

CE 440
Homework #3
Due Friday, September 23, 2005

Problem 1. How could daily measurements of precipitation and streamflow at the mouth of a small watershed be used to estimate average annual evapotranspiration over a long time period (several years)? Assume that the stream and ground water are connected and that ground water discharge from the watershed is zero. Use a sketch to illustrate your answer.

Problem 2. What surface area in square feet and acres is required for a surface water wetland with the following characteristics?

Flow rate = 1000 gallons/day
Depth = 60 cm
14 day retention time
No infiltration

Problem 3. Rework the examples in Boxes 4.4 and 4.5 of your text **with CN = 83 (do not adjust for AMC)**.

Problem 4. Assume the following watershed and precipitation characteristics:

- Two hour rainfall event (main part of growing season) steadily delivering 1.5 cm in the first hour, and then steadily delivering 4 cm in the second hour
- Cotton (row crop) farmed on contour in poor condition
- The slope is 2% with slope length 100m
- The soils are sandy clay loam with 0.5 % organic matter in hydrologic group C
- AMCII
- Watershed area is 20 hectares with a delivery ratio of 85%

Use the CN approach to estimate the:

- a) time (minutes) at which runoff is initiated;
- b) peak runoff rate (cm/hr) during the storm [15 minute time step]; and
- c) The average depth of infiltration in cm on the watershed.

Problem 5. Suppose that the net solar radiation input to a water surface (at 20 deg C.) is 700 cal/cm²-day.

- (a) If 65% this energy is used to evaporate water, what is the daily depth of evaporation?
- (b) If the same amount of energy were used to melt snow, what would be the daily depth of snowmelt?

Problem 6. For a similar watershed, now assume the information provided below. Horton's equation applies with $f_c=1\text{cm/hour}$, $f_o=4\text{ cm/hour}$ and $K=2.0$. A storm occurs with the following rainfall hyetograph:

<u>Minutes</u>	<u>Average Rainfall Rate</u>
0-30	2 cm/hour
30-60	5 cm/hour
60-90	4 cm/hour

Plot the rainfall hyetograph and infiltration capacity function. Calculate an excess rainfall hydrograph by subtracting losses. Find the total depth of infiltration over the watershed during the storm. (Hint: integrate the Horton equation to find the depth of infiltration during each time interval, or use a midpoint approximation to the integral.)

Problem 7. On another watershed, assume the runoff hydrograph for a 30-minute storm at rate of 1cm/hour excess rainfall is the following:

<u>Minutes</u>	<u>Average Runoff Rate</u>
0-30	0.2 cm/hour
30-60	0.5 cm/hour
60-90	0.3 cm/hour

- Find the unit hydrograph for this watershed for a 30-minute storm producing 1 cm of excess rainfall.
- Find the runoff hydrograph for a one-hour storm with constant excess rainfall rate of 3 cm/hour.
- If the excess rainfall rate is constant during the storm, how would the actual rainfall rate vary during the storm?
- Find the total volume of runoff from this storm in m^3 if the watershed area is 20 hectares.

Problem 8. For the following soil properties, develop a plot of infiltration rate f vs. infiltration volume F using the Green and Ampt equation:

$$k_s = 1.97 \text{ in./hr.}$$

$$q_s = 0.518$$

$$q_i = 0.318$$

$$?_f = -9.37 \text{ in.}$$

$$i = 7.88 \text{ in./hr.}$$

Please plot F (in) on the horizontal axis vs. f (in/hr) on the vertical axis.