Example 7.11

Develop a design storm for a watershed in Dallas, Texas, for an annual exceedance probability of 0.02 and duration of 24 hours, using a computational time interval of 2.0 hours.

Solution An annual exceedance probability of 0.02 is equivalent to a recurrence interval of 50 years.

$$T = \frac{1}{P} = \frac{1}{0.02} = 50 \text{ years}$$

Equation 7.50 is used with coefficients from Table 7.6 for a 50-year storm in Dallas County. The city of Dallas is located within Dallas County.

$$i = \frac{a}{(t+b)^c} = \frac{101}{(t+8.7)^{0.771}}$$

For a rainfall duration t of 24 hours or 1,440 minutes,

$$i = \frac{101}{(1{,}440+8.7)^{0.771}} = 0.369 \text{ inches/hour} \quad (9.38 \text{ mm/hr})$$

The total rainfall depth P for this 50-year, 24-hour rainfall event is

$$P = i\Delta t = (0.369 \text{ in./hr})(24 \text{ hrs}) = 8.86 \text{ inches } (225 \text{ mm})$$

The total rainfall durations t from column 2 of the table are input into the IDF equation to obtain the intensities i recorded in column 3 that are transformed to depths P in column 4. The incremental increase in precipitation depth for each 2-hour incremental increase in duration is tabulated in column 5 ($\Delta P = P_t - P_{t-1}$). The ΔP's of column 5 are rearranged in column 6 in a triangular distribution with the largest ΔP (4.77 in.) in the center (Δt = 10–12 hrs). The 2-hour depths of column 6 are accumulated in column 7 and converted to mm in column 9. The 50-year recurrence interval design storm is plotted in Fig. 7.14. It provides the rainfall input for watershed modeling examples in Chapter 8.

				Design storm				
Duration (hr) (1)	Duration (min) (2)	Mean intensity, i (in./hr) (3)	Cumulative depth, P (in.) (4)	ΔP (in.) (5)	ΔP (in.) (6)	P (in.) (7)	ΔP (mm) (8)	P (mm) (9)
2	120	2.39	4.77	4.77	0.19	0.19	4.8	4.8
4	240	1.44	5.75	0.97	0.23	0.42	5.8	10.6
6	360	1.06	6.36	0.62	0.28	0.70	7.1	17.8
8	480	0.85	6.83	0.46	0.38	1.08	9.7	27.3
10	600	0.72	7.20	0.38	0.62	1.70	15.7	43.0
12	720	0.63	7.52	0.32	4.77	6.47	121.0	164.0
14	840	0.56	7.81	0.28	0.97	7.44	24.6	189.0
16	960	0.50	8.06	0.25	0.46	7.90	11.6	201.0
18	1,080	0.46	8.28	0.23	0.32	8.22	8.1	210.0
20	1,200	0.42	8.49	0.21	0.25	8.47	6.4	215.0
22	1,320	0.39	8.68	0.19	0.21	8.68	5.3	221.0
24	1,440	0.37	8.86	0.18	0.18	8.86	4.6	225.0

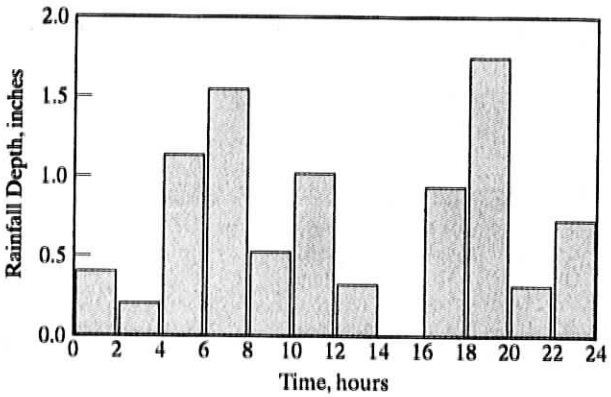

Figure 7.13 The distribution of rainfall during an actual storm is typically very random and sporadic.

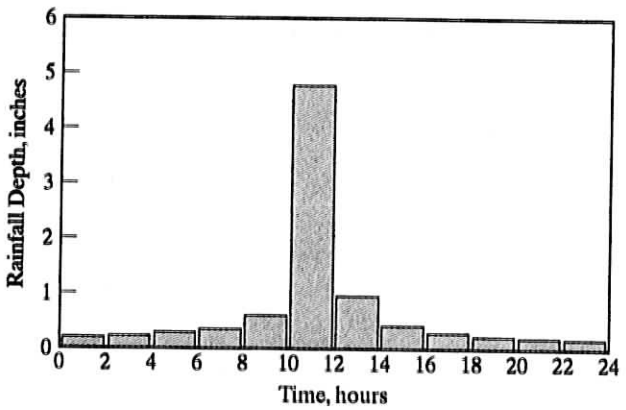

Figure 7.14 The hyetograph for the synthetic design storm developed in Example 7.11 illustrates the balanced triangular (alternating block) distribution of rainfall over time.