TABLES

Changes reflecting Atlas 14 high-lighted in yellow

3.2.1.6.3: Channel or Storm Drain Flow

The velocity in an open channel or a storm drain not flowing full can be determined by using Manning's Equation. Channel velocities can also be determined by using backwater profiles. For open channel flow, average flow velocity is usually determined by assuming a bank-full condition. Note that the channel flow component of the time of concentration may need to be divided into multiple segments in order to represent significant changes in channel characteristics.

For storm drain flow under pressure conditions (where the hydraulic grade line is higher than the lowest crown of a storm drain) the following equation should be applied:

$V = Q/A$ [Equation 3.6]

Where:

V = Average velocity, feet/s

Q = Design discharge, cfs

A = Cross-sectional area, ft^2

Flow travel time through a channel can be calculated by Equation 3.7:

$$T_t = \sum \frac{L_i}{60V_i}$$ [Equation 3.7]

Where:

L_i = The i-th channel segment length, feet

V_i = The average flow velocity within the channel segment, feet/s

T_t = Total flow travel time through the channel, minutes

Rainfall Intensity (i)

Rainfall intensity (i) is the average rainfall rate in inches per hour and is selected on the basis of design rainfall duration and design frequency of occurrence. The design duration is equal to the time of concentration for the drainage area under consideration. The design frequency of occurrence is a statistical variable which is established by design standards or chosen by the engineer as a design parameter. The selection of the frequency criteria is necessary before applying any hydrologic method. Storm drainage improvements in San Marcos must be designed to intercept and carry the runoff from a 25-year frequency storm (4% annual chance event), with an auxiliary or overflow system capable of carrying a 100-year frequency storm (1% annual chance event).

The rainfall intensity used in the rational method can be read from the intensity-duration-frequency (IDF) curves based on the selected design frequency and design duration. The design engineer can also calculate the value of rainfall intensity from the best-fit IDF Equation 3.8 to be discussed later in this sub-section with known Tc value for the entire drainage area of interest.

The depth-duration frequency (DDF) and IDF values are shown in Table 3.3 and Table 3.4. These tables have been updated to reflect precipitation-frequency values for San Marcos obtained from NOAA's Atlas 14 Precipitation-Frequency Atlas of the United States (NOAA Atlas 14, Volume 11, version 2.0). Rainfall point locations were taken at the San Marcos City Hall located at 630 E. Hopkins Street.

TABLE 3.3 DEPTH-DURATION FREQUENCY TABLE FOR THE SAN MARCOS REGION

Annual Chance Exceedance	Recurrence Interval (Year)	Depth of Precipitation (Inches)							
		5-min	15-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr
50%	2	0.52	1.06	1.95	2.43	2.71	3.19	3.65	4.15
20%	5	0.66	1.33	2.47	3.11	3.50	4.18	4.84	5.54
10%	10	0.78	1.56	2.92	3.75	4.28	5.18	6.04	6.92
4%	25	0.95	1.89	3.56	4.70	5.46	6.74	7.90	9.07
2%	50	1.09	2.16	4.07	5.52	6.51	8.15	9.58	11.00
1%	100	1.23	2.45	4.62	6.43	7.71	9.80	11.60	13.20
0.5%	200	1.38	2.74	5.23	7.45	9.06	11.70	13.90	15.80
0.2%	500	1.59	3.14	6.12	8.95	11.10	14.50	17.30	19.90

*Atlas 14 Rainfall Point Location: San Marcos City Hall

Table 3.4 Intensity-Duration-Frequency Table for the San Marcos Region

Annual Chance Exceedance	Recurrence Interval (year)	Precipitation Intensity (inches per hour)							
		5-min	15-min	60-min	2-hr	3-hr	6-hr	12-hr	24-hr
50%	2	6.25	4.24	1.95	1.21	0.90	0.532	0.303	0.173
20%	5	7.90	5.31	2.47	1.56	1.17	0.698	0.402	0.231
10%	10	9.34	6.24	2.92	1.87	1.42	0.864	0.501	0.288
4%	25	11.40	7.57	3.56	2.35	1.82	1.130	0.656	0.378
2%	50	13.00	8.65	4.07	2.76	2.17	1.360	0.795	0.457
1%	100	14.80	9.78	4.62	3.21	2.57	1.640	0.959	0.550
0.5%	250	16.60	11.00	5.23	3.73	3.02	1.950	1.150	0.660
0.2%	500	19.00	12.50	6.12	4.48	3.68	2.420	1.440	0.829

*Atlas 14 Point Location: San Marcos City Hall

The following equation mathematically represents the San Marcos area intensity-duration-frequency curves:

$$i = \frac{a}{(t+b)^c}$$ [Equation 3.8]

Where,

i = Average rainfall intensity, inches per hour

t = Storm duration in minutes, which is equal to the time of concentration for the entire drainage area of interest

a, b, and c = Coefficients for different storm frequencies (see Table 3.5)

Table 3.5 San Marcos Region Intensity-Duration Frequency Curve Coefficients

Annual Chance Exceedance	Recurrence Interval (year)	Fitting Parameters for IDF Curves (Equation 3.8)		
		A	B	C
50%	2	46.949	9.522	0.750
20%	5	54.734	8.937	0.732
10%	10	58.315	8.132	0.709
4%	25	62.103	7.109	0.680
2%	50	64.030	6.398	0.657
1%	100	64.735	5.477	0.631
0.4%	250	66.309	4.889	0.609
0.2%	500	68.848	4.352	0.581

*Altas 14 Point Location: San Marcos City Hall

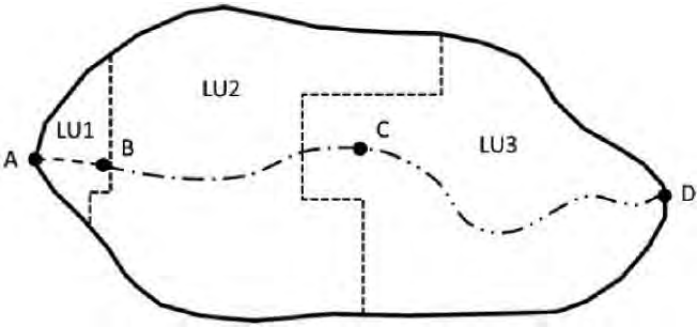
The a, b and c parameters listed in Table 3.5 were derived using nonlinear regression methods and the data included in Table 3.4. The IDF curves and the IDF equations are applicable for all design frequencies shown. They are required for use in determining peak flows by the Rational Method or other appropriate methods.

3.2.1.7: Drainage Area (A)

The size (acres) of the watershed needs to be determined for application of the Rational Method. The area may be determined through the use of topographic maps, supplemented by field surveys where topographic data has changed or where the contour interval is too great to distinguish the direction of flow. The drainage divide lines are determined based on topography, street layout, lot grading, building structure configuration and orientation, drainage system layout and other features that are created by the urbanization process.

Example 3.1

An urbanized watershed is shown on the following figure. Three types of flow conditions exist between the most distant point in the watershed and the outlet. The calculation of time of concentration and travel time in each reach is as follows:



Reach	Description of Flow	Slope (%)	Length (Ft.)	"n" Value/ Surface Type
A to B	Sheet flow (grass lawn)	1.8	50	0.24
B to C	Shallow concentrated flow (gutter)	2.0	840	Paved
C to D	Storm drain with inlets (D=3 feet)	1.5	1,200	0.015

For reaches A-B and B-C, the travel time can be calculated from Equations 3.3 and 3.4.

$T_{t(A-B)} = 0.42(nL)^{0.8}/(P_2)^{0.5}s^{0.4}$

$T_{t(A-B)} = 0.42(0.24 \times 50)^{0.8}/(3.44)^{0.5}(0.018)^{0.4}$

$= 8.25$ minutes

$T_{t(B-C)} = L/(60(20.3282)(s^{0.5}))$

$T_{t(B-C)} = 840/(60(20.3282)(0.020)^{0.5})$

$= 4.87$ minutes

The flow velocity in reach C-D needs to be calculated from Manning's Equation, using the assumption of full pipe flow, as follows:

$V(C-D) = (1.49/n)\ R^{0.67}s^{0.5}$

$= (1.49/n)\ (D/4)^{0.67}s^{0.5}$

$= (1.49/0.015)\ (3/4)^{0.67}\ (0.015)^{0.5}$

$= 10.0$ ft/s

The channel flow travel time is calculated by dividing the length by the velocity.

$T_{t(C-D)} = 1200/(60 \times 10.0) = 2.0$ min

The total time of concentration is calculated by adding the component sheet, shallow concentrated and channel flow segments.

$T_c = 8.25 + 4.87 + 2.0 = 15.12$ min

The runoff coefficients (C) for the three (3) areas are given as follows for the 100-year storm (1% annual chance event).

Area	Land Use	C	Area
LU_1	Grass Area (fair condition, flat)	0.41	3
LU_2	Commercial (composite of paved and grassed areas)	0.85	20
LU_3	Industrial (composite of paved and grassed areas)	0.81	30
		Total	53

The rainfall intensity (i) of the 100-year storm can be calculated using Equation 3.8 together with the coefficients in Table 3.5 for a time of concentration of 15.12 minutes as 9.60 inches per hour.

The composite runoff coefficient (C) = (0.41 X 3 + 0.85 X 20 + 0.81 X 30)/53= 0.80

Thus, the peak flow Q_p = CiA = 0.80 X 9.60 in/hr X 53 acre = 407 cfs

3.2.1.8: The Soil Conservation Service Method for Calculation of Peak Flows

The Soil Conservation Service hydrologic method is widely used by engineers and hydrologists for analyses of small urban watersheds. This method is based on extensive analytical work using a wide range of statistical data concerning storm patterns, rainfall-runoff characteristics and many hydrologic observations in the United States.

The SCS method can be applied to urban drainage areas of any size. The major parameters required to calculate a runoff hydrograph with the method include the rainfall distribution, runoff curve numbers, time of concentration and drainage area. For detailed information regarding the SCS method and the TR-20 program, the user is referred to the following NRCS publications. These can be obtained from the Natural Resources Conservation Service at http://www.wcc.nrcs.usda.gov/. They are:

NEH-4: "Hydrology," Section 4, National Engineering Handbook

TR-20: Computer Program for Project Formulation, Hydrology

TR-55: Urban Hydrology for Small Watersheds

TP-149: A Method for Estimating Volume and Rate of Runoff in Small Watersheds

The HEC-HMS programs can be downloaded from the US Army Corps of Engineers website at http://www.hec.usace.army.mil/.

3.2.1.8.1: San Marcos Twenty-Four (24) Hour Storm Rainfall Distributions

The City of San Marcos has adopted the use of an SCS 24-hour storm duration with a frequency temporal distribution of rainfall depths method. This distribution method is consistent with studies conducted by the Guadalupe Blanco River Authority (GBRA) studies for the Blanco River watershed. The DDF and IDF values to be used for the San Marcos region are shown in Table 3.3 and Table 3.4. For use in spreadsheet calculations, Table 3.6 provides the distribution ordinates in 5-minute increments as derived from the HEC-HMS program. The ordinates should be multiplied by the total 24-hour precipitation depth to produce the design rainfall distribution. When using the HEC-HMS model, the computational time interval should be selected based on criteria for the minimum lag time. The maximum computational time interval used in a HEC-HMS model should be 6 minutes.

Table 3.6 Type III Distribution Ordinates in 5-Minute Time Increments

Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)	Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)
0:00	0.0000	0.0000	0.0000	0.0000	12:30	0.1651	8.8637	0.0125	0.6721
0:05	0.0086	0.0086	0.0006	0.0006	12:35	0.1796	9.0433	0.0136	0.6857
0:10	0.0086	0.0172	0.0007	0.0013	12:40	0.1662	9.2096	0.0126	0.6984
0:15	0.0087	0.0259	0.0007	0.0020	12:45	0.1554	9.3650	0.0118	0.7101
0:20	0.0087	0.0346	0.0007	0.0026	12:50	0.1464	9.5114	0.0111	0.7212
0:25	0.0088	0.0434	0.0007	0.0033	12:55	0.1388	9.6501	0.0105	0.7318
0:30	0.0088	0.0522	0.0007	0.0040	13:00	0.1322	9.7823	0.0100	0.7418
0:35	0.0089	0.0610	0.0007	0.0046	13:05	0.1186	9.9009	0.0090	0.7508
0:40	0.0089	0.0700	0.0007	0.0053	13:10	0.1136	10.0144	0.0086	0.7594
0:45	0.0090	0.0790	0.0007	0.0060	13:15	0.1091	10.1235	0.0083	0.7677
0:50	0.0090	0.0880	0.0007	0.0067	13:20	0.1051	10.2286	0.0080	0.7756
0:55	0.0091	0.0971	0.0007	0.0074	13:25	0.1015	10.3300	0.0077	0.7833
1:00	0.0091	0.1062	0.0007	0.0081	13:30	0.0982	10.4282	0.0074	0.7908
1:05	0.0092	0.1154	0.0007	0.0088	13:35	0.0734	10.5016	0.0056	0.7963
1:10	0.0093	0.1247	0.0007	0.0095	13:40	0.0709	10.5726	0.0054	0.8017
1:15	0.0093	0.1340	0.0007	0.0102	13:45	0.0686	10.6412	0.0052	0.8069
1:20	0.0094	0.1434	0.0007	0.0109	13:50	0.0665	10.7077	0.0050	0.8120
1:25	0.0094	0.1528	0.0007	0.0116	13:55	0.0645	10.7722	0.0049	0.8168
1:30	0.0095	0.1623	0.0007	0.0123	14:00	0.0627	10.8349	0.0048	0.8216
1:35	0.0096	0.1718	0.0007	0.0130	14:05	0.0610	10.8959	0.0046	0.8262
1:40	0.0096	0.1815	0.0007	0.0138	14:10	0.0594	10.9553	0.0045	0.8307
1:45	0.0097	0.1911	0.0007	0.0145	14:15	0.0579	11.0132	0.0044	0.8351
1:50	0.0098	0.2009	0.0007	0.0152	14:20	0.0565	11.0698	0.0043	0.8394
1:55	0.0098	0.2107	0.0007	0.0160	14:25	0.0552	11.1250	0.0042	0.8436
2:00	0.0099	0.2206	0.0007	0.0167	14:30	0.0540	11.1789	0.0041	0.8477
2:05	0.0099	0.2305	0.0008	0.0175	14:35	0.0528	11.2317	0.0040	0.8517
2:10	0.0100	0.2405	0.0008	0.0182	14:40	0.0517	11.2834	0.0039	0.8556
2:15	0.0101	0.2506	0.0008	0.0190	14:45	0.0506	11.3340	0.0038	0.8594
2:20	0.0102	0.2608	0.0008	0.0198	14:50	0.0496	11.3837	0.0038	0.8632
2:25	0.0102	0.2710	0.0008	0.0205	14:55	0.0487	11.4323	0.0037	0.8669
2:30	0.0103	0.2813	0.0008	0.0213	15:00	0.0478	11.4801	0.0036	0.8705
2:35	0.0104	0.2916	0.0008	0.0221	15:05	0.0330	11.5131	0.0025	0.8730
2:40	0.0104	0.3021	0.0008	0.0229	15:10	0.0323	11.5454	0.0024	0.8755
2:45	0.0105	0.3126	0.0008	0.0237	15:15	0.0317	11.5771	0.0024	0.8779
2:50	0.0106	0.3232	0.0008	0.0245	15:20	0.0311	11.6081	0.0024	0.8802
2:55	0.0107	0.3339	0.0008	0.0253	15:25	0.0305	11.6386	0.0023	0.8825
3:00	0.0108	0.3446	0.0008	0.0261	15:30	0.0299	11.6685	0.0023	0.8848
3:05	0.0108	0.3555	0.0008	0.0270	15:35	0.0294	11.6979	0.0022	0.8870

Table 3.6 Type III Distribution Ordinates in 5-Minute Time Increments

Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)	Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)
3:10	0.0109	0.3664	0.0008	0.0278	15:40	0.0289	11.7267	0.0022	0.8892
3:15	0.0110	0.3774	0.0008	0.0286	15:45	0.0284	11.7551	0.0022	0.8914
3:20	0.0111	0.3885	0.0008	0.0295	15:50	0.0279	11.7830	0.0021	0.8935
3:25	0.0112	0.3996	0.0008	0.0303	15:55	0.0274	11.8104	0.0021	0.8956
3:30	0.0113	0.4109	0.0009	0.0312	16:00	0.0270	11.8374	0.0020	0.8976
3:35	0.0114	0.4223	0.0009	0.0320	16:05	0.0266	11.8639	0.0020	0.8996
3:40	0.0114	0.4337	0.0009	0.0329	16:10	0.0262	11.8901	0.0020	0.9016
3:45	0.0115	0.4452	0.0009	0.0338	16:15	0.0258	11.9159	0.0020	0.9036
3:50	0.0116	0.4569	0.0009	0.0346	16:20	0.0254	11.9412	0.0019	0.9055
3:55	0.0117	0.4686	0.0009	0.0355	16:25	0.0250	11.9662	0.0019	0.9074
4:00	0.0118	0.4804	0.0009	0.0364	16:30	0.0247	11.9909	0.0019	0.9093
4:05	0.0119	0.4924	0.0009	0.0373	16:35	0.0243	12.0152	0.0018	0.9111
4:10	0.0120	0.5044	0.0009	0.0382	16:40	0.0240	12.0392	0.0018	0.9129
4:15	0.0121	0.5165	0.0009	0.0392	16:45	0.0237	12.0629	0.0018	0.9147
4:20	0.0122	0.5288	0.0009	0.0401	16:50	0.0233	12.0862	0.0018	0.9165
4:25	0.0124	0.5411	0.0009	0.0410	16:55	0.0230	12.1092	0.0017	0.9182
4:30	0.0125	0.5536	0.0009	0.0420	17:00	0.0227	12.1320	0.0017	0.9200
4:35	0.0126	0.5661	0.0010	0.0429	17:05	0.0225	12.1544	0.0017	0.9217
4:40	0.0127	0.5788	0.0010	0.0439	17:10	0.0222	12.1766	0.0017	0.9233
4:45	0.0128	0.5916	0.0010	0.0449	17:15	0.0219	12.1985	0.0017	0.9250
4:50	0.0129	0.6045	0.0010	0.0458	17:20	0.0217	12.2202	0.0016	0.9266
4:55	0.0131	0.6176	0.0010	0.0468	17:25	0.0214	12.2416	0.0016	0.9283
5:00	0.0132	0.6308	0.0010	0.0478	17:30	0.0211	12.2627	0.0016	0.9299
5:05	0.0133	0.6441	0.0010	0.0488	17:35	0.0209	12.2836	0.0016	0.9315
5:10	0.0134	0.6575	0.0010	0.0499	17:40	0.0207	12.3043	0.0016	0.9330
5:15	0.0136	0.6711	0.0010	0.0509	17:45	0.0204	12.3247	0.0015	0.9346
5:20	0.0137	0.6848	0.0010	0.0519	17:50	0.0202	12.3449	0.0015	0.9361
5:25	0.0138	0.6986	0.0010	0.0530	17:55	0.0200	12.3649	0.0015	0.9376
5:30	0.0140	0.7126	0.0011	0.0540	18:00	0.0198	12.3847	0.0015	0.9391
5:35	0.0141	0.7267	0.0011	0.0551	18:05	0.0150	12.3997	0.0011	0.9403
5:40	0.0143	0.7410	0.0011	0.0562	18:10	0.0148	12.4145	0.0011	0.9414
5:45	0.0144	0.7554	0.0011	0.0573	18:15	0.0147	12.4292	0.0011	0.9425
5:50	0.0146	0.7700	0.0011	0.0584	18:20	0.0145	12.4437	0.0011	0.9436
5:55	0.0148	0.7848	0.0011	0.0595	18:25	0.0144	12.4581	0.0011	0.9447
6:00	0.0149	0.7997	0.0011	0.0606	18:30	0.0142	12.4723	0.0011	0.9458
6:05	0.0197	0.8193	0.0015	0.0621	18:35	0.0141	12.4863	0.0011	0.9468
6:10	0.0199	0.8392	0.0015	0.0636	18:40	0.0139	12.5002	0.0011	0.9479
6:15	0.0201	0.8593	0.0015	0.0652	18:45	0.0138	12.5140	0.0010	0.9489

Table 3.6 Type III Distribution Ordinates in 5-Minute Time Increments

Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)	Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)
6:20	0.0203	0.8797	0.0015	0.0667	18:50	0.0136	12.5276	0.0010	0.9500
6:25	0.0206	0.9002	0.0016	0.0683	18:55	0.0135	12.5411	0.0010	0.9510
6:30	0.0208	0.9210	0.0016	0.0698	19:00	0.0134	12.5545	0.0010	0.9520
6:35	0.0210	0.9420	0.0016	0.0714	19:05	0.0132	12.5677	0.0010	0.9530
6:40	0.0213	0.9633	0.0016	0.0730	19:10	0.0131	12.5808	0.0010	0.9540
6:45	0.0215	0.9848	0.0016	0.0747	19:15	0.0130	12.5938	0.0010	0.9550
6:50	0.0218	1.0066	0.0017	0.0763	19:20	0.0129	12.6067	0.0010	0.9559
6:55	0.0220	1.0286	0.0017	0.0780	19:25	0.0127	12.6194	0.0010	0.9569
7:00	0.0223	1.0509	0.0017	0.0797	19:30	0.0126	12.6320	0.0010	0.9579
7:05	0.0226	1.0735	0.0017	0.0814	19:35	0.0125	12.6445	0.0009	0.9588
7:10	0.0229	1.0964	0.0017	0.0831	19:40	0.0124	12.6569	0.0009	0.9598
7:15	0.0232	1.1196	0.0018	0.0849	19:45	0.0123	12.6692	0.0009	0.9607
7:20	0.0235	1.1431	0.0018	0.0867	19:50	0.0122	12.6814	0.0009	0.9616
7:25	0.0238	1.1669	0.0018	0.0885	19:55	0.0121	12.6935	0.0009	0.9625
7:30	0.0241	1.1911	0.0018	0.0903	20:00	0.0120	12.7055	0.0009	0.9634
7:35	0.0245	1.2156	0.0019	0.0922	20:05	0.0119	12.7174	0.0009	0.9643
7:40	0.0248	1.2404	0.0019	0.0941	20:10	0.0118	12.7291	0.0009	0.9652
7:45	0.0252	1.2656	0.0019	0.0960	20:15	0.0117	12.7408	0.0009	0.9661
7:50	0.0256	1.2912	0.0019	0.0979	20:20	0.0116	12.7524	0.0009	0.9670
7:55	0.0260	1.3171	0.0020	0.0999	20:25	0.0115	12.7639	0.0009	0.9679
8:00	0.0264	1.3435	0.0020	0.1019	20:30	0.0114	12.7753	0.0009	0.9687
8:05	0.0268	1.3702	0.0020	0.1039	20:35	0.0113	12.7866	0.0009	0.9696
8:10	0.0272	1.3975	0.0021	0.1060	20:40	0.0112	12.7978	0.0009	0.9704
8:15	0.0277	1.4251	0.0021	0.1081	20:45	0.0111	12.8090	0.0008	0.9713
8:20	0.0281	1.4532	0.0021	0.1102	20:50	0.0110	12.8200	0.0008	0.9721
8:25	0.0286	1.4818	0.0022	0.1124	20:55	0.0110	12.8310	0.0008	0.9730
8:30	0.0291	1.5109	0.0022	0.1146	21:00	0.0109	12.8418	0.0008	0.9738
8:35	0.0296	1.5406	0.0022	0.1168	21:05	0.0108	12.8526	0.0008	0.9746
8:40	0.0302	1.5708	0.0023	0.1191	21:10	0.0107	12.8633	0.0008	0.9754
8:45	0.0308	1.6015	0.0023	0.1214	21:15	0.0106	12.8740	0.0008	0.9762
8:50	0.0314	1.6329	0.0024	0.1238	21:20	0.0106	12.8845	0.0008	0.9770
8:55	0.0320	1.6649	0.0024	0.1262	21:25	0.0105	12.8950	0.0008	0.9778
9:00	0.0326	1.6975	0.0025	0.1287	21:30	0.0104	12.9054	0.0008	0.9786
9:05	0.0473	1.7448	0.0036	0.1323	21:35	0.0103	12.9157	0.0008	0.9794
9:10	0.0482	1.7931	0.0037	0.1360	21:40	0.0103	12.9260	0.0008	0.9802
9:15	0.0492	1.8422	0.0037	0.1397	21:45	0.0102	12.9362	0.0008	0.9809
9:20	0.0501	1.8923	0.0038	0.1435	21:50	0.0101	12.9463	0.0008	0.9817

Table 3.6 Type III Distribution Ordinates in 5-Minute Time Increments

Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)	Time	Incremental Rainfall* (Inches)	Cumulative Rainfall* (Inches)	Incremental Rainfall (Percentage)	Cumulative Rainfall (Percentage)
9:25	0.0512	1.9435	0.0039	0.1474	21:55	0.0101	12.9564	0.0008	0.9825
9:30	0.0522	1.9957	0.0040	0.1513	22:00	0.0100	12.9663	0.0008	0.9832
9:35	0.0534	2.0491	0.0040	0.1554	22:05	0.0099	12.9763	0.0008	0.9840
9:40	0.0546	2.1037	0.0041	0.1595	22:10	0.0098	12.9861	0.0007	0.9847
9:45	0.0559	2.1595	0.0042	0.1638	22:15	0.0098	12.9959	0.0007	0.9855
9:50	0.0572	2.2167	0.0043	0.1681	22:20	0.0097	13.0056	0.0007	0.9862
9:55	0.0587	2.2754	0.0044	0.1725	22:25	0.0097	13.0152	0.0007	0.9869
10:00	0.0602	2.3356	0.0046	0.1771	22:30	0.0096	13.0248	0.0007	0.9877
10:05	0.0618	2.3974	0.0047	0.1818	22:35	0.0095	13.0344	0.0007	0.9884
10:10	0.0636	2.4610	0.0048	0.1866	22:40	0.0095	13.0438	0.0007	0.9891
10:15	0.0655	2.5265	0.0050	0.1916	22:45	0.0094	13.0532	0.0007	0.9898
10:20	0.0675	2.5940	0.0051	0.1967	22:50	0.0094	13.0626	0.0007	0.9905
10:25	0.0698	2.6637	0.0053	0.2020	22:55	0.0093	13.0719	0.0007	0.9912
10:30	0.0722	2.7359	0.0055	0.2075	23:00	0.0092	13.0811	0.0007	0.9919
10:35	0.0966	2.8325	0.0073	0.2148	23:05	0.0092	13.0903	0.0007	0.9926
10:40	0.0998	2.9323	0.0076	0.2224	23:10	0.0091	13.0994	0.0007	0.9933
10:45	0.1032	3.0356	0.0078	0.2302	23:15	0.0091	13.1084	0.0007	0.9940
10:50	0.1070	3.1426	0.0081	0.2383	23:20	0.0090	13.1174	0.0007	0.9947
10:55	0.1113	3.2538	0.0084	0.2467	23:25	0.0090	13.1264	0.0007	0.9954
11:00	0.1160	3.3698	0.0088	0.2555	23:30	0.0089	13.1353	0.0007	0.9960
11:05	0.1292	3.4990	0.0098	0.2653	23:35	0.0089	13.1441	0.0007	0.9967
11:10	0.1353	3.6344	0.0103	0.2756	23:40	0.0088	13.1529	0.0007	0.9974
11:15	0.1424	3.7768	0.0108	0.2864	23:45	0.0087	13.1617	0.0007	0.9980
11:20	0.1507	3.9275	0.0114	0.2978	23:50	0.0087	13.1704	0.0007	0.9987
11:25	0.1606	4.0880	0.0122	0.3100	23:55	0.0086	13.1790	0.0007	0.9993
11:30	0.1726	4.2606	0.0131	0.3231	0:00	0.0086	13.1876	0.0007	1.0000
11:35	0.1563	4.4169	0.0119	0.3349					
11:40	0.1754	4.5923	0.0133	0.3482					
11:45	0.2023	4.7947	0.0153	0.3636					
11:50	0.3162	5.1109	0.0240	0.3876					
11:55	0.3934	5.5043	0.0298	0.4174					
12:00	0.7162	6.2205	0.0543	0.4717					
12:05	1.2238	7.4443	0.0928	0.5645					
12:10	0.4977	7.9420	0.0377	0.6022					
12:15	0.3484	8.2903	0.0264	0.6286					
12:20	0.2206	8.5110	0.0167	0.6454					
12:25	0.1876	8.6986	0.0142	0.6596					

*Rainfall in inches is the 1% annual chance (100-year), Atlas 14 rainfall for a 24-hr duration