4

PC-based Simplified Sewer Design

4.1 OVERVIEW

This Section describes the Windows-based simplified sewerage design program contained on the CDROM supplied with this Manual. The purpose of the program is to aid the design of simplified sewerage systems. It seeks to do this by:

(1) automating – and thus speeding up – the necessary design calculations;
(2) providing a tool for analysing different design permutations / configurations; and
(3) being suitable for training / learning purposes.

The program should only be used by engineers who are "computer-literate." It is not really suitable for use by others.

4.1.1 System requirements

The program will run on any of the following Microsoft Windows-based operating systems:

Windows 95
Windows 98
Windows 2000
Windows NT4

It will **not** run on computers running the Windows 3.1 operating system.

The monitor screen resolution must be 800 x 600 pixels or greater (this is a very common resolution – only one step up from the minimum possible).

The hardware requirements are not demanding – any PC capable of running one of the above versions of Windows should be able to run this program.

4.1.2 Obtaining the program

If the CDROM is missing from this copy of the Manual, there is an Internet website from where the program can be downloaded; its address (URL) (which is case-sensitive) is:

`http://www.efm.leeds.ac.uk/CIVE/Sewerage`

From this site you can obtain the most up-to-date version of, and latest information on, the program.

4.1.3 The definition of a sewer network used in the program

The program requires the sewer network to be described as a series of linked sewer pipes. The sewers may only be linked in a *tree* type manner – that is, the network expands from the most downstream point branching at junctions to several upstream ends. And there must be no loops in the network. (The program has built-in automatic checks which show warnings if any network is entered that cannot be calculated.)

To cater for designing individual sections of a sewer network (which may be drawn together at the end of the design process), the network may be split into sub-networks, termed *sub-nets* in the program. Sub-nets may join other sub-nets at "drop" junctions – i.e. those at which the sewers are not necessarily at the same level. The typical case would be for a small branch sewer sub-network to be designed. When complete, this needs to be linked into a main street/collector sewer that may be at a much lower level.

In summary:

- A **network** consists of one or more **sub-nets** which may join at drop junctions.

- A **sub-net** is a tree structure of sewers whose ends join at continuous levels, i.e. without drop junctions.

In general sub-nets correspond to condominial systems as detailed in Section 3.3.6, and these then form the input into public collector sewers as described in Section 3.3.7.

4.1.4 The minimum information necessary to use the program

As a minimum to get your basic layout entered, you will need the length of the sewer and number of people connected to it (this may be described in terms of the number of houses connected together with a mean number of people per house, or in terms of a single total number of people who live in houses connected to the sewer). To be of practical use you will also need the ground levels at the end of each sewer length.

4.1.5 Getting started

If you really want to jump straight into a design, you can go directly to Section 4.7, where four step-by-step examples are presented. The next sections describe in detail the various screens contained within the program.

On first starting the program you are presented with the screen shown in Figure 4.1.

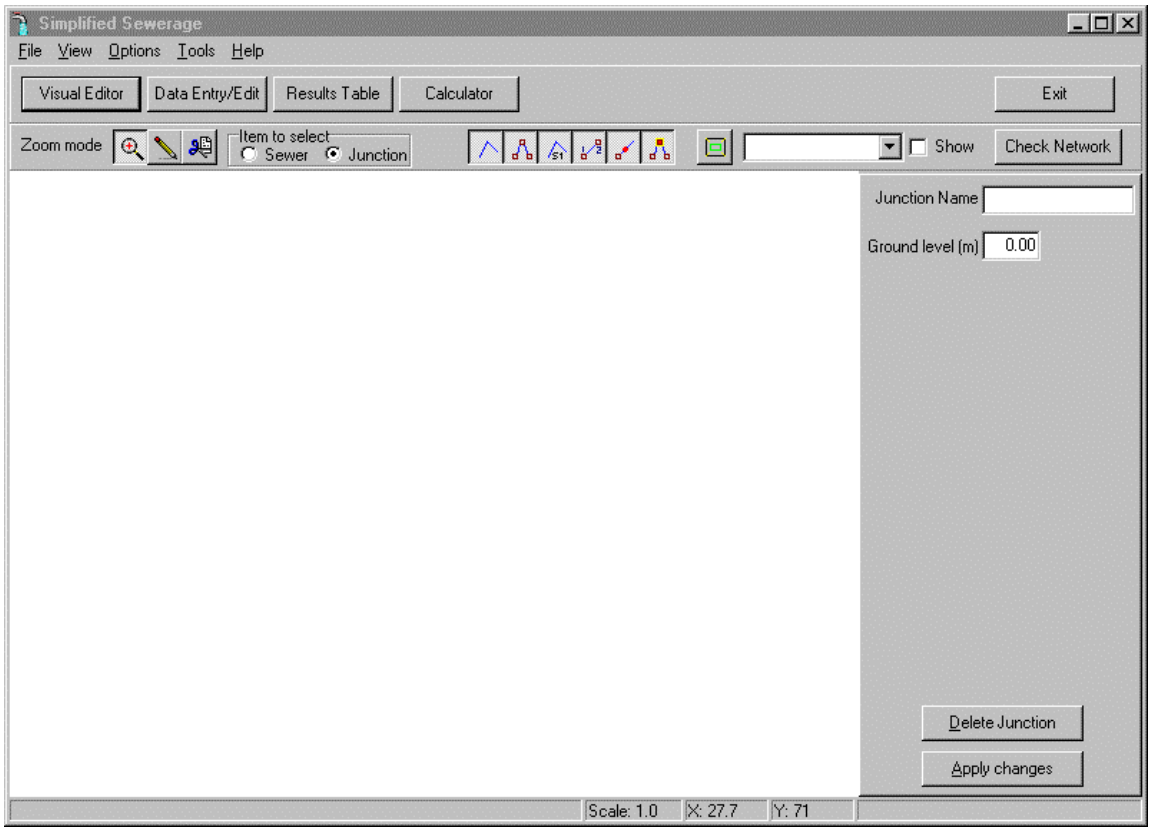


Figure 4.1 The Initial screen.

Below the main menu bar are four buttons (Figure 4.2) which allow you to switch between the four main screens of the program:

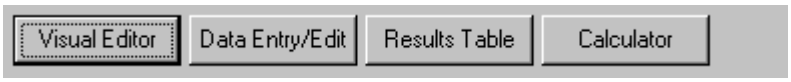


Figure 4.2 The main Tool Button bar.

The first button takes you to the ***Visual Editor*** screen. This is the screen that is shown when you first start the program – see Figure 4.1. Here you can draw the sewer network on-screen and also edit all the network description parameters. It provides the normal means of entering all the necessary design data. Section 4.2 contains a detailed description of this screen. An alternative to this method of entering data is by using the ***Data Entry/Edit*** screen – see below. You may use either or both of these screens to edit your network data.

The second button switches to the ***Data Entry/Edit*** screen. This is the alternative, table-based method for editing the sewer network description. It is described in detail in Section 4.3.

The third button takes you to the ***Results Table*** screen – a table of the detailed design results for the sewer network. Here you may also change some of the design calculations and recalculate to show these changes. Section 4.4 contains a detailed description of this screen.

The fourth button displays the ***Calculator*** screen. On this screen you can see the details of calculations performed for each sewer in the network and adjust the parameters to examine possible design changes. This screen is fully described in Section 4.5.

Figure 4.3 Exit button.

There is a fifth button on this toolbar – the ***Exit*** button (Figure 4.3), to allow you to leave the program. You will be prompted for confirmation to prevent accidental closure of the program or closure before first saving your edited network.

4.2 VISUAL EDITOR SCREEN

This screen (Figure 4.4) allows you to draw the sewer network on-screen and also edit all the network description parameters. This screen should be used as the main set-up screen for any network that you wish to develop, following the procedure given in Section 3.3.6. From this screen all network changes can be made. An alternative method of changing/specifying the network is provided using the ***Data Entry/Edit*** screen (Section 4.3) where all changes are made by entries in tables and boxes. Changes made on one screen are automatically changed on the other.

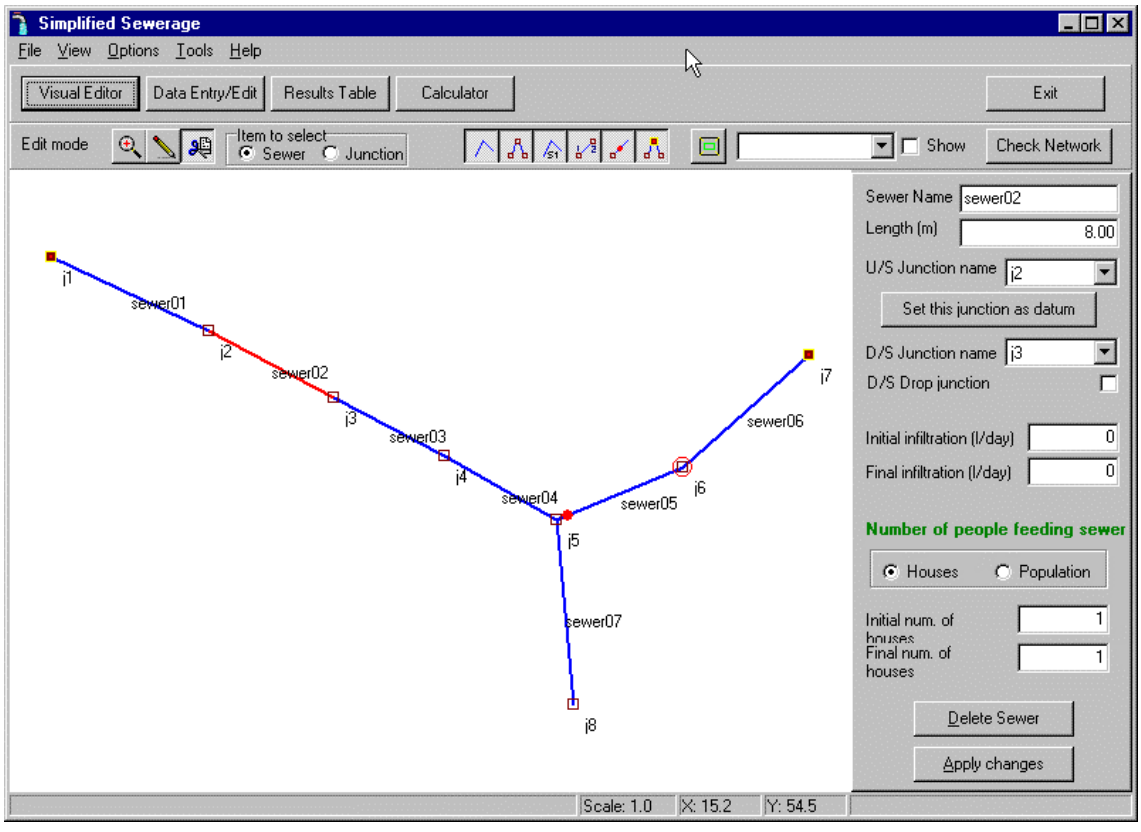


Figure 4.4 Visual Editor screen.

Note that this screen does **not** draw the network to scale. Lengths drawn on the screen do **not** necessarily represent the actual length on the ground, or the actual length entered in the data; thus changing the data values in the program will not change the view on the screen. The reason for this is that simplified sewerage is designed without requiring a detailed survey of positions of sewer ends (only levels are required); hence the co-ordinates of sewer ends are not usually known. It would, of course, make sense to draw any network on the screen to look *similar* to that being designed on the ground.

There are three main parts to this screen: the toolbar (Figure 4.5), which allows setting of the editing and display options for the network.

Figure 4.5 Visual Edit toolbar.

The details panel to the right provide the means for giving, and allowing changes to, details of either the selected sewer or junction (see Figures 4.12 and 4.15)

The initially blank white panel (Figure 4.1) is where the network will be displayed and the status bar at the bottom (Figure 4.6) displays such information as scale factor, and the mouse co-ordinates.

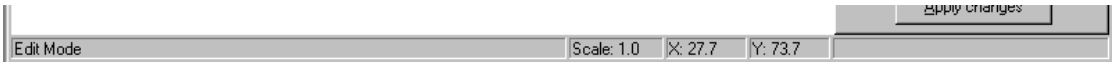


Figure 4.6 Status bar.

On starting the program this screen shows a blank white panel (Figure 4.1). You have two options at this point:

(1) To read in an existing network, or
(2) To start drawing your sewers on the white panel.

1. To read an existing file:

An existing network can be read from the main menu by choosing the File/Read Network option (Figure 4.7).

You will be prompted to choose a sewer network file. These files have the extension ".snt" and all existing network files will be displayed in the open file dialog box. Several network files are supplied with the program in the directory Networks.

When you have chosen the file and clicked the *open* button, it will be read in and you will see a display similar to that of Figure 4.4. You can now edit this network, change any parameters or perform the calculation.

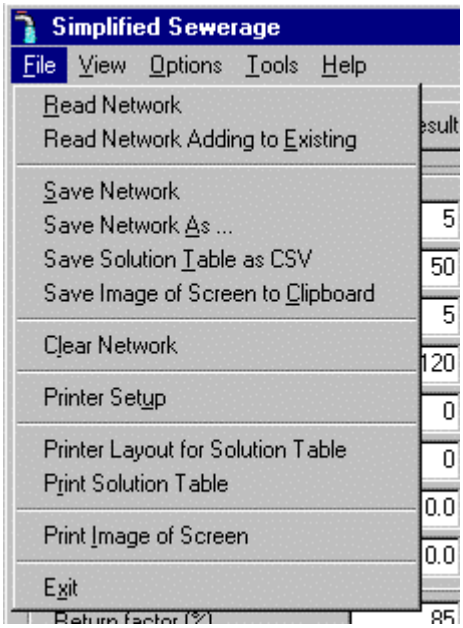


Figure 4.7 The file menu showing the "Read Network" option.

2. To draw a new network:

To start drawing you need to be in "Draw mode". Click on the Draw Mode button (a picture of a yellow pencil) (Figure 4.8).

Figure 4.8 Draw Mode button.

Press the left mouse while on the white panel, keep it pressed, move the mouse, and a grey line will be drawn. When you release the mouse button the line will be turn blue, indicating a sewer, and there will be a maroon square at each end indicating junctions. The sewer and the junctions will all have default names chosen by the program. These can easily be changed later. Do the same again with the mouse and you can draw several more sewers.

Zooming in and out

To zoom in and out of the sewer diagram you need to be in "Zoom mode". To switch to zoom mode, press the Zoom Mode button shown in Figure 4.9.

Figure 4.9 Zoom Mode button.

To zoom in, click the left mouse button. To zoom out click the right mouse button. The position of the click moves to the centre of the panel. Note that text and

junctions do not change size. The amount of zoom (scaling) is shown in the status bar at the base of the window (Figure 4.6).

Displaying and changing details of a sewer

Change to “Edit mode” by clicking the button shown in Figure 4.10 and choose “Sewer” from the two options in the “Item to select” box next to it.

Figure 4.10 Edit Mode button and selector.

Now click (left or right button) on the white panel. The nearest sewer will turn red (Figure 4.11) and its details will be displayed on the panel to the right (Figure 4.12).

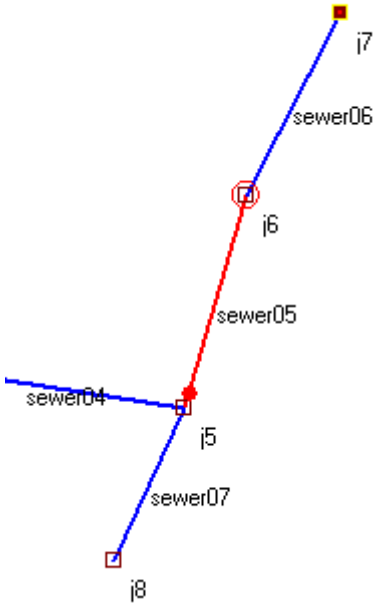


Figure 4.11 A highlighted selected sewer.

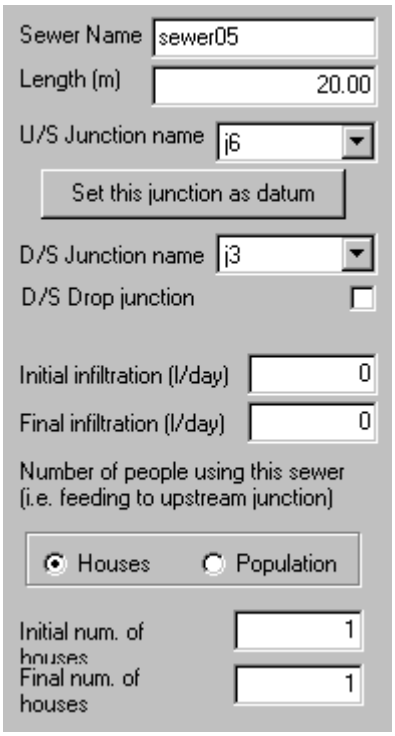


Figure 4.12 Details of selected sewer.

A sewer has the following properties:

1. Name,
2. Length (in metres),
3. Upstream junction name,
4. Downstream junction name,
5. Whether the U/S junction is a datum, and if so its level,
6. Whether the D/S junction is a drop junction,
7. Initial infiltration rate (in litres per day),
8. Final expected infiltration rate (in litres per day), and
9. Description of the initial and final number of people connected to the sewer (i.e. number of houses linked to the upstream junction).

In the example shown in Figure 4.12, sewer “sewer05” is 20m long, its upstream junction is named j6 and its downstream junction j5. From the details we cannot tell whether the upstream junction is a datum, but from the screen view (Figure 4.11) we can see that it is not as it is not marked with a yellow box. The sewer has no initial infiltration and none expected at the end of its life. Initially one house is linked to the upstream junction, and at the end of its life there will still only be one house connected. An increase in population can be designed for by changing the *average number of people per house* in the initial and final calculations – this is done on the Results Table screen. An alternative would be to specify the initial and final number of people in the houses that connect to the sewer.

Any of the above values may be altered in the Edit box – as you type, the text colour will change to red. It will change to black when you click on another box – if it does not change back to black, it has not been recorded!

To change the name of the sewer, simply type a new name. Clicking on the next box or clicking the “Apply Changes” button will change the text colour to black and record the change. (Note that the Apply Changes button does not need to be pressed if the colour has changed – but it does no harm to press it!)

In this example you can see that “sewer05” has a upstream junction named “j6” and a downstream junction “j5”. To change this connectivity, just select a different junction from the list for either the upstream (U/S) or downstream (D/S) junction name.

Datum setting

All sub-nets need one junction to be specified as the datum junction. To do this you select the sewer whose upstream junction will be the datum. Then on the Sewer Details panel click on the “Set this junction as datum” button. This will display the dialog box shown in Figure 4.13.

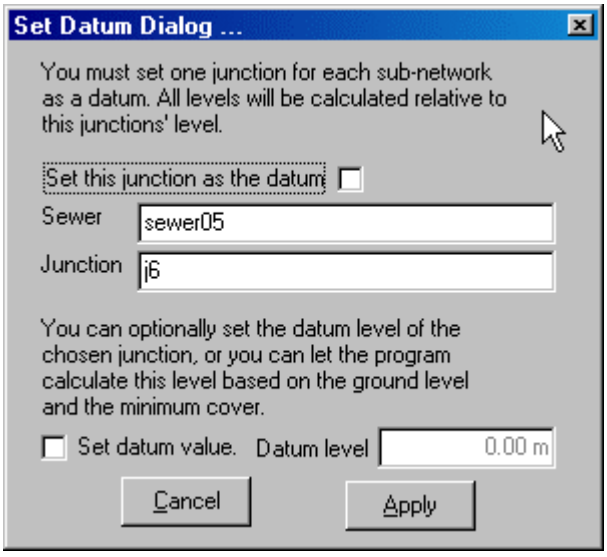


Figure 4.13 Datum setting dialog.

Click the check box to set the junction shown as the datum. You can specify the actual datum invert level by clicking the “Set datum value” check box and entering a value. Alternatively, and more conveniently, uncheck this check box (as shown in Figure 4.13) which will tell the program to calculate a datum level based on the ground level of the junction and the minimum cover. You will need to press the “Apply” button to save this information and close the dialog box.

When attempting to do the calculation, you will be given a warning if there is no datum set or if there is more than one for any particular sub-net.

Deleting sewers

Clicking on the “Delete Sewer” button (Figure 4.4) will give you the option to delete the selected sewer or not. Note that the attached junctions will not be deleted (as you may want to use them). To delete junctions, see below.

Displaying, repositioning and changing details of a junction

As with the sewer details, change to Edit mode by clicking the button shown in Figure 4.10. This time choose “Junction” from the two options in the “Item to select” box next to it.

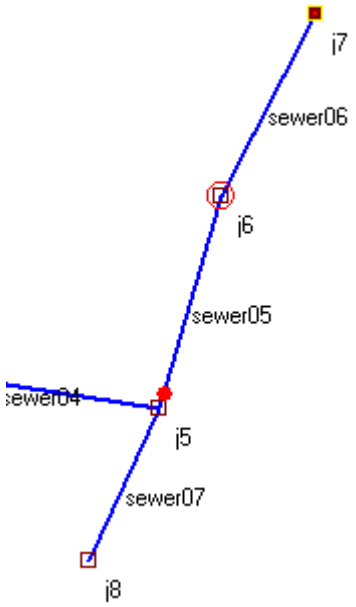


Figure 4.14 Highlighted selected junction.

To reposition a junction, left click on the white panel, the nearest junction will be highlighted with a red circle – see junction j6 in Figure 4.14. By moving the mouse while still pressed, the position of the junction and the sewers connected to it can be changed.

[Note again that this position, and sewer length change, is only a convenience for viewing; it does not necessarily represent what the network looks like on the ground. The simplified sewerage system does not take into account the orientation of individual sewers – only their gradient. However, it is probably useful to draw the network so that it is at least *similar* to the expected layout.]

To highlight the junction without moving it, right-click the mouse near a junction. Details will be displayed on the right panel – see Figure 4.15.

Like sewers, junctions also have properties that are displayed when clicking on the junction. There are only two properties:

1. Name, and
2. Ground level (in metres).

These properties may be changed on the Details panel to the right (Figure 4.15).

Figure 4.15 Details panel for junctions.

Deleting junctions

Clicking on the “Delete Junction” button will give you the option to delete the selected junction – but only if the junction is currently not connected to a sewer. If it is attached to a sewer, you must first delete the connected sewer before deleting the junction.

Changing what is displayed

To change how much detail is displayed on the screen there are seven “Display option” buttons, as shown in Figure 4.16.

Figure 4.16 Display option buttons.

The first six toggle on and off to show sewers, junctions, sewer names, junction names, drop junctions and datum junctions, respectively.

The seventh button scales the network so that it is all shown in the window.

Displaying of sub-nets

To the right of the tool bar are three controls for viewing sub-nets (Figure 4.17): a drop down list selector to choose the sub-net to highlight, an option to show the sub-net or not and a button labelled “Check Network”. Initially the selection list is empty, and no sub-net can be shown. Before they can be shown the network must be checked for consistency of the sub-nets. Pressing the Check Network button does this. If the network passes the connectivity check, the selector list will automatically be filled with the names of the existing sub-nets. Check the “Show” box and the chosen sub-network will be displayed in green.

Figure 4.17 Sub-network display controls.

4.3 DATA ENTRY/EDIT SCREEN

This screen (Figure 4.18) presents a series of tables and boxes to allow you enter (or edit) data to describe the sewer network layout, and usage requirements.

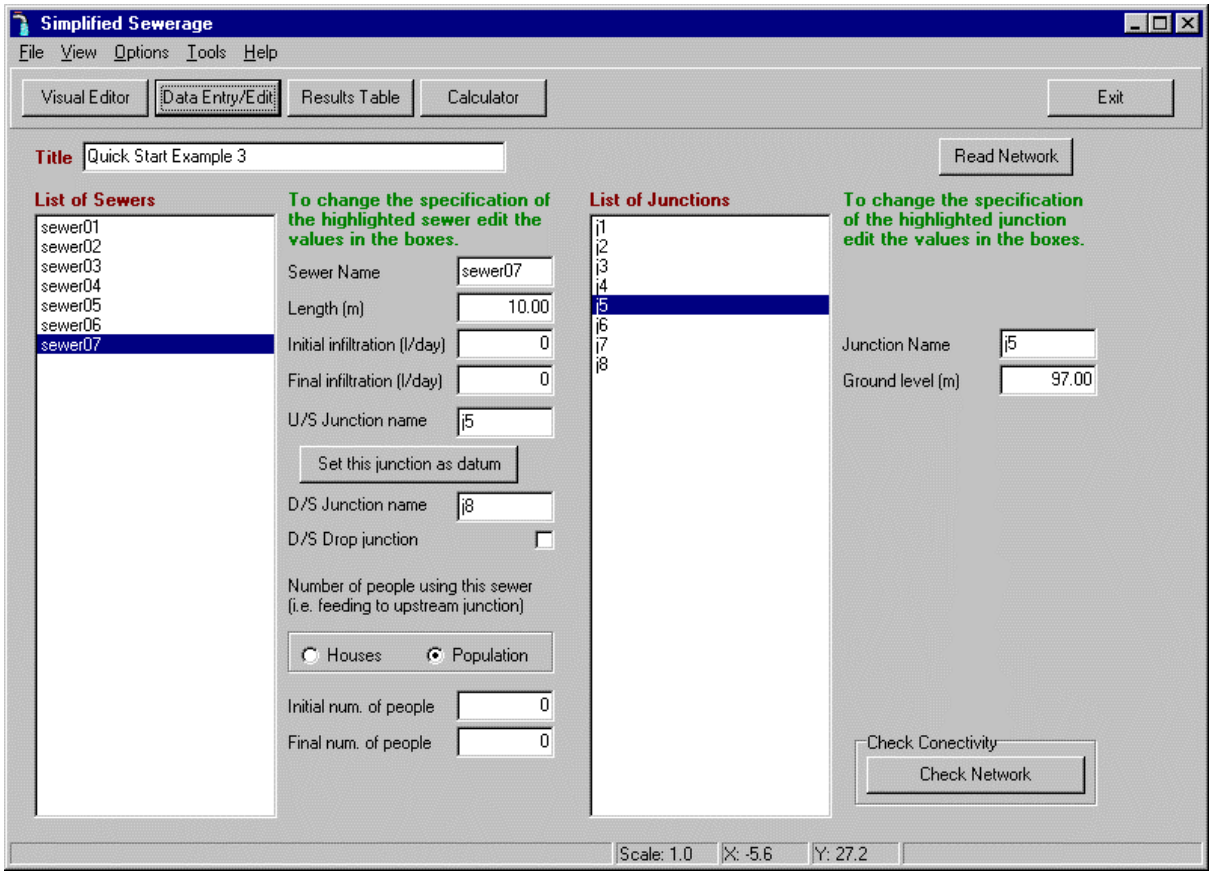


Figure 4.18 The Data Entry/Edit Screen with example data.

Figure 4.18 shows the lists and boxes filled in for a typical example (details of this example network can be found in Section 4.7.3.) This example is stored in the sewer network file *example03.snt*. These files all have the extension ".snt". An .snt file contains the network description as well as the calculated details – sizes, slopes, depths etc. – if they have been calculated. These files may be easily read, saved and read back into the program. From this data entry screen the button labelled "Read Network" (Figure 4.19) will open a dialog allowing you to choose one of these files and load it into the program.

Figure 4.19 The Read Network button.

You have the choice to either use an old network file or create a new one. If you read one in, you may freely edit and change its configuration to the new design. However, it may sometimes be more convenient to start a new network.

You may enter a network, or project, title in the Title Edit box (Figure 4.20). This title will be saved in the .snt file and appear on graphs and other printouts of the solution.

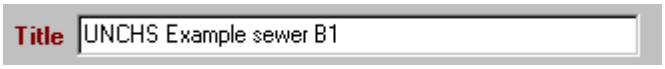


Figure 4.20 The Title Edit box.

A sewer network is made up of named sewers that join at named junctions. Thus each sewer has an upstream and a downstream junction. Sewers and junctions each have their own properties (see below) which in total describe the sewer layout and the wastewater flows for which the design will be made.

This screen provides an alternative to the Visual Edit screen for entering, displaying and editing all of the network and demand properties.

The names of all the sewers are listed in the Sewer List box (Figure 4.21). Clicking on any one of these displays the properties of that sewer in the edit boxes to the right.

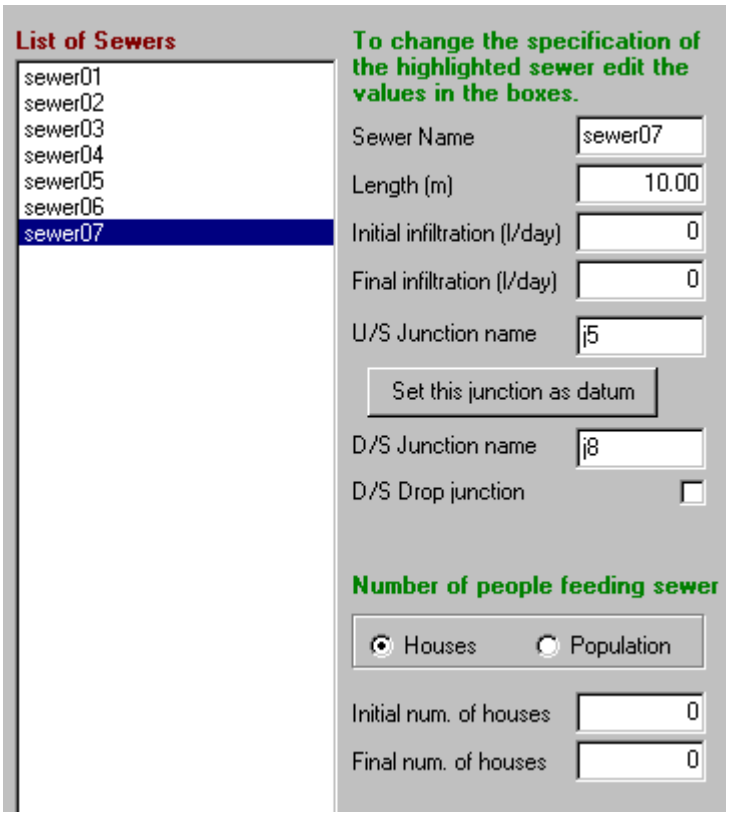


Figure 4.21 The Sewer List Box and Sewer Data Edit boxes.

Editing sewer properties

See Section 4.3 (under the heading *Displaying and changing details of a sewer*) for a detailed description of the sewer properties that need to be entered.

Many of the sewer properties may be altered in the edit boxes – the text colour will change to red. It will change back to black when you click on another box – if it does not change back to black, it has not been recorded!

If a junction name is entered that does not appear in the junction list on the right, that name is automatically created and displayed as a new junction on the list.

A new sewer can be added to the network by pressing the right mouse button in the sewer list box and selecting Add Sewer (Figure 4.22). The sewer is given a unique name and default property values which must be edited to fit in the network.

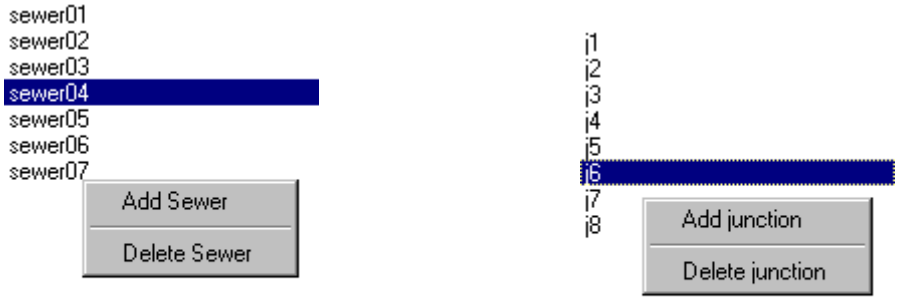


Figure 4.22 The Add/Delete options for Sewer/Junction when right-clicking the list .

To remove a selected sewer from the network choose the Delete Sewer option. You will be prompted to confirm this deletion to help prevent accidental removal.

Editing junction properties

Like sewers, junctions also have properties that are displayed when clicking on the junction name in the junction list box (Figure 4.23). These properties are described in detail in Section 4.3 (under the heading *Displaying, repositioning and changing details of a junction*).

Again, as for sewers, the junction properties may be edited and the changes recorded by pressing the Apply Change button below the Junction Data Edit box.

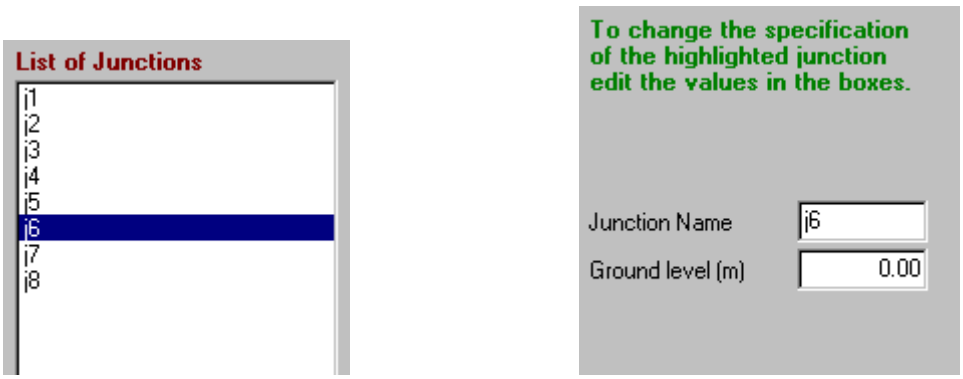


Figure 4.23 The Junction List and Junction Data Edit boxes.

Once the sewers and junctions have been specified, the sewer network description is complete. It is necessary to perform some checks to ensure that it is described correctly and that it does not contain any loops. To perform these checks, press the Check Network button shown in Figure 4.24.

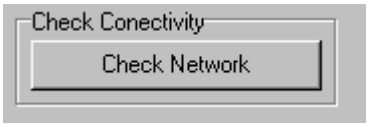


Figure 4.24 The Check Network button.

A network may be valid and correct with junctions that are not connected anywhere. It may be that these are placed with the expectation that new sewers will join them later. On the other hand it may be better to remove them to keep the network tidy. To remove all unconnected junctions choose the Options menu so that the item “Delete Unused Junctions” (see Section 4.6 for all menu details) is checked *before* pressing the Check Network button. (You could also remove the surplus junctions one by one by clicking on their name in the junction list box and pressing the Delete Junction button shown in Figure 4.22.)

Once the network has been entered and checked, it should be saved before going any further. As mentioned above, sewer networks should be saved to .snt files. To save a sewer network, choose File from the main menu bar, and select either Save Network or Save Network As … (Figure 4.25); the latter option allows you to save it under a new name.

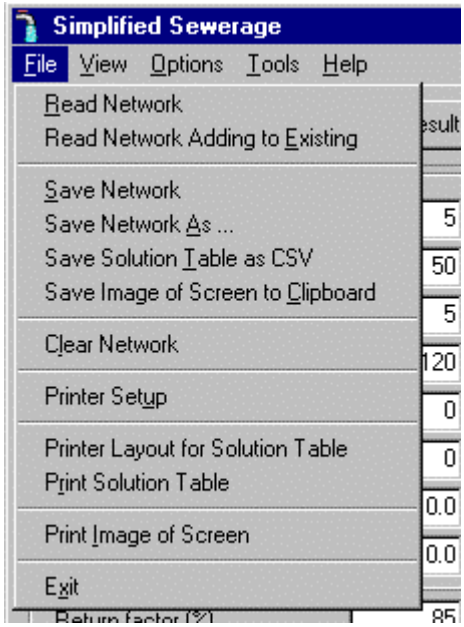


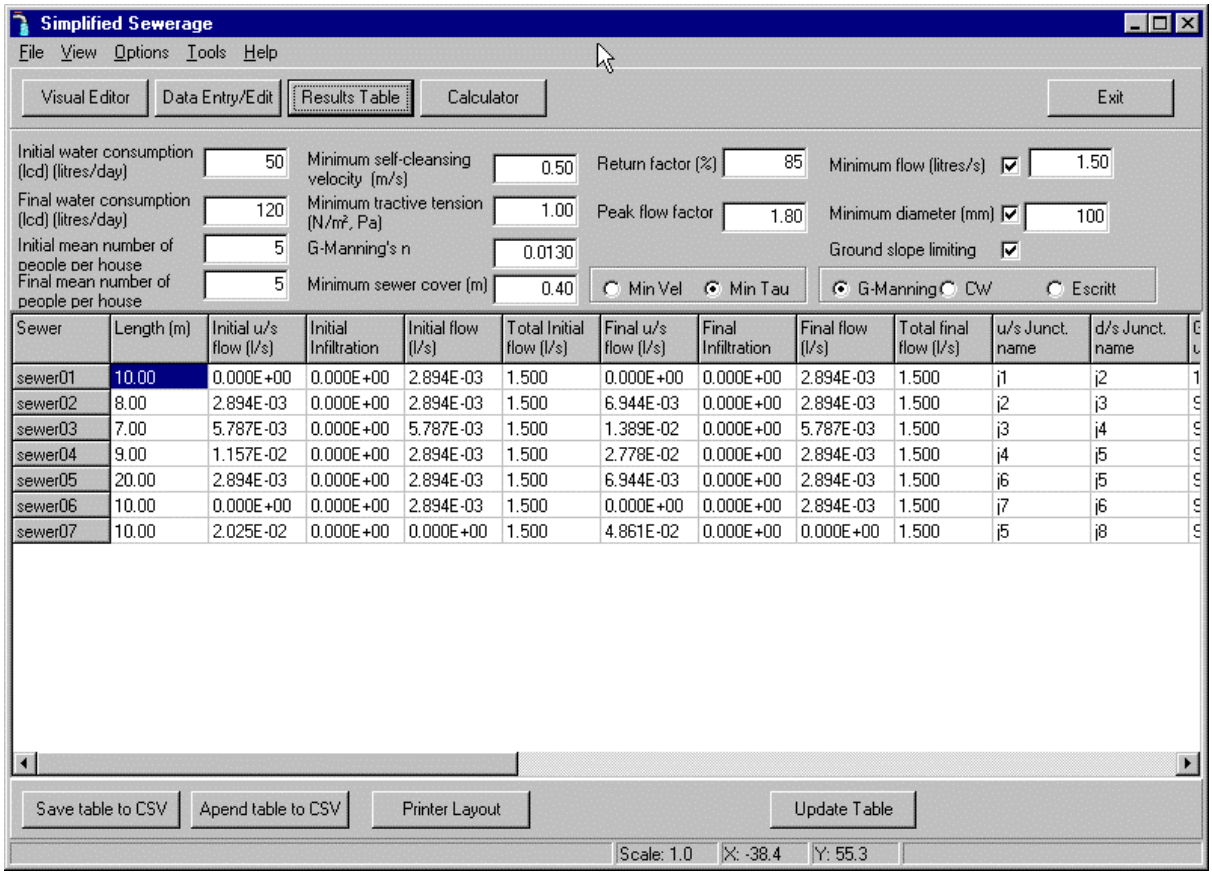
Figure 4.25 The File Menu showing the “Save Network” options.

This saved file can be read in again during this session on the program or at any time in the future when the network description will be again be displayed in the tables exactly as it was saved.

After entering and saving the network, go on to the Results Table screen by pressing the Results Table button on the top tool-button bar. A solution will be automatically calculated and displayed.

4.4 RESULTS TABLE SCREEN

This screen (Figure 4.26) presents the designed sewer network. All the required data for constructing the sewer are shown in this table.



Sewer	Length (m)	Initial u/s flow (l/s)	Initial Infiltration	Initial flow (l/s)	Total Initial flow (l/s)	Final u/s flow (l/s)	Final Infiltration	Final flow (l/s)	Total final flow (l/s)	u/s Junct. name	d/s Junct. name
sewer01	10.00	0.000E+00	0.000E+00	2.894E-03	1.500	0.000E+00	0.000E+00	2.894E-03	1.500	j1	j2
sewer02	8.00	2.894E-03	0.000E+00	2.894E-03	1.500	6.944E-03	0.000E+00	2.894E-03	1.500	j2	j3
sewer03	7.00	5.787E-03	0.000E+00	5.787E-03	1.500	1.389E-02	0.000E+00	5.787E-03	1.500	j3	j4
sewer04	9.00	1.157E-02	0.000E+00	2.894E-03	1.500	2.778E-02	0.000E+00	2.894E-03	1.500	j4	j5
sewer05	20.00	2.894E-03	0.000E+00	2.894E-03	1.500	6.944E-03	0.000E+00	2.894E-03	1.500	j6	j5
sewer06	10.00	0.000E+00	0.000E+00	2.894E-03	1.500	0.000E+00	0.000E+00	2.894E-03	1.500	j7	j6
sewer07	10.00	2.025E-02	0.000E+00	0.000E+00	1.500	4.861E-02	0.000E+00	0.000E+00	1.500	j5	j8

Figure 4.26 The Results Table screen.

If a sewer network has been previously entered – by reading from an existing file, via either the Data Entry/Edit or Visual Editor screens – then the solution will be automatically shown when this screen is displayed.

Note: You cannot edit the values in this table. To obtain a different solution you must edit the initial data and/or the calculation parameters.

Each column of the table has a heading, shown more clearly in Figure 4.27, which identifies the parameter found there for each sewer. The data for each sewer are written on a single row, and the sewer is identified by its name in the first column headed "Sewer".

Sewer	Length (m)	Initial u/s flow (l/s)	Initial Infiltration	Initial flow (l/s)
sewer01	10.00	0.000E+00	0.000E+00	2.894E-03
sewer02	8.00	2.894E-03	0.000E+00	2.894E-03
sewer03	7.00	5.787E-03	0.000E+00	5.787E-03
sewer04	9.00	1.157E-02	0.000E+00	2.894E-03

Figure 4.27 A sample of the Results Table.

The table will normally be wider and longer than your monitor screen; the columns and rows that are not visible can be viewed by moving the bottom and right scroll bars. Each column width may be changed (widened or narrowed) by placing the mouse cursor over the line separating any heading; when the cursor changes to two vertical lines, press the left mouse button – moving the mouse will then adjust the column widths of the two adjacent columns.

As well as displaying the solution, this screen also allows the setting of parameters for the *whole* network (the Data Entry/Edit screen allows setting of data for individual sewers of the network). These “global” settings are made by changing the values in the edit boxes above the table.

The default values which appear on this screen have been chosen to be those (or very close to those) that should be used. Great care should be taken when using parameter values that differ greatly from these default values.

The parameter setting will now be explained. The first column of four edit boxes (Figure 4.28) deals with water consumption which, together with the population setting from the Data Entry/Edit screen of each sewer (Figure 4.21) define the water use. If “Population” was chosen to define use, then only the top two boxes – initial and final consumption – need be set. However, if “Houses” was chosen, then the lower two boxes – the initial and final mean number of people per house – are also required to define the total number of people using the sewer and hence the total water use.

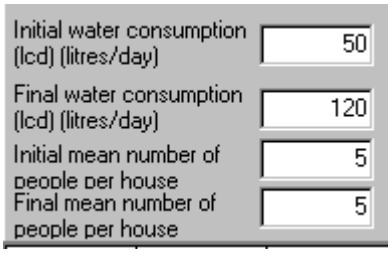


Figure 4.28 Water consumption data edit boxes.

The rest of the settings deal with how the sewer design calculations are to be performed.

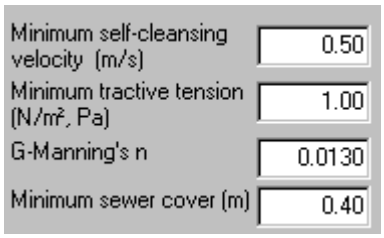


Figure 4.29 Calculation parameters.

Figure 4.29 shows the options to set either the minimum self-cleaning velocity or minimum tractive tension, or both. (Only one solution will be displayed based on one of these methods; however both calculations are performed, so both values should be entered.) The value for Gaukler-Manning's *n* (shown as G-Manning's *n*) may also be set in the next edit box. The minimum cover of sewer is the depth set for the upstream junction that has been designated as the datum junction. All other depths will be calculated relative to this according to the calculated sewer gradients.

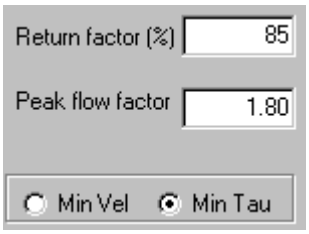


Figure 4.30 Calculation parameters.

Figure 4.30 shows the edit boxes for Return Factor (entered as a percentage) and Peak Flow Factor. Also shown is the choice of calculation for which results will be presented – Min Vel refers to the calculation based on minimum self-cleansing velocity, while Min Tau refers to that based on minimum tractive tension.

It may be desirable to set some design limits for the calculation. Three check boxes are provided for this (Figure 4.31). Ticking the Minimum Flow check box means that if the sewer demand is less than the minimum entered in the edit box to the right, then this minimum is used for the sewer design. Ticking the Minimum Diameter check box means that no sewer of diameter less than the entered minimum will be used. Ticking the Ground Slope Limiting box means that the minimum slope of the sewer will not be less than the ground slope.

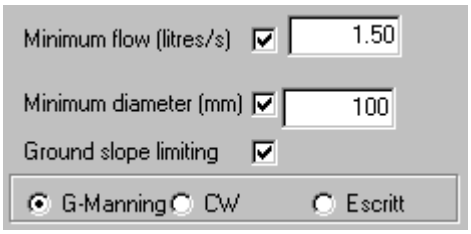


Figure 4.31 Limiting values and Velocity of Flow equations.

Also shown in Figure 4.31 is the choice of velocity of flow equation – Gaukler-Manning (shown as G-Manning), Colebrook White (shown as CW) or Escritt.

When changes have been made to any parameters, to see what effect these changes have on the solution the Update Table button (located below the table – Figure 4.32) must be pressed. The table will then be updated with the new results.

Figure 4.32 The buttons below results table.

The other three buttons shown in Figure 4.32 allow the saving and printing of the solution. The first two buttons save to CSV files (CSV files contain data from the Results table with each item of data being separated by a comma – thus CSV from "comma separated variable"). This format of file can be easily read into most spreadsheet programs (including Microsoft Excel), so enabling further processing or presentation in reports. The Save Table to CSV button allows saving to a new or existing file; and the Append Table to CSV button adds the data in the table to the bottom of an existing file; this is useful if several scenarios are to be tested and analysed later.

The Print Page Layout button opens a dialog to allow the setting of print options – page margin, orientation etc. The Print Preview button allows a preview of the page; you may also print directly from this preview screen.

Should it be necessary to examine the detail of a calculation for a particular sewer, then choose that sewer (just click on a particular row of the table) and press the Calculator button on the main Tool Button Bar (Figure 4.2). The calculation screen will be displayed containing full details of the calculation performed and solutions obtained for that sewer. This screen is described in detail in Section 4.5.

4.5 CALCULATOR SCREEN

This screen (Figure 4.33) presents the detail of the calculation for an individual sewer. Opening the screen automatically displays the design parameters for the current sewer of the Results Table (the last sewer row to be clicked on or highlighted on the Visual Edit screen).

This screen allows the calculation to be performed with new demand data or new calculation parameters, so that changes in design can be investigated. Any changes made to this screen are **not** transferred to the Results Table of sewer data.

To the left hand side of the screen are displayed all the design parameters; these have been taken from those previously entered on the either the Data Entry/Edit or Results Table screens.

The first eight of the edit boxes for the design parameters deal with the sewer's initial and final demand in terms of population and water consumption (Figure 4.34); see Section 4.2 for a description of these.

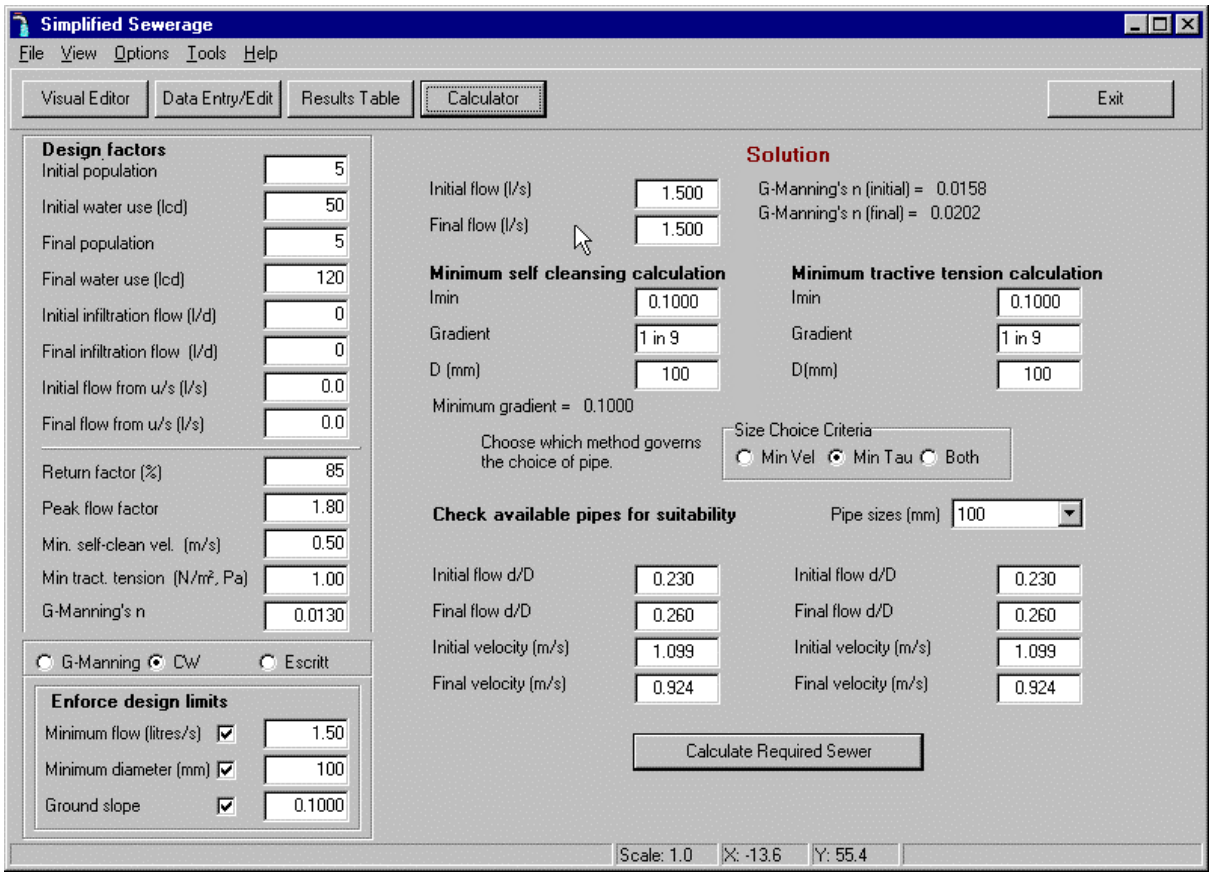


Figure 4.33 Sewer Calculation screen.

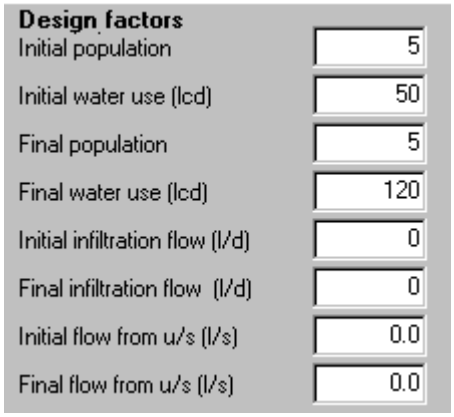


Figure 4.34 Water consumption settings.

Below these the design parameters (Figure 4.35) and design limits (Figure 4.36) are displayed.

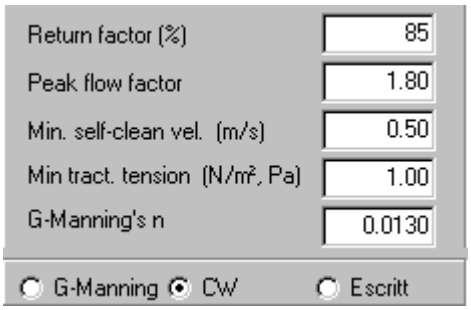


Figure 4.35 Design parameters.

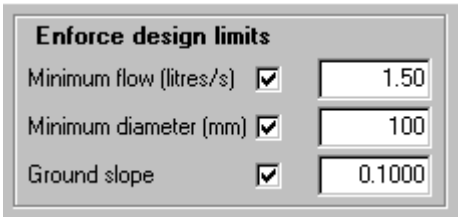


Figure 4.36 Design limits.

Note that you may change the ground slope here; this is not possible on the Results Table form as that would entail changing junction/network data. It is possible here as this screen is only concerned with a single sewer.

The Calculator screen shows results of calculations based on both minimum self-cleaning velocity and minimum tractive tension. The results are displayed side-by-side, as shown in Figure 4.37.

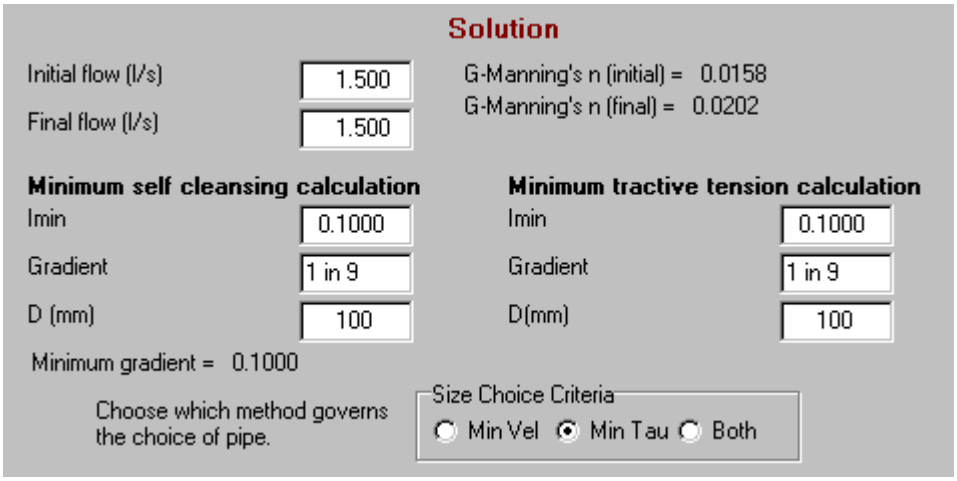


Figure 4.37 The two solutions side by side.

The calculated gradient and diameter of the sewer for both calculations are shown in Figure 4.37 (the diameter may be the set minimum if that option was chosen). If the gradient is limited by the ground slope, then this limit will be shown as the minimum gradient.

The total initial and final flows are calculated and displayed at the top of the screen. If either the Colebrook-White or Escritt equations have been chosen, then the *equivalent* Gauckler-Manning's *n* is displayed next to these (Figure 4.38).

In Figure 4.39 the chosen sewer (from the list of available sewers) is displayed and, to enable a check on the solution, so are the d/D and velocity values for the initial and final flows. (Remember d/D should always be greater than 0.2 and the minimum velocity should be greater than that set – if this was the chosen design method.)

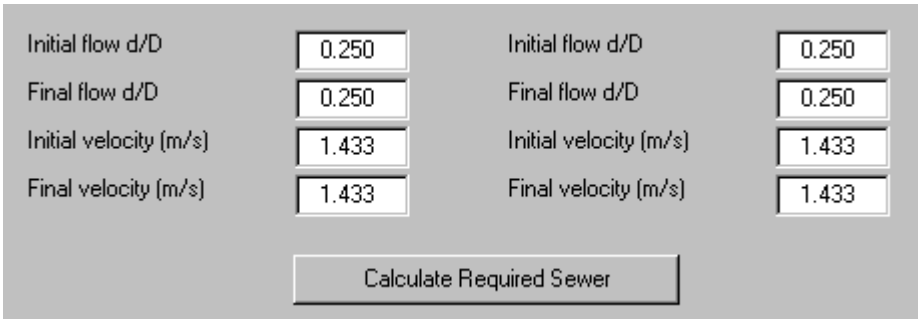


Figure 4.38 Check sewer design.

Figure 4.39 Chosen sewer selector.

4.6 MAIN MENU OPTIONS

The Menu bar at the top of the screen allows an alternative way to perform several of the operations available on the four main screens, as well as offering some additional functionality.

4.6.1 File Menu

The File menu (Figure 4.40) allows you to save and read the network description using the Save Network and Read Network options.

The Clear Network option deletes all entered data and starts a new network – so **be careful** with this option!

The Save Solution Table as CSV option allows saving of the results table to a CSV file – see the description of the Results Table screen (Section 4.4) for a full explanation of this.

The Save Image of Screen to Clipboard option makes a copy of the program screen in the Windows clipboard – you may then copy this into your word processor by choosing the paste function (or pressing keys Ctrl-V) from within that program. This may be useful for including design details in reports.

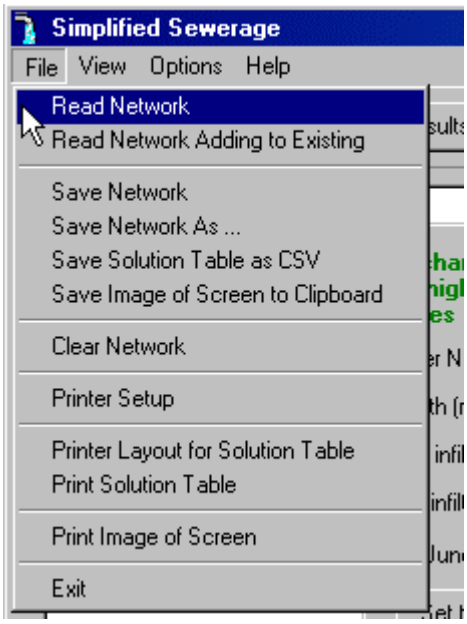


Figure 4.40 File Menu.

The next four options deal with printing the results. Print Setup allows you to choose which printer and paper to use. Print Image of Screen will print the displayed program screen on the chosen (or default) printer.

4.6.2 View Menu

The View menu has five options (Figure 4.41). The first four reproduce the functionality of the first four buttons of the main toolbar (Figure 4.2), i.e. they enable switching between the four main forms of the program.

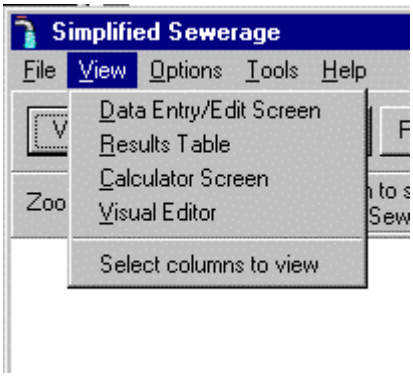


Figure 4.41 The View menu.

The fifth option opens a window that allows control of the appearance of the Result Table. This window is shown in Figure 4.42.

The window contains a list of the headings for each column of the Results Table. If the adjacent check box is ticked, then that column will be displayed in the Results Table. By default all columns are shown. To view any change in the Results Table press the Apply button.

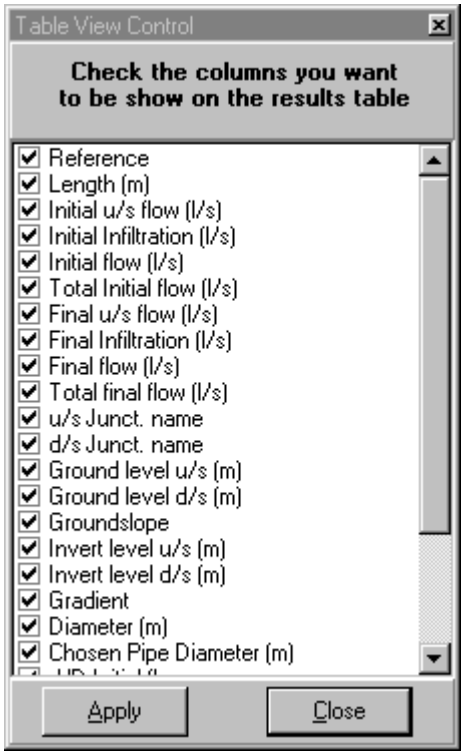


Figure 4.42 Table View Control window.

4.6.3 Options Menu

The Options menu gives two choices. The first item “Delete unused junctions” can be ticked on or off (Figure 4.43 shows it on). When on, any unused junctions (i.e. those not associated with a sewer) will be deleted when a check on the network is performed.

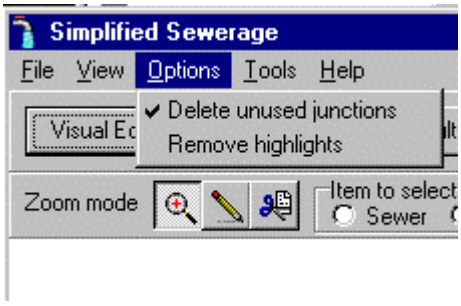


Figure 4.43 The Options menu.

It is sometimes useful not to have these deleted – for example, when you wish to use the junction at a later time, but wish to check its current connectivity.

The “Remove highlights” option refers to any sewer or junction that has been displayed (highlighted) in red on the Visual Editor screen. Choosing this item will clear this highlighting.

4.6.4 Tools Menu

The Tools menu displays two items that give access to small “helper” screens that appear when the item is chosen.

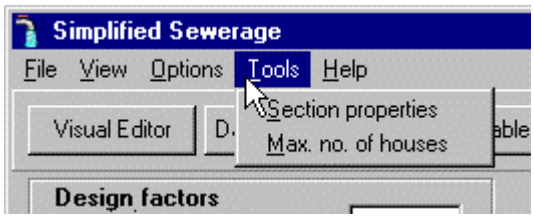


Figure 4.44 The Tools Menu.

The “Section properties” item displays the screen shown in Figure 4.45. This screen allows quick calculation of the hydraulic properties of circular channels.

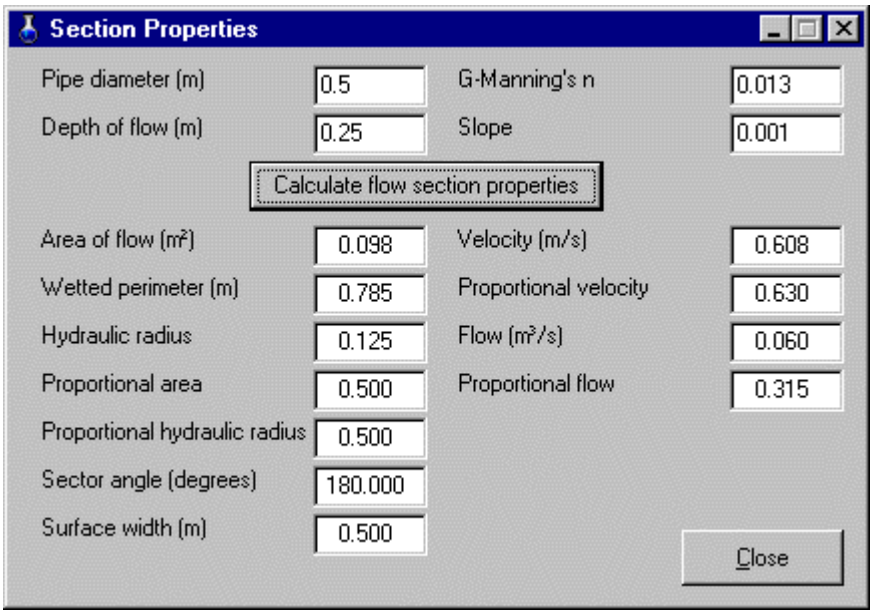


Figure 4.45 The Section Properties Helper screen.

The second item “Max. no. of houses” shows a screen (Figure 4.46) that allows a quick calculation of the number of houses that can be safely connected to a minimum sized sewer at minimum gradient, based on the minimum flow (single WC flush) (see Section 3.3.6).

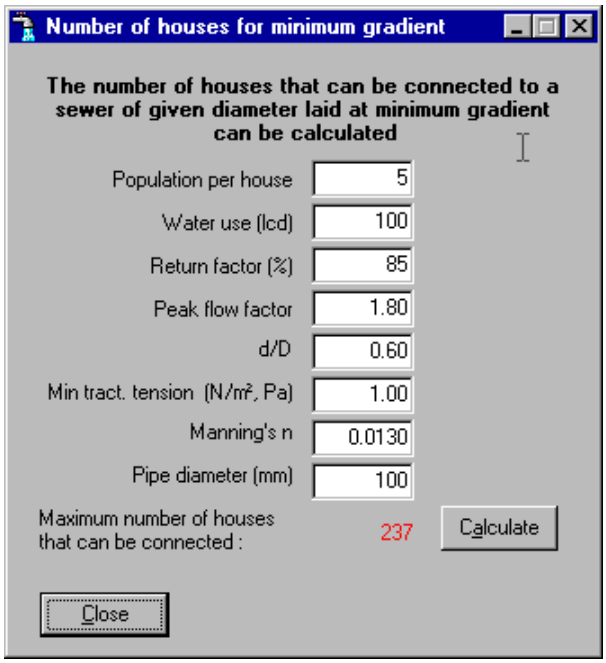


Figure 4.46 The Minimum Gradient Helper screen.

4.6.5 Help Menu

The Help Menu has three items, which are typical choices for Windows-based programs. “Contents” brings up the help pages which should help answer most queries about how to use the program

If a query is not answered, it may be worthwhile choosing the second option “Web page” which will attempt to open the PC’s standard web browser in order to connect to the web support page for the program.

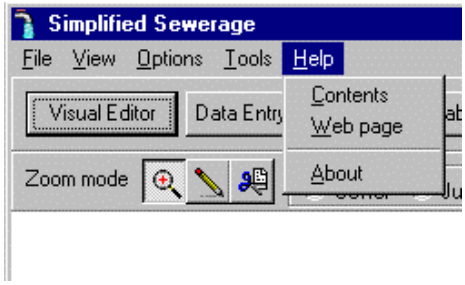


Figure 4.47 The Help Menu.

The “About” item displays useful program and author details.

4.7 QUICK START EXAMPLES

These four worked examples demonstrate all the steps necessary to build simple sewer networks. These examples also demonstrate the use of some of the calculation options. Data for all four examples can be found in the Networks directory where the program was installed.

4.7.1 Example 1 – A single line of sewers

This example is a simple series of four connected sewers joined as shown in Figure 4.48.

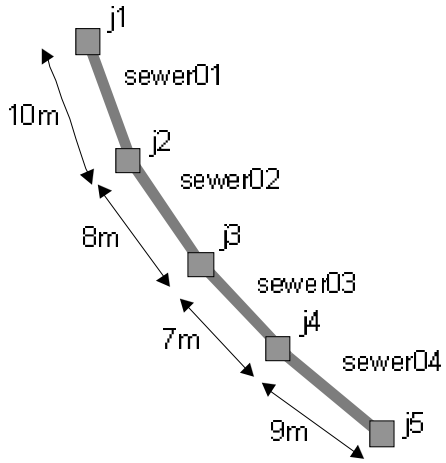


Figure 4.48 Example 1 sewer layout.

The first thing to do before entering the sewer network data on the Data Entry/Edit screen is to draw your system of sewers on paper and label each junction and sewer in a similar way to that shown in Figure 4.48; this will make the job of data entry much easier.

As a minimum to get your basic layout entered you will also need the following for each sewer: its length, and the number of people using the sewer (this may be described in terms of the number of houses connected together with a mean number of people per house, or in terms of a single total number of people who live in houses connected to the sewer). This example will specify the number of houses connected. For each junction (or node) of the network the ground level is required.

The data for this example are as follows:

Sewer name	Length (m)	Number of houses connected
Sewer01	10	1
Sewer02	8	1
Sewer03	7	2
Sewer04	9	1

Junction name	Ground level (m)
j1	100.0
j2	99.0
j3	98.0
j4	97.0
j5	97.0

To enter the data display the Data Entry/Edit screen. First enter a title for the network in the edit box next to the label "Title". This will appear on saved results and printouts. To input the sewer data first create the sewers by pressing right mouse button and choosing the “Add Sewer” option (see Figure 4.22). Do this **four** times. This will create four new sewers with the names S0, S1, S2 and S3, all with the same default data. These can now be edited to represent the above network.

Click on S0 in the list of sewers and change the sewer name to sewer01, the length to 10.00, the upstream junction to j1 and the downstream junction to j2. Click on the “Houses” option so that a black dot appears next to the label “Houses” and enter 1 in both the initial and final number of houses edit boxes. The data in the edit boxes should now look like those in Figure 4.49.

All names and labels in this program are case sensitive. For example, a sewer named sewer01 is **not** the same as a sewer named Sewer01.

Note: as you type in any of the boxes on this screen the text will change to red indicating that the data have been changed. Clicking on the next box will change the text colour to black. Only when the text has changed colour back to black will the change be recorded.

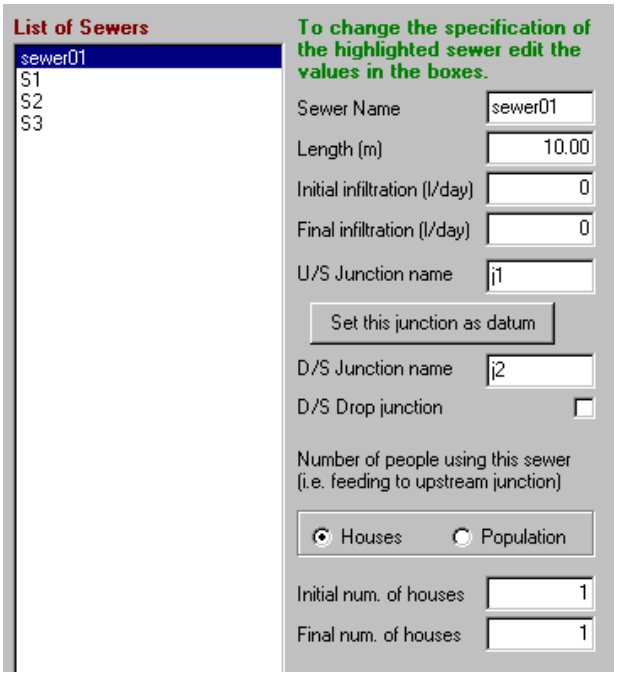


Figure 4.49 Data for sewer01.

In a similar way enter the data for sewer02, sewer03 and sewer04, so that the data are as shown in Figures 4.50, 4.51 and 4.52, respectively.

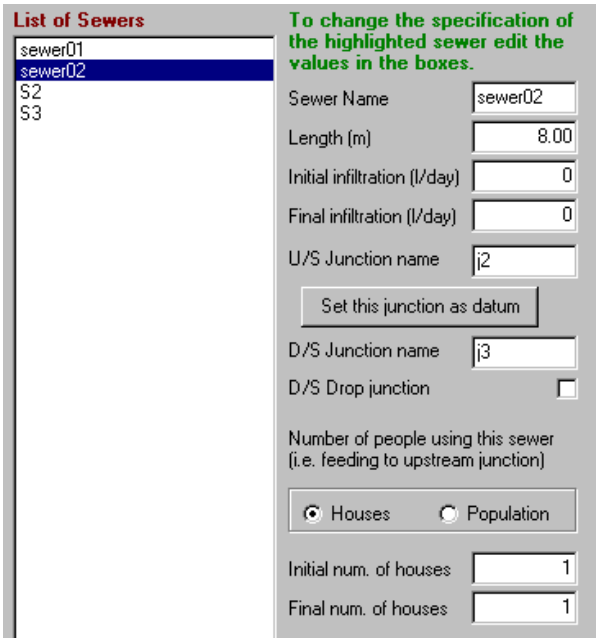


Figure 4.50 sewer02 data.

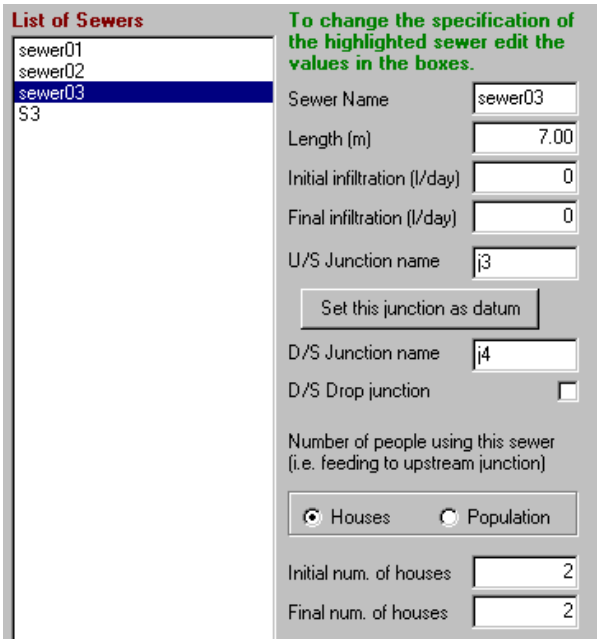


Figure 4.51 sewer03 data.

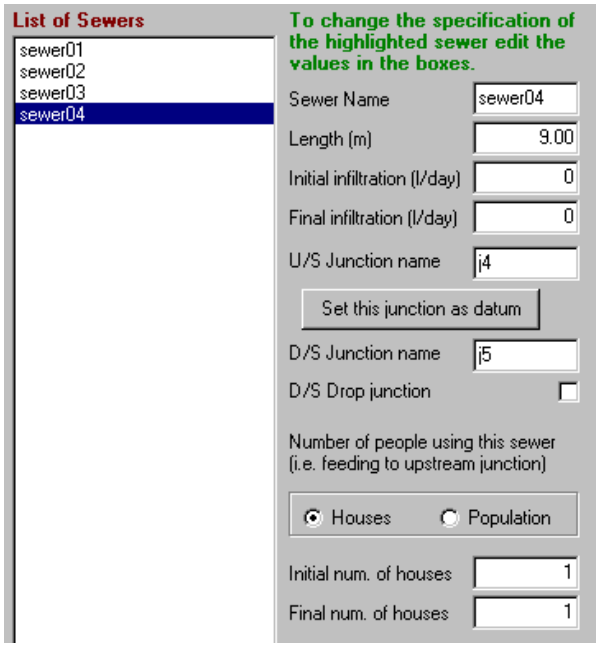


Figure 4.52 sewer04 data.

Now enter the junction data. There should be a list of seven junctions in the junction list – the five you have entered plus “J_up” and “J_down” which are default names; these may be left in or deleted. Leave them in for now.

Click on ”j1” to display the junction data. Leave the name but enter the ground level as 100.00 m. The data should then appear as shown in Figure 4.53.

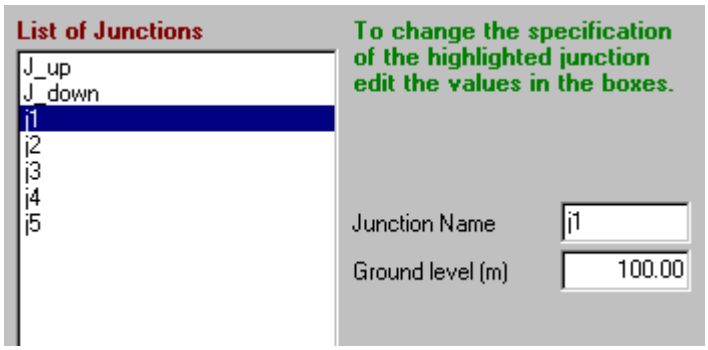


Figure 4.53 Junction j1 data.

In the same way change the data for junctions j2, j3, j4 and j5 to appear as shown in Figures 4.54, 4.55, 4.56 and 4.57, respectively.

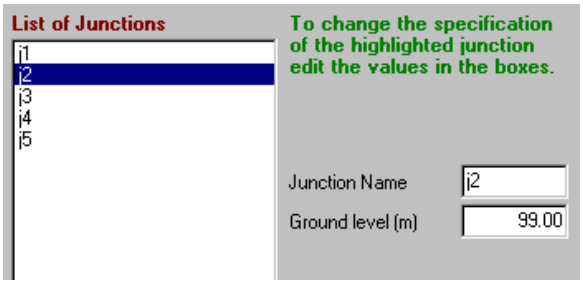


Figure 4.54 Junction j2 data.

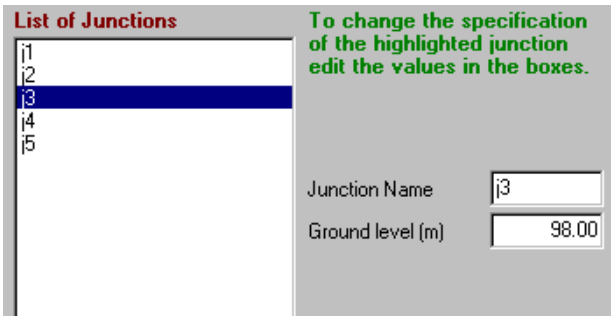


Figure 4.55 Junction j3 data.

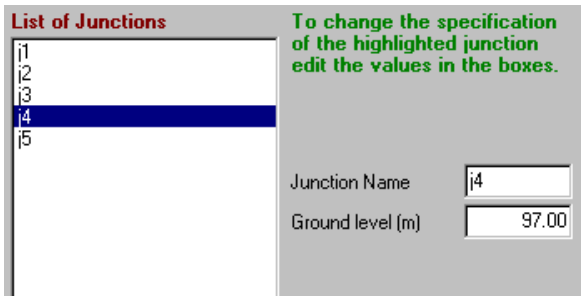


Figure 4.56 Junction j4 data.

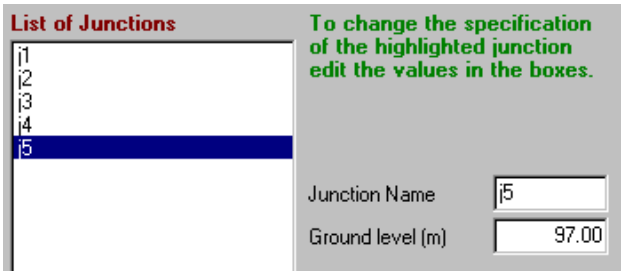


Figure 4.57 Junction j5 data.

The datum junction must now be set. We will use the upstream end of the network for this, i.e. the upstream junction of sewer01, j1. Click on sewer01 in the **sewer** list, so that the screen looks something like Figure 4.49. Click on the “Set this junction as datum” button and the screen shown in Figure 4.58 will appear. Check the “Set this junction as the datum” box and then press the Apply button.

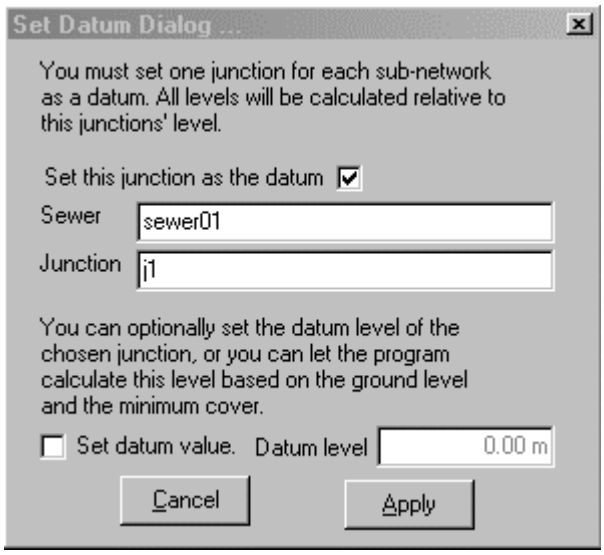


Figure 4.58 Junction j5 data.

When the data are entered, the Screen Data Edit screen should appear as shown in Figure 4.59.

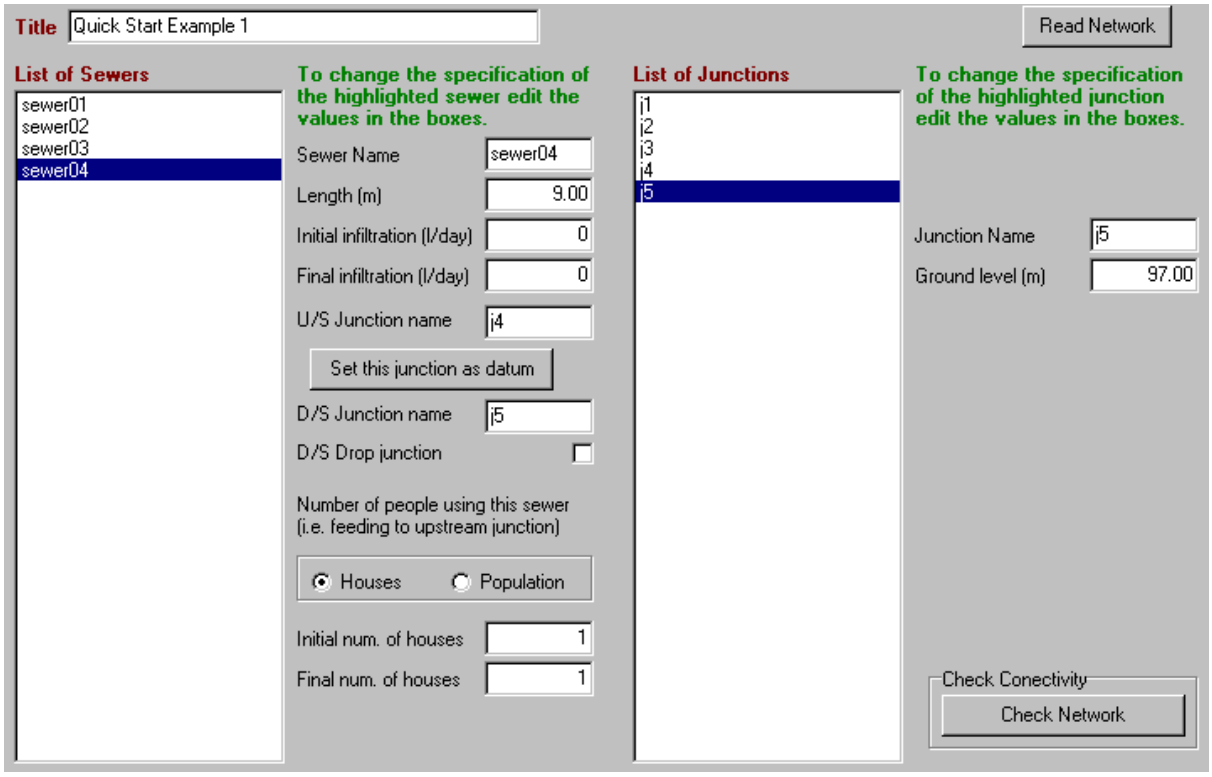


Figure 4.59 Data for Example 1.

Next check that the network is connected correctly. On the Options menu make sure the “Delete unused junctions” item is ticked (this removes the unnecessary "J_up" and "J_down" junctions during the network check), then press the Check Network button. If all is well, a message will be displayed telling you that the network has passed its check. If it does not pass, go back through all of Figures 4.49-4.59 until

your screens look the same for each junction and sewer, and then check the network again.

Now save this network: on the File menu choose the first option Save Network. A standard Save Dialog will open allowing you to either choose an existing name or enter your own file name. For this example enter your own file name with the file extension ".snt" – for example, *myexample1.snt*. This will allow the file to be found more easily when you need to read back the data.

The entered network may now be viewed on the Visual Editor screen. Click the Visual Editor button. The network will look something like that shown in Figure 4.60, and it obviously does not represent what you have entered – the problem is that you have not entered position data for the junctions. The junctions have been given default locations and sewers drawn at default lengths, which means they are all drawn on top of each other! The junctions now need to be repositioned.

Figure 4.60 View of the Quick Start Example 1 network before repositioning.

Click on the Edit Mode button and select the Junction option, as shown in Figure 4.61.

Figure 4.61 Edit Mode button and selector.

Left click the mouse on a junction and, with the mouse button pressed, drag the junction to a new position. Repeat this on each junction until all have been positioned to give a view that represents the network – similar to that shown in Figure 4.62.

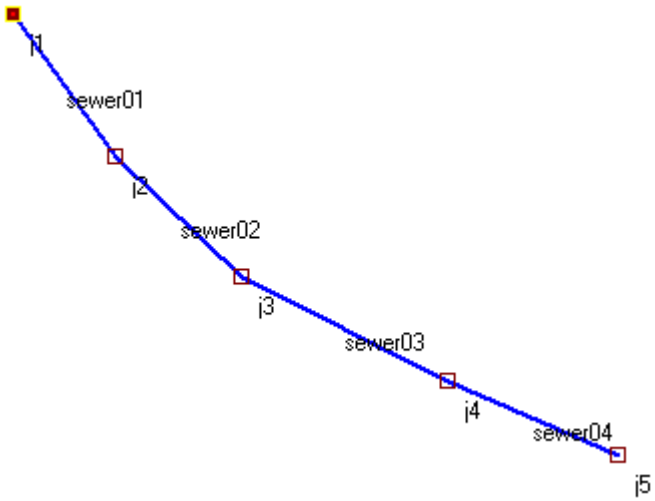
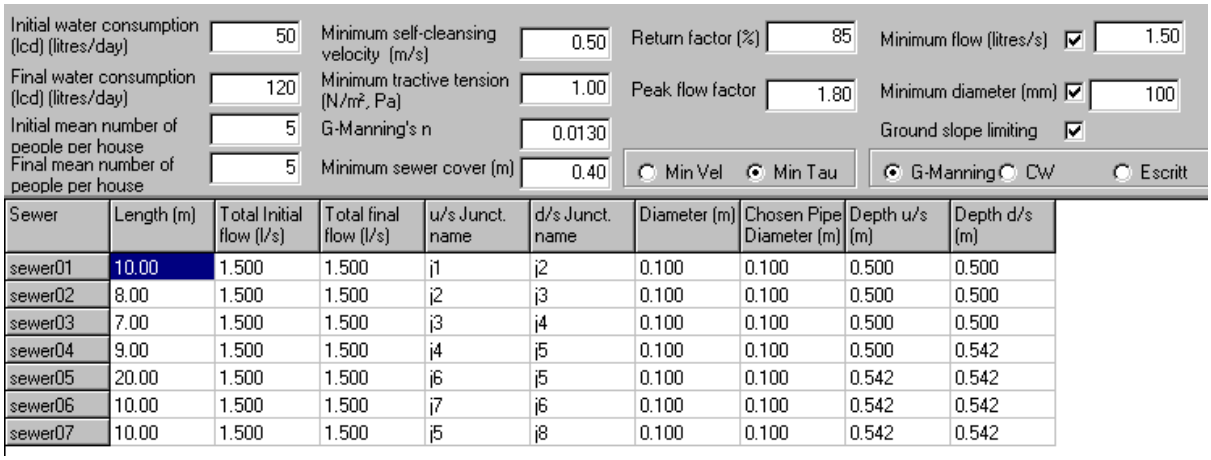


Figure 4.62 View of the Quick Start Example 1 network after repositioning.

You can now view the results. To proceed to the Results Table press the button in the top toolbar. The solution for this sewer will be displayed as shown in Figure 4.63.



Initial water consumption (lcd) (litres/day)	50	Minimum self-cleansing velocity (m/s)	0.50	Return factor (%)	85	Minimum flow (litres/s)	1.50
Final water consumption (lcd) (litres/day)	120	Minimum tractive tension (N/m², Pa)	1.00	Peak flow factor	1.80	Minimum diameter (mm)	100
Initial mean number of people per house	5	G-Manning's n	0.0130			Ground slope limiting	
Final mean number of people per house	5	Minimum sewer cover (m)	0.40	Min Vel / Min Tau		G-Manning / CW / Escritt	

Sewer	Length (m)	Total Initial flow (l/s)	Total final flow (l/s)	u/s Junct. name	d/s Junct. name	Diameter (m)	Chosen Pipe Diameter (m)	Depth u/s (m)	Depth d/s (m)
sewer01	10.00	1.500	1.500	j1	j2	0.100	0.100	0.500	0.500
sewer02	8.00	1.500	1.500	j2	j3	0.100	0.100	0.500	0.500
sewer03	7.00	1.500	1.500	j3	j4	0.100	0.100	0.500	0.500
sewer04	9.00	1.500	1.500	j4	j5	0.100	0.100	0.500	0.542
sewer05	20.00	1.500	1.500	j6	j5	0.100	0.100	0.542	0.542
sewer06	10.00	1.500	1.500	j7	j6	0.100	0.100	0.542	0.542
sewer07	10.00	1.500	1.500	j5	j8	0.100	0.100	0.542	0.542

Figure 4.63 Results Table for Quick Start Example 1.

On your screen you will probably see many more columns of data. The full number of columns displayed can be reduced to avoid confusion or to display only the data you are interested in. Choose the View Menu and the “Select Columns to View” item. This will display the window shown in Figure 4.64, which is used to switch on or off the display of each column. With the list of column titles displayed, place a tick in the boxes next to the parameters you wish to display, and then press the Apply button.

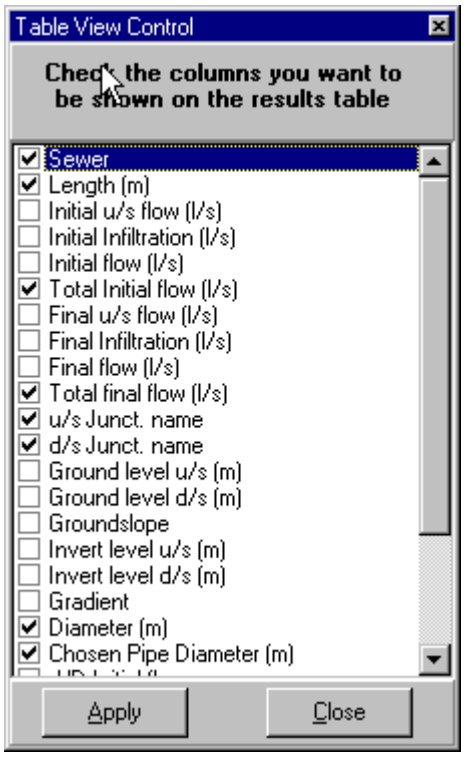


Figure 4.64 The Table View Control window.

The network data file for this example is supplied with the program under the filename *example01.snt*.

4.7.2 Example 2 – Adding a branch sewer

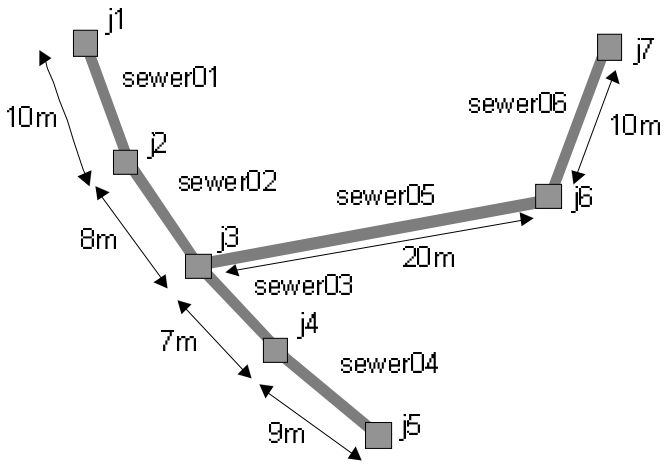


Figure 4.65 Example 2 sewer layout.

This example builds on the network described in Example 1 by attaching a sewer branch that joins at junction j3, as shown in Figure 4.65.

The first step is to read in the Example 1 data. If you completed Example 1 you may read your file; however to be sure to get the correct data, it is preferable to read the file *example01.snt* supplied with the program.

To read the data file choose the File menu and the “Read network” item. Choose the file “Example01.snt” in the Networks directory and read it in – the screen should now look similar to that shown in Figure 4.62.

On the Visual Edit screen click the Draw Mode button (the yellow pencil). Draw two lines on the screen in approximately the same place as sewer05 and sewer06 in Figure 4.65.

You should now have two new disconnected sewers, S0 and S1, and four new junctions J0-J3, as shown in Figure 4.66.

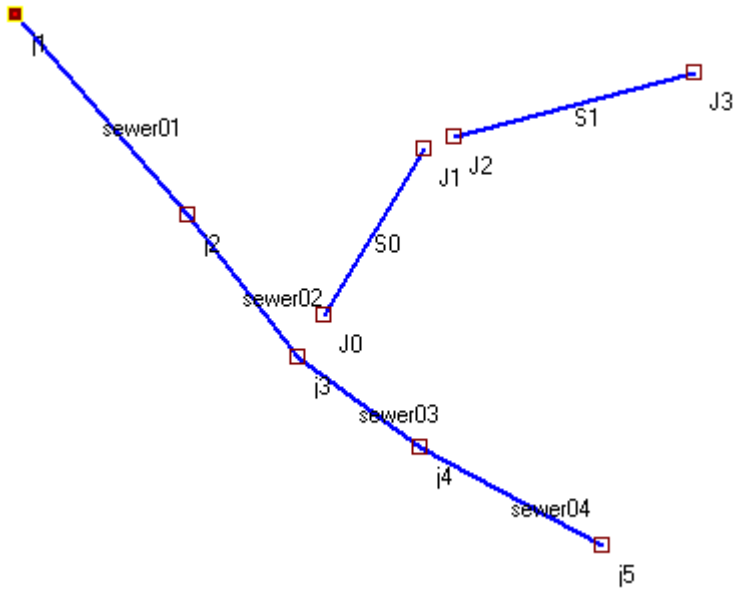


Figure 4.66 The added sewers and junctions.

These new sewers need to be connected and renamed. In the Edit Mode choose the sewer option (Figure 4.61). Click on sewer S0; it will turn red and its details will be displayed on the right panel.

Change the sewer name to sewer05, its length to 20.0m and its downstream (D/S) junction to j3 (choosing this from the list). Also choose the Houses option and set initial and final number both to 1. The display should now look something like Figure 4.67.

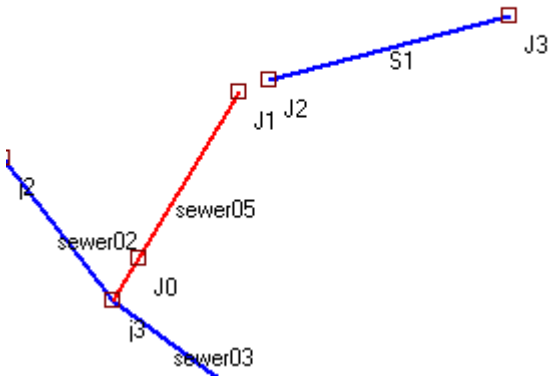


Figure 4.67 The sewer05 selected and connected to j3

Now select sewer S1 by clicking on it and change its name to sewer06, its length to 10m and select J1 for the D/S junction. Again choose the Houses option and set the initial and final number both to 1. Then choose “Junction” from the Item to select option (Figure 4.61) and click on junctions J1 and J2, one by one, dragging and repositioning them to give a better layout as necessary. The display should then look something like Figure 4.68.

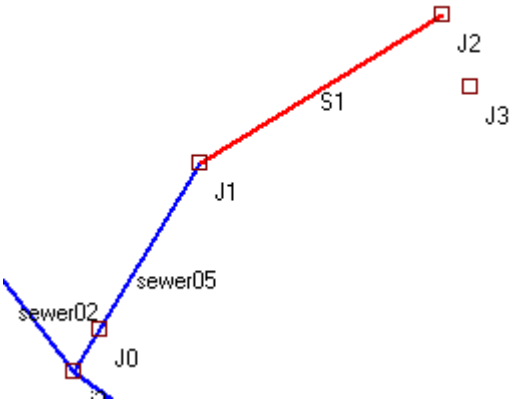


Figure 4.68 Sewers sewer05 and sewer06 connected and repositioned.

The last thing to do is to delete the unused junctions J0 and J3 and rename J1 and J2 setting their levels. To delete junction J0, make sure you are in Edit mode and have Junction chosen; now right click on the junction and it will be highlighted with a red circle and its details displayed on the right hand panel. On this panel click the "Delete Junction" button. Repeat this for junction J3.

To rename junction J1, stay in Edit mode, right click the junction until it is highlighted; now type the name "j6" in the name box and set the level to 98.0m. Click the "Apply Changes" button. Do the same for junction J2 changing its name to "j7" and its level to 99.0m.

You can now proceed to the Results Table by pressing the button in the top toolbar. The solution for this sewer will now be displayed.

The network data file for this example is supplied with the program under the filename *example02.snt*.

4.7.3 Example 3 - Branch conversion to two sub-networks

Example 2 has two branches that join at junction j3 and the whole network was calculated with all parts linked together. An alternative method of designing this type of sewer allows each branch to be designed as a separate network of defined sub-nets, as discussed in Section 4.1.3. This is useful when one of the sewers is to be designed to receive stormwater (see Section 3.3.3). We will use the data of Example 2 to demonstrate the use of sub-nets.

The network file supplied with the program for Example 2 is *example02.snt*. The first step is to read this in as a new network. We will convert this to have two sub-nets with one running from junction j1 to j5 and the other from j7 to j3. From this description there appears to be no difference between this layout and that in Example 2. This is so, but what we have done allows the second leg to be designed so that it may join at junction j3 at a different (higher) level if necessary. This may be desirable if the main leg is a previously designed sewer or one where levels are constrained for some reason.

This alteration – allowing a sewer to join a junction at a different level – creates a "drop junction" at the downstream end of the sewer. Here, it is sewer05 that will have the drop junction at junction j3 on sewer02, so select sewer05 (change to Edit Mode, choose Sewer from the selection, then click on sewer05) so that it is highlighted in red (see Figure 4.69).

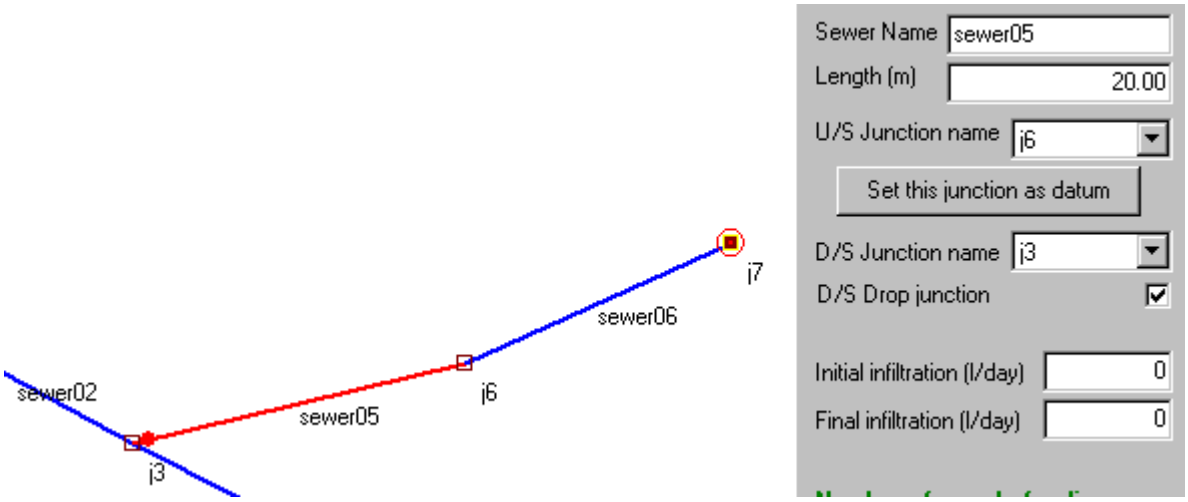


Figure 4.69 Highlighted sewer05 marked with a drop junction.

On the details panel to the right check "D/S Drop junction"; a red spot will appear on sewer05 near junction j3, indicating the drop junction. This branch is now a sub-net of two sewers, sewer05 and sewer06. As it is a sub-net it requires a datum, so select sewer06 and select its upstream junction, j7, as the datum by clicking on the "Set this junction as datum" button and completing the window so that it appears as shown in Figure 4.70.

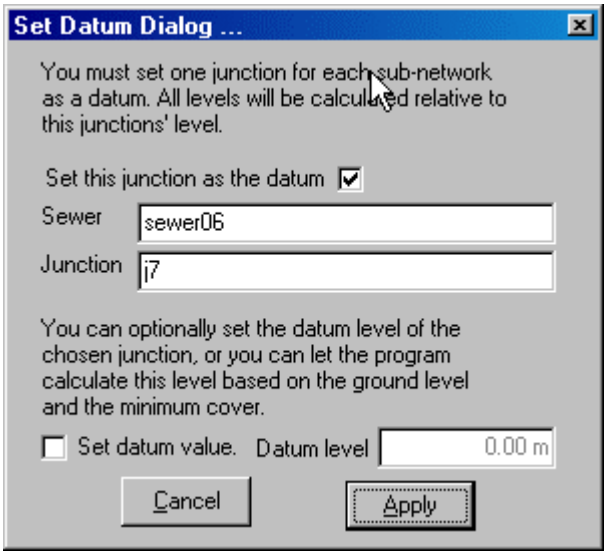


Figure 4.70 Marking the datum for the sub-net.

Remove the highlights from the network by choosing the Options menu and then the Remove Highlights option. The network should now look something like Figure 4.71.

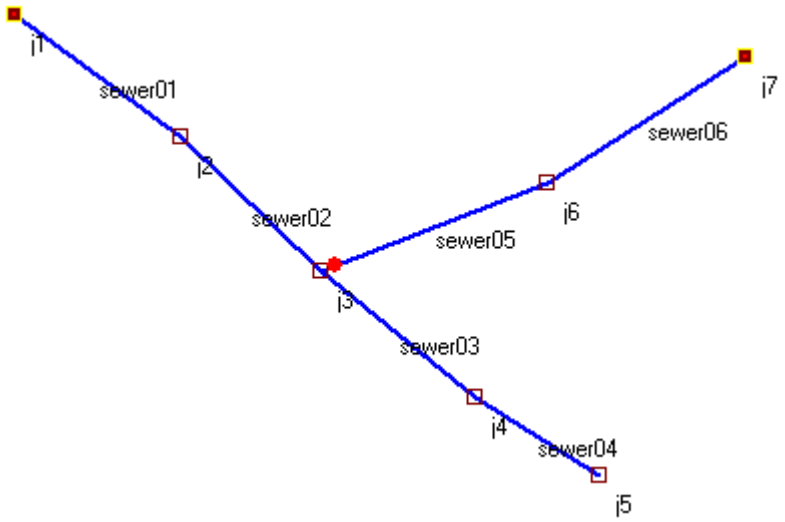


Figure 4.71 Network for Example 3.

Each sub-net can be displayed. (It is very easy to see which is which in this example, but in more complex networks this may not be the case.) First the network must be checked by clicking the Check Network button on the top tool-bar of the Visual Editor screen (Figure 4.72.)

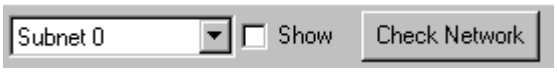


Figure 4.72 Sub-net display controls.

If the network passes the check, then a message will appear to confirm this; if not, correct the network and check again. (Failures of the network check usually occur because a datum has not been set for one or more sub-nets, or the network loops in some area.) There will now be a list of sub-nets in the dropdown box of Figure 4.72, with the first, Subnet 0, displayed. To show the sub-net on the screen tick the Show box (Figure 4.73) and the display should look like that in Figure 4.74, with the selected sub-net shown in green.

Figure 4.73 Selecting Subnet 0 to be displayed.

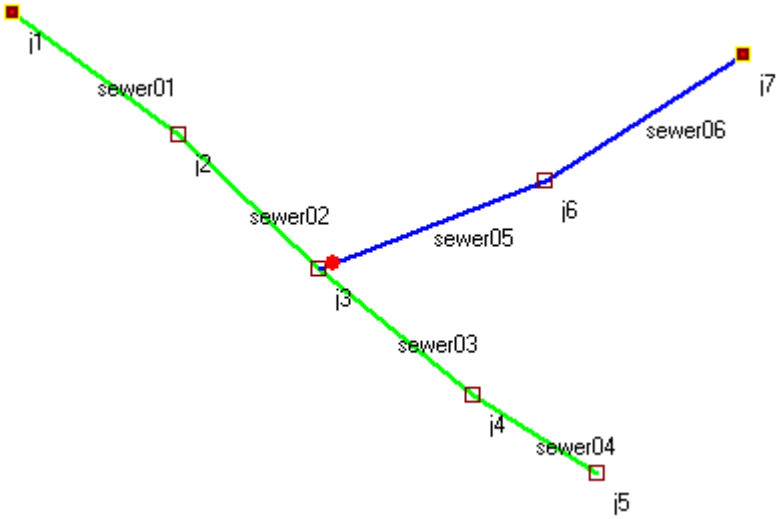


Figure 4.74 Subnet 0 displayed in green.

To highlight the second sub-net, simply select Subnet 1 from the dropdown list in Figure 4.73. This sub-net is now shown highlighted, as in Figure 4.75.

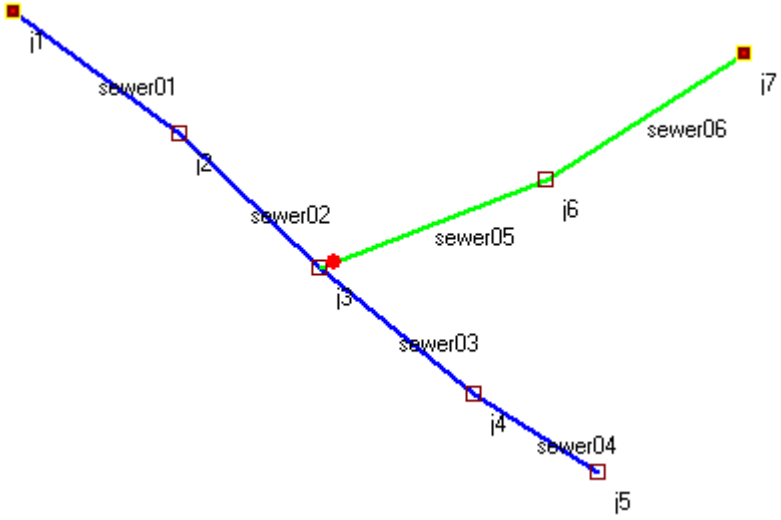


Figure 4.75 Subnet 1 displayed in green.

4.7.4 Example 4 – The UNCHS design example

This example is the UNCHS design example discussed in Appendix 2. The data for this network are supplied with the program in the file *unchs.snt*. Read this in and you should see the Data Entry/Edit form as shown in Figure 4.76. On the Visual Edit screen the display should be something like Figure 4.77. You can now proceed as described above in Examples 1-3.

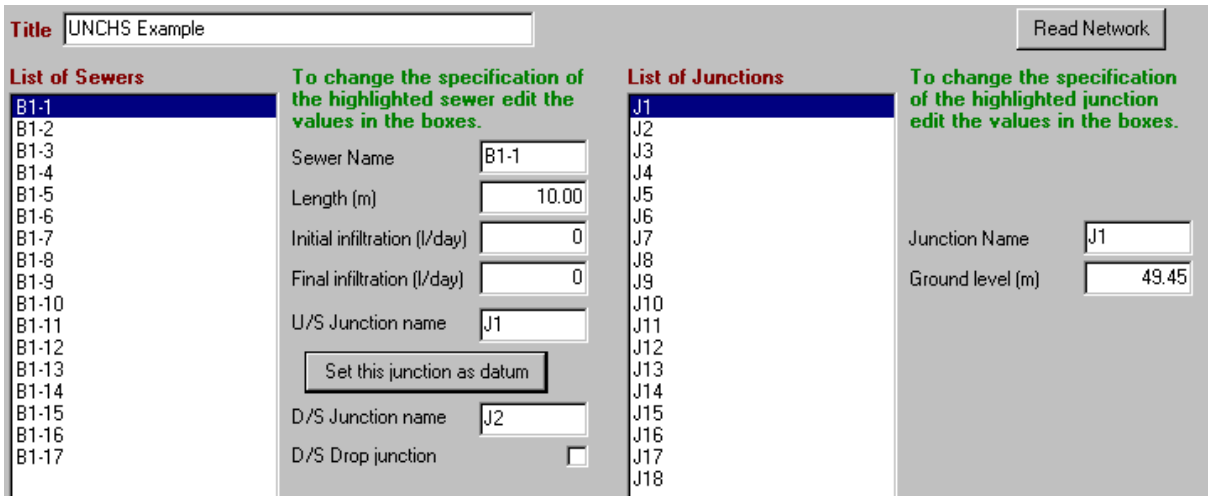


Figure 4.76 UNCHS example data.

Figure 4.77 UNCHS example data as shown on Visual Edit screen.