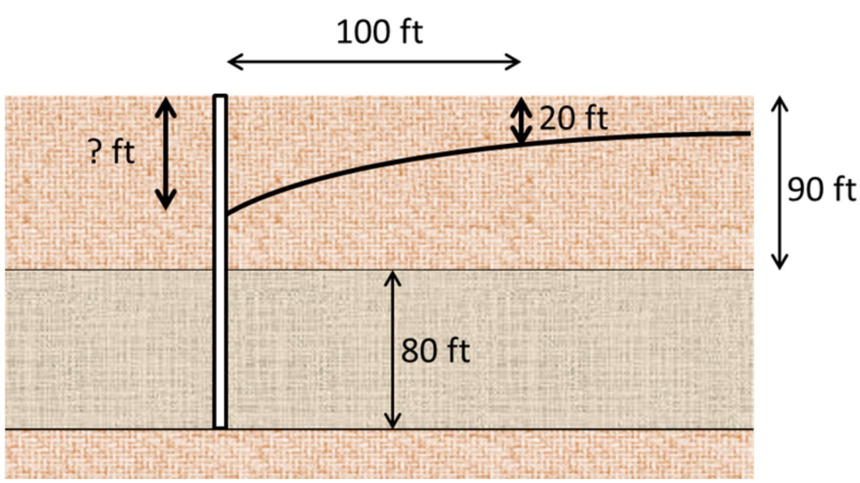
Utah State University
Department of Civil and Environmental Engineering
CEE 3430 Engineering Hydrology

Final Exam. Date: 5/2/2011
D.G. Tarboton Time: 110 min
80 Points

Open Book. Answer all questions. **Please answer on separate sheets of paper**. You may refer to the textbook, notes, solutions to homework and any other written or printed reference material that you have brought with you.
Calculator use. You may use a programmable calculator or equivalent calculating device (e.g. calculator functionality on a phone). You should limit the use of the calculating device to the performance of calculations. You may use programs that you have written to evaluate quantities commonly used in this class (e.g. infiltration rates). You may not use your calculating device to retrieve stored reference material in any form. You may not send messages or access the internet or communicate in any way with anyone other than the instructor or moderator regarding solutions to these questions. You may not use a computer.

1. In a well that fully penetrates a confined aquifer the piezometric surface is 20 ft below the surface measured at a radius r=100 ft from the well, which pumps at a rate of 20 gal min^{-1}. The aquifer is 80 ft thick with K=18 ft/day. What is the depth to the piezometric surface at the well (r=0.6 ft) for this aquifer. Assume steady state conditions. Note 1 ft^3 = 7.48 gal.



[20 points]

2. The Great Salt Lake is a closed basin lake with no outflows and no appreciable loss of water by leakage to groundwater. The only outflow is evaporation (E) and inflows are from streamflow (Q), groundwater that drains in from aquifers recharged in the surrounding mountains (G), and direct precipitation on the lake (P). Following is Great Salt Lake hydrology data for the 5 water years from 2004 to 2008.

Average streamflow inflow (Q)	1,778,000 acre ft/year
Average lake area	780,000 acres
Average Evaporation (E)	43 inches/year
Average Precipitation (P)	11.3 inches/year
Beginning level (10/1/2003)	4195.4 ft
Ending level (10/1/2008)	4194.1

For the purposes of these calculations you may assume that the lake area is constant (i.e. neglect the change in area with change in lake level)

a) Calculate the change in lake volume due to the reduction in lake level over these 5 years.
b) Calculate the average volume of precipitation inflows into the lake in acre ft per year over these 5 years.
c) Calculate the average volume of evaporation losses from the lake in acre ft per year over these 5 years.
d) Based on the water balance where the only unknown quantity is groundwater inflow calculate the groundwater inflow in acre ft per year.
e) The quantities above have some uncertainty due to measurement error. Suppose that the Ending level was really 4194.0 rather than 4194.1. How would this change your calculation of groundwater inflow?
f) Based on your result in (e) comment on the accuracy of the groundwater inflow estimate obtained in (d).

[20 points]

3. The storage capacity and stage-outflow relationship of a flood control reservoir are given by the following table.

Stage (m)	3.0	3.5	4	4.5
Storage (m^3)	180	3780	6840	27000
Discharge (m^3/s)	0	0	3.4	6.2

You may use linear interpolation to determine storage and discharge quantities between these values.

Following is inflow to this reservoir from a storm

Time (hr)	0	1	2	3
Inflow (m^3/s)	0	2	5.2	0

Inflows should be assumed to vary linearly between these times.

The initial reservoir level is 3.0 m.

a) Calculate the volume (in m^3) of the inflow hydrograph.
b) Calculate the volume (in m^3) of the outflow hydrograph.
c) Route the inflow hydrograph through the reservoir using 1 hour time steps. Continue your calculations for a sufficient number of time steps to identify the peak discharge rate and report this peak discharge rate.

[20 points]

4. Consider a soil with the following properties pertaining to the Green-Ampt infiltration equation.

Saturated Hydraulic Conductivity, K_{sat} = 0.7 cm/h
Porosity, n = 0.43
Residual moisture content, θ_r = 0.1
Wetting front capillary suction $|\psi_f|$ = 15 cm

a) Calculate the infiltration capacity f_c as a function of cumulative infiltration F for the following cumulative infiltration values: F= 1 cm, F=2 cm, F=5 cm. Plot a graph of f_c versus F indicating on this graph the asymptotic value of f_c for large F.

b) Determine the infiltration and depth of runoff generated in each time step from the following storm.

Time (hr)	0-2	2-4
Rainfall Intensity (cm/hr)	0.5	2

[20 points]