APPENDIX A

STORMWATER MANAGEMENT DESIGN CRITERIA

TABLE A-1
DESIGN STORM RAINFALL AMOUNT (INCHES)
Graterford 1E Gage (36-3437)
Source: NOAA Atlas 14 website

FIGURE A-1
ATLAS 14 TYPE II S-CURVES FOR ALL FREQUENCY STORMS (INCHES)
Graterford 1E Gage (36-3437)
Source: NOAA Atlas 14 website

TABLE A-2
RUNOFF CURVE NUMBERS
Source: NRCS (SCS) TR-55

TABLE A-3
DESIGN STORM RAINFALL AMOUNT (INCHES PER HOUR)
Graterford 1E Gage (36-3437)
Source: NOAA Atlas 14 website

FIGURE A-2
ATLAS 14 TYPE II S-CURVES FOR ALL FREQUENCY STORMS (INCHES PER HOUR)
Graterford 1E Gage (36-3437)

TABLE A-4
RATIONAL RUNOFF COEFFICIENTS
Source: Rawls et al, 1981

TABLE A-5
MANNING ROUGHNESS COEFFICIENTS

TABLE A-1

DESIGN STORM RAINFALL AMOUNT (INCHES)

The design storm rainfall amount chosen for design should be obtained from the National Oceanic and Atmospheric Administration Atlas 14 interactive website:
http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=pa

Point Precipitation Frequency Estimates (inches)
Graterford 1E Gage (36-3437)

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	0.339 (0.311-0.370)	0.403 (0.370-0.440)	0.472 (0.431-0.515)	0.520 (0.475-0.567)	0.576 (0.524-0.627)	0.614 (0.555-0.668)	0.650 (0.586-0.708)	0.682 (0.611-0.744)	0.716 (0.637-0.783)	0.741 (0.655-0.812)
10-min	0.541 (0.497-0.591)	0.645 (0.591-0.704)	0.756 (0.691-0.824)	0.832 (0.760-0.907)	0.918 (0.834-1.00)	0.978 (0.884-1.07)	1.03 (0.931-1.13)	1.08 (0.968-1.18)	1.13 (1.01-1.24)	1.17 (1.03-1.28)
15-min	0.677 (0.621-0.739)	0.811 (0.743-0.885)	0.956 (0.874-1.04)	1.05 (0.961-1.15)	1.16 (1.06-1.27)	1.24 (1.12-1.35)	1.31 (1.18-1.42)	1.36 (1.22-1.49)	1.43 (1.27-1.56)	1.46 (1.30-1.61)
30-min	0.928 (0.851-1.01)	1.12 (1.03-1.22)	1.36 (1.24-1.48)	1.52 (1.39-1.66)	1.72 (1.57-1.88)	1.86 (1.69-2.03)	2.00 (1.80-2.18)	2.12 (1.90-2.32)	2.27 (2.02-2.48)	2.37 (2.10-2.60)
60-min	1.16 (1.06-1.26)	1.41 (1.29-1.53)	1.74 (1.59-1.90)	1.99 (1.81-2.17)	2.30 (2.09-2.50)	2.53 (2.28-2.75)	2.75 (2.48-3.00)	2.98 (2.67-3.25)	3.26 (2.89-3.56)	3.46 (3.06-3.80)
2-hr	1.37 (1.24-1.51)	1.66 (1.51-1.83)	2.07 (1.88-2.28)	2.38 (2.16-2.62)	2.79 (2.51-3.06)	3.12 (2.79-3.42)	3.44 (3.06-3.77)	3.76 (3.33-4.13)	4.20 (3.67-4.62)	4.52 (3.92-4.98)
3-hr	1.49 (1.35-1.65)	1.81 (1.64-2.00)	2.26 (2.04-2.50)	2.60 (2.34-2.87)	3.05 (2.74-3.37)	3.40 (3.04-3.75)	3.76 (3.34-4.14)	4.12 (3.62-4.54)	4.59 (3.99-5.07)	4.95 (4.27-5.48)
6-hr	1.86 (1.69-2.07)	2.25 (2.04-2.50)	2.79 (2.53-3.10)	3.24 (2.92-3.58)	3.85 (3.45-4.25)	4.34 (3.86-4.78)	4.86 (4.29-5.35)	5.40 (4.71-5.93)	6.14 (5.28-6.76)	6.72 (5.71-7.42)
12-hr	2.26 (2.06-2.53)	2.73 (2.48-3.05)	3.41 (3.09-3.80)	3.98 (3.59-4.43)	4.80 (4.29-5.31)	5.48 (4.85-6.05)	6.21 (5.45-6.86)	7.00 (6.06-7.73)	8.13 (6.91-8.99)	9.06 (7.58-10.0)
24-hr	2.66 (2.44-2.92)	3.21 (2.93-3.52)	4.02 (3.67-4.41)	4.69 (4.28-5.14)	5.67 (5.14-6.19)	6.49 (5.85-7.07)	7.37 (6.61-8.02)	8.32 (7.42-9.05)	9.70 (8.55-10.5)	10.8 (9.47-11.8)
2-day	3.09 (2.82-3.40)	3.72 (3.39-4.11)	4.68 (4.26-5.16)	5.45 (4.95-6.00)	6.54 (5.91-7.19)	7.44 (6.70-8.17)	8.40 (7.52-9.22)	9.42 (8.37-10.3)	10.9 (9.57-11.9)	12.1 (10.5-13.2)
3-day	3.26 (2.98-3.58)	3.92 (3.59-4.32)	4.91 (4.49-5.40)	5.71 (5.20-6.27)	6.84 (6.21-7.50)	7.78 (7.02-8.51)	8.76 (7.87-9.59)	9.81 (8.76-10.7)	11.3 (10.0-12.4)	12.5 (11.0-13.7)
4-day	3.43 (3.14-3.75)	4.13 (3.78-4.52)	5.15 (4.71-5.64)	5.98 (5.46-6.54)	7.15 (6.50-7.80)	8.11 (7.35-8.85)	9.13 (8.23-9.95)	10.2 (9.15-11.1)	11.7 (10.4-12.8)	13.0 (11.4-14.2)
7-day	3.99 (3.69-4.35)	4.79 (4.43-5.21)	5.91 (5.46-6.43)	6.83 (6.29-7.42)	8.14 (7.47-8.83)	9.22 (8.43-9.99)	10.4 (9.43-11.2)	11.6 (10.5-12.5)	13.3 (11.9-14.4)	14.7 (13.1-15.9)
10-day	4.53 (4.21-4.89)	5.41 (5.03-5.84)	6.59 (6.12-7.11)	7.53 (6.98-8.12)	8.85 (8.17-9.53)	9.90 (9.12-10.7)	11.0 (10.1-11.8)	12.1 (11.1-13.1)	13.7 (12.4-14.8)	14.9 (13.5-16.1)
20-day	6.12 (5.69-6.58)	7.26 (6.75-7.80)	8.65 (8.05-9.30)	9.75 (9.05-10.5)	11.2 (10.4-12.0)	12.4 (11.4-13.3)	13.5 (12.5-14.5)	14.7 (13.5-15.8)	16.3 (14.9-17.5)	17.4 (15.9-18.8)
30-day	7.62 (7.17-8.09)	8.97 (8.44-9.52)	10.5 (9.83-11.1)	11.6 (10.9-12.3)	13.1 (12.3-13.9)	14.2 (13.3-15.1)	15.3 (14.3-16.3)	16.4 (15.3-17.5)	17.8 (16.5-19.0)	18.9 (17.5-20.1)
45-day	9.67 (9.16-10.2)	11.3 (10.8-12.0)	13.0 (12.3-13.8)	14.3 (13.5-15.1)	15.9 (15.0-16.8)	17.1 (16.1-18.1)	18.2 (17.2-19.2)	19.2 (18.1-20.3)	20.5 (19.3-21.7)	21.5 (20.1-22.7)
60-day	11.6 (11.0-12.2)	13.6 (12.9-14.3)	15.5 (14.7-16.3)	16.9 (16.0-17.8)	18.7 (17.7-19.7)	19.9 (18.9-21.0)	21.1 (20.0-22.3)	22.2 (21.0-23.5)	23.6 (22.2-24.9)	24.5 (23.1-25.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

FIGURE A-1

Atlas 14 Type II S-Curves for All Frequency Storms – Graterford 1E Gage (36-3437)

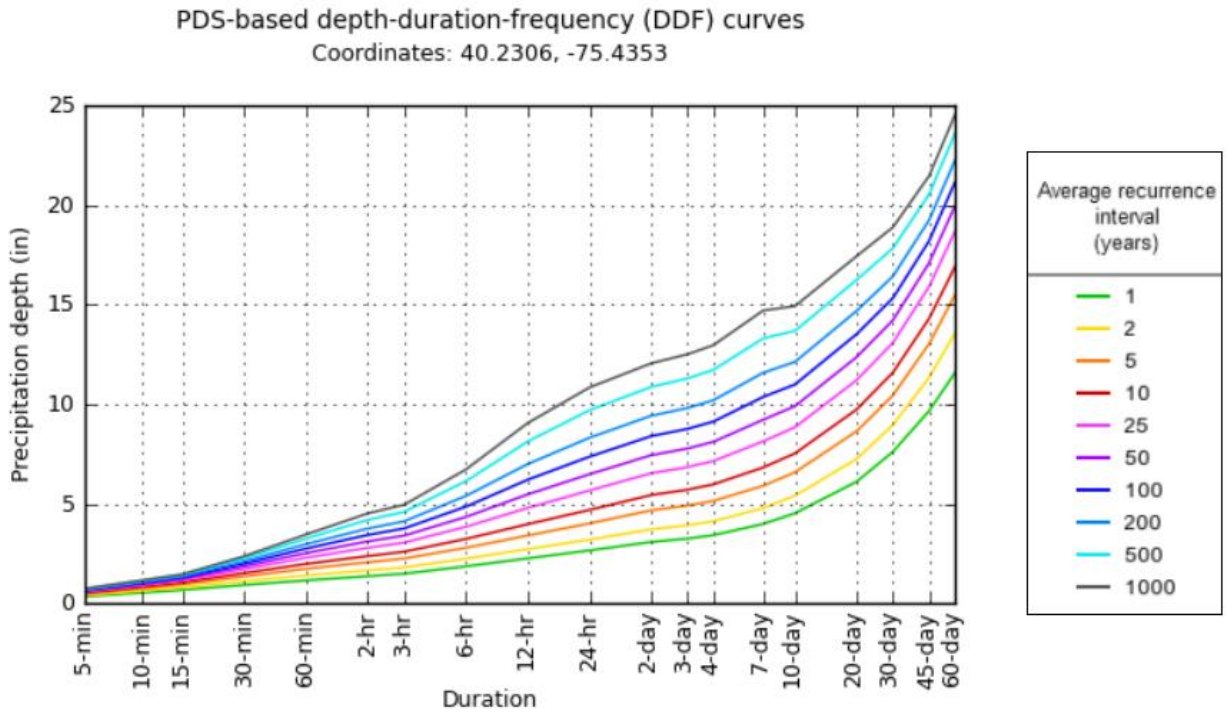

TABLE A-2

RUNOFF CURVE NUMBERS
Source: NRCS (SCS) TR-55

LAND USE DESCRIPTION		Hydrologic Condition	HYDROLOGIC SOIL GROUP A	B	C	D
Open Space						
Grass cover < 50%		Poor	68	79	86	89
Grass cover 50% to 75%	Fair	49	69	79	84	
Grass cover > 75%		Good	39	61	74	80
Meadow			30	58	71	78
Agricultural						
Pasture, grassland, or range – Continuous forage for grazing		Poor	68	79	86	89
Pasture, grassland, or range – Continuous forage for grazing.		Fair	49	69	79	84
Pasture, grassland, or range – Continuous forage for grazing		Good	39	61	74	80
Brush-weed-grass mixture with brush the major element.		Poor	48	67	77	83
Brush-weed-grass mixture with brush the major element.		Fair	35	56	70	77
Brush-weed-grass mixture with brush the major element.		Good	30	48	65	73
Fallow Bare soil		-------	77	86	91	94
Crop residue cover (CR)		Poor	76	85	90	93
		Good	74	83	88	90
Woods – grass combination (orchard or tree farm)		Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30	55	70	77
Commercial (85% Impervious)	89		92	94	95	
Industrial (72% Impervious)	81		88	91	93	
Institutional (50% Impervious)	71		82	88	90	
Residential districts by average lot size:						
	% Impervious					
1/8 acre or less * (town houses)	65		77	85	90	92
1/4 acre	38		61	75	83	87
1/3 acre	30		57	72	81	86
1/2 acre	25		54	70	80	85
1 acre	20		51	68	79	84
2 acres	12		46	65	77	82
Farmstead			59	74	82	86
Smooth Surfaces (Concrete, Asphalt, Gravel or Bare Compacted Soil)	98		98	98	98	
Water	98		98	98	98	
Mining/Newly Graded Areas (Pervious Areas Only)	77		86	91	94	

* Includes Multi-Family Housing unless justified lower density can be provided.

Note: Existing site conditions of bare earth or fallow ground shall be considered as meadow when choosing a CN value.

TABLE A-3

DESIGN STORM RAINFALL AMOUNT (INCHES PER HOUR)

The design storm rainfall amount chosen for design should be obtained from the National Oceanic and Atmospheric Administration Atlas 14 interactive website:
http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=pa

Point Precipitation Frequency Estimates (inches per hour)
Graterford 1E Gage (36-3437)

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]										
Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	4.07 (3.73-4.44)	4.84 (4.44-5.28)	5.66 (5.17-6.18)	6.24 (5.70-6.80)	6.91 (6.29-7.52)	7.37 (6.66-8.02)	7.80 (7.03-8.50)	8.18 (7.33-8.93)	8.59 (7.64-9.40)	8.89 (7.86-9.74)
10-min	3.25 (2.98-3.55)	3.87 (3.55-4.22)	4.54 (4.15-4.94)	4.99 (4.56-5.44)	5.51 (5.00-6.00)	5.87 (5.30-6.39)	6.20 (5.59-6.76)	6.48 (5.81-7.07)	6.80 (6.04-7.43)	7.00 (6.19-7.67)
15-min	2.71 (2.48-2.96)	3.24 (2.97-3.54)	3.82 (3.50-4.17)	4.21 (3.84-4.59)	4.66 (4.23-5.07)	4.95 (4.48-5.39)	5.22 (4.70-5.69)	5.45 (4.88-5.95)	5.70 (5.07-6.24)	5.86 (5.18-6.42)
30-min	1.86 (1.70-2.03)	2.24 (2.05-2.45)	2.72 (2.48-2.96)	3.05 (2.78-3.33)	3.45 (3.13-3.75)	3.73 (3.37-4.06)	4.00 (3.60-4.36)	4.24 (3.80-4.63)	4.54 (4.03-4.96)	4.74 (4.19-5.20)
60-min	1.16 (1.06-1.26)	1.41 (1.29-1.53)	1.74 (1.59-1.90)	1.99 (1.81-2.17)	2.30 (2.09-2.50)	2.53 (2.28-2.75)	2.75 (2.48-3.00)	2.98 (2.67-3.25)	3.26 (2.89-3.56)	3.46 (3.06-3.80)
2-hr	0.684 (0.622-0.754)	0.830 (0.755-0.914)	1.03 (0.938-1.14)	1.19 (1.08-1.31)	1.40 (1.26-1.53)	1.56 (1.39-1.71)	1.72 (1.53-1.89)	1.88 (1.66-2.07)	2.10 (1.83-2.31)	2.26 (1.96-2.49)
3-hr	0.497 (0.451-0.550)	0.602 (0.546-0.666)	0.751 (0.680-0.831)	0.865 (0.781-0.955)	1.02 (0.911-1.12)	1.13 (1.01-1.25)	1.25 (1.11-1.38)	1.37 (1.21-1.51)	1.53 (1.33-1.69)	1.65 (1.42-1.82)
6-hr	0.311 (0.283-0.345)	0.375 (0.341-0.417)	0.467 (0.423-0.517)	0.541 (0.488-0.598)	0.643 (0.576-0.709)	0.725 (0.645-0.799)	0.811 (0.716-0.893)	0.901 (0.787-0.991)	1.03 (0.882-1.13)	1.12 (0.953-1.24)
12-hr	0.188 (0.171-0.210)	0.227 (0.206-0.253)	0.283 (0.257-0.315)	0.330 (0.298-0.368)	0.398 (0.356-0.441)	0.455 (0.403-0.502)	0.515 (0.452-0.570)	0.581 (0.503-0.642)	0.675 (0.573-0.746)	0.752 (0.629-0.831)
24-hr	0.111 (0.102-0.122)	0.134 (0.122-0.147)	0.167 (0.153-0.184)	0.196 (0.178-0.214)	0.236 (0.214-0.258)	0.270 (0.244-0.295)	0.307 (0.275-0.334)	0.347 (0.309-0.377)	0.404 (0.356-0.439)	0.452 (0.394-0.491)
2-day	0.064 (0.059-0.071)	0.078 (0.071-0.086)	0.097 (0.089-0.108)	0.113 (0.103-0.125)	0.136 (0.123-0.150)	0.155 (0.140-0.170)	0.175 (0.157-0.192)	0.196 (0.174-0.215)	0.226 (0.199-0.248)	0.251 (0.220-0.275)
3-day	0.045 (0.041-0.050)	0.055 (0.050-0.060)	0.068 (0.062-0.075)	0.079 (0.072-0.087)	0.095 (0.086-0.104)	0.108 (0.098-0.118)	0.122 (0.109-0.133)	0.136 (0.122-0.149)	0.157 (0.139-0.172)	0.174 (0.153-0.190)
4-day	0.036 (0.033-0.039)	0.043 (0.039-0.047)	0.054 (0.049-0.059)	0.062 (0.057-0.068)	0.074 (0.068-0.081)	0.084 (0.077-0.092)	0.095 (0.086-0.104)	0.106 (0.095-0.116)	0.122 (0.109-0.133)	0.135 (0.119-0.148)
7-day	0.024 (0.022-0.026)	0.028 (0.026-0.031)	0.035 (0.032-0.038)	0.041 (0.037-0.044)	0.048 (0.044-0.053)	0.055 (0.050-0.059)	0.062 (0.056-0.067)	0.069 (0.062-0.075)	0.079 (0.071-0.086)	0.088 (0.078-0.095)
10-day	0.019 (0.018-0.020)	0.023 (0.021-0.024)	0.027 (0.025-0.030)	0.031 (0.029-0.034)	0.037 (0.034-0.040)	0.041 (0.038-0.044)	0.046 (0.042-0.049)	0.051 (0.046-0.054)	0.057 (0.052-0.061)	0.062 (0.056-0.067)
20-day	0.013 (0.012-0.014)	0.015 (0.014-0.016)	0.018 (0.017-0.019)	0.020 (0.019-0.022)	0.023 (0.022-0.025)	0.026 (0.024-0.028)	0.028 (0.026-0.030)	0.031 (0.028-0.033)	0.034 (0.031-0.036)	0.036 (0.033-0.039)
30-day	0.011 (0.010-0.011)	0.012 (0.012-0.013)	0.015 (0.014-0.015)	0.016 (0.015-0.017)	0.018 (0.017-0.019)	0.020 (0.018-0.021)	0.021 (0.020-0.023)	0.023 (0.021-0.024)	0.025 (0.023-0.026)	0.026 (0.024-0.028)
45-day	0.009 (0.008-0.009)	0.011 (0.010-0.011)	0.012 (0.011-0.013)	0.013 (0.013-0.014)	0.015 (0.014-0.016)	0.016 (0.015-0.017)	0.017 (0.016-0.018)	0.018 (0.017-0.019)	0.019 (0.018-0.020)	0.020 (0.019-0.021)
60-day	0.008 (0.008-0.008)	0.009 (0.009-0.010)	0.011 (0.010-0.011)	0.012 (0.011-0.012)	0.013 (0.012-0.014)	0.014 (0.013-0.015)	0.015 (0.014-0.015)	0.015 (0.015-0.016)	0.016 (0.015-0.017)	0.017 (0.016-0.018)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.
Please refer to NOAA Atlas 14 document for more information.

FIGURE A-2

Atlas 14 Type II S-Curves for All Frequency Storms – Graterford 1E Gage (36-3437)

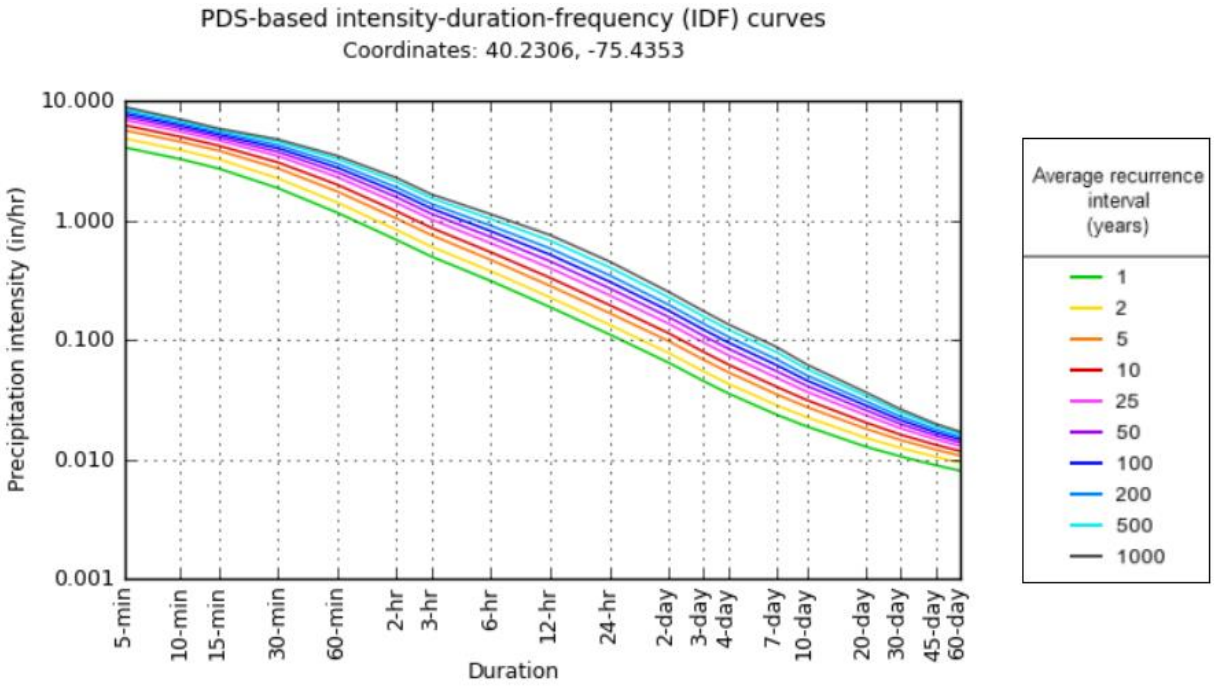

TABLE A-4

RATIONAL RUNOFF COEFFICIENTS
By Hydrologic Soils Group and Overland Slope (%)
Source: Rawls, et al, 1981

Hydrologic Soil Group	A			B			C			D		
Land Use/Slope	**0-2%**	**2-6%**	**6%+**	**0-2%**	**2-6%**	**6%+**	**0-2%**	**2-6%**	**6%+**	**0-2%**	**2-6%**	**6%+**
Cultivated Land	*0.08 **0.14	0.13 0.18	0.16 0.22	0.11 0.16	0.15 0.21	0.21 0.28	0.14 0.20	0.19 0.25	0.26 0.34	0.18 0.24	0.23 0.29	0.31 0.41
Pasture	0.12 0.15	0.20 0.25	0.30 0.37	0.18 0.23	0.28 0.34	0.37 0.45	0.24 0.30	0.34 0.42	0.44 0.52	0.30 0.37	0.40 0.50	0.50 0.62
Meadow	0.10 0.14	0.16 0.22	0.25 0.30	0.14 0.20	0.22 0.28	0.30 0.37	0.20 0.26	0.28 0.35	0.36 0.44	0.24 0.30	0.30 0.40	0.40 0.50
Forest	0.05 0.08	0.08 0.11	0.11 0.14	0.08 0.10	0.11 0.14	0.14 0.18	0.10 0.12	0.13 0.16	0.16 0.20	0.12 0.15	0.16 0.20	0.20 0.25
Resident 1/8 acre lots	0.25 0.33	0.28 0.37	0.31 0.40	0.27 0.35	0.30 0.39	0.35 0.44	0.30 0.38	0.33 0.42	0.38 0.49	0.33 0.41	0.36 0.45	0.42 0.54
1/4 acre lots	0.22 0.30	0.26 0.34	0.39 0.37	0.24 0.33	0.29 0.37	0.33 0.42	0.27 0.36	0.31 0.40	0.36 0.47	0.30 0.38	0.34 0.42	0.40 0.52
1/3 acre lots	0.19 0.28	0.23 0.32	0.26 0.35	0.22 0.30	0.26 0.35	0.30 0.39	0.25 0.33	0.29 0.38	0.34 0.45	0.28 0.36	0.32 0.40	0.39 0.50
1/2 acre lots	0.16 0.25	0.20 0.29	0.24 0.32	0.19 0.28	0.23 0.32	0.28 0.36	0.22 0.31	0.27 0.35	0.32 0.42	0.26 0.34	0.30 0.38	0.37 0.48
1 acre lots	0.14 0.22	0.19 0.26	0.22 0.29	0.17 0.24	0.21 0.28	0.26 0.34	0.20 0.28	0.25 0.32	0.31 0.40	0.24 0.31	0.29 0.35	0.35 0.46
Industrial	0.67 0.85	0.68 0.85	0.68 0.86	0.68 0.85	0.68 0.86	0.69 0.86	0.68 0.86	0.69 0.86	0.69 0.87	0.69 0.86	0.69 0.86	0.69 0.88
Commercial	0.71 0.88	0.71 0.88	0.72 0.89	0.71 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.89	0.72 0.90	0.72 0.89	0.72 0.89	0.72 0.90
Streets	0.70 0.76	0.71 0.77	0.72 0.79	0.71 0.80	0.72 0.82	0.74 0.84	0.72 0.84	0.73 0.85	0.76 0.89	0.73 0.89	0.75 0.91	0.78 0.95
Open Space	0.05 0.11	0.10 0.16	0.14 0.20	0.08 0.14	0.13 0.19	0.19 0.26	0.12 0.18	0.17 0.23	0.24 0.32	0.16 0.22	0.21 0.27	0.28 0.39
Parking	0.85 0.95	0.86 0.96	0.87 0.97	0.85 0.95	0.86 0.96	0.87 0.97	0.85 0.95	0.86 0.96	0.87 0.97	0.85 0.95	0.86 0.96	0.87 0.97

NOTES:
* Runoff coefficients for storm recurrence intervals of less than 25 years.
** Runoff coefficients for storm recurrence intervals of 25 years or more.

TABLE A-5

MANNING'S ROUGHNESS COEFFICIENTS

DESCRIPTION	Manning's n-value
Smooth-wall Plastic Pipe	0.011
Concrete Pipe	0.012
Smooth-lined Corrugated Metal Pipe	0.012
Corrugated Plastic Pipe	0.024
Annular Corrugated Steel And Aluminum Alloy Pipe (Plain or polymer coated) 68 mm × 13 mm (2 2/3 in × 1/2 in) Corrugations 75 mm × 25 mm (3 in × 1 in) Corrugations 125 mm × 25 mm (5 in × 1 in) Corrugations 150 mm × 50 mm (6 in × 2 in) Corrugations	 0.024 0.027 0.025 0.033
Helically Corrugated Steel And Aluminum Alloy Pipe (Plain or polymer coated) 75 mm × 25 mm (3 in × 1 in), 125 mm × 25 mm (5 in × 1 in), or 150 mm × 50 mm (6 in × 2 in) Corrugations	 0.024
Helically Corrugated Steel And Aluminum Alloy Pipe (Plain or polymer coated) 68 mm × 13 mm (2 2/3 in × 1/2 in) Corrugations a. Lower Coefficients* 450 mm (18 in) Diameter 600 mm (24 in) Diameter 900 mm (36 in) Diameter 1200 mm (48 in) Diameter 1500 mm (60 in) Diameter or larger b. Higher Coefficients**	 0.014 0.016 0.019 0.020 0.021 0.024
Annular or Helically Corrugated Steel or Aluminum Alloy Pipe Arches or Other Non-Circular Metal Conduit (Plain or Polymer coated)	0.024
Vitrified Clay Pipe	0.012
Ductile Iron Pipe	0.013
Asphalt Pavement	0.015
Concrete Pavement	0.014
Grass Medians	0.050
Grass – Residential	0.30
Earth	0.020
Gravel	0.030
Rock	0.035
Cultivated Areas	0.030 - 0.050
Dense Brush	0.070 - 0.140
Heavy Timber (Little undergrowth)	0.100 - 0.150
Heavy Timber (w/underbrush)	0.40
Streams: a. Some Grass And Weeds (Little or no brush) b. Dense Growth of Weeds c. Some Weeds (Heavy brush on banks)	 0.030 - 0.035 0.035 - 0.050 0.050 - 0.070

Notes:

* Use the lower coefficient if any one of the following conditions apply:

- **a.** A storm pipe longer than 20 diameters, which directly or indirectly connects to an inlet or manhole, located in swales adjacent to shoulders in cut areas or depressed medians.
- **b.** A storm pipe which is specially designed to perform under pressure.

**Use the higher coefficient if any one of the following conditions apply:

- **a.** A storm pipe which directly or indirectly connects to an inlet or manhole located in highway pavement sections or adjacent to curb or concrete median barrier.
- **b.** A storm pipe which is shorter than 20 diameters long.
- **c.** A storm pipe which is partly lined helically corrugated metal pipe.