

Ollscoil na hÉireann, Gaillimh
NATIONAL UNIVERSITY OF IRELAND, GALWAY

B.E. Degree - Civil Engineering
- Environmental Engineering

EH407 Engineering Hydrology II

SUMMER EXAMINATIONS 2000

Examiners: Professor P.E. O'Connell
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 Mr. T. Henry

Time allowed is *two* hours.
 Attempt four questions

1. (a) Show how the continuity equation is rearranged for use in the Puls method of reservoir flow routing. [3 marks]
- (b) The relationships between lake water level and the quantities $S \pm Q\Delta T/2$ for a particular lake, as a function of water level, is shown in the attached diagram. The first three lines in a forward routing calculation for this lake are as follows.

Time Step	Inflow $I(t)$	$(I_t + I_{t-1})\Delta T/2$	$S - Q\Delta T/2$	$S + Q\Delta T/2$	H_t	Q_t
days	m^3/s	million m^3	million m^3	million m^3	m	m^3/s
0.00	0.0	0.086	0.949	1.036	135.500	3.465
0.50	4.0	0.248	0.898	1.146	135.472	3.178
1.00	7.5	0.529	0.986	1.515	135.520	3.675
1.50	17.0					
2.00	28.0					
2.50	32.0					

Showing clearly how each quantity is obtained, calculate

- (i) the water levels at times 1.5, 2.0 and 2.5 days. [7.5 marks]
- (ii) the corresponding discharges given that outflow is controlled by a 5 m Crump weir with crest elevation of 135 mOD. [2 marks]
2. (a) In the context of unit hydrograph theory define what is known as an S-curve [2 marks].
- (b) The ordinates of a 1 cm 2 hour UH, at 2 hourly intervals, in m^3/s are as follows:-
- 0.0, 9.0, 22.5, 11.3, 3.2, 0.0.
- (i) Calculate and plot the corresponding S-curve [4 marks]
- (ii) Calculate the ordinates of the corresponding 1 cm 1 hour UH. [6.5 marks]

continued overleaf...

3. (a) Explain what is understood by the Index Flood method of regional flood frequency analysis and state the assumptions underlying this method. [3 marks]
- (b) The average values of coefficient of variation and coefficient of skewness of annual maximum flood series in a particular region are 0.40 and 1.20 respectively. Stating any assumptions made calculate, by the index flood method, an estimate of the 100 year return period flood for a catchment in the region which has a mean annual flood of 75 m³/s. [7 marks]
- (c) Equations of the form $\bar{Q} = c A^a R^b$ are sometimes used for determining mean annual flood values. In what circumstances may such equations be used and what are the associated disadvantages. [2.5 marks]

4. (a) Explain the principal differences between the Penman equation for open water evaporation and the Penman-Monteith equation for evaporation. [3 marks]
- (b) Define the terms field capacity and soil moisture deficit (SMD) in the context of soil moisture. [2 marks].

If an area of grassland had an SMD of 75 mm at the end of June, and rainfall and potential evaporation for July were 40 mm and 80 mm respectively, calculate the actual evaporation for the month of July. [4.5 marks].

- (c) For a location in Ireland where 2 day $R_2 = 58$ mm and $r = 60$ min $R_2/2$ day $R_2 = 0.28$ determine the rainfall intensity for a duration 30 minutes and return period 10 years. [3 marks].

5. (a) In the recently published UK Flood Estimation Handbook (FEH) the quantities known as L-moments are used. Explain briefly what these quantities are and the purposes which they serve. [4 marks]

- (b) A region, regarded as homogeneous from a flood frequency point of view, has four gauging stations whose L-Moments are as follows:

Station No.	1st L-Moment	2nd L-Moment	3rd L-Moment
1	68.77	19.95	7.99
2	6.10	2.01	1.05
3	16.45	3.37	0.50
4	96.88	19.03	5.61

Using the FEH recommended methodology determine the growth curve ordinate (growth factor) X_T , for $T = 100$ years, in that region. (See page 13 of Formula Handout) [6 marks]

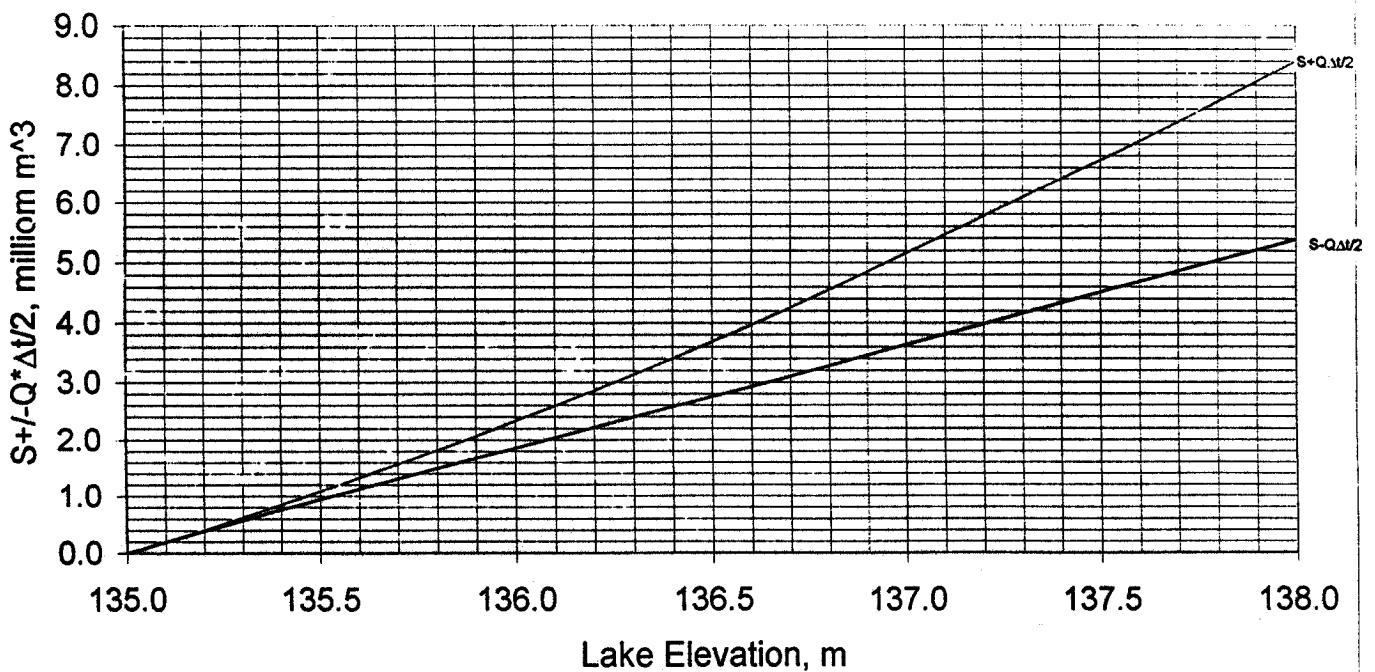
Hence obtain the Q_{100} estimate for a location which experienced the following annual maximum floods :

23, 33, 24, 27, 29, 36, 23, all in m³/s [2.5 marks]

6.

Answer both parts of the following question:

- (i) Explain how the bedrock and quaternary geology of east and south Co. Galway affects groundwater movement and quality (Your answer should include an explanation of karst formation, development and features). [10 marks]
- (ii) There are *four* major sources and causes of groundwater contamination in east and south Galway. List them, and describe *two* in detail. [10 marks].

STORAGE $\pm Q\Delta t/2$ 

A larger version of this diagram is available in loose leaf form for working purposes.