11.4.7

From Eq' (11.7): S = (25,400/CN) - 254 = (25,400/93) - 254 = 19.1 mm.; where the CN is found in Table 11.7.

Now applying Equation (11.17): $T_C = \{2.586(1,610)^{0.8} \cdot [(19.1/25.4)+1]^{0.7}\}/(1140 \cdot (2)^{0.5}) = 0.873$ hours (52.4 minutes)

The time-to-peak is estimated by Equation (11.21): $T_p = 0.67 \cdot T_c = 0.67(0.874) = 0.586$ hours (35.2 minutes)

Peak discharge (Eq'n 11.22; SI version): $q_p = (K_p \cdot A)/T_p = 2.08 \cdot [162 \text{ hec}(1 \text{ km}^2/100 \text{ hec})]/0.586 \text{ hr} = 5.75$ cms/cm

The storm duration from Equation (11.19) is: $\Delta D = 0.133 \cdot T_c = 0.133 \cdot 0.874 = 0.116$ hrs (≈ 7 minutes)

The 7-min UH is displayed below using Table 11.11. The peak flow is **5.75 cms** and occurs 35 minutes into the storm.

Time Ratios	Flow Ratios	Time	Flow
(t/t_p)	(q/q_p)	(min)	(cms)
0.0	0.000	0.0	0.00
0.2	0.100	7.0	0.58
0.4	0.310	14.0	1.78
0.6	0.660	21.0	3.80
0.8	0.930	28.0	5.35
1.0	1.000	35.0	5.75
1.2	0.930	42.0	5.35
1.4	0.780	49.0	4.49

Time Ratios	Flow Ratios	Time	Flow
(t/t_p)	(q/q_p)	(min)	(cms)
1.6	0.560	56.0	3.22
1.8	0.390	63.0	2.24
2.0	0.280	70.0	1.61
2.4	0.147	84.0	0.85
2.8	0.077	98.0	0.44
3.2	0.040	112.0	0.23
3.6	0.021	126.0	0.12
4.0	0.011	140.0	0.06

11.4.11

Multiplying the rainfall depths by (2/3) yields 2 inches of runoff in the 1st two-hour period, 3 inches of runoff in the next two-hour period, and 1 inch of runoff in the last two-hour period. Thus, multiplying the unit hydrograph by these runoff depths and lagging as appropriate yields the following total (design) runoff hydrograph (TRH):

Time	UH_2		2×UH	3×UH	1×UH	DRH	BF	TRH
			no lag	2 hr lag	4 hr lag			
(hr)	(cfs)		(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
0	0		0			0	50	50
1	300		600			600	50	650
2	800		1600	0		1600	50	1650
3	1200		2400	900		3300	50	3350
4	1000		2000	2400	0	4400	50	4450
5	700		1400	3600	300	5300	50	5350
6	400		800	3000	800	4600	50	4650
7	200		400	2100	1200	3700	50	3750
8	0		0	1200	1000	2200	50	2250
9	0		0	600	700	1300	50	1350
10	0		0	0	400	400	50	450

11.4.13

By definition, a unit hydrograph results from one unit of runoff of relatively uniform intensity. In addition, to use a 30-minute unit hydrograph as a predictive tool for a design storm, runoff values need to be in 30 minute increments. Thus, the 1-hour (unit) storm produces 0.5 inches of runoff in the first 30 minutes and 0.5 inches of runoff in the second 30 minutes. The resulting total runoff hydrograph (TRH) will be the UH_1 and is shown in the table below.

Time (hr)	$UH_{1/2}$ (m^3/s)		$0.5 \times UH_{1/2}$ (m^3/s)	$0.5 \times UH_{1/2}$ 1/2 hr lag (m^3/s)	DRH = UH_1 (m^3/s)
0.00	0		0		0
0.25	8		4		4
0.50	20		10	0	10
0.75	36		18	4	22
1.00	32		16	10	26
1.25	24		12	18	30
1.50	16		8	16	24
1.75	8		4	12	16
2.00	4		2	8	10
2.25	0		0	4	4
2.50	0		0	2	2

11.6.5

Using the SCS sheet flow equation (11.8) and Manning's channel flow equation (11.11) yields

$$T_{t1} = [0.007\,(n{\cdot}L)^{0.8}]/(P_2^{0.5}\cdot s^{0.4}) = [0.007{\cdot}(0.011{\cdot}270)^{0.8}]/\{(1.1)^{0.5}\cdot(0.005)^{0.4}\} = 0.133 \text{ hrs } (8.0 \text{ min})$$

$$V = (1.49/n){\cdot}R_h^{2/3}{\cdot}S_e^{1/2} = (1.49/0.013){\cdot}(2/4)^{2/3}{\cdot}(0.005)^{1/2} = 5.1 \text{ ft/sec}$$

$$T_{t3} = L/V = (600 \text{ ft})/(5.1 \text{ ft/sec}) = 118 \text{ sec.} = 2.0 \text{ min.}\quad \text{Thus, } T_c = T_{t1} + T_{t3} = 8.0 + 2.0 = 10.0 \text{ min.}$$

Applying the rational equation (11.27) yields

$$Q_2 = C{\cdot}I{\cdot}A = (0.90)(3.8 \text{ in./hr})(270 \text{ ft})(600 \text{ ft})(1 \text{ acre}/43{,}560 \text{ ft}^2) = \mathbf{12.7 \text{ cfs}}$$

where *C* is found using Table 11.20 (mid range) and *I* is obtained from Figure 11.4 (with a storm duration equal to the 10 minute time of concentration; i.e., sheet flow time plus channel flow time).