S.S. PAPADOPULOS & ASSOCIATES, INC.
ENVIRONMENTAL AND WATER RESOURCE CONSULTANTS

AQTESOLV
Pumping Test Exercise

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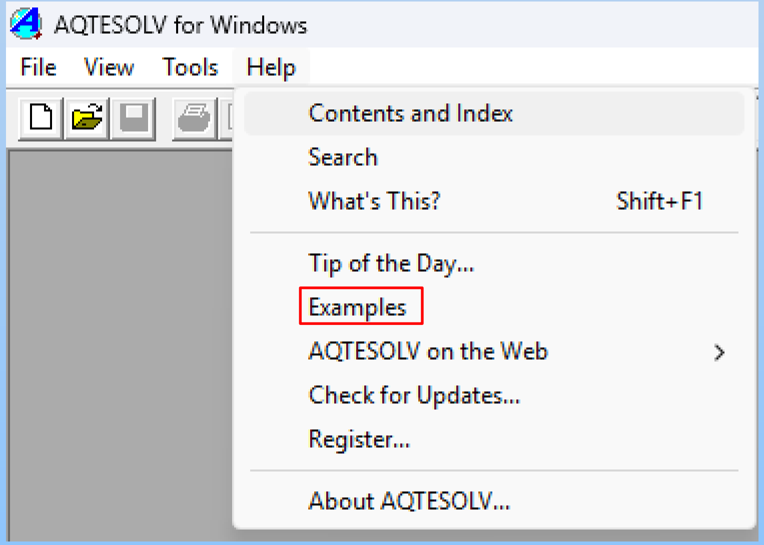
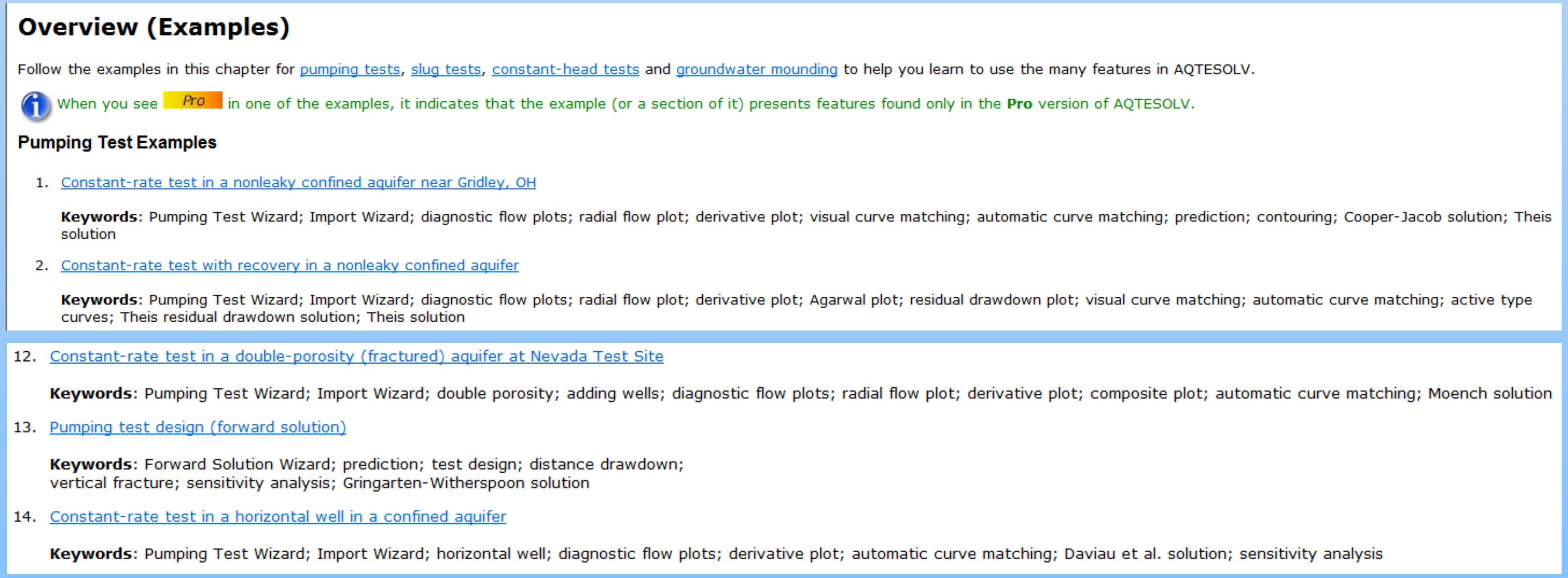
Before we start

AQTESOLV has an extensive set of excellent, step-by-step examples. If you are getting familiar with the software …





Overview (Examples)

Follow the examples in this chapter for pumping tests, slug tests, constant-head tests and groundwater mounding to help you learn to use the many features in AQTESOLV.

When you see Pro in one of the examples, it indicates that the example (or a section of it) presents features found only in the **Pro** version of AQTESOLV.

Pumping Test Examples

1. Constant-rate test in a nonleaky confined aquifer near Gridley, OH

   Keywords: Pumping Test Wizard; Import Wizard; diagnostic flow plots; radial flow plot; derivative plot; visual curve matching; automatic curve matching; prediction; contouring; Cooper-Jacob solution; Theis solution

2. Constant-rate test with recovery in a nonleaky confined aquifer

   Keywords: Pumping Test Wizard; Import Wizard; diagnostic flow plots; radial flow plot; derivative plot; Agarwal plot; residual drawdown plot; visual curve matching; automatic curve matching; active type curves; Theis residual drawdown solution; Theis solution

12. Constant-rate test in a double-porosity (fractured) aquifer at Nevada Test Site

    Keywords: Pumping Test Wizard; Import Wizard; double porosity; adding wells; diagnostic flow plots; radial flow plot; derivative plot; composite plot; automatic curve matching; Moench solution

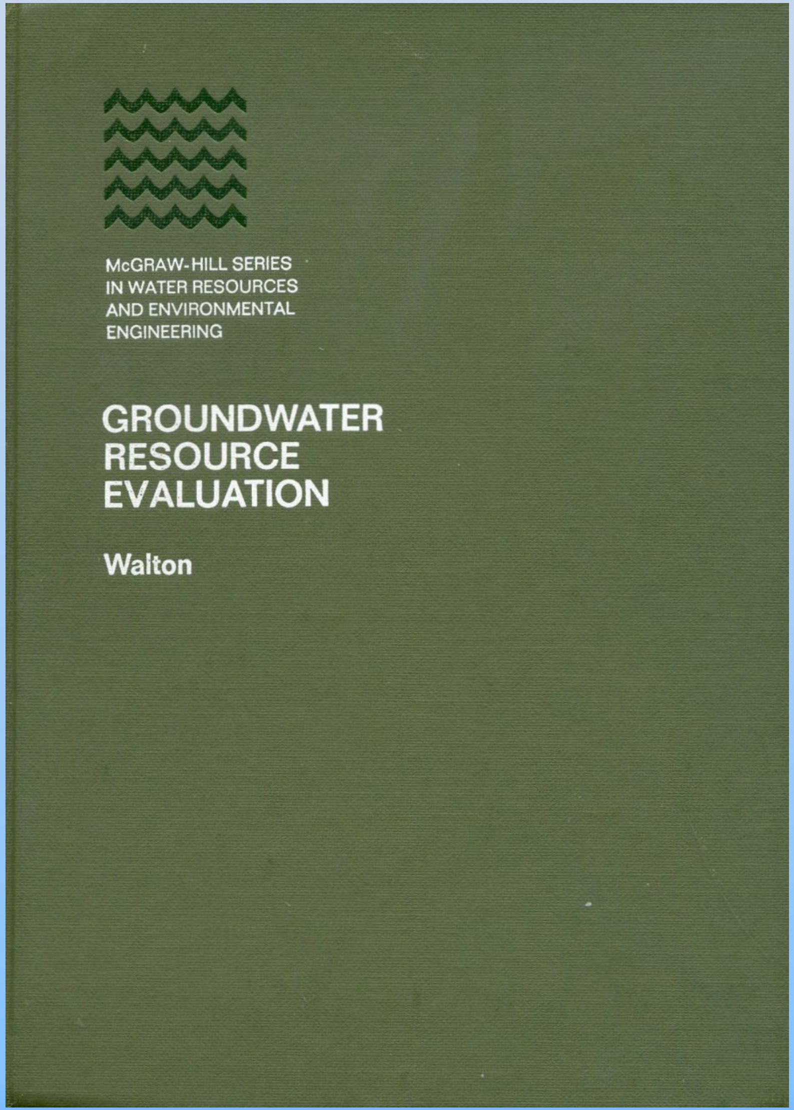
13. Pumping test design (forward solution)

    Keywords: Forward Solution Wizard; prediction; test design; distance drawdown; vertical fracture; sensitivity analysis; Gringarten-Witherspoon solution

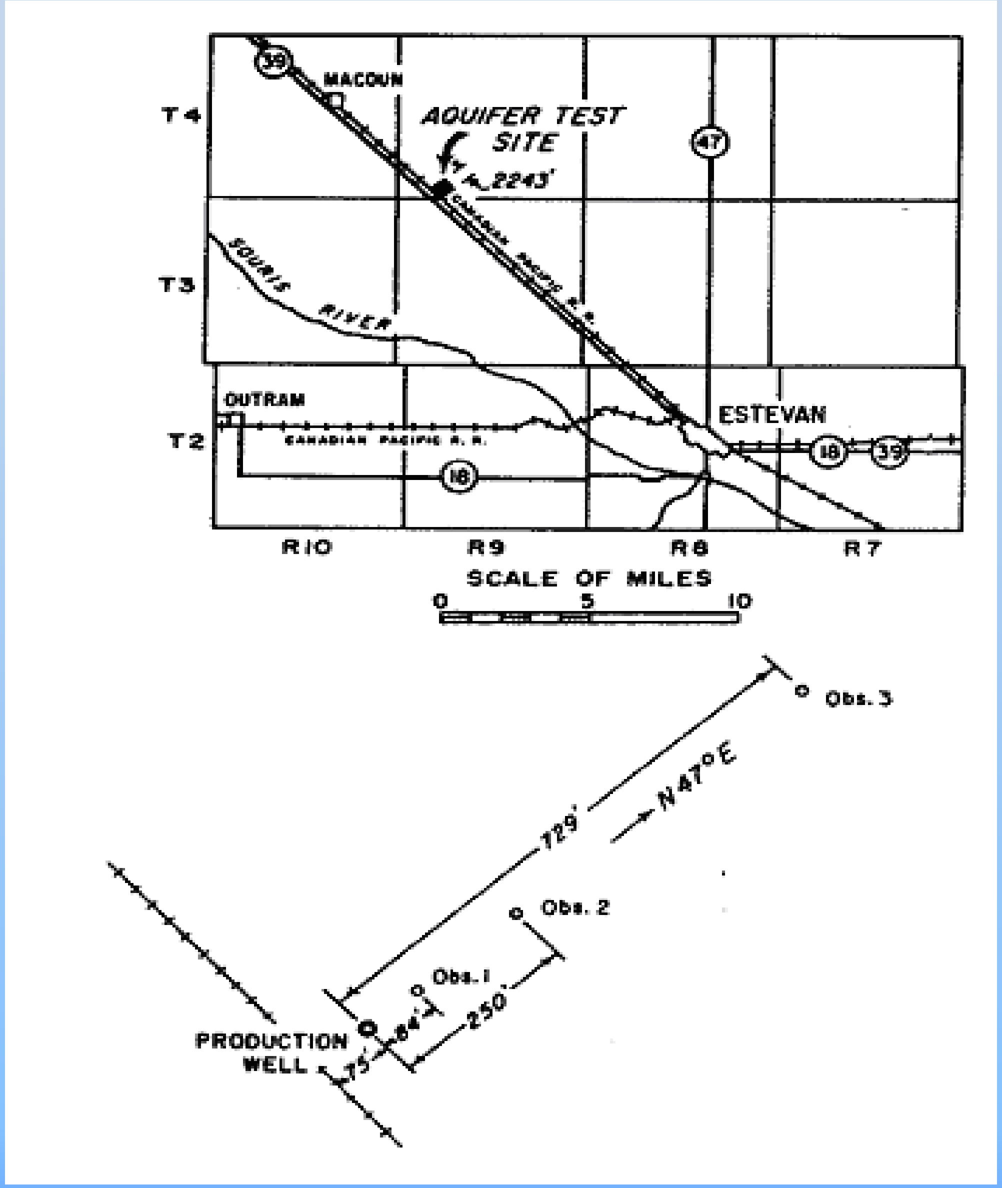
14. Constant-rate test in a horizontal well in a confined aquifer

    Keywords: Pumping Test Wizard; Import Wizard; horizontal well; diagnostic flow plots; derivative plot; automatic curve matching; Daviau et al. solution; sensitivity analysis

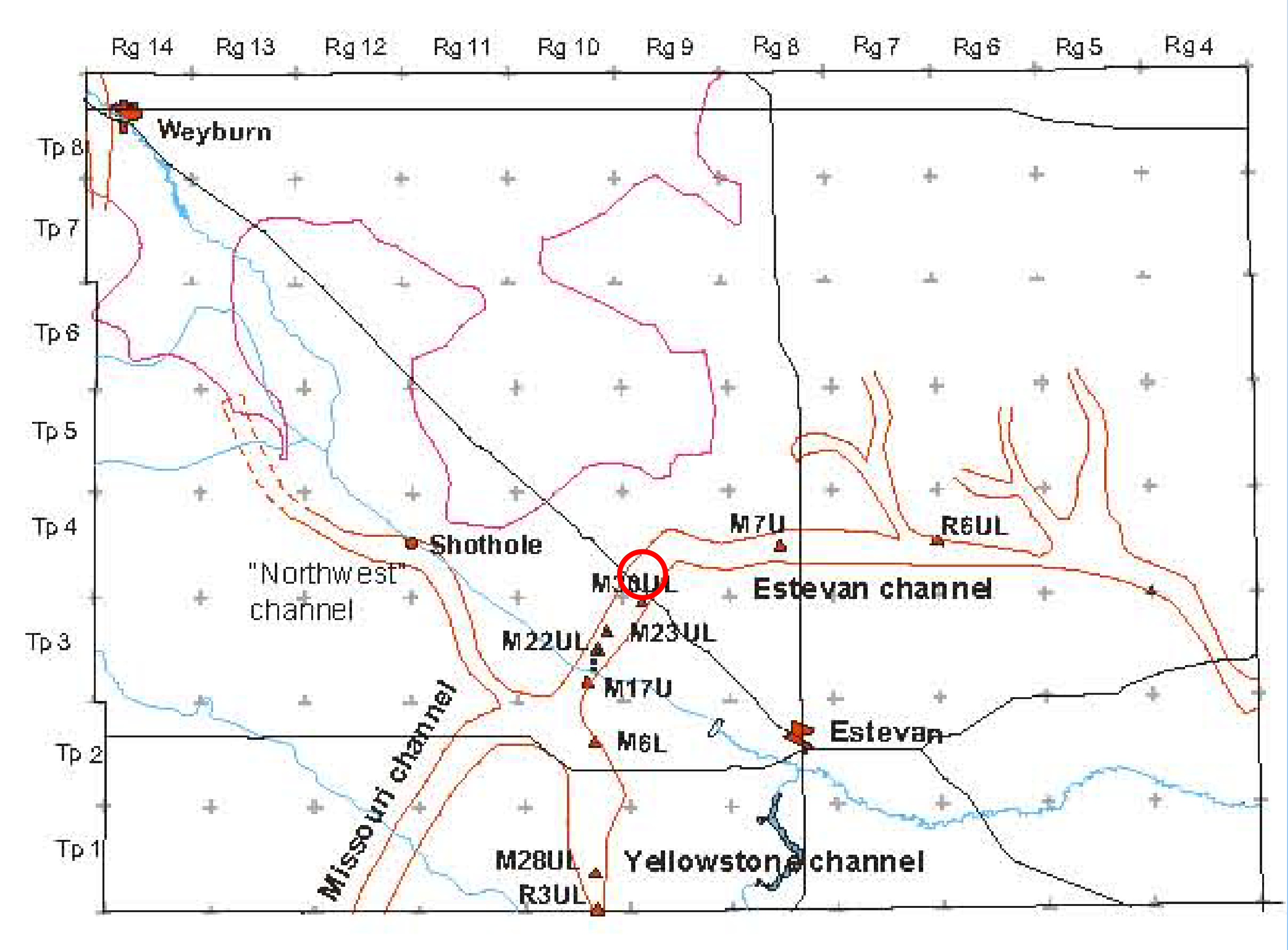
W.C. Walton (1970)



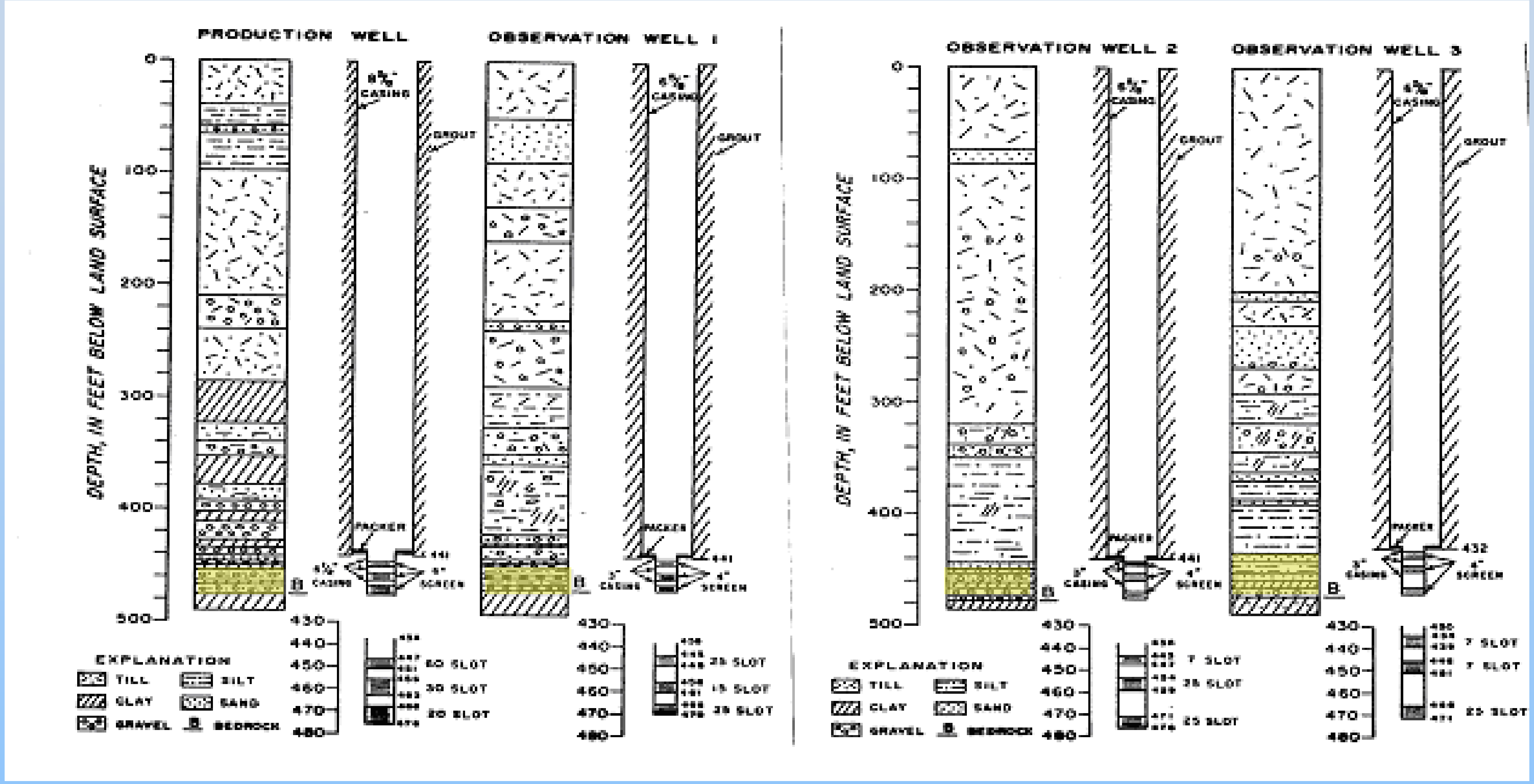
Estevan 1965 pumping test



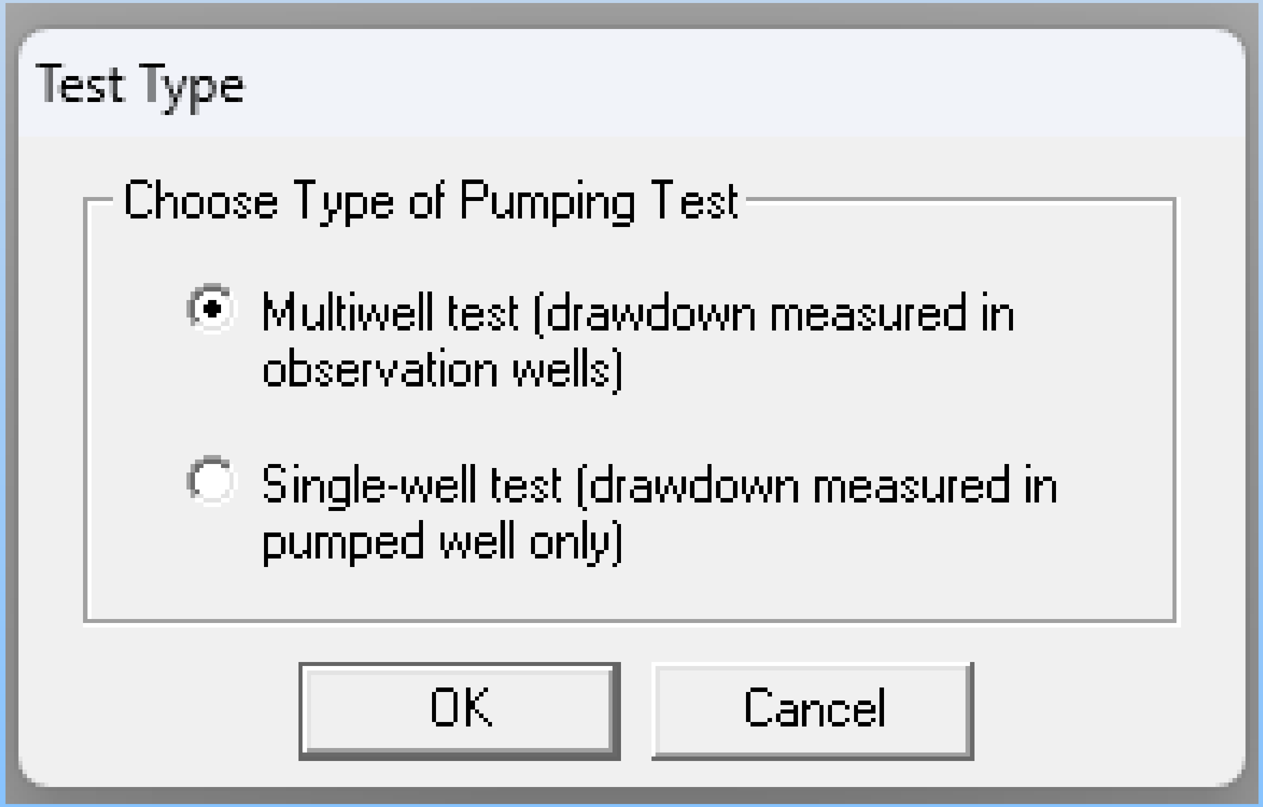
Estevan Valley aquifer system



Maathuis and van der Kamp (2003)

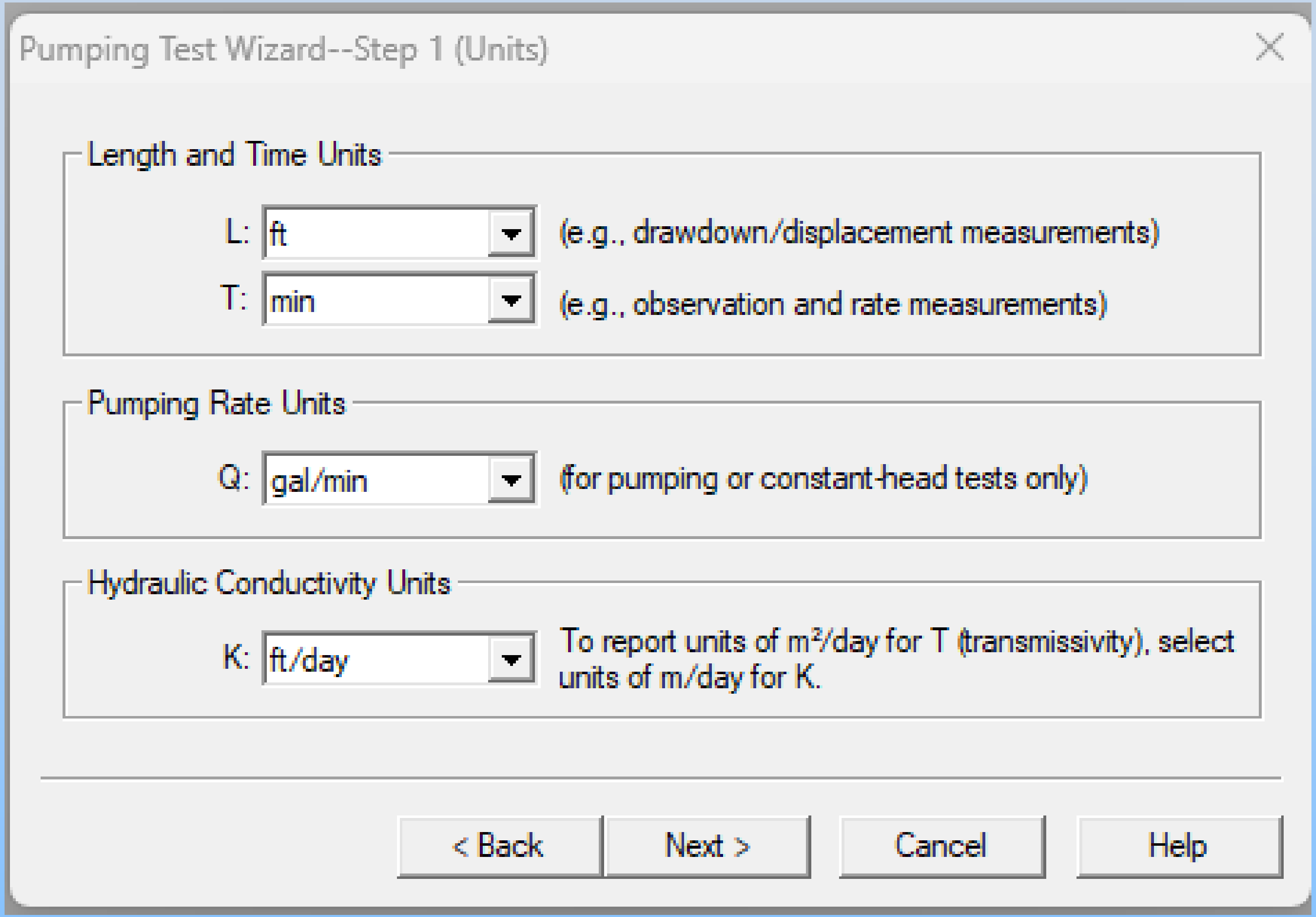

PRODUCTION WELL
OBSERVATION WELL 1
OBSERVATION WELL 2
OBSERVATION WELL 3
DEPTH, IN FEET BELOW LAND SURFACE
CASING
GROUT
PACKER
SCREEN
EXPLANATION
TILL
SILT
CLAY
SAND
GRAVEL
B BEDROCK
30 SLOT
20 SLOT
25 SLOT
15 SLOT
7 SLOT

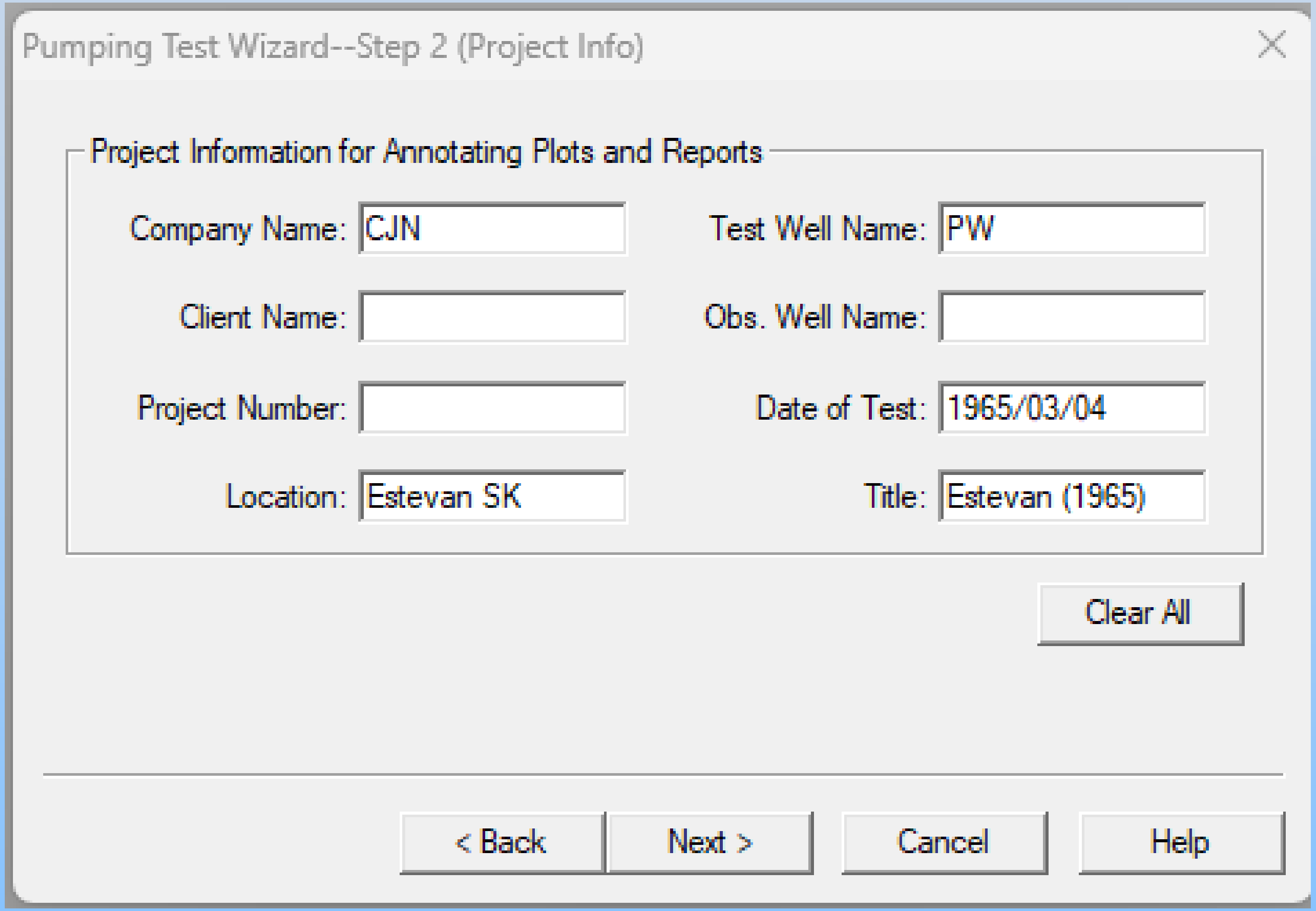
File
→ New
→ Pumping Test Wizard

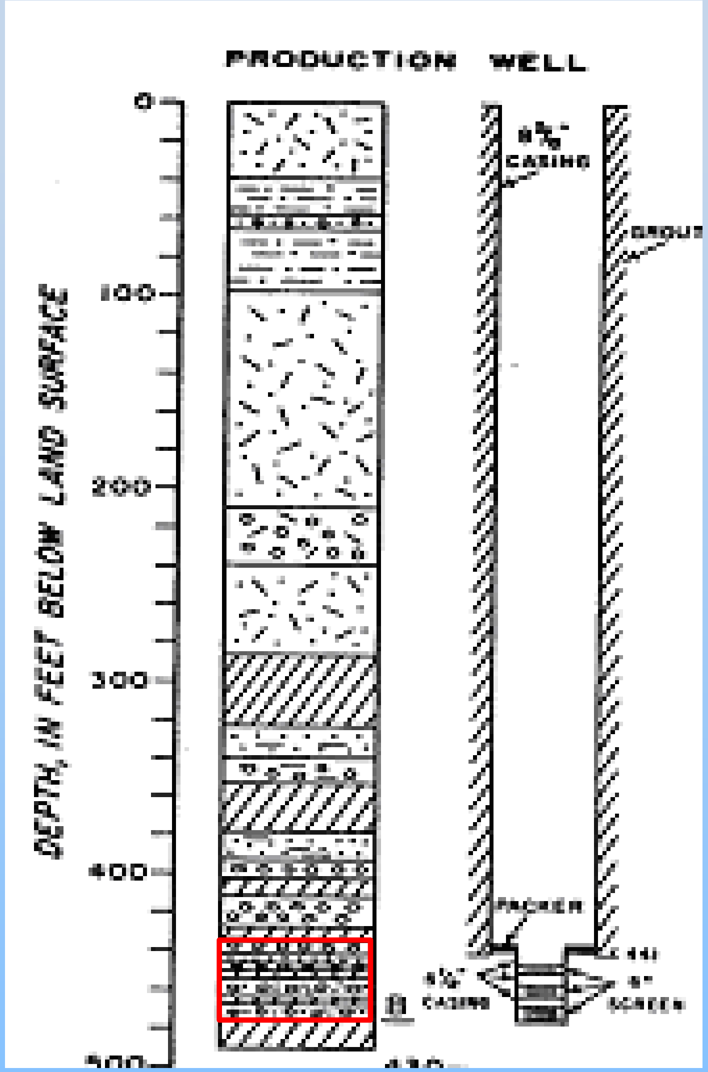


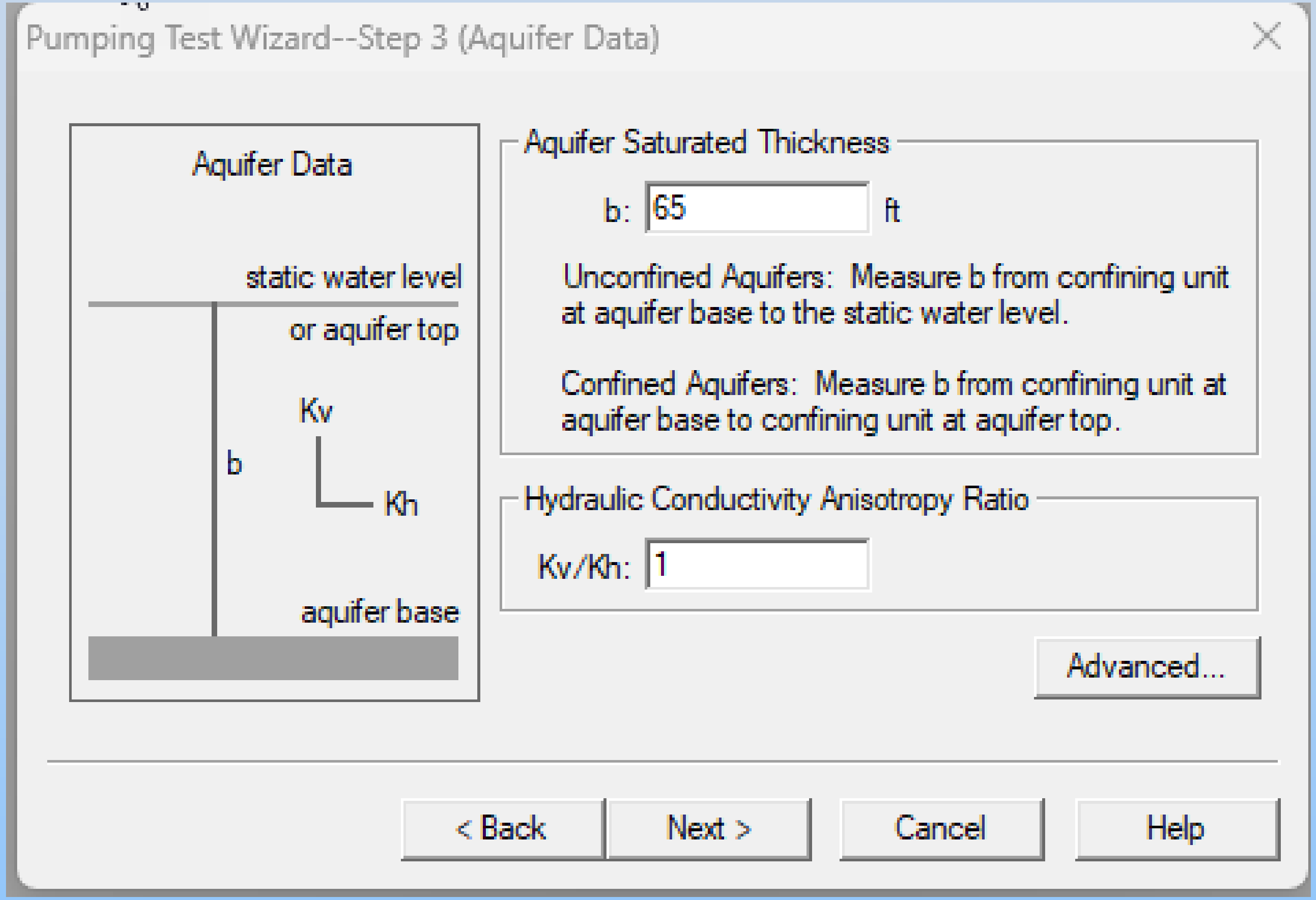
Units

AQTESOLV takes care of the unit conversions.




Pumping Test Wizard--Step 2 (Project Info)
Project Information for Annotating Plots and Reports
Company Name: CJN
Test Well Name: PW
Client Name:
Obs. Well Name:
Project Number:
Date of Test: 1965/03/04
Location: Estevan SK
Title: Estevan (1965)
Clear All
< Back
Next >
Cancel
Help

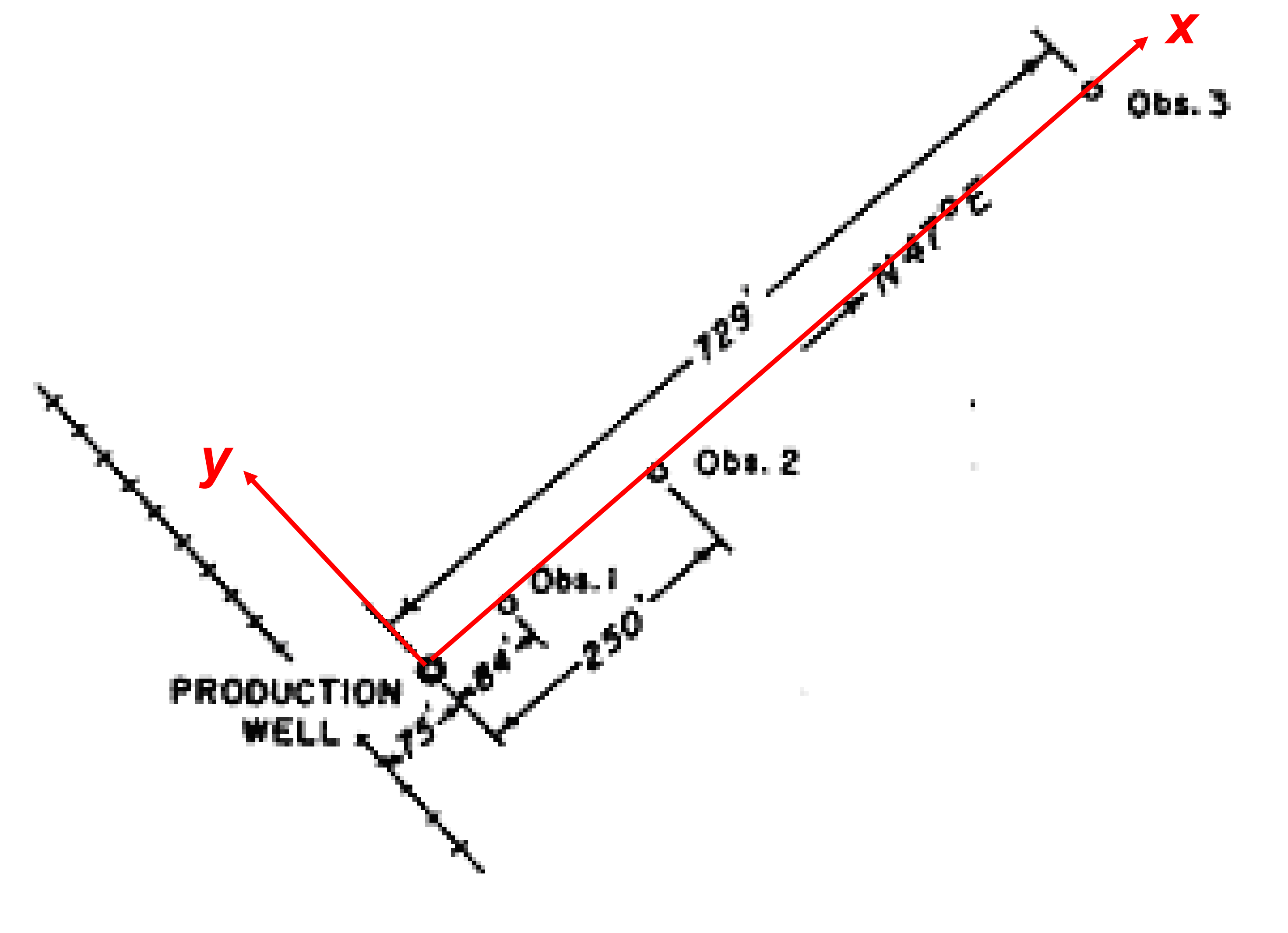


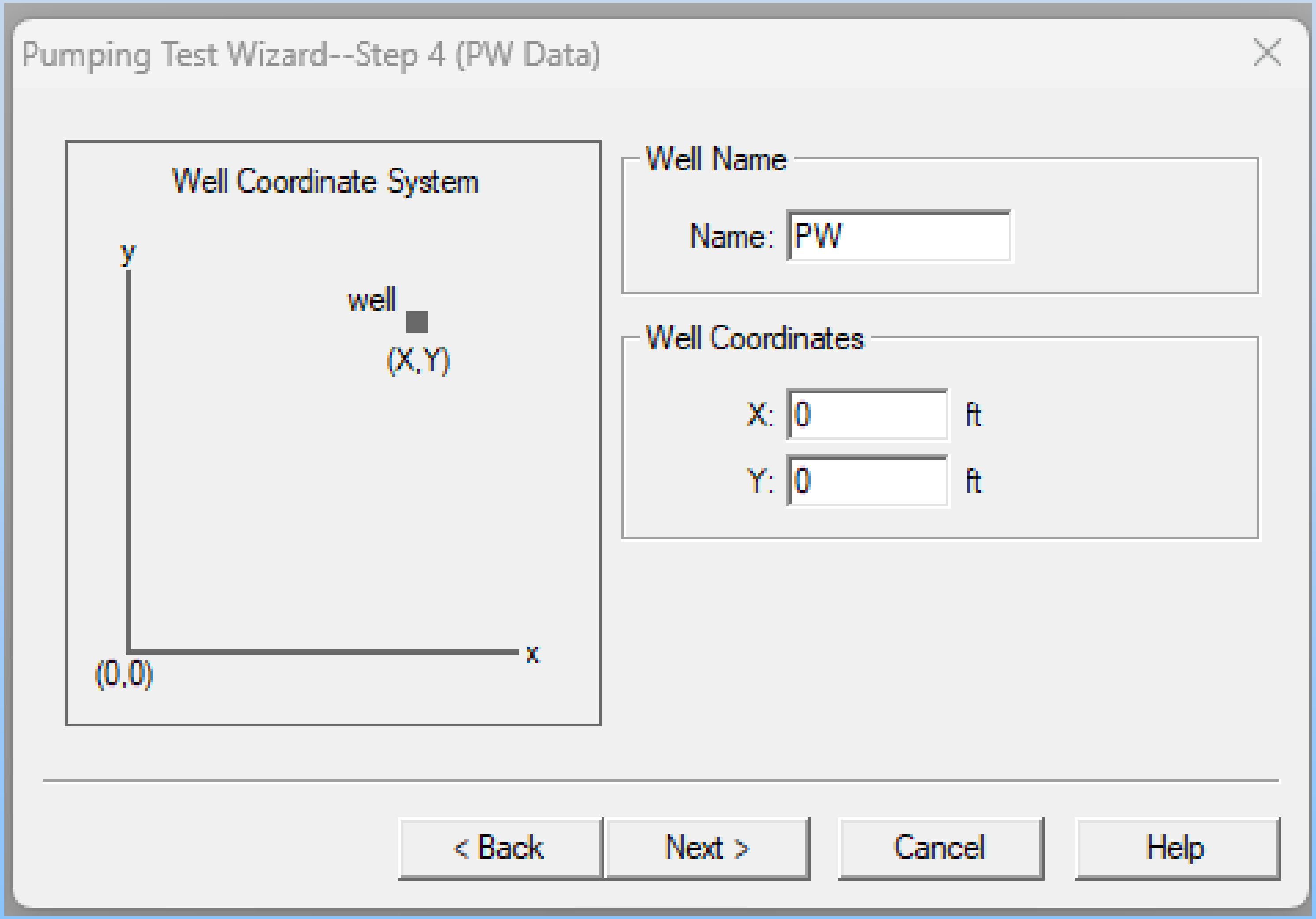


We will assume the pumping well penetrates the full thickness of the aquifer, so the anisotropy ratio is not used.

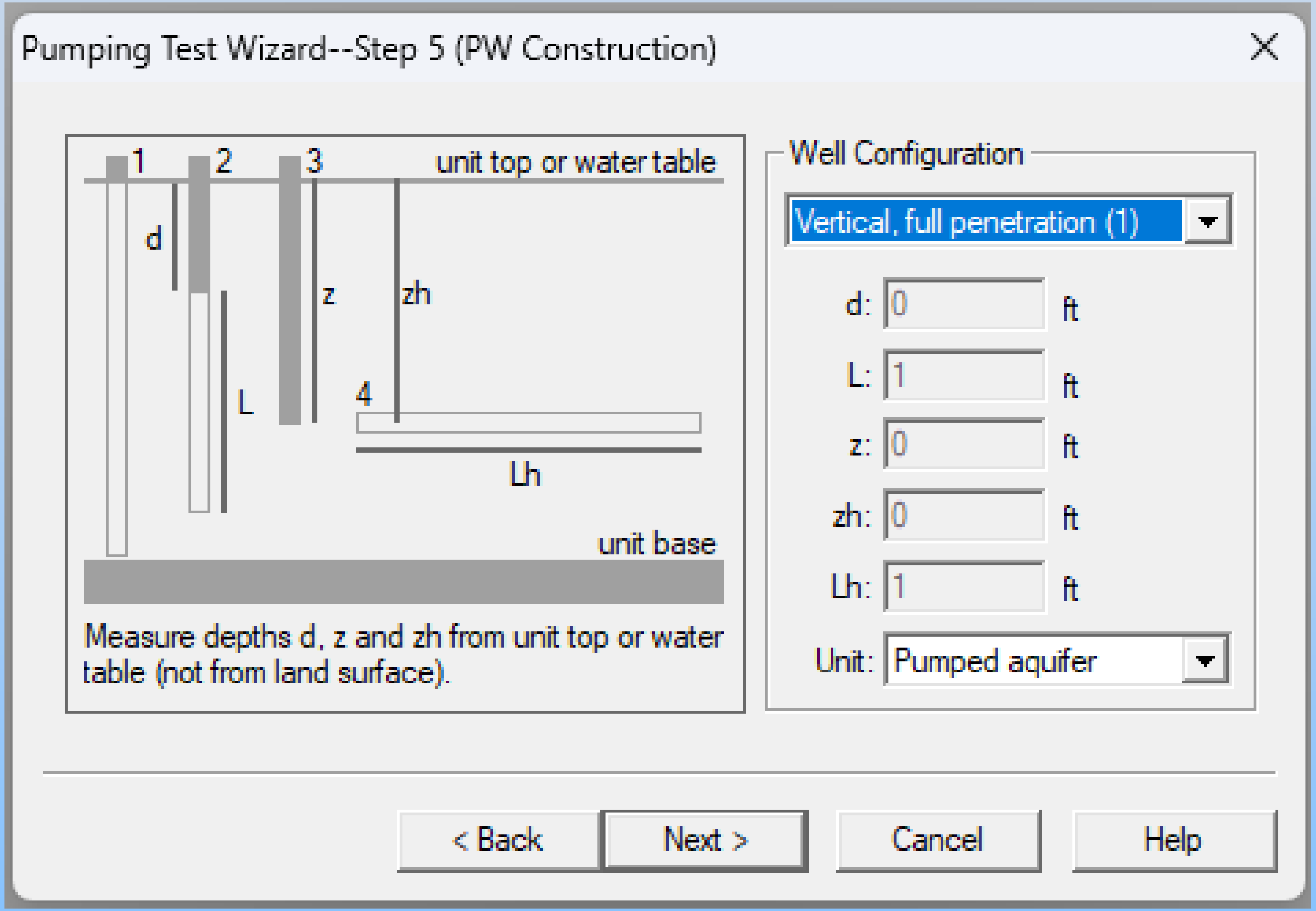
Well coordinates

We will work in terms of local coordinates centered on the pumping well.





Pumping Test Wizard--Step 4 (PW Data)
Well Coordinate System
y
well
(X,Y)
(0,0)
x
Well Name
Name: PW
Well Coordinates
X: 0 ft
Y: 0 ft
< Back
Next >
Cancel
Help

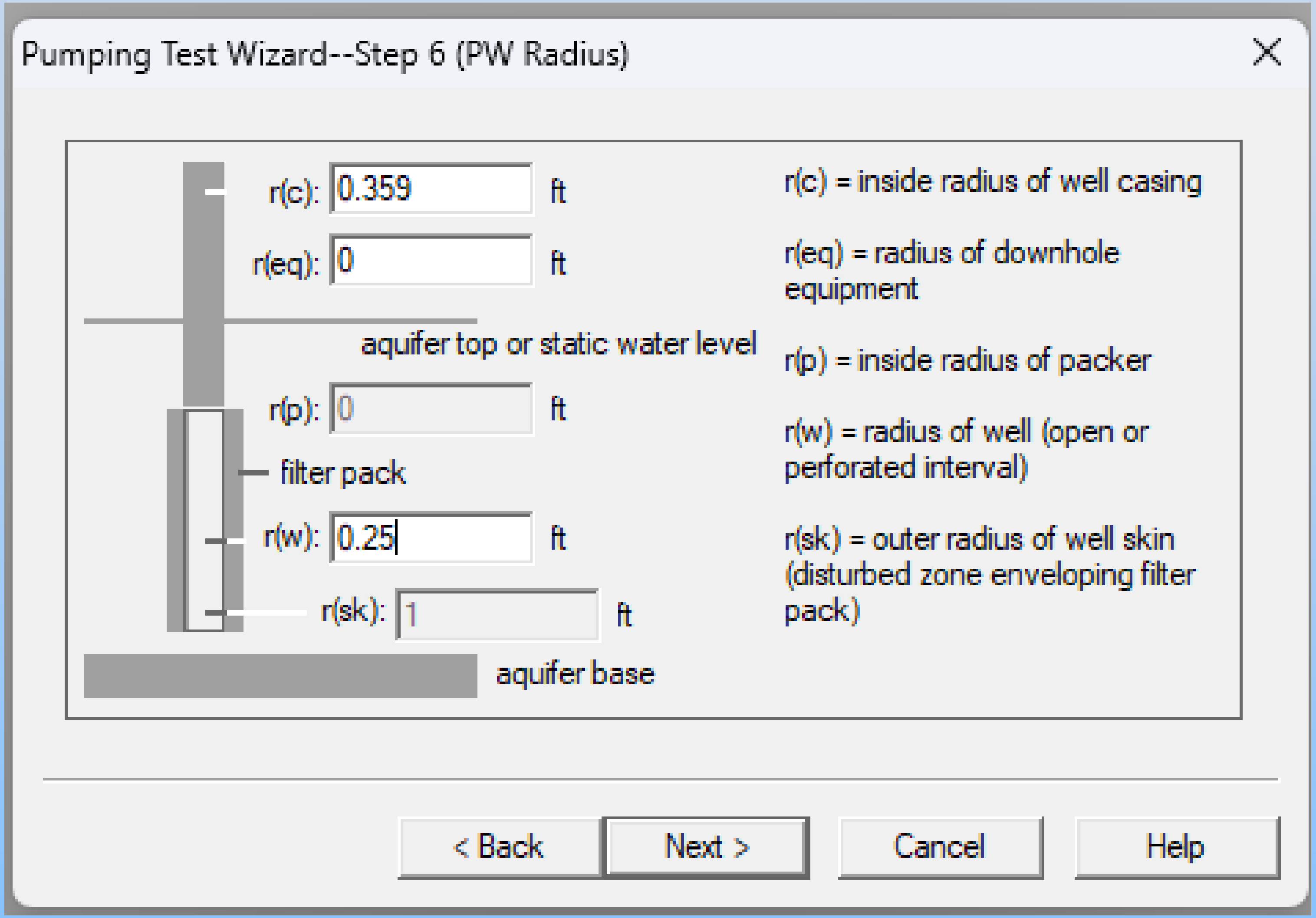


Pumping Test Wizard--Step 5 (PW Construction)
1
2
3
unit top or water table
d
z
zh
L
4
Lh
unit base
Measure depths d, z and zh from unit top or water table (not from land surface).
Well Configuration
Vertical, full penetration (1)
d: 0 ft
L: 1 ft
z: 0 ft
zh: 0 ft
Lh: 1 ft
Unit: Pumped aquifer
< Back
Next >
Cancel
Help

Diameters:

Casing:
8-5/8 inches

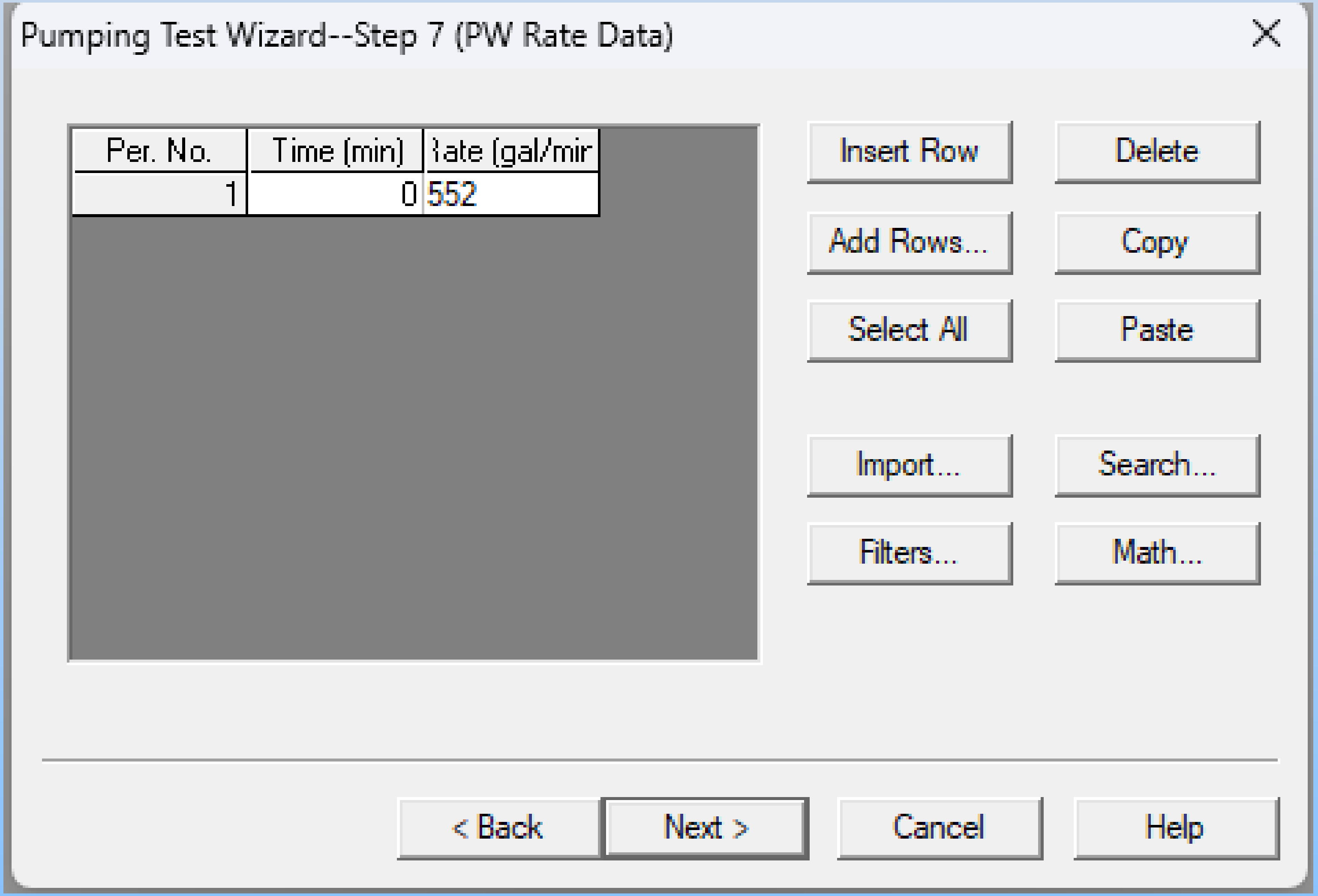
Borehole below casing:
6 inches

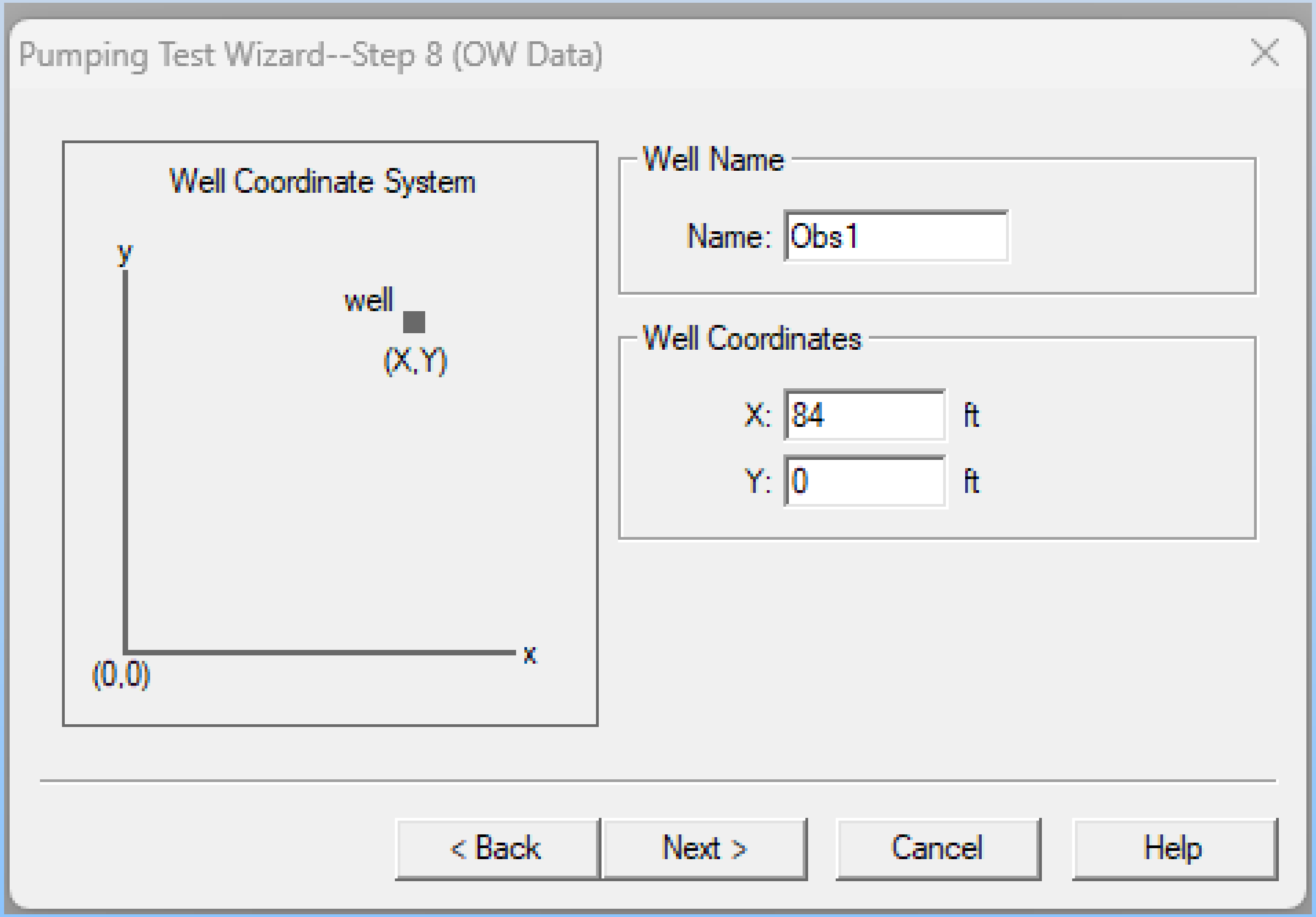


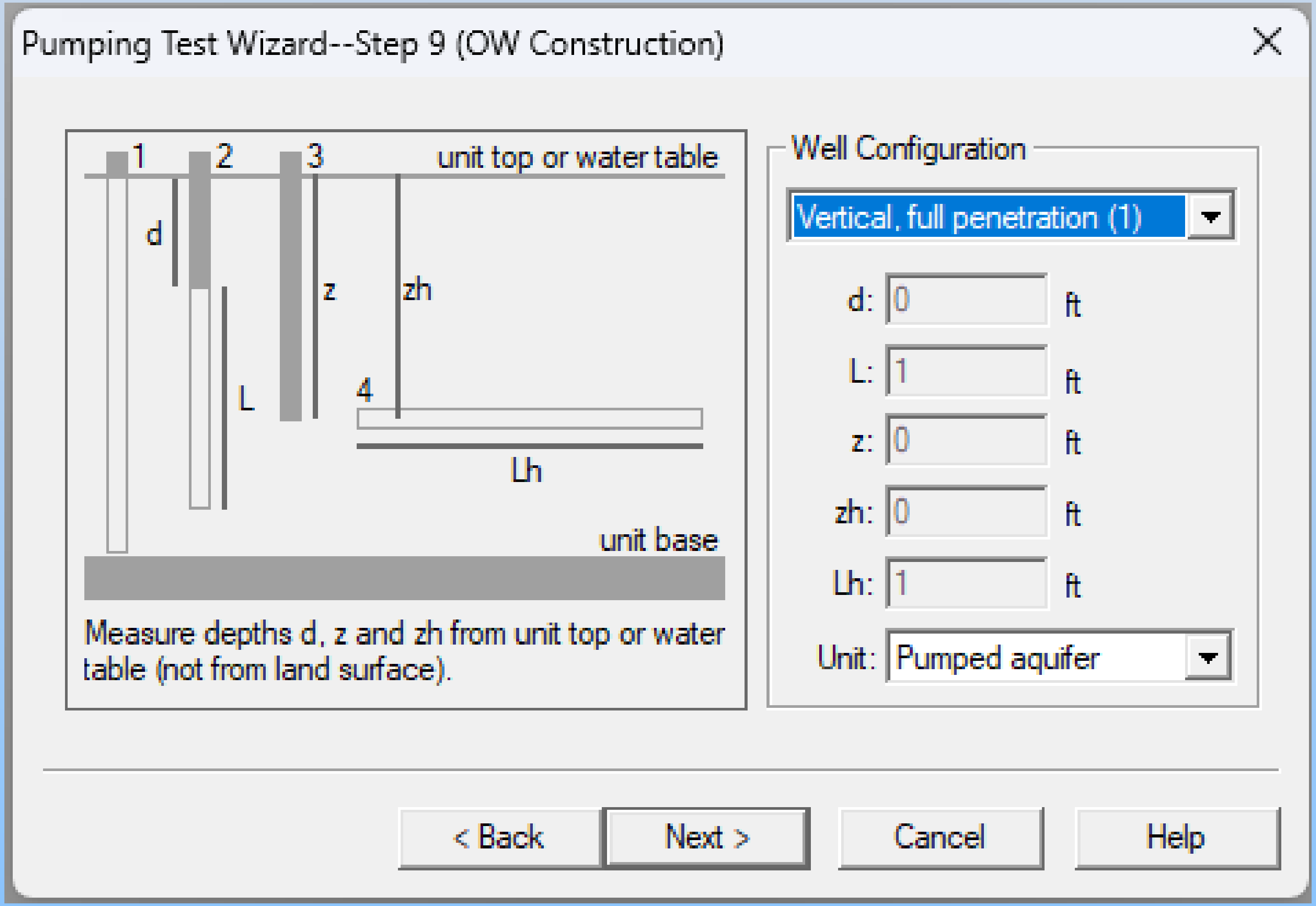
Pumping rate

The pumping rate varied between 457 and 464 igpm, with an average rate of 460 igpm.

Q_{avg} = 552 USgpm



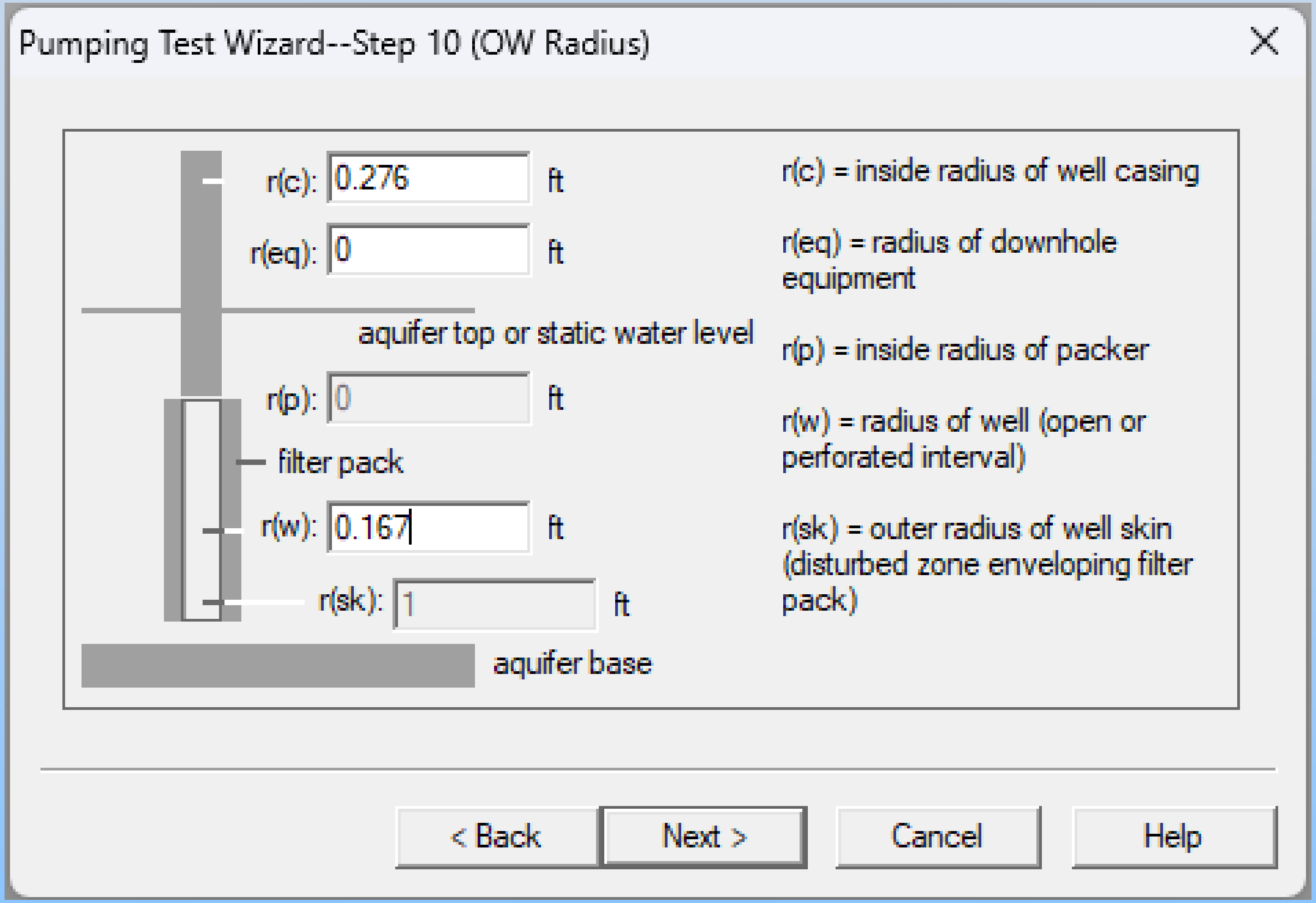

Pumping Test Wizard--Step 8 (OW Data)
Well Coordinate System
y
well
(X,Y)
(0,0)
x
Well Name
Name: Obs1
Well Coordinates
X: 84 ft
Y: 0 ft
< Back
Next >
Cancel
Help


Pumping Test Wizard--Step 9 (OW Construction)
1
2
3
unit top or water table
d
z
zh
L
4
Lh
unit base
Measure depths d, z and zh from unit top or water table (not from land surface).
Well Configuration
Vertical, full penetration (1)
d:
0
ft
L:
1
ft
z:
0
ft
zh:
0
ft
Lh:
1
ft
Unit:
Pumped aquifer
< Back
Next >
Cancel
Help

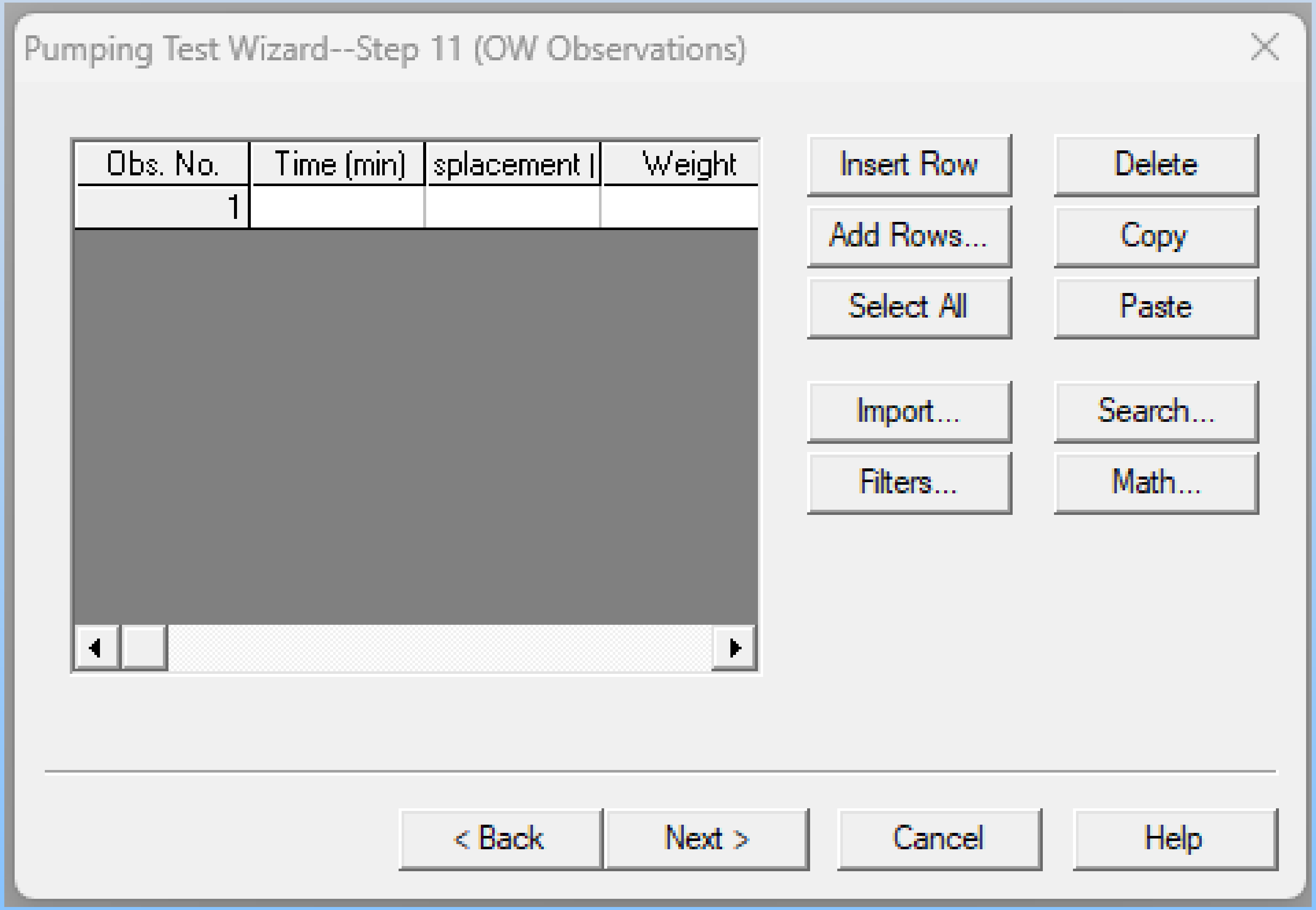
Diameters:

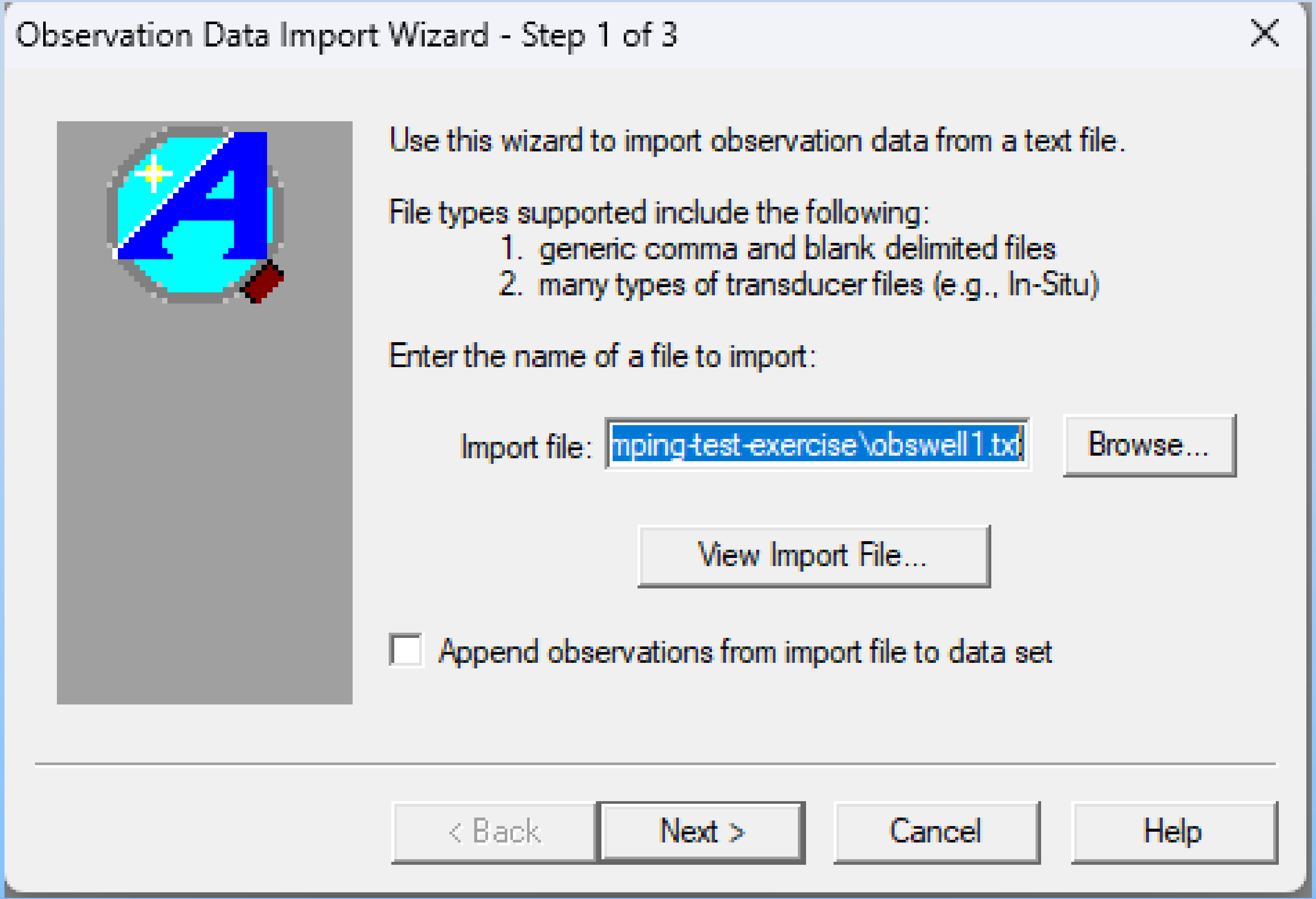
Casing:
6-5/8 inches

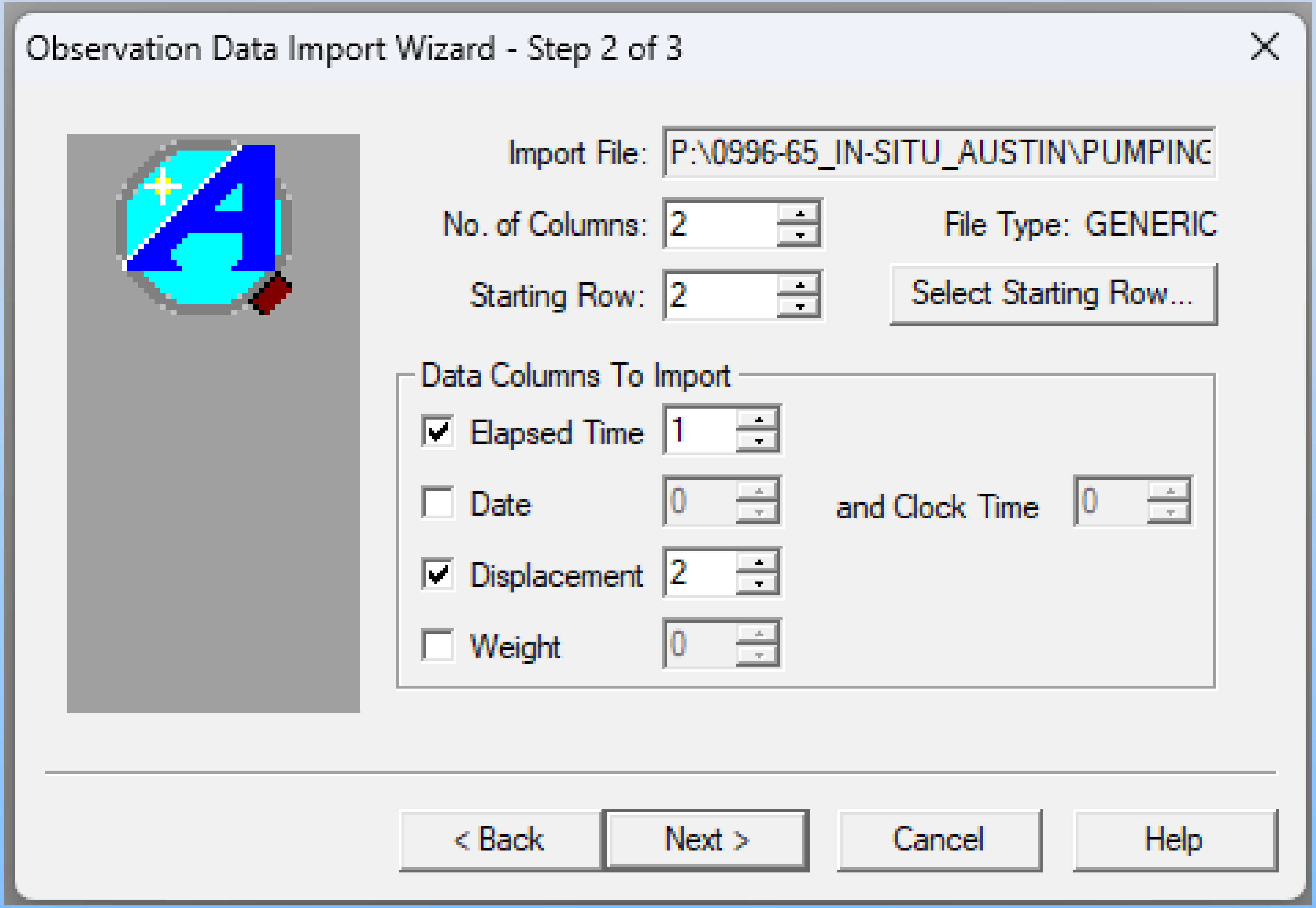
Borehole below casing:
4 inches



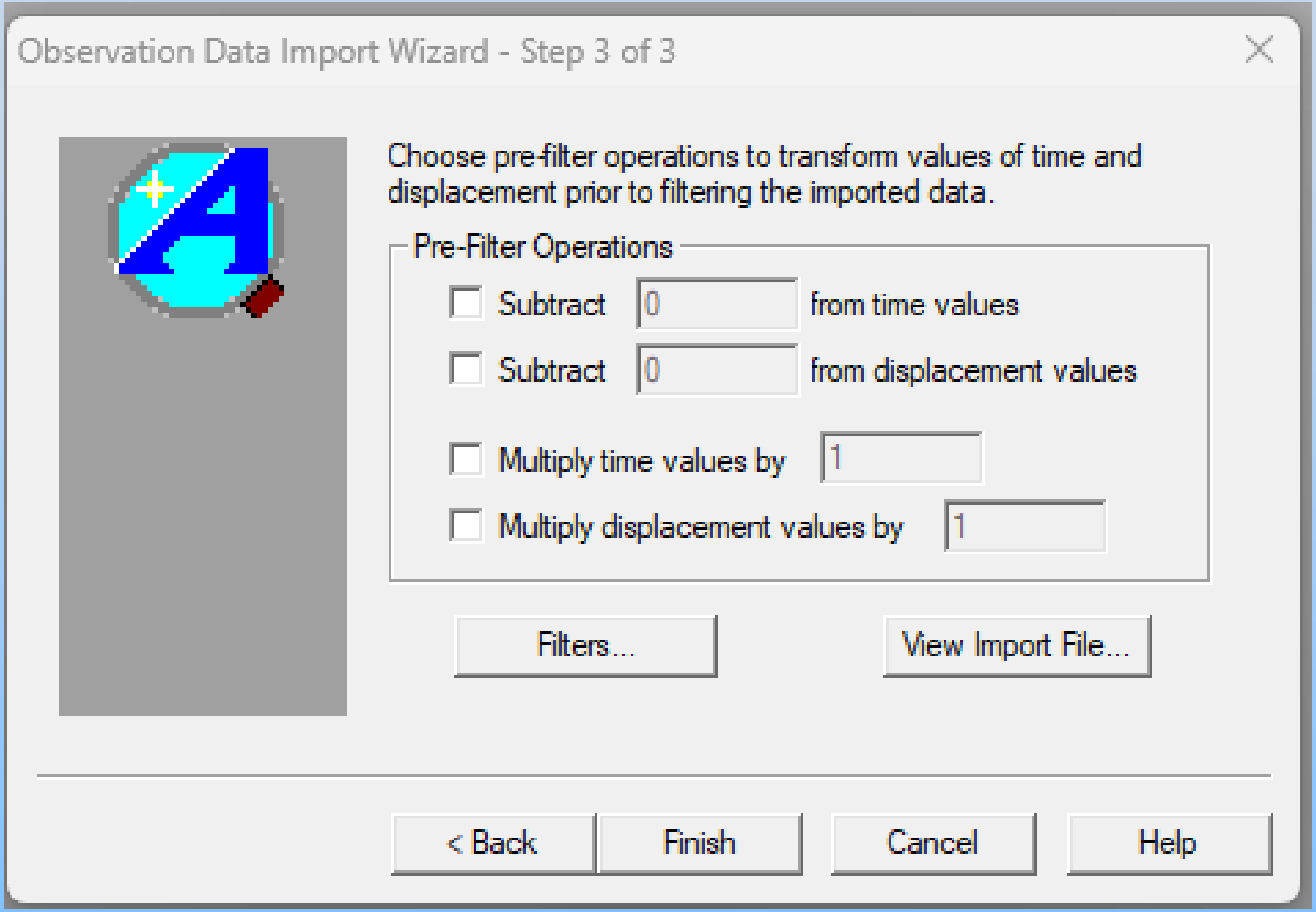
Obs1 drawdowns:
ObsWell1.txt

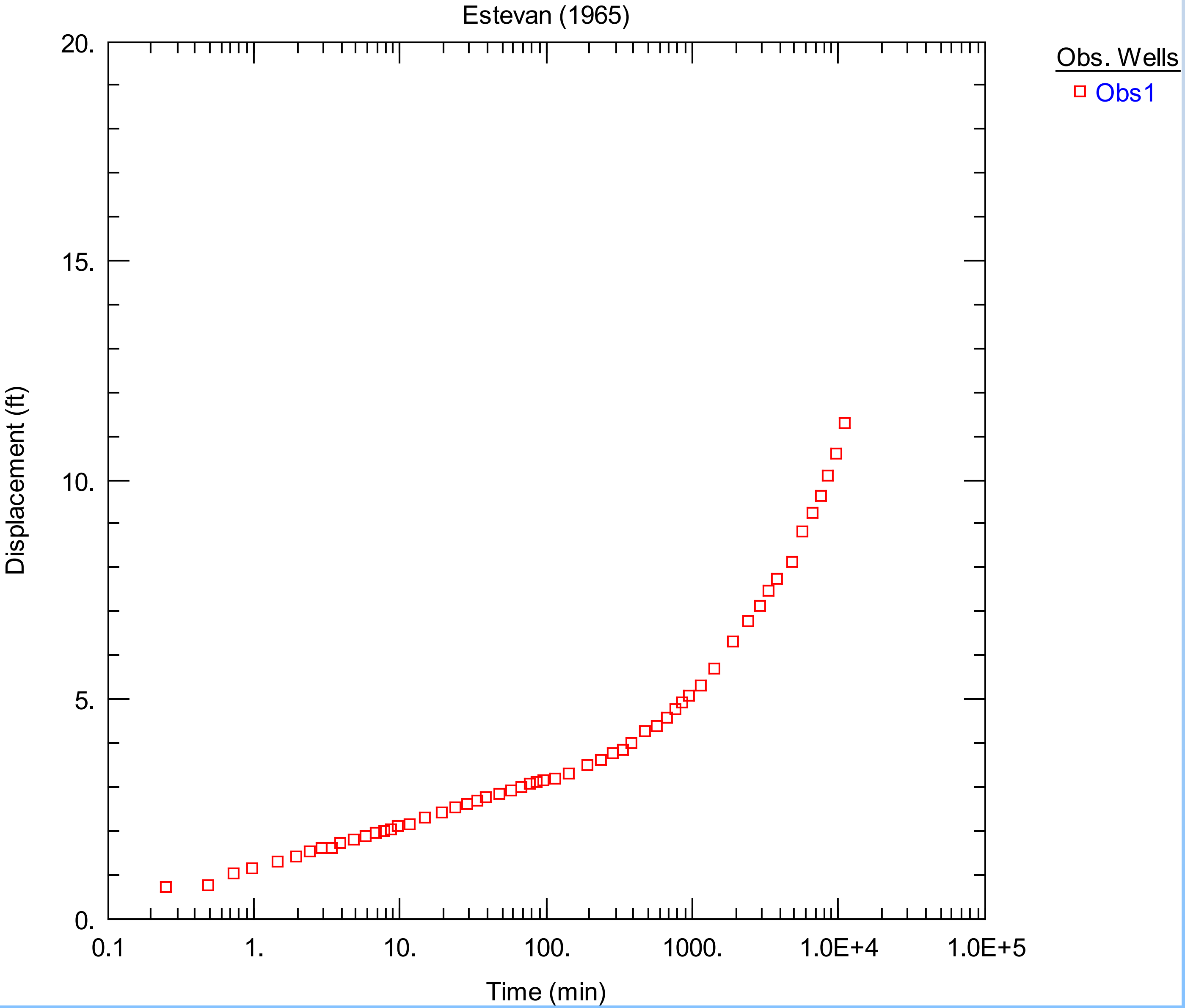



Observation Data Import Wizard - Step 1 of 3
Use this wizard to import observation data from a text file.
File types supported include the following:
1. generic comma and blank delimited files
2. many types of transducer files (e.g., In-Situ)
Enter the name of a file to import:
Import file:
mping-test-exercise\obswell1.txt
Browse...
View Import File...
Append observations from import file to data set
< Back
Next >
Cancel
Help


Observation Data Import Wizard - Step 2 of 3
Import File:
P:\0996-65_IN-SITU_AUSTIN\PUMPINC
No. of Columns:
2
File Type: GENERIC
Starting Row:
2
Select Starting Row...
Data Columns To Import
Elapsed Time
1
Date
0
and Clock Time
0
Displacement
2
Weight
0
< Back
Next >
Cancel
Help

We won't do anything to the data,
but we could.

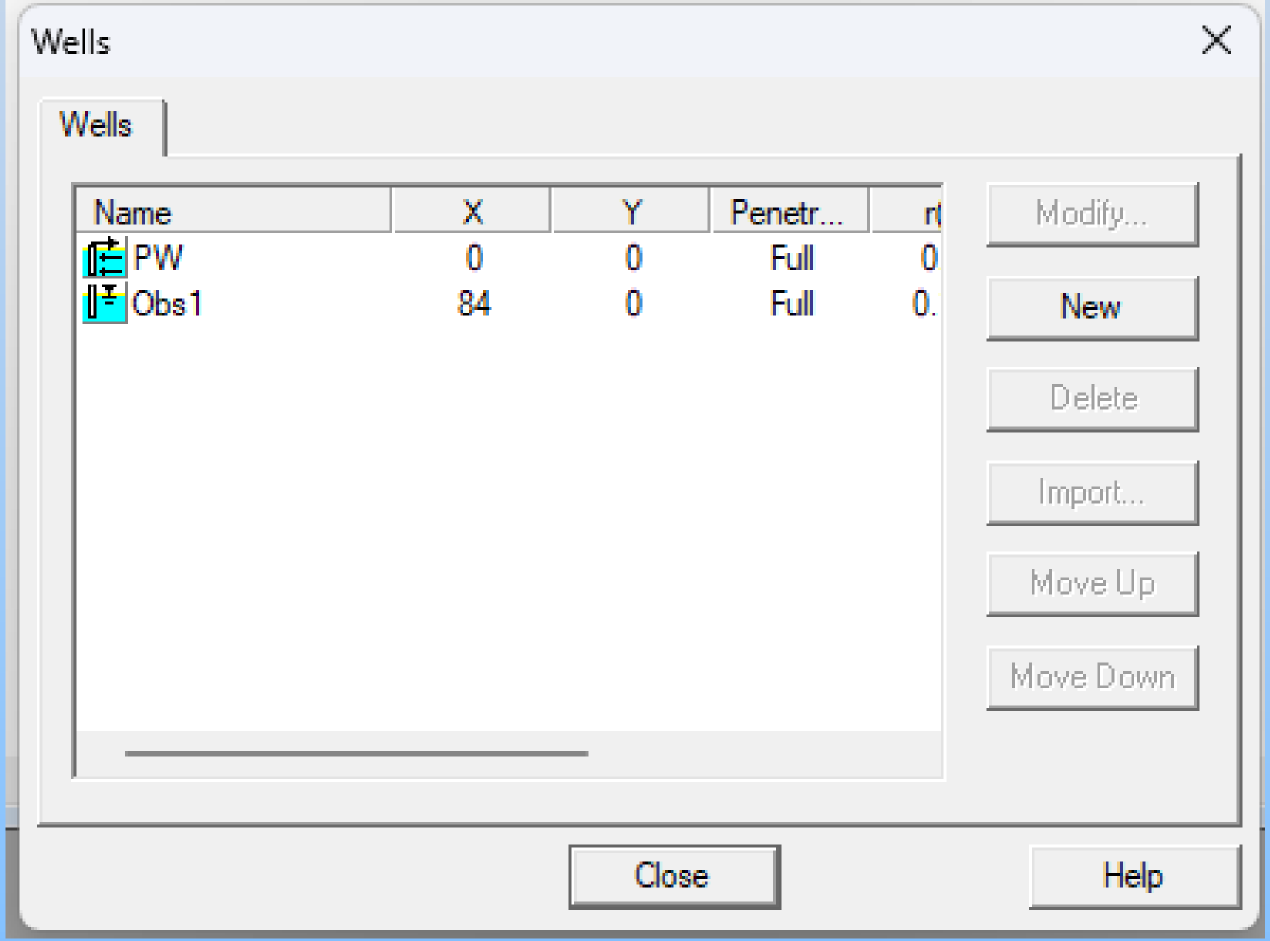




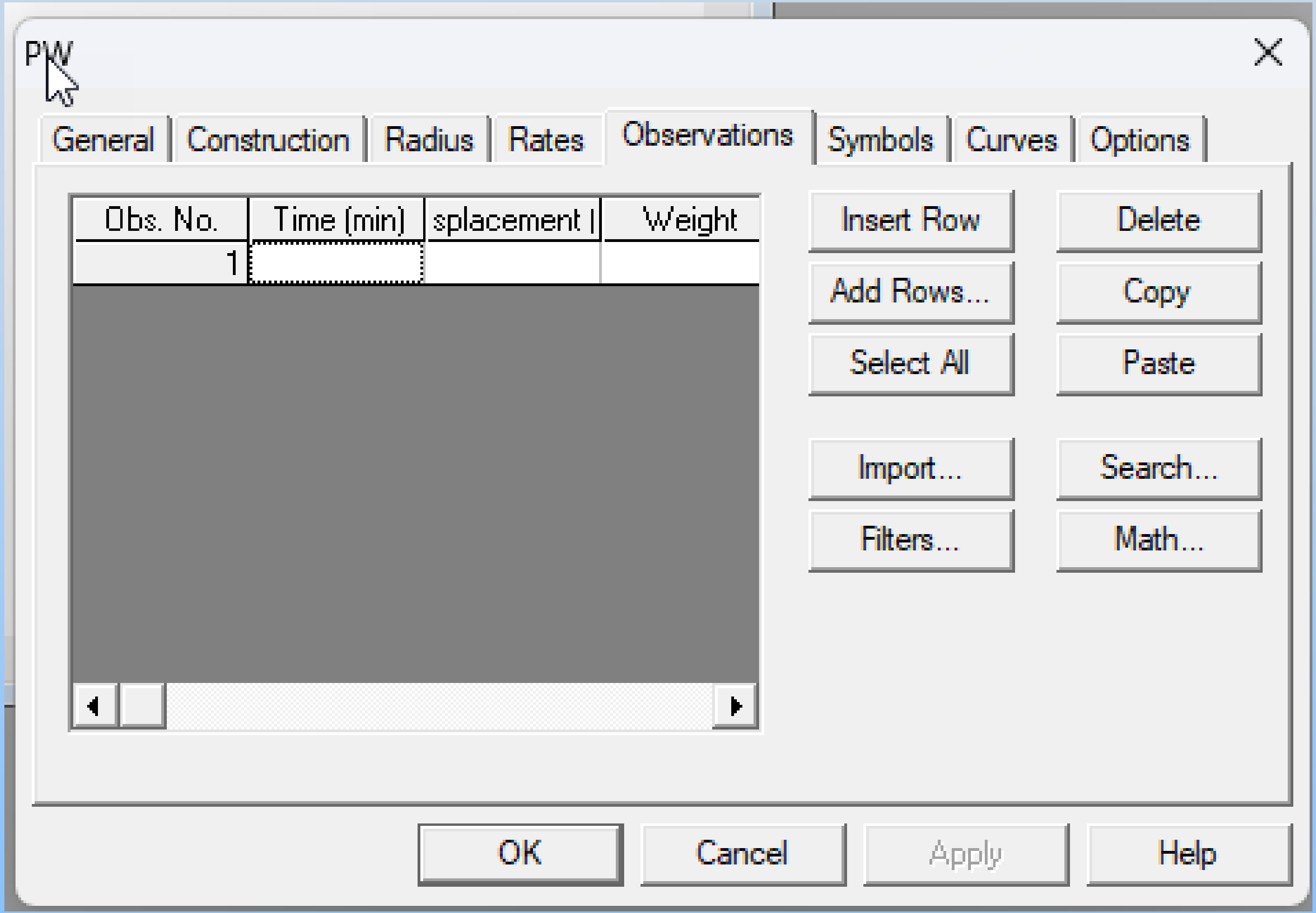
Estevan (1965)
Displacement (ft)
Time (min)
0.
5.
10.
15.
20.
0.1
1.
10.
100.
1000.
1.0E+4
1.0E+5
Obs. Wells
Obs1

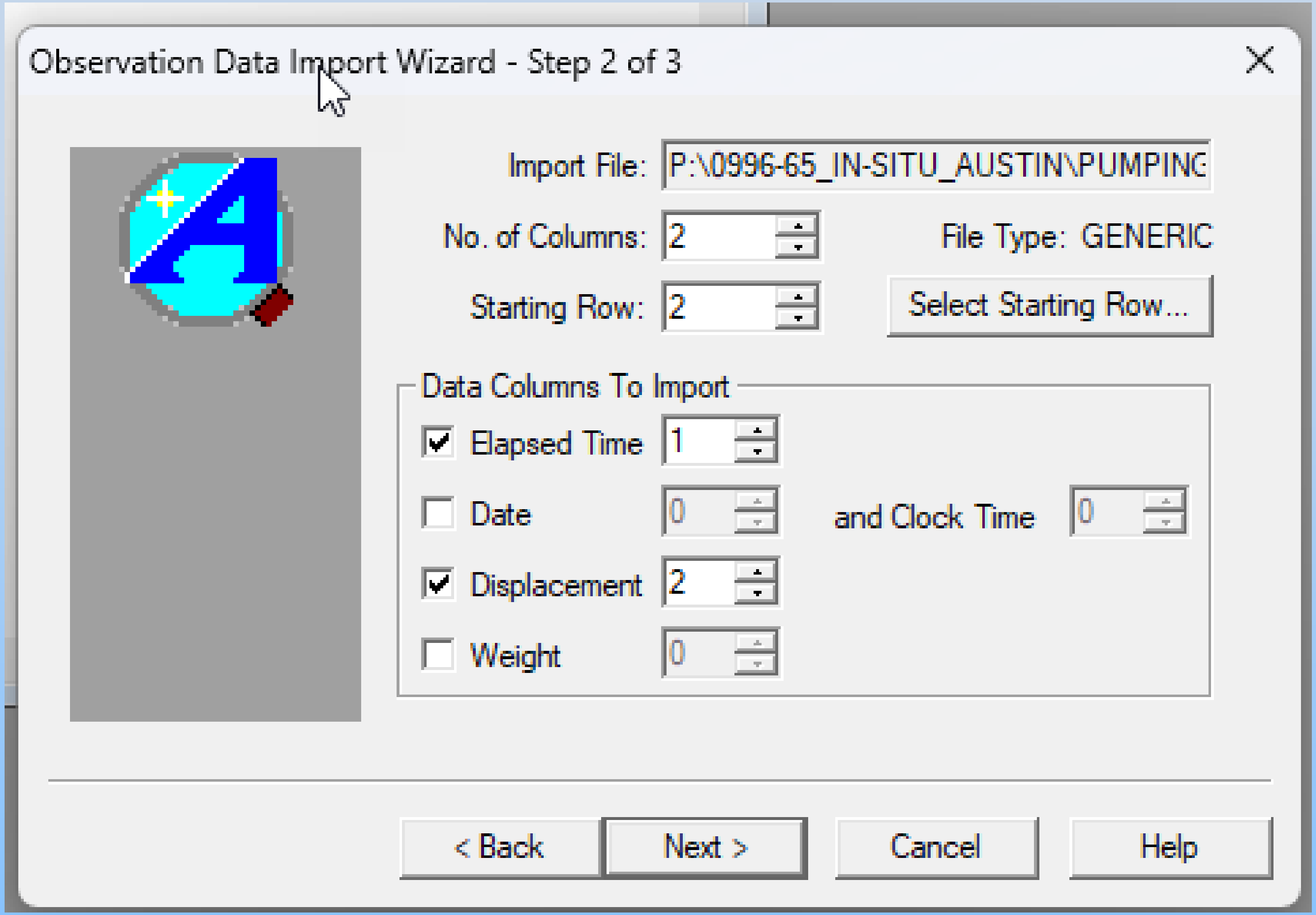
Let us go back and add the pumping well drawdowns.

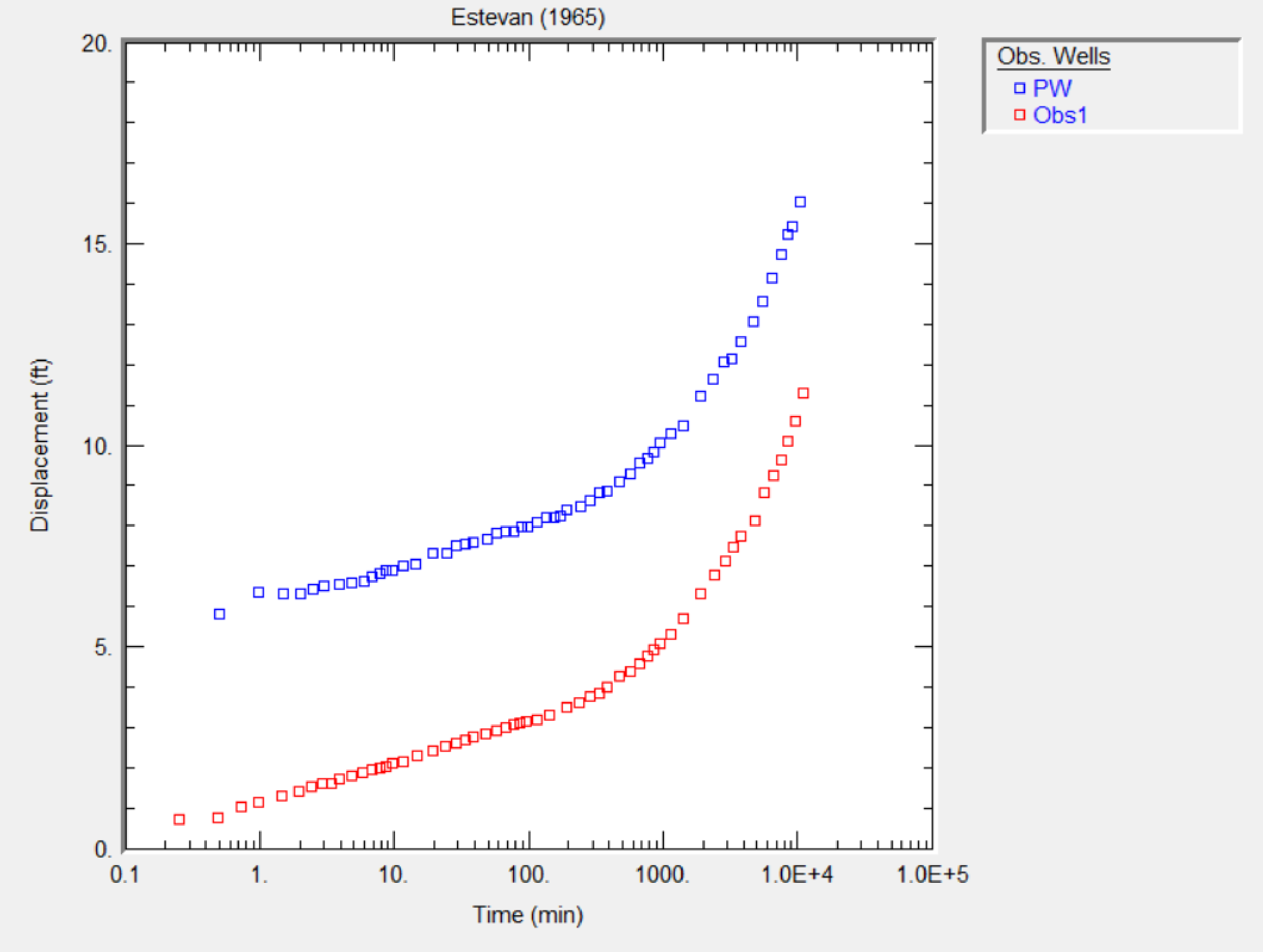
Edit
→ Wells
→ PW
→ Modify



PW drawdowns:
ProductionWell.txt




Observation Data Import Wizard - Step 2 of 3
Import File:
P:\0996-65_IN-SITU_AUSTIN\PUMPING
No. of Columns:
2
File Type: GENERIC
Starting Row:
2
Select Starting Row...
Data Columns To Import
Elapsed Time
1
Date
0
and Clock Time
0
Displacement
2
Weight
0
< Back
Next >
Cancel
Help


Estevan (1965)
Displacement (ft)
20.
15.
10.
5.
0.
0.1
1.
10.
100.
1000.
1.0E+4
1.0E+5
Time (min)
Obs. Wells
PW
Obs1

Error log

Estevan_1965.aqt

The Error Log identifies errors detected in your data set.
Choose this view when you see the "Check Errors" indicator on the status bar.

No errors detected in data set.

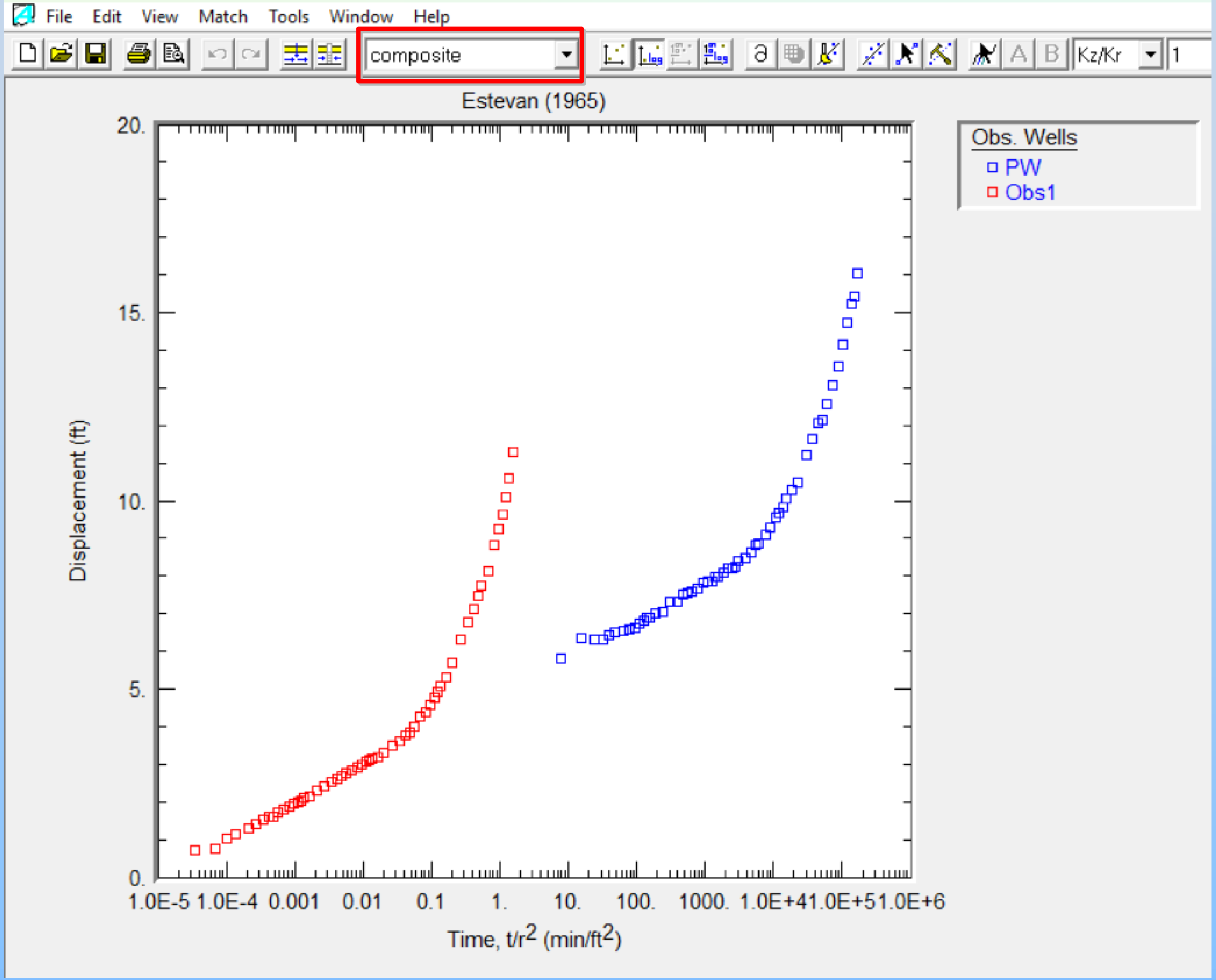
Tips for Analyzing Aquifer Tests with AQTESOLV for Windows

1. Enter Test Data
   Choose options from the Edit menu to enter or modify test data.
2. Perform Diagnostic Analyses (Optional)
   Choose diagnostic flow plot and derivative plot options from the View menu.
3. Perform Curve Matching or Prediction
   Choose the Solution or Toolbox options from the Match menu to perform forward solution analyses (prediction).
   Choose the Automatic, Visual or Toolbox options from the Match menu to perform curve matching.
4. Analysis of Residuals (Optional)
   Choose residual plot and diagnostic report options from View menu to evaluate automatic curve fit.
5. Reporting
   Choose Format option from View menu to customize appearance of plots and reports.
   Choose Print Preview and Print options from File menu to obtain hardcopy output.

Data Set Summary

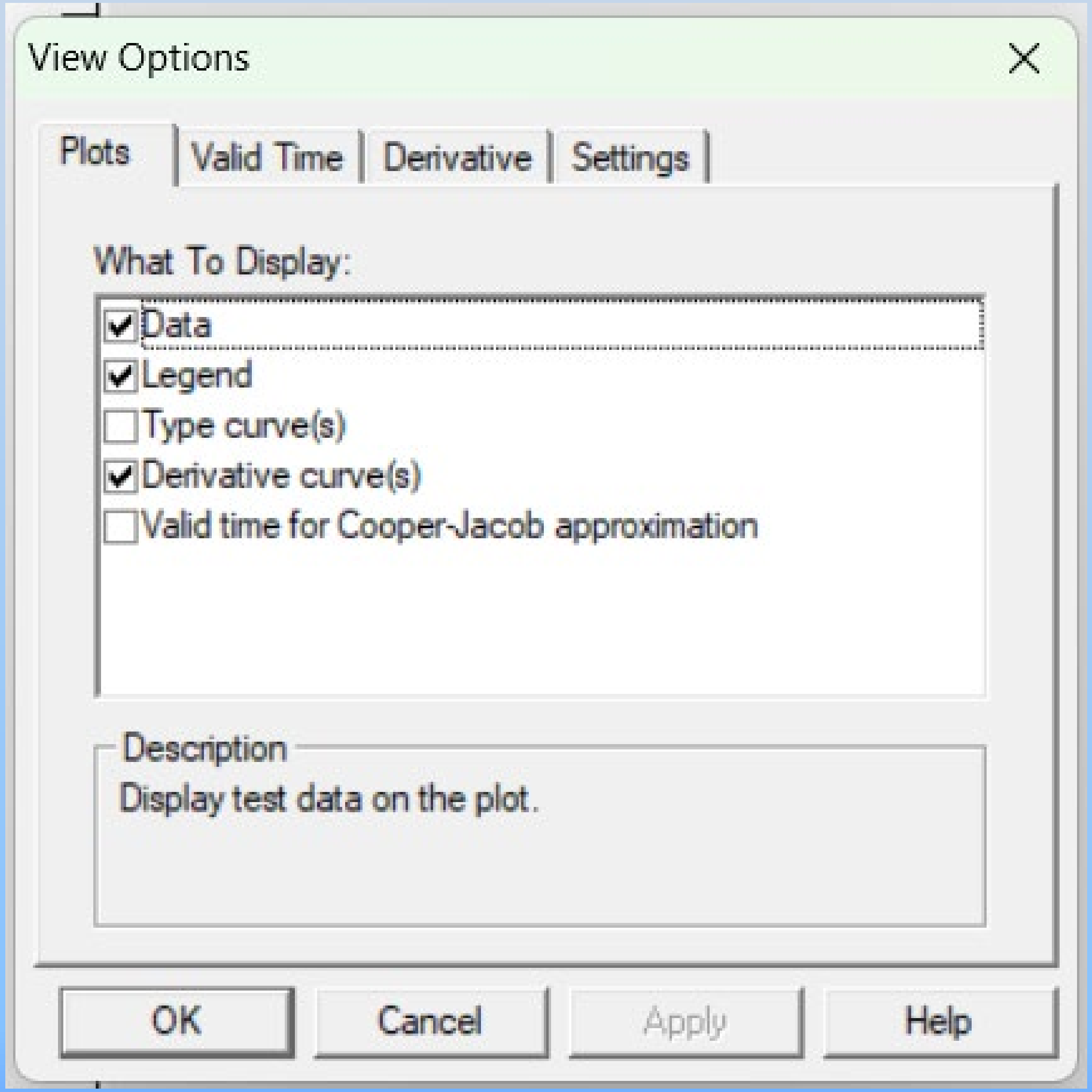
Pumping Test
No. of pumping wells: 1
No. of pumping periods (PW): 1
No. of observation wells: 2
Total no. of observations: 111
Range of time readings in obs. well(s): 0.25 to 10991.3 min
Range of displacement readings in obs. well(s): 0.71 to 16.05 ft

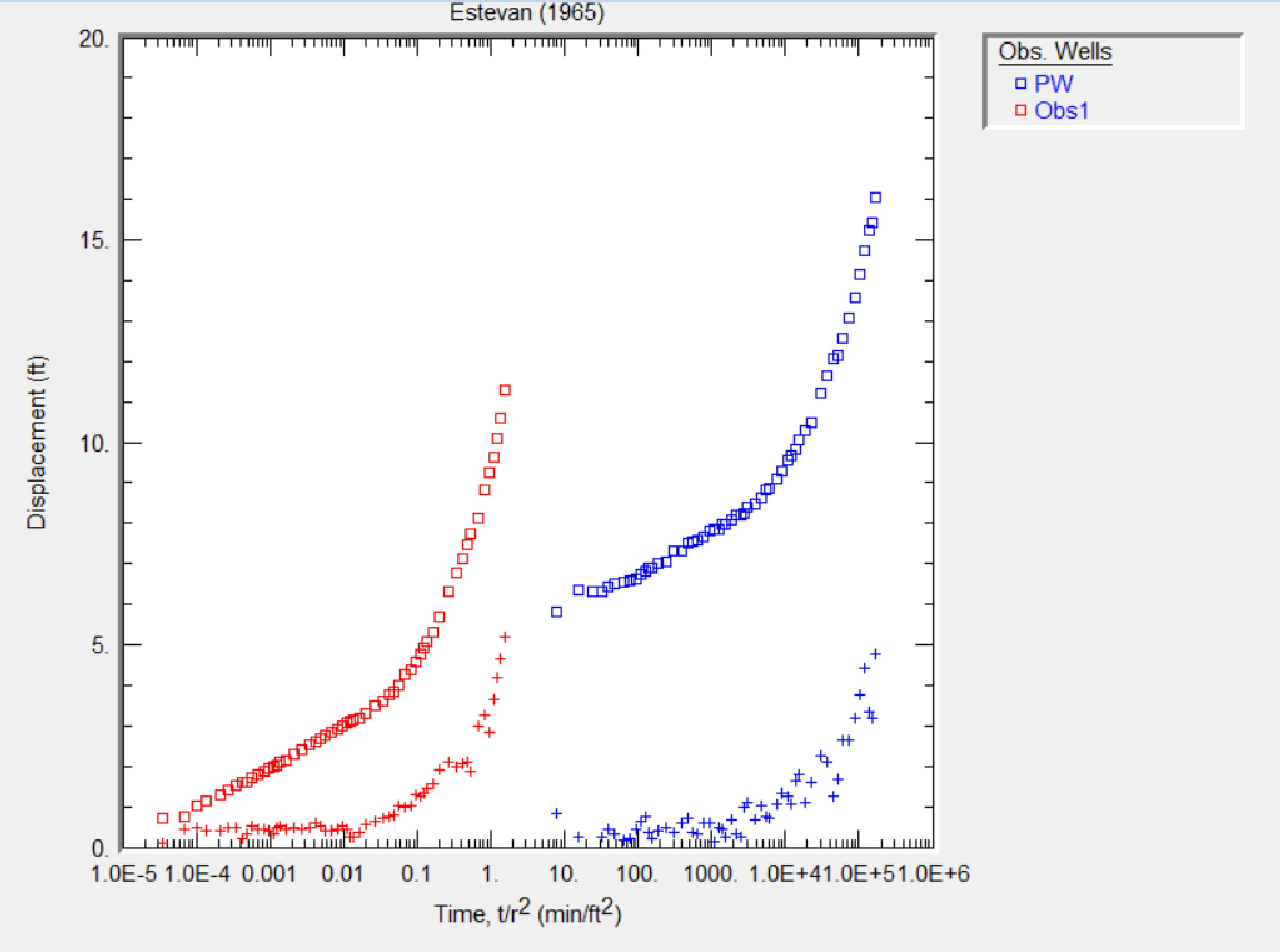
Let us change the view to the composite plot.



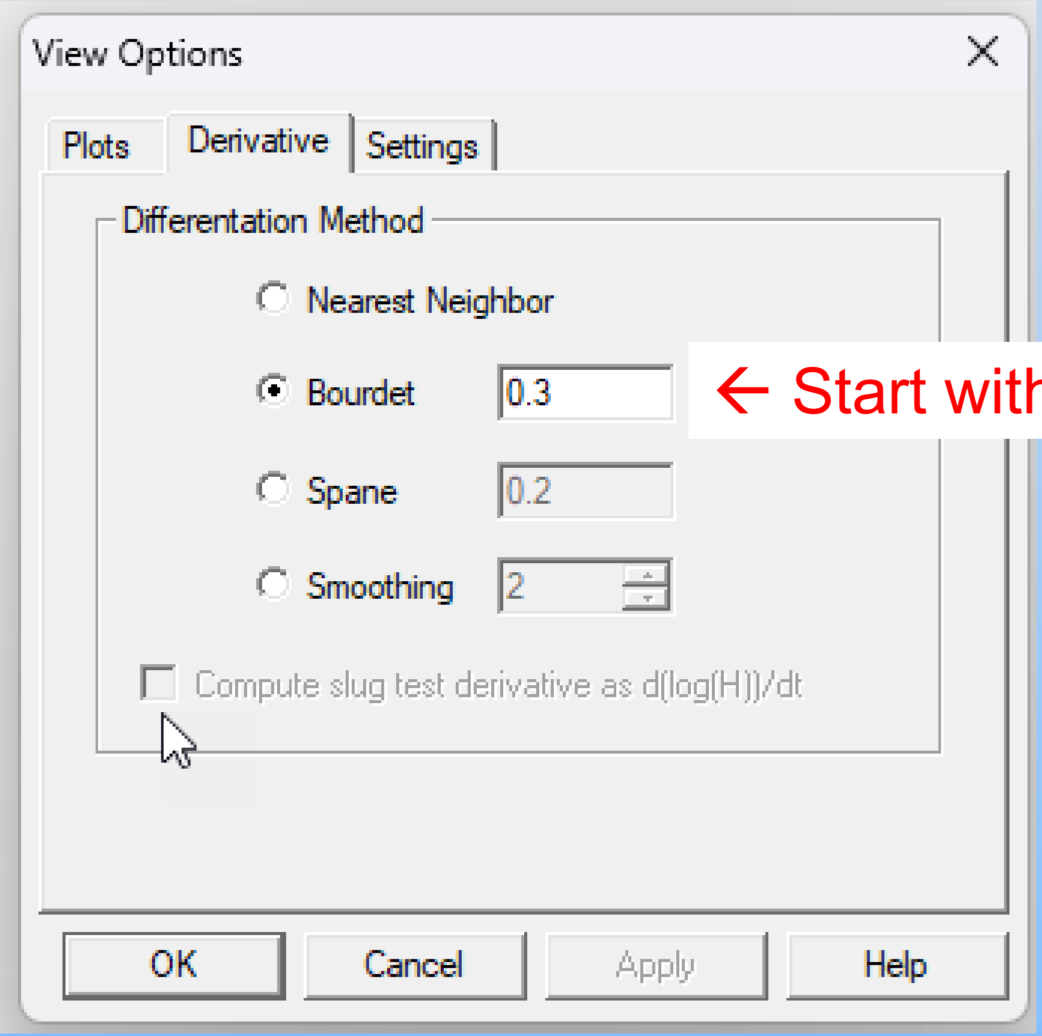
Let us add the derivatives.

View
→ Options

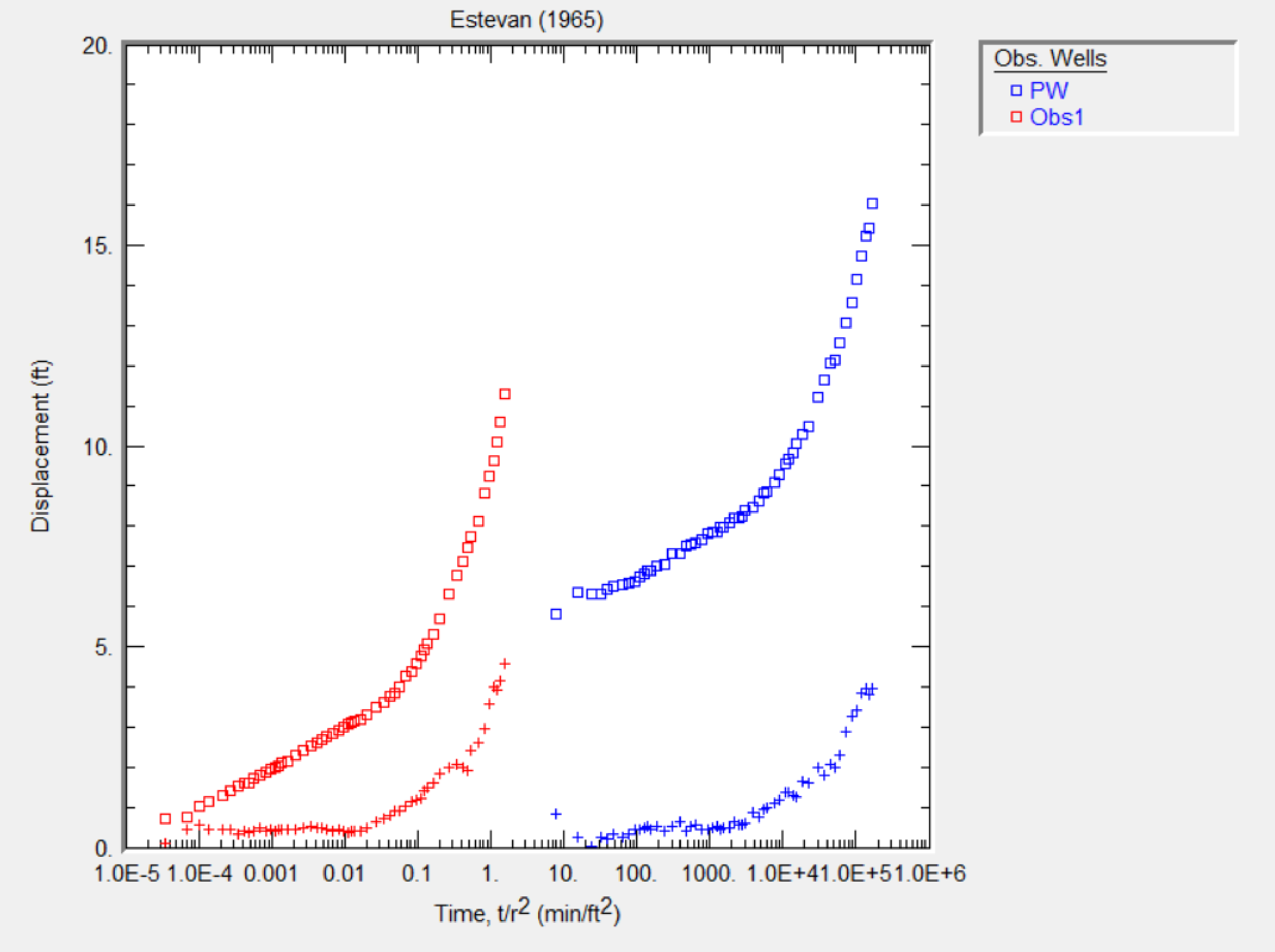



Estevan (1965)
Displacement (ft)
0.
5.
10.
15.
20.
1.0E-5
1.0E-4
0.001
0.01
0.1
1.
10.
100.
1000.
1.0E+4
1.0E+5
1.0E+6
Time, t/r2 (min/ft2)
Obs. Wells
PW
Obs1

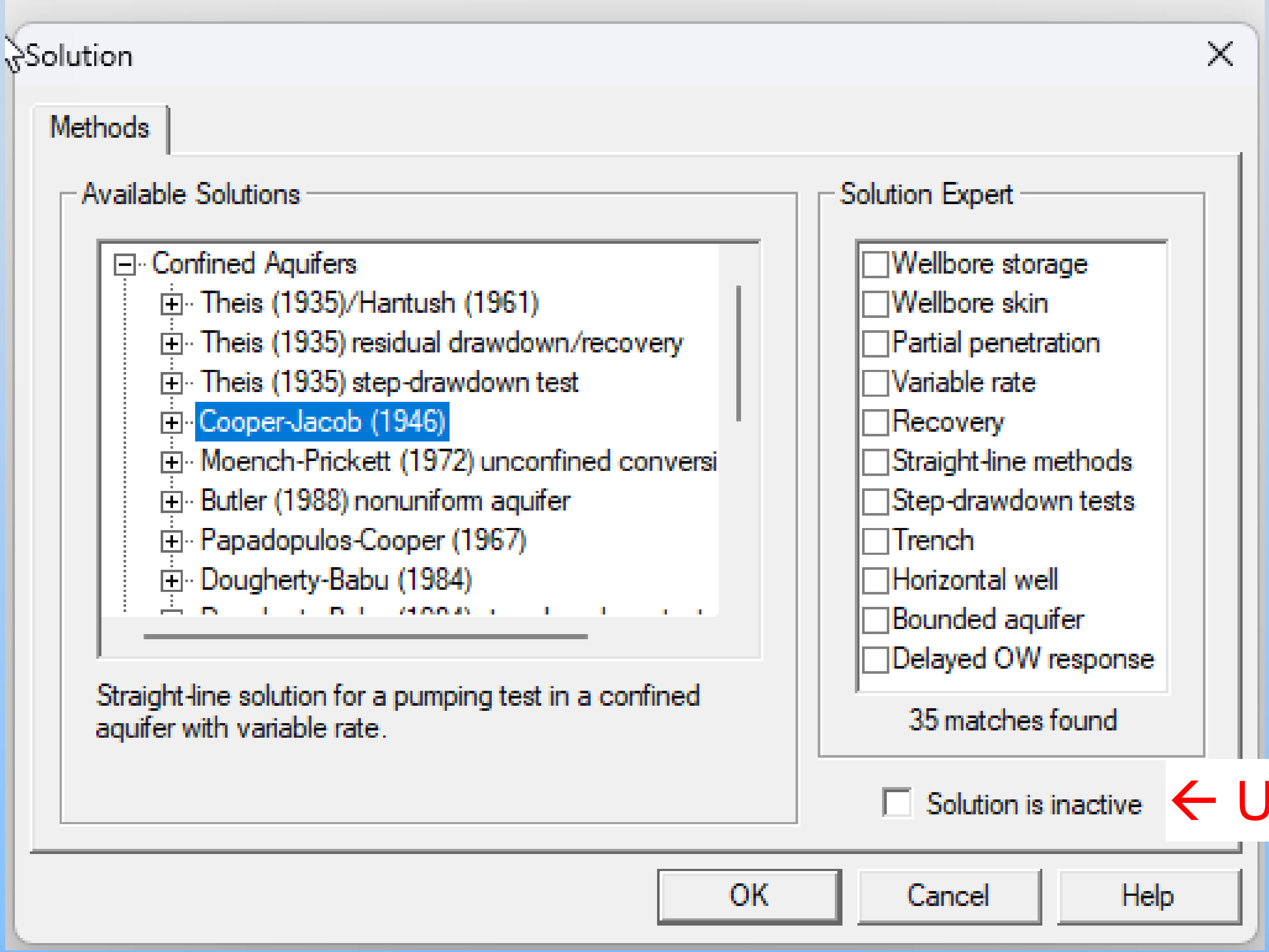
Let us try that again, but smoothing the derivative.



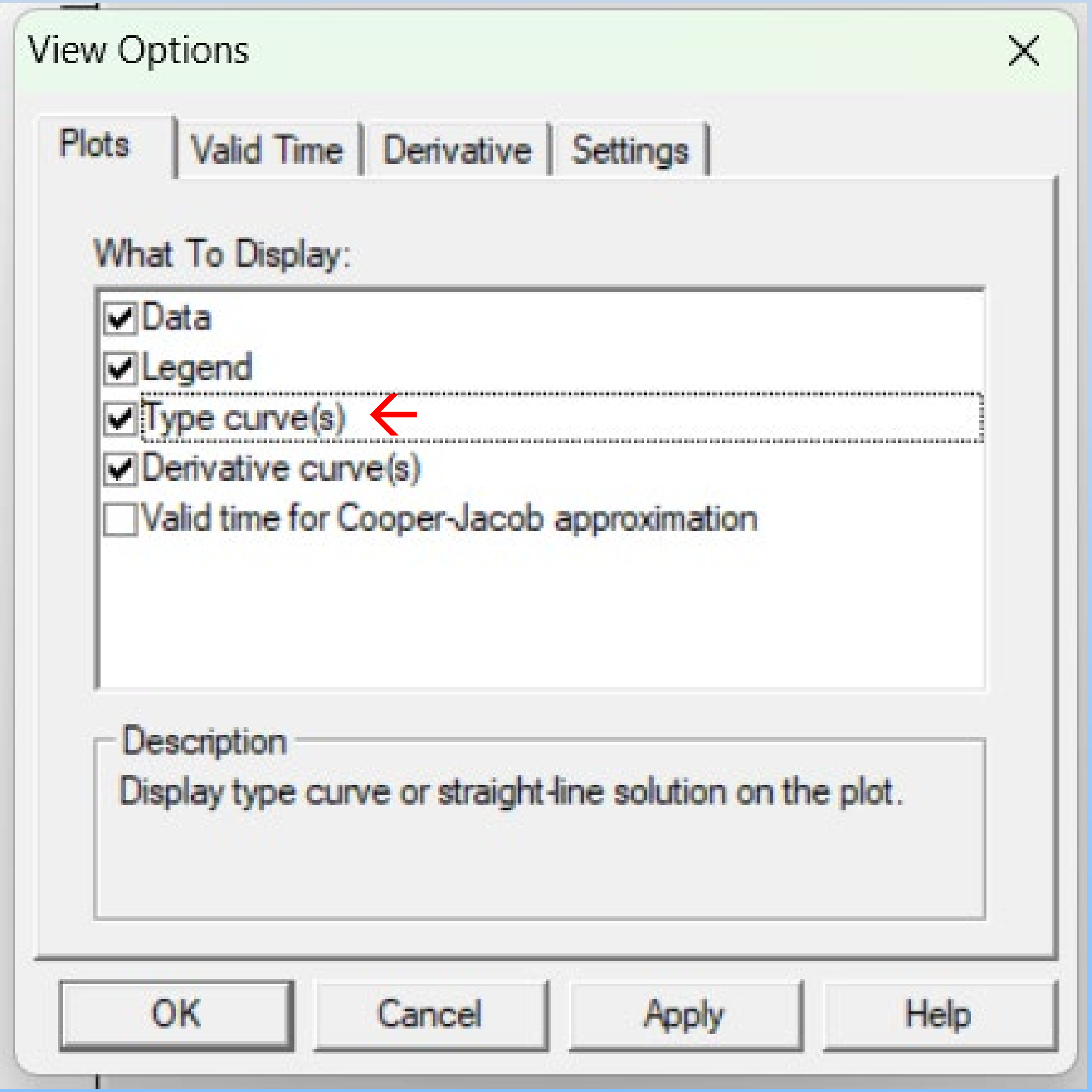
← Start with the default


Estevan (1965)
Displacement (ft)
20.
15.
10.
5.
0.
1.0E-5 1.0E-4 0.001 0.01 0.1 1. 10. 100. 1000. 1.0E+4 1.0E+5 1.0E+6
Time, t/r2 (min/ft2)
Obs. Wells
PW
Obs1

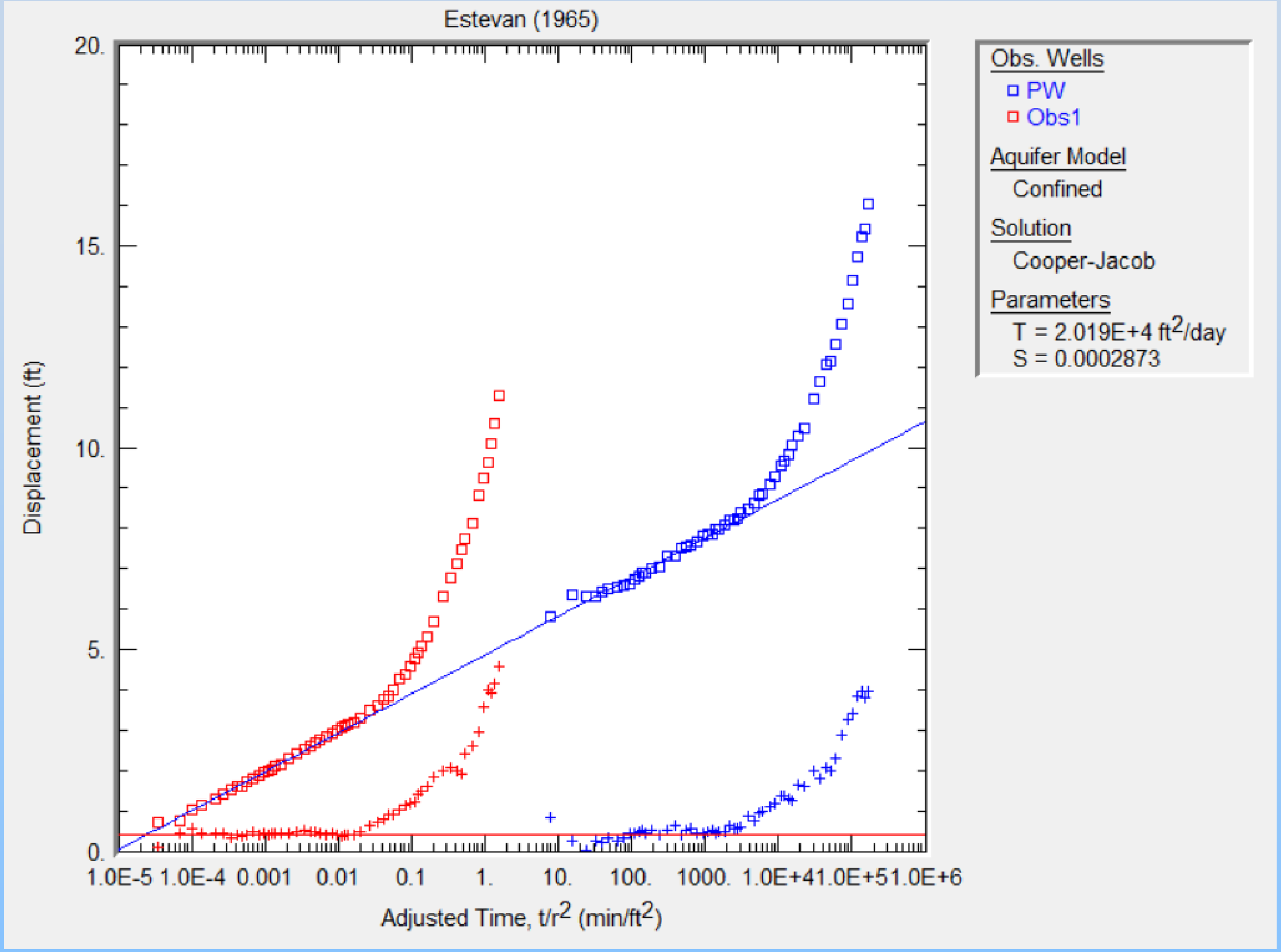
Estimate transmissivity: Cooper-Jacob analysis



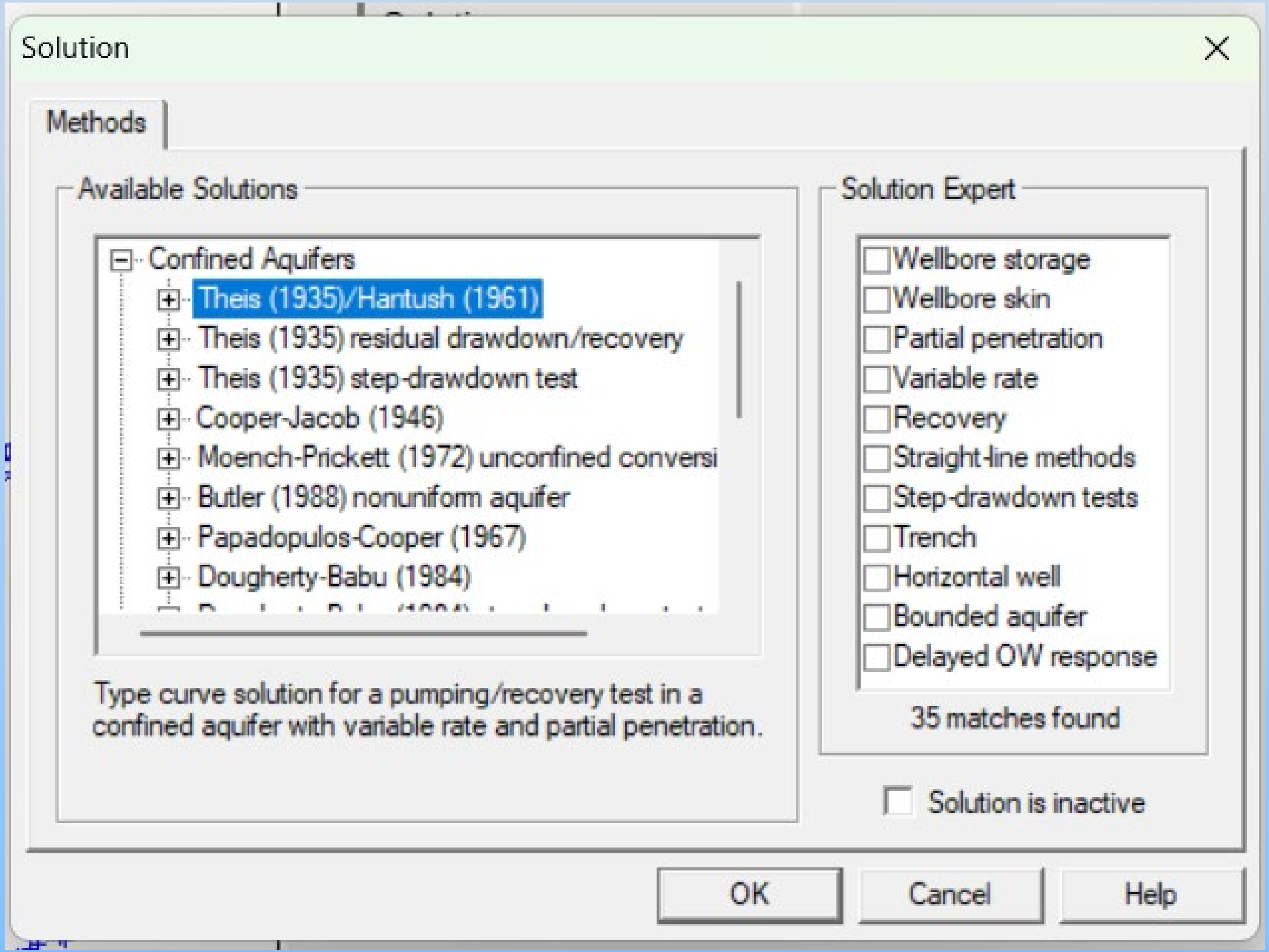
← Unchecked

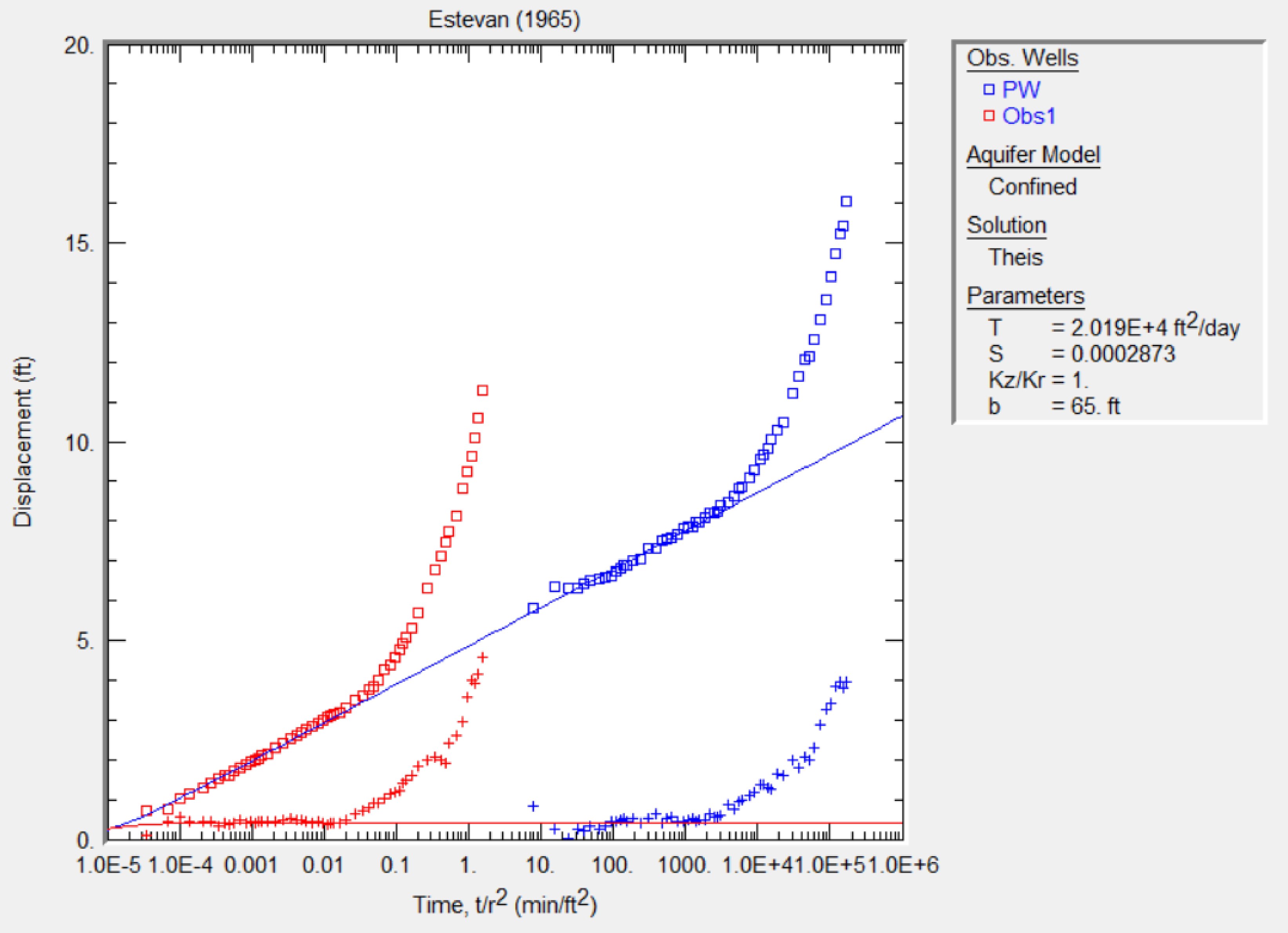

View Options
Plots
Valid Time
Derivative
Settings
What To Display:
Data
Legend
Type curve(s)
Derivative curve(s)
Valid time for Cooper-Jacob approximation
Description
Display type curve or straight-line solution on the plot.
OK
Cancel
Apply
Help

Match → Visual



The Cooper-Jacob analysis does not accommodate boundaries.
We will switch to the Theis (1935) solution, but retain the semilog plot.

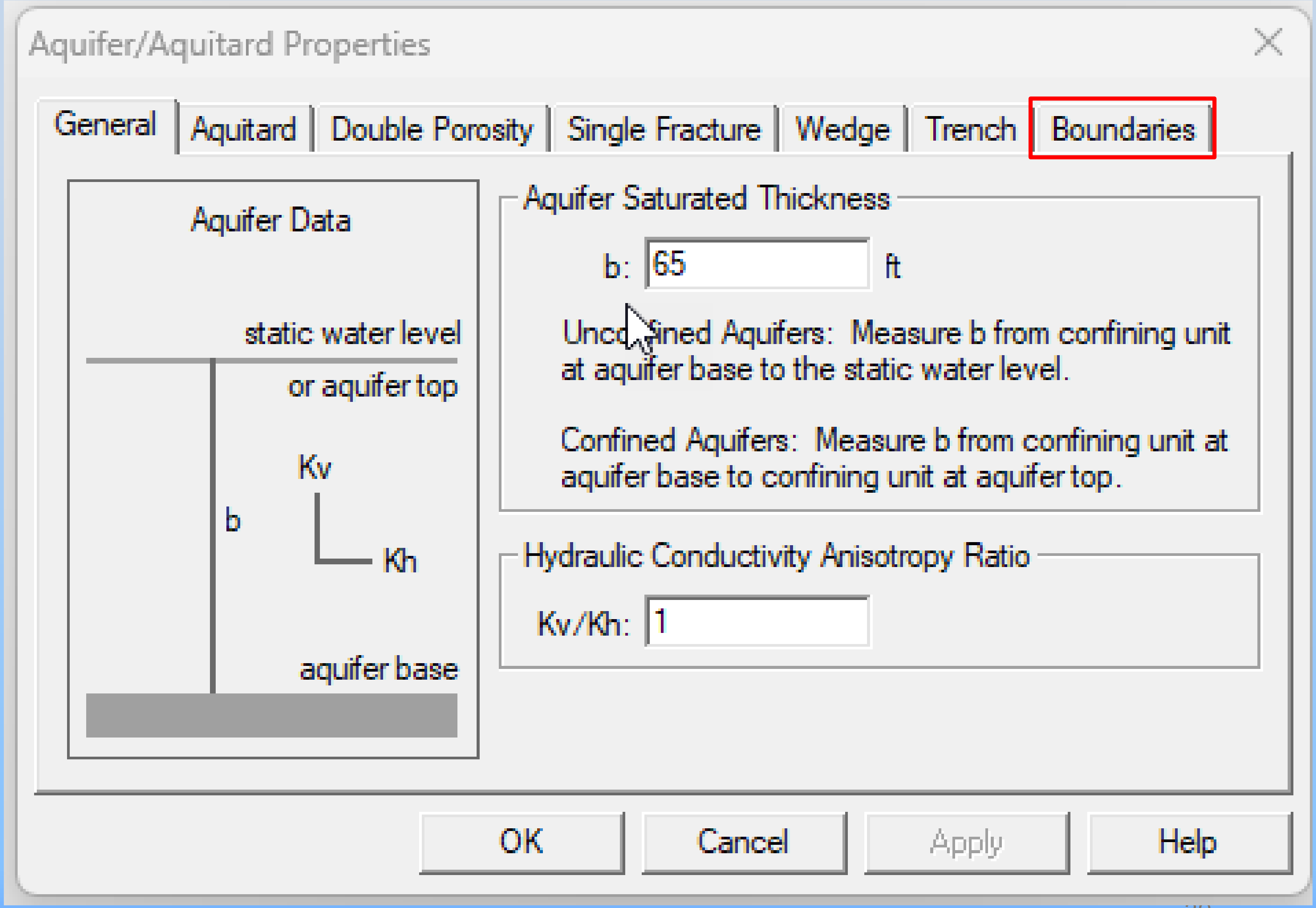


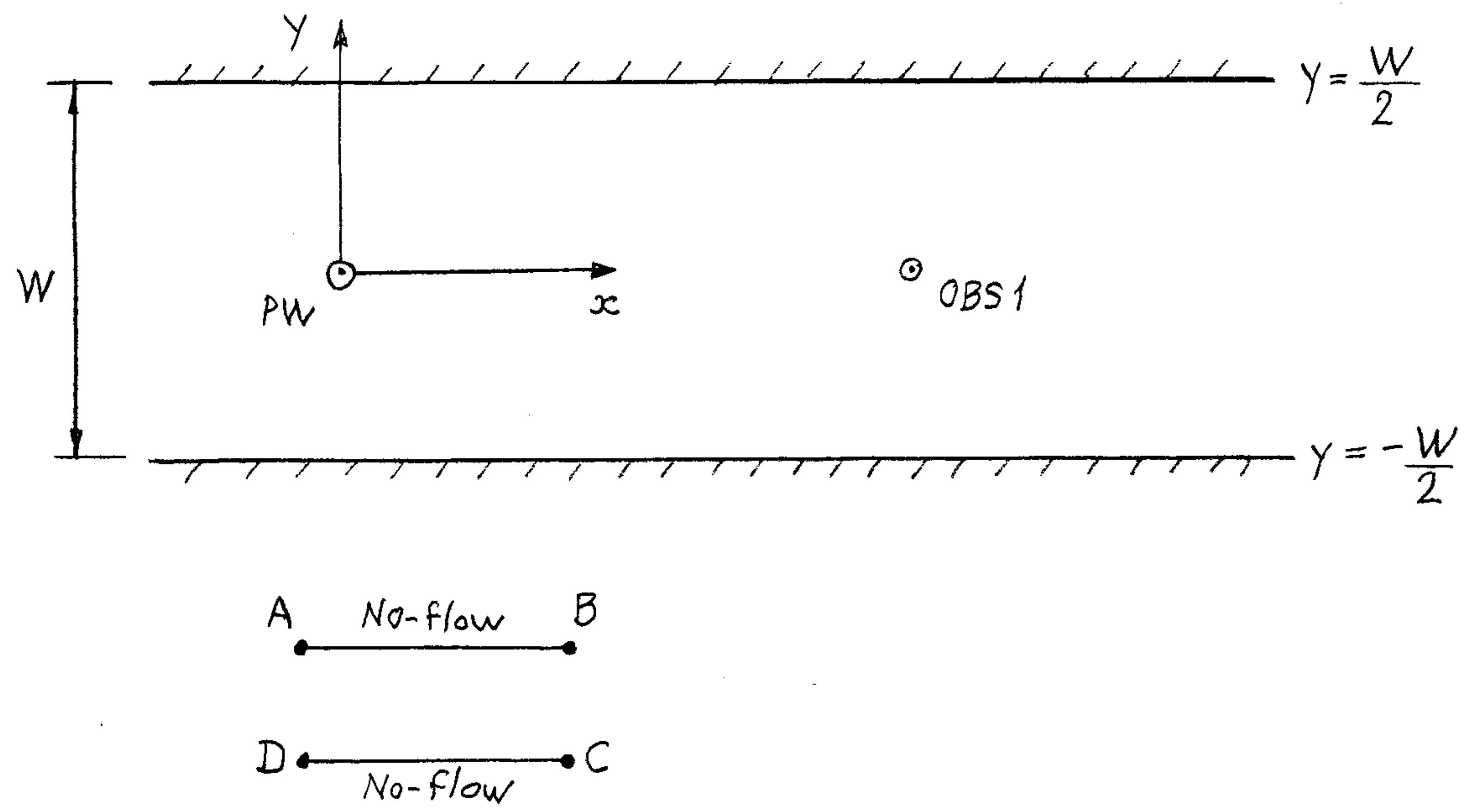


Estevan (1965)
Displacement (ft)
20.
15.
10.
5.
0.
1.0E-5
1.0E-4
0.001
0.01
0.1
1.
10.
100.
1000.
1.0E+4
1.0E+5
1.0E+6
Time, t/r2 (min/ft2)
Obs. Wells
PW
Obs1
Aquifer Model
Confined
Solution
Theis
Parameters
T = 2.019E+4 ft2/day
S = 0.0002873
Kz/Kr = 1.
b = 65. ft

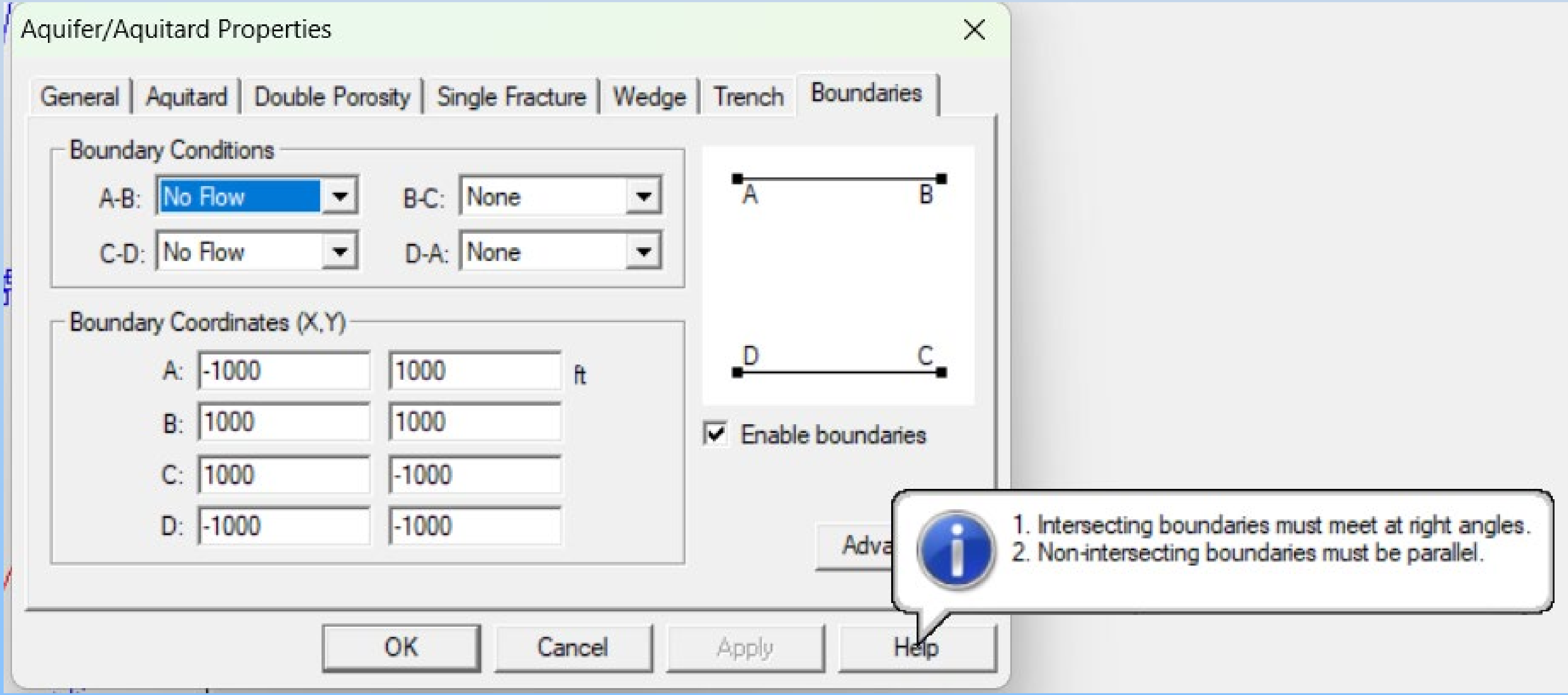
Let us build in the walls of the buried valley.

Edit
→ Aquifer Data

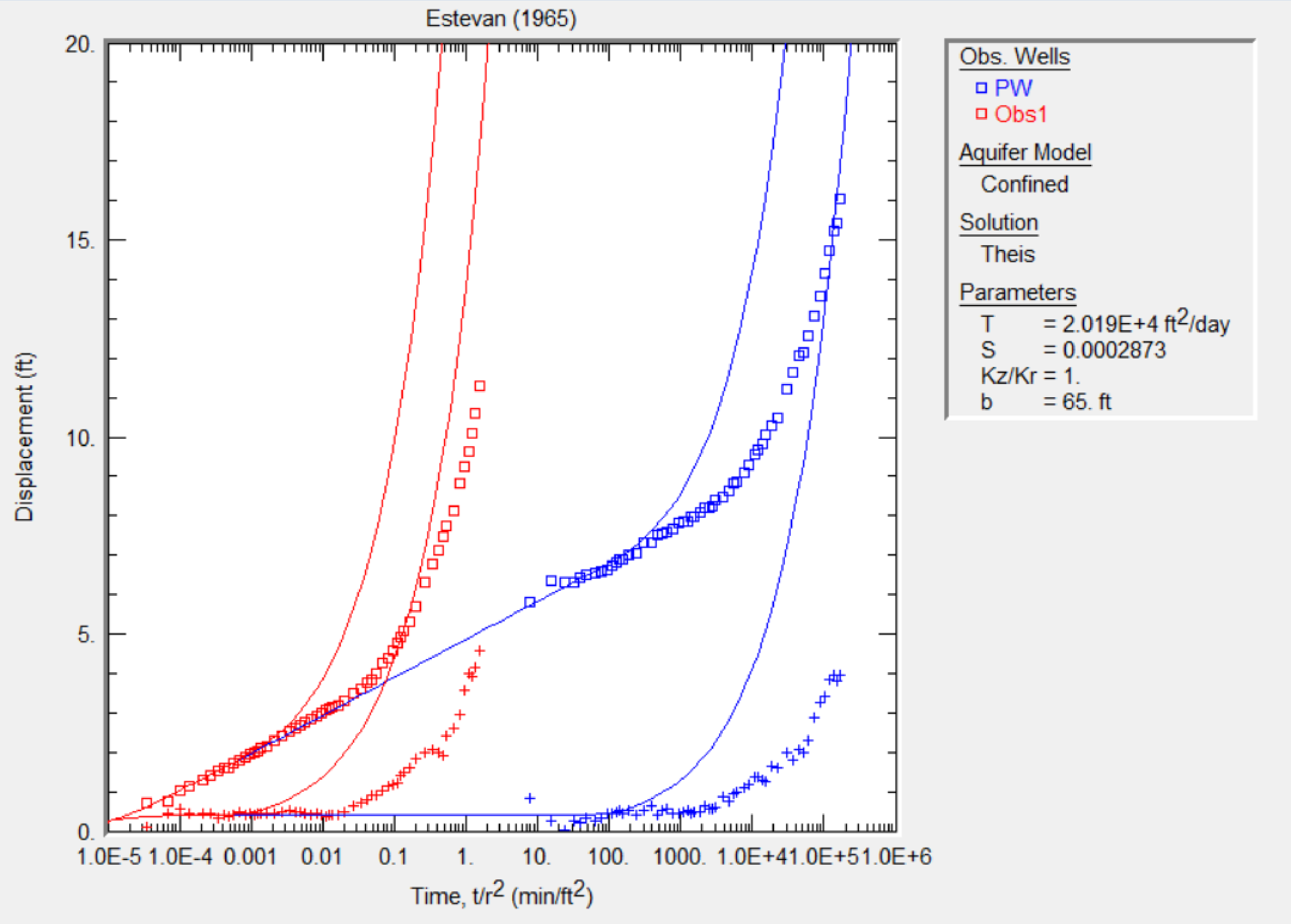



Y
$Y = \frac{W}{2}$
W
PW
x
OBS 1
$Y = -\frac{W}{2}$
A
No-flow
B
D
C
No-flow

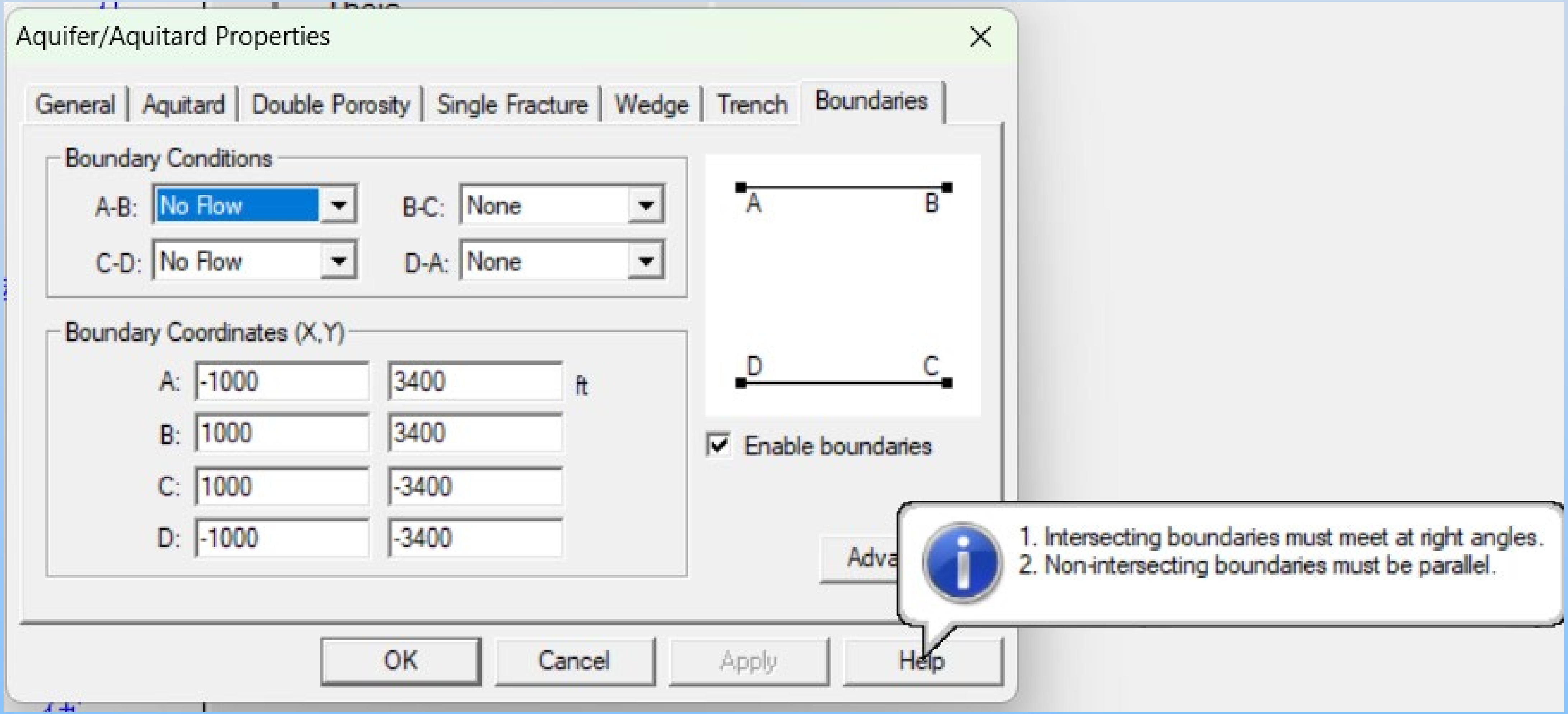
As a first guess, we will assume that the aquifer is 2000 ft wide.

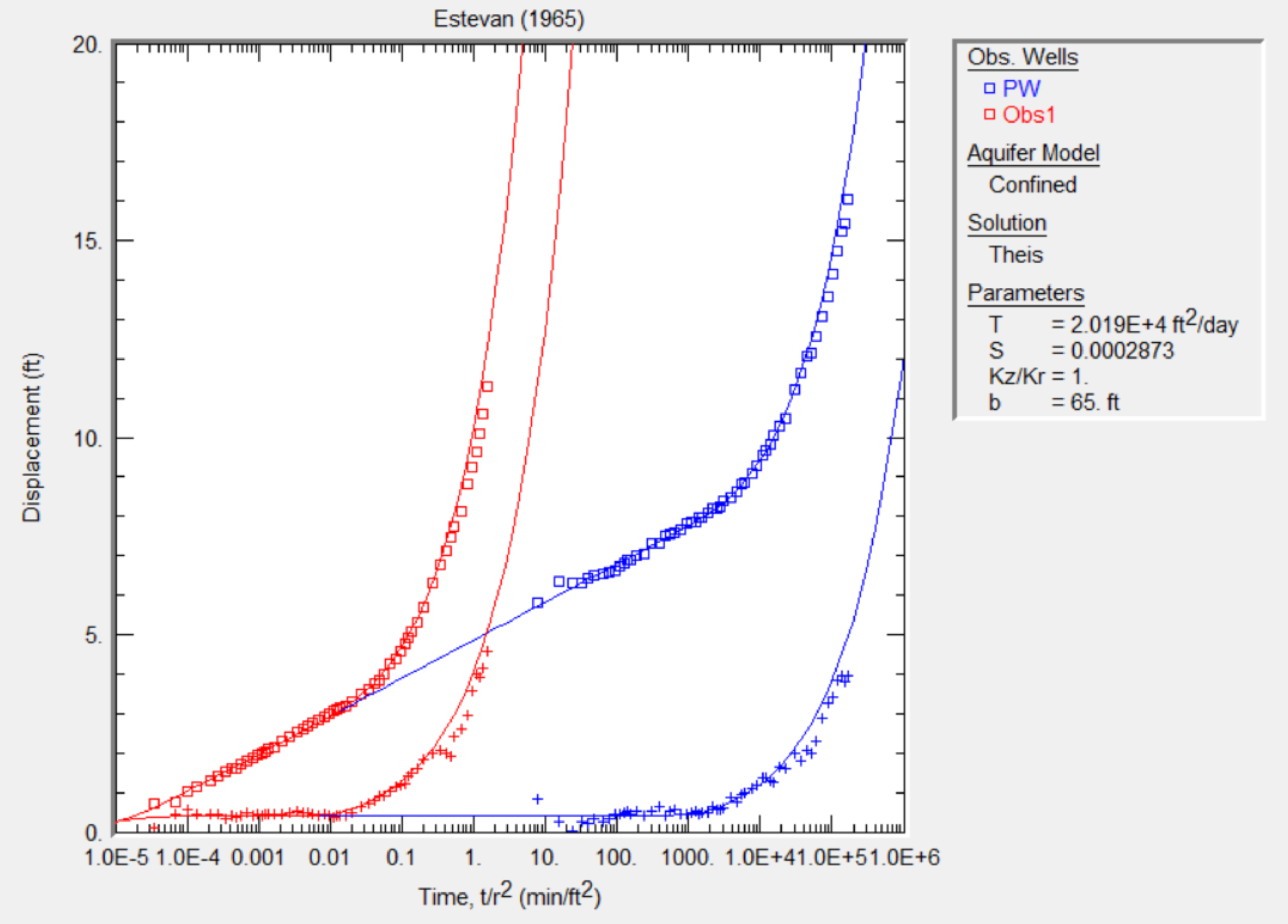


We have captured the general trend. Let us see whether we can improve the match.



Assume that the aquifer is 6800 ft wide.




Estevan (1965)
Displacement (ft)
20.
15.
10.
5.
0.
1.0E-5 1.0E-4 0.001 0.01 0.1 1. 10. 100. 1000. 1.0E+41.0E+51.0E+6
Time, t/r2 (min/ft2)
Obs. Wells
PW
Obs1
Aquifer Model
Confined
Solution
Theis
Parameters
T = 2.019E+4 ft2/day
S = 0.0002873
Kz/Kr = 1.
b = 65. ft

Class exercise: “Validation”

Can we match the drawdowns at the other two observation wells?

ObsWell2.txt:
(x = 250 ft, y = 0.0 ft)

ObsWell3.txt:
(x = 729 ft, y = 0.0 ft)