National Exams May 2014

04-Agric-B7 Soil Hydrology

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.

   Any non-communicating calculator is permitted.

3. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. Most questions require an answer involving calculations. Clarity and organization of the answer are important.

1. (20 marks)

A watershed in a rural area of some 5 km^2 is made up primarily of agricultural land used for pasturing animals. In early spring the area is completely frozen, but with little or no snow cover. The area is estimated to have a time of concentration of 60 minutes. A typical IDF curve for rainfall intensities in the area is given in the figure.

a. What are the rainfall intensities and depths expected for rainfalls of ½, equal to, and 2x the time of concentration?
b. Sketch runoff hydrographs you would expect for these three storms, all on the same graph. You are not expected to make any calculations but pay attention to the relative position of the three hydrographs with respect to overall size, peak values and rates of change.

2. (20 Marks)

Define the following terms with respect to hydrology:

a. Infiltration
b. 100-yr flood flow
c. Effective precipitation
d. Unit Hydrograph
e. Flow duration curve
f. Flood routing
g. Water Budget
h. Level Pool Method
i. Plotting position
j. IDF curve

3.(20 Marks)

The flows below are the peak discharges measured on a small creek for the past 5 years. They are considered to be representative of peak flows for the stream over the long term, even though the period of record is short.

a. Assuming the data are log-normally distributed, what do you estimate the discharges with the 2 and 10-year return periods are?

b. What check can you make of the data to give you confidence that the data are indeed log-normally distributed?

Year	Peak Discharge (m^3/s)
2013	10
2012	22
2011	28
2010	15
2009	8

4.(20 Marks)

The Horton infiltration equation is often used to estimate the infiltration during storm events when modelling the rainfall-runoff process. In one area the parameters have the values given below.

a. What would be the infiltration rate (mm/hr) and total infiltration (mm) up to a time of 30 minutes from the start of a storm, if rainfall always exceeded infiltration?

b. If the precipitation rate was 75 mm/hr for 30 minutes, what would the depth of effective precipitation be for the 30 minutes?

c. What are some of the other methods to estimate infiltration for these types of conditions and what are some of their advantages and disadvantages when compared to the Horton approach?

Parameter	Value
Equilibrium infiltration capacity	10 mm/hr
Initial infiltration capacity	150 mm/hr
Rate of decay of infiltration	5 /min

5.(20 Marks)

A simplified runoff hydrograph from a small watershed is shown in the figure attached. You have been asked to design a small flood management pond that will reduce the flooding downstream by reducing the peak flow to ½ of that in the hydrograph. The watershed has an area of 100 ha and the limits of the project dictate that the pond take up no more than 0.40 ha in area. The outflow is to be controlled by an overflow weir.

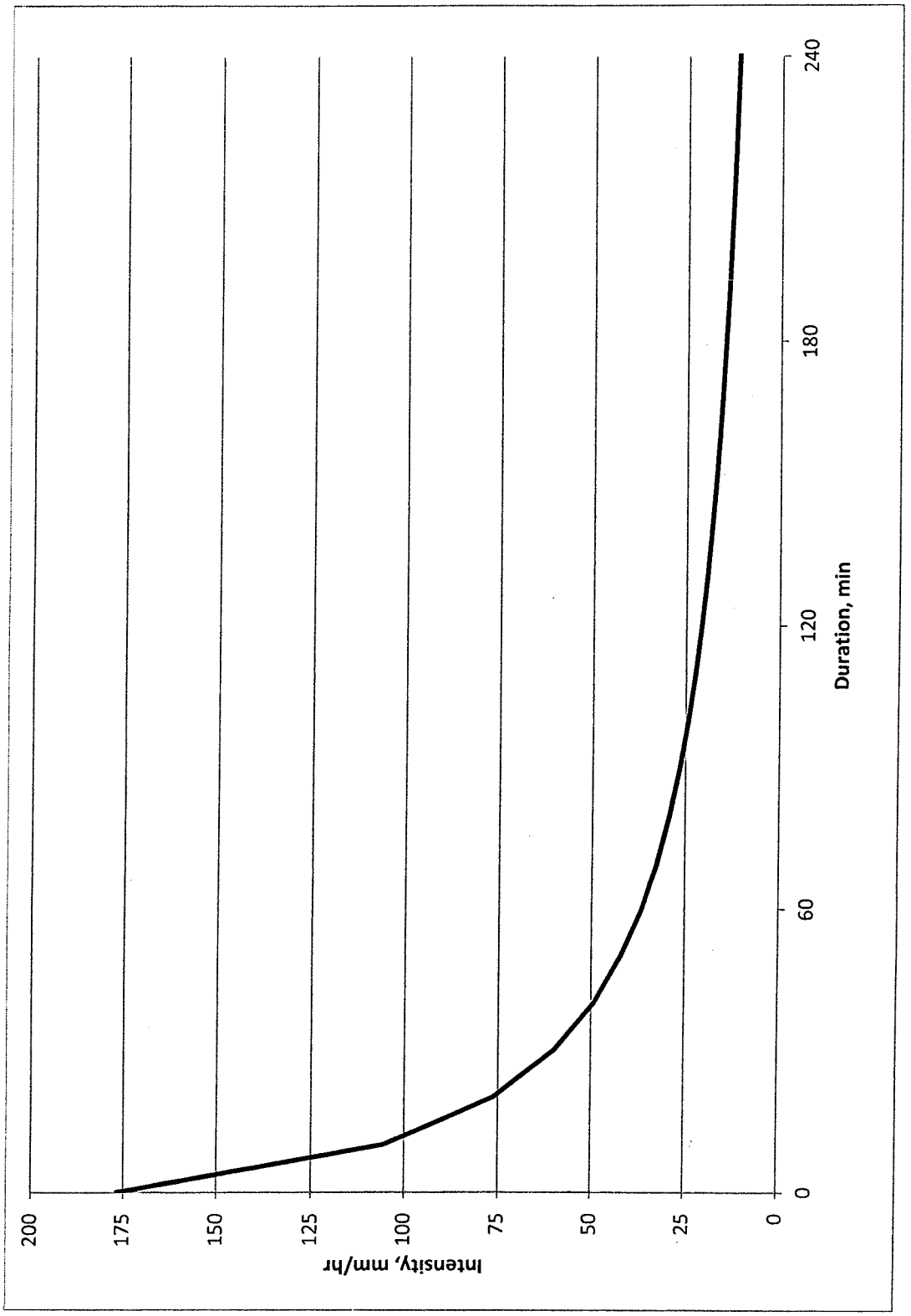
a. Based on the characteristics given, what is the total depth of runoff (effective precipitation) for this storm?
b. Sketch the outflow from the management pond on the graph, paying attention to the timing of the peak discharge and the time to when the discharge returns to 0.
c. What volume of active pond storage is required to achieve this attenuation in the peak flow?

6.(20 Marks)

A well is in an unconfined aquifer consisting of a medium sand material. The aquifer is underlain by a horizontal bedrock surface at a depth of 10 m. Two monitoring wells at radial distances from the well of 75 and 96 m from a pumping well show that while the well is pumping the water in the wells is 6 and 5 m below the ground surface, respectively.

a. What do you estimate the steady state discharge of the well to be?
b. What assumptions were required for you to answer part a?
c. If instead the aquifer was only 3 m thick above the bedrock and then overlain with clay to the surface, how would your answer to part a change (give a numerical answer)?

Graph for Question 1.



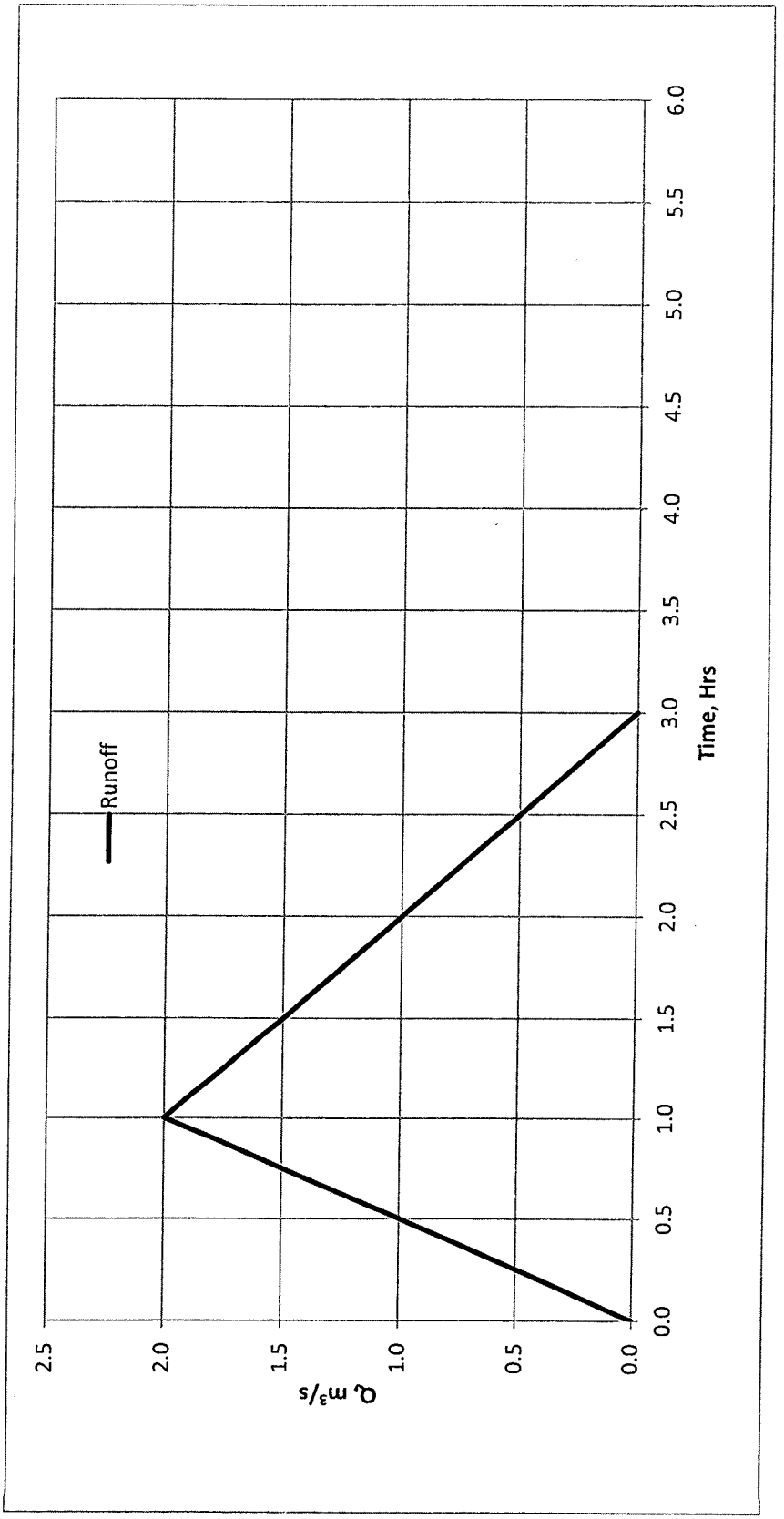


Figure for Question 5 – submit with your book.