



UTHM

Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION SEMESTER II SESSION 2022/2023

- COURSE NAME : URBAN STORMWATER MANAGEMENT
- COURSE CODE : BNA 40703
- PROGRAMME : BNA
- DATE : JULY/AUGUST 2023
- DURATION : 3 HOURS
- INSTRUCTION :
1. ANSWER ALL QUESTIONS
 2. THIS FINAL EXAMINATION IS CONDUCTED VIA **CLOSED BOOK.**
 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

TERBUKA

CONFIDENTIAL

- Q1** (a) Urban stormwater management responsibility is shared between Malaysian Federal and State agencies/institution. Identify the roles and responsibilities for each of Federal and State agencies in managing the urban stormwater in Malaysia. (7 marks)
- (b) Average Recurrence Interval (**ARI**) is important in design especially for risk analysis. Explain **THREE (3)** factors that need to be considered in choosing the average recurrence interval (**ARI**). (6 marks)
- (c) Assuming extreme value type I distribution fits the 30 years annual maximum series, analyze the 20 minutes storm and its rainfall intensity where the average intensities are associated with a 50 year ARI that could cater for a road culvert design according to annual maximum series. Refer to **Table Q1(c)(i)** and **(ii)**. (12 marks)
- Q2** (a) Recently, flash floods have often occurred in large cities and greatly destroyed people's property. As a design engineer for stormwater, describe the steps that government can take to reduce the flash floods. (8 marks)
- (b) An urban catchment with 58 hectares of commercial area in Bandar Maharani, Muar Johor is shown in **Figure Q2(b)**. By using the method from MSMA 2nd edition,
- (i) Calculate the rainfall intensity using empirical method. (5 marks)
- (ii) Plot the temporal pattern of design rainfall for 15 minutes for this catchment with return period of 10-years ARI. Refer to **Table Q2(b)(i), (ii)** and **(iii)**. (4 marks)
- (iii) Using time-area method, predict the peak discharge of the hydrograph if the design rainfall event calculated from **Question Q2(b)(ii)** occurs in this catchment. Assume continuous loss is constant at 0.8 mm/5min. Plot the hydrograph. Refer to **Table Q2(b)(iv)**. (8 marks)
- Q3** (a) Explain the procedures of estimating peak discharge for the sub-catchment using the Rational Method with the aid of flow chart. (7 marks)
- (b) List **THREE (3)** benefits of retention and detention facilities for stormwater management. (6 marks)

TERBUKA

- (c) An industrial area located in Bukit Soga, Batu Pahat, has been adopted for the warehouse development with lot area of 1 ha ($100\text{ m} \times 100\text{ m}$), floor area $60\text{ m} \times 60\text{ m}$ and parking area $60\text{ m} \times 20\text{ m}$ as shown in **Figure Q3(c)**. The stormwater runoff from the impervious area will be directed to the vegetated filter strip around the perimeter of the building and parking areas. The distributed stormwater runoff from vegetated filter strip will be collected in the grassed swale to be conveyed downstream of the lot area and treated by a bioretention facility of impermeable type. Given that velocity V and length L of flow in the swale, overland flow time t_o and average recurrence interval ARI, are 0.35 m/s, 185 m, 7 minutes, and 5 years respectively. Compute the water quality volume for this onsite retention if rainfall depth P for this area is 60 mm for 3 months ARI.

(12 marks)

- Q4** (a) Explain **FOUR (4)** examples of facilities that are effectively involve in Best Management Practice (BMPs) to control stormwater quality and quantity.

(10 marks)

- (b) Discuss the following problems and propose the solutions at the construction sites, where erosion and sedimentation occur:

- (i) Large flat exposed areas are prone to sheet erosion and should be protected.

(5 marks)

- (ii) Unprotected steep slopes are prone to erosion as runoff velocity is high.

(5 marks)

- (iii) Any construction works near or at streams or waterways caused dislodged sediments to enter water directly.

(5 marks)

-END OF QUESTION

TERBUKA

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2022/2023

PROGRAMME : BNA

COURSE NAME : URBAN STORMWATER MANAGEMENT

COURSE CODE : BNA 40703

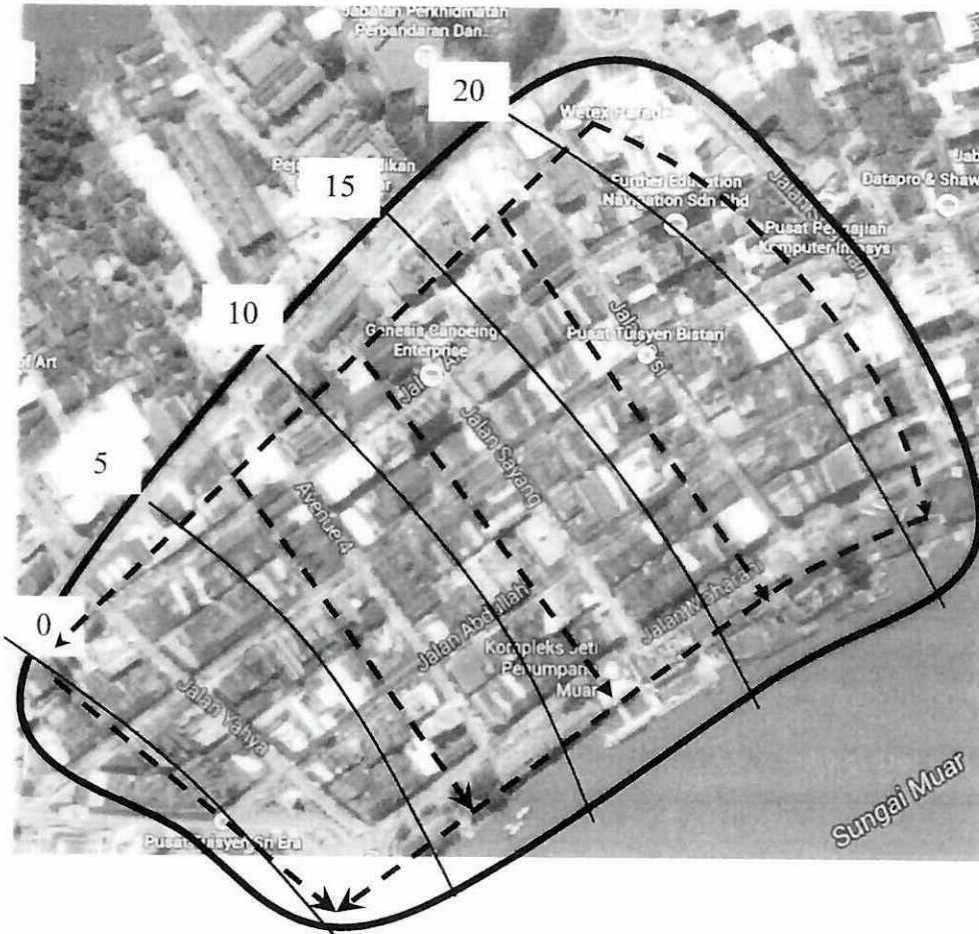


Figure Q2(b): Urban catchment with 58 hectares of commercial area in Bandar Maharani, Muar Johor

TERBUKA

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2022/2023

PROGRAMME : BNA

COURSE NAME : URBAN STORMWATER MANAGEMENT

COURSE CODE : BNA 40703

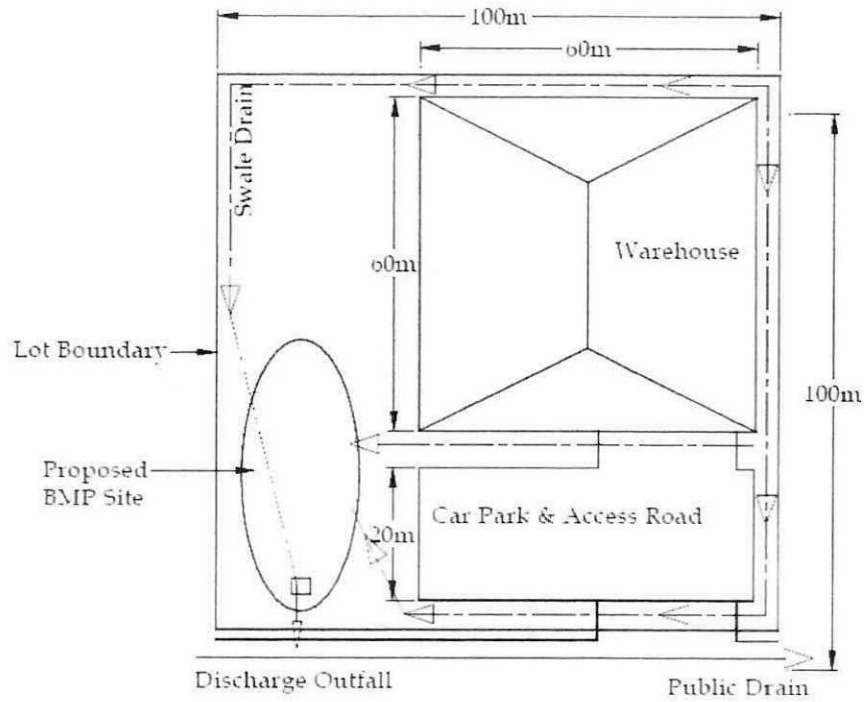


Figure Q3(c): Industrial Area located Bukit Soga, Batu Pahat

TERBUKA

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2022/2023

PROGRAMME : BNA

COURSE NAME : URBAN STORMWATER MANAGEMENT

COURSE CODE : BNA 40703

Table Q1(c)(i): 15 minutes rainfall depth

P _j (mm)	3.55	3.81	4.32	4.44	4.73	5.11	5.82
	6.84	7.33	7.85	8.88	9.55	10.20	11.26

Table Q1(c)(ii): Frequency factor, K for extreme value type I

n	T _r (years)				
	5	10	25	50	100
15	0.967	1.703	2.632	3.321	4.005
20	0.919	1.625	2.517	3.179	3.836
25	0.888	1.575	2.444	3.088	3.729
30	0.866	1.541	2.393	3.026	3.653
35	0.851	1.516	2.354	2.979	3.598
40	0.838	1.495	2.326	2.943	3.554
45	0.829	1.478	2.303	2.913	3.520
50	0.820	1.466	2.283	2.889	3.491
75	0.792	1.423	2.220	2.812	3.400
100	0.779	1.401	2.187	2.770	3.349
∞	0.719	1.305	2.044	2.592	3.137

Table Q2(b)(i): Fitting constants for the IDF empirical equation for the different location in Malaysia for high ARIs between 2 and 100 year and storm duration from 5 minutes to 72 hours

State	No	Station ID	Station Name	Constant			
				λ	κ	θ	η
Johor	1	1437116	Stor JPS Johor Bahru	59.972	0.163	0.121	0.793
	2	1534002	Pintu Kawasan Tanjung Agas	80.936	0.187	0.258	0.890
	3	1541139	Ladang Labis	45.808	0.222	0.012	0.713
Kuala Lumpur	1	3015001	Puchong Drop, K Lumpur	69.650	0.151	0.223	0.880
	2	3116003	Ibu Pejabat JPS	61.976	0.145	0.122	0.818
	3	3116004	Ibu Pejabat JPS1	64.689	0.149	0.174	0.837

TERBUKA

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2022/2023

PROGRAMME : BNA

COURSE NAME : URBAN STORMWATER MANAGEMENT

COURSE CODE : BNA 40703

Table Q2(b)(ii): Recommended Intervals for Design Rainfall Temporal Pattern

Storm Duration (minutes)	Time Interval (minutes)
Less than 60	5
60 – 120	10
121 – 360	15
Greater than 360	30

Table Q2(b)(iii): Region 2: Johor, Negeri Sembilan, Melaka, Selangor dan Pahang

No. of Block	Storm Duration			
	15-min	30-min	60-min	180-min
1	0.255	0.124	0.053	0.053
2	0.376	0.130	0.059	0.061
3	0.370	0.365	0.063	0.063
4		0.152	0.087	0.080
5		0.126	0.103	0.128
6		0.103	0.153	0.151
7			0.110	0.129
8			0.088	0.097
9			0.069	0.079
10			0.060	0.062
11			0.057	0.054
12			0.046	0.042

Table Q2(b)(iv): Areas between the isochrones

ID	Isochrones	Area (ha)
A ₁	0 – 5	18
A ₂	5 – 10	10
A ₃	10 – 15	12
A ₄	15 >	18

TERBUKA

FINAL EXAMINATION

SEMESTER/SESSION : SEM II / 2022/2023

PROGRAMME : BNA

COURSE NAME : URBAN STORMWATER MANAGEMENT

COURSE CODE : BNA 40703

APPENDIX

$$i = \frac{\lambda T^\kappa}{(d + \theta)^\eta}$$

$$Q = \frac{C.i.A}{360}$$

$$WQV = C.(P_d).A$$

$$Q = \frac{k_n T^{8/3} S_x^{5/3} S_L^{1/2}}{2.64n}$$

Table 1 : Recommended runoff coefficients for various landuses

Landuse	Runoff coefficient (C)	
	For Minor System (≤ 10 year ARI)	For Major System (> 10 year ARI)
Residential		
Bungalow	0.65	0.70
Semi-detached bungalow	0.70	0.75
Link and terrace house	0.80	0.90
Flat and apartment	0.80	0.85
Commercial and bussines centres	0.90	0.95
Industrial	0.90	0.95
Sport fields and agriculture	0.30	0.40
Open spaces		
Bare soil (no cover)	0.50	0.60
Grass cover	0.40	0.50
Bush cover	0.35	0.45
Forest cover	0.30	0.40
Road and highways	0.95	0.95

Table 2: Fitting constants for the IDF empirical equation for the different location in Malaysia for high ARIs between 2 and 100 year and storm duration from 5 minutes to 72 hours

State	No	Station ID	Station Name	Constant			
				λ	κ	θ	η
Johor	1	1437116	Stor JPS Johor Bahru	59.972	0.163	0.121	0.793
	2	1534002	Pusat Kem Pekan Nenas	54.265	0.179	0.100	0.756
	3	1829002	Setor JPS Batu Pahat	64.099	0.174	0.201	0.826
Kuala Lumpur	1	3015001	Puchong Drop, K Lumpur	69.650	0.151	0.223	0.880
	2	3116003	Ibu Pejabat JPS	61.976	0.145	0.122	0.818
Penang	1	5303001	Rumah Kebajikan P Pinang	57.326	0.203	0.325	0.791
	2	5303053	Kompleks Prai	52.771	0.203	0.095	0.717
	3	5402002	Klinik Bkt Bendera	64.504	0.196	0.149	0.723

TERBUKA