CV2020 2021/22 Sem 2

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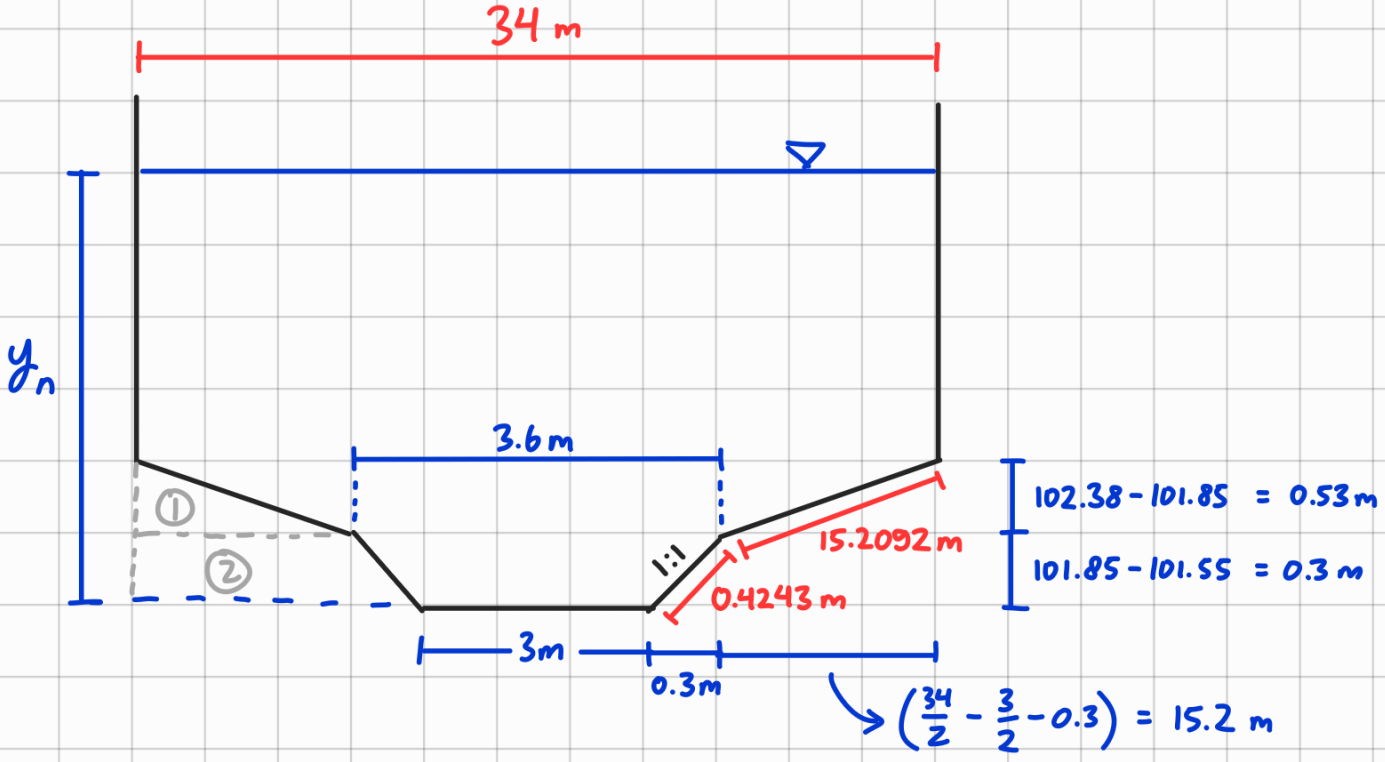
1. (a) $Q = 277.0\ m^3/s$ $B = 34\ m$

$n = 0.015$

$S_0 = \frac{1}{2000}$



$$A = A_{rectangle} - 2A_1 - 2A_2$$
$$= (34 \times y_n) - 2\left(\tfrac{1}{2} \times 15.2 \times 0.53\right) - 2\left[\tfrac{1}{2} \times 0.3 \times (15.2 + 15.5)\right]$$
$$= 34y_n - 17.266$$

$$P = 3 + (2 \times 0.4243) + (2 \times 15.2092) + 2 \times (y_n - 0.53 - 0.3)$$
$$= 2y_n + 32.607$$

$$Q = \frac{1}{n} A R_h^{2/3} S_0^{1/2}$$

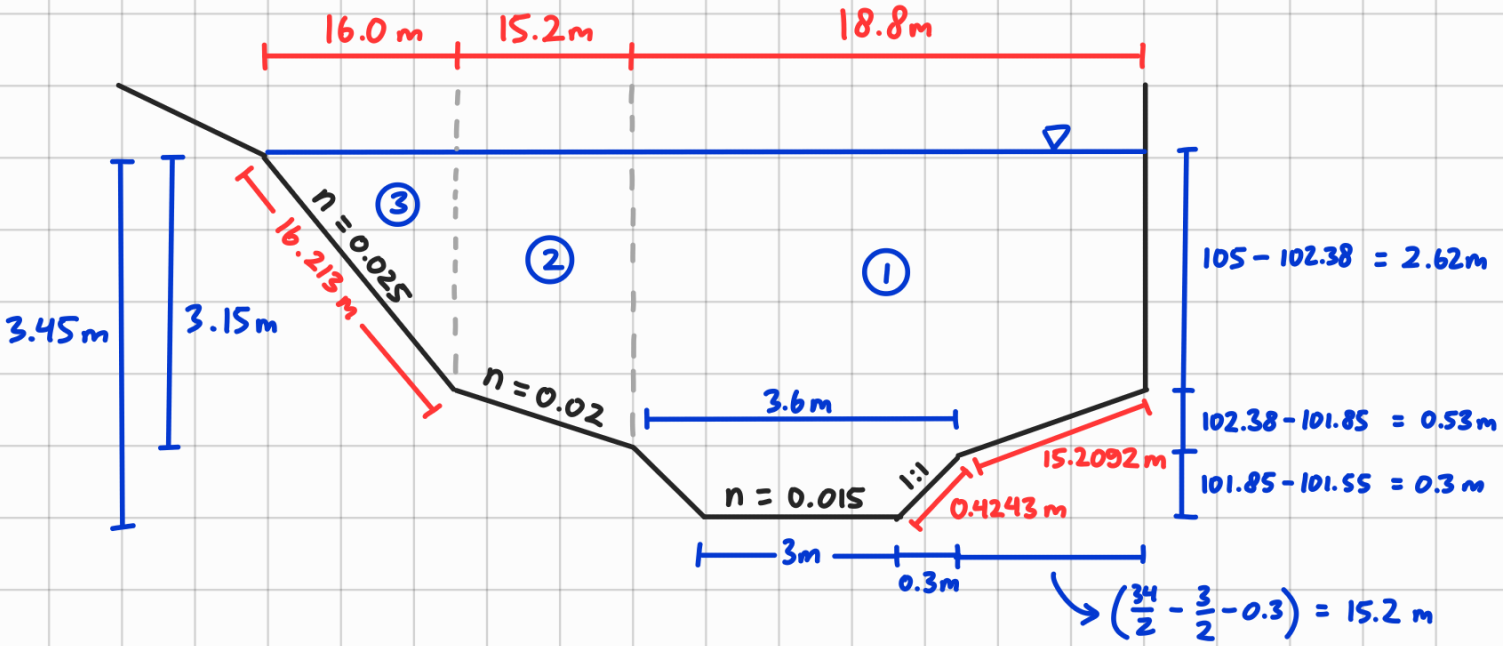
$$277 = \frac{1}{0.015}(34y_n - 17.266)\left[\frac{34y_n - 17.266}{2y_n + 32.607}\right]^{2/3}\left(\frac{1}{2000}\right)^{1/2}$$

Solving for y_n, $y_n = 3.450$ m ✓

(Use SOLVE function in calculator or plot in Graphical Calculator)

(b) $S_0 = \frac{1}{2000}$

$n = 0.015$ (concrete)



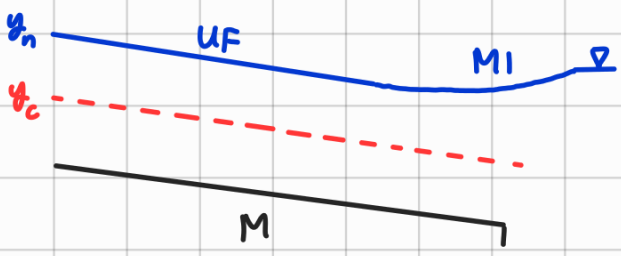
Section	P (m)	A (m^2)	$R_h = \frac{A}{P}$	n	$Q = \frac{1}{n} A R_h^{2/3} S_0^{1/2}$
①	$3 + (2 \times 0.4243) + 15.2092 + 2.62 = 21.68$	$(18.8 \times 3.45) - 2(\frac{1}{2} \times 0.3 \times 0.3) - \frac{1}{2}(15.2 \times (0.3 + 0.83)) = 56.182$	2.591	0.015	158.0 m^3/s
②	15.2092	$\frac{1}{2}(15.2)(2.62 + 3.15) = 43.852$	2.883	0.02	99.3 m^3/s
③	16.213	$\frac{1}{2} \times 16 \times 2.62 = 20.96$	1.293	0.025	22.3 m^3/s

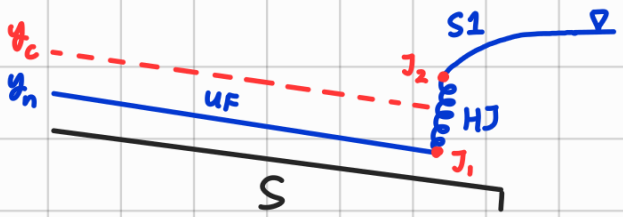
$\Sigma Q = 279.6 \ m^3/s$

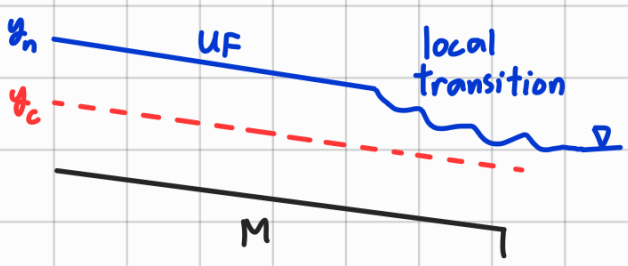
(c) The increased roughness will decrease the river's discharge, given the same flowdepth.

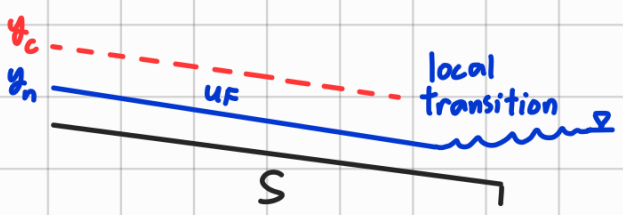
Also, the increased roughness will increase the river's water depth, given the same discharge.

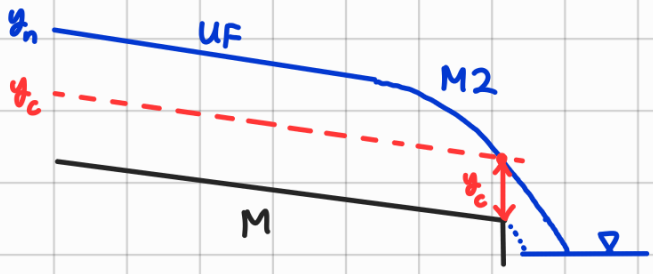
2. (a)

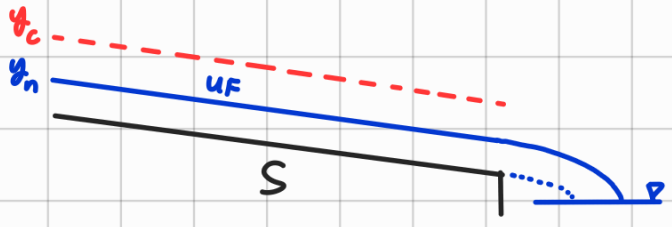

y_n
y_c
UF
M1
M


y_c
y_n
UF
S1
J_2
HJ
J_1
S

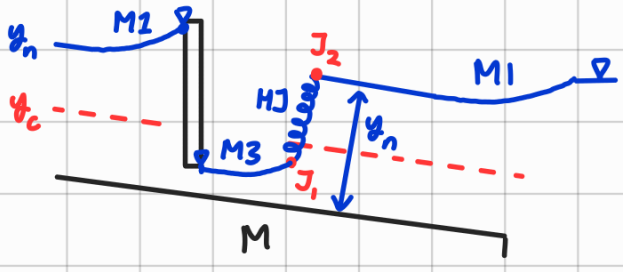

y_n
y_c
UF
local transition
M

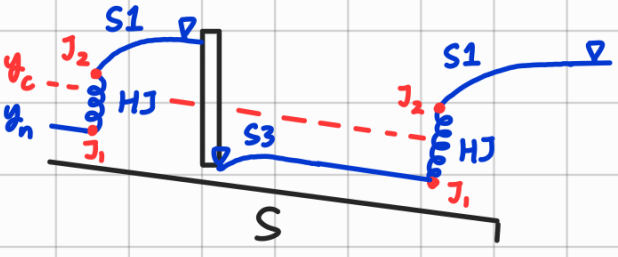

y_c
y_n
UF
local transition
S

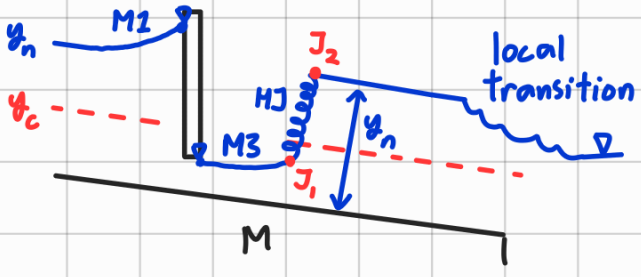

y_n
y_c
UF
M2
y_c
M

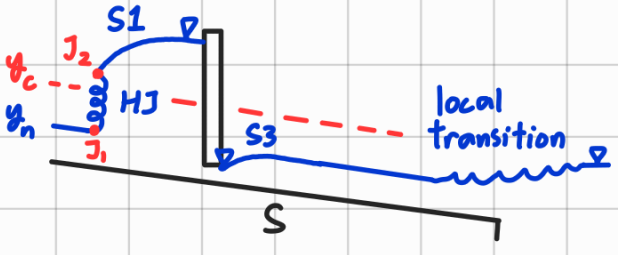

y_c
y_n
UF
S

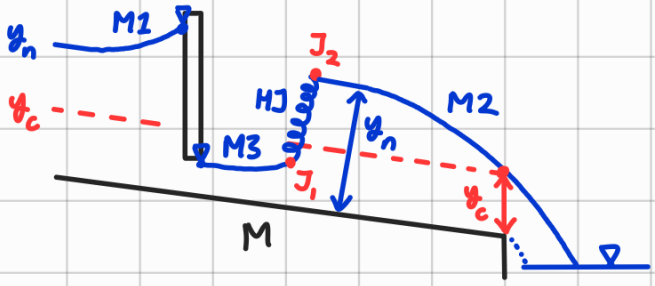
(b)

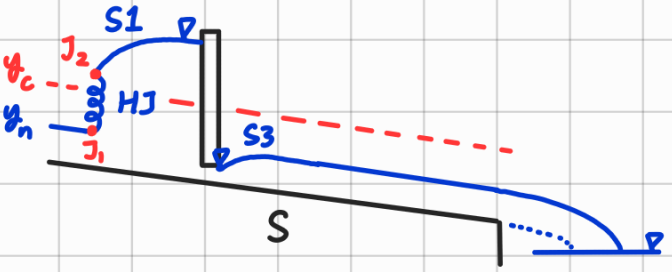

y_n
y_c
M1
M3
HJ
J_2
J_1
M1
y_n
M


S1
J_2
y_c
y_n
HJ
J_1
S3
S1
J_2
HJ
J_1
S


y_n
y_c
M1
M3
HJ
J_2
J_1
local transition
y_n
M


S1
J_2
y_c
y_n
HJ
J_1
S3
local transition
S


y_n
y_c
M1
M3
HJ
J_2
J_1
M2
y_n
y_c
M


S1
J_2
y_c
y_n
HJ
J_1
S3
S

3. (a)

Area (km^2)	Percentage Area	Isohyet (mm)	Avg. Rainfall (mm)	Avg. Rainfall * % Area (mm)
		20		
15	10.0%		35	3.50
		50		
45	30.0%		65	19.50
		80		
50	33.3%		95	31.67
		110		
30	20.0%		125	25.00
		140		
10	6.7%		155	10.33
		170		
∑A = 150		Mean Precipitation (mm) =		90

(b)

f(t) is infiltration capacity in cm/hr

S 5 $cm/hr^{0.5}$

K 1 cm/hr

$$f(t) = K + \frac{S}{2\sqrt{t + 0.1}}$$

t (hr)	Rainfall depth (cm)	Infiltration (cm/hr)	Avg. Infiltration (cm/hr)	Avg. Infiltration depth (cm)	Runoff depth (cm)
0.0		8.91			
	2		6.57	3.28	0.00
0.5		4.23		×0.5 hr	
	10		3.81	1.90	8.10
1.0		3.38			
	12		3.18	1.59	10.41
1.5		2.98			
	8		2.85	1.43	6.57
2.0		2.73			
	6		2.64	1.32	4.68
2.5		2.55			
	1		2.49	1.24	0.00
3.0		2.42			
				Total Runoff Depth (cm)	29.76

(c)

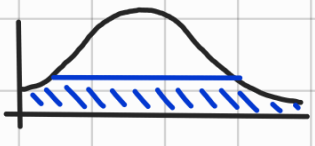
(i) Constant Baseflow Method

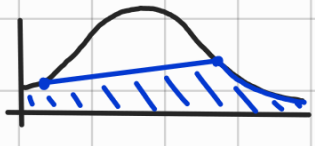
Time (day)	Flow (m^3/s)	Baseflow (m^3/s)	Runoff (m^3/s)
1	33	33 ~~41~~	0
2	141	41	100
3	356	41	315
4	242	41	201
5	168	41	127
6	119	41	78
7	87	41	46
8	56	41	15
9	41	41	0
10	35	35 ~~41~~	0
11	31	31 ~~41~~	0
12	29	29 ~~41~~	0
13	27	27 ~~41~~	0
14	25	25 ~~41~~	0

Last day of runoff

(ii) Constant Slope Method

Time (day)	Flow (m^3/s)	Baseflow (m^3/s)	Runoff (m^3/s)
1	33	33	0
2	141	34	107
3	356	35	321
4	242	36	206
5	168	37	131
6	119	38	81
7	87	39	48
8	56	40	16
9	41	41	0
10	35	35	0
11	31	31	0
12	29	29	0
13	27	27	0
14	25	25	0





4. (a) (i)

Area	46,332,000	m^2

× 3600 s

Time (hr)	Flow (m^3/s)	Baseflow (m^3/s)	Eff. Runoff (m^3/s)	Runoff Vol. (m^3)
0	5	5	0	0
1	48	6	42	151,200
2	223	7	216	777,600
3	347	8	339	1,220,400
4	307	9	298	1,072,800
5	193	10	183	658,800
6	101	11	90	324,000
7	101	12	89	320,400
8	43	13	30	108,000
9	14	14	0	0
			Total Vol. (m^3)	4,633,200

Runoff Depth = Volume/Area =	100	mm

units !

Scaling factor = 10mm/Runoff Depth =	0.1	

Scaling factor × Runoff

Time (hr)	3-hr UH (m^3/s)
0	0
1	4.2
2	21.6
3	33.9
4	29.8
5	18.3
6	9.0
7	8.9
8	3
9	0

(ii)

3-hr UH to 2-hr UH						
Time (hr)	3-hr UH (m^3/s)	S curve additions (m^3/s)	S curve (m^3/s)	Lagged S curve (m^3/s)	S – lagged (m^3/s)	2-hr UH (m^3/s)
0	0	0	0		0	0
1	4.2	0	4.2		4.2	6.3
2	21.6	0	21.6	0	21.6	32.4
3	33.9	0	33.9	4.2	29.7	44.6
4	29.8	4.2	34.0	21.6	12.4	18.6
5	18.3	21.6	39.9	33.9	6.0	9.0
6	9.0	33.9	42.9	34.0	8.9	13.4
7	8.9	34.0	42.9	39.9	3.0	4.5
8	3.0	39.9	42.9	42.9	0	0
9	0	42.9	42.9	42.9	0	0

(b)

$\times 10^3 m^3$

$$S = 3.6Q^2 - 1.8Q + 7.2$$

m^3

$$\frac{S}{1000} = 3.6Q^2 - 1.8Q + 7.2$$

$$S = 3600Q^2 - 1800Q + 7200$$

$$2S = 7200Q^2 - 3600Q + 14400$$

Interval of 1 hr

$$\frac{2S}{\Delta t} = 2Q^2 - Q + 4$$

$$\left(\frac{2S}{\Delta t} + Q\right) = 2Q^2 + 4 \quad \Longleftrightarrow \text{Rearrange} \quad Q = \sqrt{\frac{\left(\frac{2S}{\Delta t} + Q\right) - 4}{2}}$$

$$\left(\frac{2S}{\Delta t}+Q\right) = 2Q^2+4 \iff Q = \sqrt{\frac{\left(\frac{2S}{\Delta t}+Q\right)-4}{2}}$$

$$I_1 + I_2 + \left(\frac{2S_1}{\Delta t} - Q_1\right) = \left(\frac{2S_2}{\Delta t} + Q_2\right)$$

$$\left(\frac{2S}{\Delta t} - Q\right) = \left(\frac{2S}{\Delta t} + Q\right) - 2Q$$

Time (hr)	I (m^3/s)	2S/Δt - Q (m^3/s)	2S/Δt + Q (m^3/s)	Q (m^3/s)
0	5	44	54	5
1	27	64	76	6
2	41	116	132	8
3	89	224	246	11
4	83	368	396	14
5	65	484	516	16
6	33	548	582	17

(c) $\frac{dS}{dt} = I - Q$

$$\Delta S = \Delta t \left(\frac{I_1 + I_2}{2} - \frac{Q_1 + Q_2}{2}\right)$$

Time (hr)	Inflow (m^3/s)	Outflow (m^3/s)	Storage (m^3)
0	4	6	10,000
1	10	4	17,200
2	60	16	107,200
3	76	54	226,000
4	44	70	218,800
5	26	30	164,800

$10000 + 3600\left(\frac{4+10}{2} - \frac{6+4}{2}\right)$

$17200 + 3600\left(\frac{10+60}{2} - \frac{4+16}{2}\right)$

$\vdots$

$\therefore t = 3$ hours, $S_{max} = 226\,000\ m^3$