UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

BSc Environmental Health Science

MAIN EXAMINATION PAPER MAY 2014

TITLE OF PAPER	:	WATER DRAINAGE AND SEWERAGE
COURSE CODE	:	EHS 587
DURATION	:	2 HOURS
MARKS	:	100
INSTRUCTIONS	:	THERE ARE FIVE QUESTIONS IN THIS EXAM
	:	ANSWER <u>ANY FOUR</u> OUT OF THE FIVE QUESTIONS
	:	EACH QUESTION CARRIES A MAXIMUM OF 25 MARKS

QUESTION ONE (25 Marks)

(Note each question below carries 5 marks)

A. Define i) infiltration   ii) inflow   iii) combined sewer overflows.

B. Describe with the help of a sketch the following structures: i) Manholes   ii) Inlets   iii) Inverted siphons   iv) Sewer outlets and sewer outfalls.

C. Explain how the laying out of sewer is made under the condition that the sewer has to be laid above a water supply pipe because of constraints imposed by gravity flow.

D. Explain why a combined sewer system may not be appropriate for towns with rainfall intensities that are high and rainfall concentrated in few months like in monsoon climates.

E. Describe Outline the problems associated with long length of sewers and state how these problems may be overcome.

QUESTION TWO (25 Marks)

A. The population of a city is 150,000 inhabitants in 2010. What is the predicted population in 2030 if the growth rate of population of the city is 1.5% per year and the population grows exponentially? ....[5 Marks]

B. For the city mentioned in question number 2A, the water demand in 2010 is 90 liter per person per day. The water demand grows 1.5% per year. Assuming that 80% of the water demand ends up as waste water in the sewer system; calculate the total daily waste water to be carried by the sewer system in 2030. Use the population projection calculation you made for question 2A. ....[5 Marks]

C. You are required to design wastewater flows for a town having an area of 2000 ha. The residential area is 65% of the total area, whereas commercial and industrial areas are 25% and 10% of the total area, respectively. Of the residential area, 45% are large lots, 50% small single-family lots and 5% multistory apartments. The population densities are 10 persons per hectare for the large lots, 80 persons per hectare for small single family lots and 2600 persons per hectare for multi-story apartments. The wastewater from the residential area is estimated to be 700 lpcd. The sewage from commercial and industrial areas is estimated to be 20000 L/ha/d and 35000 L/ha/d, respectively. Calculate:

   i.   The total average daily wastewater flow ....[5 Marks]

  ii.   The minimum flow ....[5 Marks]

 iii.   Peak flow ....[5 Marks]

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QUESTION THREE (25 Marks)

A. In the following Map (scale 1:1000): houses quarters, contour lines and the treatment plant location are shown:

     i)   Make layout of sewers system...…….. [5 Marks].

     ii)   Indicate the location of pumping station if needed. ....…….[5 Marks]
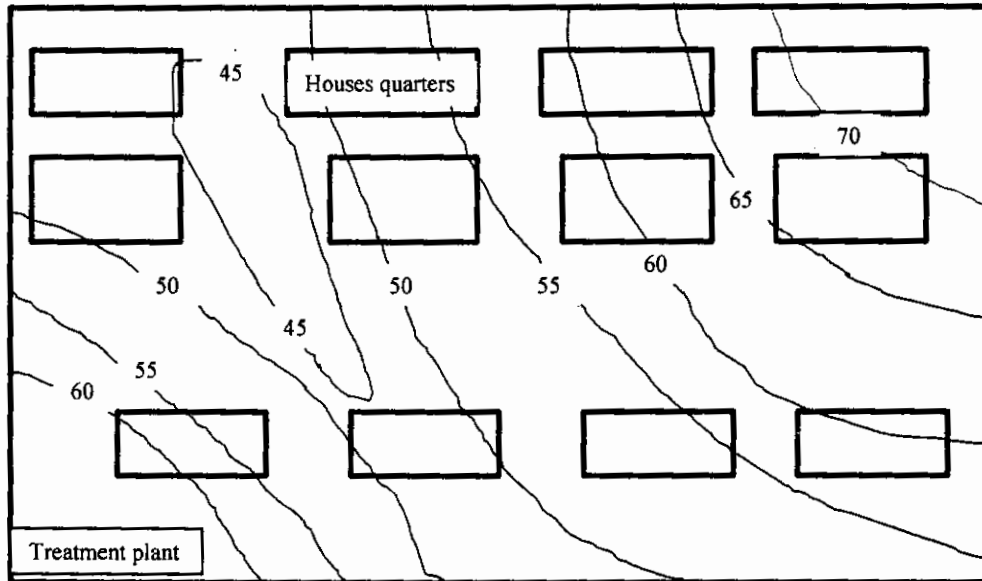
B. A sanitary sewer with a design flow of 0.284 m^3/sec enters manhole A. The distance downstream to the next manhole B is 122 meters. The finished street surface elevation at manhole A is 50.72 m and that at manhole B is 50.11 m. For manning's n = 0.013 and using the partial flow diagram shown in Figure Q3-1 over page find;

     i)   The nominal diameter of the pipe to carry the flow under full flow conditions..[5 Marks]

     ii)   The depth of flow and velocity at minimum flow which is equal to 25% of the design flow. ....[5 Marks]

     iii) In both cases check if the range of velocities fall in the desirable range between 1m/sec and 1.5m/sec...….........[5 Marks]
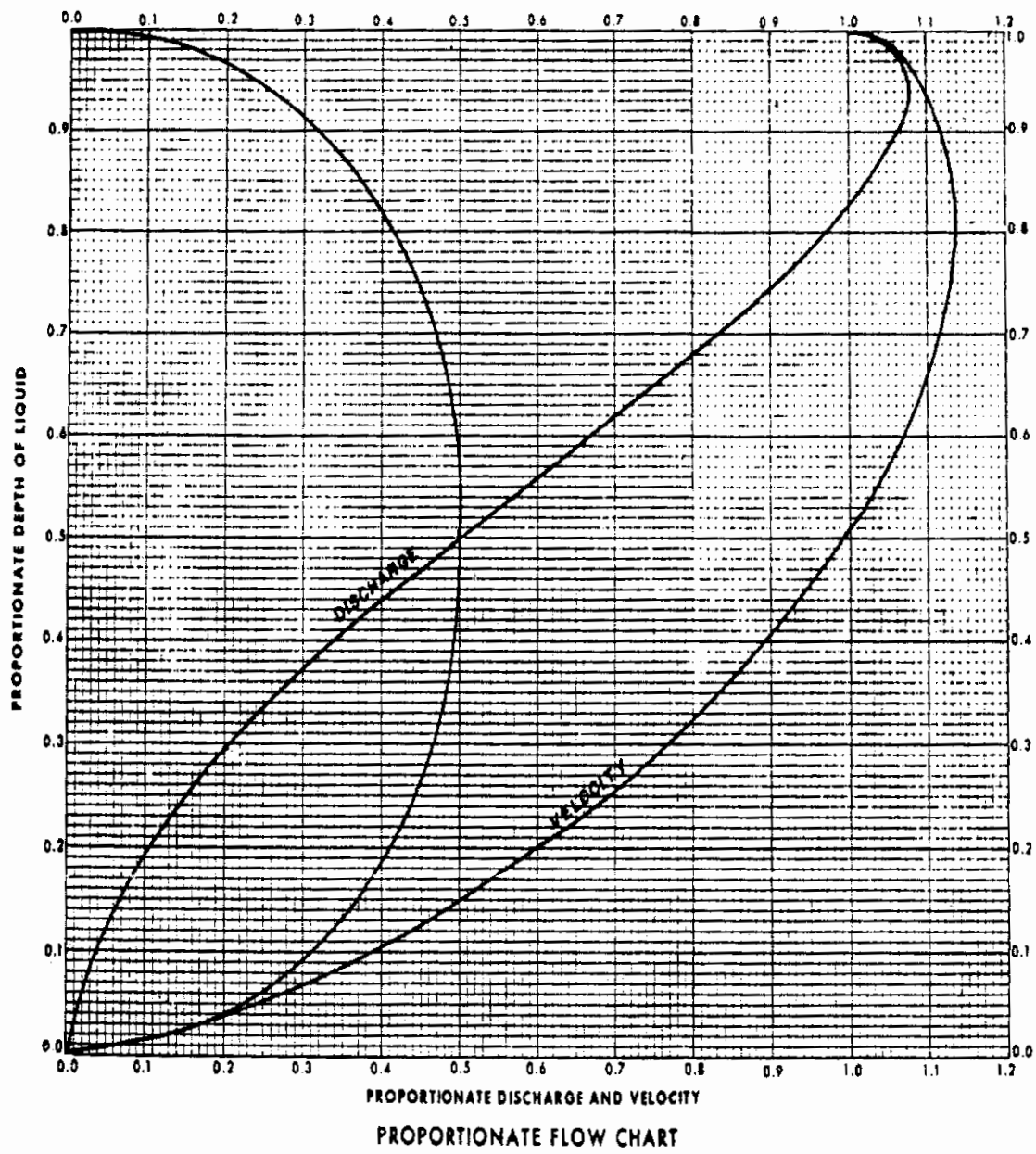
Figure Q3-1 Partial flow graph for Sewer flow calculation

QUESTION FOUR (25 Marks)

(Note: each question carries 5 marks)

    A. Discuss in detail how urbanization affects the local hydrology of a given catchment.

    B. Discuss the advantages of wetlands in an urban drainage context.

    C. Describe retention ponds and indicate how drainage water may be fed to retention ponds.

    D. Describe swales and the function it provides in urban drainage context.

    E. Discuss the importance of groundwater recharge of drainage water in coastal areas.

QUESTION FIVE (25 Marks)

A steep drainage channel drains in to an impounding reservoir whose water level behind the dam is 5 meters. The flow rate in the drainage channel is 50 m³/sec. The channel slope is 5^0. The channel is of rectangular cross section of width 10 meters throughout the channel length. The roughness height of the channel surface (K_s) is 5 mm. The Darcy-Weisbach friction factor can be taken as 0.015 and the flow is fully turbulent.

    A. To which back water curve classification does this gradually varied flow of the channel belong?. Give reasons. ....10 Marks)

    B. Plot the back water curve profile from the reservoir (taking the depth of 5m) backwards to the point where a hydraulic jump occurs. Determine the position of the hydraulic jump measured from the reservoir position......................... (15 Marks)