NOTE: Supplemental Materials pages 9-12

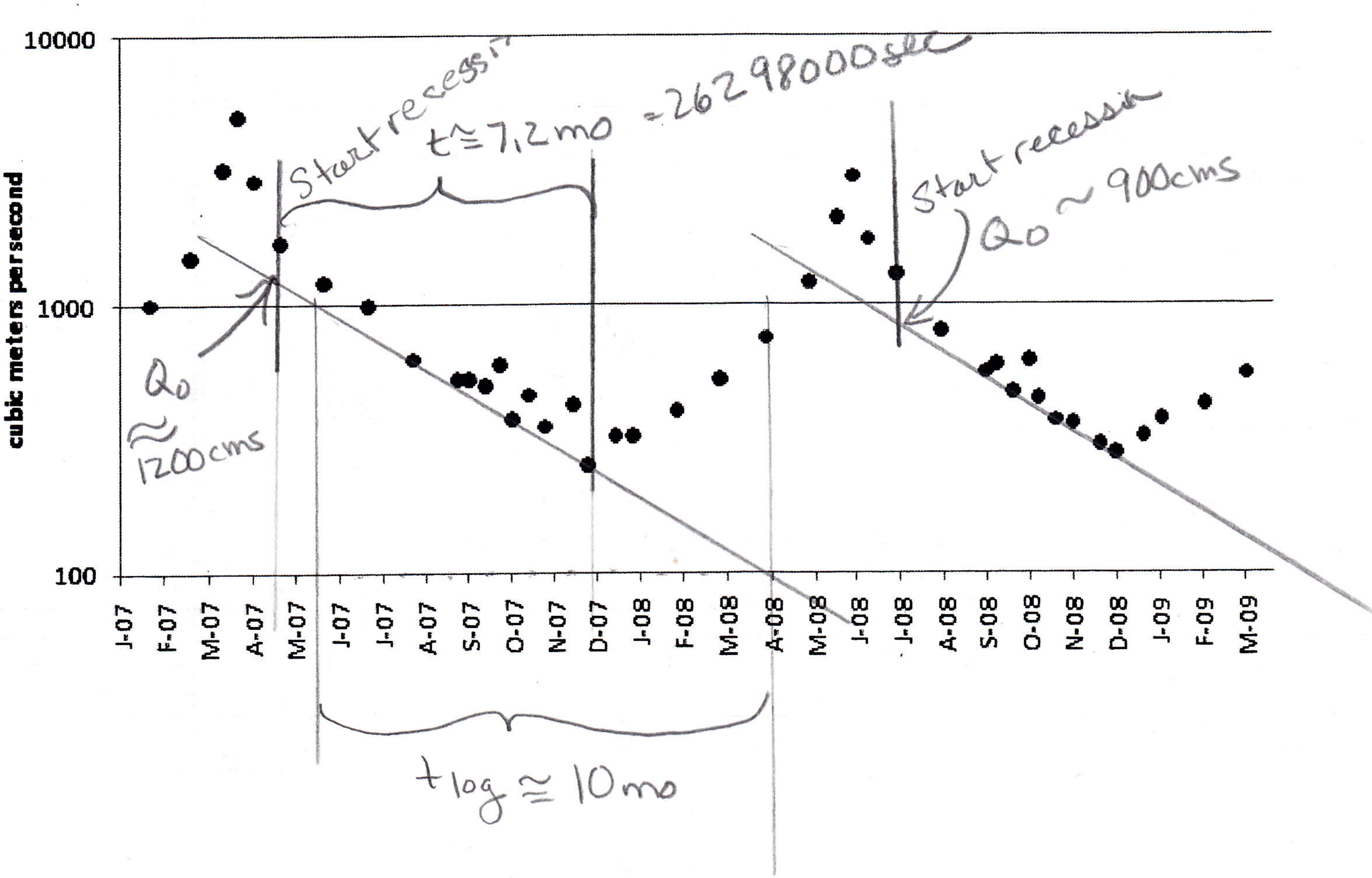
PROBLEM #1 - 25 points **USE UNITS of METERS and DAYS**
Write your answer on the following page. SHOW YOUR WORK

The hydrograph shown below is from a basin that is 5 kilometers by 5 kilometers. The specific yield of the geologic materials average 0.013.

1a) What was the volume of recharge between the 2007 and the 2008 water years?

1b) If all of that water was spread uniformly throughout the basin, how much would the water level change?

To get full credit:
SHOW HOW YOU OBTAIN THE VALUES YOU USED ON THE GRAPH BELOW



PROVIDE CALCULATIONS AND ANSWERS TO PROBLEM 1 HERE
USE UNITS of METERS and DAYS
SHOW YOUR WORK

1a) (20pts) What was the volume of recharge between the 2007 and the 2008 water years?

$$VR2007 = \frac{Q_0 t_{log}}{2.3(10^{t/t_{log}})} = \frac{1200 \frac{m^3}{s} 26298000s}{(2.3)\ 10^{7.2/10}} = 2614424659 m^3$$

$$VTP = \frac{Q_0 t_{log}}{2.3} = \frac{900 \frac{m^3}{s} 26298000s}{2.3} = 10290521739 m^3$$

$$VTP2008 - VR2007 = 7.68 \times 10^9 m^3$$

Remember To get full credit: SHOW HOW YOU OBTAIN THE VALUES YOU USED ON THE GRAPH ON THE PREVIOUS PAGE

1b) (5pts) If all of that water was spread uniformly throughout the basin, how much would the water level change?

$$\text{Water Level Rise} = \frac{Vol}{Area\ SY} = \frac{7.68 \times 10^9 m^3}{5000m\ 5000m\ 0.013}$$

$$= 23619 m$$

? unreasonable

watch for these things in your work!

but so is this discharge from a 5x5Km basin
it should be 500 x 500 Km then it would
be a 2.36 m rise

Many of you recognized this
Good Job!

PROVIDE CALCULATIONS AND ANSWERS TO PROBLEM 2 HERE
USE UNITS of METERS and DAYS
SHOW YOUR WORK

2a) (15pts) What is the volumetric flow rate through the tube?

$$Q = KiA$$

$$K = \frac{8\,m}{\frac{3\,m}{0.001\,m/d} + \frac{5\,m}{0.03\,m/d}} = 2.526 \times 10^{-3} \frac{m}{d}$$

$$A = 1.5\,m \times 1.5\,m = 2.25\,m^2$$

$$i = \frac{2.5 - 1.5}{8} = 0.125$$

$$Q = 7.1 \times 10^{-4} \frac{m^3}{d}$$

2b) (10pts) What is the head difference across the light colored material in the middle of the tube?

$$dh = \frac{QL}{KA} = \frac{7.1 \times 10^{-4} \frac{m^3}{d}\ 5\,m}{0.03 \frac{m}{d}\ 2.25\,m^2}$$

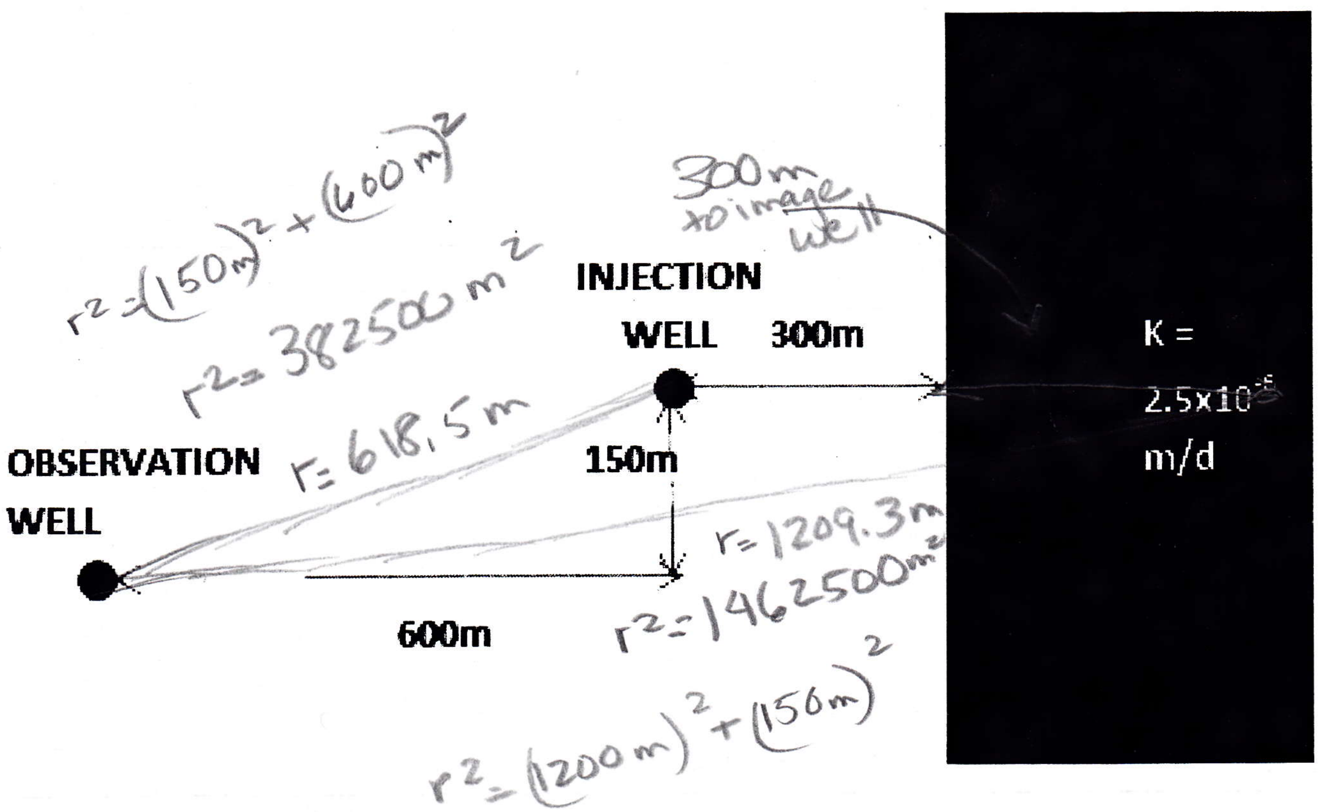
$$= 0.053\,m$$

PROBLEM #3 – 25 points __**USE UNITS of METERS and DAYS**__
__**Write your answer on the following page. SHOW YOUR WORK**__

The confined limestone shown in the diagram below is 10 meters thick, has a hydraulic conductivity of 25 m/d and a specific storage of 1×10^{-6} m^{-1}. The limestone abuts a crystalline rock formation to the east with a hydraulic conductivity of 2.5×10^{-6} m/d. That contact continues for a long distance to the north and south. The limestone is uniform and extensive for a large distance in the other three directions.

1000 cubic meters of water per day is injected in the injection well for 7 days then the injection is stopped.

3a) What is the change in head from the pre-pumping condition at the observation well 1 day after the injection stops?



PROVIDE CALCULATIONS AND ANSWERS TO PROBLEM 3 HERE
USE UNITS of METERS and DAYS
SHOW YOUR WORK

3a) (25pts) What is the change in head from the pre-pumping condition at the observation well 1 day after the injection stops?

$T = Kb = 250\ m^2/day$
$S = S_s b = 1\times10^{-5}$

injection at pumping well 8 days: $u = \frac{r^2 S}{4Tt} = 0.000478$ $W(u) = 7.068$ (a)

image well same Q 8 days: " $= 0.001828$ " $= 5.727$ (b)

withdraw at pumping well 1 day: " $= 0.003825$ " $= 4.99$ (c)

at image well 1 day: " $= 0.014625$ " $= 3.65$ (d)

$s = \frac{Q}{4\pi T} W(u)$

$\frac{1000 m^3/d}{4(3.14)\,250 m^2/day}$

$-Q$ $s_{(a)} = -2.25$ m
$-Q$ $s_{(b)} = -1.82$ m
$+Q$ $s_{(c)} = +1.59$ m
$+Q$ $s_{(d)} = +1.16$ m

-1.32 m head rises

PROVIDE CALCULATIONS AND ANSWERS TO PROBLEM 4 HERE
USE UNITS of METERS and DAYS
Also MILLIGRAMS and LITERS
SHOW YOUR WORK

$$\bar{v} = \frac{Ki}{\phi} = \frac{25\frac{m}{d}\,0.001}{0.2} = 0.125\frac{m}{d} \qquad \lambda = \frac{0.693}{1825d} = 0.00038$$

4a) (23pts) What is the concentration at the well?

long time = steady state with decay on centerline

$$C = C_0 \exp\left(\frac{x}{2\alpha_x}\left(1-\sqrt{1+\frac{4\lambda\alpha_x}{\bar{v}}}\right)\right)\operatorname{erf}\left(\frac{Y}{4\sqrt{\alpha_y x}}\right)\operatorname{erf}\left(\frac{Z}{4\sqrt{\alpha_z x}}\right)$$

$$= 750\frac{mg}{L}\exp\left(\left(\frac{250m}{(2)10m}\right)\left(1-\sqrt{1+\frac{(4)0.00038(10m)}{0.125}}\right)\right)\operatorname{erf}\left(\frac{20m}{4\sqrt{5m\,250m}}\right)\operatorname{erf}\left(\frac{1m}{4\sqrt{2m\,250m}}\right)$$

$$= 750\frac{m}{L}\exp(-0.7377)\operatorname{erf}(0.1414)\operatorname{erf}(0.0126)$$

$$= 750\frac{m}{L}(0.478)(0.159)(0.013) = 0.57\frac{mg}{L}$$

4b) (2pts) What do you think constitutes a long period of time? You will only get credit for this answer if you properly explain how you ~~choose the time.~~

When the mass entering the system balances the mass decaying. That is when steady state has been reached