UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	HYDROLOGY
COURSE CODE	:	BFC 3092
PROGRAMME	:	3 BFF
EXAMINATION DATE	:	APRIL / MAY 2011
DURATION	:	2½ HOURS
INSTRUCTIONS	:	**PART A** IS **COMPULSORY** QUESTION. ANSWER **FOUR (4)** QUESTIONS IN **PART B**

THIS PAPER CONSISTS OF **NINETEEN (19)** PAGES

PART A
ANSWER QUESTION 1

Q1 (a) State **FOUR (4)** importance of groundwater investigations.

(4 marks)

(b) What is your opinion about problems that may occur due to over-pumping of ground water and discuss the solutions.

(4 marks)

(c) List **THREE (3)** advantages and **THREE (3)** disadvantages of using groundwater compared to surface runoff.

(6 marks)

(d) A 50 cm well was drilled penetrating straight into an unconfined aquifer at a depth of 90 m. Two other wells were drilled at a distance of 20 m and 100 m from the initial well, which show 12 m and 8 m decrease in water level respectively from the initial groundwater level. If the aquifer has a permeability of 100 m/day, what is the pumping rate of the groundwater well.

(6 marks)

PART B
*ANSWER **ANY FOUR (4)** QUESTIONS*

Q2 (a) Discuss **TWO (2)** types of precipitation formation.

(5 marks)

(b) **Table Q2** shows the monthly inflow and outflow for a small reservoir. If the reservoir has an initial storage of 60000 m^3 on 1st January, what is the storage at the end of June and October for the year. Plot the graph of water storage against time.

Table Q2

Month	Inflow (m^3/s)	Outflow (m^3/s)	Storage (m^3)
1 January 2010			60 000
31 January 2010	4	4.002	
28 February 2010	3	3.005	
31 March 2010	5	5.002	
30 April 2010	4	4.006	
31 May 2010	3	3.003	
30 June 2010	4	4.004	
31 July 2010	10	9.998	
31 August 2010	30	29.983	
30 September 2010	15	14.989	
31 October 2010	6	5.999	

(15 marks)

Q3 (a) What could you explain about infiltration and how could you describe any factor(s) which affects infiltration process.

(5 marks)

(b) Using Penman method, estimate evapotranspiration (ET) from the data given in **Table Q3**.

Table Q3

Parameter	Value
Temperature (water surface)	20 °C
Temperature (air)	32 °C
Relative humidity	45 %
Wind speed	1.5 mph (36 mi/day)
Month	June
Location	33° north latitude
r	0.08
n/D	0.73

Necessary references are in **Appendix I** to **III**.

(15 marks)

Q4 (a) An important watershed characteristic is drainage area. Explain how the drainage area is identified using the "stone-age" method.

(5 marks)

(b) A lawn drain shown in **Figure Q4 (a)** is to be designed. Compute the peak runoff Q_p using the rational method for a 25-year storm event. Use the proposed lawn drain as the point of analysis. The outlet elevation is 377 ft. The total drainage basin area is 2.10 acres comprises of 1.22 acres woods, 0.14 acres impervious area and 0.74 acre grass.

Runoff coefficient is provided in **Table Q4**. Flow path consists of overland flow and shallow concentrated flow. The surface of overland flow is average grass. All necessary figures (**Figure Q4 (a) to Figure Q4 (d)**) are provided in the **Appendix IV to VII**.

(Hint : Use thread or paper to measure the distance on the map).

Table Q4

Surface Type	Runoff Coefficient	
	Range of Values	Typical Design
Impervious (Pavement, roofs)	0.75 – 0.95	0.90
Lawns	0.05 – 0.35	0.30
Unimproved (Woods, brush)	0.10 – 0.30	0.20

Note: The ranges of C values are for return period of 2 – 10 years. Higher values are appropriate for larger design storms. The typical of C values are for lower intensity storm (up to 25-year return period). Suggested multiplier factors for larger design storms are :-

Return period	Multiplier
25-year	1.15
50-year	1.20
100-year	1.25

(15 marks)

Q5 (a) With the aid of figure, explain **TWO (2)** techniques of baseflow separation.

(5 marks)

(b) Derive a 3-hour Snyder unit hydrograph for a 8.5×10^7 m^2 catchment shown in **Figure Q5**. Sketch graphically the elements computed from this unit hydrograph. Given $C_p = 0.65$ and $C_t = 2.0$.

(15 marks)

Q6 (a) What is stream flow routing. List **FOUR (4)** applications of flood routing.

(5 marks)

(b) **Table Q6** gives the inflow and outflow measured for a particular reach of a river. Justify whether the Muskingum parameter x for the reach is 0.2 or 0.3.

Table Q6

Time (hours)	Inflows (m^3/s)	Outflows (m^3/s)
2	110	110
4	380	120
6	680	240
8	530	490
10	420	500
12	330	428
14	240	357
16	150	300
18	105	250
20	10	170

(15 marks)

BAHAGIAN A
JAWAB SOALAN 1

S1 (a) Nyatakan **EMPAT (4)** kepentingan penyiasatan air bumi.

(4 markah)

(b) Apa pendapat anda berkenaan permasalahan yang mungkin timbul akibat daripada pengepaman air bumi yang berlebihan dan bincangkan penyelesaiannya.

(4 markah)

(c) Senaraikan **TIGA (3)** kebaikan dan **TIGA (3)** keburukan menggunakan air bumi berbanding air larian permukaan.

(6 markah)

(d) Sebuah 50 cm telaga digali menusuki terus ke lapisan akuifer tak terkurung sedalam 90 m. Dua buah telaga lain yang dikorek pada jarak 20 m dan 100 m dari telaga yang asal menunjukkan 12 m dan 8 m penurunan aras air masing-masing dari paras air bumi yang asal. Sekiranya akuifer tersebut mempunyai kebolehtelapan 100 m/hari, berapakah kadar pengepaman telaga air bumi tersebut.

(6 markah)

BAHAGIAN B
*JAWAB **MANA-MANA EMPAT (4)** SOALAN*

S2 (a) Bincangkan **DUA (2)** jenis pembentukan hujan.

(5 markah)

(b) **Jadual S2** menunjukkan kadar alir masuk dan keluar bulanan bagi sebuah empangan kecil. Jika empangan tersebut mengandungi simpanan air awalan sebanyak 60000 m^3 pada 1 Januari, berapakah simpanan empangan pada penghujung bulan Jun dan Oktober tahun tersebut. Plot graf simpanan air melawan masa.

Jadual S2

Bulan	Kadar alir masuk (m^3/s)	Kadar alir keluar (m^3/s)	Simpanan (m^3)
1 Januari 2010			60 000
31 Januari 2010	4	4.002	
28 Februari 2010	3	3.005	
31 Mac 2010	5	5.002	
30 April 2010	4	4.006	
31 Mei 2010	3	3.003	
30 Jun 2010	4	4.004	
31 Julai 2010	10	9.998	
31 Ogos 2010	30	29.983	
30 September 2010	15	14.989	
31 Oktober 2010	6	5.999	

(15 markah)

S3 (a) Apa yang anda boleh jelaskan berkenaan penyusupan dan bagaimana anda boleh huraikan mana-mana faktor yang mempengaruhi proses penyusupan.

(5 markah)

(b) Menggunakan kaedah Penman, anggar sejatpeluhan (ET) daripada data yang diberikan dalam **Jadual S3** :-

Jadual S3

Parameter	Nilai
Suhu (permukaan air)	20 °C
Suhu (udara)	32 °C
Kelembapan bandingan	45 %
Kelajuan angin	1.5 mph (36 mi/day)
Bulan	June
Lokasi	33° north latitude
r	0.08
n/D	0.73

Jadual yang diperlukan diberi di **Lampiran I** hingga **III.**

(15 markah)

S4 (a) Satu ciri penting kawasan tadahan ialah keluasan saliran. Terangkan bagaimana luas saliran ini dikenalpasti menggunakan kaedah "*stone-age*".

(5 markah)

(b) Sebuah saliran kawasan berumput seperti ditunjukkan dalam **Rajah S4 (a)** perlu direkabentuk. Kira kadar alir puncak Q_p menggunakan kaedah rasional untuk peristiwa hujan 25-tahun. Gunakan saliran kawasan berumput yang dicadangkan sebagai titik analisis. Aras alur keluar ialah 377 kaki. Jumlah luas kawasan ialah 2.10 ekar merangkumi 1.22 ekar hutan, 0.14 ekar kawasan tidak telap dan 0.74 ekar rumput.

Pekali air larian diberi dalam **Jadual S4**. Laluan aliran merangkumi aliran permukaan tanah dan aliran tumpuan cetek. Permukaan aliran atas tanah ialah rumput secara purata. Kesemua rajah yang diperlukan **(Rajah S4 (a)** hingga **Rajah S4 (d))** diberi dalam **Lampiran IV** hingga **VII**.

(Panduan : Gunakan benang atau kertas untuk mengukur jarak di atas peta)

Jadual S4

Jenis Permukaan	Pekali Air Larian	
	Julat nilai	Rekabentuk Biasa
Tidak telap (Turapan, bumbung)	0.75 – 0.95	0.90
Kawasan berumput	0.05 – 0.35	0.30
Tidak dibangunkan (Hutan, belukar)	0.10 – 0.30	0.20

Nota: Had-had nilai C adalah untuk kala kembali 2 – 10 tahun. Nilai tertinggi adalah untuk rekabentuk ribut besar yang bersesuaian. Nilai-nilai C yang biasa adalah untuk keamatan ribut yang rendah (sehingga 25 tahun kala kembali). Faktor pengganda yang dicadangkan untuk rekabentuk ribut yang lebih besar adalah :-

Kala Kembali	Pengganda
25 tahun	1.15
50 tahun	1.20
100 tahun	1.25

(15 markah)

S5 (a) Berbantukan gambarajah, huraikan **DUA (2)** teknik pengasingan aliran dasar.
(5 markah)

(b) Terbitkan sebuah hidrograf unit Synder 3-jam bagi sebuah kawasan tadahan seluas 8.5×10^7 m^2 seperti dalam **Rajah S5**. Lakarkan secara grafik elemen-elemen yang dikira daripada hidrograf unit ini. Diberi $C_p = 0.65$ dan $C_t = 2.0$.
(15 markah)

S6 (a) Apakah penghalaan aliran sungai. Senaraikan **EMPAT (4)** kegunaan penghalaan banjir.
(5 markah)

(b) **Jadual S6** ialah kadar alir masuk dan kadar alir keluar yang diukur untuk sebuah jangkauan sungai. Berikan justifikasi sama ada parameter Muskingum x untuk jangkauan ini ialah 0.2 atau 0.3.

Jadual S6

Masa (jam)	Kadar alir masuk (m^3/s)	Kadar alir keluar (m^3/s)
2	110	110
4	380	120
6	680	240
8	530	490
10	420	500
12	330	428
14	240	357
16	150	300
18	105	250
20	10	170

(15 markah)

APPENDIX 1

FINAL EXAMINATION

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TABLES

Table Q3 (a) : Values of temperature-dependent coefficient B for use in the Penman equation

T_a (°K)	B (mm H_2O/day)	T_a (°F)	B (mm H_2O/day)
270	10.73	35	11.48
275	11.51	40	11.96
280	12.40	45	12.45
285	13.20	50	12.94
290	14.26	55	13.45
295	15.30	60	13.96
300	16.34	65	14.52
305	17.46	70	15.10
310	18.60	75	15.65
315	19.85	80	16.25
320	21.15	85	16.85
325	22.50	90	17.46
		95	18.10
		100	18.80

Note : $B = \sigma T_a$ where :-

σ is the Boltzmann constant, 2.01×10^{-9} mm/day

°K = °C + 273° or °F = 1.8(°C) + 32°

APPENDIX II

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Table Q3 (b) : Tabulated values of R, mean monthly intensity of solar radiation on a horizontal

	Latitude (degree)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North	60	1.3	3.5	6.8	11.1	14.6	16.5	15.7	12.7	8.5	4.7	1.9	0.9
	50	3.6	5.9	9.1	12.7	15.4	16.7	16.1	13.9	10.5	7.1	4.3	3
	40	6.0	8.3	11.0	13.9	15.9	16.7	16.3	14.8	12.2	9.3	6.7	5.5
	30	8.5	10.5	12.7	14.8	16.0	16.5	16.2	15.3	13.5	11.3	9.1	7.9
	20	10.8	12.3	13.9	15.2	15.7	15.8	15.7	15.3	14.4	12.9	11.2	10.3
	10	12.8	13.9	14.8	15.2	15.0	14.8	14.8	15.0	14.9	14.1	13.1	12.4
South	10	15.8	15.7	15.1	13.8	12.4	11.6	11.9	13.0	14.4	15.3	15.7	15.8
	20	16.8	16.0	14.6	12.5	10.7	9.6	10.0	11.5	13.5	15.3	16.4	16.9
	30	17.3	15.8	13.6	10.8	8.7	7.4	7.8	9.6	12.1	14.8	16.7	17.6
	40	17.3	15.2	12.2	8.8	6.4	5.1	5.6	7.5	10.5	13.8	16.5	17.8
	50	17.1	14.1	10.5	6.6	4.1	2.8	3.3	5.2	8.5	12.5	16	17.8
	60	16.6	12.7	8.4	4.3	1.9	0.8	1.2	2.9	6.2	10.7	15.2	17.5

Table Q3 (c) :Properties of water in SI units

Temperature (°C)	Vapor pressure		
	mm Hg	mb	g/cm^2
0	4.58	6.11	6.23
5	6.54	8.72	8.89
10	9.20	12.27	12.51
15	12.78	17.04	17.38
20	17.53	23.37	23.83
25	23.76	31.67	32.30
30	31.83	42.43	43.27
35	42.18	56.24	57.34
40	55.34	73.78	75.23
50	92.56	123.40	125.83
60	149.46	199.26	203.19
70	233.79	311.69	317.84
80	355.28	473.67	483.01
90	525.89	701.13	714.95
100	760.00	1013.25	1033.23

APPENDIX III

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FIGURES

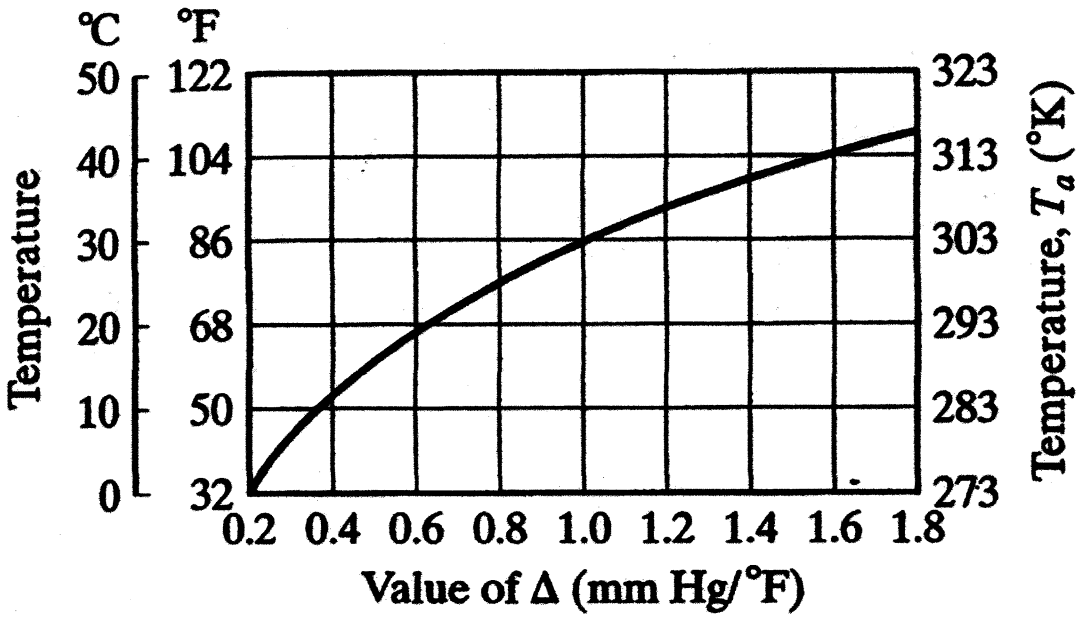

Figure Q3 : Value of Δ

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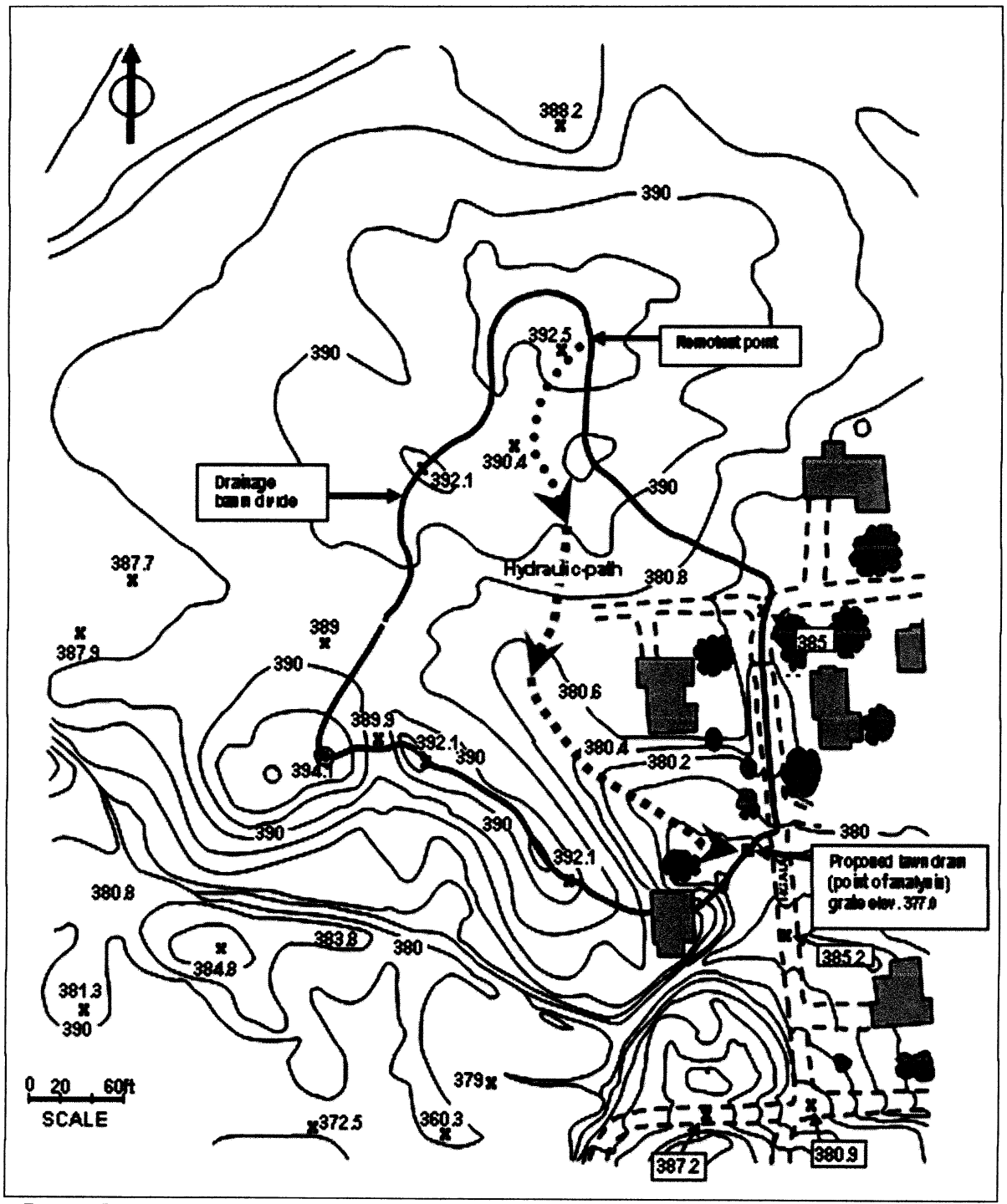

Lagend :-

Overland flow path

Shallow concentrated flow path

Figure Q4 (a)

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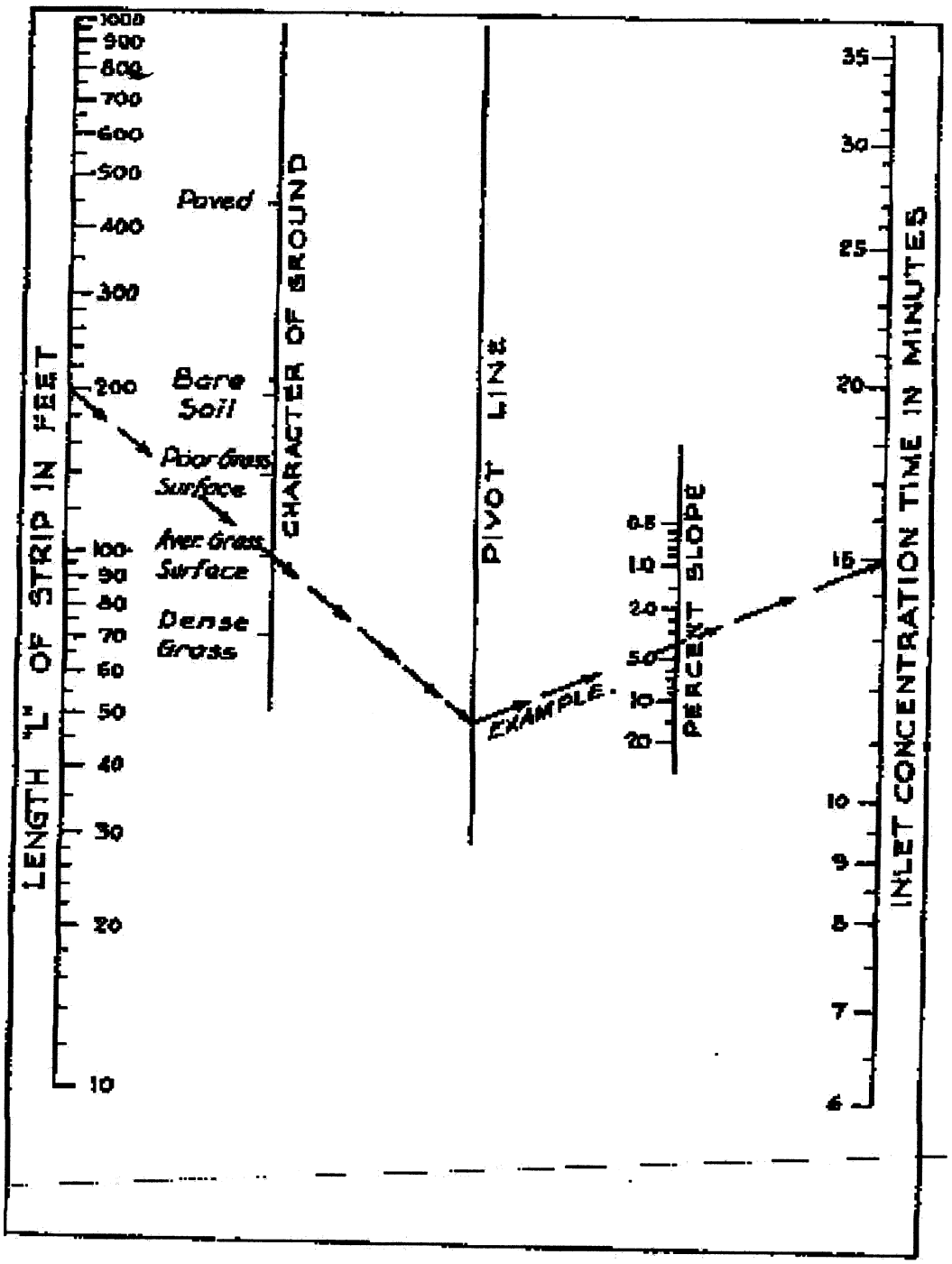

Figure Q4 (b) : Nomograph for overland flow time

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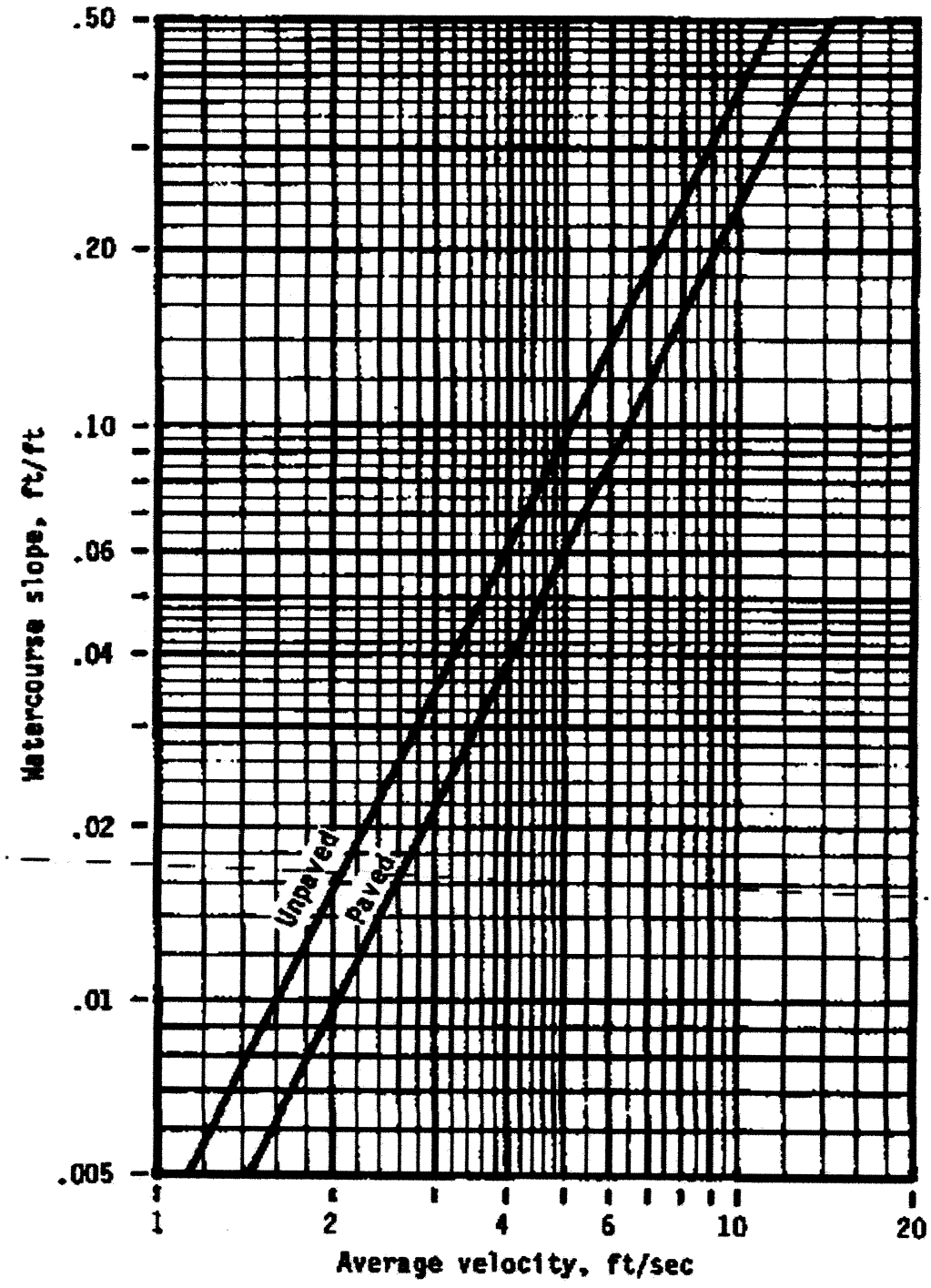

Figure Q4 (c) : Average velocities for estimating travel time for shallow concentrated flow

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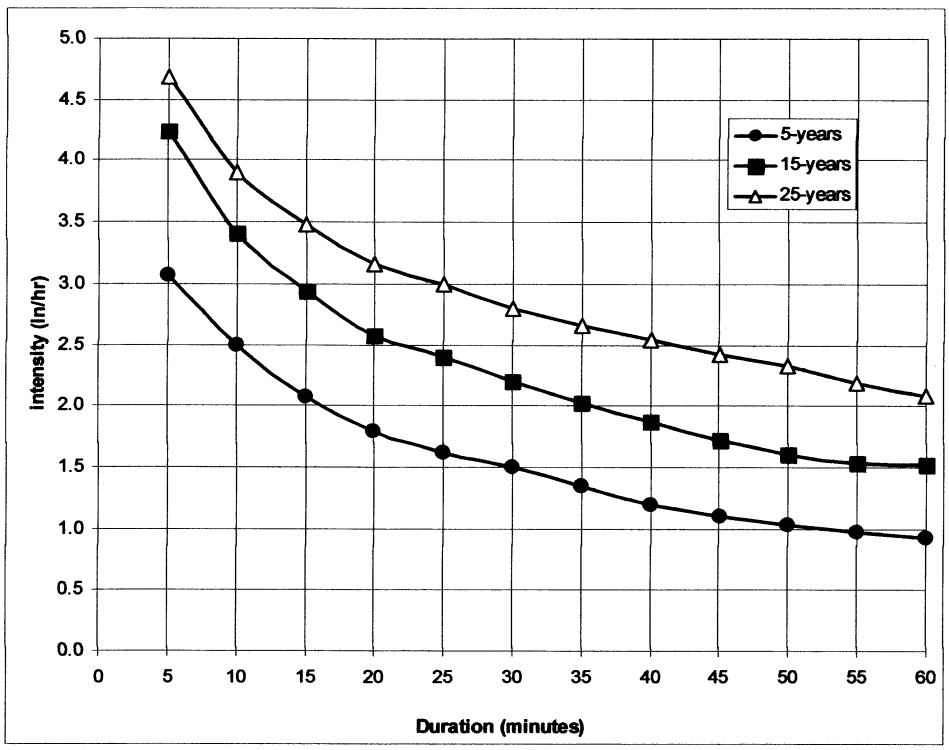

Figure Q4 (d) : Intensity-duration-frequency (IDF) curve

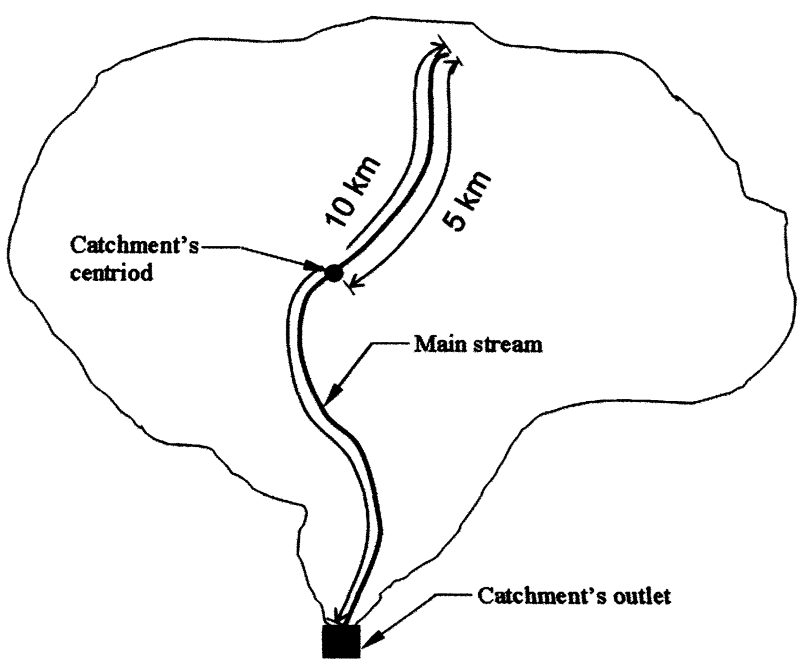

Figure Q5

APPENDIX VIII

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EQUATIONS

$$Q_p = 2.78\left[\frac{C_p A}{t_l}\right] \qquad t_r = \frac{t_L}{5.5} \qquad t_L = 0.75C_t(L.L_c)^{0.3}$$

$$t_{IR} = t_L + 0.25(t_R - t_r) \qquad W_{50} = \frac{5.87}{(Q_{pR}/A)^{1.08}} \qquad W_{75} = \frac{3.35}{(Q_{pR}/A)^{1.08}}$$

$$O_2 = C_O I_2 + C_1 I_1 + C_2 O_1 \qquad C_O = \frac{0.5\Delta t - Kx}{K(1-x) + 0.5\Delta t} \qquad xI + (1-x)O$$

$$C_1 = \frac{0.5\Delta t + Kx}{K(1-x) + 0.5\Delta t} \qquad C_2 = \frac{K(1-x) - 0.5\Delta t}{K(1-x) + 0.5\Delta t}$$

$$S_2 = S_1 + \Delta t\left[\frac{I_1 + I_2}{2} - \frac{O_1 + O_2}{2}\right] \qquad Q = iCA \qquad Q = \frac{1.49}{n} AR^{2/3}\sqrt{S_o}$$

$$P_a = P_o.\left(\frac{M_a}{M_o}\right) \qquad E_o = 0.35(e_s - e_a)(1 + 0.0098u_2)$$

$$H = R(1-r)[0.18 + 0.55(n/D)] - B(0.56 - 0.092\sqrt{e_a})[0.1 + 0.9(n/D)]$$

$$ET_p = \frac{\Delta H + 0.27E_o}{\Delta + 0.27} \qquad H^2 - h^2 = \frac{Q}{\pi K}\ln\frac{R}{r} \qquad H - h = \frac{Q}{2\pi bK}\ln\frac{R}{r}$$

$$t_p = \frac{t_R}{2} + t_{IR} \qquad t_B = 72 + 3t_{IR} \qquad Q_{PR} = 2.78\frac{C_p A}{t_{IR}}$$

$$W_{50} = \frac{5.87}{\left(\frac{Q_{PR}}{A}\right)^{1.08}} \qquad W_{75} = \frac{3.35}{\left(\frac{Q_{PR}}{A}\right)^{1.08}} \qquad I - O = \frac{\Delta S}{\Delta t}$$