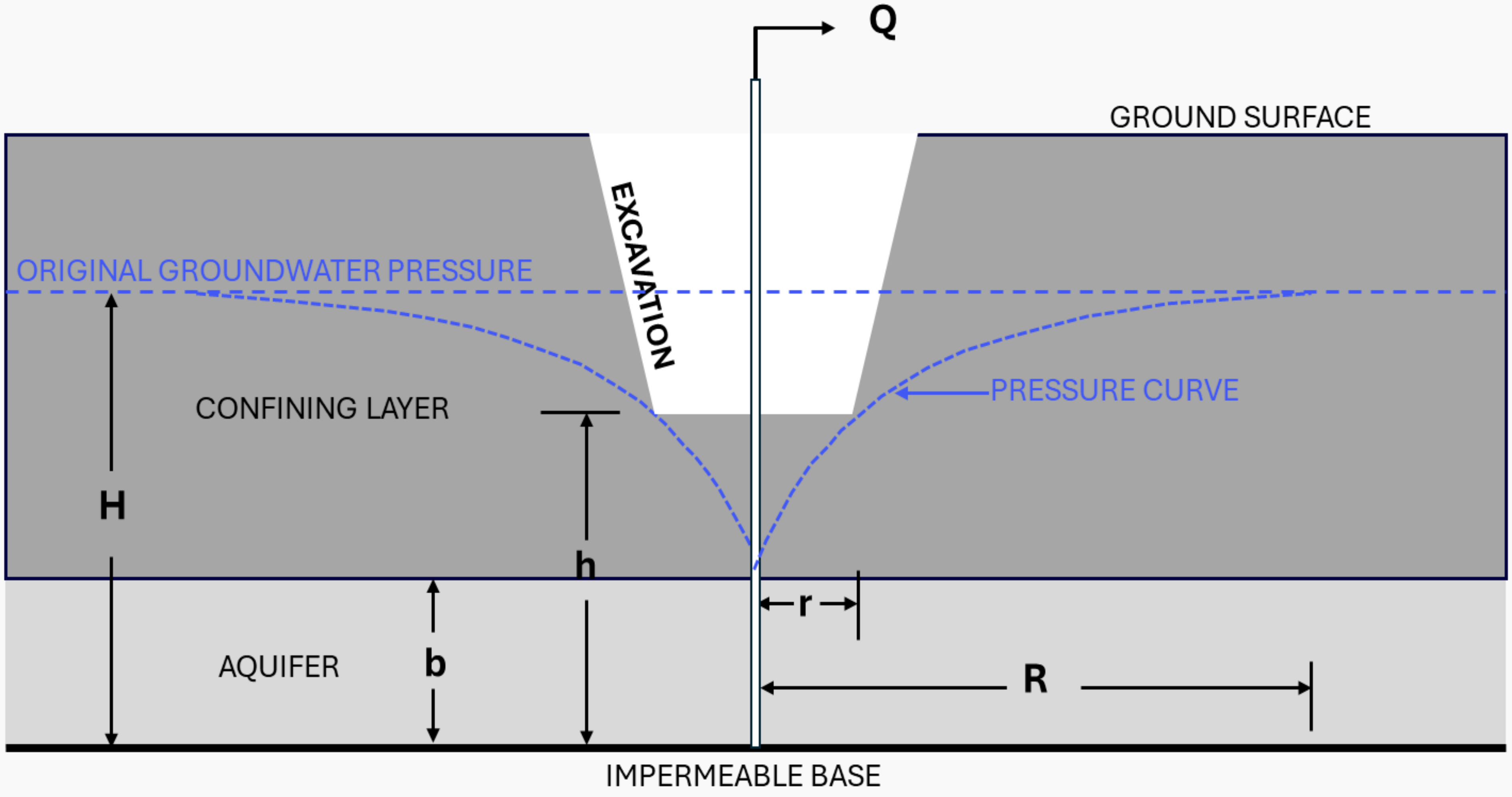
Aquifer Depressurizing Model by Equivalent Well Method

Application: Confined Aquifer



$$Q = \frac{2\pi K b (H - h)}{\ln\left(\frac{R}{r}\right)}$$

Flow Rate (Q)

Estimate pumping rate needed to control groundwater in excavation or pit.

Groundwater Head (h_2)

Approximate the new aquifer head at any distance (r_2) beyond the pit.

$$h_2 = H - (H - h)\frac{\ln\left(\frac{R}{r_2}\right)}{\ln\left(\frac{R}{r}\right)}$$

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When to use it

Use this method when you need a quick estimate of depressurizing flow and groundwater head change around an excavation.

Typical applications include:

- Construction dewatering
- Quarries
- Open-Pit Mines

What you need

Aquifer properties:

- Hydraulic conductivity
- Storativity for the transient calculation
- Aquifer thickness and initial head

Excavation properties:

- Length, width, and depth

Limitations

- Applicable when an excavation or pit in a confined aquifer can be treated as a single-layer problem and simplified to an equivalent circle.
- Best suited to excavations with a length-to-width ratio of about 1.5 or less.
- Cannot estimate groundwater head change within the excavation ut not inside it.
- A radius of influence must be defined, but that is not always straightforward because it changes with time and can be estimated in several ways.

Equivalent Well Method

This method simplifies an excavation as a large-diameter well inside a drawdown cone. While that geometry is not physically realistic, it can still give results that are close to actual field performance.

The method is usually presented only in steady-state form. Here, we extend it to transient conditions by introducing a time-dependent radius of influence.

Model Variables

Symbol	Units	Description
H	L	The initial aquifer head.
h_2	L	The resulting (depressurized) aquifer head at distance 'r_2' from centre of excavation.
h	L	The target depressurized aquifer head at the equivalent well radius (i.e. the excavation edge)
r	L	Radius of the 'equivalent well' representing the excavation or pit.
r_2	L	Radial distance from the excavation centre to the point where h_2 is calculated.
R	L	Radius of influence due to pumping.
K	L/T	Hydraulic conductivity of the aquifer.
b	L	Aquifer thickness.
Q	L^3/T	Pumping rate.

Notes

Radius of influence (R)

There are many equations available to calculate the radius of influence. Exactly what the radius of influence represents in the real world is debatable, but in this dewatering model it is simply a mathematical boundary required for the calculation.

The following R equations are common:

$$\textit{Sichardt Equation [Steady State]}: R = 3000\, h_w \sqrt{K}$$

$$\textit{Theis Equation [Transient]}: R = 1.5 \sqrt{\frac{tKb}{S}}$$

Where:

K = hydraulic conductivity
h_w = aquifer head at the excavation edge
b = aquifer thickness
t = time
S = aquifer storativity