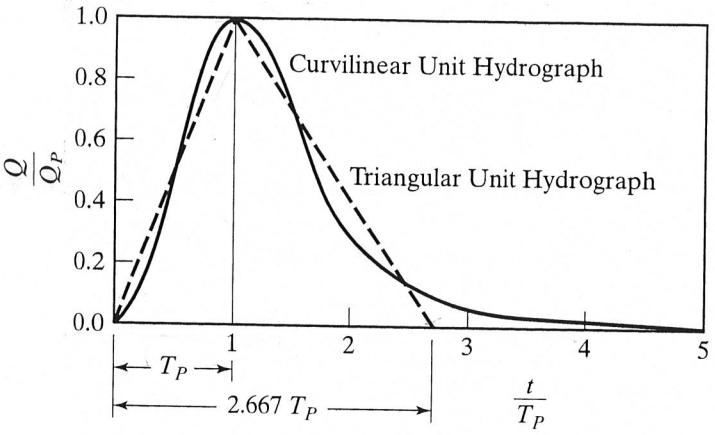
8.6.4 NRCS Dimensionless Unit Hydrograph



Developed from A < 25 mi² NRCS has used it for areas 100-200 mi² but < 50 mi²

Figure 8.11 Either the triangular or curvilinear version of the NRCS dimensionless unit hydrograph is combined with Eqs. 8.38–8.40.

TABLE 8.6 TIME AND DISCHARGE RATIOS FOR NRCS CURVILINEAR DIMENSIONLESS UNIT HYDROGRAPH

t/T_P	Q/Q_P	t/T_P	Q/Q_P	t/T_P	Q/Q_P
0	0.000	1.1	0.990	2.4	0.147
0.1	0.030	1.2	0.930	2.6	0.107
0.2	0.100	1.3	0.860	2.8	0.077
0.3	0.190	1.4	0.780	3.0	0.055
0.4	0.310	1.5	0.680	3.2	0.040
0.5	0.470	1.6	0.560	3.4	0.029
0.6	0.660	1.7	0.460	3.6	0.021
0.7	0.820	1.8	0.390	3.8	0.015
0.8	0.930	1.9	0.330	4.0	0.011
0.9	0.990	2.0	0.280	4.5	0.005
1.0	1.000	2.2	0.207	5.0	0.000

$$T_P = \frac{D}{2} + t_L \tag{8.38}$$

$$Q_p = \frac{484A}{T_P} \tag{8.39}$$

A in mi²
Qp in cfs

$$Q_p = \frac{2.08A}{T_P} \tag{8.40}$$

A in km²
Qp in m³/s

Example 8.10

The direct runoff from observed rainfall was computed in Example 8.6 for the 6.2 km^2 watershed of Fig. 8.4. A t_L of 1.83 hours was estimated in Example 8.1. Develop a unit hydrograph (U.H.) for this watershed for a rainfall duration D of 20 minutes using the NRCS triangular dimensionless unit hydrograph. Use the unit hydrograph to predict the flows to result from the rainfall given in Example 8.6.

Solution

$$T_P = \frac{D}{2} + t_L = \frac{1/3 \text{ hr}}{2} + 1.83 \text{ hr} = 2.0 \text{ hrs}$$

$$Q_p = \frac{2.08A}{T_P} = \frac{2.08(6.2 \text{ km}^2)}{2 \text{ hrs}} = 6.45 \frac{\text{m}^3}{\text{s}}$$

The unit hydrograph is tabulated in columns 1–3 at a time step of 20 minutes. Column 2 is column 1 divided by the T_P of 120 minutes. With the triangular unit hydrograph, the discharge ordinates increase linearly from zero at time zero and 320 minutes (t/T_P of 0 and 2.667) to Q_P = 6.45 m^3/s at T_P = 120 minutes (t/T_P = 1). In Example 8.6, runoff depths ΔV_R for each of five 20-minute increments of rainfall ΔP were estimated to be 4.1, 19.2, 11.1, 23.6, and 3.0 cm, respectively. The results of convoluting the unit hydrograph with these runoff depths are presented in columns 4–8. The resulting storm hydrograph ordinates are tabulated in column 9.

Time (min) (1)	Ratio t/T_P (2)	U.H. (m^3/s) (3)	Incremental hydrographs (m^3/s) 4.1 cm (4)	19.2 cm (5)	11.1 cm (6)	23.6 cm (7)	3.0 cm (8)	Hydrograph (m^3/s) (9)
0	0.00	0.00	0					0
20	0.17	1.07	4	0				4
40	0.33	2.15	9	21	0			29
60	0.50	3.22	13	41	12	0		66
80	0.67	4.30	18	62	24	25	0	129
100	0.83	5.37	22	83	36	51	3	194
120	1.00	6.45	26	103	48	76	6	260
140	1.17	5.80	24	124	60	101	10	318
160	1.33	5.16	21	111	72	127	13	344
180	1.50	4.51	19	99	64	152	16	350
200	1.67	3.87	16	87	57	137	19	316
220	1.83	3.22	13	74	50	122	17	277
240	2.00	2.58	11	62	43	107	15	237
260	2.17	1.93	8	50	36	91	14	198
280	2.33	1.29	5	37	29	76	12	159
300	2.50	0.64	3	25	21	61	10	119
320	2.67	0.00	0	12	14	46	8	80
340				0	7	30	6	43
360					0	15	4	19
380						0	2	2
400							0	0

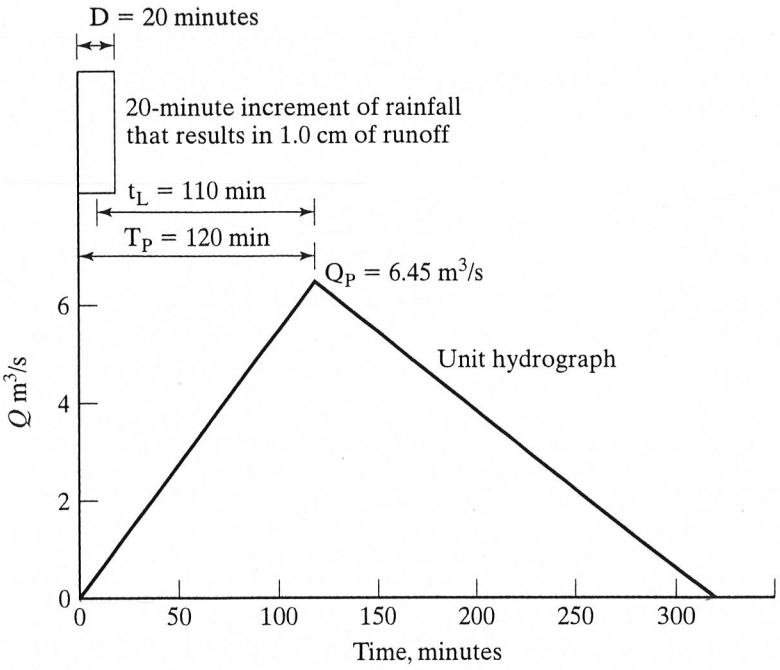


Figure 8.12 This unit hydrograph was developed in Example 8.10 using the NRCS triangular dimensionless unit hydrograph method.

SOURCE: Wurbs & James (2002)