		
105	(including pipework)		
106	WC suite		3250
107	WHB		1850
108	Bath, 1,8m		3850
109	Sink		1650
110	Shower		2850
111	Shower grating		185
112	15mm pipework, inc bends/lm		42

	H	I
116	External plumbing	
117	15mm piping in ground	86
118	15mm brass stopcock	125
119	15mm brass hose tap	90
120	Supply water meter and box	480
121	Install water meter	226
122	Water deposit	600
123		
124		
125	Drainage	
126	100mm VP/lm	65
127	100mm pipe in ground	120
128	100mm inspection eye	48
129	100mm bend	34
130	100mm inspection eye bend	42
131	100mm junction	24
132	100mm inspection eye junction	43
133	Gully	180
134	100mm cleaning eye	86
135	Connection to main	1500
136		
137		
138	Electricity	
139	Mains cable/lm	128
140	Termination	146
141	Joint to reticulation	100
142	Sub board/cable	4000
143		
144		
145	Light point	380
146	Power point	500
147	Water heater point	400
148	Supply meter, box, circuit brkr	6800
149	Install meter etc	200
150	Geyser relay	186
151	Electricity deposit	300
152		
153		
154	Glazing	
155	3mm glass/sm	120
156	4mm glass	180
157		
158	Painting	
159	PVA on plastered walls	28
160	PVA on bagged walls	32
161		
162	Enamel on plastered walls/sm	34
163	Enamel on bagged walls/sm	39
164	Enamel on door frames/sm	33
165	Enamel on windows frames/sm	36
166	Enamel on doors/sm	32
167	Carbolineum, expsd tmbrs/sm	18
168	Painting: burglar bars/sm	36
169		
170	SITE WORKS	
171	Fencing .9 m high/lm	70
172	Fencing 1.8m high/lm	120
173	Poles .9m high/unit, inc found	82
174	Poles 1.8m high/unit, inc found	108
175	Stays/unit	65
176		

	R	S
1	Date of Tender	Sept 2007
2		
3	BASIC COSTS	
4	ROADS	
5	Total cost of contract exc VAT	956727
6	P & G	114807
7	Roads	
8	Site Clearance/sm	12
9	Bulk excavations/cm	38
10	0	
11	Excavate and fill to level/cm	38
12	0	
13	High traffic roads	
14	Sub-base	
15	150mm fill and compact/cm	150
16	Scarify/sm	12
17	Stabilization/sm	22
18	Lime for stabilization/ton	1180
19		
20	Base	
21	150mm crushed stone/cm	220
22	Tar/sm	38
23		
24	Surface course	
25	20mm pre-mix/sm	38
26		
27	Low volume roads	
28	Sub-base	
29	Grade and scarify/sm	12
30		
31	Base course	
32	150mm fill and compact/cm	150
33	Stabilization/sm	12
34	Lime for stabilization/ton	1180
35		
36	Stormwater drainage	
37	Unlined open channels/lm	60
38	SW drainage lining/sm	140
39	Supply and lay sw pipes 600mm/lm	865
40	Extra over for rock/cm	260
41	SW manholes	8000
42		
43	Headwalls for culverts	6500
44		
45	Kerbing/lm	120
46		
47		
48		
49		
50	0	
51	WATER	
52	Total cost of contract (exc VAT)	1999612
53	P & G	239953
54		
55	Excavation: total	0
56	(including fill etc)	
57		
58	Pipelaying	
59	Total length of all pipes	614
60	(excavation)/lm	0
61	(excavation, rock)/cm	4865
62	Total cost	
63	(pipes)	25793
64	(bends)	9397
65	(tees)	4576
66	(hydrants)	13400
67	(caps)	658
68	(gate valves)	3850
69	(thrust blocks)	2140
70		
71		
72	House connections	
73	Total cost of saddles and piping	141225
74	Number of connections	1500
75	Meter/unit	450
76		
77		
78	SEWERAGE	
79	Pipelaying	
80	Total length	
81	(of all pipes measured)/lm	364
82		
83	Excavation and backfill	
84	Total cost	0
85		
86	Total cost	
87	(pipes)	34454
88	(junctions)	16407
89	(manholes)	70785
90		
91	Excavation in rock/cm	8736
92		
93		

	Y	Z
1		
2		
3	Rates not in bills	
4		
5	Soil Cement blocks/sm	55
6	PVC tiles/sm	86
7	Wall tiles/sm	54
8	K. cpbds (floor)/lm	1450
9	K. cupbrds (upper)/lm	1200
10	VIP latrine complete	6500
11	Double pit VIP latrine	11000
12	Composting pit latrine	11000
13	Small bore shallow sewers	7000
14	WHB tap	85
15	Hot water heater	2850
16	RC in columns, inc shuttering/cm	960
17	RC in slabs, inc shtt/cm	920
18	RC staircase inc shtt/cm	960
19	RC edge beams, inc shtt/cm	960
20	Paving bricks	120
21	Paving bricks, laying	28
22		
23	Street Lighting	
24	Full standard pole+fitting	8000
25	Security Ltg. pole+fitt	5000
26	Wiring/lm	165
27	Transformers/unit	240000
28		
29	Tower lighting/ha	30000
30		
31	ELECTRICAL RETICULATION	
32	Wiring/lm	385
33	Poles	500
34	Transformers/unit	62500
35		
36	LIFTS	
37	7 Storey 1000kg	485000
38	Extra per floor	34000
39		
40	RAILINGS	
41	Access way railing/lm	340
42	Staircase handrail/lm	850
43		
44		

	AW	AX	AY	AZ
1	Plannning Data			
2	Standard Variables			
3	Pers/stand	5		
4	Facility	Pop	Area including access	
5	Creche	900	1000	(per stand)
6	Primary Schoo	2750	28000	550
7	2	5500	48000	1100
8	3	8250	76000	1650
9	4	11000	96000	2200
10	5	13750	124000	2750
11	6	16500	144000	3300
12	High School	6875	48000	1375
13				
14	Local Shops	50	50	
15	Neighbourhd	450	900	
16	Central shops	10000	20000	
17				
18	Community cer	1000	600	
19	Worship	500	600	
20	Clinic	5000	1000	
21				
22	Park	5	36	
23				
24				
25	Erf Frontage	8		
26	Erf Depth	20		
27	Gross area	191		
28				