

CE EN 431
Engineering Hydrology
Winter 1994
Section 1

Lab 12: Groundwater Pumping Test

Submitted to:
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Introduction

For this report, I used the Theis non-equilibrium method and the modified Theis (Cooper-Jacob) method to determine the storage coefficient (S_c) and the coefficient of transmissivity (T). After finding S_c and T by the two methods, I used the Theis non-equilibrium (more accurate) method to calculate the drawdown in an observation well due to a new well.

This lab was highly interesting and informative for me. I learned the two ways to find the necessary constants to determine the drawdown in an observation well.

Objectives/Procedure

For the objectives and procedure, I have included the lab handout. You can find the lab handout in the appendix.

Results

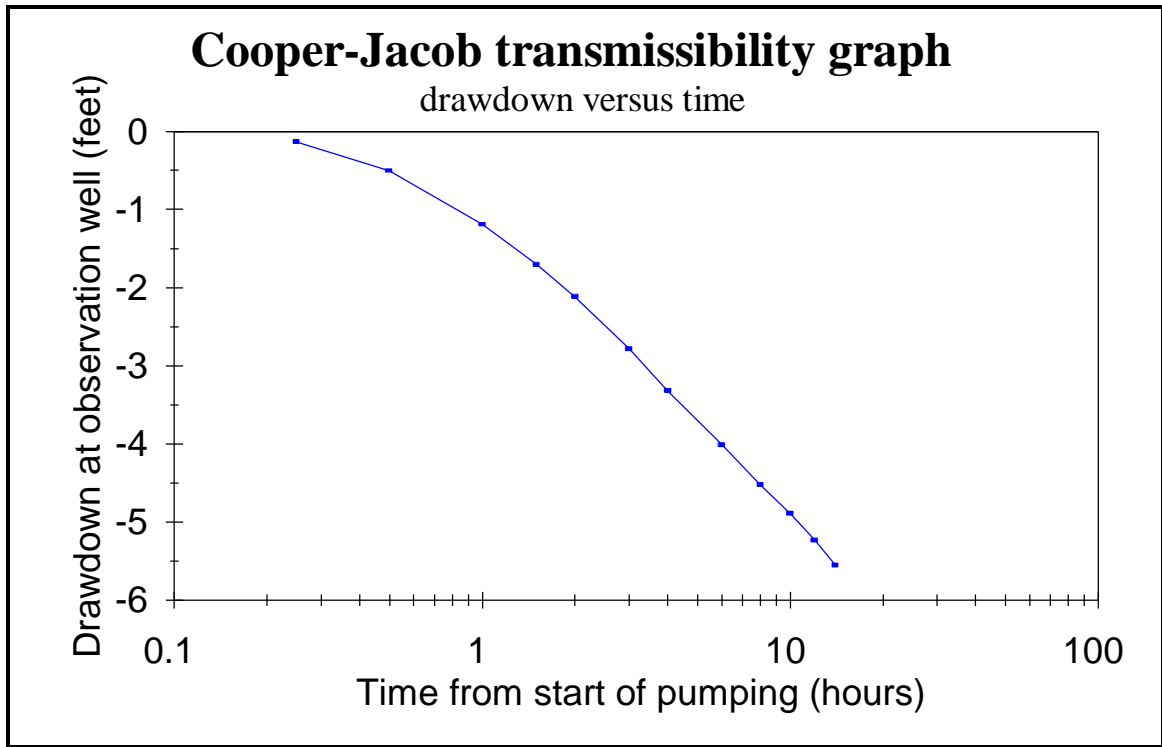


Figure 1: The Cooper-Jacob transmissibility graph for drawdown at the test well.

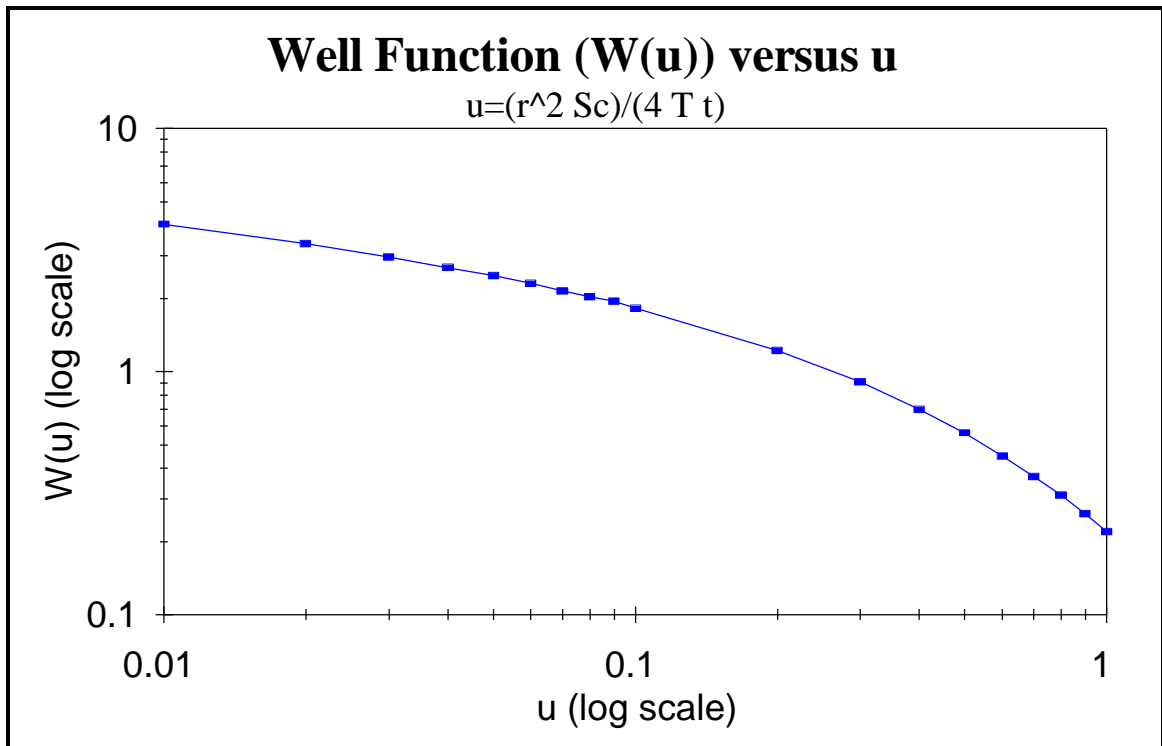


Figure 2: Graph of W(u) vs. u for u between 0.01 and 1.0.

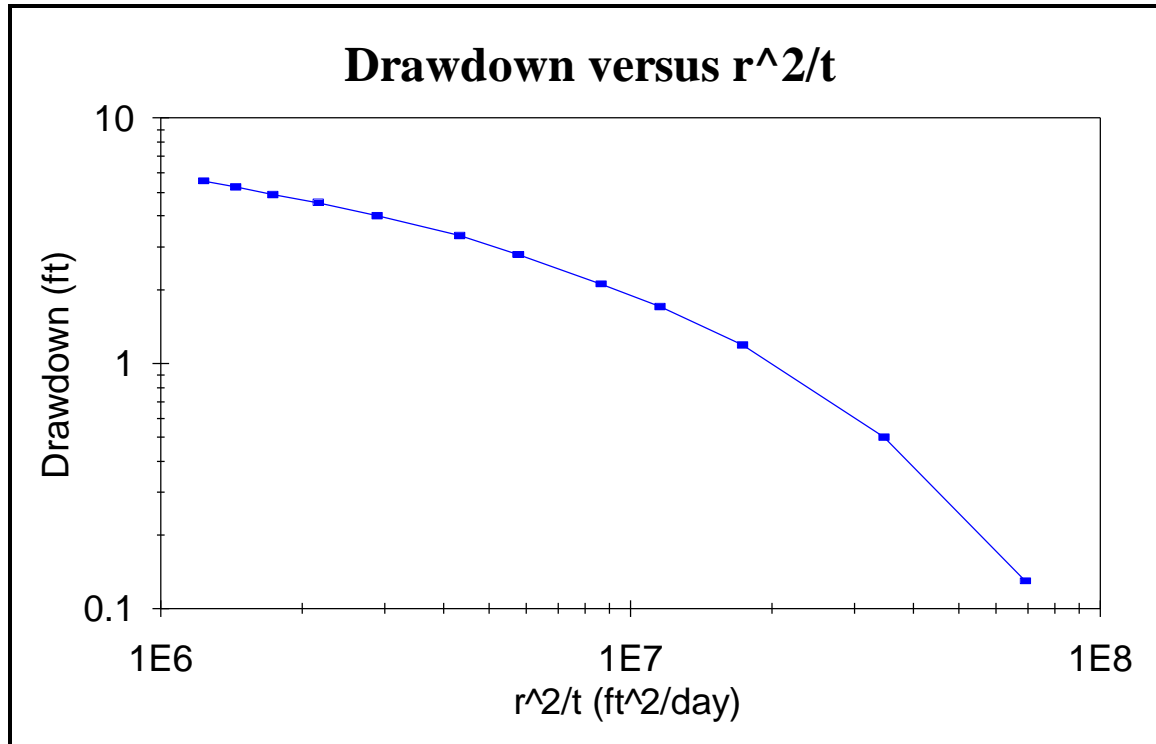


Figure 3: Graph of r^2/t versus drawdown in the test well. The calculations are located in appendix C--Calculations.

Table 1: Values of S_c , T , drawdown, and other stuff for the test well. Data used and calculations are located in appendix C.

Parameter	Value
Transmissivity--Theis non-equilibrium method	9558.2 ft ³ /day-ft
Storage Coefficient--Theis non-equilibrium method	1.072×10^{-3}
Transmissivity--modified Theis (Cooper-Jacob) method	10569 ft ³ /day-ft
Storage Coefficient--modified Theis (Cooper-Jacob) method	8.21×10^{-4}
Pump rate for proposed new well	562 gal/minute
Time of pumping in new well	130 days
Distance from observation well	2500 ft
Draw down at observation well from proposed new well	5.52 ft

Discussion

You can see the results in figure 1 and table 1.

Differences between the two methods. The Theis non-equilibrium method gives more accurate values for the storage coefficient and the coefficient of transmissivity for shorter times than the Cooper-Jacob method. As you can see from table 1, however, the transmissivity from the Cooper-Jacob method (10569 ft³/day-ft) and the Theis method (9558 ft³/day-ft) are about the same. Also, the storage coefficients for the two methods are similar. Both storage coefficients were about 1×10^{-3} . The results should be similar, however, since both ways are valid for a long pumping time. I think enough data was given to say that the pumping occurred for a long length of time.

Drawdown in the observation well from the new well. To calculate the drawdown in the observation well from the new well, I used the storage coefficient and the transmissivity from the Theis non-equilibrium method. This method gives the most accurate storage coefficient and transmissivity value for the relatively short time that the pumping test was performed. With a pump rate of 562 gallons/minute, a time of pumping of 130 days, and a distance from the observation well of 2500 ft, the **drawdown at the observation well was 5.52 feet.**

Calculations

The calculations were fairly straightforward and involved finding the storage coefficients by both methods, the transmissivity by both methods, and calculating the drawdown in the observation well from the proposed new well. *My calculations and data are located in Appendices B and C.*

First, I created the graphs of $W(u)$ versus u and drawdown versus r^2/t . From these graphs, I found the values of $W(u)$, u , drawdown, and r^2/t that could be used in the equations. I found where the graphs crossed each other the greatest while keeping the axes parallel. Then, I took the center of this line and found the values of $W(u)$, u , drawdown, and r^2/t at this point.

After finding these values, I calculated the transmissivity (T) for the Theis method using the following equation:

$$T = \frac{Q \times W(u)}{z \times 4P} \text{ --equation 1}$$

where T is the transmissivity in $\text{ft}^3/\text{day-ft}$, $W(u)$ is the unitless well function, Q is the flow in ft^3/day , and z is the drawdown in feet.

Then, I calculated the storage coefficient using the following equation:

$$S_c = \frac{4 \times T \times u}{r^2 / t} \text{ --equation 2}$$

where S_c is the unitless storage coefficient, T is the transmissivity, u is defined by the equation and is unitless, r is the distance to the observation well in feet, and t is the time in days.

I calculated the transmissivity and storage coefficient by the Cooper-Jacob method using the method outlined on pages 369-370, part 10.7.3 of the hydrology textbook (see appendix A for reference).

Finally, I calculated the drawdown by using the following steps:

1. I found u from equation b on the lab handout (equation 2 above).
2. Then, I went to the back side of the lab handout to obtain $W(u)$ from u . I linearly interpolated between the values to get $W(u)$.
3. Then I used equation a on the lab handout (equation 1 above) to find the drawdown in the observation well.

Conclusions/Applications

In conclusion, this lab was highly excellent and useful. Using experimental test wells, groundwater hydrologists can find the drawdown at the test well. From the

drawdown at the test well, a hydrologist can calculate the storage coefficient and the transmissivity of the aquifer. From these values, you can determine the drawdown at the test well from a proposed new well.

The Theis non-equilibrium method and the Cooper-Jacob methods are two ways of determining the coefficient of storage and the transmissivity of an aquifer. These methods were presented in this fine lab. The Theis method should be used for short pumping times, while the Cooper-Jacob method is more accurate for long pumping times.

Some error may be associated with interpreting the data by the two methods. But for the most part, the two methods give good results.

Appendix

Appendix A: References

- Wanielista, Martin. **Hydrology and Water Quantity Control**. John Wiley and Sons, Inc. 1990.

The lab handout and my calculations are located on the following pages.

Appendix B: Lab Handout

Appendix C: Calculations and Data