

# Transient Aquifer Dynamics In Response To Tidal River Fluctuation

## (Wave Propagation in Aquifer)

Waves in surface water bodies will propagate into aquifers that are in direct communication with them (See Figure 1.).

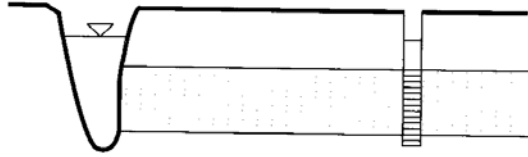


Figure 1. Cross-section of an aquifer in direct communication with a surface water body

## Analytical Solution

The problem has been investigated by Ferris (1951) who considered the sinusoidal stage changes in a surface water body. If  $s$  is the stage change in the aquifer (departure from the equilibrium piezometric head value), then the equation found by Ferris (1951) is:

$$s(x, t) = s_r \exp\left(-\sqrt{\frac{\omega S x^2}{2T}}\right) \sin\left(\omega t - \sqrt{\frac{\omega S x^2}{2T}}\right) \quad (1)$$

Where

$s_r$  = is the amplitude or half-range of the stage change in the surface water body [L]

$\omega = 2\pi / \tau$  = is frequency; [Radian per unit time]

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

$T$  = is the aquifer transmissivity, [L<sup>2</sup>/T]

$t$  = is the time. [T]

$x$  = is the distance from surface water body [L]

## IGW Numerical Solution

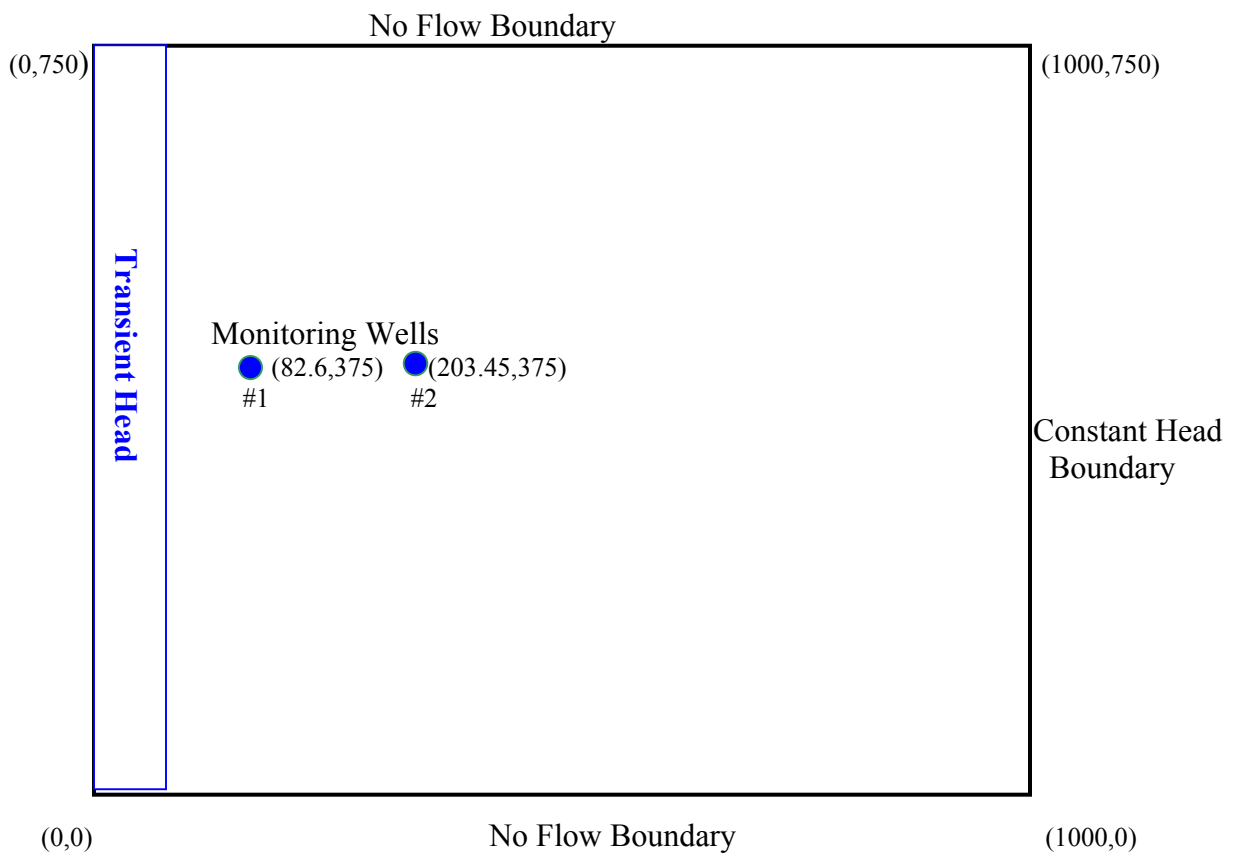
IGW is utilized to solve the flow problem for the following situation (figure 2).

**Given Physical parameters:**

$h_0 = 0$  m (Starting head)  
 $S = 0.0002$   
 $t = 0 \dots 1120$  days  
 $x = 82.61$  m (Monitoring Well #1) and  $203.452$  m (Monitoring Well #2)  
 $s_r = 2$  m  
 $\omega = 2\pi/360 = 1$  rad/day  
 $T = 0.1$  m<sup>2</sup>/day =  $K_x \cdot \text{Thickness} = 0.005$  m/day  $\cdot 20$  m

**Given Numerical Parameters:**

$\Delta x = 8.5$  m    Spacing between the cells in the x-direction  
 $\Delta y = 8.5$  m    Spacing between the cells in the y-direction  
 $\Delta t = 2$  days    Time step

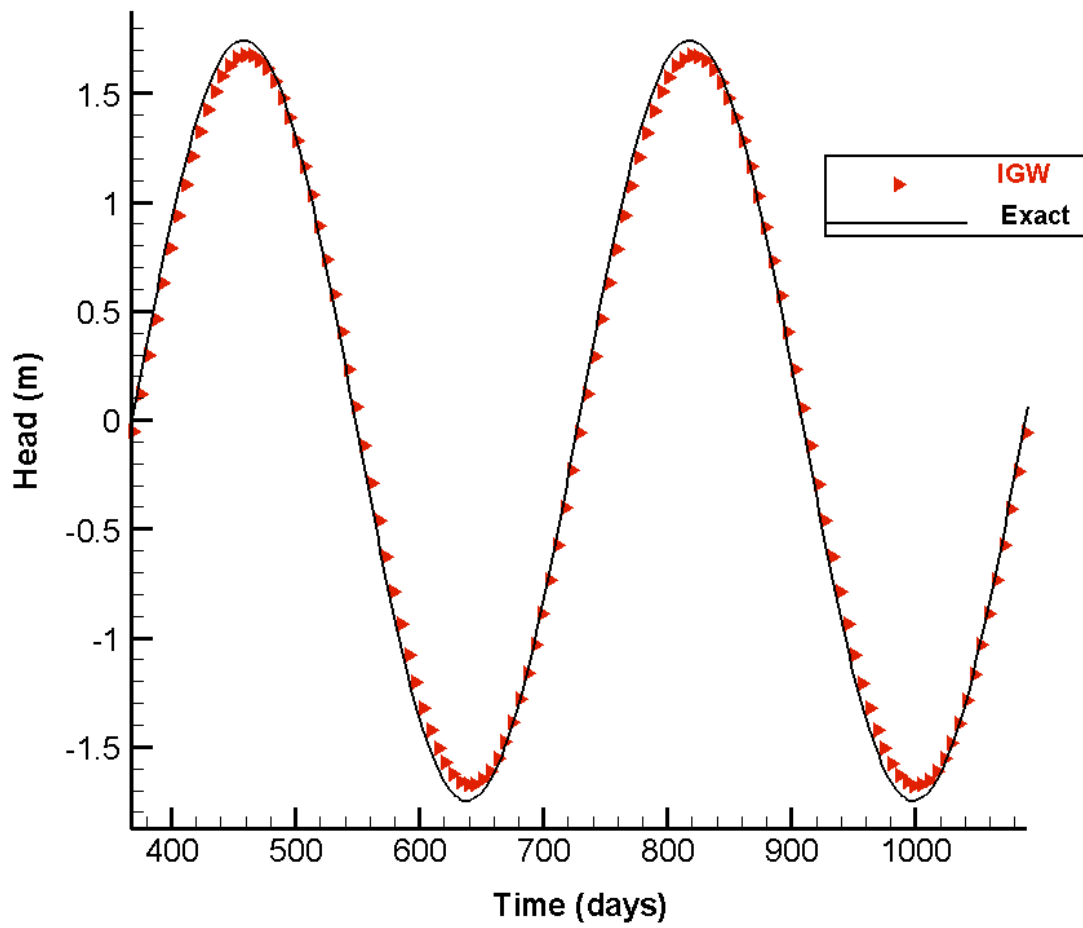


*Fig 2. Plan view of IGW model set up for comparison to the Analytical Solution*

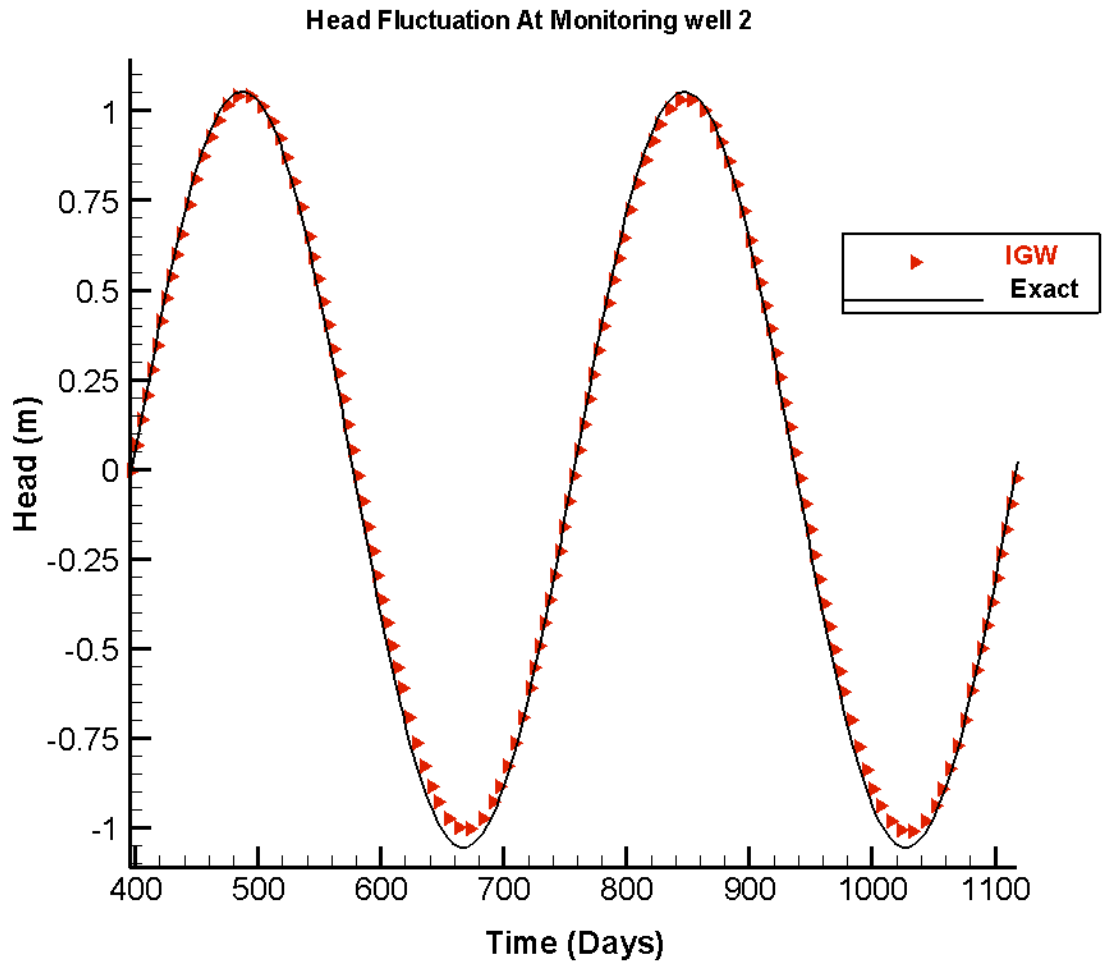
**Analytical Solution versus IGW**

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

### Head Fluctuation At Monitoring Well#1



*Fig.3. Transient aquifer dynamics in response to tidal surface bodies at monitoring well number 1 (Exact solution versus IGW).*



*Fig4. Transient aquifer dynamics in response to tidal surface water bodies at monitoring well number 2 (Exact solution versus IGW).*

The numerical solution is graphically indistinguishable from the exact solution.