Unconfined Aquifer- Steady State Flow With Recharge

Consider an unconfined aquifer that is adjacent to two constant head boundaries and a constant recharge infiltrate to top of the aquifer (see Figure 1).

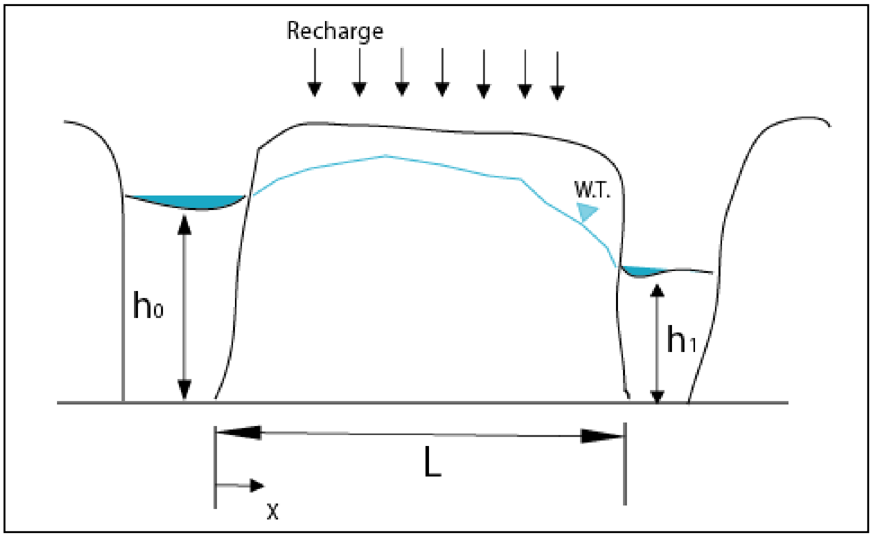

Figure 1. Unconfined aquifer with two constant head boundaries

Analytical Solution

The analytical solution for steady state flow for head prediction along the aquifer's length (1D) is presented in equation 1. Assume that aquifer is homogenous.

$$h(x) = \sqrt{h_0^2 - \frac{(h_0^2 - h_1^2)x}{L} + \frac{r}{k}(L - x)x} \qquad (1)$$

Where:

$h(x)$ Predicted head at any given distance [L]

h_0 and h_1 Constant heads at the boundaries [L]

x Distance from constant head boundary (1D) [L]

L Length of the aquifer in x direction [L]

r Recharge [L/T]

k Hydraulic conductivity [L/T]

IGW Numerical Solution

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

Given Physical parameters:

$h_1 = 10$ m
$h_0 = 20$ m
k $= 50$ m/day
$r = 0.1$ m/day
$L = 1000$ m

Aquifer top elevation 30 m
Aquifer bottom elevation 0 m

Given Numerical Parameters:

Steady state condition.
$\Delta x = 5.5$ m Grid spacing in x direction.
$\Delta y = 5.5$ m Grid spacing in y direction.

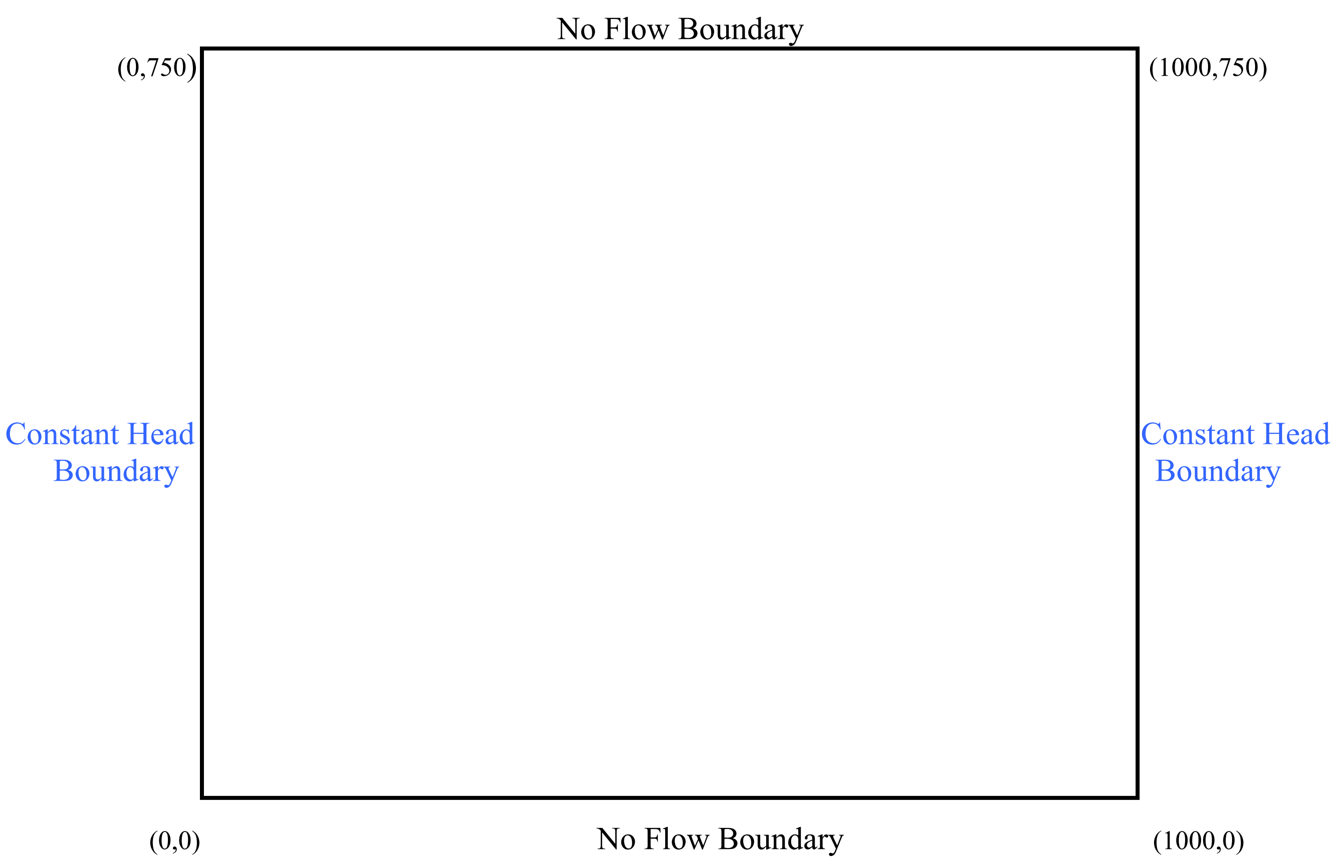

Fig 2. Plan view of IGW model set up for comparison to the Analytical Solution

Analytical Solution Versus IGW

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

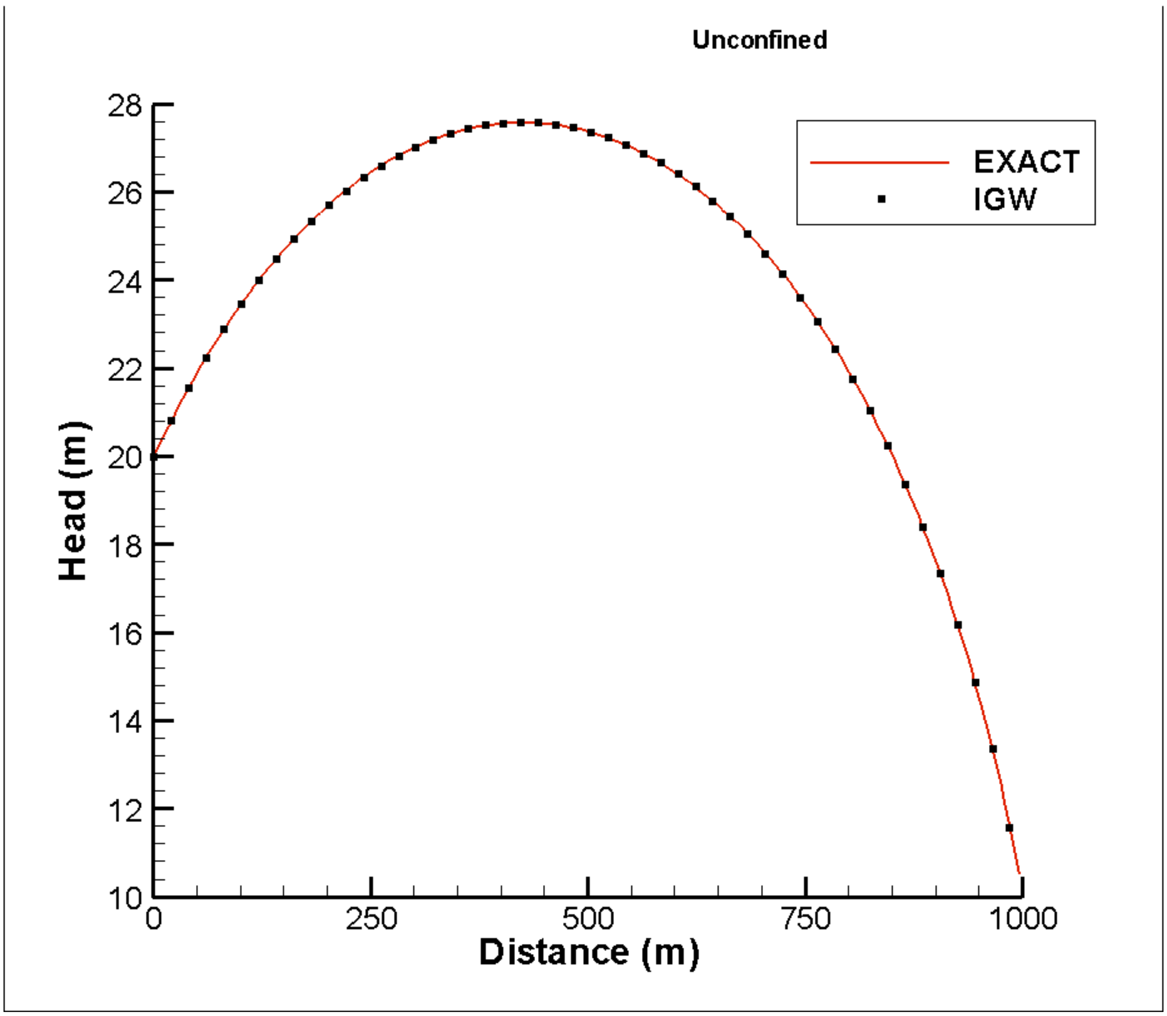

Fig 3. Comparison of the Analytical solution and IGW solution.

The numerical solution is graphically indistinguishable from the exact solution.