

## CE 103 Comp Question 2014

The Rational Method and the Unit Hydrograph Method for predicting runoff can be related to each other based on the way that runoff is modeled in each case.

Assume that the time of concentration ( $T_c$ ) is given by the Rational Method formula:

$$T_c = 0.062 \left( \frac{L}{\sqrt{S_a}} \right)^{0.8}$$

Where  $T_c$  is in hours,  $L$  is the travel distance from the catchment edge to the outlet in km, and  $S_a$  represents the average catchment slope.

The goal of this question is to use the Rational Method concepts to compute a unit hydrograph and to assess the effect of catchment shape on the hydrograph.

Consider a rectangular catchment with length  $L$  and width  $W$  subject to rainfall with intensity  $I$  and duration  $T_c$ .

- a) Sketch the catchment and show how it could be divided into a series of e.g.  $i$  nested subcatchments, all sharing the same outlet, with lengths given by  $L_i$ , where  $L_i = L/i, 2L/i, 3L/i \dots L$ . (0.5)
- b) Based on the rational method, what is the time of concentration ( $T_{ci}$ ) and the peak flow ( $Q_i$ ) associated with subcatchment  $i$ ? (0.5)
- c) How long after the rainfall ceases will flow from subcatchment  $i$  continue to flow to the outlet? (0.5)
- d) Once flow from subcatchment  $i$  is no longer flowing to the outlet, what flow is still available at the outlet? (1.5)
- e) Setting  $i=4$ ,  $L = 1$  km,  $S_a = 0.05$ ,  $C = 1$ ,  $W=1$  km, and letting  $I \times D = 1$  cm, use your answers to plot the hydrograph for the rectangular catchment. (3)  
*Hint – you may find it helpful to tabulate  $T_{ci}$ ,  $A_i$ ,  $Q_i$  for each subcatchment – and similarly for times  $> T_c$  when the flow is declining.*
- f) If instead of the catchment width = 1, the width varied so that it was 1km at the outlet and 5km at position  $L$  (i.e. the catchment was trapezoidal), show how the hydrograph would change (plot on the same axes as for question e). (3)
- g) Explain how the catchment shape affects the hydrograph you generated. (1)