GW Engineering EXAM I FALL 2010 NAME KEY

PROBLEM #1 - 25 points **USE UNITS of METERS SECONDS and GRAMS**

Prepare a water budget for the year 2009 for the unconfined sedimentary aquifer that constitutes the basin illustrated below. The basin is surrounded by a topographic divide that coincides with the water table divide. Delineate each item of the water budget and show your calculations on the following page.

The unconfined aquifer has a Transmissivity of 120m^2/day and a Specific Yield of 0.12

The climate is such that evapotranspiration is about 90% of precipitation.

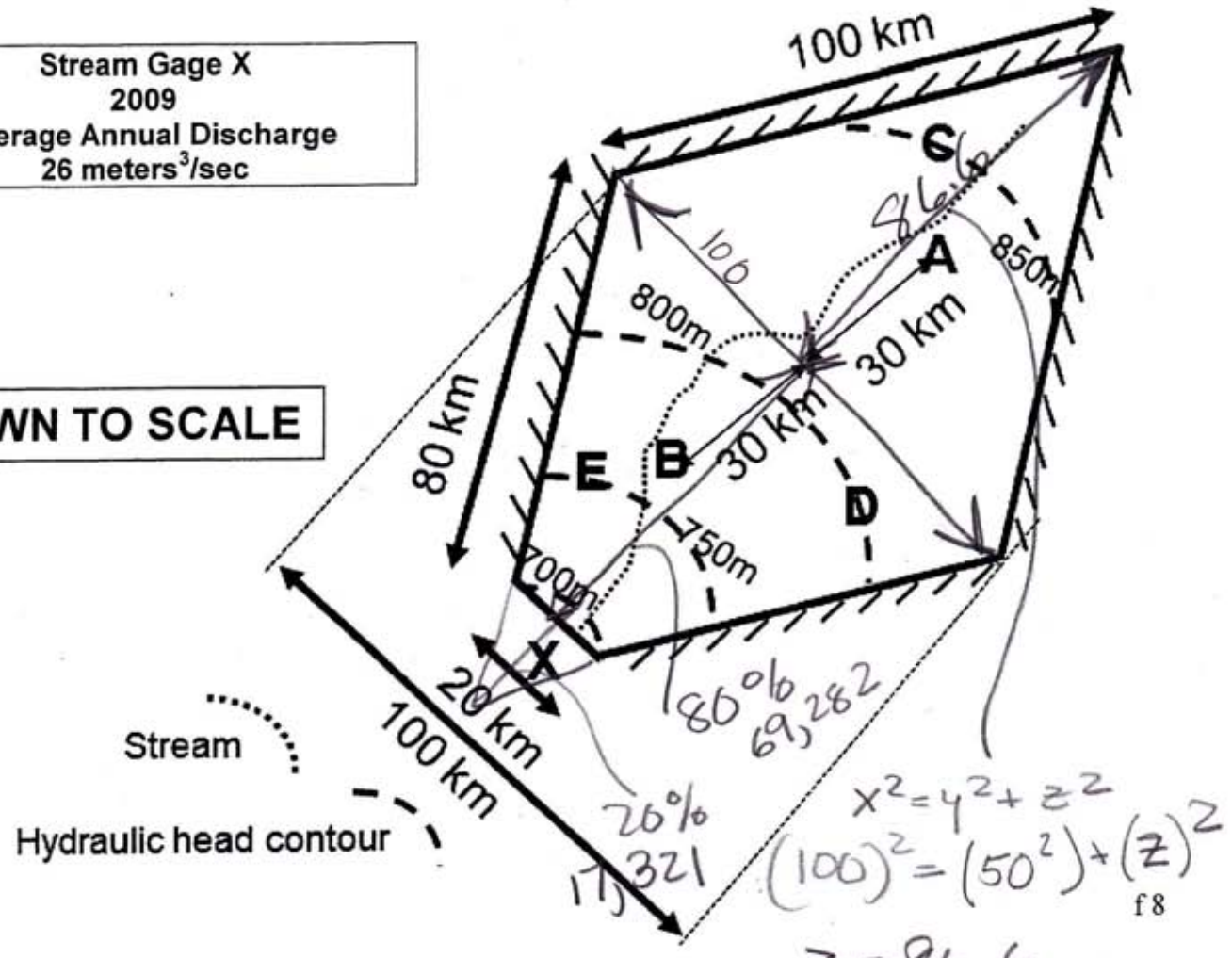
The basin is residential with approximately 5000 homes obtaining water from domestic wells.

Precipitation Stations Annual Precipitation for 2009 was the same as the average annual precipitation for the past century	
A	830 mm
B	620 mm

Water Level in meters Measured at the precipitation stations Contoured Water Levels are July 1, 2009		
Location	Jan 1, 2009	Dec 31, 2009
C Δ1.5	850.8 m	849.3 m
D Δ1.5	800.3 m	798.8 m
E Δ1.5	751.1 m	749.6 m

Stream Gage X
2009
Average Annual Discharge
26 meters^3/sec

DRAWN TO SCALE



PROVIDE CALCULATIONS AND ANSWERS TO PROBLEM 1 HERE

USE UNITS of METERS SECONDS and GRAMS meters & seconds

Delineate each item of the budget, show your calculations for each, and present the budget.

$IN = OUT + \Delta S$

$P + SWIN + GWIN + IMPORT = ET + EVAP + SWOUT + GWOUT + EXPORT + CONSUME + \Delta S$

$$P = A_A P_A + A_B P_B = \left(\left[\tfrac{1}{2}\,100{,}000\,m\;86{,}600\,m\left(0.83\tfrac{m}{y}\right)\right] + \left[A_A - \tfrac{1}{2}\,20{,}000\,m\;17321\,m\right]\left(0.62\tfrac{m}{y}\right)\right)\frac{3.1\,yr}{3.15576\times10^7\,s}$$

$$P = \left[\left[4.33\times10^9\,(0.83)\right] + \left[4.15679\times10^9\,(0.62)\right]\right]\frac{1}{3.15576\times10^7} = 195.547\,\frac{m^3}{s}$$

$SWIN = 0$ $GWIN = 0$ $IMPORT = 0$ $EVAP = 0$ $EXPORT = 0$

$ET = 0.9\,P = 175.992\,\frac{m^3}{s}$

$SWOUT = 26\,\frac{m^3}{s}$

$GWOUT = K \cdot A = T \cdot w = 120\,\frac{m^2}{d}\,\frac{50\,m}{20000\,m}\,20000\,m\,\frac{1\,d}{86400\,s} = 0.0694\,\frac{m^3}{s}$

note $T = Kb$ $A = wb$

$CONSUME = 5000\,homes\,\frac{200\,GAL}{day}\,\frac{4\,L}{GAL}\,\frac{1\,m^3}{1000\,L}\,\frac{1\,d}{86400\,s}\,(1 - 0.8) = 0.0093\,\frac{m^3}{s}$ (0.8 return)

$\Delta S = \Delta h\,A\,S_y = -1.5\,\frac{m}{yr}\,\frac{1\,yr}{3.15576\times10^7\,s}\,8.48679\times10^9\,m^2\,0.12 = -48.4\,\frac{m^3}{s}$

IN $IN - OUT - \Delta S = ERROR$

$195.547\,\frac{m^3}{s} - (175.992 + 26 + 0.0694 + 0.0093)\,\frac{m^3}{s} - \left(-48.4\,\frac{m^3}{s}\right) = 41.9\,\frac{m^3}{s}$

202.07

$\approx 19\%$ error

avg $\frac{IN \text{ \& } OUT}{+\Delta S} = 223$

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PROVIDE CALCULATIONS AND ANSWERS TO PROBLEM 1 HERE

USE UNITS of METERS SECONDS and GRAMS meters & years

Delineate each item of the budget, show your calculations for each, and present the budget.

$IN = OUT + \Delta S$

$P + SWIN + GWIN + IMPORT = ET + EVAP + SWOUT + GWOUT + EXP + CONSUME + \Delta S$

$P = Area_A P_A + Area_B P_B = \left(\frac{1}{2}(100{,}000\,m)(86{,}600\,m)\,0.83\,\frac{m}{yr}\right) + \left(A_A - \left[\frac{1}{2}\,20{,}000\,m\,|\,17321\,m\right]\right)\left(0.62\,\frac{m}{yr}\right)$

$P = 4.33\times10^{9}\,m^2\,(0.83\,m/yr) + 4.15679\times10^{9}\,m^2\,(0.62\,m/yr) = 6.171\times10^{9}\,\frac{m^3}{yr}$

$3.5939\times10^{9}\,m^3/yr + 2.57721\times10^{9}\,m^3/yr$

$SWIN = 0 \quad GWIN = 0 \quad IMPORT = 0 \quad IN = P$

$ET = 0.9\,P = 5.554\times10^{9}\,m^3/yr$

$EVAP = 0$

$SWOUT = 26\,\frac{m^3}{s}\,\frac{365\,d}{yr}\,\frac{86400\,s}{day} = 8.1993\times10^{8}\,\frac{m^3}{yr}$

$GWOUT = KiA = Tiw = 120\,\frac{m^2}{d}\,20{,}000\,m\,\frac{50\,m}{28000\,m}\,\frac{365\,d}{yr}$

$= 2.19\times10^{6}\,m^3/yr$

$EXPORT = 0$

$CONSUMED = 5000\,homes\,\frac{200\,GAL}{day\,home}\,\frac{4\,Liter}{GAL}\,\frac{1\,m^3}{1000\,L}\,\frac{365\,d}{yr}\,0.2\ \text{loss} = 2.92\times10^{5}\,\frac{m^3}{yr}$

$\Delta S = -1.5\,m\ \ 8.6598\times10^{9}\,m^2\ \ 0.12 = 1.5276\times10^{9}\,m^3/yr$

$IN - OUT + \Delta S = ERROR$

$6.171\times10^{9}\,m^3 - 6.37641\times10^{9} - (-1.5276\times10^{9}) = 1.322\times10^{9}\,m^3$

avg $\frac{7.6976\times10^{9}\,m^3 + 6.37641\times10^{9}\,m^3}{2} = 7.037\times10^{9}\,m^3$ 19% error