University of Anbar
Department of Applied Geology
Ramadi-Iraq
Mahmood H. D. Al-Kubaisi

Lecture (8)

Pumping tests

The principle of a pumping test is that if we pump water from a well and measure the discharge of the well and the drawdown in the well and piezometers at known distances from the well, we can substitute these measurements into an appropriate well-flow equation and can calculate the hydraulic characteristics of the aquifer (Figure 1).

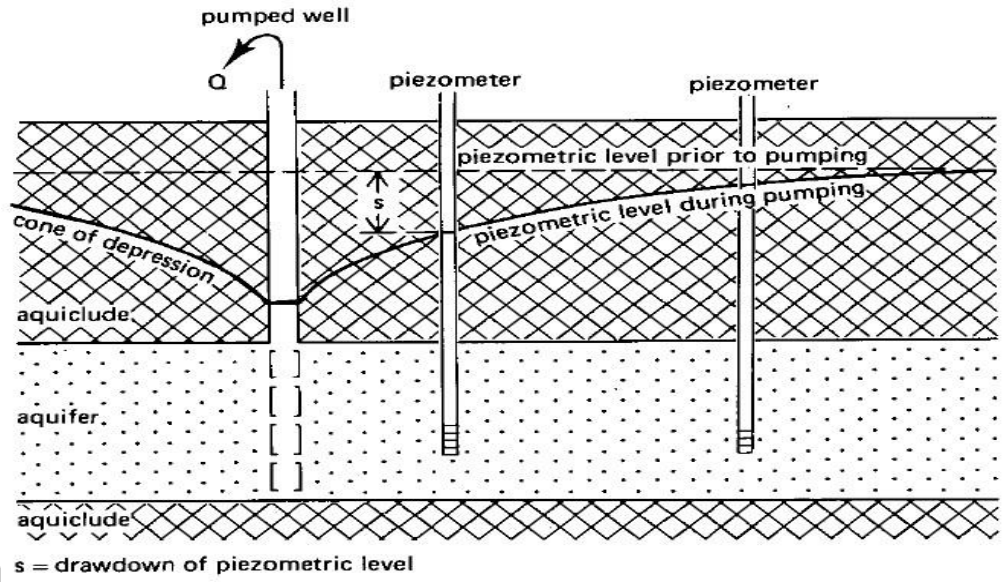


Figure 1: Drawdown in a pumped aquifer

Preliminary studies

Before a pumping test is conducted, geological and hydrological information on the following should be collected:

- The geological characteristics of the subsurface (i.e. all those lithological, stratigraphic, and structural features that may influence the flow of groundwater) ;

- The type of aquifer and confining beds;

- The thickness and lateral extent of the aquifer and confining beds;

- Data on the groundwater-flow system: the horizontal or vertical flow of groundwater, water table gradients, and regional trends in groundwater levels;

- Any existing wells in the area. From the logs of these wells, it may be possible to derive approximate values of the aquifer's transmissivity and storativity and their spatial variation.

Selecting the site for the well

When an existing well is to be used for the test or when the hydraulic characteristics of a specific location are required, the well site is predetermined and one cannot move to another, possibly more suitable site. When one has the freedom to choose, however, the following points should be kept in mind:

- The hydrogeological conditions should not change over short distances and should be representative of the area under consideration, or at least a large part of it;

- The site should not be near railways or motorways where passing trains or heavy traffic might produce measurable fluctuations in the hydraulic head of a confined aquifer;

- The site should not be in the vicinity of existing discharging wells;

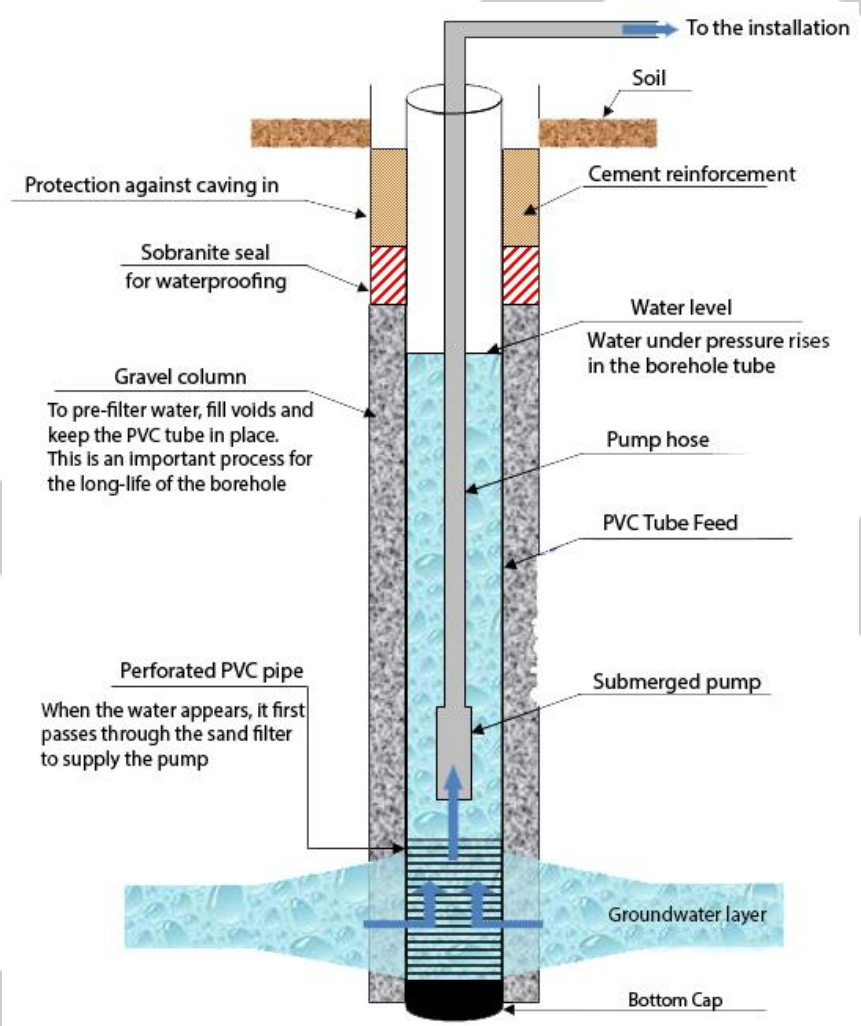
- The pumped water should be discharged in a way that prevents its return to the aquifer;

- The gradient of the water table or piezometric surface should be low;

- Manpower and equipment must be able to reach the site easily.

The well

After the well site has been chosen, drilling operations can begin. The well will consist of an open-ended pipe, perforated or fitted with a screen in the aquifer to allow water to enter the pipe, and equipped with a pump to lift the water to the surface.



CUTTING DRILLING

1. Well diameter

A pumping test does not require expensive large-diameter wells. If a suction pump placed on the ground surface is used, as in shallow water table areas, the diameter of the well can be small. A submersible pump requires a well diameter large enough to accommodate the pump.

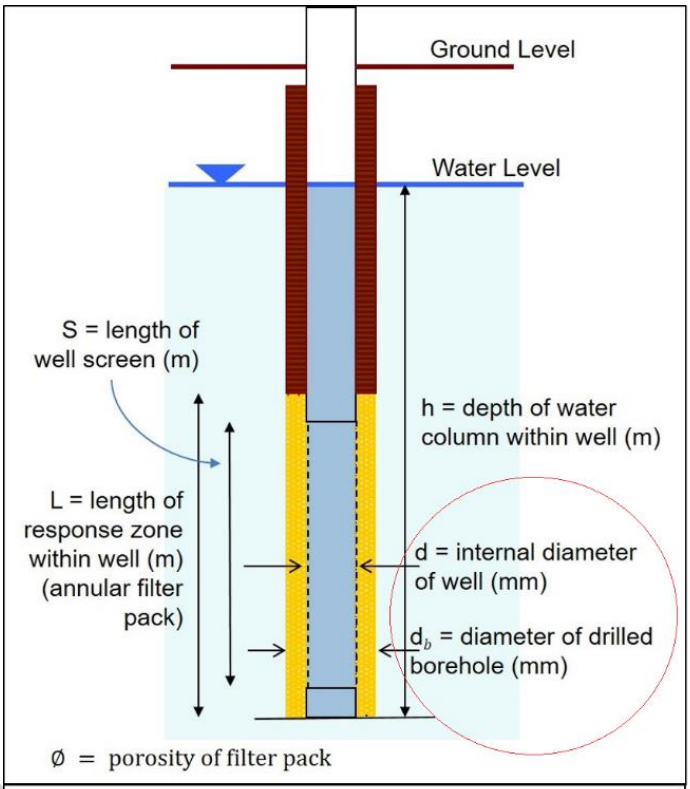
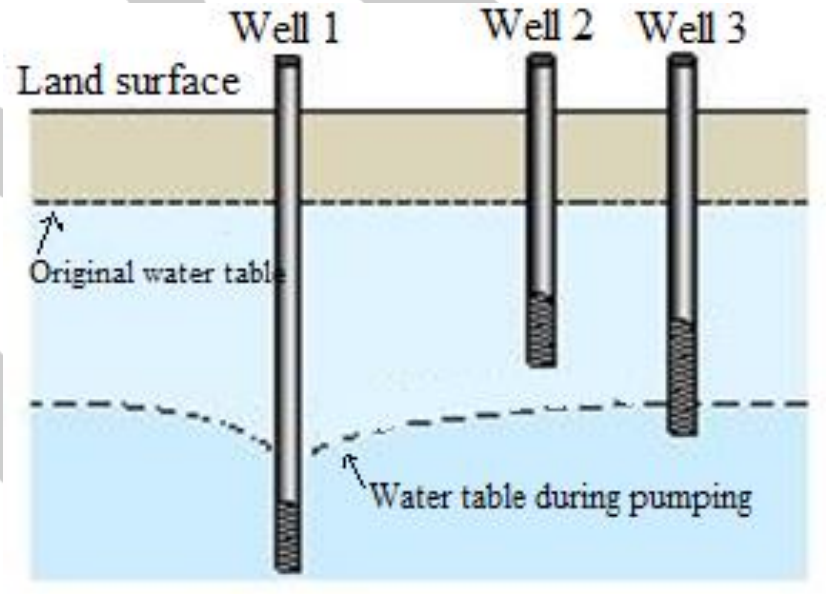


Figure : Well dimensions and units

2. Well depth

The well should be drilled to the bottom of the aquifer, if possible, because this has various advantages, one of which is that it allows a longer well screen to be placed, which will result in a higher well yield.



3. Well screen

If the aquifer consists of coarse gravel, the screen can be made locally by sawing, drilling, punching, or cutting openings in the pipe. In finer formations, finer openings are needed.

A general rule is to screen the well over at least 80 percent of the aquifer thickness because this makes it possible to obtain about 90 percent or more of the maximum yield. Another even more important advantage of this screen length is that the groundwater flow towards the well can be assumed to be horizontal, an assumption that underlies almost all well-flow equations (Figure 2A).

There are some exceptions to the general rule:

- In unconfined aquifers, it is common practice to screen only the lower half or lower one-third of the aquifer because, if appreciable drawdowns occur, the upper part of a longer well screen would fall dry;
- In a very thick aquifer, the screen will have to be less than 80 percent, simply for reasons of economy.
- Wells in consolidated aquifers do not need a well screen because the material around the well is stable.

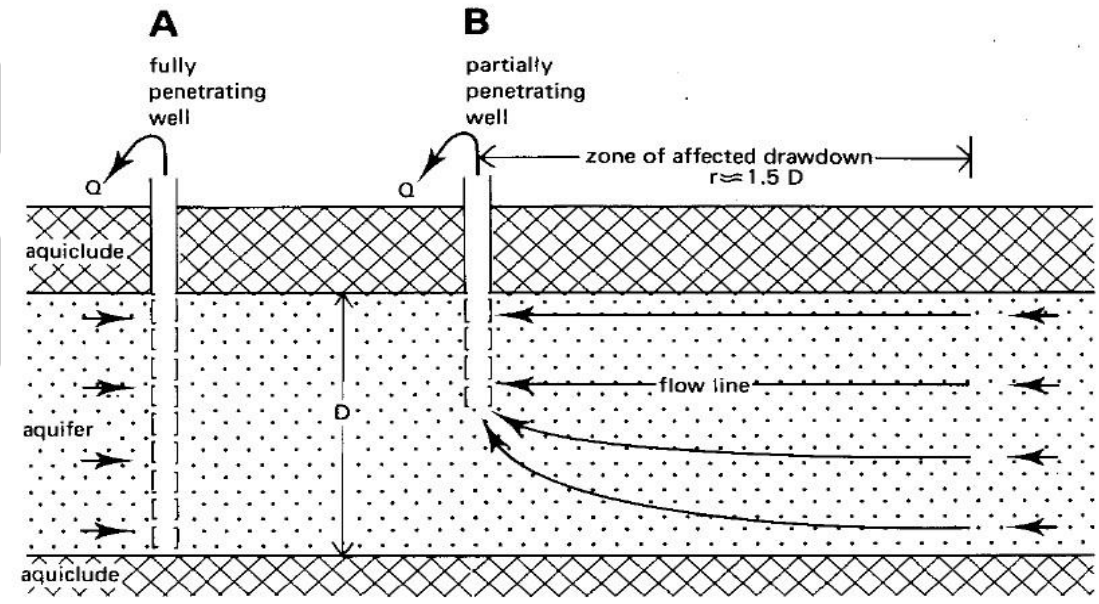
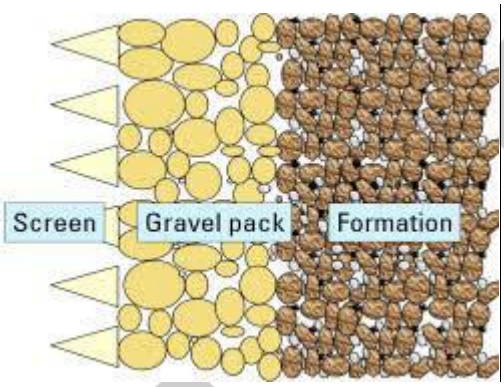
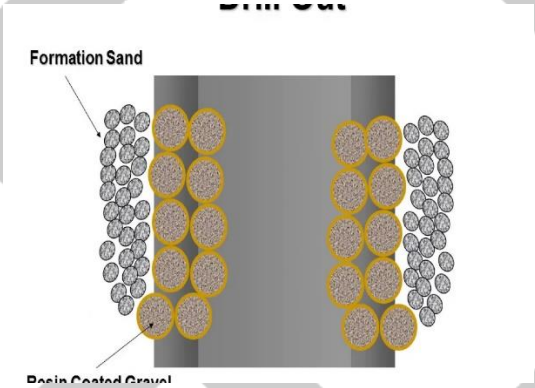


Fig. 2: A) A fully penetrating well; B) A partially penetrating well.

4. Gravel pack

When the well is pumped, the gravel pack will retain much of the aquifer material that would otherwise enter the well. With a gravel pack, larger slot sizes can be selected for the screen. The thickness of the pack should be in the range of 8 to 15 cm. Gravel pack material should be clean, smoothly-rounded grains.

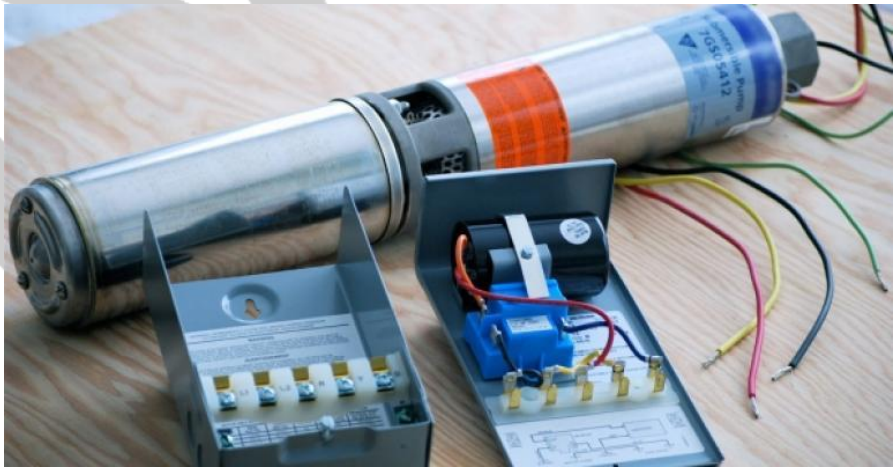




5. The pump

After the well has been drilled, screened, and gravel-packed, as necessary, a pump has to be installed to lift the water.

After the pump has been installed, the well should be developed by being pumped at a low discharge rate. When the initially cloudy water becomes clear, the discharge rate should be increased and pumping continued until the water clears again. This procedure should be repeated until the desired discharge rate for the test is reached or exceeded.



6. Discharging the pumped water

The water delivered by the well should be prevented from returning to the aquifer. This can be done by conveying the water through a large-diameter pipe, say over a distance of 100 or 200 m, and then discharging it into a canal or natural channel.

References:

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