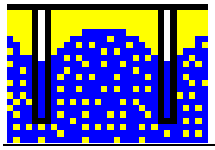
Analysis of multiple well installations with optimisation routines

GGU-DRAWDOWN

VERSION 3



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1 Preface

The **GGU-DRAWDOWN** program allows analysis of multiple well installations. The theoretical basis for the calculations is mainly taken from HERTH/ARNDTS '*Theorie und Praxis der Grundwasserabsenkung*' (Ernst & Sohn, Berlin; 3rd Edition, 1994). Further to this, you are referred to the section on '*Grundwasserströmung - Grundwasserhaltung*' from RIESS, in the *Grundbautaschenbuch* (1997), where the theoretical principles are well explained.

Rectangular and any other shape of excavations can be analysed. The influence of open water and of sheet pile walls can be taken into consideration. The program has optimisation routines for well number, well radius and well depth. After entering the excavation dimensions, you can thus immediately switch to the optimisation routines and get, within seconds, an optimally configured groundwater management regime. Comprehensive graphical evaluation options (drawdown sections, system sections, normal and coloured contours, as well as several legends) allow presentation of the complete analysis results on the screen. Besides this, you naturally have the option of printing a data output table.

Several example files are provided with the program. Before starting work with the program you should open these files to view the variety of visualisation options the program offers (select the menu item "**File/Load**" for this).

The program system allows comfortable data input. Reading of the manual can mostly be dispensed with, because

"**Info**" buttons

dealing with many geohydraulic and program-specific problems are available in the dialog boxes. You are presented with the necessary information by clicking the "**Info**" buttons (see also Section 8.1).

Graphic output supports the true-type fonts supplied with WINDOWS, so that excellent layout is guaranteed. Colour output and any graphics (e.g. files in formats BMP, JPG, PSP, TIF, etc.) are supported. DXF files can also be imported by means of the integrated Mini-CAD module (see the **Mini-CAD** manual).

The program system has been thoroughly tested. No faults have been found. Nevertheless, liability for completeness and correctness of the program and the manual, and for any damage resulting from incompleteness or incorrectness, cannot be accepted.

2 Licence protection and installation

In order to guarantee a high degree of quality, a hardware-based copy protection system is used for the **GGU-DRAWDOWN** program.

The GGU software protected by the ***CodeMeter*** copy protection system is only available in conjunction with the ***CodeMeter stick*** copy protection component (hardware for connection to the PC, "***CM stick***"). Because of the way the system is configured, the protected software can only be operated with the corresponding CM stick. This creates a fixed link between the software licence and the CM stick copy protection hardware; the licence as such is thus represented by the CM stick. The correct Runtime Kit for the CodeMeter stick must be installed on your PC.

Upon start-up and during running, the **GGU-DRAWDOWN** program checks that a CM stick is connected. If it has been removed, the program can no longer be executed.

For installation of GGU software and the CodeMeter software please refer to the information in the ***Installation notes for GGU Software International***, which are supplied with the program.

3 Language selection

GGU-DRAWDOWN is a bilingual program. The program always starts with the language setting applicable when it was last ended.

The language preferences can be changed at any time in the "**Info**" menu, using the menu item "**Spracheinstellung**" (for German) or "**Language preferences**" (for English).

4 Starting the program

After starting the program, you will see two menus at the top of the window:

- File
- Info

After clicking the "**File**" menu, either an existing system can be opened by means of the "**Load**" menu item, or a new system can be entered using "**New**". After clicking "**File/New**" you will first see a dialog box for selecting the type of excavation (rectangle or polygon). An example well installation is then displayed on the screen. The menu bar will then show nine menus:

- File
- Edit
- Excavation polygon
- System
- Evaluation
- Section
- Graphics preferences
- Page size + margins
- Info

After clicking one of these menus, the so-called menu items roll down, allowing you access to all program functions.

The program works on the principle of ***What you see is what you get***. This means that the screen presentation represents, overall, what you will see on your printer. In the last consequence, this would mean that the screen presentation would have to be refreshed after every alteration you make. For reasons of efficiency and as this can take several seconds for complex screen contents, the **GGU-DRAWDOWN** screen is not refreshed after every alteration.

If you would like to refresh the screen contents, press either [**F2**] or [**Esc**]. The [**Esc**] key additionally sets the screen presentation back to your current zoom, which has the default value 1.0, corresponding to an A3 format sheet.

5 Theoretical principles

5.1 Rectangular excavations

The explanation will be for a rectangular excavation. With reference to excavations bordered with polygons, only minor deviations result, which will be handled in the following section. The main variables are contained in the following two figures.

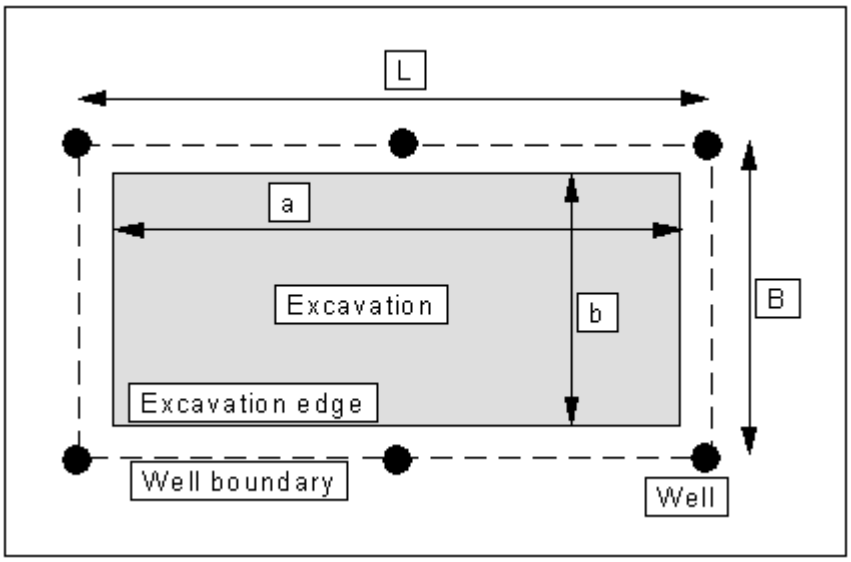


Figure 1 Designations (plan)

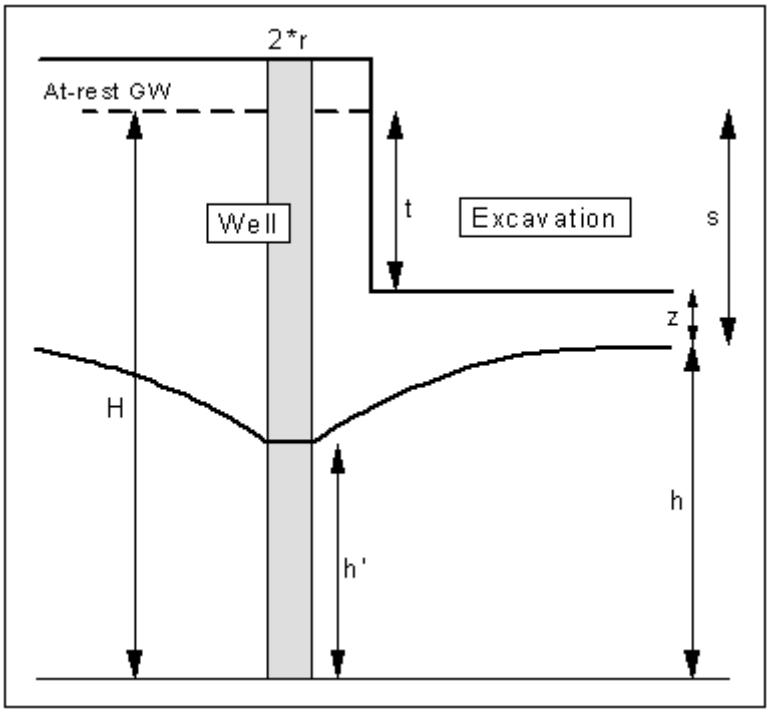


Figure 2 Designations (section)

The range R can be defined in three different ways:

a) after Sichardt

$$R = 3000 \cdot s \cdot \sqrt{k} \quad (1a)$$

b) after Kussakin

$$R = 575 \cdot s \cdot \sqrt{H \cdot k} \quad (1b)$$

c) after Weyrauch
for unconfined aquifer:

$$R = 5400 \cdot s \cdot \sqrt{H \cdot k} \quad (1c)$$

for confined aquifer:

$$R = 1800 \cdot \sqrt{m \cdot k} \quad (1d)$$

c) as fixed, which you enter yourself.

For small k-values, small drawdown and large excavations, a correction of the range R is necessary.

$$R_O = \sqrt{R^2 + A_{RE}^2} \quad (2)$$

(A_{RE} = substitute radius, see below)

It is your own decision as to when this correction should be used.

The drawdown value you wish to achieve is given with the values t and z. Together with the permeability k, the area of the excavation (+ distance of wells from the excavation edge) and the range R, the total discharge Q_{max} (formula 20 or 93 in HERTH/ ARNDTS) results from this drawdown.

$$Q = \frac{\pi \cdot k \cdot (H^2 - h^2)}{ln(R) - ln(A_{RE})} \quad (3)$$

or, for a confined aquifer

$$Q = \frac{\pi \cdot 2 \cdot m \cdot s \cdot k}{ln(R) - ln(A_{RE})} \quad (4)$$

(m = thickness of aquifer)

The above two formulas are valid for values of:

$$ln\left(\frac{R}{A_{RE}}\right) > 1$$

For values smaller than '1', instead of the expression

$$\frac{1}{ln(R) - ln(A_{RE})}$$

the relationship

$$2 \cdot \frac{A_{RE}}{R} + 0{,}25$$

is used.

The value Q contains possible surcharges for a faster achievement of the drawdown target (after HERTH/ARNDTS generally 10 %) and for possible imperfect wells (after HERTH/ARNDTS generally 10 to 30 %, but see also the critical notes by RIESS in the *Grundbautaschenbuch*).

The value A_{RE} is the so-called substitute radius. The program contains all known possibilities for calculating the substitute radius.

a) A_{RE} is calculated from

$$A_{RE} = \sqrt{B \cdot L}$$

b) From a suggestion of Weber's, A_{RE} is calculated from

$$A_{RE} = \eta \cdot L$$

(with $\eta = 0{,}2 \cdot L/B + 0.37$)

c) A_{RE} is calculated from L/3 for elongated excavations, taking into account the drawdown at the centre of a row of wells.

d) A_{RE} is calculated from L/5 for elongated excavations, taking into account the drawdown at the end of a row of wells.

e) A_{RE} is user-defined

To get an estimation of the necessary number of wells, enter an estimated wetted filter length h'. With this, the capacity of a well q is calculated (formula 77 in HERTH/ARNDTS).

$$q = 2 \cdot \pi \cdot r \cdot h' \cdot \frac{\sqrt{k}}{15} \quad (5)$$

An estimation of the necessary number of wells n results from Q/q. The actual number of wells necessary is achieved with the following detailed installation calculation. The estimated wetted filter length h' therefore has no influence on the calculation results.

After draft design, you must distribute the wells meaningfully around the excavation. The calculation proper of the installation then takes place. First, a follow-up calculation of the proposed installation is carried out, to find the most unfavourable spot on the edge of the excavation (see also HERTH/ARNDTS formula 18).

$$Q = \frac{\pi \cdot k \cdot (H^2 - h^2)}{ln(R) - \frac{1}{n}\sum ln(x)} \quad (6)$$

(with x = distance to well n)

or, for a confined aquifer

$$Q = \frac{\pi \cdot 2 \cdot m \cdot s \cdot k}{ln(R) - \frac{1}{n}\sum ln(x)} \quad (7)$$

or, for a semi-confined aquifer

$$Q = \frac{\pi \cdot k \cdot [(H^2 - h^2) - (H - m)^2}{ln(R) - \frac{1}{n}\sum ln(x)} \quad (8)$$

The program investigates the whole excavation border in 0.2 m steps and determines from this the most unfavourable point (MUP). The above 3 formulas are valid for an installation with wells of equal diameter. If varying well radii are present, the expression

$$\frac{1}{n}\sum ln(x)$$

is to be replaced by

$$\frac{1}{\sum q}\sum ln(x^q) \quad (8a)$$

In which q is the capacity of the corresponding well.

$$q = 2 \cdot \pi \cdot r \cdot h' \cdot \frac{\sqrt{k}}{15}$$

To avoid complex iteration, it is assumed in the program that all wells possess the same h'.

The actual water ingress to the excavation results from formula (6), (7) or (8). From this new, possibly larger Q_{max}, together with the selected number of wells, the minimum necessary well capacity (q) results. After this, the program determines the average well separation b', and from this - in case of activated "**Wetted filter length after HERTH/ARNDTS**" check box - the actual wetted filter length of the wells s_{eb} (formula 98 in HERTH/ARNDTS) or the current capacity of the wells.

$$s_{eb} = h - \sqrt{h^2 - \frac{1{,}5 \cdot q \cdot (ln(b') - ln(r))}{\pi \cdot k}}$$

Alternatively, you have the possibility of deactivating the "**Wetted filter length after HERTH/ARNDTS**" check box and having the wetted filter length calculated for each well individually. The present wetted filter length then results from the well with the largest drawdown. Which of the two methods for calculation of wetted filter length is the theoretically correct one is disputed. In HERTH/ARNDTS all examples are calculated with the average well separation. In the '*Grundbautaschenbuch*' (1997) however, RIESS criticises the dimensioning practice of HERTH/ARNDTS and favours the second method.

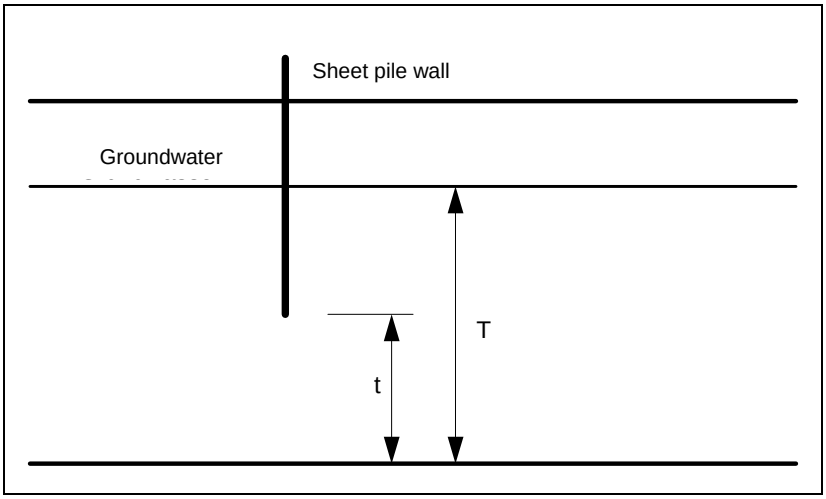
If the calculated wetted filter area is larger than, or equal to, the necessary wetted filter area (the capacity of a well results from this), the installation is sufficiently dimensioned. If this condition is not met, the program issues a warning message with notes on how to proceed further. You have the following possibilities:

- Enlarge well radius
- Enlarge well number
- Enlarge well depth

After successful installation dimensioning, the program calculates the drawdown in the individual wells and the drawdown in the centre of the excavation or, for an excavation bounded by a polygon, in the excavation centroid. As, especially with excavations bounded by polygons, this is not the point with the least drawdown, an additional random generator is started, which then searches for the point with the least drawdown within the excavation.

5.2 The influence of sheet pile walls

The influence of sheet pile walls is taken into consideration via a reduction in water ingress according to HERTH/ARNDTS. The sheet pile wall is always outside of the well group.



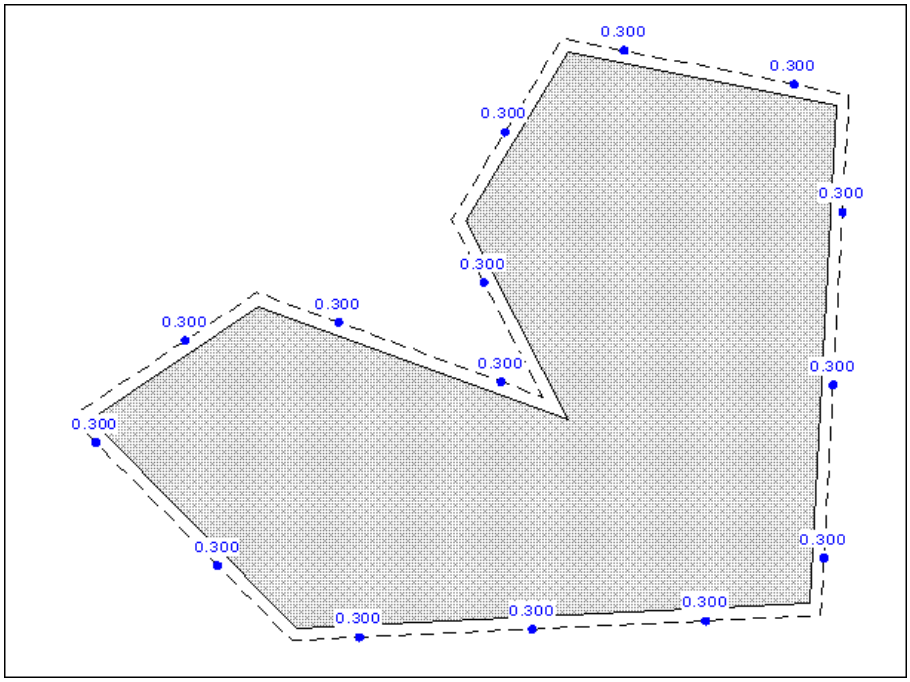
The reduction is dependent upon the ratio of t/T, and is shown in Figure 83 (HERTH/ARNDTS). In the program, you must give the position of the drawndown groundwater level in the area of the sheet pile wall, and define the penetration depth of the wall. Input of drawndown groundwater level is necessary, as the assumption that we have here the at-rest water level, with a small distance of the well from the sheet pile wall, would lead to unrealistically large reductions.

5.3 The influence of open water

After RIESS (*Grundbautaschenbuch* 1997), for groundwater drawdown next to open water with a leaky base, the double distance from the centre of the excavation to the water's edge is to be used, instead of the range. For elongated excavations, running parallel to water, the influence increases, in which case the single distance is to be used. This is realised in the program by selecting "**= fixed value**" as ***Range R*** in the "**Edit/Base data**" menu item and then entering this fixed value (simple or double distance to waters edge) in the menu item "**System/Analyse**" before starting calculation.

5.4 Excavations bounded by polygons

The procedure for excavations bounded by polygons is analogous to the above explanations concerning rectangular excavations.



The only difference is in the calculation of the substitute radius. As a length and a width cannot always be defined, the only possibility is to define the substitute radius from the area A of the polygon which surrounds the wells (dashed line in the above figure).

$$A_{RE} = \sqrt{F}$$

Alternatively, you can also define a fixed value for A_{RE}.

When arranging the wells, they need not be at the well boundary. However, the program always calculates the substitute radius from the area surrounded by the dashed line.

6 Program use based on a worked example

6.1 Example system

As, from personal experience, the reading of manuals is a chore, there will now follow a short description of the main program functions, using an example. After studying this section you will be in a position to calculate a multiple well installation. You can take the finer details of the program from the further sections.

A excavation with the following dimensions is to be calculated:

- Length = 71 m
- Width = 33.5 m
- Distance of wells from the excavation edge = 2.0 m

The wells are to have a radius of 0.3 m. The k-value is $5 * 10^{-4}$ m/s. Further system values can be taken from the figure.

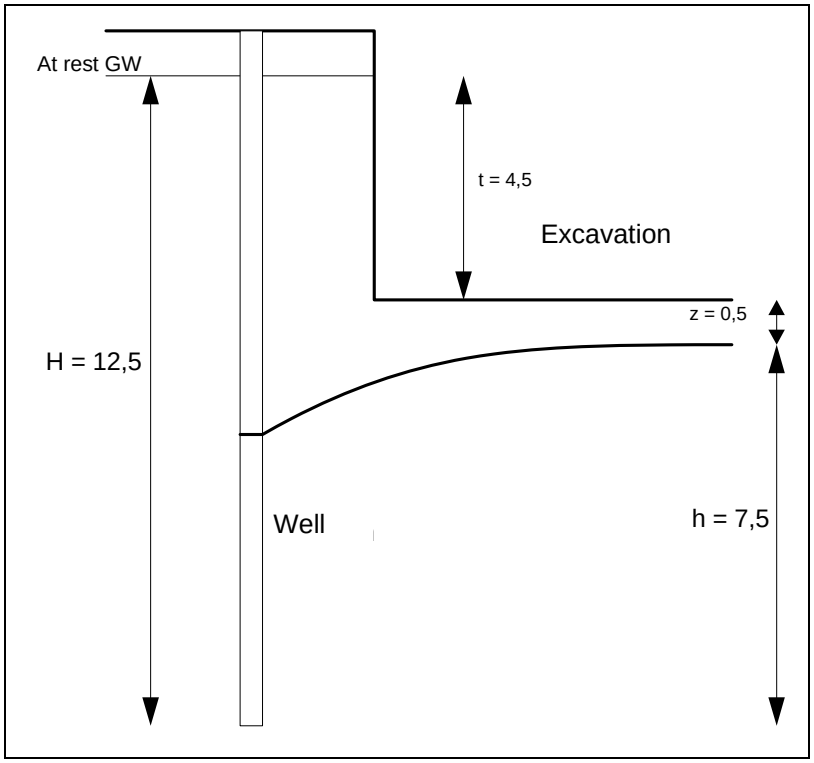
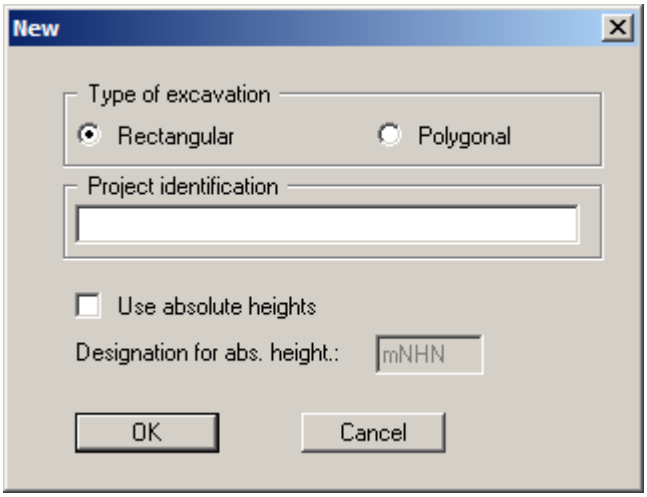


Figure 3 Example system

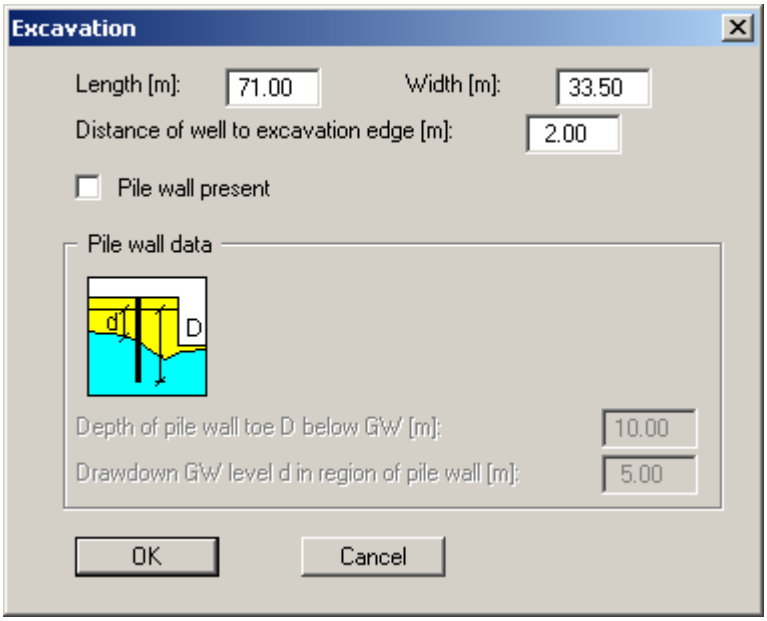
6.2 Define excavation

To enter a new well installation, first go to the menu item "**File/New**". The following dialog box opens



If you have just started the program an example well installation with an excavation (length = 64 m; width = 24 m) and 20 wells will be displayed on the screen after clicking the "**Rectangular**" button. The wells are arranged 1 m from the edge of the excavation. If a different installation was previously modelled the existing excavation dimensions and wells will initially be displayed on the screen.

For input of excavation dimensions of the example, select the "**Edit/Excavation**" menu item. You will see the following dialog box where you enter length and width of our excavation, and the distance of the wells from the excavation edge. Negative values are also allowed if, e.g., the wells are situated inside the excavation.

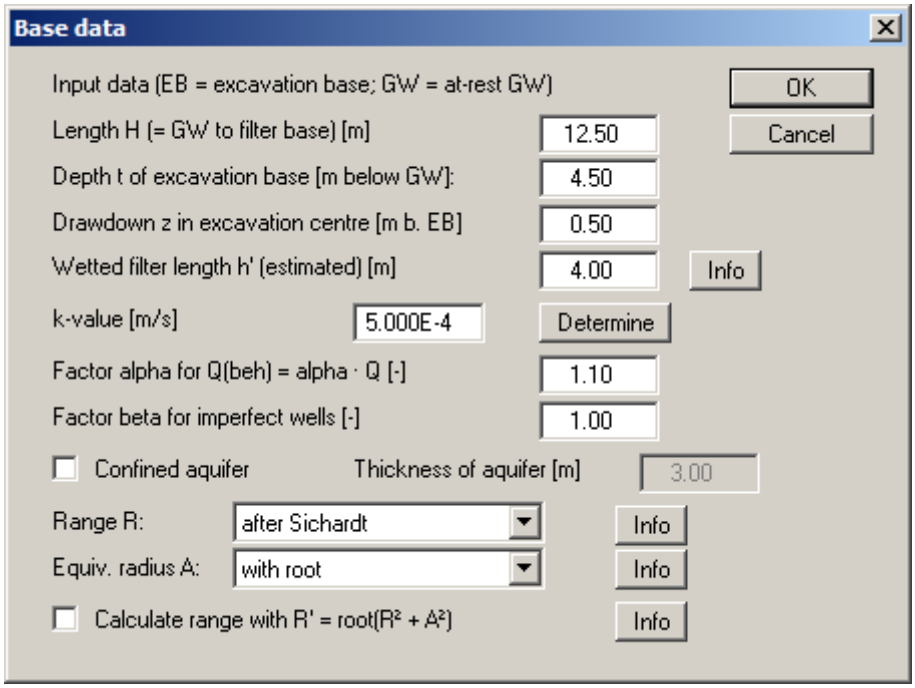


After confirming your input by pressing "**OK**" the program first performs a draft design and the results of this draft design are displayed in a message box. If you exit the message box the excavation is displayed on the screen with the new dimensions. If the excavation no longer fits on the screen due to the changes made, go to the menu item "**Page size + margins/Auto resize**" or, alternatively, press [**F9**]. The proposed wells will initially be displayed in the old position.

The excavation boundaries are displayed on the screen as a continuous line. The program will look for the "**most unfavourable point**" along the excavation edge, for calculation of the actual discharge. The line upon which the wells theoretically lie runs parallel to the excavation edge. This boundary is displayed with a dashed line. The wells need not necessarily be arranged on this line. However, this border will be used for calculation of the substitute radius independently of the actual position of the wells.

6.3 Enter base data for calculation

For input of system base data and for an estimation of the number of wells, select the menu item "**Edit/Base data**". You will see the following dialog box:



The variables are explained in Figure 1 and Figure 2. The k-value can be entered directly or be determined using the Hazen or Beyer method after clicking the "**Determine**" button and used in the input box.

The default aquifer is assumed to be unconfined. If the system is confined, activate the "**Confined aquifer**" check box and enter the thickness of the aquifer in addition to the other data.

With regard to specifying the range and computing the equivalent radius, please refer to the information available by pressing the corresponding buttons in the dialog box. After editing the data, select the "**OK**" button.

6.4.1 General note

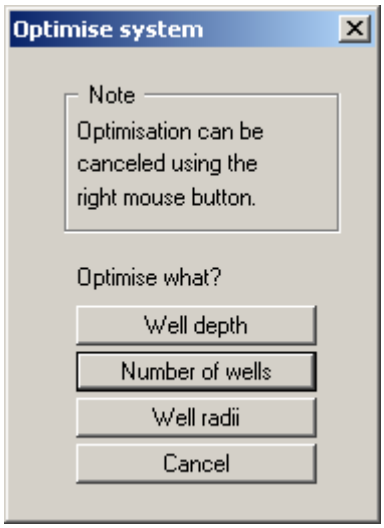
In order to position the wells sensibly around the edge of the excavation, four alternative procedures are available:

- Method A: Optimise the number of wells
- Method B: Semi-automatic well determination (see Section 7.2.7)
- Method C: Graphic well determination (see Section 7.2.6)
- Method D: Determining wells via editor (see Section 7.2.8)

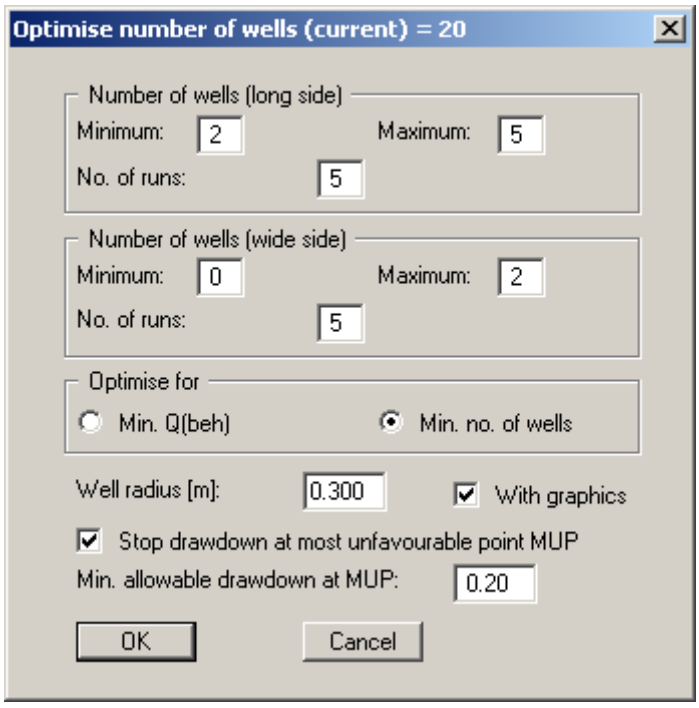
Method A is normally the simplest method for creating an optimum well arrangement. Using the "**System/Optimise**" menu item you have this task done completely by the program.

6.4.2 Optimise the number of wells for rectangular excavations

Select the menu item "**System/Optimise**". The following dialog box appears:

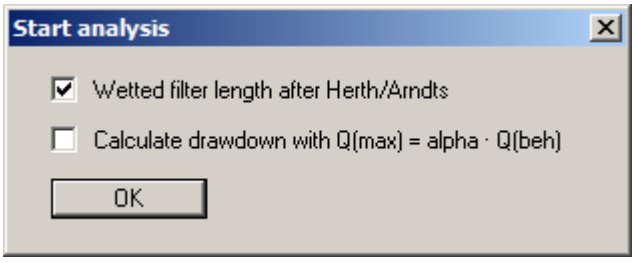


For our example, select the "**Number of wells**" button and accept the value specified in the following dialog box. Enter '**0.30**' for the well radius.



In the box you enter the minimum and maximum number of wells, on the long and the wide side, to be investigated. With the number after "**No. of runs through**", the variation of the position of the first and last well along each edge is controlled. During the optimisation process the current positions of the wells will be displayed as an animation on the screen, allowing you to control your input. Further, select whether or not optimisation is to be carried out for a minimum discharge or for a minimum number of wells. If you activate the "**Stop drawdown at most unfavourable point MUP**" check box, the program check the given value and refuse all well positions which do not conform with the condition. During the optimisation process, all new wells will be given a uniform diameter, which you define as radius in the dialog box.

The program first informs you how many wells will be investigated using your settings. When the optimisation is started a dialog box opens allowing further settings to be made for the analysis.



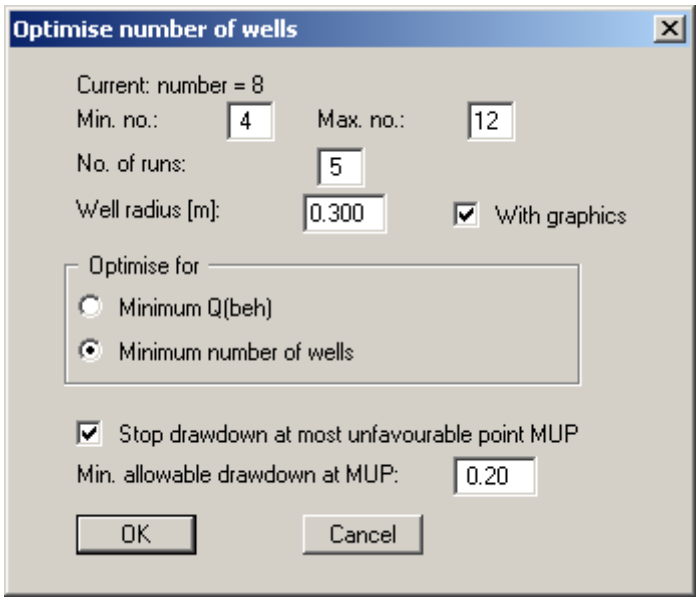
For the example, activate the upper check box and confirm with "**OK**". During optimisation the current number and position of the wells is graphically displayed. In the status bar at the bottom screen edge, information on the calculation results is displayed. A running optimisation can be cancelled with the right mouse button. The program identifies an optimum number of 8 wells for the example. Finally, you can decide whether or not to accept the optimisation results. The optimised system must then be recalculated, in order to refresh the graphics.

When the analysis is complete information on the results is displayed in a number of dialog boxes. You can see the location of the well and the drawdown in the graphics. In the program's default settings the drawdown is visualised as [m] below at-rest groundwater level. You can select a different visualisation in the "**Evaluation/Display drawdowns**" menu item, e.g. drawdown below excavation base.

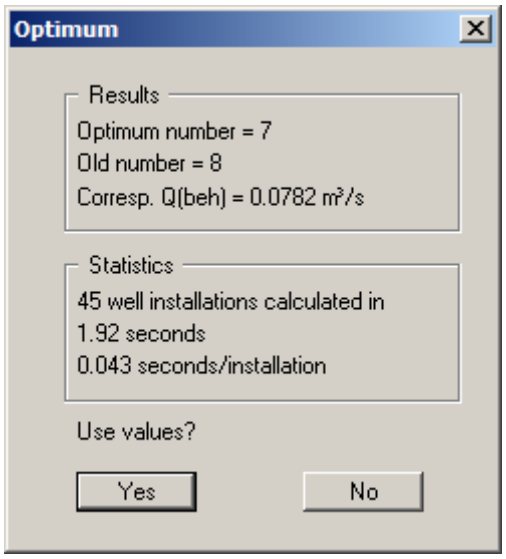
6.4.3 Optimise the number of wells for excavations bounded by polygons

For optimisation of rectangular excavations, only an even number of wells can be created. Uneven numbers of wells are allowed for excavations bounded by a polygon. For this reason, select the menu item "**File/New**" again and click on the "**Polygonal**" button in the type of installation dialog box. A prompt appears:

Accept your previous excavation settings with "**Yes**" and then select the "**System/Optimise**" menu item once again. After clicking the "**Number of wells**" button a slightly different dialog box opens:



As for excavations bounded by a polygon, generally, a differentiation between long and wide side can no longer be made, the wells will be distributed around the excavation with a constant distance to each other. Using "**No. of runs through**", the position of well no. 1 can be influenced. The result of the optimisation is now:

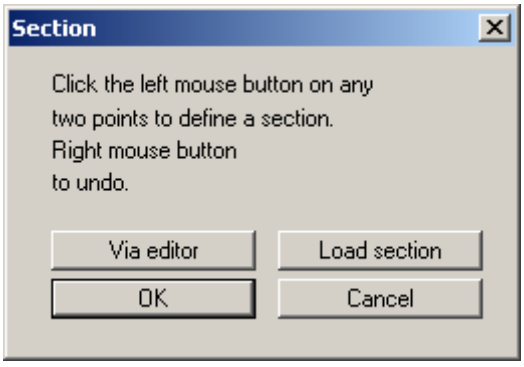


The number of wells has been reduced to '**7**'. Confirm the result with "**Yes**" and recalculate the optimised installation.

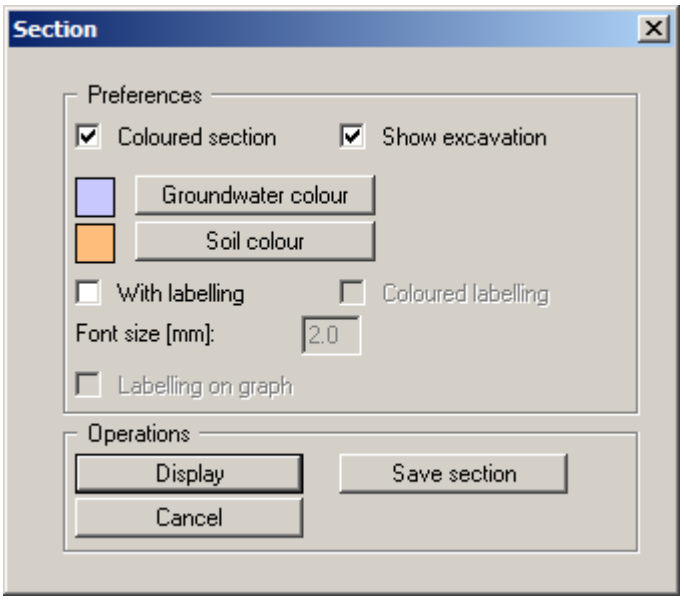
6.5 Result output

Once your well installation has been analysed the most relevant results are displayed in a number of dialog boxes, which are closed by pressing "**OK**". Your input data and the analysis results are displayed on the screen in legends. The design of the legends can be edited, or they can be switched off completely, via the menu items "**Graphics preferences/Input data legend**" and "**Graphics preferences/Result data legend**" (see Sections 7.7.7 and 7.7.8).

For further evaluation you can use the "**Section/User-defined section**" menu item (see Section 7.6.2). Click "**OK**" in the dialog box to define a new section using the mouse.



Using the left mouse button, click the start and end points of the required section through the excavation. The number of subdivisions for the section is specified in a further dialog box. This defines the number of model points at which the program calculates and visualises drawdowns along the section. A dialog box then opens for specifying section visualisation settings.



If you accept your settings by pressing the "**Display**" button, a section through the excavation will be displayed on the screen, which may resemble the following figure, for example:

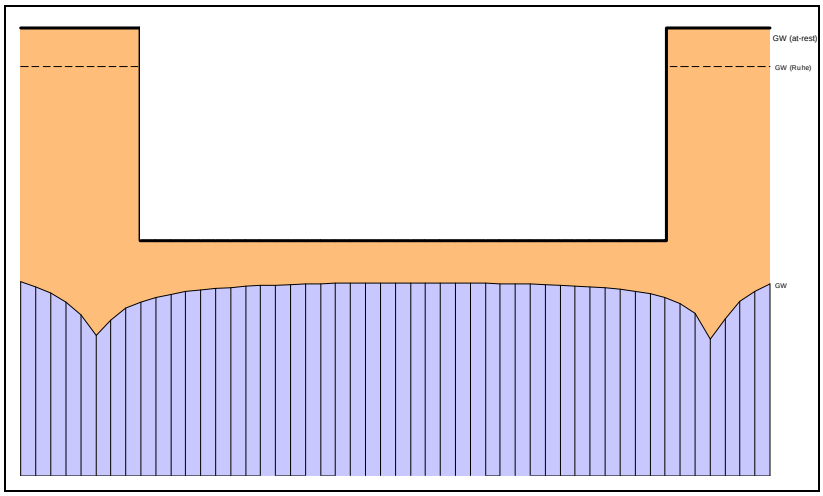


Figure 4 ***Evaluation by means of section visualisation***

Additionally, a legend will now be shown, with the position of the section in plan (see "**Graphics preferences/Section course legend**" menu item, Section 7.7.9).

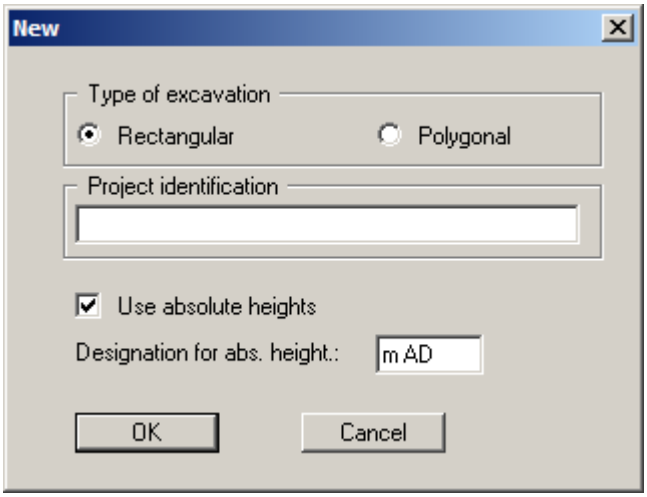
At any editing stage of your problem, you can have the current screen contents printed. Select the menu item "**File/Print and export**" button "**Printer**". A dialog box appears, in which you alter the printer alignment from "**Portrait**" to "**Landscape**" by clicking on the appropriate button, if necessary. If you are using a printer which cannot take a complete A3 page, then click on the "**Fit to page**" button. This will calculate a reduction factor (zoom factor), ensuring complete page output to the printer. Otherwise, several pages will be printed. After this, select the "**OK**" button, in order to start printer output. You can achieve result output as an output table using the menu item "**File/Print output table**" (see Section 7.1.5).

7 Description of menu items

7.1 File menu

7.1.1 "New" menu item

A new multiple well installation can be analysed. A dialog box for selecting the type of excavation always appears first:



If you wish you can enter a description of the problem being worked on in this dialog box; this will then be used in the ***Input data legend***. Otherwise the project identification is entered using the menu item "**Edit/Project identification**".

If the "**Use absolute heights**" check box is activated, enter your base data (ground level, at-rest GW level, well screen base, excavation base) in absolute values (see Section 7.2.3). The designation for the absolute elevation, e.g. **mAD**, can be edited below.

After clicking the "**OK**" button an example installation is displayed on the screen. The existing excavation dimensions can be used if the excavation type is changed.

7.1.2 "Load" menu item

You can open a file with system data, which was created and saved at a previous sitting, and then edit the test data.

7.1.3 "Save" menu item

You can save data entered or edited during program use to a file, in order to have them available at a later date, or to archive them. The data is saved without prompting with the name of the current file.

7.1.4 "Save as" menu item

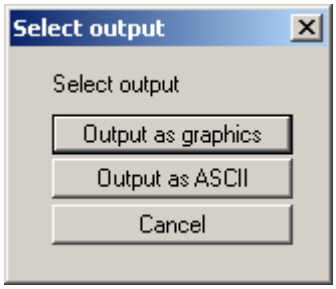
You can save data entered during program use to an existing file or to a new file, i.e. using a new file name. For reasons of clarity, it makes sense to use "**.mbr**" as file suffix, as this is the suffix used in the file requester box for the menu item "**File/Load**". If you choose not to enter an extension when saving, "**.mbr**" will be used automatically.

7.1.5 "Print output table" menu item

7.1.5.1 Selecting the output format

You can have a table printed containing the current analysis results. The results can be sent to the printer or to a file (e.g. for further editing in a word processor). The output contains all information on the current state of analysis, including the system data.

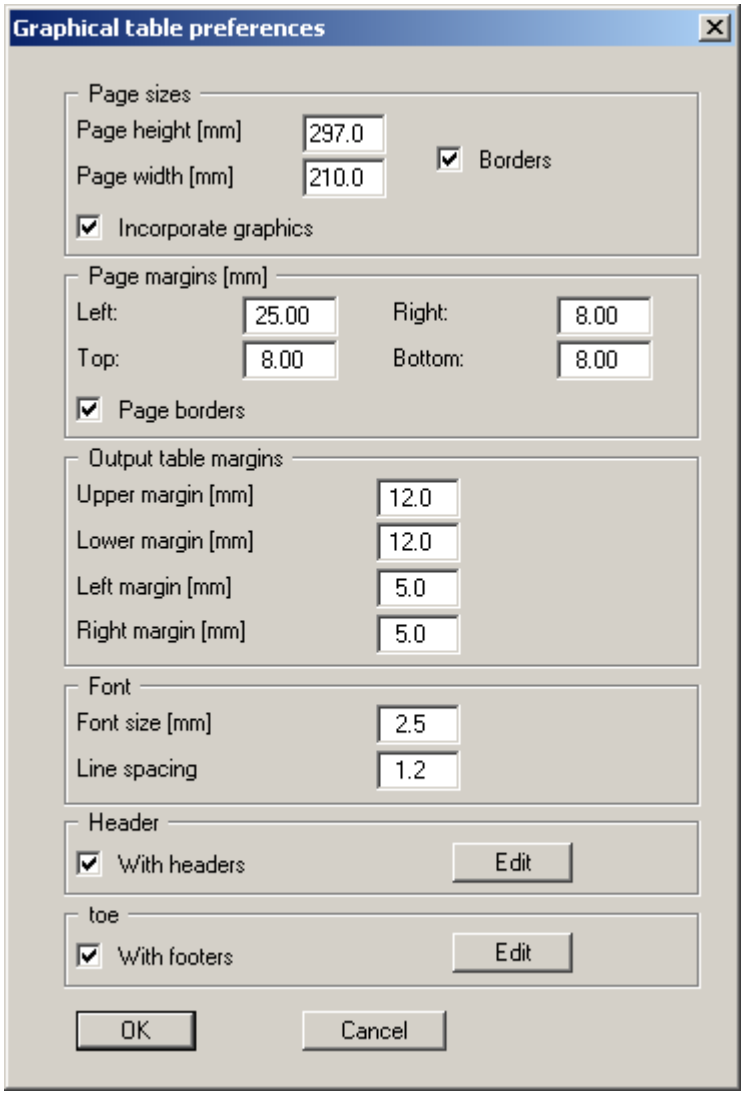
You have the option of designing and printing the output table as an annex to your report within the **GGU-DRAWDOWN** program. To do this, select "**Output as graphics**" from the following options.



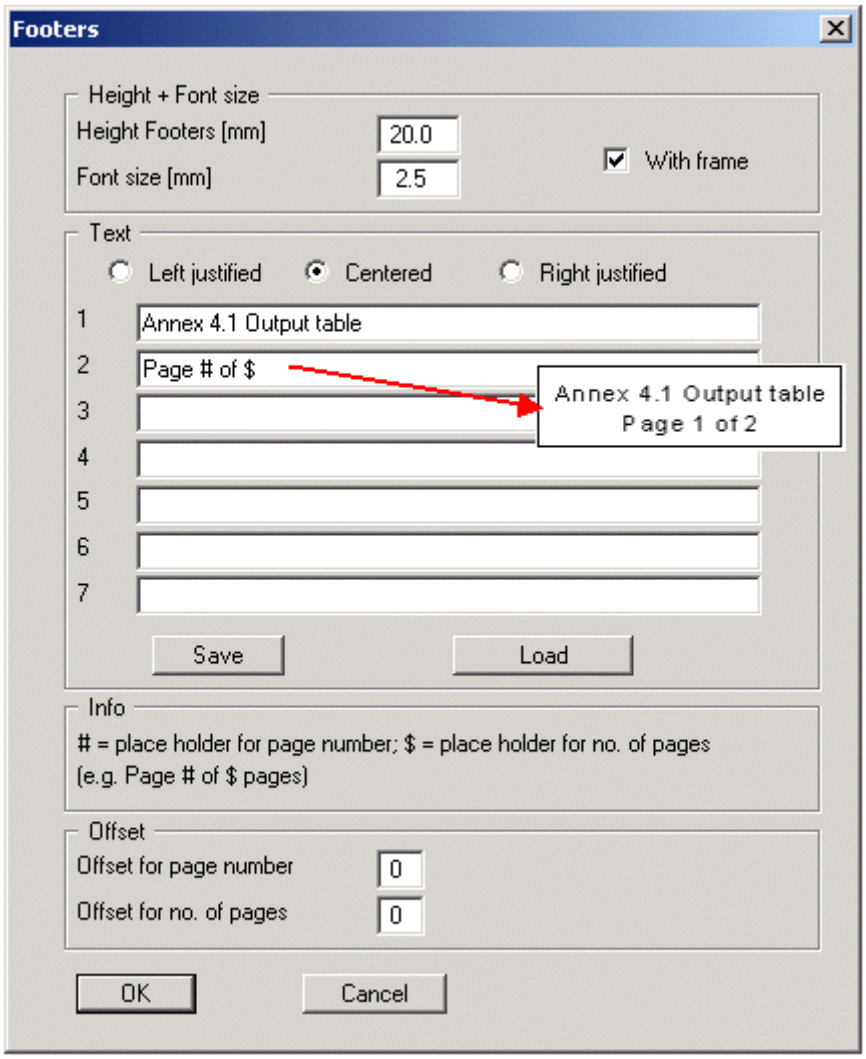
If you prefer to easily print or process the data in a different application, you can send them directly to the printer or save them to a file using the "**Output as ASCII**" command button.

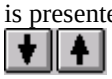
7.1.5.2 Button "Output as graphics"

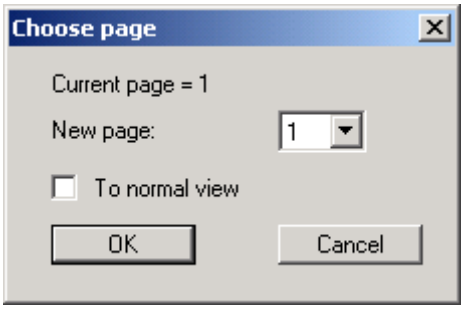
If you selected the "**Output as graphics**" button in the previous dialog box a further dialog box, in which you can define further preferences for result presentation.



You can define the desired layout for the output tables in various areas of the dialog box. By activating the "**Incorporate graphics**" button, a sketch of the system is integrated in the output table. If you need to add a header or footer (e.g. for page numbering), activate the appropriate check boxes "**With headers**" and/or "**With footers**" and click on the "**Edit**" button. You can then edit as required in a further dialog box.

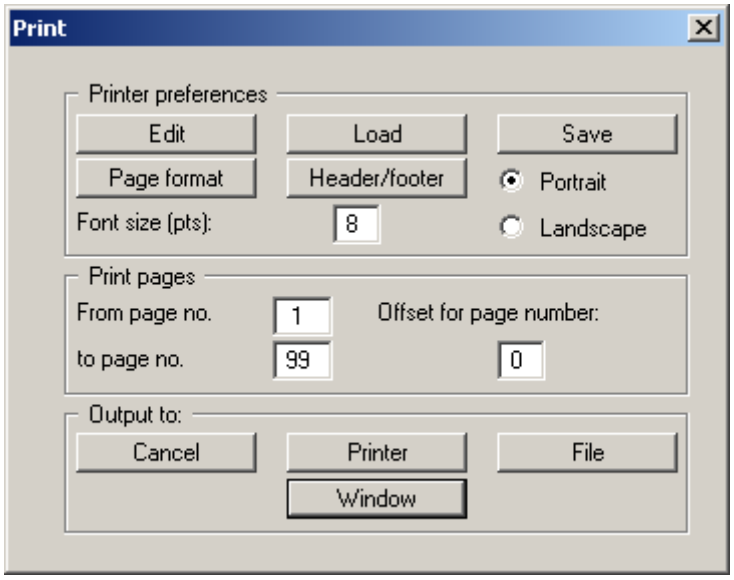


Automatic pagination can also be employed here if you work with the placeholders as described. After exiting the dialog boxes using "**OK**" you will see a further dialog box in which you can select the parameters to be used in the output table. If you click the "**Start**" button the output table is presented on the screen page by page. To navigate between the pages, use the arrow tools  in the toolbar. If you need to jump to a given page or back to the graphical representation, click on the tool. You will then see the following box:



7.1.5.3 Button "Output as ASCII"

You can have your analysis data sent to the printer, without further work on the layout, or save it to a file for further processing using a different program, e.g. a word processing application. After selecting the button "**Output as ASCII**" you will see a further dialog box in which you can select the parameters to be used. If you click the "**Start**" button, the following dialog box appears in which you can define output preferences.



In the dialog box you can define output preferences:

- "**Printer preferences**" group box
  Using the "**Edit**" button the current printer preferences can be changed or a different printer selected. Using the "**Save**" button, all preferences from this dialog box can be saved to a file in order to have them available for a later session. If you select "**GGU-DRAWDOWN.drk**" as file name and save the file in the program folder (default), the file will be automatically opened the next time you start the program.

  Using the "**Page format**" button you can define, amongst other things, the size of the left margin and the number of rows per page. The "**Header/footer**" button allows you to enter a header and footer text for each page. If the "#" symbol appears within the text, the current page number will be entered during printing (e.g. "***Page*** #"). The text size is given in "**Pts**". You can also change between "**Portrait**" and "**Landscape**" formats.

- "**Print pages**" group box
  If you do not wish pagination to begin with "***1***" you can add an ***offset number*** to the check box. This offset will be added to the current page number. The output range is defined using "**From page no.**" "**to page no.**".

- "**Output to:**" group box
  Start output by clicking on "**Printer**" or "**File**". The file name can then be selected from or entered into the box. If you select the "**Window**" button the results are sent to a separate window. Further text editing options are available in this window, as well as loadning, saving and printing.

7.1.6 "Export GGU-GEO-GRAPH data" menu item

This menu item is only visible if at least 3 individual drawdowns have been computed (see menu item "**Evaluation/Compute individually**"). It allows the coordinates and drawdowns at the analysed points to be saved to a file. The data can be processed and evaluated in the **GGU-GEO-GRAPH** program.

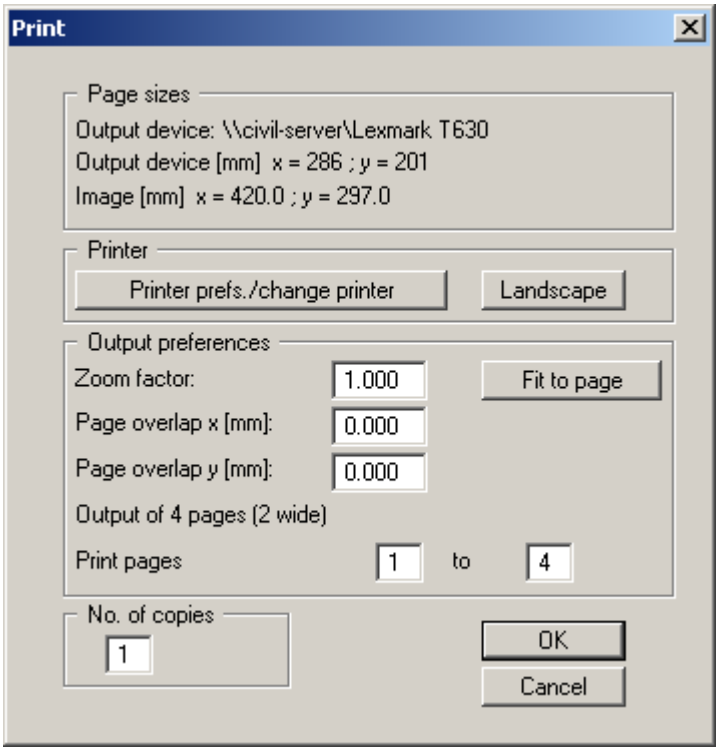
7.1.7 "Printer preferences" menu item

You can edit printer preferences (e.g. swap between portrait and landscape) or change the printer in accordance with WINDOWS conventions.

7.1.8 "Print and export" menu item

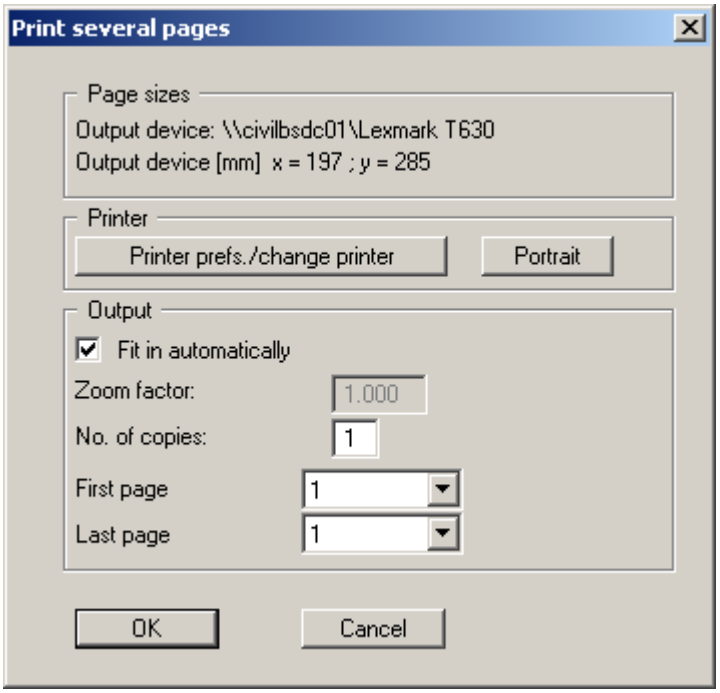
You can select your output format in a dialog box. You have the following possibilities:

- "**Printer**"
  allows graphic output of the current screen contents (***graphical representation***) to the WINDOWS standard printer or to any other printer selected using the menu item "**File/Printer preferences**". But you may also select a different printer in the following dialog box by pressing the "**Printer prefs./change printer**" button.



In the upper group box, the maximum dimensions which the printer can accept are given. Below this, the dimensions of the image to be printed are given. If the image is larger than the output format of the printer, the image will be printed to several pages (in the above example, 4). In order to facilitate better re-connection of the images, the possibility of entering an overlap for each page, in x and y direction, is given. Alternatively, you also have the possibility of selecting a smaller zoom factor, ensuring output to one page ("**Fit to page**" button). Following this, you can enlarge to the original format on a copying machine, to ensure true scaling. Furthermore, you may enter the number of copies to be printed.

If you have activated the ***tabular representation*** on the screen, you will see a different dialog box for output by means of the "**File/Print and export**" menu item button "**Printer**".



Here, you can select the table pages to be printed. In order to achieve output with a zoom factor of 1 (button "**Fit in automatically**" is deactivated), you must adjust the page format to suit the size format of the output device. To do this, use the dialog box in "**File/Print output table**" button "**Output as graphics**".

- "**DXF file**"
  allows output of the graphics to a DXF file. DXF is a common file format for transferring graphics between a variety of applications.
- "**GGUCAD file**"
  allows output of the graphics to a file, in order to enable further processing with the GGUCAD program. Compared to output as a DXF file this has the advantage that no loss of colour quality occurs during export.
- "**Clipboard**"
  The graphics are copied to the WINDOWS clipboard. From there, they can be imported into other WINDOWS programs for further processing, e.g. into a word processor. In order to import into any other WINDOWS program you must generally use the "*Edit/Paste*" function of the respective application.
- "**Metafile**"
  allows output of the graphics to a file in order to be further processed with third party software. Output is in the standardised EMF format (Enhanced Metafile format). Use of the Metafile format guarantees the best possible quality when transfering graphics.

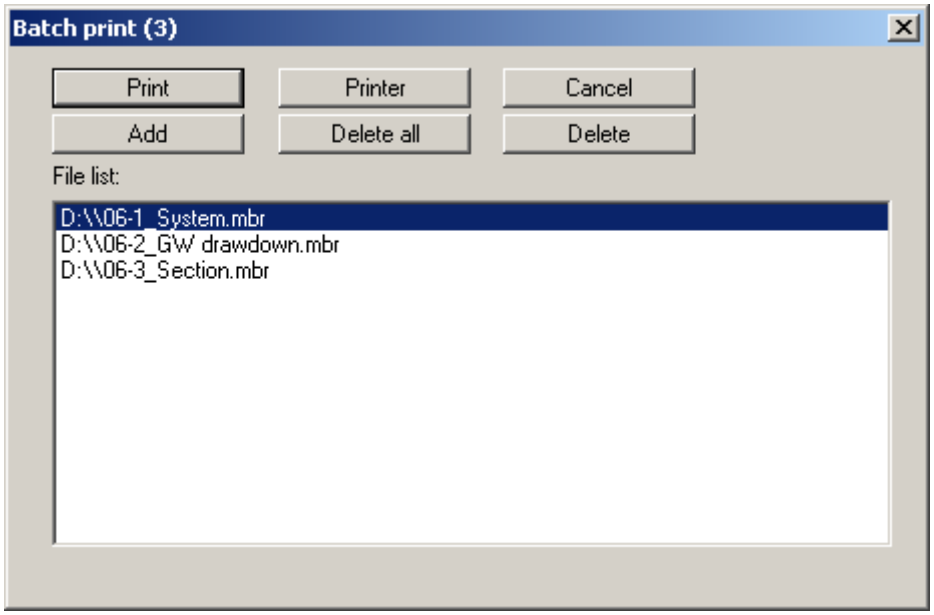
If you select the "**Copy/print area**" tool from the toolbar, you can copy parts of the graphics to the clipboard or save them to an EMF file. Alternatively you can send the marked area directly to your printer (see "**Tips and tricks**", Section 8.4).

Using the "**Mini-CAD**" program module you can also import EMF files generated using other GGU applications into your graphics.

- "**MiniCAD**"
  allows export of the graphics to a file in order to enable importing to different GGU applications with the Mini-CAD module.
- "**GGUMiniCAD**"
  allows export of the graphics to a file in order to enable processing in the GGUMiniCAD program.
- "**Cancel**"
  Printing is cancelled.

7.1.9 "Batch print" menu item

If you would like to print several annexes at once, select this menu item. You will see the following dialog box:



Create a list of files for printing using "**Add**" and selecting the desired files. The number of files is displayed in the dialog box header. Using "**Delete**" you can mark and delete selected individual files from the list. After selecting the "**Delete all**" button, you can compile a new list. Selection of the desired printer and printer preferences is achieved by pressing the "**Printer**" button.

You then start printing by using the "**Print**" button. In the dialog box which then appears you can select further preferences for printer output such as, e.g., the number of copies. These preferences will be applied to all files in the list.

7.1.10 "Exit" menu item

After a confirmation prompt, you can quit the program.

7.1.11 "1, 2, 3, 4" menu items

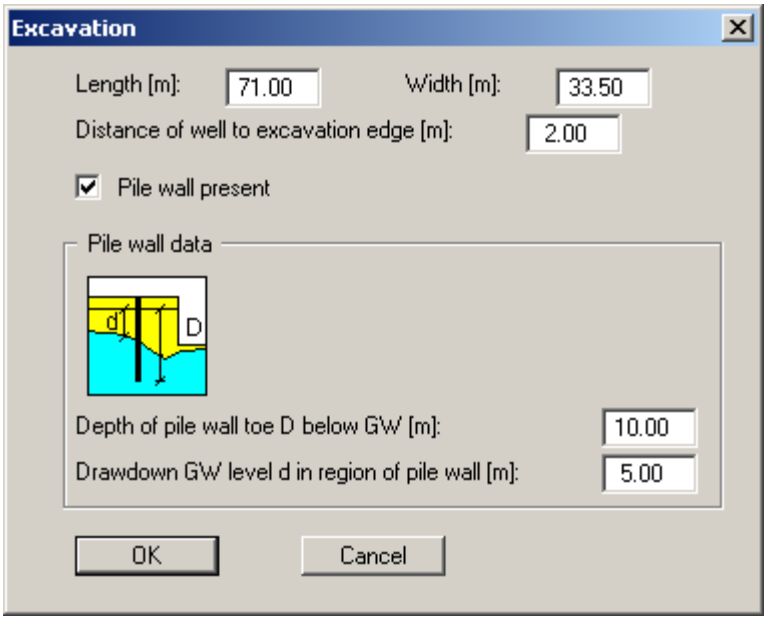
The "**1, 2, 3, 4**" menu items show the last four files worked on. By selecting one of these menu items the listed file will be opened. If you have saved files in any other folder than the program folder, you can save yourself the occasionally onerous ***rummaging*** through various sub-folders.

7.2.1 "Project identification" menu item

You can enter a description of the current system; this will then be used in the ***Input data legend*** (see Section 7.7.7) and the output table.

7.2.2 "Excavation" menu item

For rectangular excavations, enter the length and width of the excavation, and the distance of the wells from the excavation edge. Additionally, the influence of any sheet pile walls may be considered. For this, activate the "**Pile wall present**" check box in the following dialog box:

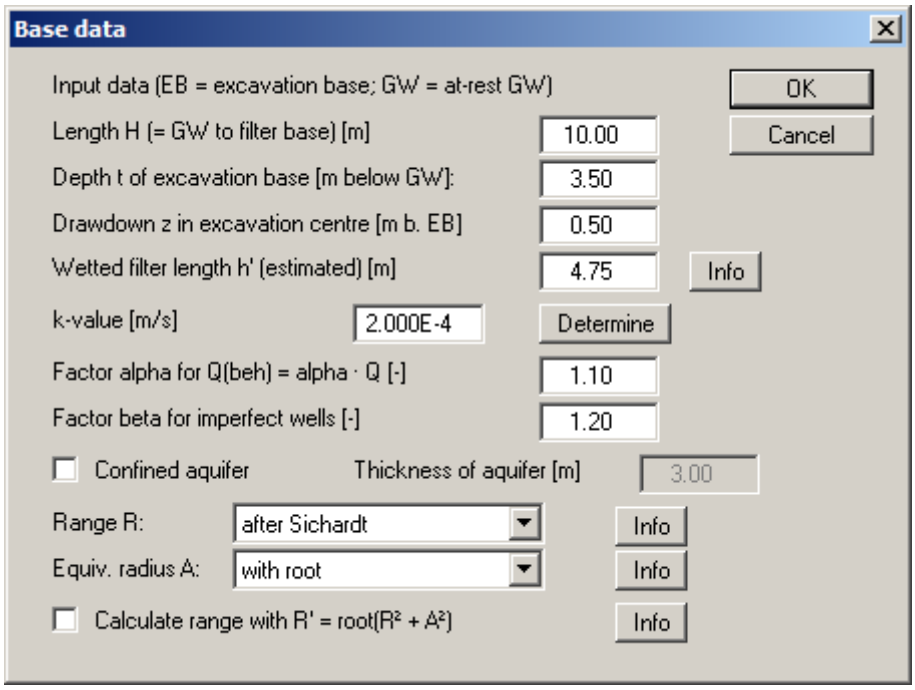


Here, you enter the depth of the sheet pile wall and the drawdown water level in the area of the pile wall. Using the "**Show system section**" menu item, you can get an overview on the position of the sheet pile wall (see Section 7.2.10).

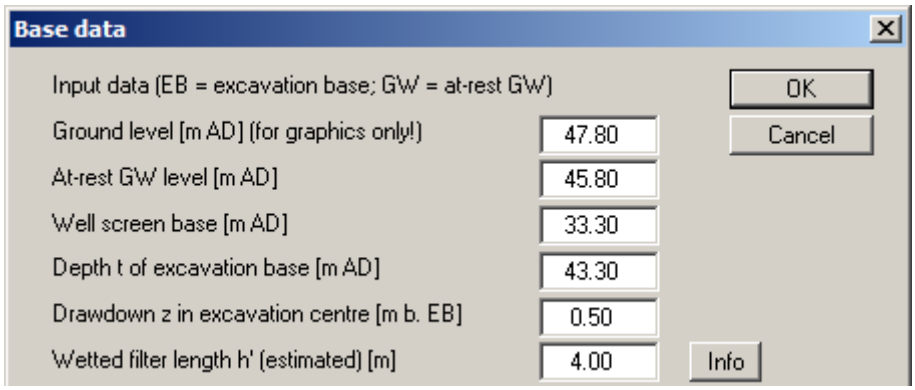
For excavations bounded by polygons, you only enter the distance of the wells from the well boundary. The shape of the excavation is defined using the "**Excavation polygon**" menu items, the input boxes for length and width are therefore switched off in the dialog box.

7.2.3 "Base data" menu item

This is the central menu item of the program. Here you can enter almost all base data for the well installation. After clicking this menu item the following dialog box appears, for example. It can also be opened by pressing the [F3] function key:



If you are working with absolute heights, the depths have to be entered in absolute values m AD:



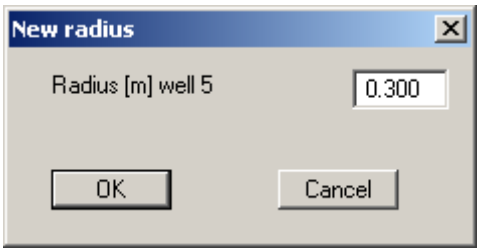
For an explanation of the input data see Section 6.3 in the example.

7.2.4 "Well radius" menu item

Use this menu item to specify a radius for new wells in the visualisation. The radius value entered can be transferred to all existing wells by pressing the "**Apply to all**" button.

7.2.5 "Edit well radii" menu item

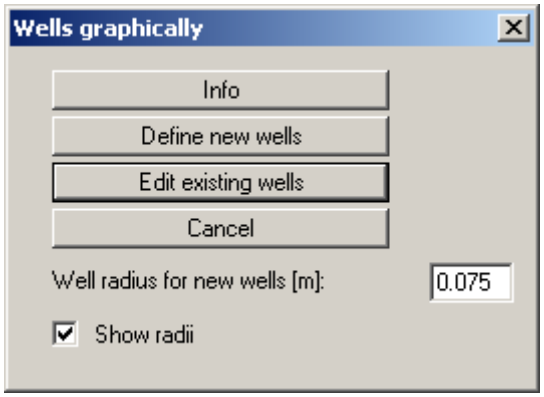
Use this menu item for editing individual well radii. Click the required well with the left mouse button after closing a small message box.



The new radius for the selected well can be entered in the dialog box.

7.2.6 "Well positions (graphically)" menu item

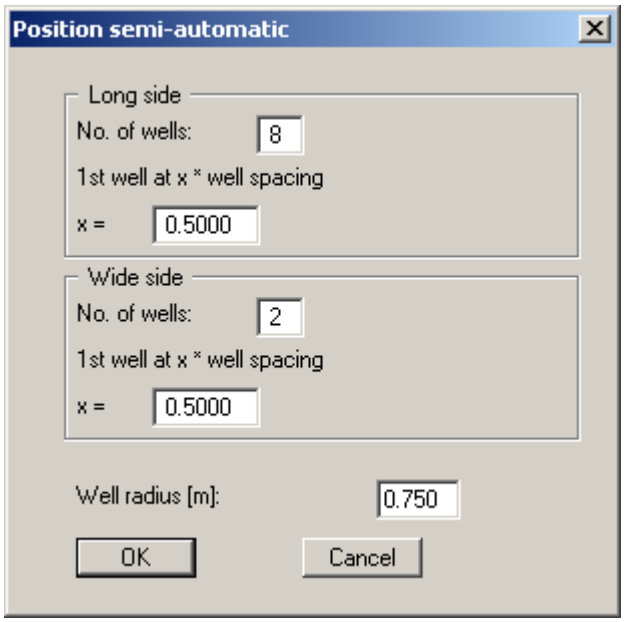
After selecting this menu item you can define well positions graphically with the mouse. The following dialog box appears:



Select the "**Info**" button to see information on graphical determination of well positions. If you want to edit a current well installation by adding or deleting of individual wells, select the "**Edit existing wells**" button. If, at first, all current wells should be deleted, select the "**Define new wells**" button. You can then position new wells by clicking the left mouse button or, by clicking the right mouse button, delete current wells. By activating the "**Show radii**" check box, the well radii will entered in the graphical display, otherwise the numbers of the wells are displayed in the graphics (see menu item "**Edit/Visualisation**" in Section 7.2.9).

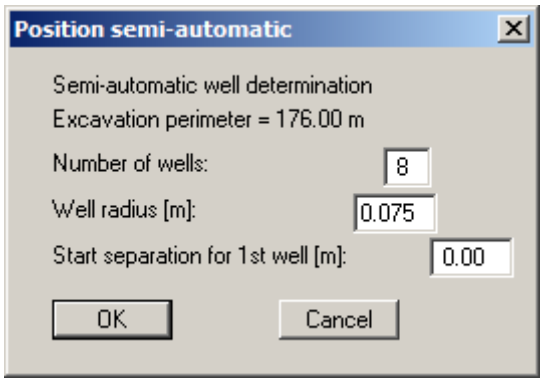
7.2.7 "Semi-automatic" menu item

After selecting this menu item you can define well positions semi-automatically. The following dialog box appears when a rectangular excavation has been entered:



Enter into this dialog box the number of wells on the long and wide side of the excavation, and the well radius. The well radius shown is always the value entered in "**Edit/Well radius**". Additionally, you can determine the position of the first and last well from each edge as multiples of the well separation. Then select the "**OK**" button. The excavation system and the position of the wells will then be displayed on the screen. If you would like to alter the position of the wells further, select "**Edit/Semi-automatic**" again, or go on to method ***Graphic well determination*** (see Section 7.2.6).

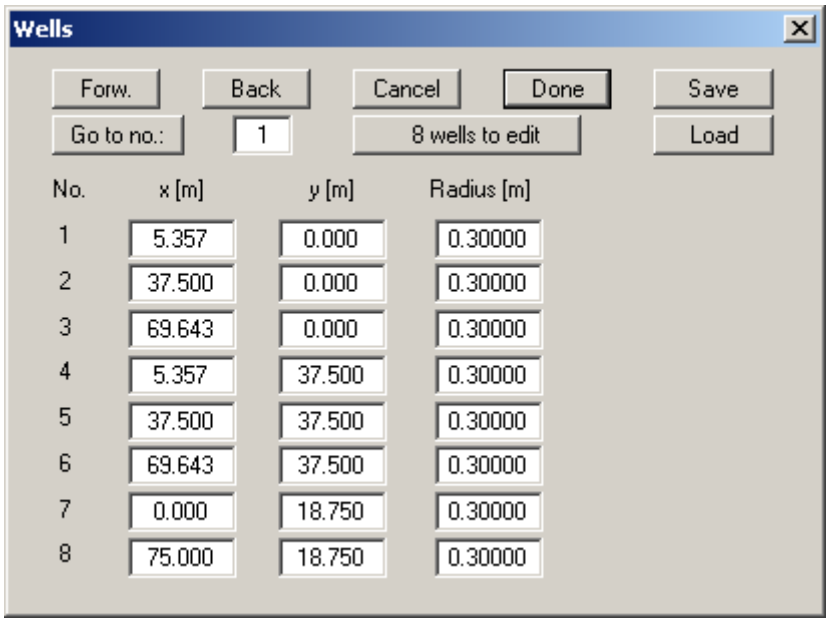
The dialog box is slightly different for excavations bounded by polygons.



The defined number of wells will be arranged with equal spacing around the excavation. By entering a start distance you can influence the position of the 1st well. Starting point 0.00 is the upper right corner of the excavation. The wells are distributed anticlockwise.

7.2.8 "Via editor" menu item

Using this menu item well coordinates and radii can be entered via an editor. The following dialog box appears, e.g.:



If necessary, edit the number of wells with the "**x wells to edit**" button. Then enter the corresponding values into the table. With the "**Forw.**" and "**Back**" buttons you can move through the table, if more than 12 wells are present.

7.2.9 "Visualisation" menu item

By default, the wells are displayed in the screen visualisation with the well number. Using this menu item a dialog box opens allowing you to change between well visualisation using numbers or radii by clicking the corresponding buttons.

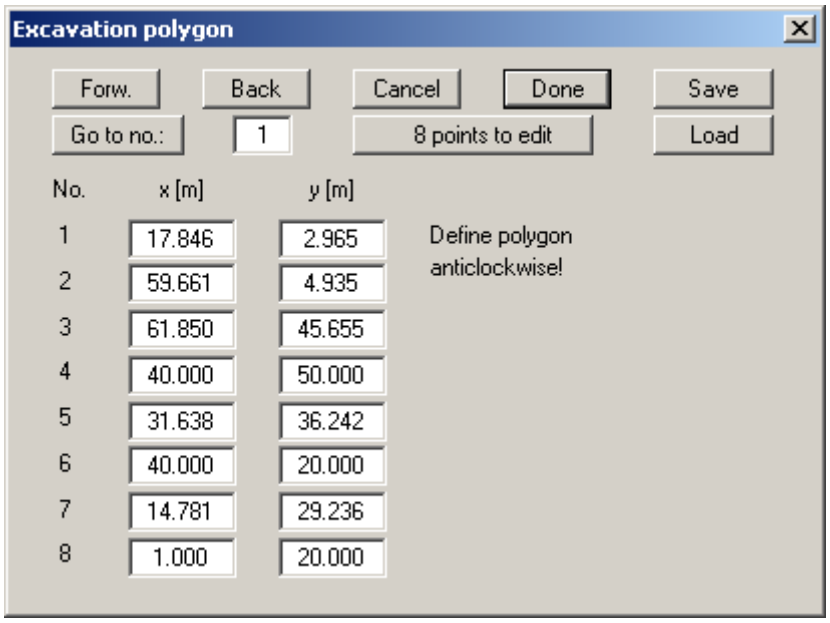
You can also use this menu item to display the well numbers or radii once again following analysis with subsequent well drawdown visualisation (menu item "**Evaluation/Display drawdowns**", Section 7.5.1).

7.2.10 "Show system section" menu item

Using this menu item the well installation is displayed in section on the screen. The same graphics can be used as a legend in the plan view (see menu item "**Graphics preferences/System section legend**" in Section 7.7.10).

7.3.1 "Define via editor" menu item

When editing an excavation bounded by a polygon, you can enter x and y coordinates for the polygon course here.



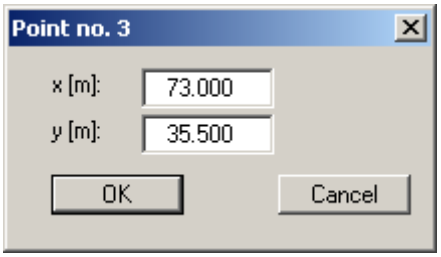
Please remember that the polygon course must be oriented anti-clockwise. With the "**x points to edit**" button you can redefine the number of points. If more than eight points are present you can move through the table with the "**Forw.**" and "**Back**" buttons. You can save a polygon course in a file with the "**.bgp**" or open one previously saved.

7.3.2 "Move polygon points" menu item

Using this menu item individual points of the excavation polygon can be moved using the mouse. Click on the desired polygon point with the left mouse button and move it by holding the left mouse button. An erroneous movement can be undone with the key combination [**Alt**] + [**Back**].

7.3.3 "Edit polygon points" menu item

Using this menu item the coordinates of the excavation corners can be edited. After clicking the required corner points with the left mouse button the following editor box opens, for example, allowing the coordinates of the point to be edited.



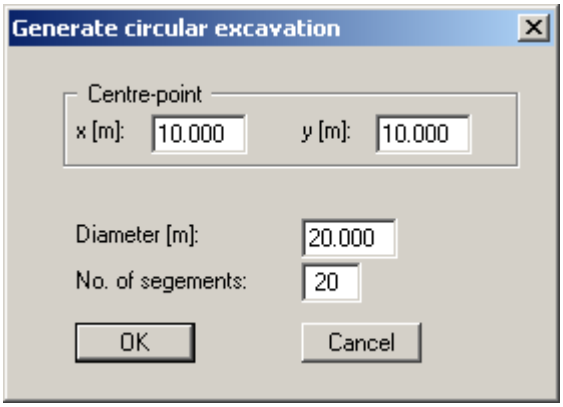
7.3.4 "Paste/Delete polygon points" menu item

After going to this menu item excavation points can be added or deleted. Click the centre of a polygon course section with the left mouse button to add new polygon points. Click the polygon course point with the right mouse button to remove.

Accidental changes can be restored using the [**Alt**] + [**Back**] key combination.

7.3.5 "Create circular excavation" menu item

You can create a circular excavation using this menu item.



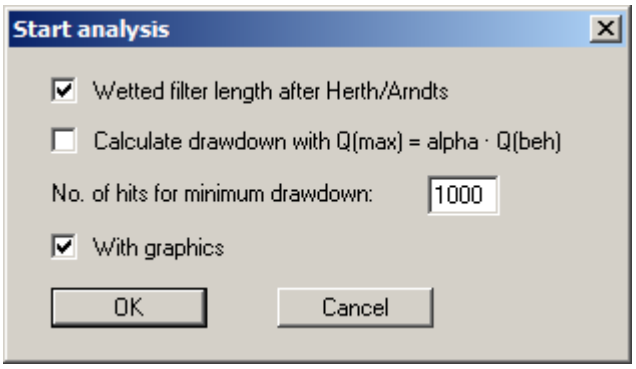
In the dialog box you enter the coordinates for the center-point and the diameter of the circle. With "**No. of segments**" you define subdivisions for the circle.

7.4.1 "Info" menu item

You will see information on the type of installation (rectangle or polygon) and the number of installed wells. If a confined aquifer exists it is also listed in the message box.

7.4.2 "Analyse" menu item

With this menu item you can begin calculating the installation. First, a plausibility control of the input data will be carried out. If necessary, you will see an error message, with an appropriate note on corrections. A dialog box with analysis preferences then appears:



You can control the type of calculation of the wetted filter length. Further to this, you can select whether the drawdown, and with this the wetted filter length, is to be calculated with the surcharge alpha, for achievement of the equilibrium state. If the "**= fixed value**" setting has been specified as the range in the "**Edit/Base data**" menu item, a further input box appears in the dialog box above, allowing the value for the range to be defined:

Using a random generator, the program searches for the least drawdown within the excavation. This is almost always at the well edge. But it also makes sense to search inside the excavation, especially with excavations bounded by a polygon and complicated well installations. With "**No. of hits for minimum drawdown**" you define the number of points to be searched for by the random generator, within the excavation.

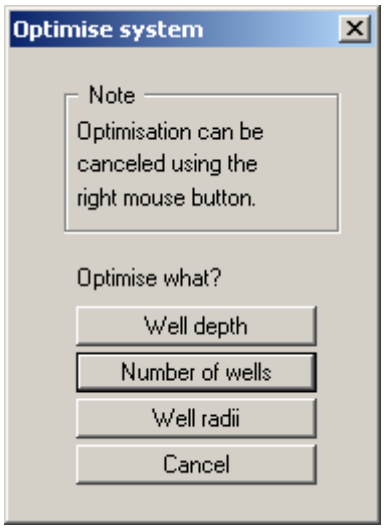
After selecting the "**OK**" button, the calculation of the installation takes place. If adequate dimensioning cannot be calculated, error messages will appear, with notes on recalculation.

Otherwise, intermediate results will be shown on the screen, which will also appear in the result legend and in the protocol. After successful calculation, the drawdown in the wells and in the centre of the excavation or, for rectangular excavations, in the centroid, will be displayed graphically on the screen. Additionally, "**MUP**" designates the most unfavourable point.

7.4.3 "Optimise" menu item

7.4.3.1 Select type of optimisation

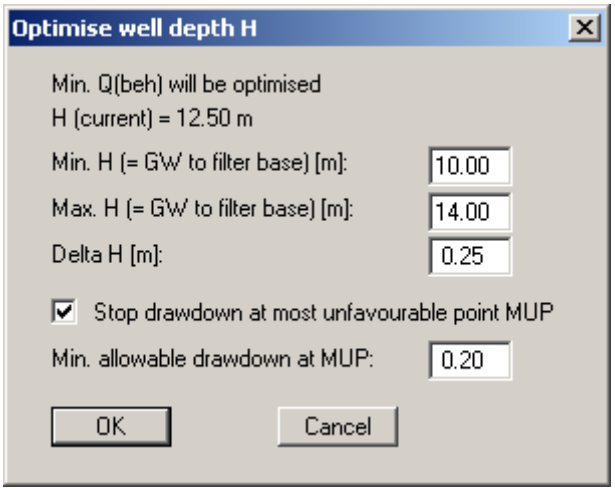
The program has different optimisation routines. Therefore, clicking on this menu item you first get an selection box:



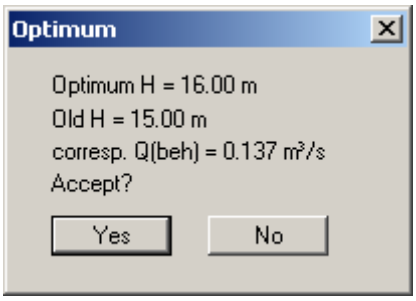
Leave the box by pressing the button for the required type of optimisation.

7.4.3.2 Optimise well depth

Using this button you can optimise the well depth.



Enter a minimum and a maximum well depth H, between which the program is to vary. With the input for "**Delta H**" you define the variation separation. Below this, you can determine whether or not a minimum drawdown at the most unfavourable point is to be adhered to. Well depths which do not keep this condition when this check box is activated will not be accepted. Once optimisation is complete the result is displayed and the optimised well depths can be accepted for further use. The optimised system should then be reanalysed.



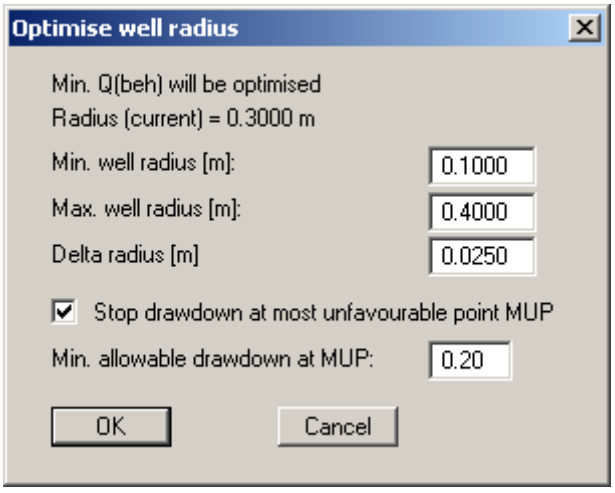
Please remember that for well depth optimisation, no increase in the factor for the influence of an imperfect well will be carried out. After calculations are complete you should check this condition for yourself or, at the start of the optimisation process, define a large enough factor to take the influence of an imperfect well into consideration.

7.4.3.3 Optimise the number of wells

The procedure for optimisation of well numbers has been explained fully in the example (see Section 6.4). Please refer to these sections.

7.4.3.4 Optimise well radii

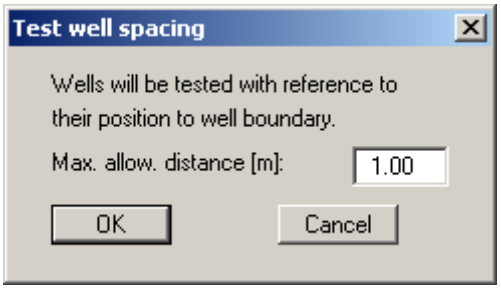
It is also possible to optimise the well radius.



In analogy to well depth optimisation, you enter the range of variation for the program here via a minimum and a maximum well radius. The input following "**Delta radius**" is used to define the variation spacing. Below this, specify whether a minimum drawdown should not be exceeded at the most unfavourable point. Well radii that do not adhere to this condition when the check box is activated are rejected. Once optimisation is complete the result is displayed and the optimised well radius can be accepted for further use. The optimised system should then be reanalysed.

7.4.4 "Test" menu item

This menu item is only activated for rectangular excavations. If you have defined wells using the mouse via the menu item "**Edit/Well positions (graphically)**" and do not know whether a distance to the edge of the excavation must be adhered to, this can be tested using this menu item.



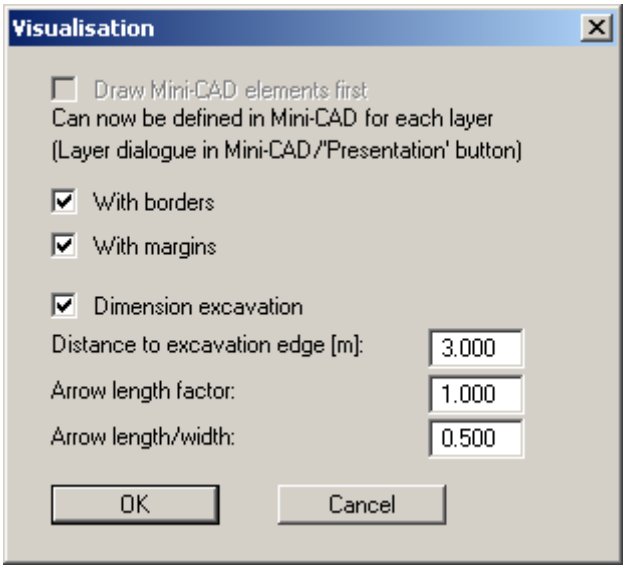
A maximum distance can be specified. All wells located further away from the edge of the excavation will be displayed in sequence.

7.4.5 "Results" menu item

The results of the analysis are summarised in a dialog box to give a quick overview.

7.4.6 "Graphics preferences" menu item

The dialog box for this menu item allows settings to be defined for visualisation.

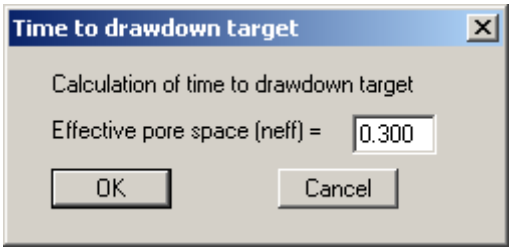


Objects added using **Mini-CAD** are normally drawn via the system representation. If the **Mini-CAD** objects are to be positioned behind the graphics this can be specified in the pop-up menu of the **Mini-CAD** module (layer dialog in **Mini-CAD**/"**Presentation**" button).

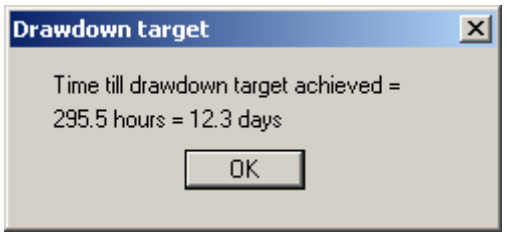
By deactivating the corresponding check boxes in the menu item "**Page size + margins/Page size and margins**" the defined borders and page margins may be switched off (see Section 7.8.5). If the "**Dimension excavation**" check box is activated, the distance to the edge of the excavation, and the length and width of the dimension arrows can be specified in the following input boxes.

7.4.7 "Time" menu item

This menu item provides an estimate of the time required until the drawdown target is achieved. The effective pore space must be entered in the following dialog box and analysis initiated by pressing "**OK**".



Once the analysis is complete the results are displayed in a message box.

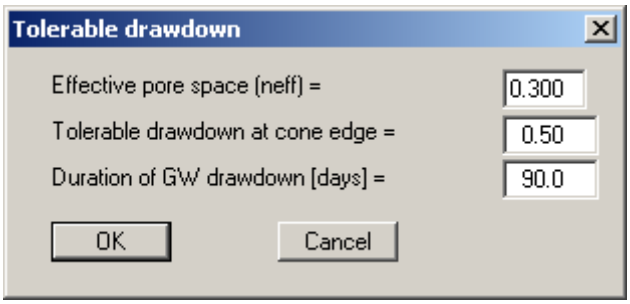


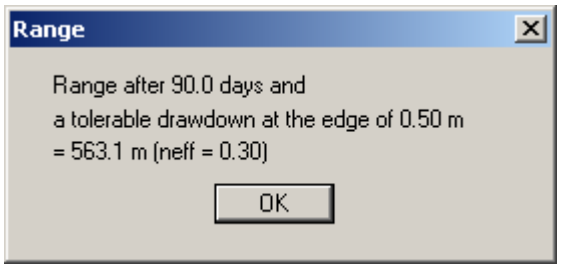
7.4.8 "Influence area" menu item

Using this menu item the drawdown range, as a function of drawdown time (days), is calculated.

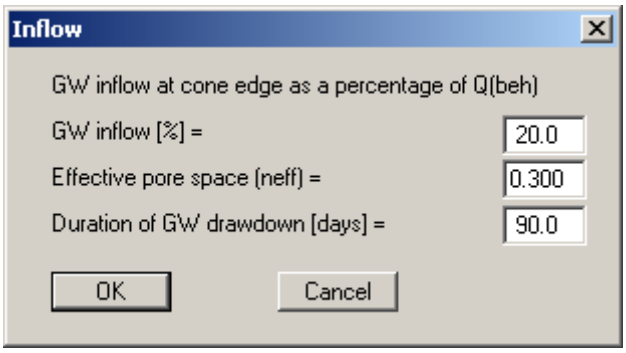
You can choose from two calculation methods. The effective pore space and the time must be given for both calculation types. The differences are as follows:

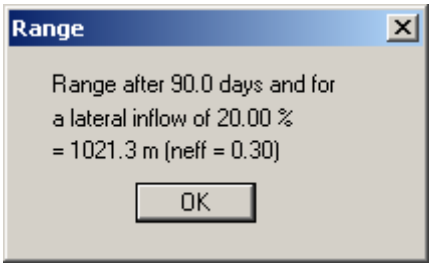
- **Max. drawdown:**
  Influence area as a function of the tolerable drawdown at the cone edge.





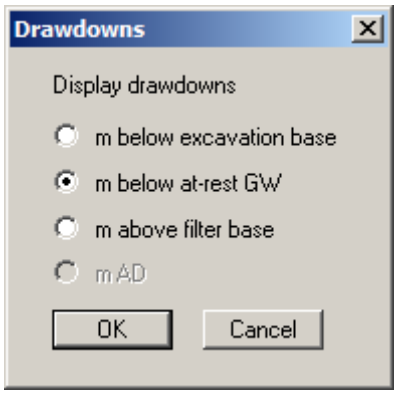
- **Lateral inflow:**
  Influence area as a function of groundwater ingress at the cone edge in [%] of Q_{beh}.





7.5.1 "Display drawdowns" menu item

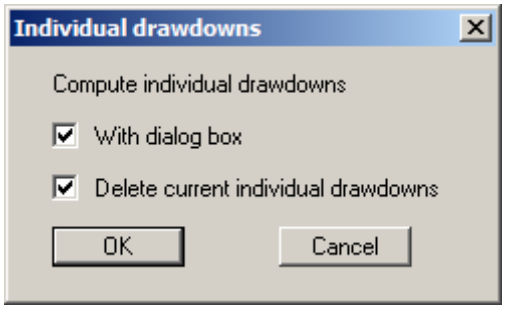
Once the installation has been analysed the drawdowns in the wells can be entered in the screen graphics. In the dialog box that follows, select the type of drawdown visualisation.



If you then wish to return to well visualisation with numbers or radii, go to the menu item "**Edit/Visualisation**" and select the appropriate button (see Section 7.2.9).

7.5.2 "Compute individually" menu item

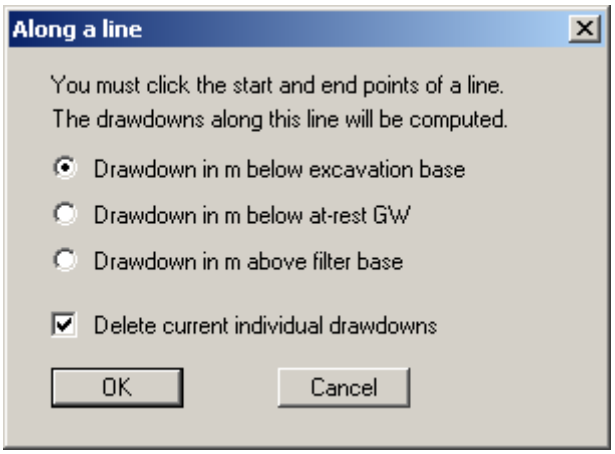
After installation analysis you can have any drawdown computed, inside or outside the excavation. You need simply to click with the left mouse on the point for which you would like to compute a drawdown. The drawdown will then be displayed on the screen. If the screen section is too small to display a drawdown outside the excavation, select the menu item "**Page size + margins/Manual resize (editor)**" and change the values to those required (see also further below). Drawdown above the base of the excavation will be displayed as negative.



If the "**With dialog box**" check box is activated a message box opens for every clicked point giving the computed drawdown values in m below the excavation base, m below at-rest GW and m above filter base. The drawdown selected as the final option in the menu item "**Evaluation/Display drawdowns**" is then visualised on the screen. If individual drawdowns have already been computed, the existing individual drawdowns can be deleted by going to this menu item again and activating the appropriate check box.

7.5.3 "Along a line" menu item

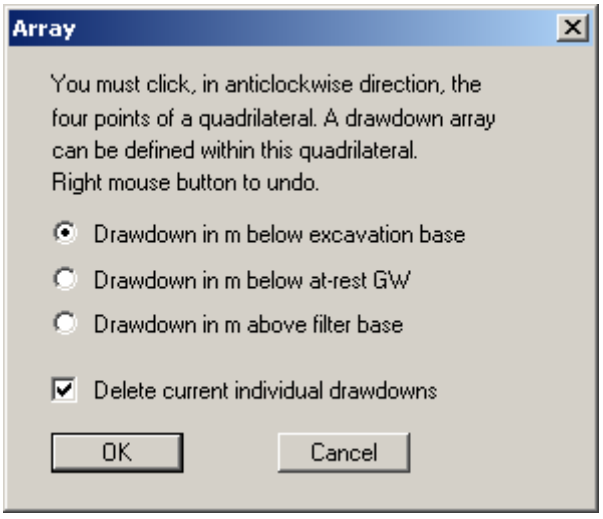
This menu item supports calculation of drawdowns along a user-defined line. The line is defined using the mouse. First, a dialog box opens for selecting the type of drawdown to be computed:



If individual drawdowns have previously been computed they can be deleted by activating the appropriate check box. After leaving the dialog box by pressing "**OK**" define the start and end point of the line using the left mouse button. Then specify the number of line subdivisions and thus the drawdown modelling points. If you go to the menu item "**Section/Define automatically**" following analysis the defined line is adopted as the section. This allows a drawdown cone to be visualised, for example.

7.5.4 "In an array" menu item

Following installation analysis individual drawdowns in an array within a defined quadrilateral can be computed using this menu item. Here, too, select the type of drawdown in a dialog box and delete existing individual drawdowns if required.



After leaving the dialog box, define a quadrilateral by clicking the corners anticlockwise with the left mouse button. After clicking the fourth points, specify the number of array points in x- and y-direction and start the computation with "**OK**". Drawdowns inside and outside of the excavation can thus be computed and visualised, and the impact of groundwater management on the excavation environs be identified.

7.5.5 "Load point coordinates" and "Save point coordinates" menu items

The x- and y-coordinates of the user-defined drawdown points can be saved to a file with the extension "**.abs**"; the exact same coordinates are then available at a later date.

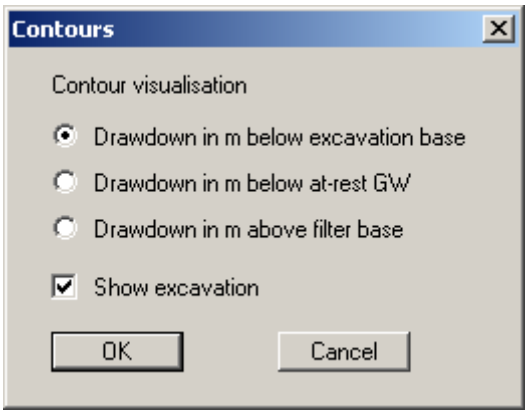
7.5.6 "Delete drawdown points" menu item

All user-defined, computed drawdowns are deleted from the screen graphics.

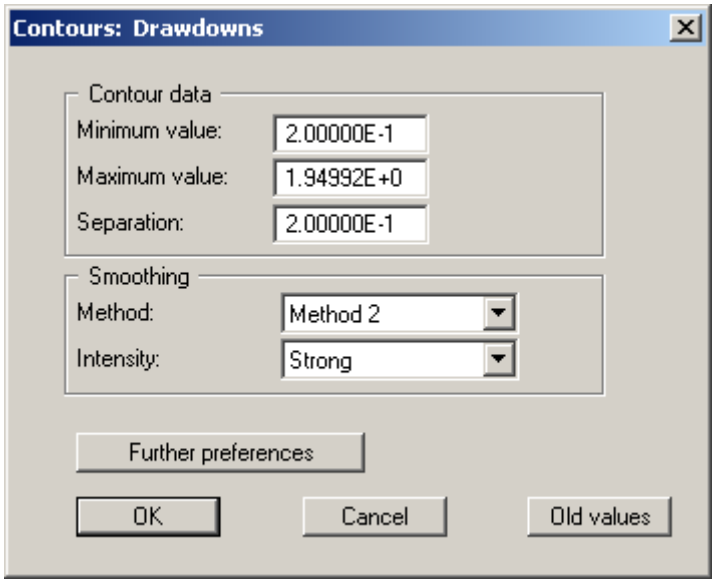
7.5.7 "Normal contours" menu item

The program carries out a triangulation with all calculated drawdowns and creates from this an interpolation grid, which then forms the basis for the contour presentation. If you have not yet calculated any individual drawdown, you can do this using, e.g. the menu item "**Evaluation/In an array**".

First, specify the type of drawdown for contour visualisation:



The triangulation then follows, which may take several seconds for a large number of points, and/or with a slow PC. The following dialog box appears:



The program shows the existing smallest and largest values and the separation of the contour lines. If you want the representation to begin with a different value, the initial value can be entered here. You can also vary the spacing, in order to reduce the number of contour lines drawn for example. The settings displayed here are always those automatically selected by the program. Using the "**Old values**" button, the preferences used for the previous contour line diagram are adopted.

The program supports three smoothing out procedures:

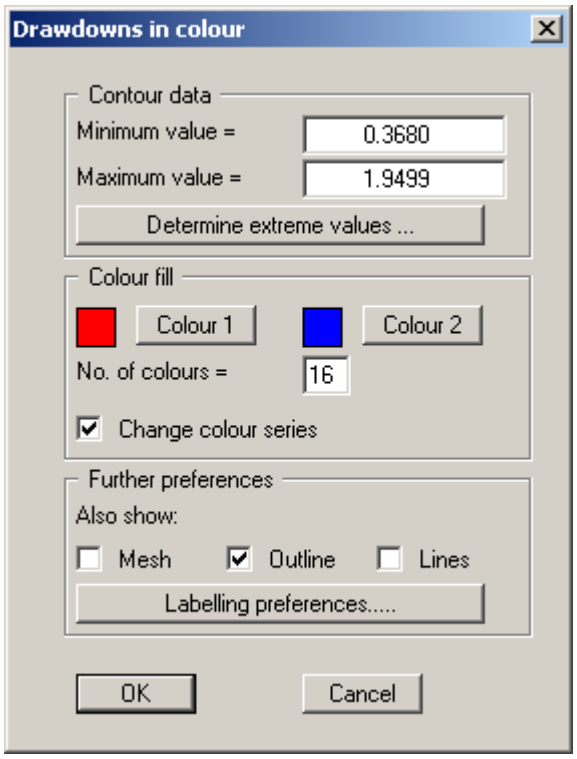
- "**Do not smooth**"
  As a linear method is implemented within the triangle elements, this will provide analysis results without smoothing performed by the program.
- "**Method 1**" and "**Method 2**"
  these smoothing out procedures employ two different Bezier splines. Smoothing out intensities can be given for both in order to acquire smooth contour lines. **Method 2** creates very "**round**" contours, with the danger that the true results may be falsified.

You can specify the type of visualisation for the contour lines by means of the "**Further preferences**" button, e.g. system boundaries, triangle mesh, contour labelling, font size, etc.

If your preferences are confirmed by pressing "**OK**" the contours are displayed on the screen. The colour and pen width defined in "**Graphics preferences/Pen colour and width**" is used. If you need to display the contours in a different colour or pen width they can be edited using this menu item (see Section 7.7.3).

7.5.8 "Coloured contours" menu item

In analogy to the previous menu item, colour-filled contours can also be created. After selecting the type of drawdown the following dialog box appears:

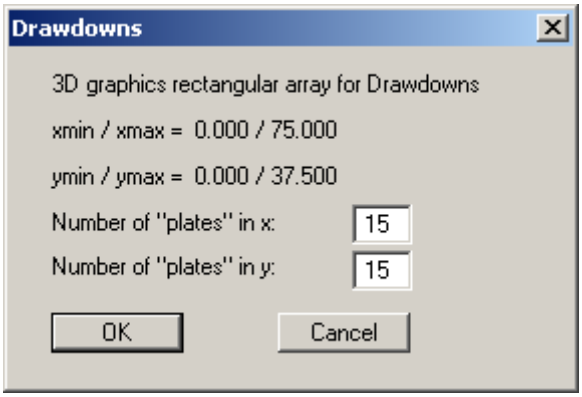


- "**Contour data**" group box
  The "**Determine extreme values**" button computes the minimum and maximum drawdowns and enters them into the appropriate input boxes. However, you need not retain these values, but can also define your own. No smoothing of the contour lines can be performed here.
- "**Colour fill**" group box
  You can control the colour subdivisions of the contour diagram using "**No. of colours**". In the example above, 16 colours will be displayed between "**Colour 1**" and "**Colour 2**". The default setting is a colour course from red to blue. These colours can be edited as required after selecting the "**Colour 1**" and "**Colour 2**" buttons, or simply reverse the choice by selecting the "**Change colour series**" check box.
- "**Further preferences**" group box
  In addition to the colour presentation you can also have the triangle mesh and/or the outline displayed. Additional contour lines can also be drawn. Line labelling preferences can be defined by means of the "**Labelling preferences**" button.
- "**OK**"
  The colours will be drawn after confirmation.

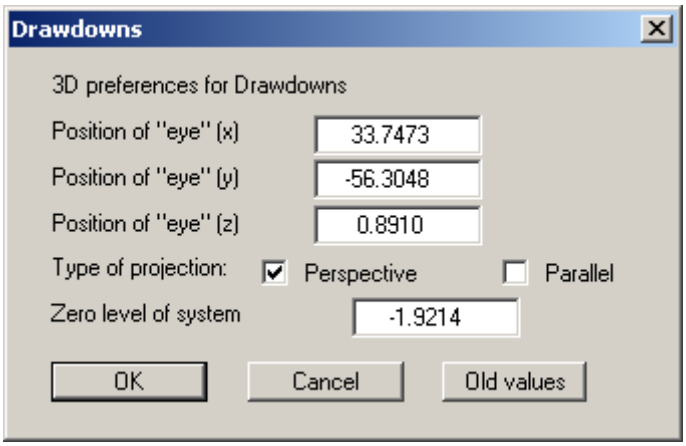
A colour bar at the right edge of the sheet allows correlation between the colour and the corresponding value. If this colour bar is drawn in the right page margin, specify a larger value for the right plotting margin (e.g. 25 mm) in the "**Page size + margins/Page size and margins**" menu item (see Section 7.8.5).

7.5.9 "3D contours" menu item

This menu item allows presenting contours as a three dimensional image in a rectangular array. After selecting the type of drawdown you can define the array by selecting the number of x and y subdivisions (plates) in the following dialog box:

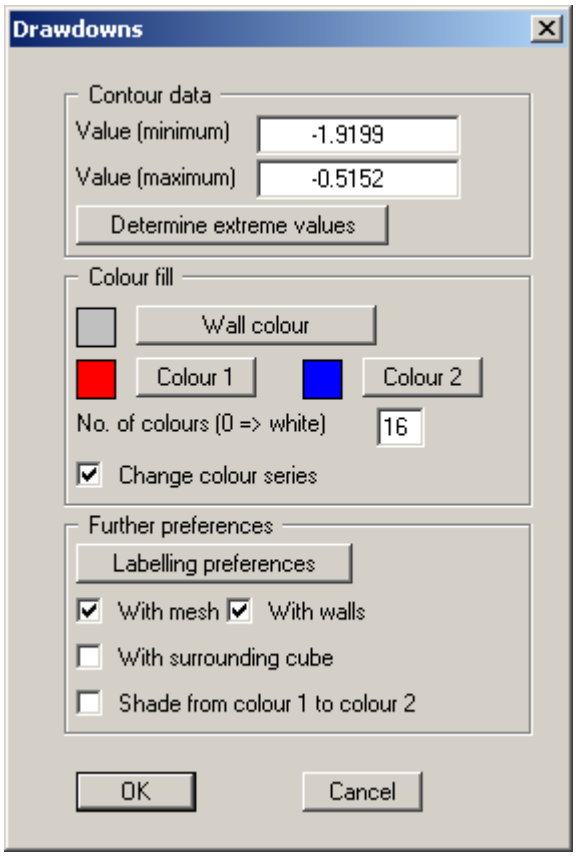


The program interpolates the values to be represented at the array points from the underlying triangle mesh. After leaving the dialog box by pressing "**OK**" you will see the following box:



Here, select the point of observation (position of the ***eye*** in x, y and z coordinates), the type of projection and the zero level of the 3D presentation. The drawdowns are displayed above and below the zero level (z ordinate) in three dimensions. The program will generally make sensible suggestions for the input values in the dialog box, so you will not normally need to make alterations.

After leaving the dialog box by pressing "**OK**" you will see the following dialog box. It greatly resembles the box shown in the "**Evaluation/Coloured contours**" menu item (see Section 7.5.8).



You can also specify whether an enclosing cube should be displayed; in some cases this improves the 3D effect. The "**Shade from colour 1 to colour 2**" check box represents a bit of a special effect. If this check box is activated a light source is simulated in the region of the eye. The angle between the light beam and the respective 3D surface represents a measure of the reflection. The area is shaded in accordance with colours 1 and 2. A good choice of colours, for example, would be dark grey for colour 1 and pale grey for colour 2.

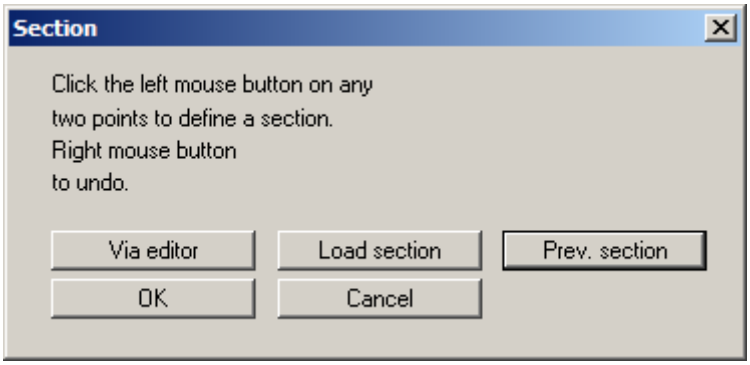
7.6.1 General notes on sections

You can have any of the drawdowns represented in true-to-scale sections. A differentiation is made between "**user-defined**" sections for which the drawdown values are newly calculated at the defined points and sections with drawdowns at fixed, currently calculated drawdown points.

7.6.2 "User-defined section" menu item

7.6.2.1 Define section course

After selecting this menu item a dialog box opens containing a description of the procedure for defining the section then opens:

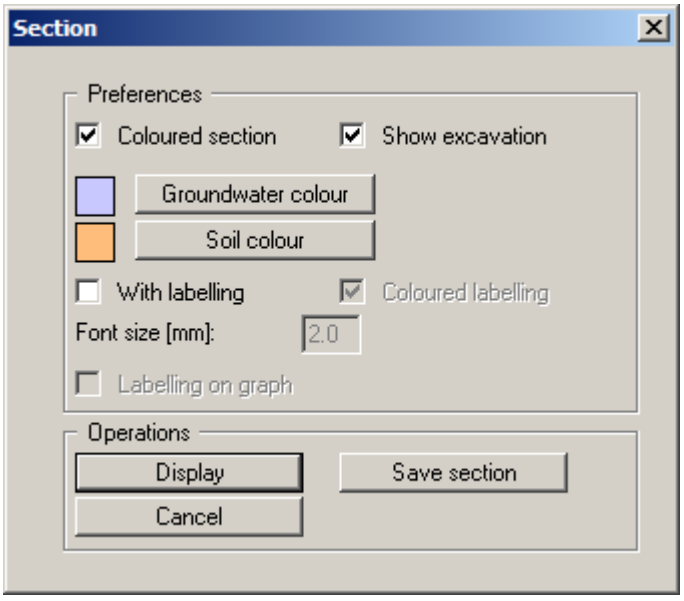


For this type of evaluation the section course is no longer bound to the drawdown points, but consists of a start and an end point. Using the "**Via editor**" button you can specify the start and end points using numerical values instead of the mouse. If you have previously saved a section it can be loaded again using "**Load section**". The "**Prev. section**" button is only visible if a section has already been defined and loads the section defined immediately prior.

If you click "**OK**" you define a new section by clicking the start and end points using the mouse. Once the end point is defined a dialog box opens for input of the number of subdivisions. The number of subdivisions defines the number of drawdown points for calculation. The greater the number of drawdown points, the more complex is the section computation; however, at the same time the ***resolution*** is increased, assuming sufficient points have been defined.

7.6.2.2 Section visualisation preferences

After entering the subdivisions the following dialog box opens:



- "**Preferences**" group box
  If the "**Coloured section**" check box is activated the whole area of the groundwater and soil layer is filled. Directly below this, the colours can be adapted to taste. Activate the corresponding check box if the excavation is to be visualised in section. This generally provides for better visualisation of the groundwater situation below the excavation.

  Activating the "**With labelling**" check box automatic section labelling can be used. When activated the program inserts a table below the section, containing the calculated drawdowns at the drawdown points defined. The labelling font size can be altered to suit requirements. If the "**Coloured labelling**" check box is activated the groundwater level is visualised in the above defined colour. The drawdowns can also be entered directly at the drawdown point. To do this, activate the "**Labelling on graph**" check box.

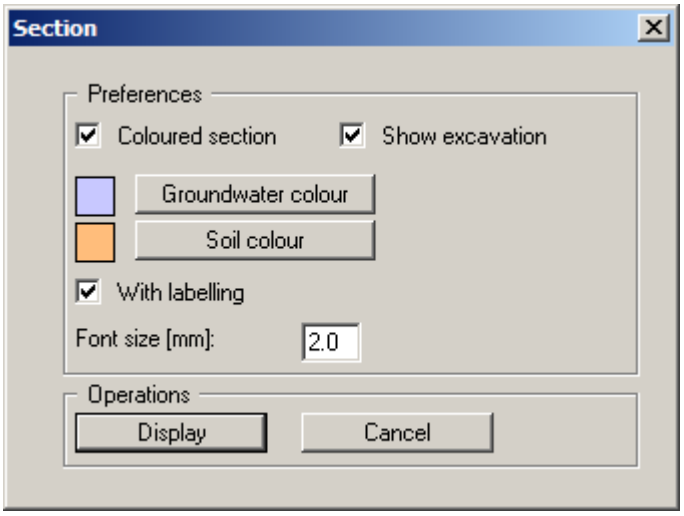
- "**Operations**" group box
  The current section can be saved to a file using "**Save section**". The section will be drawn on the screen after clicking the "**Display**" button. A location sketch is automatically displayed on the screen showing the system outline and the defined section. This section course legend is activated by default, but can be deactivated in the "**Graphics preferences/Section course legend**" menu item (see Section 7.7.9).

7.6.3 "User-defined section preferences" menu item

Use this menu item to make changes to the visualisation of the "**User-defined**" section. The same dialog box opens as following section course definition. A description can therefore be found in Section 7.6.2.2. If you leave the dialog box by pressing the "**Display**" button, the section is displayed using the new settings.

7.6.4 "Define along drawdown points" menu item

Using this menu item it is possible to summarise computed drawdowns in a section by clicking the drawdown points in the required sequence using the left mouse button. The last point defined is deleted from the list by clicking the right mouse button. When the section is how you want it press [**Return**]. A dialog box opens for specifying section visualisation settings:



If the "**Coloured section**" check box is activated the whole area of the groundwater and soil layer is filled. Directly below this, the colours can be adapted to taste. Activate the corresponding check box if the excavation is to be visualised in section. This generally provides for better visualisation of the groundwater situation below the excavation. The section will be drawn on the screen after clicking the "**Display**" button. A location sketch is automatically displayed on the screen showing the system outline and the defined section. This section course legend is activated by default, but can be deactivated in the "**Graphics preferences/Section course legend**" menu item (see Section 7.7.9).

7.6.5 "Define automatically" menu item

Instead of manually compiling the individual drawdowns to a section they can be compiled automatically using this menu item. The section is compiled in the same sequence that the drawdown points were defined. A message box opens giving information on the number of nodes used and the section can be visualised after closing the message box by clicking "**Yes**". The section course legend is also displayed in this case. If the section visualisation needs to be changed, go to the menu item "**Section/Point section preferences**" and make the necessary changes (see Section 7.6.6).

7.6.6 "Point section preferences" menu item

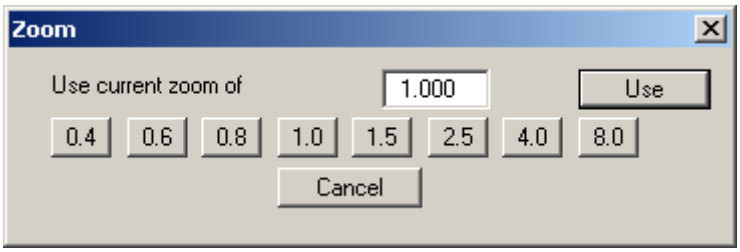
Use this menu item to make changes to the visualisation of the user-defined or automatic section along computed drawdown points. The same dialog box opens as following manual section course definition. A description can therefore be found in Section 7.6.4. If you leave the dialog box by pressing the "**Display**" button, the section is displayed using the new settings.

7.7 Graphics preferences menu

7.7.1 "Refresh and zoom" menu item

The program works on the principle of ***What you see is what you get***. This means that the screen presentation represents, overall, what you will see on your printer. In the last consequence, this would mean that the screen presentation would have to be refreshed after every alteration you make. For reasons of efficiency and as this can take several seconds for complex screen contents, the screen is not refreshed after every alteration.

If, e.g., after using the zoom function (see below), only part of the image is visible, you can achieve a complete view using this menu item.



A zoom factor between 0.4 and 8.0 can be entered in the input box. By then clicking on "**Use**" to exit the box the current factor is accepted. By clicking on the "**0.4**", "**0.6**", etc. buttons, the selected factor is used directly and the dialog box closed.

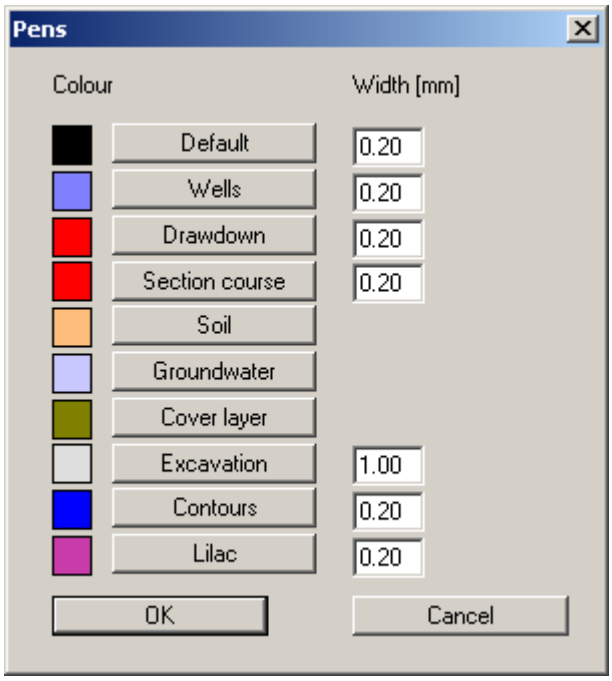
It is much simpler, however, to get a complete overview using [**Esc**]. Pressing [**Esc**] allows a complete screen presentation using the zoom factor specified in this menu item. The [**F2**] key allows screen refreshing without altering the coordinates and zoom factor.

7.7.2 "Zoom info" menu item

By clicking two diametrically opposed points you can enlarge a section of the screen in order to view details better. An information box provides information on activating the zoom function and on available options.

7.7.3 "Pen colour and width" menu item

For reasons of clarity different colours are used as default for the graphical representation of drawdowns, contour lines, groundwater, etc. You can edit the pen widths for the elements shown in the dialog box; by clicking on the button with the element designation you can also edit the pen or fill colours.



On ***monochrome printers*** (e.g. laser printers), colours are shown in a corresponding grey scale. Graphic elements employing very light colours may be difficult to see. In such cases it makes sense to edit the colour preferences.

7.7.4 "Mini-CAD toolbar" and "Header toolbar" menu items

Using these two menu items you can add free text to the graphics and add lines, circles, polygons and images (e.g. files in formats BMP, JPG, PSP, TIF, etc.). The same pop-up menu opens for both menu items, the icons and functions used are described in more detail in the **Mini-CAD** manual provided. The differences between the Mini-CAD and Header CAD are as follows:

- Objects created with **Mini-CAD** are based on the coordinate system (generally in metres), in which the drawing is produced, and are shown accordingly. You should use the "**Mini-CAD toolbar**" when you wish to add information to the system (for example, labelling of slope inclinations or the location of any foundations).
- Objects created with the **Header CAD** are based on the page format (in mm). This makes you independent of the coordinate system and keeps you in the same position on the page. You should select the "**Header toolbar**" if you wish to place general information on the drawing (company logo, report numbers., plan numbers, stamp etc.). Once you have saved the header information to disk (see **Mini-CAD** user manual), you can load it into completely different systems (with different system coordinates). The saved header information will appear in exactly the same position on the page, which greatly simplifies the creation of general page information

7.7.5 "Legend font selection" menu item

With this menu item you can switch to a different true-type font. All available true-type fonts are displayed in the dialog box.

7.7.6 "Toolbar preferences" menu item

After starting the program a horizontal toolbar for menu items appears below the program menu bar. If you would rather work with a popup window with several columns, you can specify your preferences using this menu item. The smarticons can also be switched off.

At the bottom of the program window you find a status bar with further information. You can also activate or switch off the status bar here. The preferences will be saved in the "**GGU-DRAWDOWN.alg**" file (see menu item "**Graphics preferences/Save graphics preferences**") and will be active at the next time the program is started.

By clicking on the tools (smarticons) for the menu items you can directly reach most of the program functions. The meaning of the smarticons appears as a text box if you hover with the mouse pointer over the tools. Some of the tool functions can be activated from the normal menu items.

"**Next page**"/"**Previous page**"
Using this icon, you can navigate between the individual pages in the ***tabular representation***.

"**Select page**"
If you are in the ***tabular representation***, you can use this icon to jump to a specific page or to return to the ***normal representation***, that is, to the graphics.

"**Zoom out**"
If you have previously ***zoomed in***, this tool returns to a full screen display.

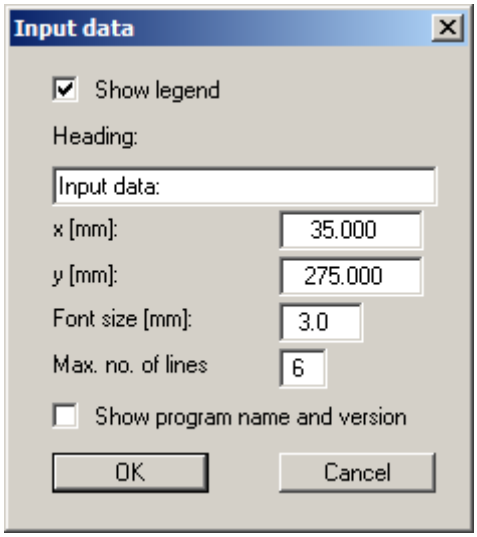
"**Zoom (-)**"/"**Zoom (+)**"
With the zoom functions you can zoom in or out of parts of the image, by clicking the left mouse button.

"**Copy/print area**"
Use this tool to copy only parts of the graphics in order to paste them, e.g. to a report. You will see information on this function and can then mark an area, which is copied to the clipboard or can be saved in a file. Alternatively you can send the marked area directly to your printer (see "**Tips and tricks**", Section 8.4).

"**Colour on/off**"
If you need to remove the colour from the system or section presentation, to create a black and white printout, for example, use this on/off switch.

7.7.7 "Input data legend" menu item

If you click the "**Show legend**" check box, a legend with input data will be displayed. You can alter the position and appearance of the legend.

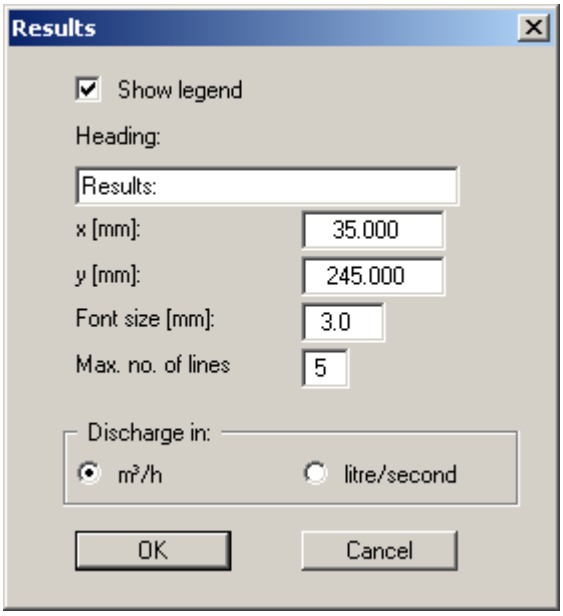


A text can be specified as legend header. You can define and edit the position of the legend using the values "**x**" and "**y**". You control the size of the legend using "**Font size**" and "**Max. no. of lines**"; where necessary, several columns are used. The fastest way to modify the position of the legend is to press the [**F11**] function key and then to pull the legend to the new position with the left mouse button pressed.

You can display the program name and version, if the corresponding check box is activated. Any project identification entered (see Section 7.2.1) will also be shown in the ***input data legend***.

7.7.8 "Result data legend" menu item

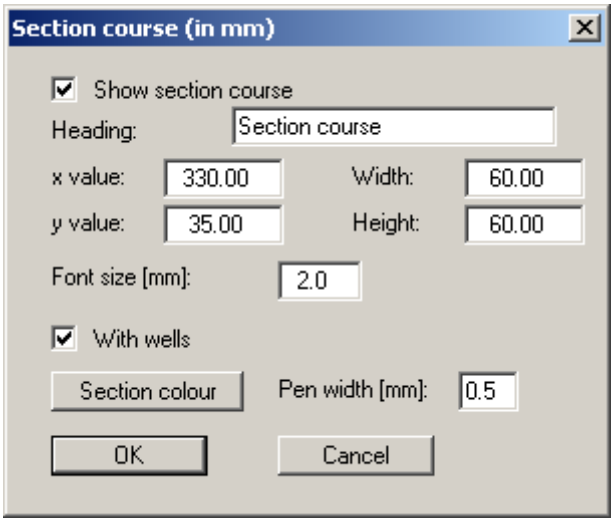
If you have analysed your system the detailed analysis results can be shown in a legendby activating the "**Show legend**" check box. You can alter the position and appearance of the legend.



A text can be specified as legend header. You can define and edit the position of the legend using the values "**x**" and "**y**". You control the size of the legend using "**Font size**" and "**Max. no. of lines**"; where necessary, several columns are used. The fastest way to modify the position of the legend is to press the [**F11**] function key and then to pull the legend to the new position with the left mouse button pressed. Additionally, the discharge dimension can be selected.

7.7.9 "Section course legend" menu item

If a section is visualised a legend is shown which includes a section location sketch. If the "**Show section course**" check box is activated the presentation format can be edited in the dialog box for this menu item. The dialog box can also be accessed by double-clicking in the legend box.

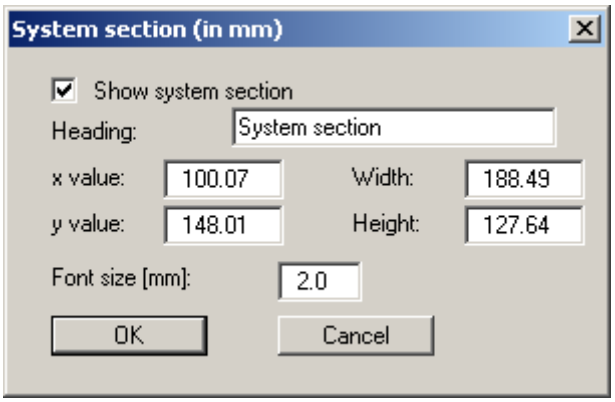


The position of the legend can be defined and edited using the values "**x**" and "**y**", "**Width**" and "**Height**". You can edit the font size of the entered heading. The fastest way to modify the position or size of the legend is to press the [**F11**] function key and then to pull the legend to the new position or alter size with the left mouse button pressed.

Activate the appropriate check box if the wells are to be displayed in the legend. The line describing the section course can be edited by pressing the "**Section colour**" button and changing the value in the "**Pen width**" input box.

7.7.10 "System section legend" menu item

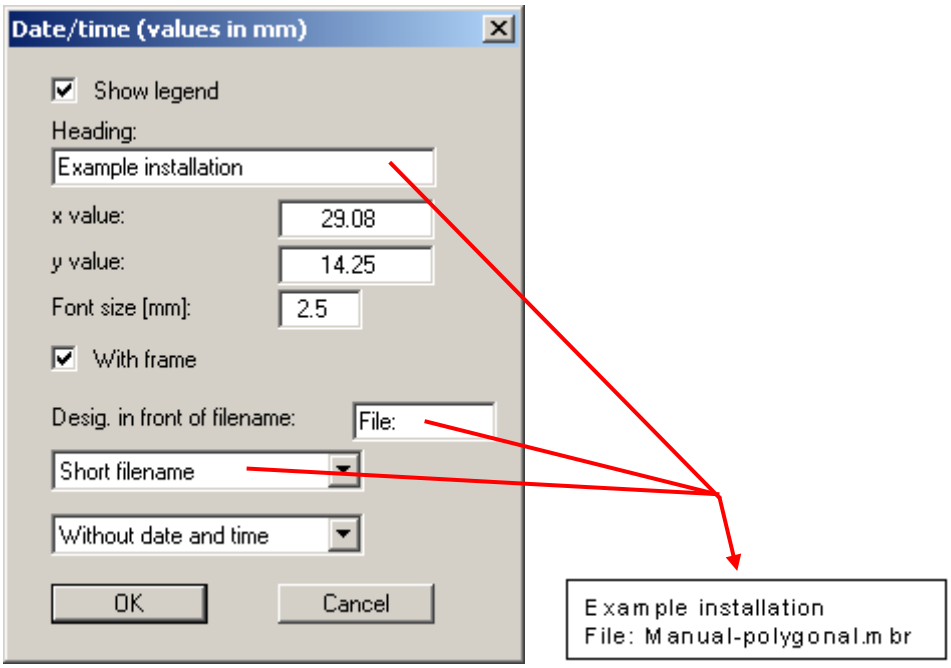
You can have a legend containing a system section presented in the graphics. The shape and appearance of the legend can be edited.



The position of the legend can be defined and edited using the values "**x**" and "**y**", "**Width**" and "**Height**". You can edit the font size of the entered heading. The fastest way to modify the position or size of the legend is to press the [**F11**] function key and then to pull the legend to the new position or alter size with the left mouse button pressed.

7.7.11 "File name legend" menu item

A file name legend can be displayed by activating this menu item. The legend will be represented according to the information entered in the dialog box.



You can define and edit the position of the legend using the values "**x**" and "**y**". You control the size of the legend using "**Font size**". The fastest way to modify the position of the legend is to press the [**F11**] function key and then to pull the legend to the new position with the left mouse button pressed.

The file name can be excluded or, by using "**Short filename**" or "**Complete filename**" displayed automatically with or without the file path. The date and time can also be displayed, either completely or in part.

7.7.12 "Move objects" menu item

When you go to this item you can move the various objects with the aid of the mouse. Move the mouse over the object to be moved. When you are located above a moveable object the mouse pointer appears in the shape of a cross. You can now press and hold the left mouse button and drag the object to the required position.

> After going to this menu item only one object at a time can be moved using the mouse or its size be altered.
>
> In order to move or edit several objects, this function can be more quickly activated by pressing [**F11**].

The size of an object can also be altered using this menu item or the [**F11**] key. If you move over the frame of a changeable object after activating this function the mouse assumed the shape of a double-headed arrow. Hold the left mouse button and move the frame until the element has reached the required size. To retain the ratio of the sides, pull at one corner only. If on one side only is pulled the object will become higher or wider.

7.7.13 "Load graphics preferences" menu item

You can reload a graphics preferences file into the program, which was saved using the "**Graphics preferences/Save graphics preferences**" menu item. Only the corresponding data will be refreshed.

7.7.14 "Save graphics preferences" menu item

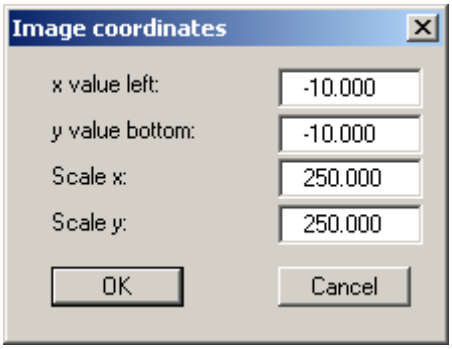
Some of the preferences you made with the menu items of the "**Graphics preferences**" menu can be saved to a file. If you select "**GGU-DRAWDOWN.alg**" as file name, and save the file on the same level as the program, the data will be automatically loaded the next time the program is started and need not be entered again.

7.8.1 "Auto-resize" menu item

This menu item provides a to-scale visualisation, in both x and y coordinates, of the system and result graphics. If you have previously altered the image coordinates using "**Page size + margins/Manual resize (editor)**" or "**Page size + margins/Manual resize (mouse)**", you can quickly achieve a complete view using this menu item. This function can also be accessed using the [**F9**] function key.

7.8.2 "Manual resize (editor)" menu item

You can alter the image coordinates by direct numerical input in a dialog box. This allows precise scale input. The coordinates refer to the ***drawing area***. This can be defined in the "**Page size + margins/Page size and margins**" menu item by means of the plot margins (see Section 7.8.5).



For section visualisation, define the minimum and the maximum spacing on the x-axis (section stationing) and the minimum and maximum drawdown for the y-axis.

7.8.3 "Manual resize (mouse)" menu item

You can use the coordinates of a section of the visualisation as the new image coordinates by marking the desired area with the mouse, pressing the left mouse button and holding the [**Ctrl**] and [**Shift**] keys. The scales of the x- and y-axes are adjusted accordingly. If the previous proportions (scale x-direction/scale y-direction) need to be retained, the "**Proportional section**" check box must be activated.

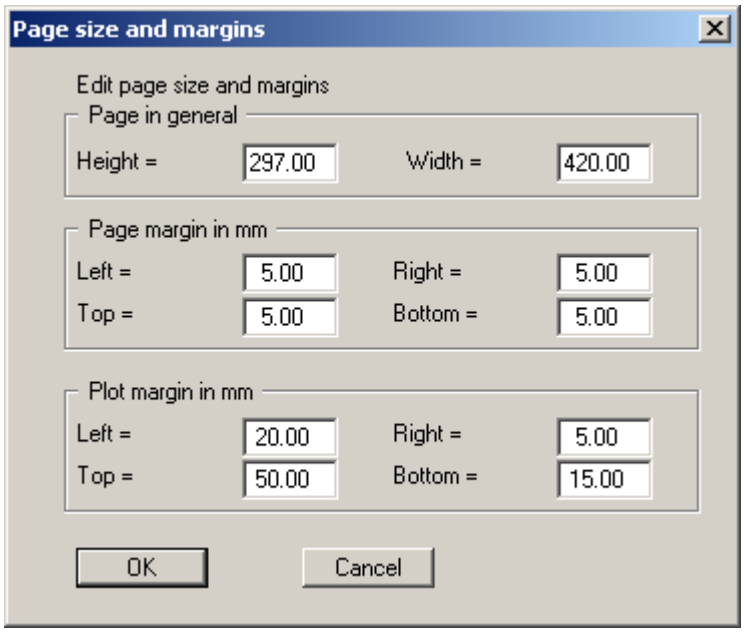
Alternatively, you can simply "**Redefine origin**" of the visualisation. The previous scale preferences are not affected by this.

7.8.4 "Zoom" menu item

You can reduce the graphical screen presentation by any factor. The initial size can be restored using the "**Page size + margins/Auto-resize**" menu item.

7.8.5 "Page size and margins" menu item

The default page set-up is A3 when the program is started. You can edit the page format in the following dialog box.



- "**Page in general**" defines the size of the output sheet. The A3 format is set as default. The program automatically draws thin cutting borders around the page, which are required when using a plotter on paper rolls. The borders can be switched off by deactivating the "**With borders**" button in the "**System/Graphics preferences**" menu item (see Section 7.4.6).
- "**Page margin**" defines the position of a frame as a distance to the margins. This frame encloses the subsequent diagram. The margins can be switched off by deactivating the "**With margins**" button in the "**System/Graphics preferences**" menu item (see Section 7.4.6).
- The "**Plot margin**" define a set distance between the page margin and the actual ***drawing area*** in which the graphical evaluation of your input is presented.

7.8.6 "Font size selection" menu item

You can edit font sizes for labelling the various drawing elements.

The font sizes of text within legends are edited in the respective legend editor. Just double-click in a legend to do this.

7.9.1 "Copyright" menu item

You will see a copyright message and information on the program version number.

The "**System**" button shows information on your computer configuration and the folders used by **GGU-DRAWDOWN**.

7.9.2 "Maxima" menu item

You will see information on the maximum number of wells and individual drawdowns allowed by the program.

7.9.3 "Help" menu item

The **GGU-DRAWDOWN** manual is opened as a PDF document. The help function can also be accessed using the [**F1**] function key.

7.9.4 "GGU on the web" menu item

Using this menu item you can access the GGU Software website: www.ggu-software.com.
Keep in touch with new program versions and the regular ***download*** offers.

If you would like to be automatically notified about program innovations, please register for the Newsletter in our Knowledge Base. Go to the following website: http://kbase.civilserve.com.

7.9.5 "GGU support" menu item

This menu item takes to the GGU-Software Support area at www.ggu-software.com.

7.9.6 "What's new?" menu item

You will see information on program improvements in comparison to older versions.

7.9.7 "Language preferences" menu item

This menu item allows you to switch the menus and the graphics from German to English and vice versa. To work in German, deactivate the two check boxes "**Dialoge + Menüs übersetzen (translate dialogues, menus)**" und "**Graphiktexte übersetzen (translate graphics)**".

Alternatively, you can work bilingually, e.g. with German dialog boxes but with graphic output in English. The program always starts with the language setting applicable when it was last ended.

8 Tips and tricks

8.1 "Info" buttons

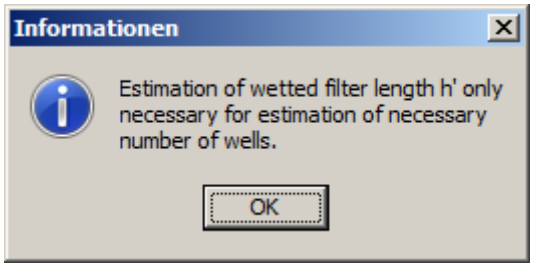
Reading of the manual can mostly be dispensed with, because

"**Info**" buttons

dealing with many geohydraulic and program-specific problems are available in the dialog boxes. You are presented with the necessary information by clicking the "**Info**" buttons.

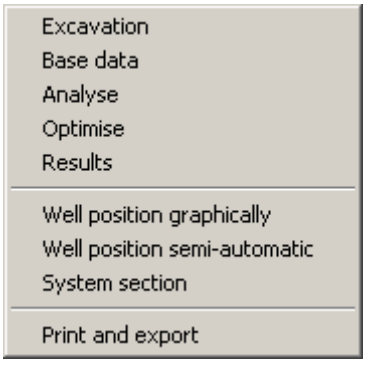
For example, the following check box can be found in the "**Edit/Base data**" dialog box:

If you click on the check box, you will see the following message box:



8.2 Keyboard and mouse

If you click the right mouse button anywhere on the screen a context menu containing the principal menu items opens.



By double-clicking the left mouse button on output sheet or **Mini-CAD** objects, the editor for the selected element immediately opens, allowing it to be edited.

You can scroll the screen with the keyboard using the cursor keys and the [**Page up**] and [**Page down**] keys. By clicking and pulling with the mouse, with [**Ctrl**] pressed, you activate the zoom function, i.e. the selected section will fill the screen. Use the mouse wheel to zoom in our out of the screen view or to pan.

In addition, the system graphics image coordinates (drawing area within the plotting margins) can be altered directly using the mouse wheel. The following mouse wheel functions are available

Change system graphics (new values can be checked in "Page size + margins/Manual resize (editor)"):

- [**Ctrl**] + mouse wheel up = enlarge system graphics (change of scale)
- [**Ctrl**] + mouse wheel down = shrink system graphics (change of scale)
- [**Shift**] + mouse wheel up = move system graphics up (change in system coordinates)
- [**Shift**] + mouse wheel down = move system graphics down (change in system coordinates)
- [**Shift**] + [**Ctrl**] + mouse wheel up = move system graphics right (change in system coordinates)
- [**Shift**] + [**Ctrl**] + mouse wheel down = move system graphics left (change in system coordinates)

Change screen coordinates:

- Mouse wheel up = move screen image up
- Mouse wheel down = move screen image down
- [**Alt**] + [**Ctrl**] + mouse wheel up = enlarge screen image (zoom in)
- [**Alt**] + [**Ctrl**] + mouse wheel down = shrink screen image (zoom out)
- [**Alt**] + [**Shift**] + mouse wheel up = move screen image right
- [**Alt**] + [**Shift**] + mouse wheel down = move screen image left

8.3 Function keys

Some of the function keys are assigned program functions. The allocations are noted after the corresponding menu items. The individual function key allocations are:

- [**Esc**] refreshes the screen contents and sets the screen back to A3 format. This is useful if, for example, you have used the zoom function to display parts of the screen and would like to quickly return to a complete overview.
- [**F1**] opens the manual file.
- [**F2**] refreshes the screen without altering the current magnification.
- [**F3**] opens the menu item "**Edit/Base data**".
- [**F4**] opens the menu item "**Edit/Visualisation**".
- [**F5**] opens the menu item "**System/Analyse**".
- [**F6**] opens the menu item "**System/Optimise**".
- [**F7**] opens the menu item "**System/Results**".
- [**F8**] opens the menu item "**Evaluation/In an array**".
- [**F9**] activates the menu item "**Page size + margins/Auto-resize**".
- [**F11**] activates the menu item "**Graphics preferences/Move objects**".

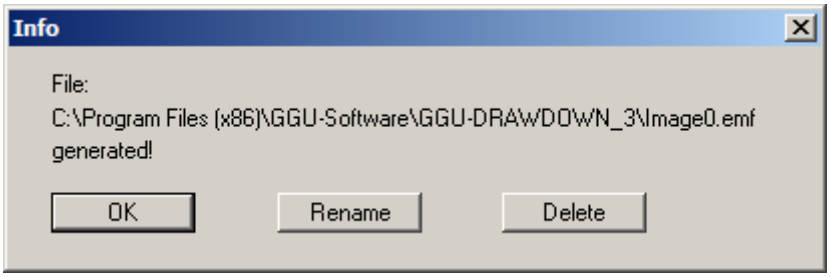
8.4 "Copy/print area" icon

A dialog box opens when the "**Copy/print area**" icon in the menu toolbar is clicked, describing the options available for this function. For example, using this icon it is possible to either copy areas of the screen graphics and paste them into the report, or send them directly to a printer.

In the dialog box, first select where the copied area should be transferred to: "**Clipboard**", "**File**" or "**Printer**". The cursor is displayed as a cross after leaving the dialog box and, keeping the left mouse button pressed, the required area may be enclosed. If the marked area does not suit your requirements, abort the subsequent boxes and restart the function by clicking the icon again.

If "**Clipboard**" was selected, move to the MS Word document (for example) after marking the area and paste the copied graphics using "*Edit/Paste*".

If "**File**" was selected, the following dialog box opens once the area has been defined:



The default location of the file is the folder from which the program is started and, if several files are created, the file is given the file name "**Image0.emf**" with sequential numbering. If the "**Rename**" button in the dialog box is clicked, a file selector box opens and the copied area can be saved under a different name in a user-defined folder. Saving can be aborted by pressing the "**Delete**" button.

If the "**Printer**" button was pressed in the first dialog box, a dialog box for defining the printer settings opens after marking the area. Following this, a dialog box for defining the image output settings opens. After confirming the settings the defined area is output to the selected printer.

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