CHARLES DARWIN UNIVERSITY

Family name	
Given names	
Student number	
Teaching period	Semester 1, 2017

FINAL EXAMINATION	**DURATION**
ENG462 – Water Resources Engineering	Reading time: **10** minutes Writing time: **180** minutes

INSTRUCTIONS TO CANDIDATES

1 Read all questions.

2 Answer **ALL** questions using the Answer Booklet supplied.

3 Ensure that your name and student number are clearly indicated on your Answer Booklet and at the top of this examination paper.

4 Show all working (*e.g*., calculations and sketches).

5 This exam constitutes 50 % of the total marks available for this Unit.

6 Total marks available on this exam: 100.

7 All questions are of equal value.

8 Use dark blue, or black, ink.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination.

Any non-programmable calculator is permitted.

No handwritten notes are permitted.

Hard copy, unannotated, English translation dictionary only.

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 20 page book 1 × Formulae and data sheet 1 x Graph paper 1 × Scrap paper

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Q1 Two pipes with circular cross-sections are connected (in series) and used to transfer water between two storage tanks, which are open to the atmosphere. The vertical elevation difference between the free water surfaces in the tanks is 40 m. Details of the pipe system are given in Table Q1.

Table Q1 Pipe system parameters

Pipe identifier	Diameter (mm)	Length (m)	Friction factor λ
1.1	600	700	0.024
1.2	450	400	0.020

(a) Determine the discharge through the pipe system (in m^3s^{-1}).

(10 marks)

(b) Assess the effect of a ± 1 % manufacturing tolerance on the pipe diameters on your answer to Q1(a), above.

(10 marks)

(Total: 20 marks)

Q2 The inflow to a reach of a river has been measured and recorded. The reach is 12 river km in length, and the water normally flows at an average velocity of 0.9 m s^{-1} therein. At a given time after a rainstorm occurring upstream of this reach of the river, and within its catchment area, there was a change in the observed water level therein. Part of the tabulated calculations used to predict the downstream outflow from the reach of this river, using the Muskingum method, is given in Table Q2. It may be assumed that the weighting factor *x* is 0.25.

Table Q2 River flow prediction data

Time (h)	Inflow (m^3s^{-1})	Outflow (m^3s^{-1})
15	28.32	23.69
18	141.6	65.14
21	118.9	128.4
24	96.28	?

(a) Recommend, and justify, a value for the kinematic wave velocity (in m s^{-1}).

(2 marks)

(b) Using the value that you recommended in Q2(a), above, calculate the storage time constant for this reach of the river (in h).

(2 marks)

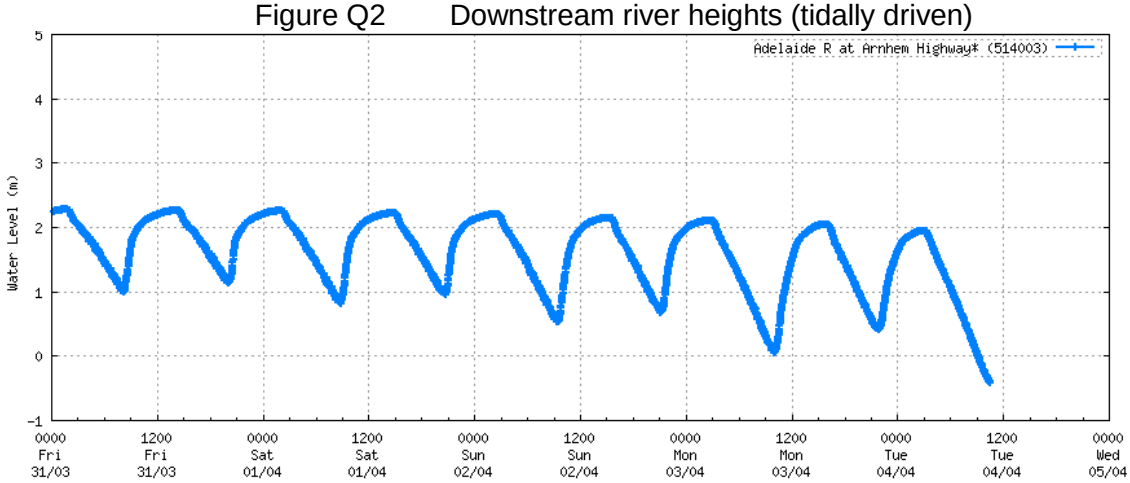
(c) Determine the predicted value of outflow from this reach of the river after 24 h.

(10 marks)

(d) Assess the effects of the downstream tidal influx (Figure Q2) on the accuracy of your predicted outflow hydrograph for the river in Q2(c) above.

(6 marks)

Figure Q2 Downstream river heights (tidally driven)



(Australian Government Bureau of Meteorology (2017) Latest river heights for Adelaide R. at Arnhem Highway. Station no. 514003, BoM, Melbourne, Australia. Available from: http://www.bom.gov.au/fwo/IDD60322/IDD60322.514003.plt.shtml Last accessed: 4 April, 2017.)

(Total: 20 marks)

Q3 In the analysis of unsteady flow in a river using the US Army Corps of Engineers HEC-RAS Version 5.0 software, the results for one of the cross-sections within the model is as shown in Figure Q3.

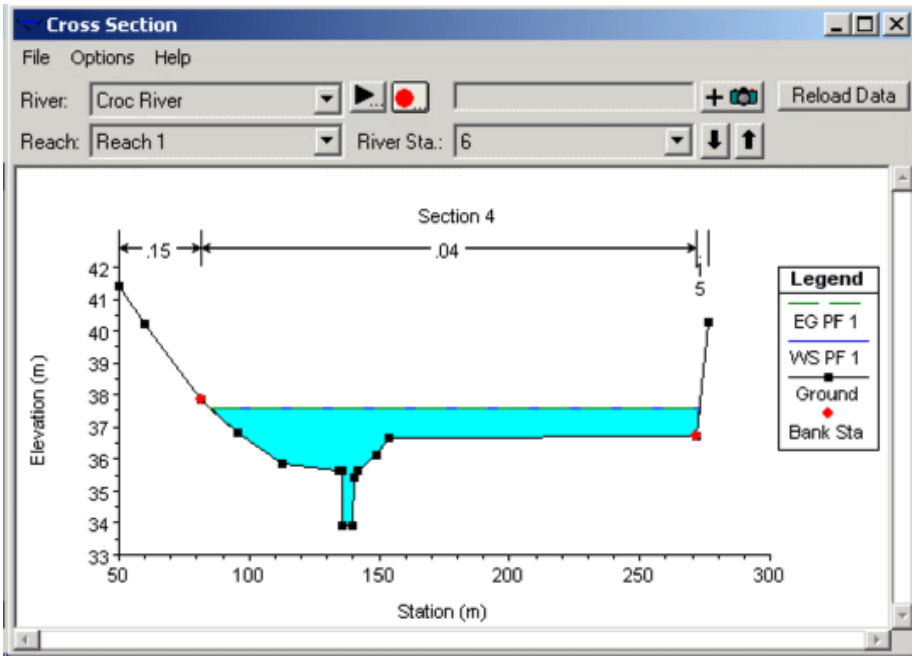


Figure Q3 Cross-section through the Croc River and floodplain

(US Army Corps of Engineers (2016) HEC-RAS River Analysis System User's Manual. US ACE, Institute for Water Resources, Hydrologic Engineering Center, Davis, CA, USA. Available from: http://www.hec.usace.army.mil/ Last accessed: 4 April, 2017.)

(a) Explain what is indicated by the red, and black, dots and their significance within the model.

(8 marks)

(b) A reach of the Croc River, downstream from the cross-section shown in Figure Q3, is predicted to flood beyond acceptable limits. Describe the changes to the river model that you could make to explore ways in which to prevent the downstream flooding from occurring. Identify any socio-economic implications of the suggestions made in your answer.

(12 marks)

(Total: 20 marks)

Q4 An unconfined aquifer has 20 m depth of fresh water (density 1000 kg m^{-3}) overlying 30 m depth of saline water (density 1015 kg m^{-3}). Two standpipe piezometers are installed in the aquifer such that the open section of Piezometer A is at a depth of 10 m below the water table, and the open section of Piezometer B is at a depth of 40 m below the water table.

(a) Define what is meant by the term "unconfined aquifer".

(2 marks)

(b) Assuming that there is no groundwater flow in the aquifer, and that the piezometers contain water of the same density as that surrounding the open section thereof, determine the vertical difference in height between the water levels in Piezometers A and B, and state which (if any) has the higher water level relative to the base of the aquifer.

(8 marks)

(c) Now assuming that there *is* some three-dimensional groundwater flow in the aquifer, discuss the implications of the vertical injection of a well point, such as is used in hydraulic fracturing operations, through the aquifer to a depth of 1.2 km.

(10 marks)

(Total: 20 marks)

Q5 A rectangular, open, channel is 25 m wide and has a bed slope of 3 m per km. The Manning coefficient *n* for the sides, and bed, thereof is 0.038.

(a) If the discharge from the channel is 45 $m^3 s^{-1}$, determine the normal depth of flow in the channel. Hint: the normal depth of flow is between 1.0 m and 1.5 m.

(10 marks)

(b) A weir is located across the channel and causes the depth of water in the channel to become 4.5 m at a flowrate of 45 $m^3 s^{-1}$. Using the Direct Step Method and depth increments of 0.2 m, determine the distance from the weir at which the depth of the water in the channel becomes 4.3 m.

(10 marks)

(Total: 20 marks)