

## Pumping Near A Constant Head Boundary

When a Confined aquifer is bounded on one side by a straight constant head boundary, drawdown due to pumping will be less near the boundary (See Figure 1).

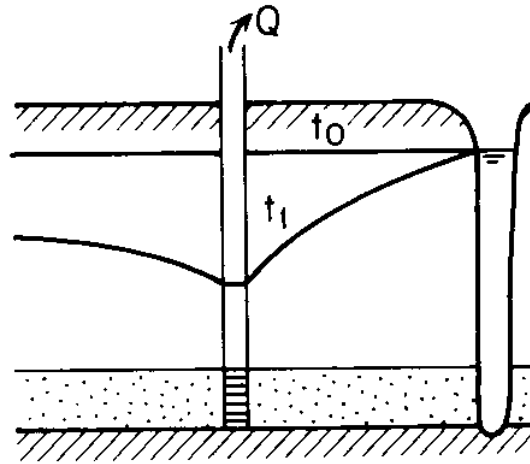


Figure 1. Drawdown near a constant head boundary (Freeze and Cherry 1979)

### Analytical Solution

The analytical solution for drawdown near a constant head boundary as a function of time and space is given by the following equation (Ferris et al., 1962)

$$h_0 - h(x, y, t) = \frac{Q}{4\pi T} [W(u_r) - W(u_i)] \quad (1)$$

Where

$$u_r = \frac{[(x - a)^2 + y^2]S}{4Tt} \quad (2)$$

$$u_i = \frac{[(x + a)^2 + y^2]S}{4Tt} \quad (3)$$

$$W(u) = \int_u^\infty \frac{e^{-u} du}{u} \quad (4)$$

and

$x, y$  = rectilinear coordinates relative to the pumping well, [m]

$a$  = is the distance of pumping well from constant head boundary, [m]

$S$  = is the aquifer storage coefficient, [-]

$T$  = is the aquifer transmissivity, [ $L^2/T$ ]

$t$  = is the time, [T]

$h_0$  = is the initial head in the boundaries before pumping, [L]

$Q$  = is the constant flow rate abstracted from the well, [ $L^3/T$ ]

$W(u)$  = is the well function

\*Note:  $r$  and  $i$  subscripts stand for real and imaginary.

## IGW Numerical Solution

IGW is applied to solve a flow problem for the following situation (figure 2):

### *Given Physical parameters:*

$$Q = 1000 \text{ m}^3/\text{day}$$

$$h_0 = 20 \text{ m}$$

$$S = 0.0002$$

$$t = 0.00175 \text{ days} = 151.37 \text{ sec}$$

$$T = 1000 \text{ m}^2/\text{day} = K_x \cdot \text{Thickness} = 50 \text{ m/day} \cdot 20 \text{ m}$$

$$a = 50 \text{ m}$$

### *Given Numerical Parameters:*

$$\Delta x = 10 \text{ m}$$

$$\Delta y = 10 \text{ m}$$

$$\Delta t = 1.036 \text{ sec}$$

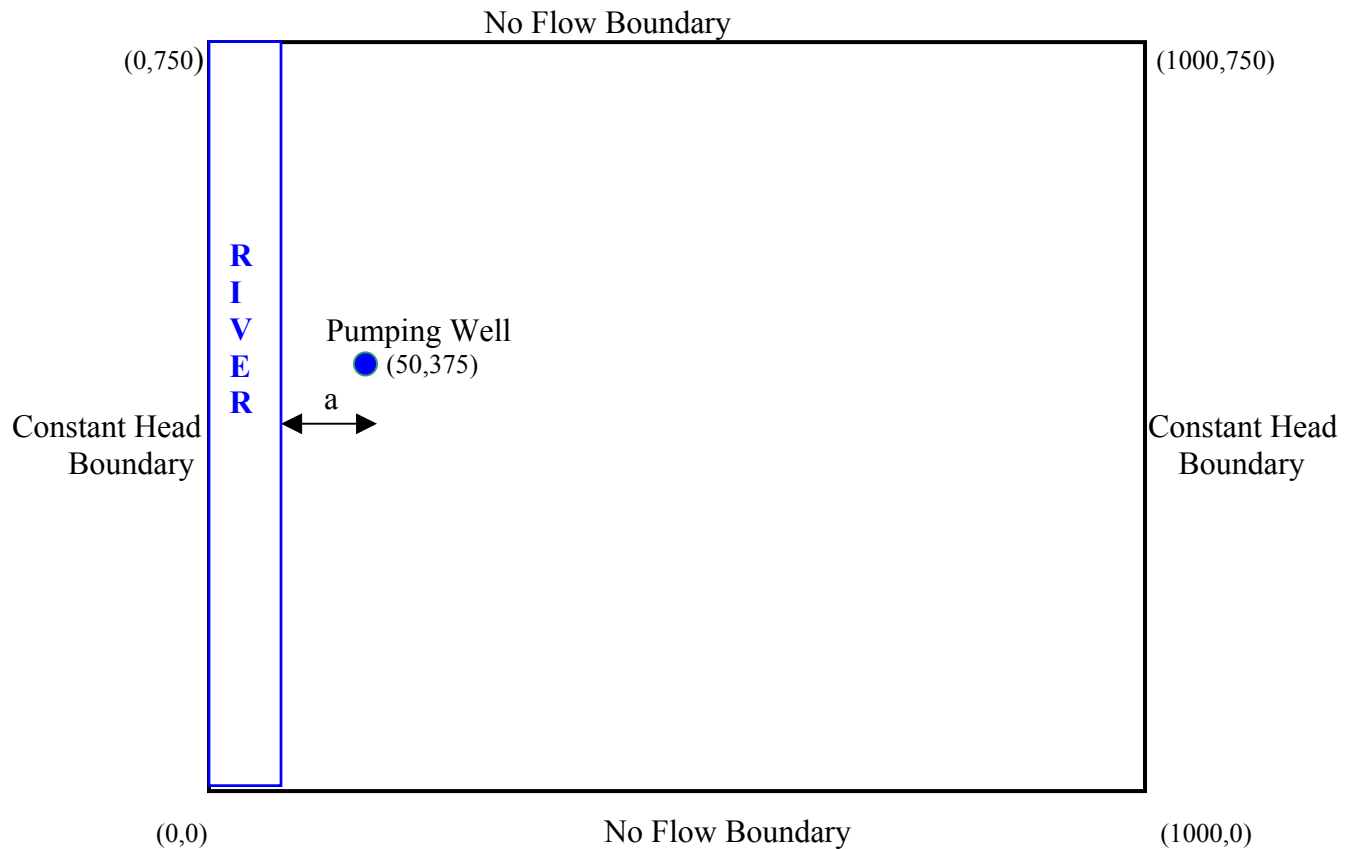
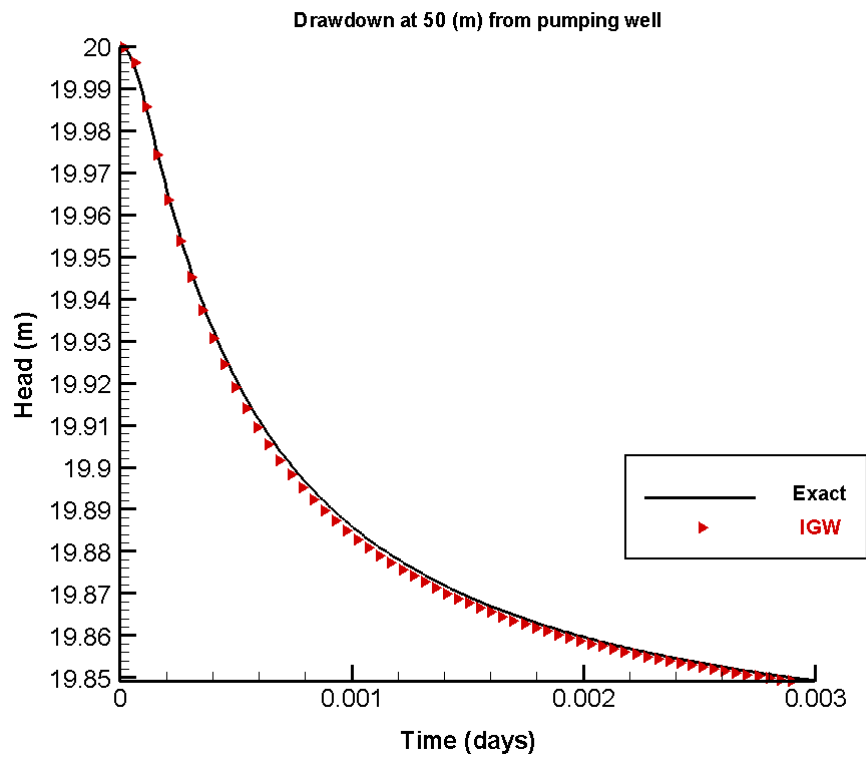


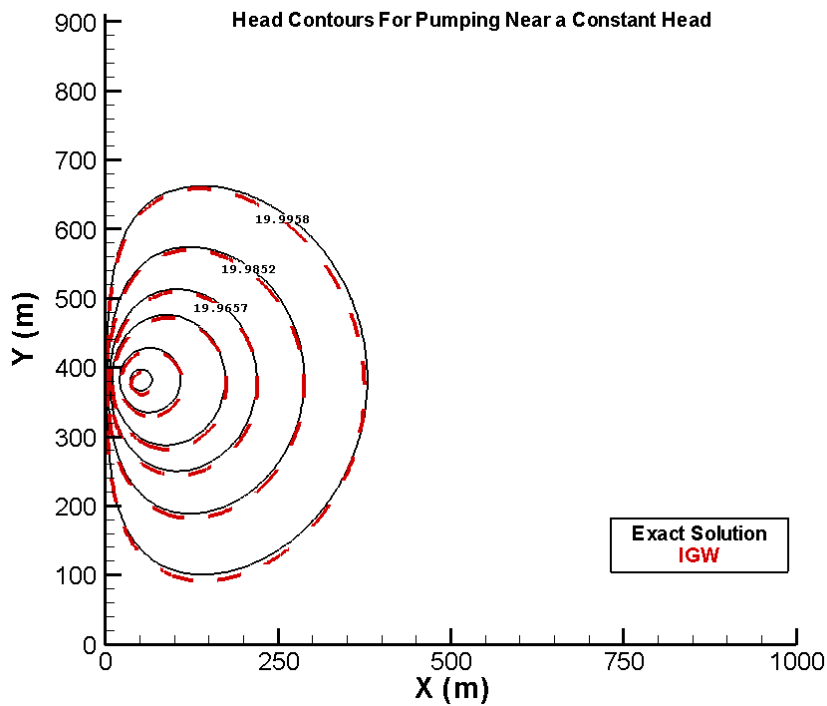
Fig 2. Plan view of IGW model set up for comparison to the Analytical Solution

## Analytical Solution versus IGW

The IGW solution is presented and compared with the exact solution in Figures 3 and 4.



[\*Fig 3. Transient Comparison between the analytical solution and IGW \(monitoring well at 50 meters from the well\).\*](#)



[\*Fig 4. Comparison of the exact solution with IGW solution at 151.37 seconds\*](#)

The numerical solution is graphically indistinguishable from the exact until the drawdown influence begin to reach the boundaries.

The cone of depression is plotted in 3D in Figure 5.

### Cone Of Depression In The Pumping Well

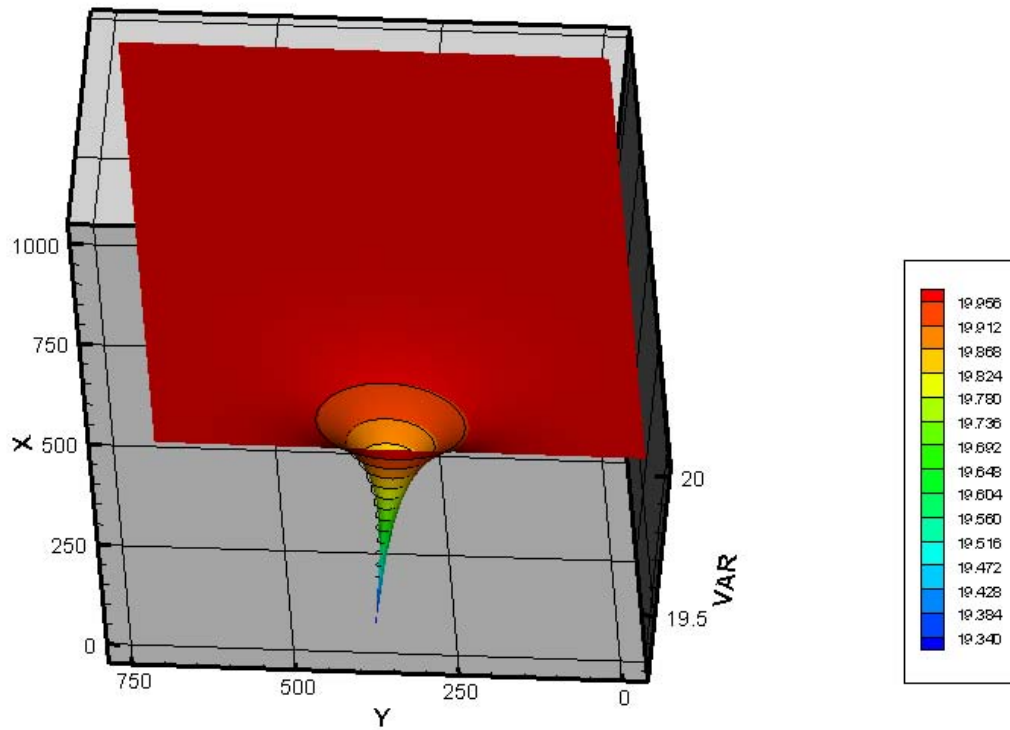


Figure 5. The Cone of depression due to pumping near a constant head boundary.