

BRSLUG User Manual

BRSLUG for Windows, Version 3.0 Software Users Manual
For Windows 95, 98, NT 4.0 or later.

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1.0 Introduction

Welcome to BRSLUG for Windows, Version 3.0. This User Manual will tell you how to install and use the program. This manual is not a tutorial in slug test analysis. I would recommend you read the separate eight page paper, "The Bouwer-Rice Slug Test", included with the BRSLUG material, for more background on the theory and application of Bouwer-Rice slug test analysis.

1.1 Computer System Requirements

The program is written in Visual Basic 6.0, but you do not need Visual Basic to run BRSLUG. The program runs under Windows 95, 98, NT 4.0 or later. The program will not run under Windows 3.1 or earlier, and will not run under MS-DOS.

The program is not very large, so there are not any specific requirements for processor type or speed, memory or hard disk space. If you are running Windows 95, 98 or NT 4.0 or later, you should have no problem running the program. It is assumed you are familiar with the basic functions of the Windows Operating System.

2.0 Installing BRSLUG

The program comes on three disks, which includes an installation program. You must install the program using the setup program. Simply copying the files to your hard disk will not install the program.

2.1 Installation from your Hard Disk or Floppies

You can, however, install the program from your hard disk. To do this, first simply copy all the files from the three disks to an empty directory on your hard disk. One of the files you will have copied to your hard disk is SETIJP (SETUP.EXE). To run the SETUP program from your hard disk, run the SETUP.EXE file you have copied to your hard disk (in Explorer double-click on the file name) The installation program will start and install the program.

You can also install the program directly from the floppy disks. To do so, insert Disk 1/3 in your floppy drive and run A:\SETIJP.

You may find you need to run SETUP twice. The setup program checks whether your Windows System files need to be updated, and if so, will indicate this and ask to update your Windows Systems files. If this is the case the setup program will update the system files, and you will need to run the setup program again to install BRSLUG.

You may also find during installation that the installation notes that you have a more recent version of a file on your computer (i.e. MFC40.dll). In that situation the installation program will recommend you do not replace the more recent version of the file already on your computer with the older version on the installation disk. You should follow this advice.

I should note the setup files are created using a wizard which comes with Visual Basic 6.0 (a Microsoft product).

2.2 Uninstalling BRSLUG

The setup program also installs the information needed to remove BR.SLUG (uninstall). If for some reason you wish to uninstall BRSLUG, go to the Control Panel and select Add/Remove Programs.

3.0 Using BRSLUG; A Tutorial

Important Note:

When inputting text and data into BRSLUG, you should not use the quote (") symbol. Use of the quote symbol will create problems when the program attempts to read a data file.

As we cover the features of BRSLUG, we will use an example problem to help illustrate the program. I would recommend

you start BRSLUG at this time. Included as part of the program installation is an example file, "User Manual Examp.br2". The default data file extension for BRSLUG, version 3, is br2.

4.0 The File Menu

4.1 Open: Opening a Data File

After you have started BRSLUG, click "File", then "Open" on the drop down menu to bring up the "Open" dialog form. By default the "Open" dialogue box lists files with an extension of (*.br2). One of the files listed should be "User Manual Examp.br2". Select this file to open, and click OK.

If the file is not shown, you may not be in the directory where BR.SLUG is installed. In that case, first change to the directory where the BRSLUG is installed (by default, BRSLUGV3).

When you open a new data file, all data currently active in the program is over-written, so make sure you have saved any existing data you wish to keep to a file, before you open a new data file.

When you have opened a data file, or saved data to a file, the currently active file name is shown at the top of the BRSLUG program. The file pathname for the file is shown (i.e. C:\BRSLUGV3\User Manual Examp.br2).

4.2 Opening BRSLUG data files from Previous Versions

Version 3 of BRSLUG can read the slug test data files from previous versions of BRSLUG. If you wish to open the data file from a previous version of BRSLUG, simply use "File", "Open" to open the file. The software will first check whether the data file is from version 3, and if not, check if the file is from an earlier version of BRSLUG. If the data file is from an earlier version of BRSLUG, BRSLUG will read the data from the file.

If you open the data file from a previous version of BRSLUG, I would recommend you immediately use "File", "Save As" to save the data to a version 3 data file with a new name and extension. In this way the old version of the data file will be preserved, in case there is some difficulty with reading the data file from a previous version.

Previous versions of BRSLUG can not read data files created with version 3.

4.3 New: Starting a New Project

Selecting "File", "New" tells the program you want to start a "New" slug test analysis. When "New" is implemented, any existing program data is cleared. You should save any existing data you want to keep to a file before selecting "New".

The only information that is not cleared by selecting "New" is the Consultant information (covered later), on the assumption that most or all of this information will usually remain unchanged from one slug test analysis to another.

4.4 Save As

If you select "File", "Save" and the data have not previously been saved to a data file, the "Save As" file menu is activated. You can also active "Save As" directly by clicking "Save As", under "File". You might do this if you want to save the data to a different file.

When you select or specify a "File Name" under "Save As", and click "OK", the current data is saved to the file, and the active file path as the top of the BRSLUG program will reflect the new data file.

4.5 Save

What happens when you click "File", "Save" depends on whether there is a current data file. If there is a current data file

(from Using Open or Save As) the file name will be shown at the top of the program (i.e. C:\BRSLUGV3\User Manual Examp.br2).

If there is a current data file (the data file shown at the top of BRSLUG), the current data file will be automatically updated with the data in BRSLUG when you click "File", "Save".

If there is not a current data file, selecting "File", "Save" will bring up the "Save As" menu so you can provide a File Name to save the data to.

4.6 Data File Format

The slug test data files created by BRSLUG are ASCII format, meaning they can be opened or viewed by Word Processing Software. However, I would not recommend you do this. The data is stored in a particular format, and saving the data from a Word processor may disrupt the structure.

If, for some reason, you want to work with the data file directly I would strongly suggest you work with a copy of the file, and not the original file. I would also suggest you use an editor like Notepad, rather than MS Word, etc.

If you do have problems with a data file apparently being corrupted, please contact me and I may be able to recover the data file.

5.0 The TAB STRIP

If you have not already done so, please start BRSLUG and use "File", "Open" to open the example slug test data file: 'User Manual Examp.br2'.

You use the TAB STRIP to easily move about in BRSLUG. The Tab headings are:

Site ID

Well/Test ID

Well Geometry

Recovery Data

Compute K

When a "New" project is started or a data file opened the first Tab, "Site ID", is always initially selected by default.

6.0 Site ID

If it is not already selected, select (click with the left mouse button) the "Site ID" Tab. The text boxes shown are used to enter information about the site, the client, and you, the consultant. Any information you enter here will be stored in the slug test data file.

Some of the information (LUST No., UST No., and Certified Groundwater Professional) is specific to the Leaking Underground Storage Tank program for Iowa and may not be familiar to you. You can, of course, leave any text boxes blank.

7.0 Well/Test ID

Next we will look at "Well/Test ID". Click the "Well/Test ID" Tab. The information here is not essential for the slug test analysis, but is often useful as part of the printed results. All the information you input is stored in the slug test data file, and shown on the Summary of Results printout. The Monitoring Well Label and Slug Test Date are also shown on the printout of the slug test recovery plot.

8.0 Well Geometry

The first Tab that contains information required for slug test analysis is “Well Geometry”. Click the “Well Geometry” Tab. The information describing the geometry of the slug test (the well and hydrogeology) is input here.

This section also includes drawings illustrating the “Well Geometry” parameters. Click the buttons in the “Illustration” frame to change the picture from “Water Table in the Screen/Filter Pack” to “Water Table above the Screen/Filter Pack”.

8.1 Water Table above the Screen/Filter Pack

We will first discuss the situation for “Water Table above the Screen/Filter Pack”. This is also shown as Figure 1 in this manual. There are three (3) vertical measurements which describe the Well Geometry; H, Lw and Le.

H: H is the vertical distance from an impervious layer beneath the well to the water table. The water table location is the water table elevation in the well just prior to the slug test; that is just before the water table in the well is raised or lowered to start the slug test.

The concept of an impervious layer is relative. A layer with a hydraulic conductivity that is significantly lower than the area where the well is screened could be considered an impervious layer. For example, a shale underlying a sandy aquifer.

Often, it is unknown whether an impervious layer exists or the depth to such a layer. A reasonable value to use for H in that situation is $H = Lw + Le$. For the case of an unknown depth to an impervious layer, using $H = Lw + Le$ is recommended for analysis of slug tests performed as part of Iowa RBCA.

Slug tests only stress a relatively small area around a well and there is a distance below the well at which the presence of an impervious layer will have no measurable impact on the slug test. Assuming the impervious layer is a distance Le below the bottom of the well will result in an impervious layer depth which has no significant impact on the hydraulic conductivity estimate (i.e. changing the H value by 10% might change the hydraulic conductivity estimate by 1 %).

Lw: Lw is the vertical distance from the bottom of the well borehole to the static water table (water table elevation just prior to the slug test).

Le: Le is the vertical distance over which water enters the borehole from the aquifer. For the situation where the water table is above the top of the filter pack, this would be the height of the filter pack, as shown in Figure 1.

de: de is the diameter of the well casing.

dw: dw is the diameter of the well borehole.

The Bouwer-Rice analysis is based on the radius of the casing and borehole. Of course, BRSLUG calculates the radius values by dividing the diameters by 2.

drained filter pack porosity: The drained filter pack porosity is an estimate of how much water might have drained out of the filter pack during the slug test recovery. For the situation where the water level in the well remains above the filter pack during the slug test, the filter pack remains saturated and does not drain. For this case the drained filter pack porosity is 0%.

8.2 Water Table in the Screen/Filter Pack

The Bouwer-Rice analysis method was originally derived for the situation where the water level is above the filter pack. None the less, in many cases slug tests are performed with water surface levels in the filter pack. The well geometry parameter definitions are the same, however some special cases arise, as illustrated in

Figure 2.

L_e and L_w : When the water level is in the filter pack, then L_e and L_w have the same value, the vertical distance from the pre-slug water level to the bottom of the well.

H : H is still the vertical distance from the pre-slug water table to the impervious layer. Again, if H is unknown, using $H = L_e + L_w$ is a reasonable approach.

d_w and d_e : d_w and d_e have the same definitions as before. d_w is the diameter of the borehole and d_e is the diameter of the well casing.

drained filter pack porosity: For the case where the water level is in the filter pack, when the water level is lowered (bail test or rising head test) water will drain out of the filter pack. During the later stages of recovery this drained area will be refilled. The refilling of this drained area affects the rate of recovery. To adjust for this, you can enter a drained filter pack porosity (see the discussion in "The Bouwer-Rice Slug Test"). This is an estimate of what fraction of the total filter pack porosity drained during the early stages of the slug test recovery.

A precise value to use for drained filter pack porosity cannot be given, but there are some measurements to suggest values between 10% to 20%. For slug test analysis for Iowa RBCA LUST sites, a drained porosity value of 15% is required, unless justification is provided for another value.

8.3 Example Problem Values

For our example problem, the values we will use are shown on

Figure 3 and in

Table 1. In particular the values are:

H: 15 ft
Lw: 7.5 ft
Le: 7.5 ft
dw: 6.25 in
de: 2 in
Drained Filter Pack Porosity: 15 %

Go ahead and type these values into the "Well Geometry" section of BRSLUG. You will note you need to specify the units. You specify the units for the parameters using the drop down list boxes in the "Vertical Measurements" and "Radial Measurements" boxes.

It is assumed that H, Lw and Le have the same units, and dw and de have the same units. The choices for units of length are:

in (inch)
ft (feet)
cm (centimeter)
m (meter)

The units selections in "Well Geometry" do not perform unit conversions. You are simply telling the program what units the data are in. For our example problem, set the "Vertical Measurements" units to "ft" and the "Radial Measurements" units to "in".

After you have entered the "Well Geometry" data, click "File", "Save" to update the slug test data file.

You will also notice a "Check Data" button on the "Well Geometry" section. If you click this button the program will check whether you have entered all the required data, and whether they are consistent (i.e. $de \leq dw$). You do not have to click the "Check Data" button. The program will automatically check the data before computing the hydraulic conductivity.

9.0 Recovery Data

We will now turn to the section where the slug test recovery data is entered. Click the "Recovery Data" tab on the tab strip.

9.1 Units

The drop-down list boxes in the "Units" frame are used to tell BRSLUG the "Time" units and "Water Level" units for the recovery data. Again, this does not do a unit conversion. You are simply telling BRSLUG what the units are for the recovery data.

For "Time" units the options are:

sec (second)
min (minute)
hr (hour)
day (day)

For "Water Level" units, the options are units of length:

in (inch)
ft (feet)

cm (centimeter)

m (meter)

9.2 Water Level Measurement

The drop down list box in the “Water Level Measurement” frame tells BRSLUG the vertical measurement coordinate system for the slug test recovery data.

There are three selections for recovery data “Water Level Measurement” method:

D: Depth to Groundwater

H: Groundwater Head

Y: Change in Head

9.2.1 D: Depth to Groundwater

If “D: Depth to Groundwater” is selected as the “Water Level Measurement” method, you are telling BRSLUG that the coordinate system for recovery water level measurements is positive in the vertically downward direction, as illustrated in

Figure 4. In

Figure 4, D2 is larger (more positive) than D1. That is, an increase in D means the water level is farther down in the well (or the water level elevation is lower). In this situation the top of the casing is often chosen as the origin, but this is not necessary.

9.2.2 H: Groundwater Head

If **"H: Groundwater Head"** is selected as the **"Water Level Measurement method"**, you are telling the program that the coordinate system for recovery water level measurements is positive in the vertically upward direction, as illustrated in

Figure 5. The origin might be based on mean sea level, but this is not required. Any origin can be selected.

The origin could, for example, be the top of the casing. In that situation H1 and H2 would both be negative, but H1 would still be larger (more positive) than H2.

9.2.3 Y: Change in Head

The Bouwer-Rice Slug test analysis is based on the change in head from the initial water level. For the case of “Depth to Groundwater” or “Groundwater Head” water level measurements the program will compute Y. If the recovery data is already in terms of the change in head (Y), you should select “Y: Change in Head” as the “Water Level Measurement” method. Some pressure transducers and data loggers can be set to directly measure change in head during a slug test.

Change in head, Y, is determined irrespective of whether the water level was raised or lowered in the well, as illustrated in

Figure 6. That is, change in head from the initial water level is considered positive, regardless of whether the water level was raised or lowered during the slug test. For example, for a rising head test, Y is measured positive downward from the initial water table, while for a falling head test Y is measured positive upward from the initial water table.

The only situation where negative values of Y are correct is when the water level in the well recovers past the initial (static) water table. Although this is not common, it can happen near the end of a slug test.

9.3 Slug Test Type

You need to specify the slug test type. There are two options:

Rising Head
Falling Head

Your selection, along with the "Water Level Measurement" method, is used by BRSLUG to calculate Y, the change in head.

The selection is based on what the water level in the well is doing during slug test recovery, rising or falling.

9.3.1 Rising Head

If the water level in the well is lowered (decrease in elevation, increase in depth to groundwater) to start the slug test, then during the slug test the water level will rise (increase in elevation, decrease in depth to groundwater). This is a "Rising Head" test. For example, if you removed water from the well to start the slug test, the test is a "Rising Head" test.

9.3.2 Falling Head

If the water level in the well is raised (increase in elevation, decrease in depth to groundwater) to start the slug test, then during the slug test the water level will fall (decrease in elevation, increase in depth to groundwater). This is a "Falling Head" test. For example, if you added water to the well (or dropped a solid slug into the well) to start the slug test, the test is a "Falling Head" test.

9.4 Pre-Slug Test Condition (Prior to Slug or Bail)

If the "Water Level Measurement?" method is "D: Depth to Groundwater" or "H: Groundwater Head", you need to enter the "Pre-Slug Test Condition". This is the water level in the well just prior to the slug test; just prior to when you lower or raise the water level in the well to start the slug test. This is sometimes called the initial or static water level. This measurement is required for BRSLUG to calculate Y, the change in head.

If you are inputting "Y: Change in Head", the change in head directly as the recovery data, then the "Pre-Slug Test Condition" is not needed.

9.5 Volume of Slug

You can enter a value for the "Volume of Slug". This is the volume of water displaced for the slug test. For example, the volume of water bailed from the well or the volume of water displaced by adding or removing a solid slug from the well.

It is not necessary for you to put in a value for the "Volume of Slug". The "Volume of Slug" is not used as part of the Bouwer-Rice analysis in BRSLUG. However, the "Volume of Slug" is requested as part of the information provided for slug test analysis for Iowa RBCA Tier 1 or Tier 2 analysis.

9.6 Recovery Data

The grid under "Recovery Data" is used to input the slug test recovery data. The headings for "Time" and "Recovery"

change automatically to reflect your selections for units and water level measurement method.

A data "point" consists of a pair of values; the time since the start of the slug test when a water level measurement was taken, and the water level measurement at that time.

You can simply type in the recovery data. To move from one cell to another you can use the "Enter" key, the arrow keys, or click the cell you want to move to with the left mouse button.

If you are adding data and get to the last row in the grid, pressing "Enter" will automatically add a new row.

The data can be entered in any order (i.e. does not have to be sorted by time), and blank rows can be left between data.

9.7 Recovery Data Editing

9.7.1 Copy, Cut and Paste

The buttons to the left of the Recovery Data grid are used for editing the recovery data. You first need to select the area of data to edit (click the left mouse button and hold it down, drag over the area, release the left mouse button), (press the shift key and hold it down, use the arrows keys or page up or page down keys to select an area, release the shift key). You can then use "Copy" or "Cut". To "Paste" you do not need to select the entire area you want to "Paste" to, just click the cell at the upper left corner of the area you want to "Paste" to. "Paste" will write over any existing data in the area you "Paste" to.

You can also use Copy, Cut and Paste to move data between the BRSLUG Recovery Data grid and other Windows programs. For example, if you had the recovery data in a spreadsheet, you could copy the data in the spreadsheet and paste it to the Recovery Data grid.

9.7.2 Insert Rows, Delete Rows

You can use the Insert Rows and Delete Rows buttons to insert or delete additional rows. To delete rows, select the rows you want the delete and click the delete rows button. To insert rows, click the current row in the grid where you want to insert rows, either before or after the current row, then click the Insert Rows button.

9.7.3 Sort

The "Sort" button sorts the recovery data by time, in order of increasing time. It is not necessary for you to sort the data. However, it is convenient to have the data sorted. You can also use the sort as a convenient tool to remove blank rows. When you sort the data, any blank rows are automatically removed from the data.

9.8 Example Problem Data

For our example problem, at this time specify the following in me Recovery Data grid.

Time units: sec (seconds)

Water Level units: ft (feet)

Water Level Measurement: D: Depth to Groundwater

Slug Test Type: Rising Head

Pre-Slug Test Condition: 6.56 ft (also shown in

Table 1)

All the recovery data has already been entered, except for the last two data points shown in

Table 1. Add the following 2 data points to the recovery data,

Time (sec)	Depth to GW (ft)
454	6.74
494	6.73

After adding the data points, click “File”, “Save” to update the data file.

9.9 Computed Y values

When you enter “D: Depth to Groundwater” or “H: Groundwater Head” recovery data, BRSLUG computes the Y values (change in head) needed for Bouwer-Rice slug test analysis.

To see the results of the Y computation, click the “Check Data/Show Y's” button. When you do this the program first checks the recovery data for missing or invalid values, then computes the Y values and displays them in the grid beneath the button. It is not required that you click this button, BRSLUG will compute the Y values automatically when needed. However, I would recommend you do so to check your data.

For the Y values to be computed properly, you need to have specified the correct “Water Level” measurement method, the correct “Slug Test Type”, and the correct “Pre-Slug Test Condition” and to have entered the data properly.

The equations used to compute Y are as follows:

Water Level Measurement: D: Depth to Groundwater

Rising Head Test, $Y(t) = D(t) - D_i$

Falling Head Test, $Y(t) = D_i - D(t)$

Water Level Measurement: H: Groundwater

Head Rising Head Test, $Y(t) = H_i - H(t)$

Falling Head Test, $Y(t) = H(t) - H_i$

Where $Y(t)$ is the Y value for time (t), D_i is the Pre-Slug Depth to Groundwater, $D(t)$ is the Depth to Groundwater at time (t), H_i is the Pre-Slug Groundwater Head and $H(t)$ is the Groundwater Head at time (t).

To see the effect of an incorrect selection on computed Y's, set the “Slug Test Type” to “Falling Head” and click “Check Data/Show Y's”. You will get a possible error warning about Y values ≤ 0 . Check “OK” on the message box, and you can see that all the computed Y values are negative. Y values ≤ 0 cannot be used for hydraulic conductivity estimation. This is because the algorithm for the slope of the recovery uses the natural logarithms of Y.

At this time be sure to set “Slug Test Type” back to “Rising Head” and click “Check Data/Show Y's”. You can see that the Y values are all positive.

There are situations where some of the computed Y values may be negative with legitimate recovery data. If the water level recovers to and past the “Pre-Slug Test” water level, the Y values for this situation are ≤ 0 . You do not need to delete such data points, but they can not be used for parameter estimation. If all your computed Y values are negative, this is an indication of an error in the recovery data or the recovery data selections (i.e. Water Level Measurement, Slug Test Type).

10.0 Compute K

We are now at the point where we are ready to have BRSLUG compute the hydraulic conductivity.

Click 4 “Compute K” on the tab strip. When you click the “Compute K” tab BRSLUG first checks the “Well Geometry” and “Recovery Data” you have entered. If BRSLUG finds an error in the data it will pop up a message box with a description of the problem and automatically return you to “4 Well Geometry” or “Recovery Data”.

To have BRSLUG compute the hydraulic conductivity and plot the recovery data and best-fit line for the slope, click the “Compute K/Plot” button.

The computed K is shown just to the right of the “Compute K/Plot” button. For our example, the hydraulic conductivity estimate is 0.313 m/day. The units buttons shown to the right of the hydraulic conductivity do perform units conversions. As you change the units selected, the hydraulic conductivity estimate is shown in the selected units. For example, if you select cm and sec, the hydraulic conductivity is shown in units of cm and sec; i.e. 3.63×10^{-4} cm/sec. When you print a graph or send the results to the printer, the units used for K on the printout will be the units selected at the time you generate the printouts.

The on-screen plot shows the actual recovery data as circles. The units for the graph are always the units the recovery data is in.

10.1 Details

To see more details about the parameter estimation, click the “Details” button under the K value. This will pop up a “Details” window. The grid at the top of the “Details” window shows the recovery data and the Y value for the best fit line (Fit Y). The Fit Y is the computed Y value at the time shown, from the best fit slope. If you look at the on-screen plot, the recovery data are shown as circles. For each circle, if you draw a vertical line to the best fit line (red line), the Fit Y is the Y value at that point on the line.

The text box below the grid contains a summary of the results, including the Well Geometry data and Bouwer-Rice coefficients (see the Bouwer-Rice summary paper by LaDon Jones). When you are done viewing the “Details” windows, click the “Close” button.

10.2 Criteria for Slope Estimation

According to Bouwer-Rice theory a plot of $\log_e(Y)$ versus time should be a straight line; where $\log_e(Y)$ is the natural logarithm of Y or log to the base e of Y. In practice this is the exception rather than the rule. When the plot of $\log_e(Y)$ versus time is not a straight line, the hydraulic conductivity estimate depends on the portion of data used for estimating the slope of the recovery ($\log_e(Y)$ versus time).

BRSLUG allows you to select which data points you want to use for estimating the slope. If you look at the grid to the left of the plot on the Compute K frame, you will note that the grid shows the recovery data time and Y, and a column labeled “Criteria”. The “Criteria” column is used to specify which data points to use for the slope of $\log_e(Y)$ versus time.

A “Criteria” of “Use” means the data point will be used for slope estimation. A “Criteria” of “Ignore” means the data point will not be used for slope calculations.

Currently, if you have been following along with the example, you can see that all the data points have been used for estimating the slope of the recovery. Data points that have been used for slope estimation are shown as red circles on the plot. The best-fit line (slope) is shown as a solid red line on the plot.

To change the “Criteria”, you first select the rows in the grid you want to change. To select the rows you want to change, place the mouse cursor on a row in the “Criteria” column, click and hold down the left mouse button, drag the mouse upward or downward in the column, then release the left mouse button. An alternative method for selecting rows is to, click on a row in the column, press and hold down the shift key, move upward or downward using the arrow keys or Page Up or Page Down keys, then release the shift key.

After you have selected the rows in the “Criteria” column you want to change, there are two alternatives. The first alternative changes all the selected rows to either “Use” or “Ignore”. If you press the “U” key, the criteria in all the selected rows are changed to “Use”. If you press the “I” key, the criteria in all the selected rows are changed to “Ignore”. The second alternative toggles the values. If you press the space bar, in the selected rows all “Use” are changed to “Ignore” and all “Ignore” are changed to “Use”.

10.3 Example Problem

We will demonstrate the use of “Criteria” selection for our example problem. Change the criteria for samples 1 to 13 (2 to 106 seconds) to “Ignore”, with the criteria for the remaining data points as “Use”. Now click the “Compute K/Plot” button. You can see that the slope line on the graph of the recovery has changed (the slope is found using the data points from 154 seconds to 494 seconds), and the hydraulic conductivity estimate has changed from 0.313 m/day to 0.193 m/day. Since the slope is flatter, the hydraulic conductivity estimate is lower. On the plot the data points used for slope estimation are shown as red circles and the data points not used for slope estimation (“Ignored”) are blue circles.

We will now use the early recovery data to estimate the slope, the data from 2 to 106 seconds. The easiest way to do this is to select all the rows in the “Criteria” column, then press the “Space Bar”. In any case, set the data from 2 to 106 seconds to “Use” and the data from 154 to 494 seconds to “Ignore”. Click the “Compute K/Plot” button. The hydraulic conductivity estimate is now 0.635 m/day.

11.0 Printing the Recovery Data Plot

To print a copy of the recovery data plot, from the “Compute K” section of the program click “Graph” in the “Print” frame. This will bring up the “Print the Plot” window. You can input up to three lines of text to use for the graph title. The text in the three text boxes is saved in the slug test data file.

When you are ready to print, click the “Print” button. The graph is sent to the printer. The graph printout is sent to the default printer. The graph printout is formatted for 8 ½ x 11-inch paper, with a landscape orientation. An example of printout is shown as

Figure 7. The units used for Hydraulic Conductivity will be the units selected for K at the time the printout is made. If you have a color printer the data points used for the best fit line are shown as red circles, the data points not used for slope estimation are shown as blue circles, and the best fit line is shown as a red line.

11.1 Printing and Saving the Results

Besides the graph, you can also send a detailed copy of the slug test data and results to the printer. To see this, from "Compute K", click "Summary" in the "Print" frame. From the "Print/Save the Results" window you can send the Results to the printer or save them to a file.

To send the results to the printer select the "Send to Printer" option, then click "OK". An example of the printout of the Results is shown as Table 2.

You can also save the Results to a file. Select the "Save to File" option, then click "OK". The "Save As" dialogue box is activated for you to choose a file name to save the Results to.

Important: The slug test data file, which BRSLUG uses to store the slug test data you have input, is a different file from the Results file. The data file is reached using "File" at upper left of the BRSLUG program. You should, of course, always save the slug test data and other information you have input into BRSLUG to a data file. The default extension for BRSLUG data files is *.br2 (although you can use any extension you want). The Results file is essentially a copy of the results information sent to the printer (Table 2). The Results file has a different format than the data file, and BRSLUG only creates the Results file, it does not read the Results file. You should never save the Results file to an existing BRSLUG data file. If you do, you will lose access to the slug test data in the data file. I would recommend you always use a file name extension for the Results file that is different from the extension you use for the slug test data file.

Saving the results to a Results file is not required. However, the Results file is an ASCII file and can be imported into a word processor or spreadsheet. The main reason to create a Results file is if you want to import the file into a spreadsheet or word processor and create your own format for printing the results, or create your own recovery data plot.

12.0 Conclusion

This concludes the User Manual for BRSLUG. I hope you find the program useful and easy to use.

If you have any problems with or questions about the program, please let me know. Also, if you have suggestions for program modifications or new features which you think would improve the program, I would be very interested in your hearing about your recommendations.

Figure 1. Fully Submerged Filter Pack

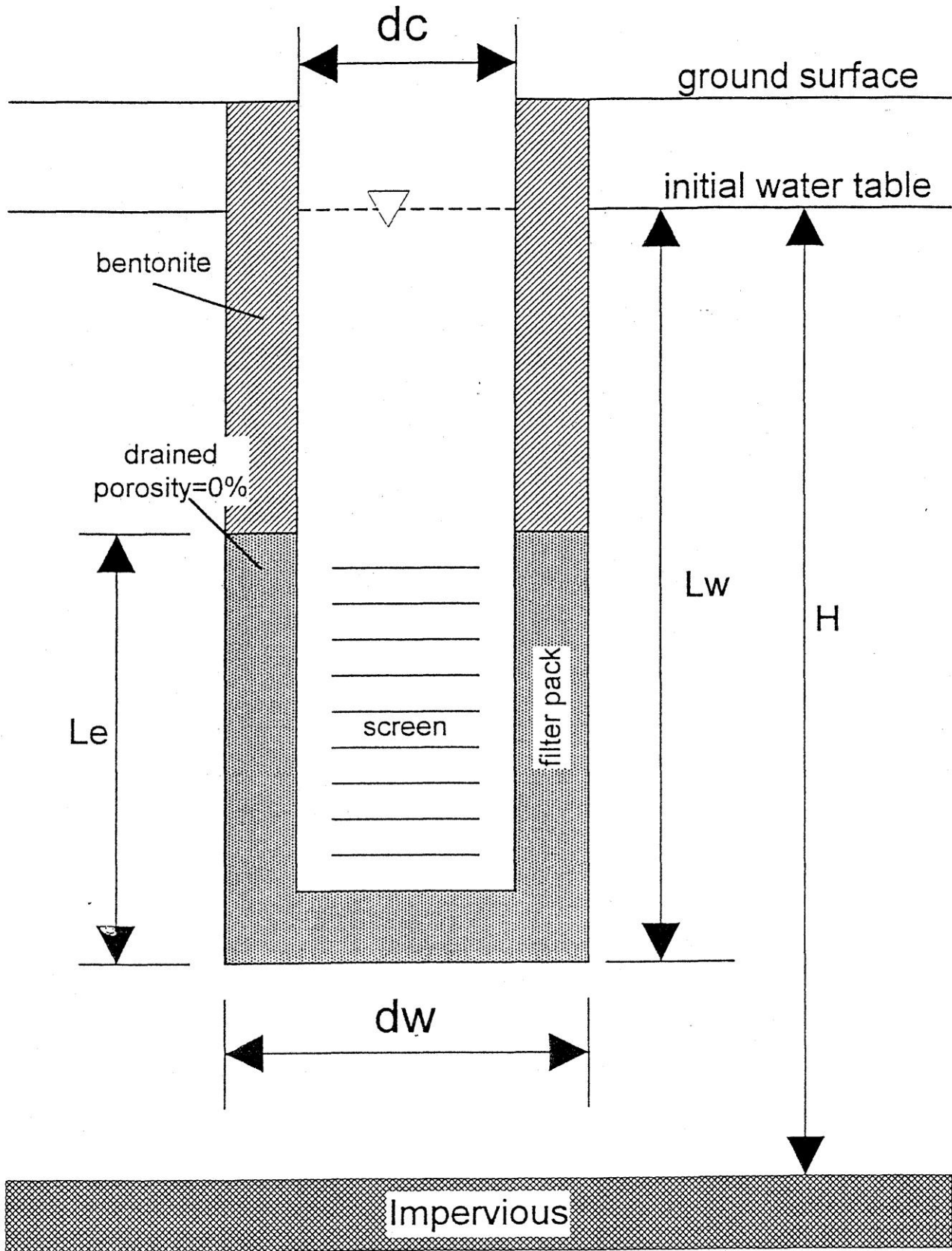


Figure 2. Partially Submerged Filter Pack

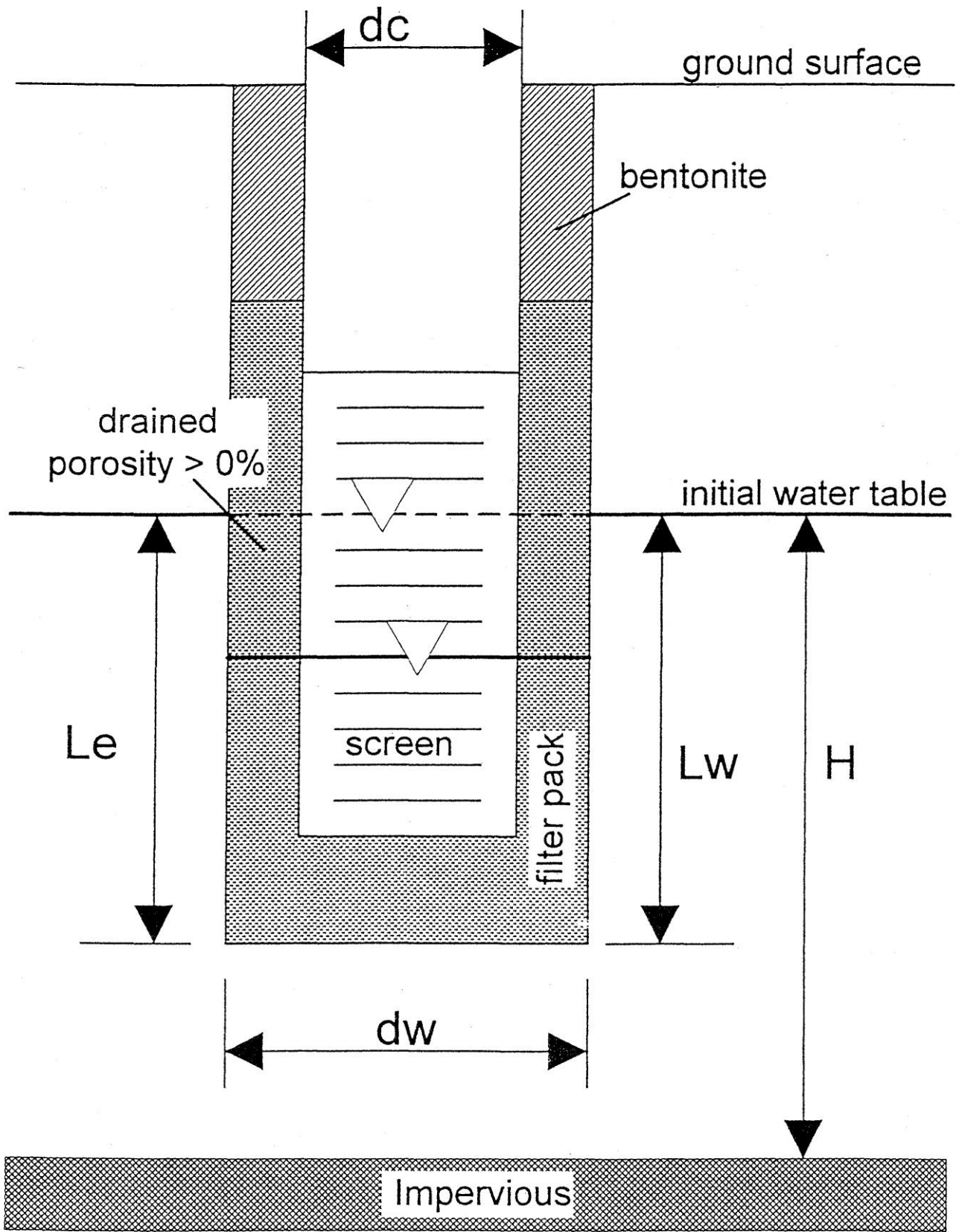


Figure 3. Example Problem Well Geometry

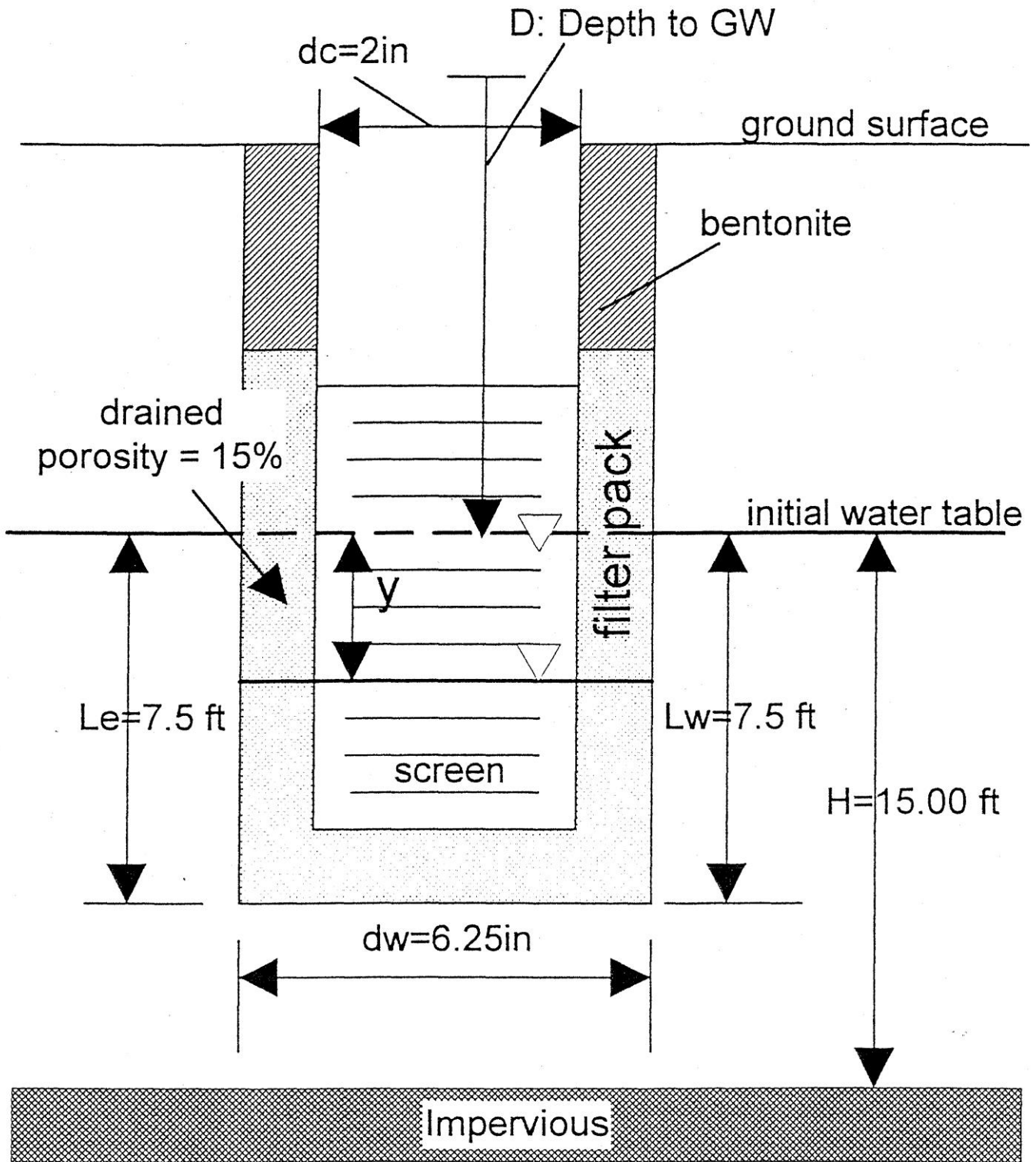


Figure 4. D: Depth to Groundwater

$$D_2 > D_1$$

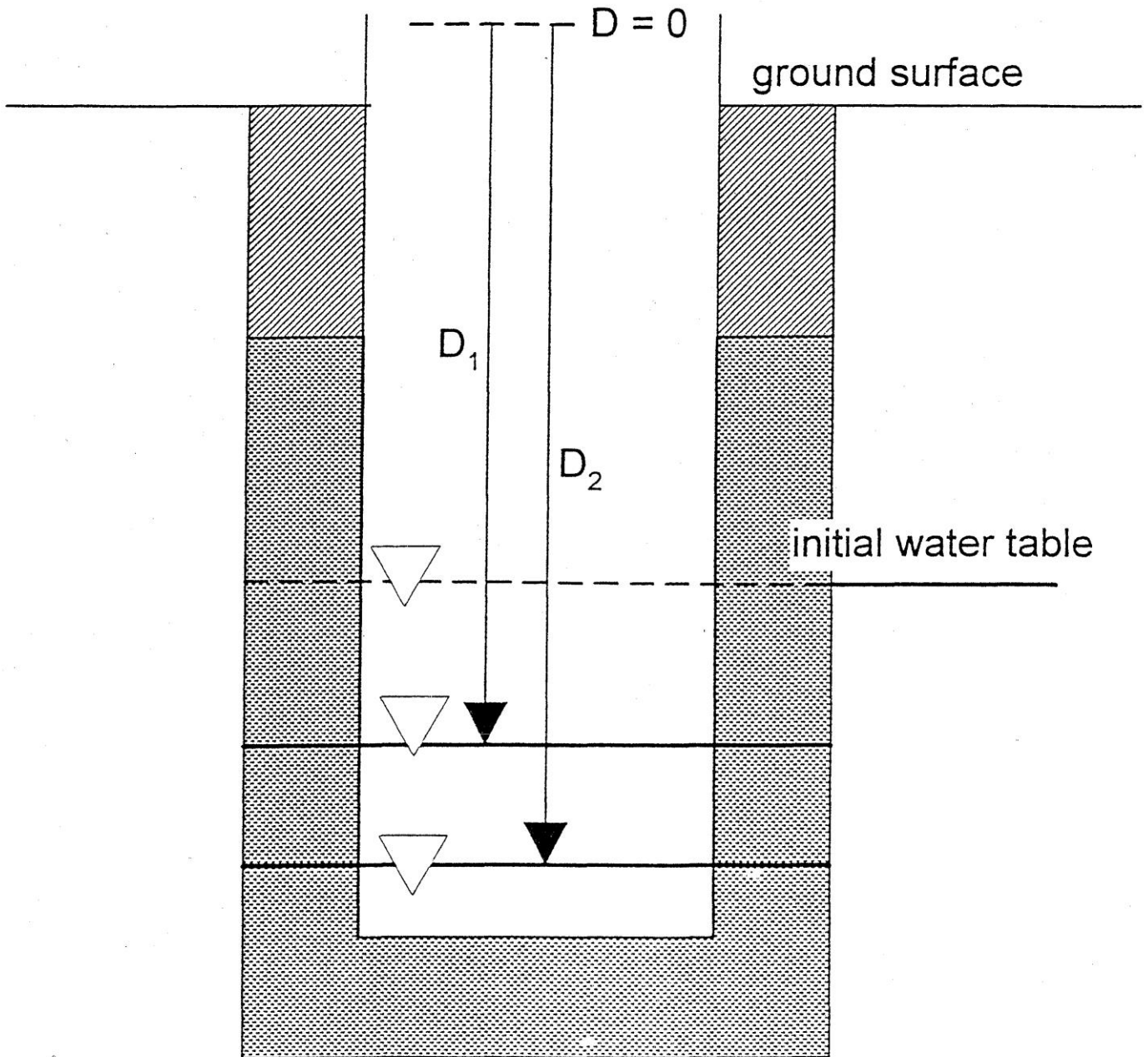


Figure 5. H: Groundwater Head

$$H_1 > H_2$$

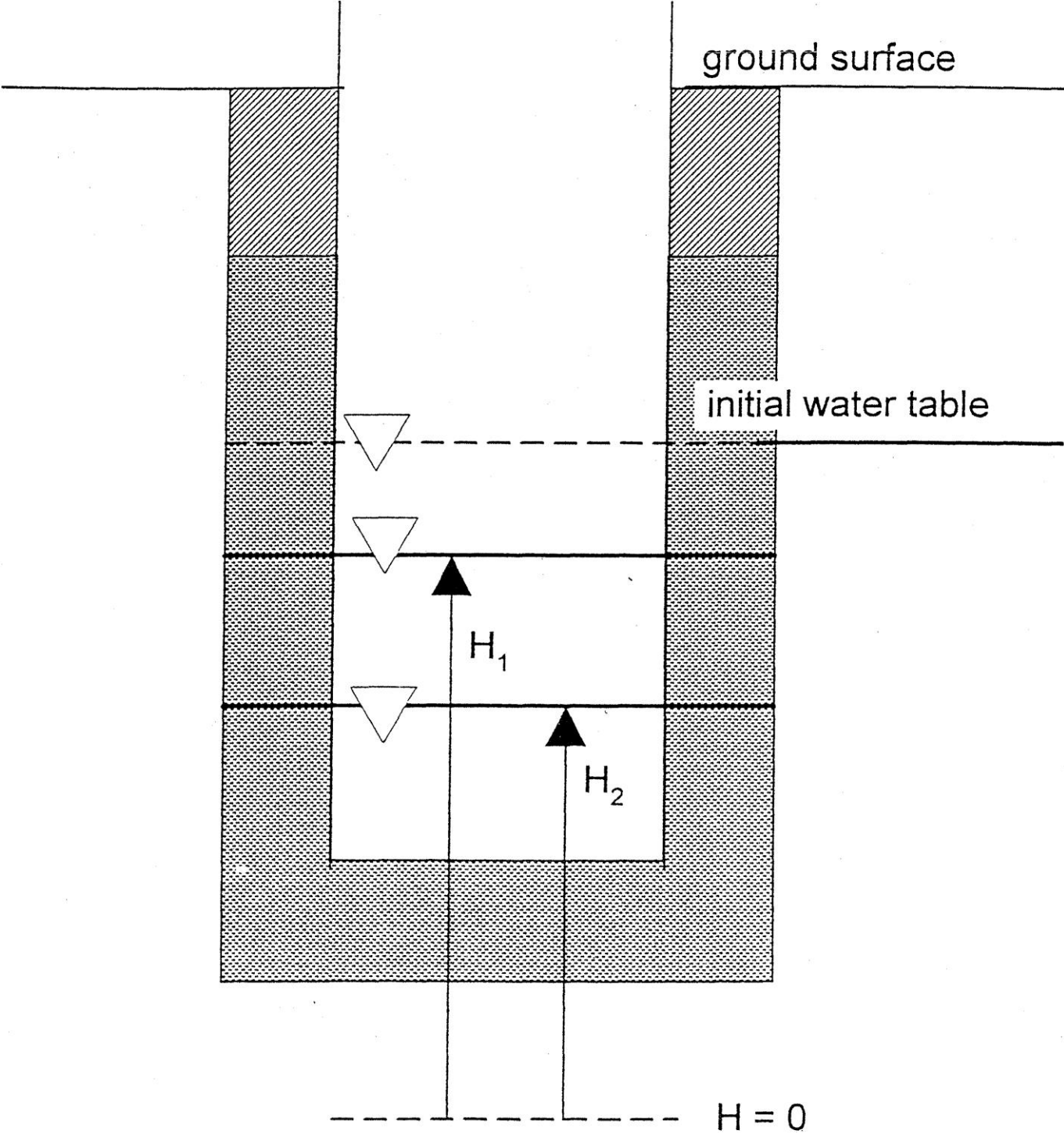


Figure 6. Y: Change in Head

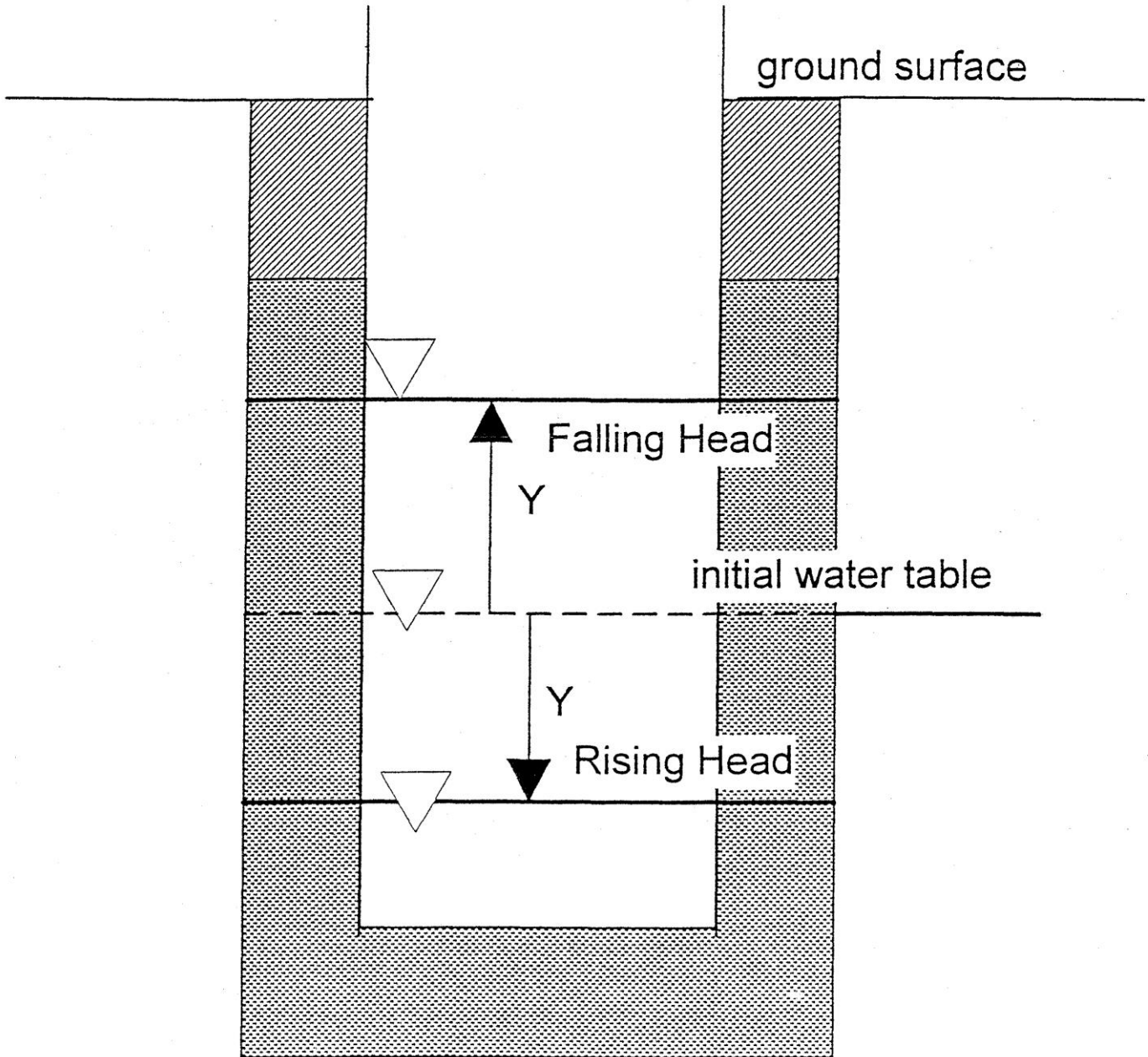
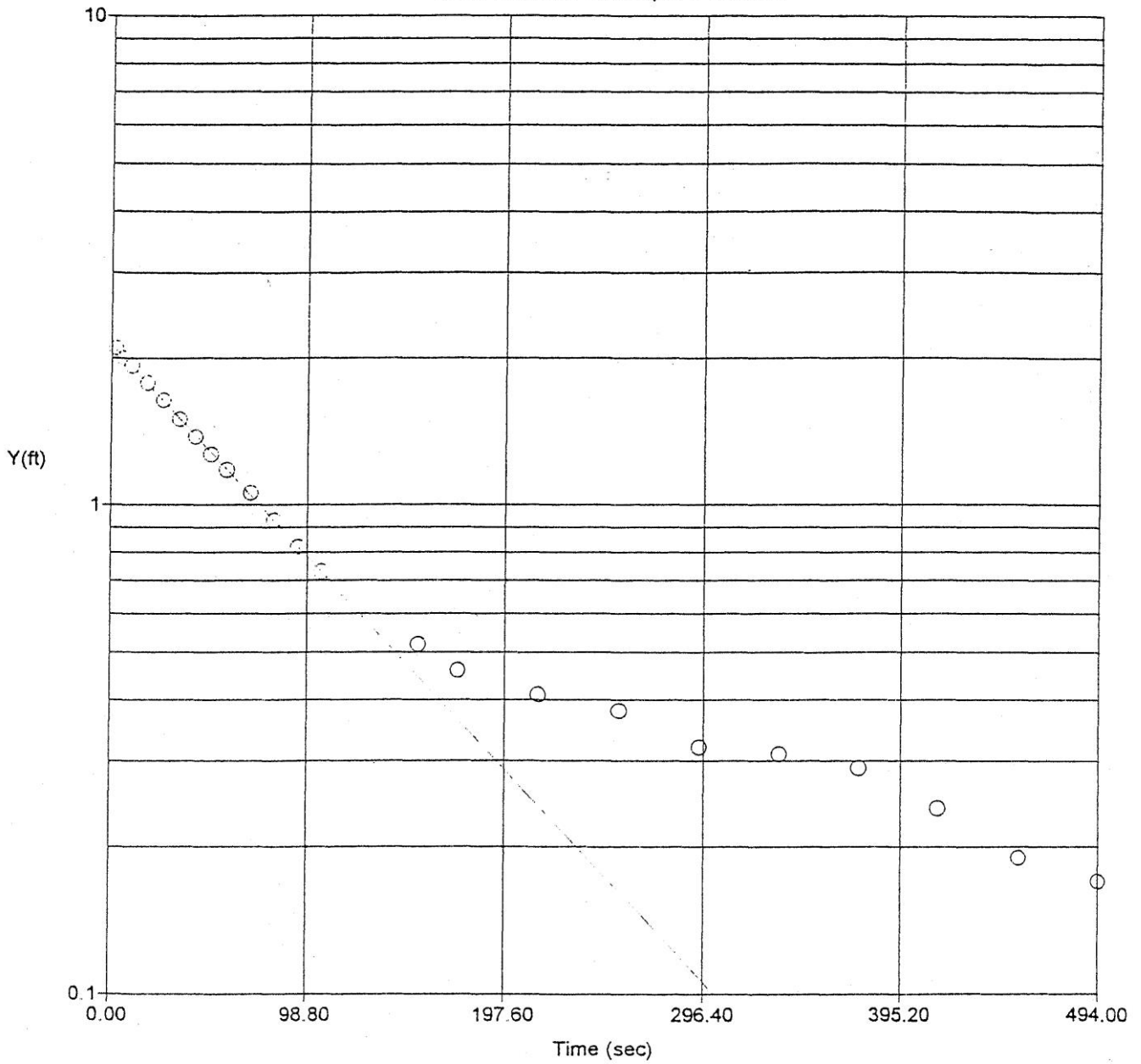


Figure 7. Example printout of the Recovery Data Plot

User Manual Example Problem



LUST No.: 8LTF56	Site Name: Truckers Paradise Night 'O Rest	
Hydraulic Conductivity: 0.635 m/day	Well: MW-3	Slug Test Date: 3/6/1999
Something Environmental, Inc.	CGWP: William Jefferson Clinton, 54321	

Table 1. Example Problem Data

User's Manual Example Problem

Water level in the Screen

H (ft)	15
Lw (ft)	7.5
Le (ft)	7.5
dw (in)	6.25
dc (in)	2
Drained filter pack porosity (%)	15
Initial (Static) depth to GW (ft)	6.56

time (sec)	Depth to GW (ft)	y (ft)
2	8.66	2.. 10
6	8.56	2.00
10	8.49	1.93
18	8.34	1.78
26	8.. 20	1.64
34	8.. 06	1.50
42	7.. 94	1.38
50	7.83	1.27
58	7.. 74	1.18
70	7..62	1.06
82	7.49	0.93
94	7.. 38	0.82
106	7..29	0.73
154	7.08	0.52
174	7.02	0.46
214	6.. 97	0..41
254	6.. 94	0.38
294	6.. 88	0.32
334	6.. 87	0.31
374	6.. 85	0.29
414	6.. 80	0..24
454	6.. 75	0.. 19
494	6.73	0.. 17

Table 2. Example Results Printout

BOUWER-RICE SLUG TEST ANALYSIS

SITE

Truckers Paradise Night 'O Rest
555 Main Street South
Lake Wobegon, Minnesota, 67856-7894
LUST No. SLTF56

CLIENT

Joe Bob Briggs
123 Peach Tree Lane
Atlanta, Georgia, 31545-3526
Job/Account: UGST-23-1999

CONSULTANT

Something Environmental, Inc.
Industrial Park Drive, Suite 13
Pleasantville, Iowa, 50394-9385
Certified Groundwater Professional: William Jefferson Clinton, 54321

SLUG TEST

Hydraulic Conductivity: 0.635 m/day
Monitoring Well: MW-3
Test Date: 3//6/1999
Field testing by: Harrison Ford
Test Analysis by: Jimmy Crack Corn

WELL GEOMETRY

H: 15.0 ft
Lw: 7.5 ft
Le: 7.5 ft
dw: 6.25 in, rw: 3.13 in
de: 2 in, re: 1.0 in
Drained Filter Pack Porosity (%): 15
Effective Radius (re): 1.52 in
Slug Volume (L): 1.2

BOUWER-RICE COEFFICIENTS

Le/rw: 28.8
A 2.39
B: 0.344
C: 1.94
Ln(Re/rw) 2.22

LEAST SQUARES BEST FIT

Ln(Y)-cm versus Time-sec
Slope: -1.01e-02
Intercept: 4.17

Slug Test Type: Rising head

Recovery Data Type: D: Depth to Groundwater

Static Water Level: 6.56 ft

Table 2. Example Results Printout (Continued)

Time (sec)	Recovery: D(ft)	Fit Criteria	Y(ft)	Fit Y(ft)
2	8.66	Use	2.1	2.09
6	8.56	Use	2	2.0
10	8.49	Use	1.93	1.92
18	8.34	Use	1.78	1.77
26	8.20	Use	1.64	1.64
34	8.06	Use	1.5	1.51
42	7.94	Use	1.38	1.39
50	7.83	Use	1.27	1.28
58	7.74	Use	1.18	1.18
70	7.62	Use	1.06	1.05
82	7.49	Use	0.93	0.928
94	7.38	Use	0.82	0.72
106	7.29	Use	0.73	0.728
154	7.08	Ignore	0.52	0.448
174	7.02	Ignore	0.46	0.366
214	6.97	Ignore	0.41	0.244
254	6.94	Ignore	0.38	0.163
294	6.88	Ignore	0.32	0.108
334	6.87	Ignore	0.31	0.0723
374	6.85	Ignore	0.29	0.0482
414	6.80	Ignore	0.24	0.0322
454	6.75	Ignore	0.19	0.0215
494	6.73	Ignore	0.17	0.0143