

OLLSCOIL NA hÉIREANN, GAILLIMH
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS 2001

FOURTH SCIENCE EXAMINATION – EH 403 HYDROLOGY

Examiners: Professor P.E. O'Connell
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Time allowed is *three* hours.

Attempt Question 1 (Section A), and any two questions from each of Section B and of Section C,
All questions carry equal marks.

SECTION A

1. Answer any eight of the following:

- (a) What factors affect transpiration in conifers?
- (b) Define Permanent Wilting Point?
- (c) What is a lysimeter used for?
- (d) Three factors are required for continuous evaporation from a free water surface. What are they?
- (e) What is the difference between available soil moisture and available water capacity?
- (f) What is tortuosity? Explain why its value in porous media is always greater than one.
- (g) What is the difference between insular and pendular saturation?
- (h) What is the difference between imbibition and drainage?
- (i) What is the basic difference between advection and dispersion?
- (j) What does the Peclet Number represent?

(2.5 marks each)

SECTION B

- 2. Explain how soil moisture is a limiting factor on evaporation. Your answer should look at several of the many variables that affect this relationship.
(20 marks)
- 3. Compare and contrast the various methods available for calculating potential evapotranspiration. Your answer should include a discussion of the strengths and weaknesses of each method.
(20 marks)

Section B continues overleaf

4. Answer either (a) *or* (b). Not both.

- (a) While the Aral Sea has a desperate shortage of water, fields and desert hollows throughout the basin are choked with irrigation water. Explain how this situation arose.

or

- (b) The Colorado River has been described as the world's most legislated, debated and litigated river. How did the river gain this notoriety?

(20 marks)

5 A quarry is being developed in Co. Tipperary. You are hired to carry out the hydrology and hydrogeology components of the Environmental Impact Statement (EIS).

The Average Annual Rainfall (AAR) in the area is determined to be 1035mm/year. The Average Potential Evaporation is determined to be 459mm/year. The surface area of the catchment up-gradient of the proposed quarry (including the quarry site itself) is 40km².

- (a) What is the Effective Rainfall (ER) for the area in which the quarry will be sited? (Assume Actual Evaporation = 0.95PE)

(4 marks)

- (b) Assuming that 30 percent of rainfall in the area recharges directly to groundwater, and assuming that the quarry will be entirely above the water table; what volume of water would be available as runoff to the quarry each year?

(4 marks)

- (c) The quarry will employ 30 people. Effluent will be collected and treated in a proprietary treatment unit on site before being discharged to a local stream. Assuming that effluent production is 100 litres/person/day how much effluent will be produced on a daily and yearly basis?

(4 marks)

- (d) The lowest recorded flow in the stream into which the effluent will be discharged is 0.005m³/second. Tipperary County Council require that the effluent be diluted to an 8:1 standard in the stream. Given the effluent discharge calculated above and the recorded low flow, will the stream be suitable to receive the treated water?

(4 marks)

- (e) The quarry site is located in the catchment of the River Suir that has an area of 1830km² in the vicinity of the quarry. What is the total volume of water available for runoff or groundwater recharge in the entire catchment? (Assume that ER and PE are as above.)

(4 marks)

SECTION C

6. Answer both (a) and (b).
- (a) Explain how a sudden, large volume loss of L-NAPL would behave in an unconfined aquifer, compared with the long-term, slow leak of L-NAPL in a similar aquifer. (Account for *all* phases of the L-NAPL.)
(10 marks)
- (b) How would a falling and rising water table affect the distribution of all phases of an L-NAPL spill?
(10 marks)
7. *In situ* bioremediation is widely used in remediating contaminated soils and aquifers. Explain the theory and methodology involved in using this approach, and outline the advantages and disadvantages (as well as the limitations) of its use as a remediation strategy.
(20 marks)
8. The macroscopic outcome of mass transport in fractured media is the result of both mechanical mixing and diffusion. How does this differ from what occurs in porous media? Your answer should include an explanation of the different causes of dispersion in fractured rocks, and an explanation of the ADTS model developed by Raven, Novakowski and Lapcevic (1988).
(20 marks)
9. An aquifer is contaminated as a result of a contaminant spill. Your company has been contracted to deal with the problem. Assuming the legal aspects have been dealt with, you are asked to devise a strategy to deal with the problem. Outline this strategy, providing specific action options that could be used.
(20 marks)