UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2013/2014

December 2013 / January 2014

REG 563 – Sustainable Infrastructure
(Infrastruktur Lestari)

Duration: 3 hours
(Masa: 3 jam)

Please check that this examination paper consists of FIFTEEN pages of printed material before you begin the examination.

Sila pastikan bahawa kertas peperiksaan ini mengandungi LIMABELAS muka surat yang tercetak sebelum anda memulakan peperiksaan ini.

Students are allowed to answer the questions either in English OR in Bahasa Malaysia only.

Pelajar dibenarkan menjawab soalan dalam Bahasa Inggeris ATAU Bahasa Malaysia.

Answer **FIVE** questions only.

*Jawab **LIMA** soalan sahaja.*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai].

1. (a) Describe the four (4) primary strategies towards the development of sustainable infrastructure.

Terangkan empat (4) strategi utama ke arah pembangunan infrastruktur mampan.

(6 marks/*markah*)

(b) By using the method prescribed in the Urban Storm Water Management Manual (MSMA), design a suitable open flow channel to receive and drain the storm water runoff for a given catchment area which has the following site parameters. Please refer Appendix 1 for the relevant information to facilitate the design process. Assume drain size of 0.35m (width) x 0.35 m (height) and channel friction slope of 1 in 200 for calculation of the in-channel flow time, t_{ch}.

Dengan menggunakan kaedah yang dinyatakan dalam Manual Saliran Mesra Alam (MSMA), rekabentuk sebuah saluran pengaliran terbuka untuk menerima dan menyalurkan air ribut bagi sebuah kawasan tadahan yang mempunyai parameter tapak berikut. Sila rujuk Appendix 1 untuk maklumat yang berkenaan bagi memudahkan proses rekabentuk. Anggap saiz saluran sebagai 0.35m (lebar) x 0.35m (dalam) dan kecerunan geseran saluran sebagai 1 dalam 200 untuk pengiraan masa pengaliran dalam saluran, t_{ch}.

Type of open flow channel: U-channel without upstream channel

Jenis saluran terbuka

Manning roughness coefficient for catchment surface, $n_{catchment} = 0.011$

Pekali kekasaran Manning permukaan kawasan tadahan

Average surface slope for the catcment area, S = 1 in 100 (or 1%)

Kecerunan purata permukaan kawasan tadahan

Total surface area of catchment area, A = 0.5260 hectre

Jumlah luas permukaan kawasan tadahan

Length of overland flow path, L_o = 250 m

Panjang pengaliran permukaan

Length of reach/channel, L_{ch}= 20 m

Panjang saluran pengaliran

Type of proposed development in the catchment: High density residential area

Jenis cadangan pembangunan dalam kawasan tadahan

Drainage channel system type: Minor system

Jenis sistem saliran

Fitted coefficient of rainfall intensity duration frequency (IDF) curve:

Pekali geraf kekerapan jangka masa intensiti hujan

a= 3.7277, b= 1.4393, c= -0.4023 and d= 0.0241

Runoff coefficient of catchment, C =0.9

Pekali air larian kawasan tadahan

Manning roughness coefficient for drain channel surface, $n_{channel}$ = 0.013

Pekali kekasaran Manning permukaan saluran pengaliran

(14 marks/*markah*)

2. (a) Describe the function of the stormwater detention facilities and the types of facilities commonly used.

Terangkan fungsi kolam penahanan air ribut dan jenis kolam penahanan yang biasa digunakan.

(6 marks/*markah*)

(b) By using the method prescribed in the Urban Storm Water Management Manual (MSMA), determine the necessity for the installation of an on-site detention pond for a proposed development which has the following site parameters. In addition, calculate the required permissible site discharge for ARI of 2 years (PSD_2) for the proposed development assuming that an above ground detention pond will be installed. Please refer Appendix 1 for the relevant information to facilitate the design process.

Dengan menggunakan kaedah yang dinyatakan dalam Manual Saliran Mesra Alam (MSMA), tentukan sama ada kolam penahanan air ribut diperlukan bagi projek pembangunan yang dicadangkan berdasarkan parameter tapak yang berikut. Sebagai tambahan, kirakan kadar alir air ribut yang dibenarkan untuk ARI 2 tahun (PSD_2) untuk cadangan pembangunan tersebut dengan anggapan bahawa kolam penahanan air ribut atas tanah akan digunakan. Sila rujuk Apendix 1 untuk maklumat yang berkenaan bagi memudahkan proses pengiraan.

Location of project: Alor Star, Kedah

Lokasi tapak projek:

Total land area of project site =8000 m^2

Jumlah keluasan tapak projek

Total green area before development=8000 m^2

Jumlah keluasan kawasan hijau sebelum pembangunan

Type of green area before development: Clays soil with open crop, close crop and forest

Jenis kawasan hijau sebelum pembangunan

Total green area remaining after development=2000 m^2

Jumlah keluasan kawasan hijau selepas pembangunan

Type of paved area after development: Impervious roof and concrete pavement

Jenis kawasan berturap selepas pembangunan

Average Recurrance Interval (ARI)= 2 years

Purata jangkamasa antara peristiwa hujan

Measured time of concentration, t_c = 10 minutes

Jangkamasa peristiwa ribut terukur

Fitted coefficient of rainfall intensity duration frequency (IDF) curve:

Pekali geraf kekerapan jangka masa intensiti hujan (IDF)

a= 5.679, b= -0.0276, c= -0.0993 and d= 0.0033

(14 marks/*markah*)

3. (a) What are the major test to be carried out to determine the suitability of the cement replacement materials or aggregate replacement materials for concrete structures. Furthermore, on the same graph sketch the stress-stain relationship of plain concrete containing RHA and without RHA. Also estimates Young's modulus (E) for both concrete in kN/mm^2.

Apakah ujian-ujian utama perlu dilakukan untuk menentukan kesesuaian bahan-bahan gantian simen atau bahan-bahan gantian konkrit untuk struktur konkrit. Seterusnya, di atas graf yang sama lakarkan hubungan tegasan-terikan untuk konkrit biasa yang mengandungi RHA dan tanpa RHA. Juga anggarkan modulus Young (E) untuk kedua-dua konkrit tersebut dalam kN/mm^2.

(10 marks/*markah)*

(b) Explain the term “Control low strength materials”. Can we use CLSM as an alternative infrastructure material for bridges piers, bridge deck and building repairs. Explain why?

Terangkan terma “Bahan kekuatan rendah kawalan”. Boleh kita gunakan BKRK sebagai bahan infrastruktur alternatif untuk baikpulih dermaga jambatan, dek jambatan dan bangunan. Terangkan kenapa?

(10 marks/*markah*)

4. (a) Roads are built in urban and rural areas. Each area has its own issues and advantages. Discuss the issues and the advantages that arise in rural and urban roadways planning.

Jalanraya dibina di kawasan bandar dan pedalaman. Kedua-dua bahagian ini mempunyai isu-isu dan kelebihan-kelebihan tertentu. Bincangkan isu-isu dan kelebihan-kelebihan perancangan jalanraya yang terdapat di kawasan bandar dan pedalaman.

(8 marks/*markah*)

(b) With the aid of sketches, explain roadway cross section elements and its importance toward effective roadways design.

Dengan bantuan lakaran, terangkan elemen-elemen keratan rentas jalanraya beserta kepentingannya dalam rekabentuk jalanraya yang berkesan.

(12 marks/*markah*)

5. Pavement design is very important in roadway construction as well as the choice of pavement materials. Explain the types of roadway materials, its characteristic and the testing methods for the materials.

Rekabentuk permukaan jalanraya sangat penting di dalam pembinaan jalanraya, begitu juga dengan pemilihan material untuk pembinaan permukaan jalanraya. Terangkan jenis-jenis material untuk pembinaan jalanraya, ciri-cirinya beserta kaedah ujian untuk material yang terlibat.

(20 marks/*markah*)

6. Latest trend in sewage treatment is improving the reliability and efficiency of treatment systems to treat sewage to meet standards and to reduce the land area occupied by treatment works. This is normally done by accelerating natural treatment rates under controlled conditions.

Perkembangan yang lebih terkini dalam rawatan kumbahan adalah dengan meningkatkan kebolehpercayaan dan kecekapan sistem rawatan kumbahan untuk memenuhi piawaian dan mengurangkan kawasan yang diduduki oleh kerja-kerja rawatan dengan mempercepatkan kadar rawatan semula jadi di bawah keadaan terkawal.

(a) Explain the types of public sewage treatment plants in Malaysia.

Jelaskan jenis loji rawatan kumbahan awam di Malaysia.

(8 marks/*markah*)

(b) Describe in detail the preliminary and secondary treatment in the sewage treatment process.

Huraikan secara terperinci rawatan awal dan sekunder dalam proses rawatan kumbahan.

(12 marks/*markah*)

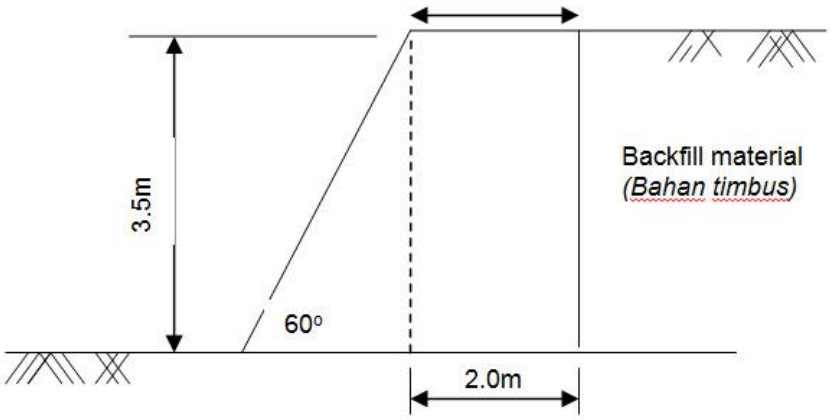
7. (a) Green technology could offer the best solution to establish a wastewater reuse while ensuring the environmental and economic sustainability of communities, in line with supporting the Government target towards increasing the use of renewable energy. Explain the wastewater reuse that can be applied from bioeffluent, biogas and biosolid applications.

Teknologi hijau boleh menawarkan penyelesaian terbaik untuk mewujudkan penggunaan semula air sisa dengan memastikan kemampanan alam sekitar dan ekonomi masyarakat, sejajar dengan usaha menyokong sasaran Kerajaan ke arah meningkatkan penggunaan tenaga boleh diperbaharui. Jelaskan penggunaan semula air sisa yang boleh digunakan dari bioeffluent, aplikasi biogas dan biosolid .

(10 marks/*markah*)

(b) Application of engineering or science principles is important to ensure the sustainable infrastructure such as road, drainage, water supply being designed properly. Based on the design code of practice/s, carry out the stability analyses of the concrete retaining wall against sliding, overturning and bearing capacity. Assume the coefficient of base friction is 0.55, the foundation soil's ultimate bearing capacity is 200kN/m^2, unit weight of concrete is 24kN/m^3 and the angle of internal friction (ϕ) of the granular soil is 30^o

Aplikasi prinsip-prinsip kejuruteraan atau sains adalah penting untuk memastikan infrastruktur mampan seperti jalan, saliran, bekalan air direkabentuk dengan betul. Berdasarkan kod amalan rekabentuk, jalankan kerja analisa kestabilan tembok penahan konkrit terhadap kegelinciran, keterbalikan dan keupayaan galas. Anggap angkali rintangan untuk tapak adalah 0.55, keupayaan galas tanah adalah 200kN/m^2, unit berat konkrit adalah 24kN/m^3 dan sudut gesaran dalaman tanah (ϕ) adalah 30^o.



(10 marks/*markah*)

APPENDIX I

$$t_o = \frac{107 n L_o^{1/3}}{S^{1/2}} \qquad \text{(Eqn. 1)}$$

where,
t_o = Overland sheet flow travel time (minutes)
L_o= Length of Overland flow path (m)
n= Manning's Roughness coefficient for the overland surface
S= Average surface slope of the catchment surface (in %)

$$t_{ch} = \frac{n.L}{60} R^{2/3} S^{1/2} \qquad \text{(Eqn. 2)}$$

where,

V = average velocity (m/s)
n = Manning's roughness coefficient
R = hydraulic radius (m)
S = friction slope (m/m)
L = length of reach (m)
t_{ch} = travel time in the channel (minutes)

$$ln^R I_t = a + b\ ln\ t + c(\ln t)^2 + d(\ln t)^3 \qquad \text{(Eqn. 3)}$$

where,
$^R I_t$= the average rainfall intensity (mm/hr) for ARI of R and duration of storm t
a,b,c and d=Fitted coefficient of rainfall intensity duration frequency (IDF) curve
t= duration of storm=time of concentration, t_c (minutes)

$$Q_R = \frac{C \,.\, {}^{R}I_t \,.\, A}{360} \qquad \text{(Eqn. 4)}$$

where,

Q_R = R year ARI peak flow (m^3/s)

C = dimensionless runoff coefficient

${}^{R}I_t$ = R year ARI average rainfall intensity over time of concentration, t_c, (mm/hr)

A = drainage area (ha)

$$Q_c = \frac{AR^{2/3}S^{1/2}}{n} \qquad \text{(Eqn. 5)}$$

Where:

Q_c= Flow capacity of channel (m^3/s)

A=Cross sectional area of channel (m^2)

R=Hydraulic Radius of flow channel (m)

S= Slope of channel (in decimal form)

n= Manning's Coefficient for channel lining

$$V = \frac{Q_c}{A} \qquad \text{(Eqn. 6)}$$

Where:

V= Flow velocity of storm water in channel (m/s)

Q_c= Flow capacity of channel (m^3/s)

A=Cross sectional area of channel (m^2)

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$$P_d = {}^{R}I_t \times d \quad \text{(Eqn. 7)}$$

Where:
P_d= Rainfall depth for a given duration of d (mm)
${}^{R}I_t$ = R year ARI rainfall intensity over time of concentration t_c (mm/hr)
d= time of concentration/storm duration (in hour)

$$P_d = P_{30} - F_D(P_{60} - P_{30}) \quad \text{(Eqn. 8)}$$

Where:
P_d= Corrected Rainfall depth for a given duration of d (mm) (for d<30minutes)
P_{30}= Rainfall depth for a given duration of 30 minutes (mm)
P_{60}= Rainfall depth for a given duration of 60 minutes (mm)
F_D= Adjustment factor for storm duration d

$$PSD = \frac{a-\sqrt{a^2-4b}}{2} \quad \text{(Eqn.9)}$$

For above ground storage:

$$a = \left(\frac{4Q_a}{t_c}\right)\left(0.333t_c\frac{Q_p}{Q_a} + t_c\right) \quad \text{(Eqn.10)}$$

$$b = 4Q_aQ_p \quad \text{(Eqn.11)}$$

For below ground storage:

$$a = \left(\frac{8.548Q_a}{t_c}\right)\left(0.333t_c\frac{Q_p}{Q_a} + t_c\right) \quad \text{(Eqn.12)}$$

$$b = 8.548Q_aQ_p \quad \text{(Eqn.13)}$$

Where:
PSD= Permissible site discharge (l/s)
t_c=Measured time of concentration (minutes)
Q_a=The post-development flow from the site from the design storm with duration equal to t_c (l/s)
Q_p=The pre-development flow from the site from the design storm with duration equal to t_c (l/s)

Table 1: ARI of design storm
Jadual 1: ARI ribut rekabentuk

Design Storm ARIs for Urban Stormwater Systems

Type of Development (See Note 1)	Average Recurrence Interval (ARI) of Design Storm (year)		
	Quantity		Quality
	Minor System	Major System (see Note 2 and 3)	
Open Space, Parks and Agricultural Land in urban areas	1	up to 100	3 month ARI (for all types of development)
Residential:			
• Low density	2	up to 100	
• Medium density	5	up to 100	
• High density	10	up to 100	
Commercial, Business and Industrial – Other than CBD	5	up to 100	
Commercial, Business, Industrial in Central Business District (CBD) areas of Large Cities	10	up to 100	

Table 2: **Values of F_D**
Jadual 2: Nilai F_D

Duration (minutes)	$^2P_{24h}$ (mm)				
	West Coast				East Coast
	≤ 100	120	150	≥ 180	All
5	2.08	1.85	1.62	1.40	1.39
10	1.28	1.13	0.99	0.86	1.03
15	0.80	0.72	0.62	0.54	0.74
20	0.47	0.42	0.36	0.32	0.48
30	0.00	0.00	0.00	0.00	0.00

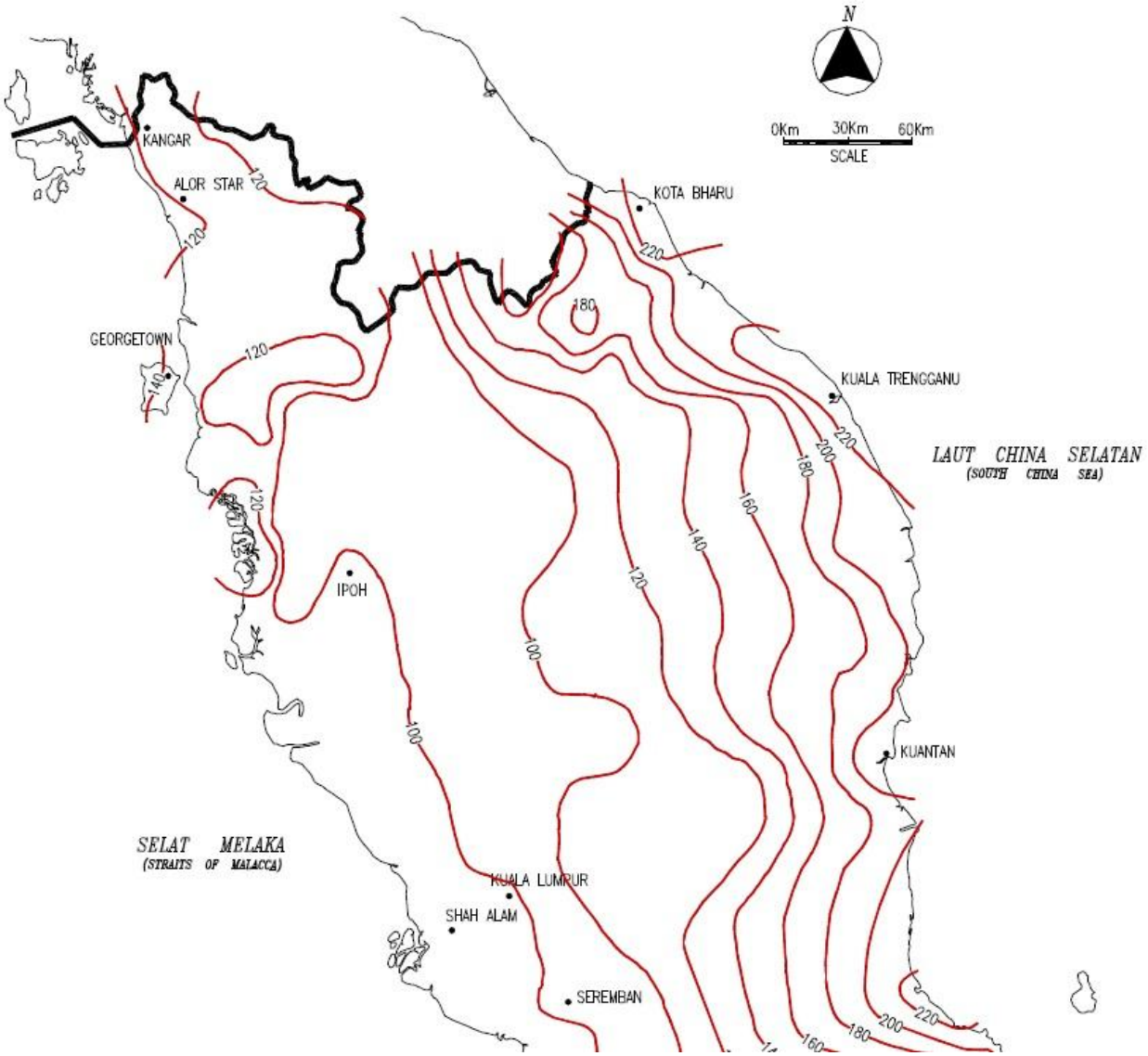

Figure 1 : $^{2}P_{24h}$ Mapping for Peninsular Malaysia

Rajah 1 : Peta $^{2}P_{24h}$ untuk Semenanjung Malaysia

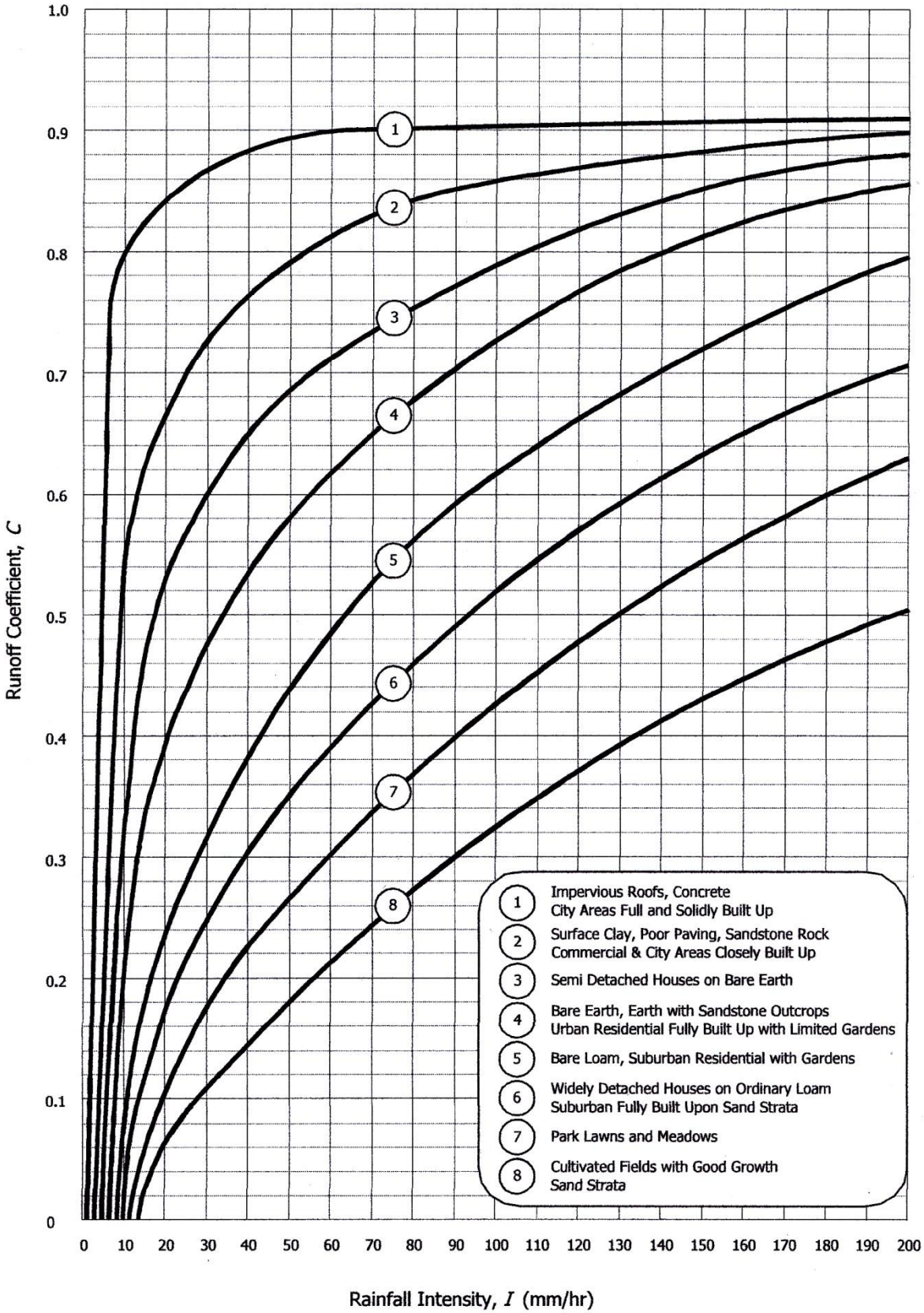

Figure 2 : Runoff coefficient for impervious surface
Rajah 2: Pekali air larian untuk permukaan tidak telap air

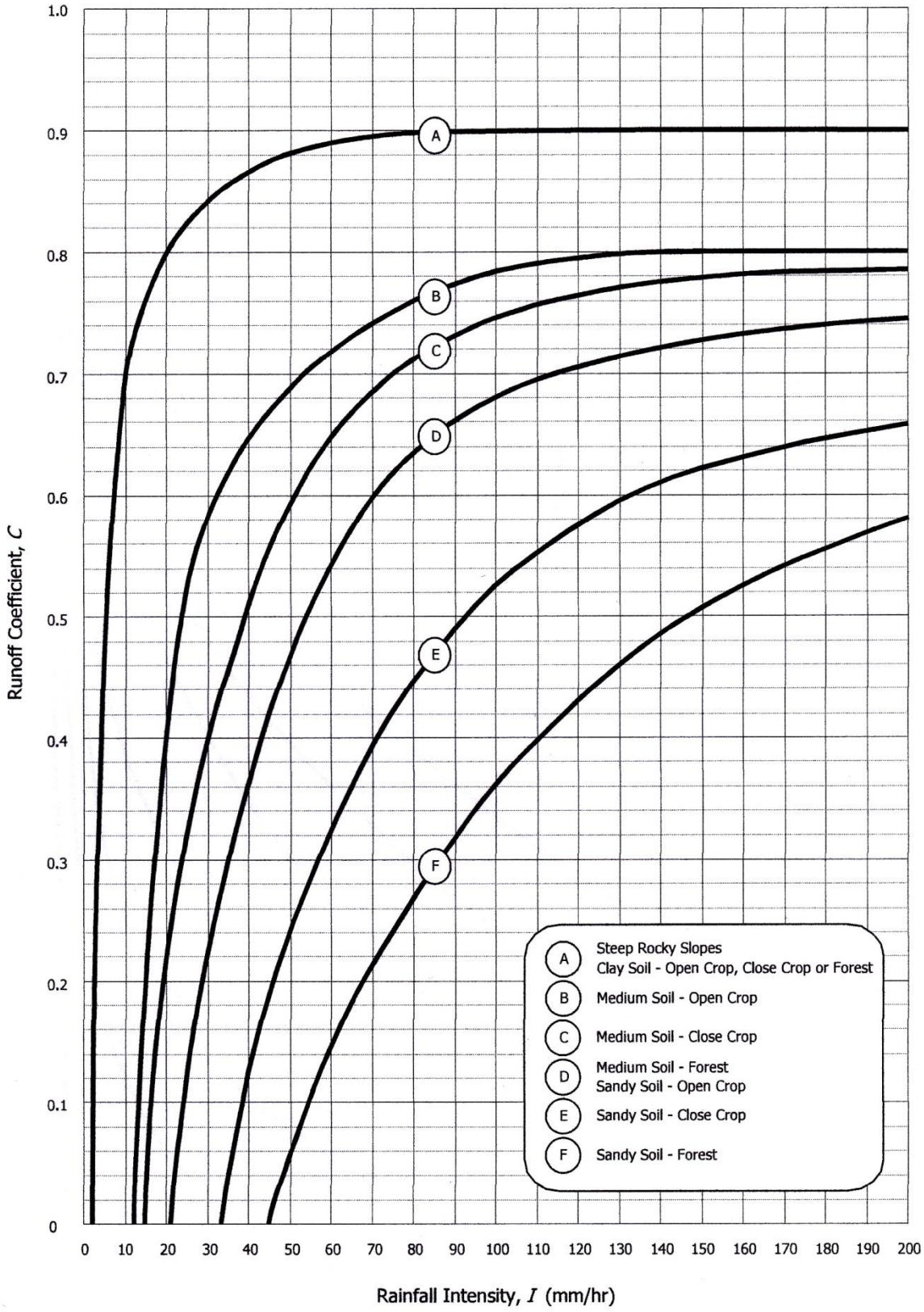

Figure 3 : Runoff coefficient for pervious surface
Rajah 3 : Pekali air larian untuk permukaan telap air

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