11.2.6 The spreadsheet solution is shown below:

t	i	ΔP	P	t/t_d	P/P_T
(hr)	(in./hr)	(in.)	(in.)		
0			0.0	0.00	0.00
	1.0	2.0			
2			2.0	0.25	0.22
	1.8	3.6			
4			5.6	0.50	0.61
	1.2	2.4			
6			8.0	0.75	0.87
	0.6	1.2			
8			9.2	1.00	1.00

11.2.11

The results are shown in the following spreadsheet.

t_d	i_{avg}	$P = i*t_d$	ΔP	ΔP/Δt	t	i
(min)	(cm/hr)	(cm)	(cm)	(cm/hr)	(min)	(cm/hr)
0		0.00			0	
			2.55	15.32		3.08
10	15.32	2.55			10	
			1.28	7.68		7.68
20	11.50	3.83			20	
			0.77	4.61		15.32
30	9.20	4.60			30	
			0.51	3.08		4.61
40	7.67	5.11			40	
			0.37	2.20		2.20
50	6.58	5.48			50	
			0.28	1.65		1.65
60	5.76	5.76			60	

The peak intensity is 15.32 cm/hr and occurs between 20 and 30 minutes into the storm (between 1/3 and 1/2 of the storm duration). If the time interval was changed to 5 minutes, the peak intensity would change. This is because the 5-minute rainfall intensity would be included in the calculations. The 5-minute rainfall intensity will always be larger than the 10-minute rainfall intensity.

11.2.13

From Fig. 11.5, the 10-yr, 24-hr rainfall = 9 in. (Miami)
From Fig. 11.7, use a Type III rainfall distribution.
The results are shown below. Peak intensity = 5.436 in./hr

1	2	3	4	5	6	7	8
t_1 (hr)	t_2 (hr)	P_1/P_t	P_2/P_t	P_1 (in.)	P_2 (in.)	ΔP (in.)	i (in/hr)
9	9.5	0.148	0.167	1.332	1.503	0.171	0.342
9.5	10	0.167	0.189	1.503	1.701	0.198	0.396
10	10.5	0.189	0.216	1.701	1.944	0.243	0.486
10.5	11	0.216	0.250	1.944	2.250	0.306	0.612
11	11.5	0.250	0.298	2.250	2.682	0.432	0.864
11.5	12	0.298	0.600	2.682	5.400	2.718	5.436
12	12.5	0.600	0.702	5.400	6.318	0.918	1.836
12.5	13	0.702	0.751	6.318	6.759	0.441	0.882
13	13.5	0.751	0.785	6.759	7.065	0.306	0.612

11.3.3

For silt loam soils from Table 11.5, $\phi = 0.501$, P_f = 16.68 cm = 6.57 in., and K = 0.68 cm/hr = 0.27 in./hr. Also, $S_i = 0.4$. The spreadsheet below provides the results. The total rainfall depth and the total infiltration depth are found from the sum of the values in Columns 4 and 7 respectively multiplied by the time step.

Total Rainfall = (14.0 in./hr)(0.25 hr) = 3.5 inches

Total Infiltration = (6.26 in./hr)(0.25 hr) = 1.57 inches

1	2	3	4	5	6	7	8	9	10
Time Step	t_1 (hr)	t_2 (hr)	i. (in./hr)	Z_1 (in.)	f_p (in./hr)	f (in./hr)	ΔZ (in.)	Z_2 (in.)	i_e (in./hr)
1	0.00	0.25	1.2	0.00	∞	1.20	1.00	1.00	0.00
2	0.25	0.50	2.4	1.00	2.05	2.05	1.70	2.70	0.35
3	0.50	0.75	4.8	2.70	0.93	0.93	0.77	3.47	3.87
4	0.75	1.00	3.6	3.47	0.78	0.78	0.65	4.12	2.82
5	1.00	1.25	1.4	4.12	0.70	0.70	0.58	4.70	0.70
6	1.25	1.50	0.6	4.70	0.65	0.60	0.50	5.20	0.00
		∑ =	14.00		∑ =	6.26		∑ =	7.74

11.3.6

Based on Table 11.7 for open space (fair condition),

$CN_1 = 69$ (B soils), and $CN_2 = 84$ (D soils).

The predevelopment area-weighted average CN is:

$\mathbf{CN_{pre}}$ = [(80 hec)(69) + (120 hec)(84)]/200 hec = **78**

Also, based on Table 11.7 for commercial areas:

$CN_3 = 88$ (B soils), and $CN_4 = 93$ (D soils).

The post-development area-weighted average CN is:

$\mathbf{CN_{post}}$ = [(80 hec)(88) + (120 hec)(93)]/200 hec = **91**

For runoff, use Eq'ns 11.7 & 11.5 with P = 100 mm:

Pre-development: $S = \{25{,}400-254(78)\}/78 = 71.6$ mm

$\mathbf{R} = [100 - 0.2(71.6)]^2/[100 + 0.8(71.6)] = \mathbf{46.7\ mm}$

Post-development: $S = \{25{,}400-254(91)\}/91 = 25.1$ mm

$\mathbf{R} = [100 - 0.2(25.1)]^2/[100 + 0.8(25.1)] = \mathbf{75.1\ mm}$

Therefore, the increase in runoff depth is:

$\mathbf{\Delta R}$ = 75.1 mm – 46.7 mm = 28.4 mm = **2.84 cm**

11.3.9

For golf course (open space) in good condition with C soils: CN = 74. From Eq'n. 11.6: S = 3.51 in.

The results are shown in the following spreadsheet.

t_1 (hr)	t_2 (hr)	i (in./hr)	ΔP (in.)	P_1 (in.)	P_2 (in.)	R_1 (in.)	R_2 (in.)	ΔR (in.)
0.0	0.5	0.7	0.35	0.00	0.35	0.00	0.00	0.00
0.5	1.0	1.4	0.70	0.35	1.05	0.00	0.03	0.03
1.0	1.5	2.3	1.15	1.05	2.20	0.03	0.45	0.42
1.5	2.0	1.8	0.90	2.20	3.10	0.45	0.97	0.52
2.0	2.5	1.0	0.50	3.10	3.60	0.97	1.31	0.34
2.5	3.0	0.4	0.20	3.60	3.80	1.31	1.45	0.14

After development: CN = 80 and S = 2.50 in.

The results are shown in the following spreadsheet.

t_1 (hr)	t_2 (hr)	i (in./hr)	ΔP (in.)	P_1 (in.)	P_2 (in.)	R_1 (in.)	R_2 (in.)	ΔR (in.)
0.0	0.5	0.7	0.35	0.00	0.35	0.00	0.00	0.00
0.5	1.0	1.4	0.70	0.35	1.05	0.00	0.10	0.10
1.0	1.5	2.3	1.15	1.05	2.20	0.10	0.69	0.59
1.5	2.0	1.8	0.90	2.20	3.10	0.69	1.33	0.64
2.0	2.5	1.0	0.50	3.10	3.60	1.33	1.72	0.39
2.5	3.0	0.4	0.20	3.60	3.80	1.72	1.88	0.16

Total runoff (R) increases to 1.88 in. from 1.45 in.

See R_2 values at t_2 = 3 hrs. (or add up the ΔR column).

ΔVol = [{(1.88 – 1.45)/12}ft](150 ac) = **5.38 ac-ft**
