Physical and Chemical Hydrogeology

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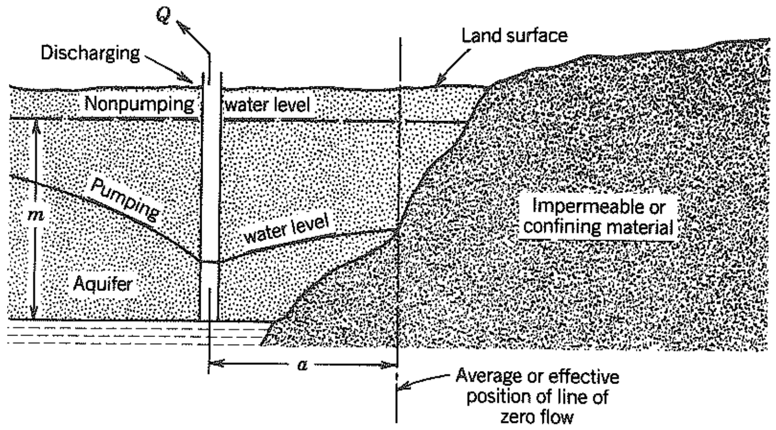
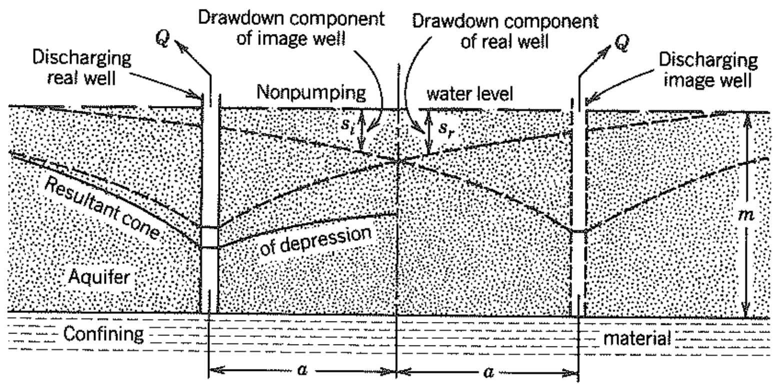


(a) Real System

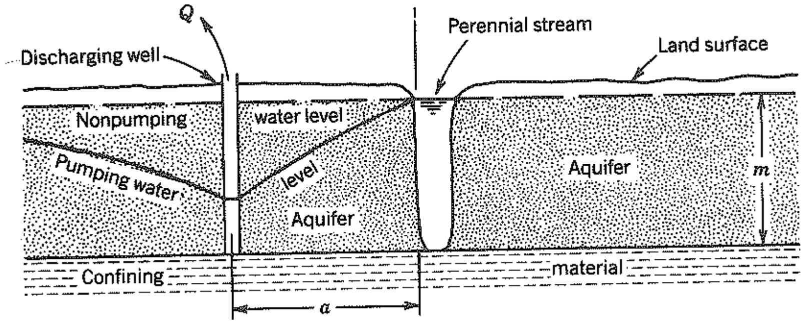


Note: Aquifer thickness m should be very large compared to resultant drawdown near real well.

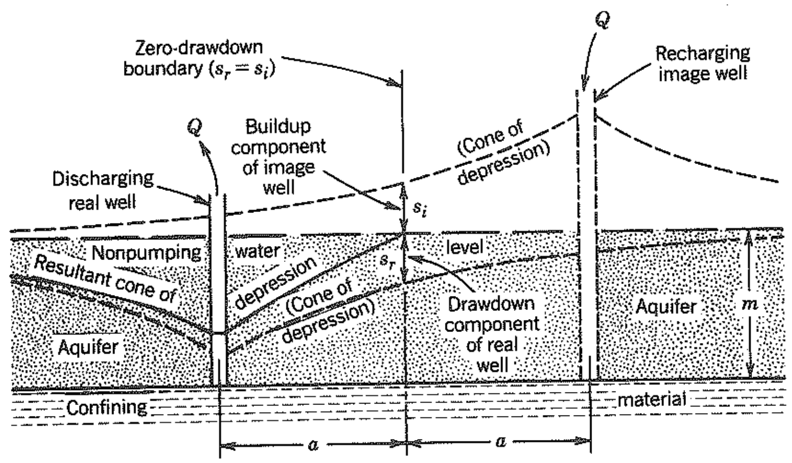
(b) Hydraulic counterpart of Real System

Figure 5.24

Diagrams of the effect of pumping near barrier and constant-head boundaries and appropriate hydraulic counterparts for image well theory (from Ferris and others, 1962). Note: Aquifer thickness m should be very large compared to resultant drawdown near real well.



(c) Real System



Note: Aquifer thickness m should be very large compared to resultant drawdown near real well.

(d) Hydraulic Counterpart of Real System

Figure 5.24
continued

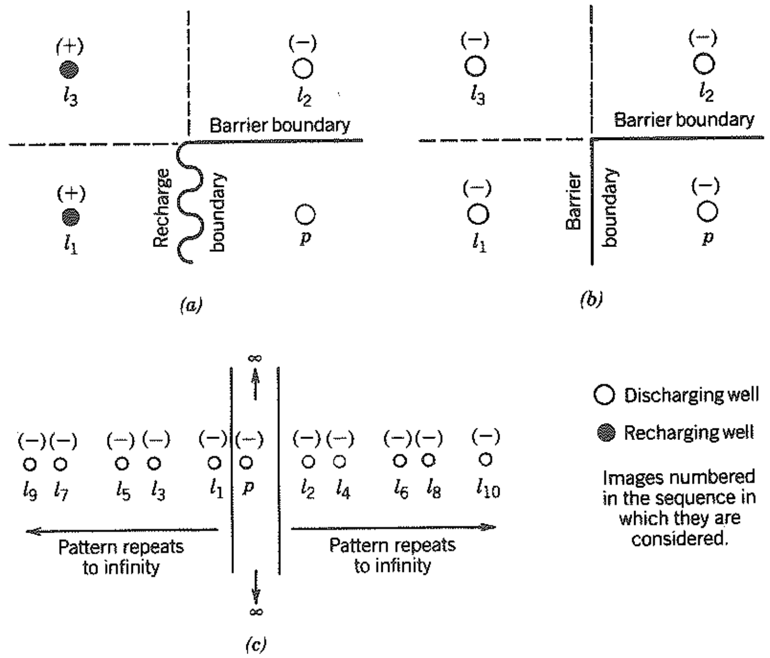


Figure 5.25
Image well systems for (*a*) wedge-shaped aquifer with both barrier and recharge boundaries, (*b*) wedge-shaped aquifer with barrier boundaries, and (*c*) infinite strip.

where

$$(u)_p = \frac{r_p^2 S}{4Tt} = \frac{(500)^2\text{ft}^2\ 5 \times 10^{-2}}{(4)(1340)\text{ft}^2/\text{day}(365)\text{day}} = 6.38 \times 10^{-3}$$

$$(u)_i = \frac{r_i^2 S}{4Tt} = \frac{(1500)^2\text{ft}^2\ 5 \times 10^{-2}}{(4)(1340)\text{ft}^2/\text{day}(365)\text{day}} = 5.75 \times 10^{-2}$$

From Table 5.1, $W(u)_p = 4.5$, $W(u)_i = 2.33$

$$s = \frac{96 \times 10^3\text{ft}^3/\text{day}}{4 \times 3.14 \times 1.34 \times 10^3\text{ft}^2/\text{day}}(6.83) = 39\text{ ft} = 11.89\text{ m}$$

Example 5.10

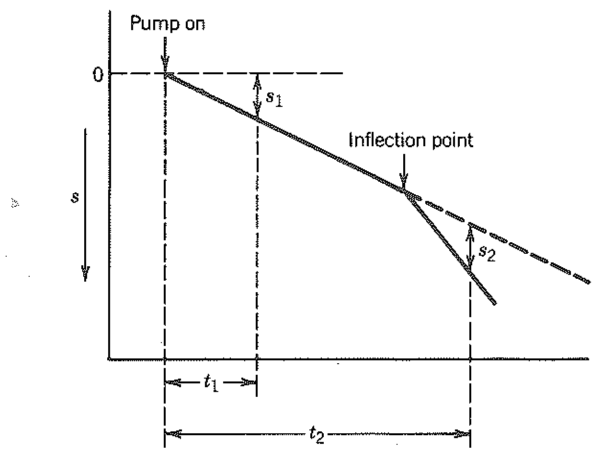
The accompanying figure depicts a time-drawdown response in an observation well affected by one pumping well and a barrier boundary. By construction, $s_1 = s_2$. It thus follows that $W(u)_1 = W(u)_2$ and

$$u_1 = \frac{r_1^2 S}{4Tt_1} \quad \text{and} \quad u_2 = \frac{r_2^2 S}{4Tt_2}$$

where $u_1 = u_2$. Thus

$$r_2 = r_1 \left(\frac{t_2}{t_1}\right)^{1/2}$$

where r_1 is the distance from the pumping well to the observation well, which is known, and r_2 is the distance from the observation well to the imaginary pumping well causing the inflection, which is readily calculated. However, because the exact location of the barrier is not known, r_2 merely defines a set of points that form a circle of radius r_2 with the observation well located at its center.



5.5 Hydraulic Testing in Fractured or Low-Permeability Rocks

Advances in hydraulic testing over the past decade have been born out of the practical necessity of evaluating rocks as hosts for chemical or nuclear wastes. In some cases, this requires testing in deep boreholes up to a few thousand feet in depth, often in rocks that are of a low permeability, and frequently in rock that is fractured. In many cases, the emphasis has been on the single-borehole test. These tests generally require special equipment such as packers to isolate testing zones, feed in apparatus whereby a slug of water may be removed from the isolated zone or the zone quickly pressurized, and pressure transducers to measure the response. With deep boreholes, temperature or salinity effects on fluid density must sometimes be accounted for. Hydraulic testing in this modern era is thus a field within itself, generally requiring a large degree of specialization. In this section, we will consider only a few of the methods in detail.