

5.2 HP5 catchment 5 Tabung Haji (Q during logging activity)

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 5 (During logging activity)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 76.63 sq. km
Length of mainstream, L = 19.39 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
8.77	60.00	0.68	7.25
4.30	200.00	4.65	9.27
6.32	100.00	1.58	7.95
19.39	360.00	6.92	24.48

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{24.48}{19.39}$$

$$= 1.59 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
Region 3 - Johor
Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 2 years (HP # 1)

$$T_c = \{1.286 \times L\} / \{A^{0.223} \times S^{0.263}\}$$

$$= \frac{\{1.286 \times 19.39\}}{\{76.63^{0.223} \times 1.593587313^{0.263}\}}$$

$$= 8.38 \text{ hours}$$

$$= 502.95 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 3)$ = 40 mm
 $x(20, 3)$ = 70 mm
 $x(2, 24)$ = 80 mm
 $x(20, 24)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 2 years.

$x(T, 3)$ = 75.00 mm
 $x(T, 24)$ = 120.00 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

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$$\begin{aligned}
 &\text{With } T_c = 8.38 \text{ hours} \\
 &\text{and } T = 2 \text{ years.} \\
 &x(2, 8.38) = 59.77 \text{ mm} \\
 &x(20, 8.38) = 104.59 \text{ mm} \\
 &x(T, 8.38) = 97.24 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 104.58971 - 59.765549 \\
 &= 44.824162 \\
 0.43 D &= 19.27439 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[\begin{matrix} 2 \\ T = 2 \end{matrix} \right] &= x(T) + 0.43 D \\
 &= 97.236243 + 19.27439 \\
 &= 116.51 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x \left(\begin{matrix} 2 \\ \text{Therefore, } i(2) \end{matrix} \right) &= 116.51063 \text{ mm} \\
 &= x(T_c) = 116.51063 \\
 &= 13.90 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region } &= 4 \\
 T &= 2 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 0.712 \\
 \text{Therefore } C_t &= 0.27
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percent age developed } &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 96.13 \text{ cu. m/s}
 \end{aligned}$$

E. DETERMINATION OF THE FLOOD WATER LEVEL AND VELOCITY

1. Plot cross-section of the river.
2. consider the recorded flood level as our first trial
3. Divide into sub-section
4. Stream slope at bridge site,

From the river survey plan :

Number of Part =		4 Section			
Part	BedL1	BedL2	Length	Slope	
1	6.880	6.544	60.000	0.006	
2	6.544	6.067	25.000	0.019	
3	6.067	6.037	25.000	0.001	
4	6.037	5.604	20.000	0.022	
5					
6					
7					
Average Slope, S _o				0.0118825	

5. Calculation of V_m and Q_c

5.2 HP5 catchment 5 Tabung Haji (Q during logging activity)

$$V_i = R_i^{(2/3)} \times S_o^{(1/2)} / n_i$$

TRY Flood Level = 7.700 m

OK

Sc.	Level	Chng.	Roughness n_i	Area, A Sq. ft	Wetted perimeter (pi) (m)	Hydraulic Radius $R_i = A_i / P_i$ (m)	Velocity v_i (m/s)	$Q = V_i A_i$ (cu. m)
	(m)	(m)						
0	9.200	0.000	0.045					
1	7.000	4.000	0.045	- 1.600	4.565	- 0.350	#NUM	
2	6.741	18.000	0.045	11.613	14.002	0.829	2.138	24.832
3	5.857	23.100	0.045	7.145	5.176	1.380	3.003	21.458
4	5.792	27.000	0.045	7.314	3.901	1.875	3.684	26.944
5	5.272	33.600	0.045	14.309	6.620	2.161	4.049	57.941
6	6.344	38.000	0.045	8.325	4.529	1.838	3.635	30.261
7	6.659	42.500	0.045	5.393	4.511	1.196	2.729	14.717
8	7.000	50.500	0.045	6.964	8.007	0.870	2.207	15.370
9	9.200	54.000	0.045					
10								
			TOTAL	59.4634			TOTAL	191.52328

Type of bed material (Code) =

7 Rock

CODE BED

- 1 Clay
- 2 Sandy Clay
- 3 Very fine sand
- 4 Fine sand
- 5 Fine Gravel
- 6 Rocky soil
- 7 Rock
- 8 Grass-lined

Therefore,

Mean velocity,

$$V_m = \frac{\sum (V_i A_i)}{\sum A_i}$$

$$= \frac{191.523277}{59.4634}$$

$$= 3.220859839 < 5.18 \text{ m/sec}$$

Therefore

OK

Discharge capacity,

$$Q_c =$$

$$= \frac{V_m \times \sum A_i}{1} = \frac{3.220859839 \times 191.523277}{1} = 616.949 \text{ cu. m}$$

Therefore

OK

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PROJECT : catchment 5 (During logging activity)
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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

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Length of mainstream, L = 19.39 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
8.77	60.00	0.68	7.25
4.30	200.00	4.65	9.27
6.32	100.00	1.58	7.95
19.39	360.00	6.92	24.48

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{24.48}{19.39}$$

$$= 1.59 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
Region 3 - Johor
Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 5 years (HP # 1)

$$T_c = \{1.286 \times L\} / \{A^{0.223} \times S^{0.263}\}$$

$$= \frac{\{1.286 \times 19.39\}}{\{76.63^{0.223} \times 1.593587313^{0.263}\}}$$

$$= 8.38 \text{ hours}$$

$$= 502.95 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 3)$ = 40 mm
 $x(20, 3)$ = 70 mm
 $x(2, 24)$ = 80 mm
 $x(20, 24)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 5 years.

$x(T, 3)$ = 98.94 mm
 $x(T, 24)$ = 176.59 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

5.2 HP5 catchment 5 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 8.3824889 \text{ hours} \\
 &\text{and } T = 5 \text{ years.} \\
 &x(2, 8.38) = 59.77 \text{ mm} \\
 &x(20, 8.38) = 104.59 \text{ mm} \\
 &x(T, 8.38) = 137.31 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 104.58971 - 59.765549 \\
 &= 44.824162 \\
 0.43 D &= 19.27 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 5 \right] &= x(T) + 0.43 D \\
 &= 137.3117 + 19.27439 \\
 &= 156.59 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(5) &= 156.58609 \text{ mm} \\
 \text{Therefore, } i(10) &= \frac{x(100)}{T_c} = \frac{156.58609}{8.3824889} \\
 &= 18.68 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region } &= 4 \\
 T &= 5 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 0.88 \\
 \text{Therefore } C_t &= 0.3344
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed } &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 159.69 \text{ cu. m/s}
 \end{aligned}$$

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Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 76.63 sq. km
Length of mainstream, L = 19.39 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
8.77	60.00	0.68	7.25
4.30	200.00	4.65	9.27
6.32	100.00	1.58	7.95
19.39	360.00	6.92	24.48

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{24.48}{19.39}$$

$$= 1.59 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 10 years (HP # 1)

$$T_c = \{1.286 \times L\} / \{A^{0.223} \times S^{0.263}\}$$

$$= \frac{\{1.286 \times 19.39\}}{\{76.63^{0.223} \times 1.593587313^{0.263}\}}$$

$$= 8.38 \text{ hours}$$

$$= 502.95 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 3)$ = 40 mm
 $x(20, 3)$ = 70 mm
 $x(2, 24)$ = 80 mm
 $x(20, 24)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 10 years.

$x(T, 3)$ = 114.79 mm
 $x(T, 24)$ = 214.06 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

5.2 HP5 catchment 5 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 8.3824889 \text{ hours} \\
 &\text{and } T = 10 \text{ years.} \\
 &x(2, 8.38) = 59.77 \text{ mm} \\
 &x(20, 8.38) = 104.59 \text{ mm} \\
 &x(T, 8.38) = 163.85 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 104.58971 - 59.765549 \\
 &= 44.824162 \\
 0.43 D &= 19.27 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[\begin{matrix} 10 \\ T = 10 \end{matrix} \right] &= x(T) + 0.43 D \\
 &= 163.84514 + 19.27439 \\
 &= 183.12 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x \left(\begin{matrix} 10 \\ \text{Therefore, } i(10) \end{matrix} \right) &= 183.11953 \text{ mm} \\
 &= x(100) = 183.11953 \\
 &\quad T_c = 8.3824889 \\
 &= 21.85 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 10 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1 \\
 \text{Therefore } C_t &= 0.38
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 212.21 \text{ cu. m/s}
 \end{aligned}$$

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 76.63 sq. km
Length of mainstream, L = 19.39 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
8.77	60.00	0.68	7.25
4.30	200.00	4.65	9.27
6.32	100.00	1.58	7.95
19.39	360.00	6.92	24.48

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{24.48}{19.39}$$

$$= 1.59 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
Region 2 - Kuala Lumpur
Region 3 - Johor
Region 4 - Kelantan, Terengganu, Pahang

C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 20 years (HP # 1)

$$T_c = \frac{1.286 \times L}{\{A^{0.223} \times S^{0.263}\}}$$

$$= \frac{1.286 \times 19.39}{\{76.63^{0.223} \times 1.593587313^{0.263}\}}$$

$$= 8.38 \text{ hours}$$

$$= 502.95 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 3)$ = 40 mm
 $x(20, 3)$ = 70 mm
 $x(2, 24)$ = 80 mm
 $x(20, 24)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 20 years.

$x(T, 3)$ = 130.00 mm
 $x(T, 24)$ = 250.00 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

5.2 HP5 catchment 5 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 & \text{With } T_c = 8.3824889 \text{ hours} \\
 & \text{and } T = 20 \text{ years.} \\
 & x(2, 8.38) = 59.77 \text{ mm} \\
 & x(20, 8.38) = 104.59 \text{ mm} \\
 & x(T, 8.38) = 189.30 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 104.58971 - 59.765549 \\
 &= 44.824162 \\
 0.43 D &= 19.27 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x(20) &= x(T) + 0.43 D \\
 [T = 20] &= 189.29665 + 19.27439 \\
 &= 208.57 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(20) &= 208.57104 \text{ mm} \\
 \text{Therefore, } i(20) &= \frac{x(100)}{T_c} = \frac{208.57104}{8.3824889} \\
 &= 24.88 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 20 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1.128 \\
 \text{Therefore } C_t &= 0.43
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 272.65 \text{ cu. m/s}
 \end{aligned}$$

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Weighted mean slope, s

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8.77	60.00	0.68	7.25
4.30	200.00	4.65	9.27
6.32	100.00	1.58	7.95
19.39	360.00	6.92	24.48

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{24.48}{19.39}$$

$$= 1.59 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' 0" E
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From figure 1 of HP # 5
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 50 years (HP # 1)

$$T_c = \{1.286 \times L\} / \{A^{0.223} \times S^{0.263}\}$$

$$= \frac{\{1.286 \times 19.39\}}{\{76.63^{0.223} \times 1.593587313^{0.263}\}}$$

$$= 8.38 \text{ hours}$$

$$= 502.95 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 3)$ = 40 mm
 $x(20, 3)$ = 70 mm
 $x(2, 24)$ = 80 mm
 $x(20, 24)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 50 years.

$x(T, 3)$ = 149.68 mm
 $x(T, 24)$ = 296.52 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

5.2 HP5 catchment 5 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 & \text{With } T_c = 8.3824889 \text{ hours} \\
 & \text{and } T = 50 \text{ years.} \\
 & x(2, 8.38) = 59.77 \text{ mm} \\
 & x(20, 8.38) = 104.59 \text{ mm} \\
 & x(T, 8.38) = 222.24 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 104.58971 - 59.765549 \\
 &= 44.824162 \\
 0.43 D &= 19.27439 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 50 \right] &= x(T) + 0.43 D \\
 &= 222.24102 + 19.27439 \\
 &= 241.52 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(50) &= 241.51541 \text{ mm} \\
 \text{Therefore, } i(50) &= \frac{x(100)}{T_c} = \frac{241.51541}{8.3824889} \\
 &= 28.81 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

$$\begin{aligned}
 \text{Region} &= 4 \\
 T &= 50 \text{ years.} \\
 C_{10} &= 0.38 \\
 C_t / C_{10} &= 1.296 \\
 \text{Therefore } C_t &= 0.49
 \end{aligned}$$

$$\begin{aligned}
 3. \text{ Percentage developed} &= 75 \% \\
 \text{Land use factor, } F &= 1.2
 \end{aligned}$$

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 362.73 \text{ cu. m/s}
 \end{aligned}$$

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Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
8.77	60.00	0.68	7.25
4.30	200.00	4.65	9.27
6.32	100.00		
19.39	360.00	5.34	16.53

$$s = \frac{\sum (l_i * \text{SQRT } s_i)}{\sum l_i}$$

$$= \frac{16.53}{19.39}$$

$$= 0.73 \%$$

B. LOCATION OF SITE

From Topo Sheet No :

Longitude 102° 18' 0" E
Latitude 4° 12' 0" N

From figure 1 of HP # 5
Region No 4

Note : Region 1 - Perlis, Kedah, Perak
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C. ESTIMATION OF THE DESIGN RAINSTORM

1. Adopt return period, T = 100 years (HP # 1)

$$T_c = \left\{ \frac{1.286 \times L}{A^{0.223} \times S^{0.263}} \right\}$$

$$= \left\{ \frac{1.286 \times 19.39}{76.63^{0.223} \times 0.726545926^{0.263}} \right\}$$

$$= 10.31 \text{ hours}$$

$$= 618.35 \text{ mins}$$

3. Values of $x(T, t)$
(N.B. values of t is to envelope the value of T_c)

From Fig. 1 to 8 of HP # 1 :

$x(2, 3)$ = 40 mm
 $x(20, 3)$ = 70 mm
 $x(2, 24)$ = 80 mm
 $x(20, 24)$ = 140 mm

4. Plot those values above on graph Figure 10 of HP # 1

5. Read off values, with T = 100 years.

$x(T, 3)$ = 164.43 mm
 $x(T, 24)$ = 331.38 mm

6. Plot values obtained in steps 3 and 5 on graph Fig. 9 of HP # 1.

7. Read off values :

5.2 HP5 catchment 5 Tabung Haji (Q during logging activity)

$$\begin{array}{rcl}
 \text{With } T_c = & 10.31 \text{ hours} \\
 \text{and } T = & 100 \text{ years.} \\
 x(2, 10.31) & = & 63.74 \text{ mm} \\
 x(20, 10.31) & = & 111.54 \text{ mm} \\
 x(T, 10.31) & = & 263.51 \text{ mm}
 \end{array}$$

8. Confidence limits

$$\begin{array}{rcl}
 D & = & x(20) - x(2) \\
 & = & 111.54349 - 63.739136 \\
 & = & 47.804352 \\
 0.43 D & = & 20.56 \text{ mm}
 \end{array}$$

$$\begin{array}{rcl}
 9. \text{ Max } x & [T = 100] & = x(T) + 0.43 D \\
 & & = 263.51308 + 20.555871 \\
 & & = 284.07 \text{ mm}
 \end{array}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{array}{rcl}
 \text{Max } x(100) & = & 284.07 \text{ mm} \\
 \text{Therefore, } i(100) & = & \frac{x(100)}{T_c} = \frac{284.06896}{10.305894} \\
 & = & 27.56 \text{ mm/hr}
 \end{array}$$

2. From Figure 4 with,

$$\begin{array}{rcl}
 \text{Region} & = & 4 \\
 T & = & 100 \text{ years.} \\
 C_{10} & = & 0.38 \\
 Q / C_{10} & = & 1.46
 \end{array}$$

$$\text{Therefore } Q = 0.5548$$

$$\begin{array}{rcl}
 3. \text{ Percentage developed} & = & 75 \% \\
 \text{Land use factor, } F & = & 1.2
 \end{array}$$

THEREFORE

$$\begin{array}{rcl}
 Q_{\max} & = & F \times 0.278 \times Q \times i(T) \times A \\
 & = & 390.93 \text{ cu. m/s}
 \end{array}$$