

7.2 HP5 catchment 7 Tabung Haji (Q during logging activity)

HYDROLOGICAL CALCULATION RATIONAL METHOD (HP # 5 - 1989)

PROJECT : catchment 7 (During logging activity)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 13.58 sq. km
Length of mainstream, L = 5.53 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
5.53	120.00	2.17	8.15
5.53	120.00	2.17	8.15

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

$$= \frac{8.15}{5.53}$$

$$= 2.17 \%$$

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)

$$T_c = \frac{1.286 \times L}{\{13.58^{0.223} \times 2.169981917^{0.263}\}}$$

$$= \frac{1.286 \times 5.53}{\{13.58^{0.223} \times 2.169981917^{0.263}\}}$$

$$= 3.24 \text{ hours}$$

$$= 194.53 \text{ mins}$$

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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$$\begin{aligned}
 &\text{With } T_c = 3.24 \text{ hours} \\
 &\text{and } T = 2 \text{ years.} \\
 &x(2, 3.24) = 41.49 \text{ mm} \\
 &x(20, 3.24) = 72.61 \text{ mm} \\
 &x(T, 3.24) = 76.68 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 72.613711 - 41.493549 \\
 &= 31.120162 \\
 0.43 D &= 13.38167 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = \frac{2}{2} \right] &= x(T) + 0.43 D \\
 &= 76.680243 + 13.38167 \\
 &= 90.06 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x \left(\frac{2}{2} \right) &= 90.061913 \text{ mm} \\
 \text{Therefore, } i(2) &= x(100) = 90.061913 \\
 &\quad T_c = 3.2422126 \\
 &= 27.78 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

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

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

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 34.05 \text{ cu. m/s}
 \end{aligned}$$

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

7.2 HP5 catchment 7 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,

$$Q_c =$$

$$= \frac{V_m \times \sum A_i}{1} = \frac{3.220859839 \times 191.523277}{1} = 616.948 \text{ cu. m}$$

Therefore

OK

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 13.58 sq. km
Length of mainstream, L = 5.53 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
5.53	120.00	2.17	8.15
5.53	120.00	2.17	8.15

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

$$= \frac{8.15}{5.53}$$

$$= 2.17 \%$$

B. LOCATION OF BRIDGE

From Topo Sheet No :

Longitude 102° 18' E
Latitude 4° 12' 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)

$$T_c = \frac{1.286 \times L}{13.58^{0.223} \times S^{0.263}}$$

$$= \frac{1.286 \times 5.53}{13.58^{0.223} \times 2.169981917^{0.263}}$$

$$= 3.24 \text{ hours}$$

$$= 194.53 \text{ mins}$$

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 :

$x(2, 3) = 40 \text{ mm}$
 $x(20, 3) = 70 \text{ mm}$
 $x(2, 24) = 80 \text{ mm}$
 $x(20, 24) = 140 \text{ mm}$

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

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

$x(T, 3) = 98.94 \text{ mm}$
 $x(T, 24) = 176.59 \text{ mm}$

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

7. Read off values :

7.2 HP5 catchment 7 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 3.2422126 \text{ hours} \\
 &\text{and } T = 5 \text{ years.} \\
 &x(2, 3.24) = 41.49 \text{ mm} \\
 &x(20, 3.24) = 72.61 \text{ mm} \\
 &x(T, 3.24) = 101.84 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 72.613711 - 41.493549 \\
 &= 31.120162 \\
 0.43 D &= 13.38 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 5 \right] &= x(T) + 0.43 D \\
 &= 101.84174 + 13.38167 \\
 &= 115.22 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(5) &= 115.22341 \text{ mm} \\
 \text{Therefore, } i(10) &= \frac{x(100)}{T_c} = \frac{115.22341}{3.2422126} \\
 &= 35.54 \text{ mm/hr}
 \end{aligned}$$

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

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 53.84 \text{ cu. m/s}
 \end{aligned}$$

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 13.58 sq. km
Length of mainstream, L = 5.53 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
5.53	120.00	2.17	8.15
5.53	120.00	2.17	8.15

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

$$= \frac{8.15}{5.53}$$

$$= 2.17 \%$$

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)

$$T_c = \frac{1.286 \times L}{13.58^{0.223} \times S^{0.263}}$$

$$= \frac{1.286 \times 5.53}{13.58^{0.223} \times 2.169981917^{0.263}}$$

$$= 3.24 \text{ hours}$$

$$= 194.53 \text{ mins}$$

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 :

$x(2, 3) = 40 \text{ mm}$
 $x(20, 3) = 70 \text{ mm}$
 $x(2, 24) = 80 \text{ mm}$
 $x(20, 24) = 140 \text{ mm}$

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

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

$x(T, 3) = 114.79 \text{ mm}$
 $x(T, 24) = 214.06 \text{ mm}$

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

7. Read off values :

7.2 HP5 catchment 7 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 3.2422126 \text{ hours} \\
 &\text{and } T = 10 \text{ years.} \\
 &x(2, 3.24) = 41.49 \text{ mm} \\
 &x(20, 3.24) = 72.61 \text{ mm} \\
 &x(T, 3.24) = 118.50 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 72.613711 - 41.493549 \\
 &= 31.120162 \\
 0.43 D &= 13.38 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 10 \right] &= x(T) + 0.43 D \\
 &= 118.50084 + 13.38167 \\
 &= 131.88 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(10) &= 131.88251 \text{ mm} \\
 \text{Therefore, } i(10) &= \frac{x(100)}{T_c} = \frac{131.88251}{3.2422126} \\
 &= 40.68 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

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

$$\text{Therefore } C_t = 0.38$$

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

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times C_t \times i(T) \times A \\
 &= 70.03 \text{ cu. m/s}
 \end{aligned}$$

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PROJECT : catchment 7 (During logging activity)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 13.58 sq. km
Length of mainstream, L = 5.53 km
Percentage developed, = 75.00 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
5.53	120.00	2.17	8.15
5.53	120.00	2.17	8.15

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

$$= \frac{8.15}{5.53}$$

$$= 2.17 \%$$

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)

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

$$= \frac{1.286 \times 5.53}{\{13.58^{0.223} \times 2.169981917^{0.263}\}}$$

$$= 3.24 \text{ hours}$$

$$= 194.53 \text{ mins}$$

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 :

$x(2, 3) = 40 \text{ mm}$
 $x(20, 3) = 70 \text{ mm}$
 $x(2, 24) = 80 \text{ mm}$
 $x(20, 24) = 140 \text{ mm}$

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

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

$x(T, 3) = 130.00 \text{ mm}$
 $x(T, 24) = 250.00 \text{ mm}$

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

7. Read off values :

7.2 HP5 catchment 7 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 3.2422126 \text{ hours} \\
 &\text{and } T = 20 \text{ years.} \\
 &x(2, 3.24) = 41.49 \text{ mm} \\
 &x(20, 3.24) = 72.61 \text{ mm} \\
 &x(T, 3.24) = 134.48 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 72.613711 - 41.493549 \\
 &= 31.120162 \\
 0.43 D &= 13.38 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x(20) &= x(T) + 0.43 D \\
 [T = 20] &= 134.48065 + 13.38167 \\
 &= 147.86 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(20) &= 147.86232 \text{ mm} \\
 \text{Therefore, } i(20) &= \frac{x(100)}{T_c} = \frac{147.86232}{3.2422126} \\
 &= 45.61 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

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

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

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times Q \times i(T) \times A \\
 &= 88.56 \text{ cu. m/s}
 \end{aligned}$$

7.2 HP5 catchment 7 Tabung Haji (Q during logging activity)

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PROJECT : catchment 7 (During logging activity)
Tabung Haji, Pahang

A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 13.58 sq. km
Length of mainstream L = 5.53 km
Percentage developed, = 75 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
5.53	120.00	2.17	8.15
5.53	120.00	2.17	8.15

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

$$= \frac{8.15}{5.53}$$

$$= 2.17 \%$$

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 = 50 years (HP # 1)

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

$$= \frac{1.286 \times 5.53}{\{13.58^{0.223} \times 2.169981917^{0.263}\}}$$

$$= 3.24 \text{ hours}$$

$$= 194.53 \text{ mins}$$

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 :

7.2 HP5 catchment 7 Tabung Haji (Q during logging activity)

$$\begin{aligned}
 &\text{With } T_c = 3.2422126 \text{ hours} \\
 &\text{and } T = 50 \text{ years.} \\
 &x(2, 3.24) = 41.49 \text{ mm} \\
 &x(20, 3.24) = 72.61 \text{ mm} \\
 &x(T, 3.24) = 155.16 \text{ mm}
 \end{aligned}$$

8. Confidence limits

$$\begin{aligned}
 D &= x(20) - x(2) \\
 &= 72.613711 - 41.493549 \\
 &= 31.120162 \\
 0.43 D &= 13.38167 \text{ mm}
 \end{aligned}$$

$$\begin{aligned}
 9. \text{ Max } x \left[T = 50 \right] &= x(T) + 0.43 D \\
 &= 155.16487 + 13.38167 \\
 &= 168.55 \text{ mm}
 \end{aligned}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{aligned}
 \text{Max } x(50) &= 168.54654 \text{ mm} \\
 \text{Therefore, } i(50) &= \frac{x(100)}{T_c} = \frac{168.54654}{3.2422126} \\
 &= 51.99 \text{ mm/hr}
 \end{aligned}$$

2. From Figure 4 with,

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

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

THEREFORE

$$\begin{aligned}
 Q_{\max} &= F \times 0.278 \times Q_c \times i(T) \times A \\
 &= 115.98 \text{ cu. m/s}
 \end{aligned}$$

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A. CATCHMENT CHARACTERISTICS

From Topo Map sheets :

Area of catchment, A_c = 13.58 sq. km
Length of mainstream L = 5.53 km
Percentage developed, = 75 % (Land use factor)

Weighted mean slope, s

l_i (km)	h_i (m)	$s_i = h_i / l_i$ (%)	$l_i * \text{SQRT } s_i$
5.53	120.00	2.17	8.15
5.53	120.00	2.17	8.15

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

$$= \frac{8.15}{5.53}$$

$$= 2.17 \%$$

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
Region 2 - Kuala Lumpur
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C. ESTIMATION OF THE DESIGN RAINSTORM

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

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

$$= \frac{\{ 1.286 \times 5.53 \}}{\{ 13.58^{0.223} \times 2.169981917^{0.263} \}}$$

$$= 3.24 \text{ hours}$$

$$= 194.53 \text{ mins}$$

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 :

7.2 HP5 catchment 7 Tabung Haji (Q during logging activity)

$$\begin{array}{rcl}
 \text{With } T_c = & 3.24 \text{ hours} \\
 \text{and } T = & 100 \text{ years.} \\
 x(2, 3.24) & = & 41.49 \text{ mm} \\
 x(20, 3.24) & = & 72.61 \text{ mm} \\
 x(T, 3.24) & = & 170.66 \text{ mm}
 \end{array}$$

8. Confidence limits

$$\begin{array}{rcl}
 D & = & x(20) - x(2) \\
 & = & 72.613711 - 41.493549 \\
 & = & 31.120162 \\
 0.43 D & = & 13.38 \text{ mm}
 \end{array}$$

$$\begin{array}{rcl}
 9. \text{ Max } x & (100) & = x(T) + 0.43 D \\
 [T = 100] & & = 170.66479 + 13.38167 \\
 & & = 184.05 \text{ mm}
 \end{array}$$

D. FLOOD ESTIMATION

1. From step C,

$$\begin{array}{rcl}
 \text{Max } x(100) & = & 184.05 \text{ mm} \\
 \text{Therefore, } i(100) & = & \frac{x(100)}{T_c} = \frac{184.04646}{3.2422126} \\
 & = & 56.77 \text{ mm/hr}
 \end{array}$$

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

$$\begin{array}{rcl}
 Q_{\max} & = & F \times 0.278 \times Q \times i(T) \times A \\
 & = & 142.68 \text{ cu. m/s}
 \end{array}$$