Drainage Report

For

Hillcrest Addition

Springhill Road
Bryant, Arkansas

July 8, 2024

Prepared By:

Lemons Engineering Consultants, Inc.
204 West Cherry Street
Cabot, Arkansas 72023
(501) 605-7565
arstrep43@gmail.com

Index

Project Information

Project Title:	Hillcrest Addition
Project Description:	13 lot single family development located on the West side of Springhill Road, North of and adjacent to Hurricane Gardens, Bryant, Arkansas (address: 3927 Springhill Road)
Owner/Developer:	Springhill – Hwy 5 Development, LLC 816 East Oak Street Conway, Arkansas 72032
Engineer of Record:	Lemons Engineering Consultants, Inc. Tim Lemons, PE 204 Cherry Street Cabot, Arkansas 72023 (501) 605-7565

General Information

This proposed development shall include 13 single family lots. This property is essentially the Northern Most tract of land within the city limits of Bryant as they presently exist. The property to the North of the subject site is developed with duplex style residential structures. The property to the South is an established subdivision (Hurricane Gardens). The property drains North to South. There have been several reports of drainage issues by the residents of Hurricane Gardens. At present, the drainage from the subject property, and that to the north of the subject property, flows onto Hurricane Gardens. No detention exists on the property located north of the subject property. In this report, we will design a detention facility to accommodate the possible increase in flow for the subject property (Hillcrest Addition). Also, our goal is to divert a large majority of the drainage falling onto Hurricane Gardens. This diversion will force the runoff to the proposed detention facility on Hillcrest Addition as shown in the civil plans.

Project Vicinity Map

Hydrological Computations

For this analysis, we will use the Rational Method in determining culvert sizes, culvert capacity computations, and other related issues on site. The total watershed size for this development is estimated at 10.57 acres. Attention is called to the Watershed Map included in this report. As per the Rational Method, the following equation is used:

$$Q = C \times I \times A$$, where:

- Q = Flowrate (cfs)
- C = Runoff Coefficient
- I = Intensity (from tables)
- A = area (acres)

The selection of the appropriate intensity is based on the estimated time of concentration (tc).

Determination of Runoff Coefficients "C"

In determining the Pre Construction C, we must consider the property to the North that is developed, and discharging onto the subject property. We will use an undeveloped C of 0.30, and a developed C of 0.60. The Pre Construction C is based on the following equation:

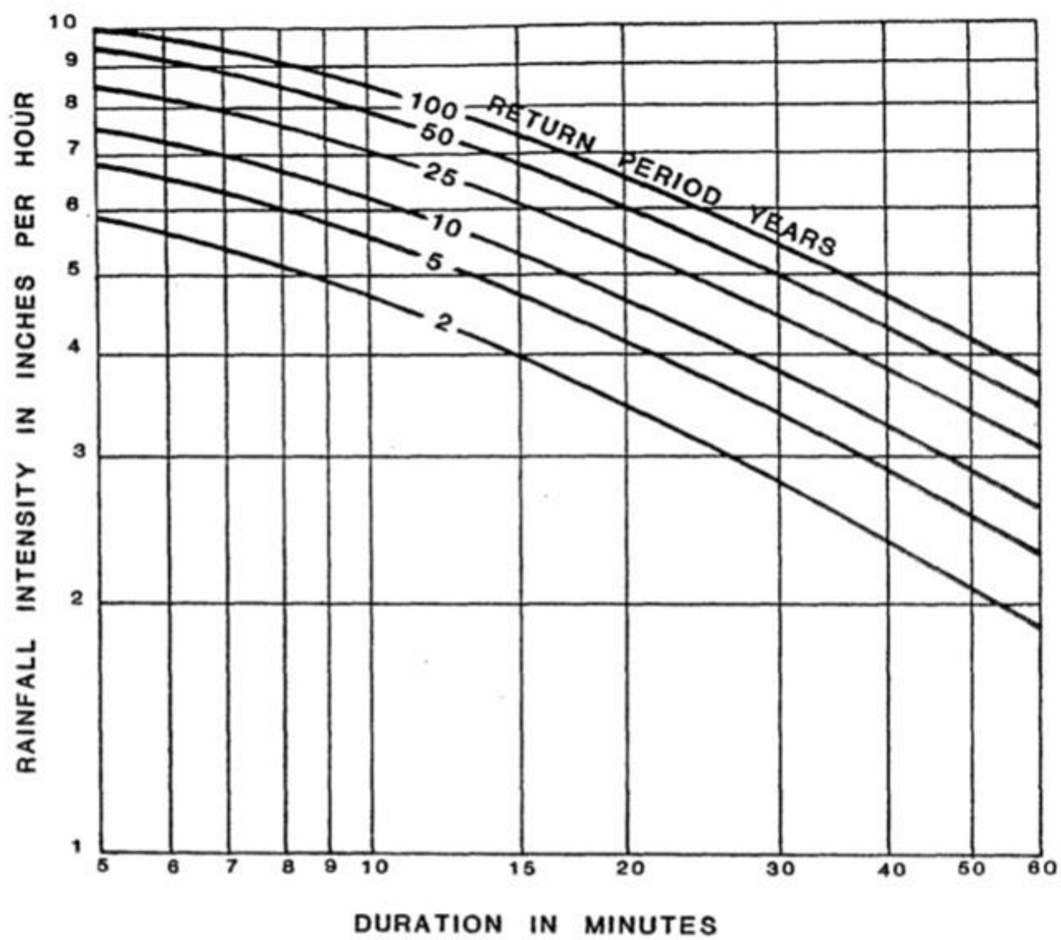
$$CwPRE = \frac{(\text{on site area})(0.30) + (\text{off site area})(0.60)}{\text{Total Area}}$$

$$CwPRE = \frac{(4.89)(0.30) + (9.38)(0.60)}{14.27} = 0.50$$

This value of 0.50 shall be used for the Pre Construction C in the Detention Design. The Post Construction C shall be 0.60. This Post Construction C shall also be used for the culvert design.

Determination of Intensity Values "I"

For this analysis, we will use the Intensity – Duration - Frequency Chart from the Little Rock Drainage Manual. Whereas the calculated value of I shall be used for Detention, we will use a tc (time of concentration) of 5 min for the culverts to also provide a conservative value.



INTENSITY - DURATION - FREQUENCY

LITTLE ROCK

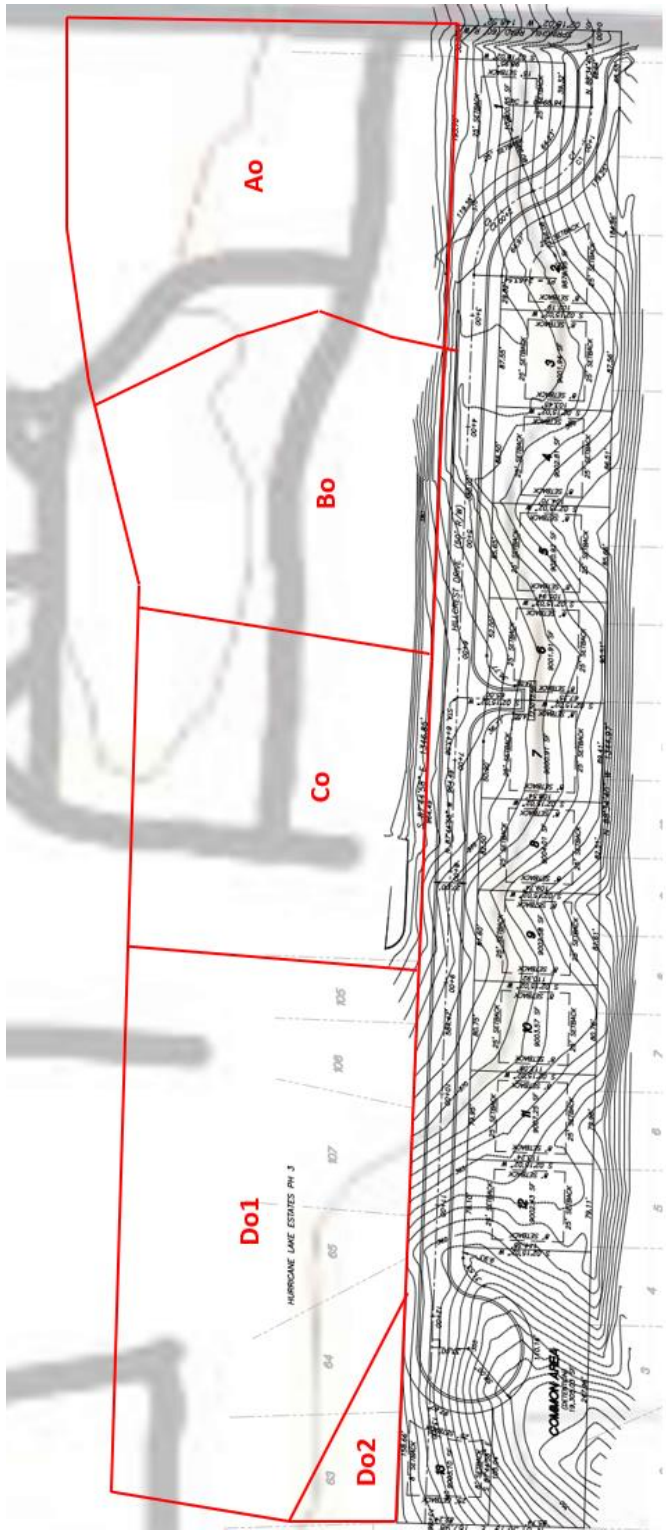
SOURCE : HYDRO 35 & T.P. No. 40

Determination of Flowrates for Culverts & Spreadflow

Attention is called to the following chart which provides C, Intensity, Area, and Flowrate (Q) of each Tract. Again, the Rational Method is being used for all basins. Attention is called to the Maps on the next two pages for a detailed drawings showing the various watershed tracts. The 25 year storm event will be used for culvert design.

Tract	C	I	A	Q
		(in/hr)	(ac)	(cfs)
Ao	0.6	8.5	2.67	13.62
Bo	0.6	8.5	1.46	7.45
Co	0.6	8.5	1.68	8.57
Do1	0.6	8.5	3.13	15.96
Do2	0.6	8.5	0.43	2.19
A1	0.6	8.5	0.54	2.75
A2	0.6	8.5	0.29	1.48
A3	0.6	8.5	0.25	1.28
B1	0.6	8.5	0.47	2.40
B2	0.6	8.5	0.33	1.68
C1	0.6	8.5	0.49	2.50
C2	0.6	8.5	0.36	1.84
D1	0.6	8.5	0.44	2.24
D2	0.6	8.5	0.32	1.63
D3	0.6	8.5	1.15	5.87

Drainage Watershed Map (Off Site)



Drainage Watershed Map (On Site)

Culvert Sizing

All culverts are sized to meet a 25 year storm, and the Rational Method is used. We will use a Manning's Coefficient of 0.012 shall be for all culverts (concrete and HDPE).

FES 1a
Q = Qao (2/3) = 13.62 (2/3) = 9.08 cfs
Use 18" @ 3.5%
Q capacity = 9.23 cfs
V actual = 11.61 fps (d/D = 0.46)

Inlet 1
Q = Qao (2/3) + Qa1 = 13.62 (2/3) + 2.75 = 11.83 cfs
Use 18" @ 1.1%
Q capacity = 12.30 cfs
V actual = 7.70 fps (d/D = 0.81)

Inlet 2
Q = Inlet 1 + Qa2 = 11.83 + 1.48 = 13.31 cfs
Use 18" @ 1.4%
Q capacity = 13.32 cfs
V actual = 8.69 fps (d/D = 0.85)

Junction Box 3 (verify capacity)
Q = Qao + Qa1 + Qa2 + Exist 18" in Hurricane Gardens
(Culvert in Hurricane Gardens is an 18" ADS at 0.46%, Capacity = 7.95 cfs at d/D=0.85)
Q = 13.62 + 2.75 + 1.48 + 7.95 = 25.8 cfs
Existing 24" Discharging from Junc Box is 24" ADS @ 5.20%
Q capacity = 57.58 cfs ***Capacity appears to exist***
V actual = 17.47 fps (d/D = 0.48)

Inlet 4
Q = Qb1 = 2.40 cfs
Use 18" @ 0.5%
Q capacity = 8.29 cfs
V actual = 4.00 fps (d/D = 0.38)

Inlet 5
Q = Inlet 4 + Qbo = 2.40 + 7.45 = 9.85 cfs
Use 18" @ 1.0%
Q capacity = 11.73 cfs
V actual = 7.25 fps (d/D = 0.72)

Inlet 6
Q = Inlet 5 + Qco = 9.85 + 8.57 = 18.42 cfs
Use 18" @ 4.60%
Q capacity = 25.15 cfs
V actual = 15.18 fps (d/D = 0.65)

Inlet 7
Q = Inlet 6 + Qdo1 = 18.42 + 15.96 = 34.38 cfs
Use 24" @ 2.0%
Q capacity = 35.71 cfs
V actual = 12.58 fps (d/D = 0.81)

Inlet 8
Q = Inlet 7 + Qd1 = 34.38 + 2.24 = 36.62 cfs
Use 18" @ 2.25%
Q capacity = 37.76 cfs
V actual = 13.30 fps (d/D = 0.79)

Street Spreadflow Analysis (Gutter Capacity)

In this Section of the Report, we will examine how the stormwater in the street gutters may impact in proposed inlets. We will use our 27' street width (back of curb to back of curb), while giving allowances for the vertical portion of the curb on each side. The crown on the street shall be 3.0%. The available street width, to handle the stormwater, has a width of 26'. Our goal is to provide a minimum "non submerged" street width ("clear space") of 8 feet. A Manning's Coefficient of 0.12 is used for the pavement surface. Attention is called to the Appendix for the spreadsheets used to evaluate these areas.

Check Inlet 1 & 2 – Hillcrest Drive

Inlet 1

Q = Qa0(1/2) + Qa1/2 = 13.62 (0.5) + 2.75 (0.5) = 8.19 cfs
Gutter Slope = 1.50%
Height of water (from gutter) = 0.32'
Width of water (from gutter) = 10.5'
Clear space (half street) = 13.0 – 10.5' = 2.5'

Inlet 2

Q = Qa2 = 1.48 cfs
Gutter Slope = 1.50%
Height of water (from gutter) = 0.17'
Width of water (from gutter) = 5.5'
Clear space (half street) = 13.0 – 5.5' = 7.5'
Total Clear Space = 2.5 + 7.5 = 10.0'

Check Inlet 4 & 5 – Hillcrest Drive

Inlet 4

Q = Qb1 = 2.40 cfs
Gutter Slope = 0.5%
Height of water (from gutter) = 0.26'
Width of water (from gutter) = 8.5'
Clear space (half street) = 13.0 – 8.5' = 4.5'

Inlet 5

Q = Qbo = 7.45 fps
Gutter Slope = 0.5%
Height of water (from gutter) = 0.39'
Width of water (from gutter) = 13.0'
Clear space (half street) = 13.0 – 13.0' = 0.0'
Total Clear Space = 4.5 + 0.0 = 4.5'

TRY 10 YEAR STORM

Inlet 4

Q = Qb1 = 2.10 cfs
Gutter Slope = 0.5%
Height of water (from gutter) = 0.23'
Width of water (from gutter) = 7.5'
Clear space (half street) = 13.0 – 7.5' = 5.5'

Inlet 5

Q = Qbo = 6.50 fps
Gutter Slope = 0.5%
Height of water (from gutter) = 0.36'
Width of water (from gutter) = 12.0'
Clear space (half street) = 13.0 – 12.0' = 1.0'
Total Clear Space = 5.5 + 1.0 = 6.5'

Check Inlet 6 & Across Street – Hillcrest Drive

Inlet 6

Q = Qco = 8.50 cfs

Gutter Slope = 2.67%

Height of water (from gutter) = 0.30’

Width of water (from gutter) = 10.0’

Clear space (half street) = 13.0 – 10.0’ = 3.0’

Across from Inlet 6

Q = Qc1 = 2.50 cfs

Gutter Slope = 2.67%

Height of water (from gutter) = 0.18’

Width of water (from gutter) = 2.5’

Clear space (half street) = 13.0 – 2.5’ = 10.5’

Total Clear Space = 3.0 + 10.5 = 13.5’

Check Inlet 7 & 8 – Hillcrest

Inlet 7

Q = Qdo1(1/2) = 15.96 (0.5) = 7.98 cfs

Gutter Slope = 4.88%

Height of water (from gutter) = 0.26’

Width of water (from gutter) = 8.5’

Clear space (half street) = 13.0 – 8.5’ = 4.5’

Inlet 8

Q = Qc1 + Qd1 = 2.50 + 2.24 = 4.74 cfs

Gutter Slope = 4.88%

Height of water (from gutter) = 0.21’

Width of water (from gutter) = 7.0’

Clear space (half street) = 13.0 – 7.0’ = 6.0’

Total Clear Space = 4.5 + 6.0 = 10.5’

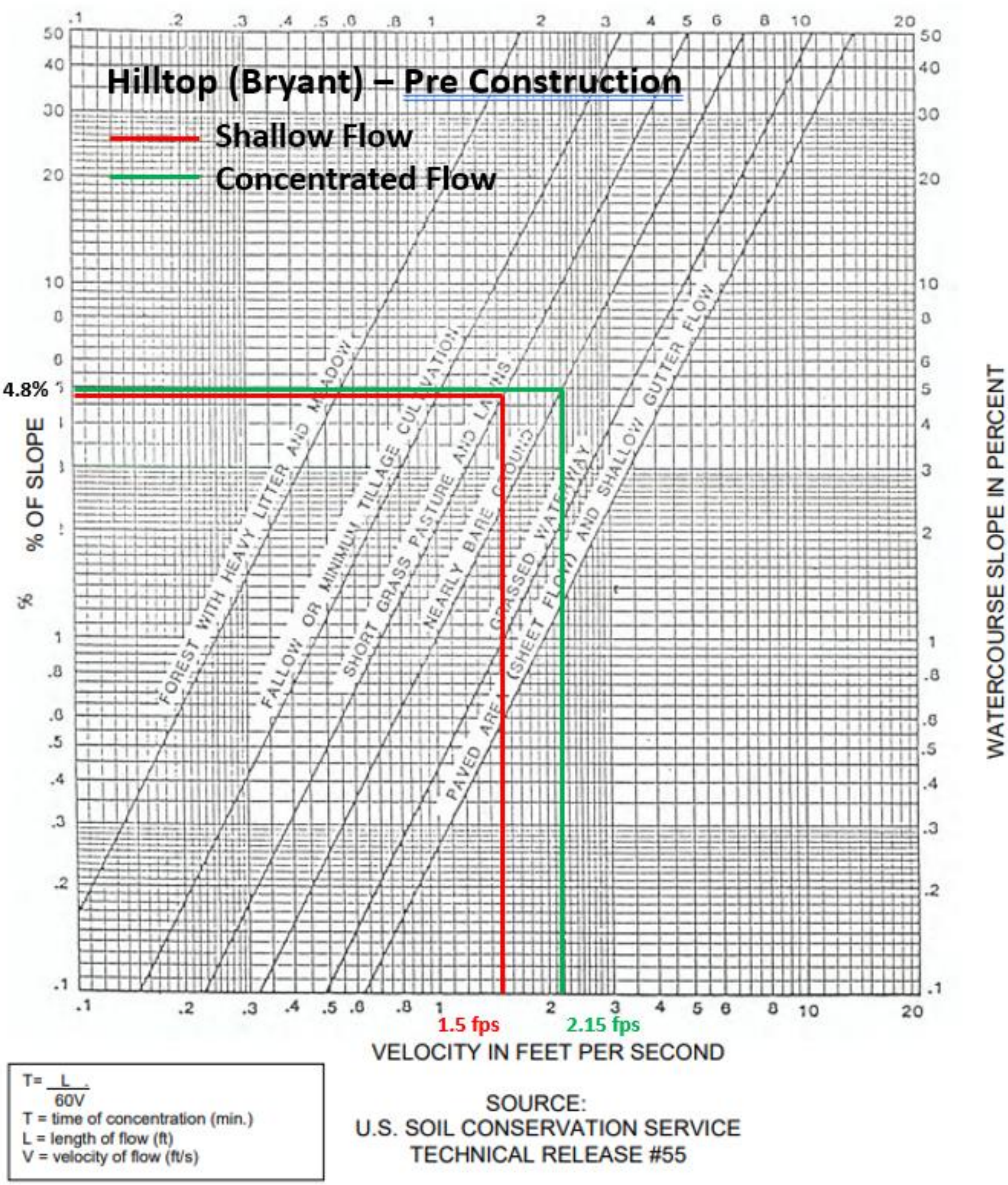
Detention Facility Computations

In this section, we will size the detention facility located in the Common Area (West side of the project). At the completion of this section, a summary of pre and post flows will be provided. Whereas the time of concentration will be used to determine the intensity (I), the runoff coefficient (C) for each detention area shall be 0.3 for pre construction, and 0.6 for post construction.

Time of Concentration (tc)

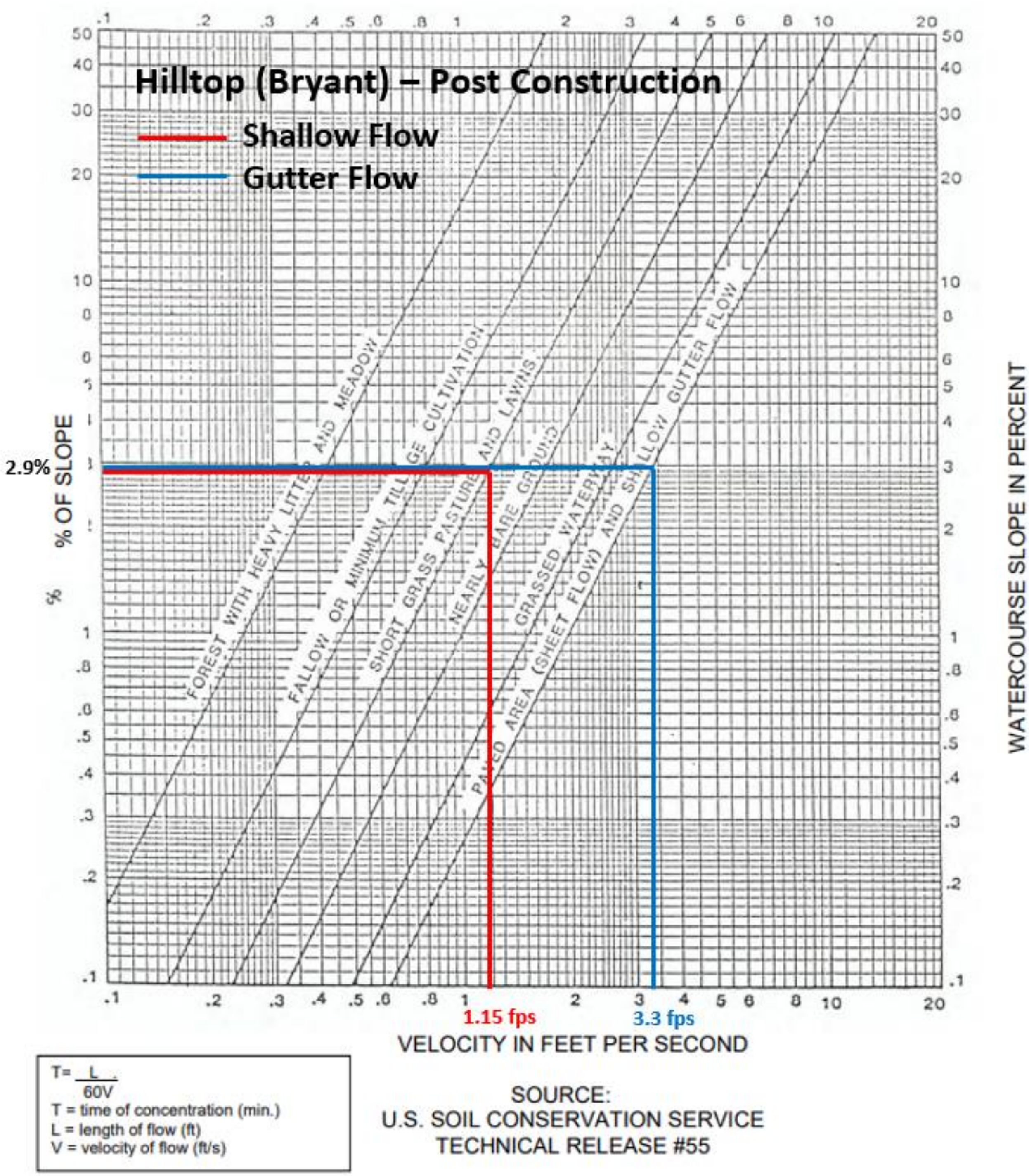
In determining the time of concentration, we must first determine the velocity of the runoff based on the type of ground cover and type of flow. The total tc is a sum of the tc for overland flow, the tc for shallow concentrated flow, and the tc for channelized flow. For this analysis, we will use the US Soil Conservation Service Technical Release #55, "Watercourse Slope vs Velocity" graph. A Pre Construction and Post Construction graph for each watershed is provided on the following pages.

Pre Construction Time of Concentration (tc)



Pre-Construction tc = Σ(L/(60)(V)) = 6 min

Post Construction Time of Concentration (tc)



Pre-Construction tc = Σ(L/(60)(V)) = 9 min

Flow Comparisons (Pre and Post Flow)

HILLTOP (BRYANT)					
STORMWATER DETENTION CALCULATIONS					
			Condition		
			Undeveloped	**Developed**	
Drainage Area (acres)			4.97	10.57	
Runoff Coefficient, C			0.50	0.60	
Time of Concentration (min)			6	9	Kirpich
Intensity (in/hr)					**Increase**
	I_2	=	5.70	4.90	-0.80
	I_5	=	6.50	5.80	-0.70
	I_{10}	=	7.20	6.50	-0.70
	I_{25}	=	8.20	7.40	-0.80
	I_{50}	=	9.20	8.20	-1.00
	I_{100}	=	9.70	8.80	-0.90
Maximum Release Rates (cfs)					**Increase**
	Q_2	=	14.16	31.08	16.91
	Q_5	=	16.15	36.78	20.63
	Q_{10}	=	17.89	41.22	23.33
	Q_{25}	=	20.38	46.93	26.55
	Q_{50}	=	22.86	52.00	29.14
	Q_{100}	=	24.10	55.81	31.71

Stage – Storage Table

The following Stage Storage Table is provided, based on the grading plan contained in the Civil Plans. The accumulative storage is provided in the right most column. A concrete trickle channel is recommended.

TYPE 3			
Stage - Storage for Irregular Detention Basin			
Top Elev	Bottom Elev	Increment	
352.5	345.5	0.5	
Stage	Area	Δ Volume	Volume
msl	sf	cf	cf
345.50	1	0	0
346.00	1369.09	342.52	342.52
346.50	1853.30	805.60	1148.12
347.00	2337.51	1047.70	2195.82
347.50	2951.40	1322.23	3518.05
348.00	3565.28	1629.17	5147.22
348.50	4240.13	1951.35	7098.57
349.00	4914.98	2288.78	9387.35
349.50	5637.46	2638.11	12025.46
350.00	6359.93	2999.35	15024.81
350.50	7118.75	3369.67	18394.48
351.00	7877.57	3749.08	22143.56
351.50	8673.71	4137.82	26281.38
352.00	9469.85	4535.89	30817.27
352.50	10265.99	4933.96	35751.23

Stage – Discharge Table

The following Stage Discharge Table is provided, based on the grading plan contained in the Civil Plans. The discharge structure planned for this facility is shown later in this report.

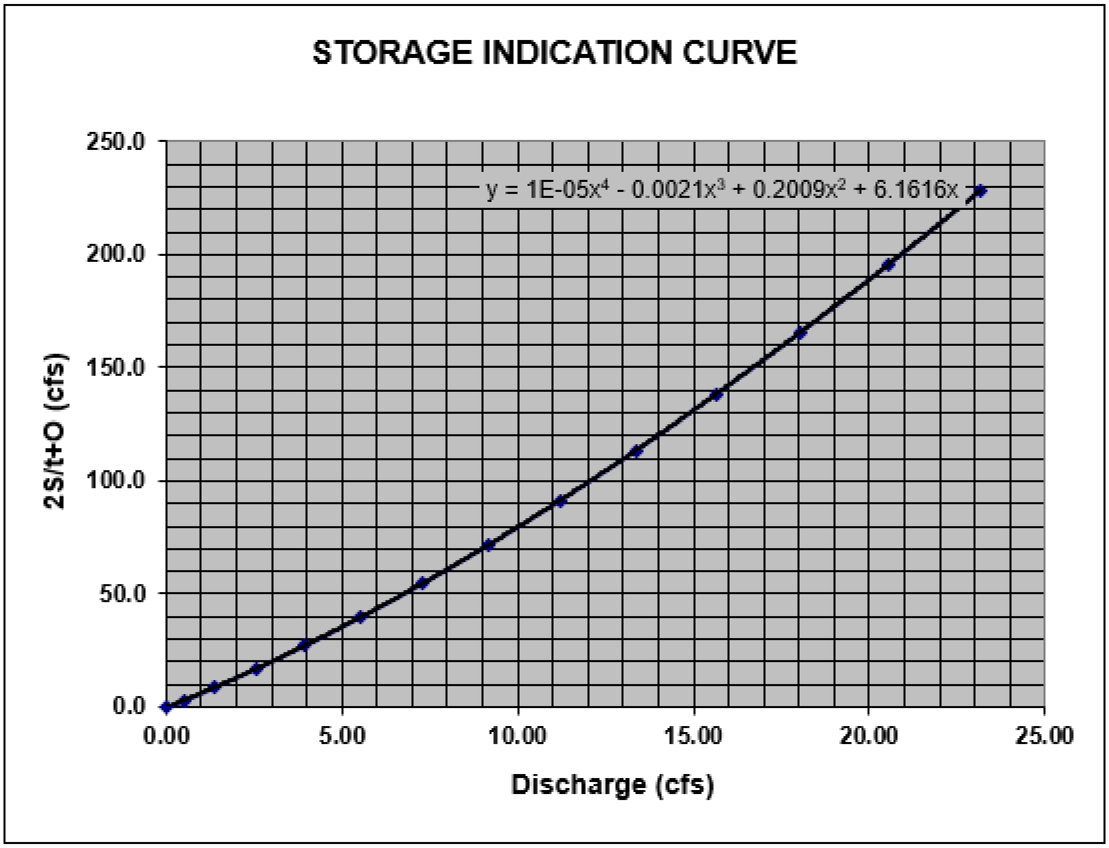
TYPE 2

Stage - Discharge for Rectangular Weir

FL Discharge	Beginning Elevation	Elevation Increment	Top of Basin
345.50	345.50	0.50	352.50

Stage	Head (H)	Weir Length (L)	Area (A)	Orifice Coefficient (C)	Velocity	Discharge (Q)
msl	ft	ft	sf		ft/s	cfs
345.50	0.00	0.42	0.00	3.33	0.00	0.00
346.00	0.50	0.42	0.21	3.33	2.35	0.49
346.50	1.00	0.42	0.42	3.33	3.33	1.40
347.00	1.50	0.42	0.63	3.33	4.08	2.57
347.50	2.00	0.42	0.84	3.33	4.71	3.96
348.00	2.50	0.42	1.05	3.33	5.27	5.53
348.50	3.00	0.42	1.26	3.33	5.77	7.27
349.00	3.50	0.42	1.47	3.33	6.23	9.16
349.50	4.00	0.42	1.68	3.33	6.66	11.19
350.00	4.50	0.42	1.89	3.33	7.06	13.35
350.50	5.00	0.42	2.10	3.33	7.45	15.64
351.00	5.50	0.42	2.31	3.33	7.81	18.04
351.50	6.00	0.42	2.52	3.33	8.16	20.56
352.00	6.50	0.42	2.73	3.33	8.49	23.18
352.50	7.00	0.42	2.94	3.33	8.81	25.90

Storage Indication Curve



Alternate Routing Time

The following spreadsheets represent the Hydrograph Routing for the various storm events. In each case, the Routing Storm Duration time was adjusted to provide the maximum storage required. A time of 40 minute time storm duration is used.

2 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0000	-0.0021	0.2009	6.1616

HYDROGRAPH ROUTING FOR 2 YEAR DESIGN STORM

Routing Storm Duration

40 **minutes**

	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	15.22	0	15.221	0	0	15.222	-0.001
5	8.46	23.68	10.617	34.294	2.302	1937.8	34.294	-0.001
10	15.22	30.44	24.614	55.056	4.840	4418.1	55.055	0.001
15	15.22	30.44	40.422	70.863	7.317	7160.8	70.862	0.001
20	15.22	30.44	52.738	83.180	9.062	9270.1	83.181	-0.001
25	15.22	30.44	62.466	92.908	10.357	10923.4	92.908	0.000
30	15.22	30.44	70.219	100.660	11.345	12234.5	100.661	-0.001
35	15.22	30.44	76.435	106.877	12.113	13282.2	106.876	0.001
40	15.22	21.99	81.443	103.429	12.717	14124.0	103.428	0.001
45	6.76	6.76	78.663	85.428	12.383	13656.9	17.722	67.707
50	0.00	0.00	80.122	80.122	2.753	12401.3	0.000	80.122
55	0.00	0.00	80.322	80.322	0.000	12018.4	0.000	80.322
60	0.00	0.00	80.522	80.522	0.000	12048.4	0.000	80.522

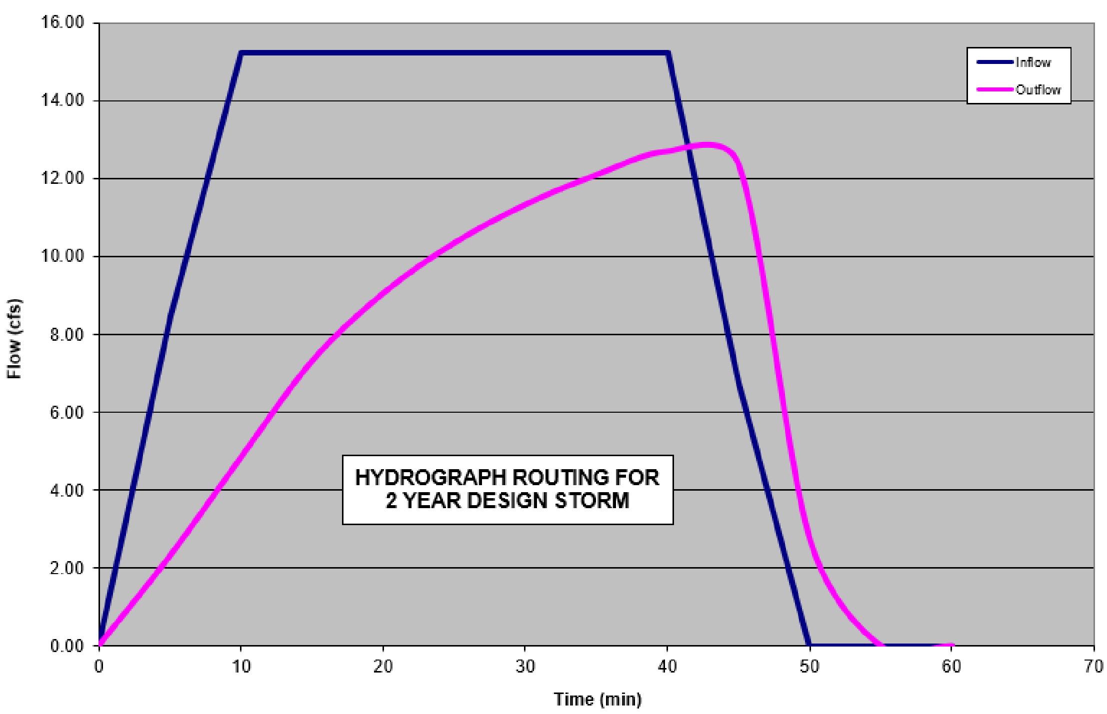
Actual Maximum Storage needed is 14124 cubic feet

Maximum Storage required is achieved at an elev. = 349.87

Maximum Allowable (undeveloped) Discharge is 14.16 cfs

Maximum Discharge for the above storm is 12.72 cfs

DETENTION HYDROGRAPH



5 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0000	-0.0021	0.2009	6.1616

HYDROGRAPH ROUTING FOR 5 YEAR DESIGN STORM

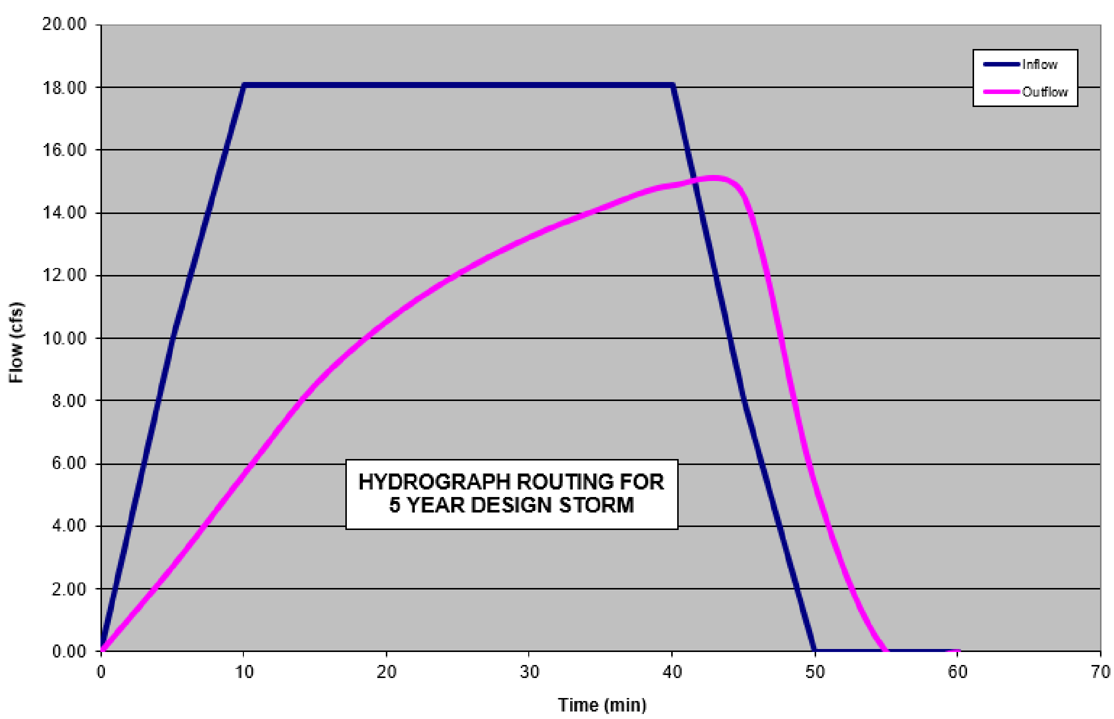
Routing Storm Duration

40 **minutes**

	1	2	3	4	5	6	7	8
Time	I_1	I_1+I_2	$2S_1/t-Q_1$	$2S_2/t+Q_2$	Q_2	S_2	2S/t-Q	Col 4 - 7
min	cfs	cfs	cfs	cfs	cfs	cf	from eqn.	
0	0.00	18.07	0	18.075	0	0	18.074	0.001
5	10.04	28.12	12.671	40.787	2.702	2305.9	40.788	-0.001
10	18.07	36.15	29.504	65.654	5.641	5271.9	65.655	-0.001
15	18.07	36.15	48.656	84.805	8.499	8573.2	84.805	0.000
20	18.07	36.15	63.758	99.907	10.524	11142.2	99.908	-0.001
25	18.07	36.15	75.830	111.979	12.039	13180.3	111.979	0.000
30	18.07	36.15	85.567	121.717	13.206	14816.0	121.718	-0.001
35	18.07	36.15	93.470	129.619	14.123	16139.0	129.619	0.000
40	18.07	26.11	99.913	126.021	14.853	17214.9	126.022	-0.001
45	8.03	8.03	96.976	105.009	14.522	16724.8	37.239	67.770
50	0.00	0.00	94.596	94.596	5.307	14955.4	0.000	94.596
55	0.00	0.00	94.796	94.796	0.000	14189.4	0.000	94.796
60	0.00	0.00	94.996	94.996	0.000	14219.4	0.000	94.996

Actual Maximum Storage needed is 17214.9 cubic feet
Maximum Storage required is achieved at an elev. = 350.29
Maximum Allowable (undeveloped) Discharge is 16.15 cfs
Maximum Discharge for the above storm is 14.85 cfs

DETENTION HYDROGRAPH



10 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0000	-0.0021	0.2009	6.1616

HYDROGRAPH ROUTING FOR 10 YEAR DESIGN STORM

Routing Storm Duration

40 **minutes**

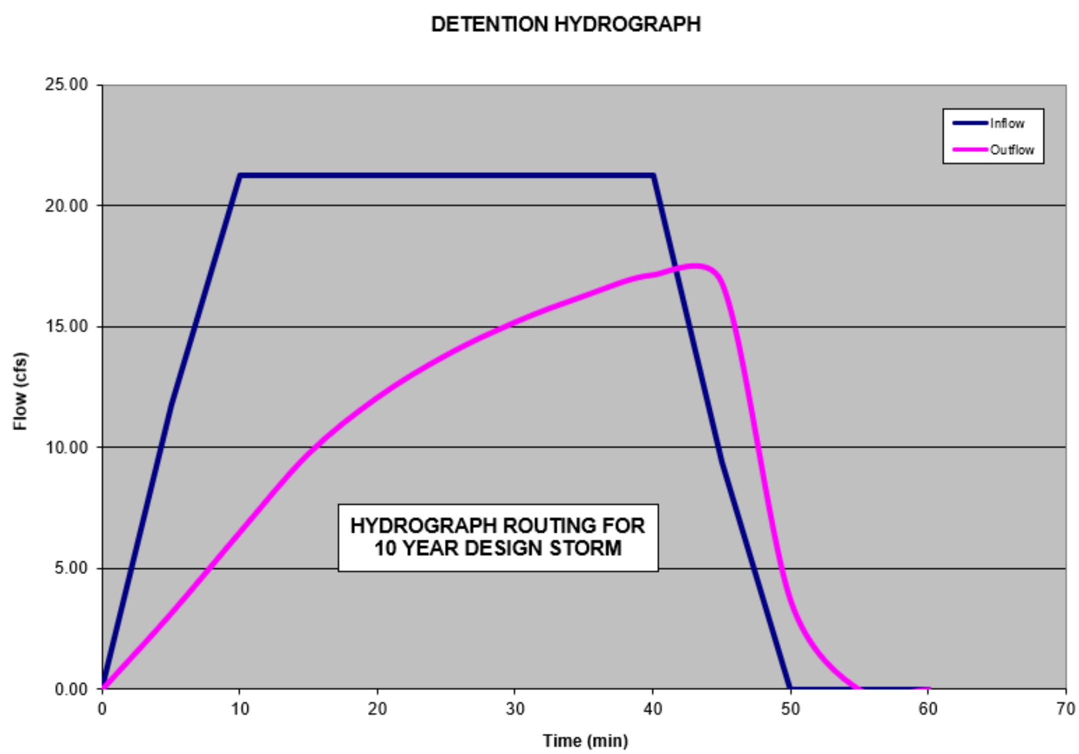
	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	21.25	0	21.246	0	0	21.245	0.001
5	11.80	33.05	14.971	48.020	3.137	2716.2	48.021	-0.001
10	21.25	42.49	35.011	77.502	6.504	6227.3	77.501	0.001
15	21.25	42.49	57.969	100.461	9.767	10160.4	100.462	-0.001
20	21.25	42.49	76.275	118.766	12.093	13255.2	118.766	0.000
25	21.25	42.49	91.071	133.563	13.848	15737.8	133.563	-0.001
30	21.25	42.49	103.137	145.629	15.213	17752.5	145.628	0.001
35	21.25	42.49	113.038	155.530	16.295	19400.0	155.530	-0.001
40	21.25	30.69	121.199	151.887	17.165	20754.6	151.888	0.000
45	9.44	9.44	118.193	127.636	16.847	20256.0	24.602	103.033
50	0.00	0.00	120.459	120.459	3.689	18592.1	0.000	120.459
55	0.00	0.00	120.659	120.659	0.000	18068.8	0.000	120.659
60	0.00	0.00	120.859	120.859	0.000	18098.8	0.000	120.859

Actual Maximum Storage needed is 20754.6 cubic feet

Maximum Storage required is achieved at an elev. = 350.75

Maximum Allowable (undeveloped) Discharge is 17.89 cfs

Maximum Discharge for the above storm is 17.17 cfs



25 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0000	-0.0021	0.2009	6.1616

HYDROGRAPH ROUTING FOR 25 YEAR DESIGN STORM

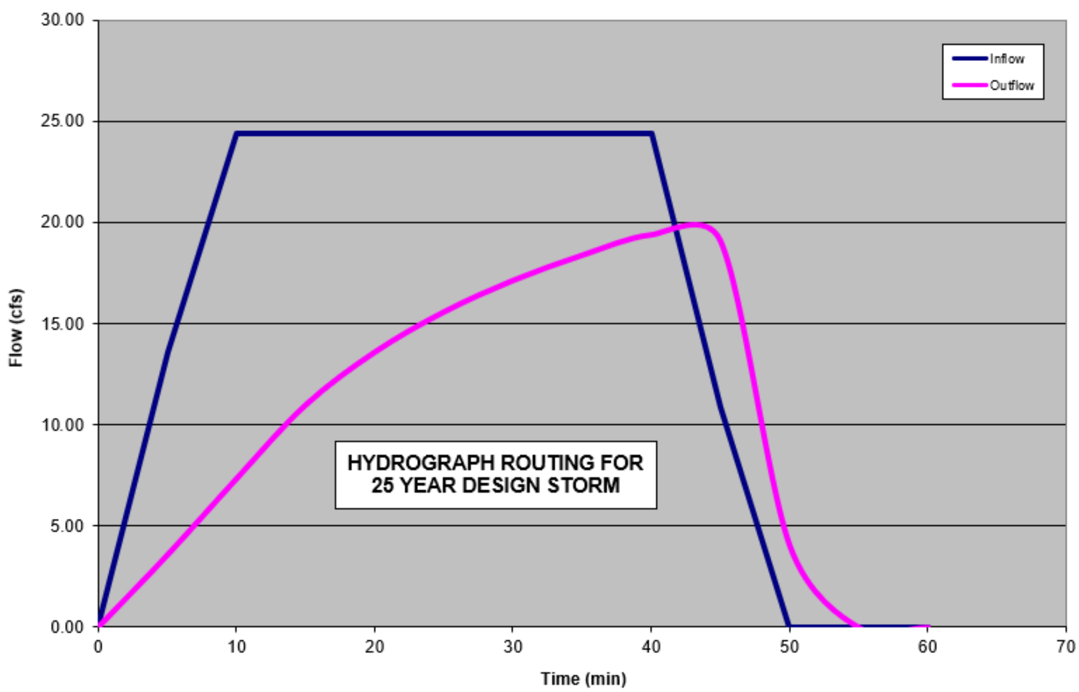
Routing Storm Duration

40 **minutes**

	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	24.42	0	24.417	0	0	24.416	0.001
5	13.56	37.98	17.289	55.271	3.564	3128.0	55.272	-0.001
10	24.42	48.83	40.587	89.420	7.342	7189.3	89.421	-0.001
15	24.42	48.83	67.433	116.266	10.994	11764.0	116.267	0.000
20	24.42	48.83	89.041	137.875	13.612	15398.1	137.874	0.001
25	24.42	48.83	106.670	155.503	15.602	18340.9	155.503	0.001
30	24.42	48.83	121.178	170.011	17.163	20751.1	170.010	0.001
35	24.42	48.83	133.190	182.024	18.410	22740.1	182.023	0.001
40	24.42	35.27	143.182	178.451	19.421	24390.5	178.452	-0.001
45	10.85	10.85	140.206	151.058	19.122	23899.3	27.502	123.556
50	0.00	0.00	143.117	143.117	4.070	22048.1	0.000	143.117
55	0.00	0.00	143.317	143.317	0.000	21467.6	0.000	143.317
60	0.00	0.00	143.517	143.517	0.000	21497.6	0.000	143.517

Actual Maximum Storage needed is 24390.5 cubic feet
Maximum Storage required is achieved at an elev. = 351.24
Maximum Allowable (undeveloped) Discharge is 20.38 cfs
Maximum Discharge for the above storm is 19.42 cfs

DETENTION HYDROGRAPH



50 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0000	-0.0021	0.2009	6.1616

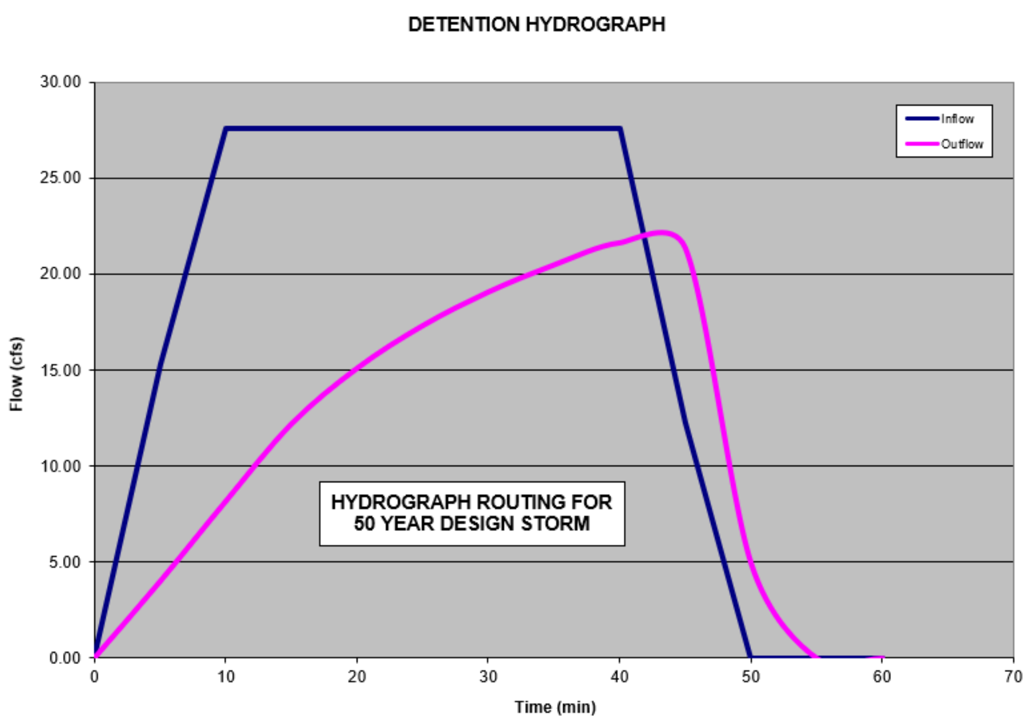
HYDROGRAPH ROUTING FOR 50 YEAR DESIGN STORM

Routing Storm Duration

40 **minutes**

	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	27.59	0	27.588	0	0	27.587	0.001
5	15.33	42.91	19.625	62.539	3.981	3540.9	62.540	-0.001
10	27.59	55.18	46.226	101.401	8.157	8157.4	101.402	-0.001
15	27.59	55.18	77.031	132.206	12.185	13382.4	132.205	0.001
20	27.59	55.18	102.028	157.203	15.089	17567.6	157.204	-0.001
25	27.59	55.18	122.582	177.757	17.311	20983.9	177.758	-0.001
30	27.59	55.18	139.629	194.804	19.064	23803.9	194.804	0.001
35	27.59	55.18	153.853	209.028	20.476	26149.3	209.028	0.000
40	27.59	39.85	165.774	205.623	21.627	28110.2	205.623	0.001
45	12.26	12.26	162.917	175.178	21.353	27640.5	34.394	140.784
50	0.00	0.00	165.473	165.473	4.952	25533.8	0.000	165.473
55	0.00	0.00	165.673	165.673	0.000	24821.0	0.000	165.673
60	0.00	0.00	165.873	165.873	0.000	24851.0	0.000	165.873

Actual Maximum Storage needed is 28110.2 cubic feet
Maximum Storage required is achieved at an elev. = 351.75
Maximum Allowable (undeveloped) Discharge is 22.86 cfs
Maximum Discharge for the above storm is 21.63 cfs



100 YEAR STORM EVENT

Coefficients for Storage Indication Curve from Chart			
Ax^4	Bx^3	Cx^2	Dx
0.0000	-0.0021	0.2009	6.1616

HYDROGRAPH ROUTING FOR 100 YEAR DESIGN STORM

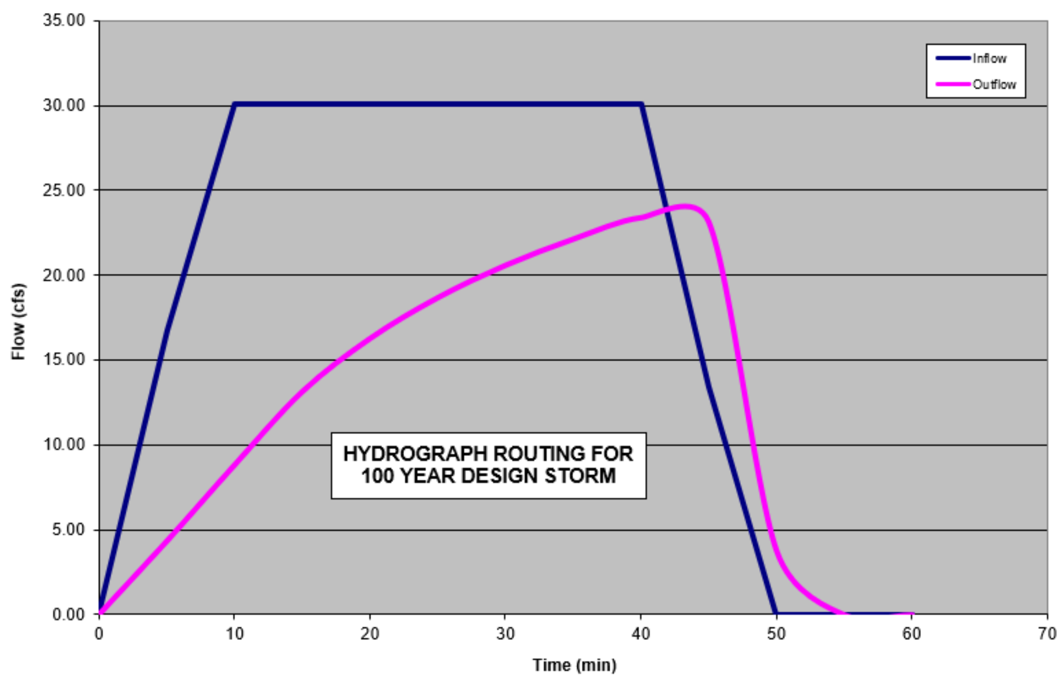
Routing Storm Duration

40 **minutes**

	1	2	3	4	5	6	7	8
Time min	I_1 cfs	I_1+I_2 cfs	$2S_1/t-Q_1$ cfs	$2S_2/t+Q_2$ cfs	Q_2 cfs	S_2 cf	2S/t-Q from eqn.	Col 4 - 7
0	0.00	30.12	0	30.125	0	0	30.124	0.001
5	16.74	46.86	21.505	68.365	4.310	3872.2	68.366	-0.001
10	30.12	60.25	50.778	111.027	8.794	8935.7	111.027	0.000
15	30.12	60.25	84.796	145.045	13.115	14686.7	145.044	0.001
20	30.12	60.25	112.558	172.807	16.243	19320.3	172.807	0.000
25	30.12	60.25	135.513	195.762	18.647	23124.0	195.761	0.000
30	30.12	60.25	154.654	214.903	20.554	26281.2	214.902	0.001
35	30.12	60.25	170.711	230.960	22.096	28921.1	230.959	0.001
40	30.12	43.51	184.240	227.754	23.360	31140.0	227.753	0.001
45	13.39	13.39	181.535	194.923	23.110	30696.6	25.275	169.648
50	0.00	0.00	187.568	187.568	3.778	28671.8	0.000	187.568
55	0.00	0.00	187.768	187.768	0.000	28135.2	0.000	187.768
60	0.00	0.00	187.968	187.968	0.000	28165.2	0.000	187.968

Actual Maximum Storage needed is 31140 cubic feet
Maximum Storage required is achieved at an elev. = 352.12
Maximum Allowable (undeveloped) Discharge is 24.1 cfs
Maximum Discharge for the above storm is 23.36 cfs

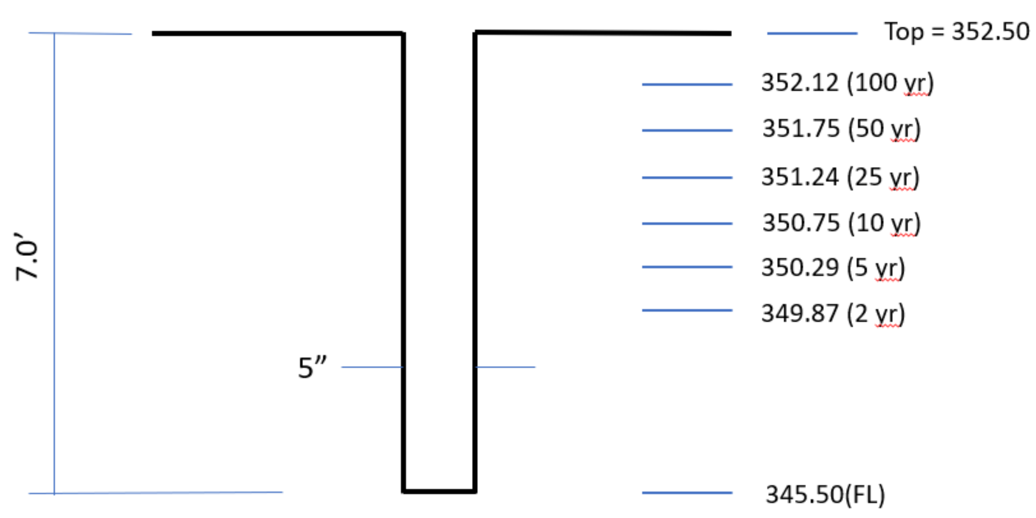
DETENTION HYDROGRAPH

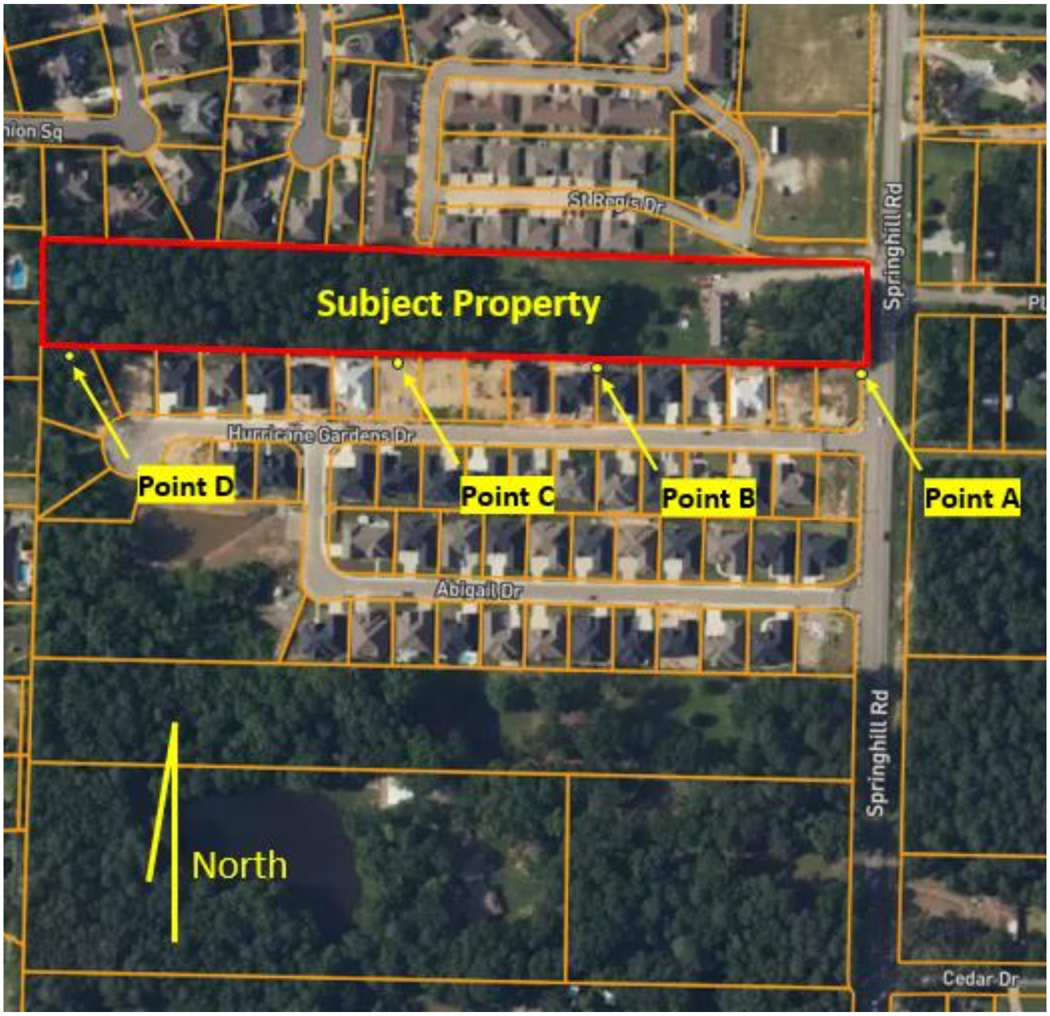


Summary – Detention

Storm Event	Volume Needed (cf)	WSE	Max Discharge Allowed (cfs)	Max Discharge Model (cfs)
2	14124.0	349.87	14.16	12.72
5	17214.9	350.29	16.15	14.85
10	20754.6	350.75	17.89	17.17
25	24390.5	351.24	20.38	19.42
50	28110.2	351.75	22.86	21.63
100	31140.0	352.12	24.10	23.36

Discharge Structure Detail





Study Point Summary (25 yr Storm)

Study Point	Pre Construction	Post Construction	Change
A	16.38 cfs	19.13 cfs	2.75 cfs*
B	12.13 cfs	2.35 cfs	-9.78 cfs
C	13.57 cfs	2.50 cfs	-11.07 cfs
D	20.38 cfs	19.42 cfs	-0.96 cfs
Total:			**-19.06 cfs**

* *Existing culvert originating at the Junction Box near the NE corner of Hurricane Gardens has adequate capacity to accept this slight increase in flow.*

Engineering Certification

I, Tim Lemons, Arkansas Registered Professional Engineer No. 7373, hereby certify that the drainage reports, and calculations contained in this report, have been prepared in accordance with sound engineering practice and principles, and based on best known available data. Improvements as outlined in this report and depicted on the preliminary plat and design drawings should not increase the risk of endangerment to life or have negative impacts on adjacent or downstream property or watersheds.

Timothy B. Lemons, PE
Arkansas Professional Engineer, #7373

Appendix

GUTTER CAPACITY OF STREETS - 27' BC to BC

Slope = 0.5%, n = 0.012

Width (ft)	Slope	Height (ft)	Area (sf)	R	R^2/3	S	S^1/2	Q (cfs)
0.5	0.030	0.02	0.00	0.01	0.04	0.00500	0.0707	0.00
1	0.030	0.03	0.02	0.01	0.06	0.00500	0.0707	0.01
1.5	0.030	0.05	0.03	0.02	0.08	0.00500	0.0707	0.02
2	0.030	0.06	0.06	0.03	0.10	0.00500	0.0707	0.05
2.5	0.030	0.08	0.09	0.04	0.11	0.00500	0.0707	0.09
3	0.030	0.09	0.14	0.04	0.13	0.00500	0.0707	0.15
3.5	0.030	0.11	0.18	0.05	0.14	0.00500	0.0707	0.22
4	0.030	0.12	0.24	0.06	0.15	0.00500	0.0707	0.32
4.5	0.030	0.14	0.30	0.07	0.16	0.00500	0.0707	0.44
5	0.030	0.15	0.38	0.07	0.18	0.00500	0.0707	0.58
5.5	0.030	0.17	0.45	0.08	0.19	0.00500	0.0707	0.75
6	0.030	0.18	0.54	0.09	0.20	0.00500	0.0707	0.94
6.5	0.030	0.20	0.63	0.10	0.21	0.00500	0.0707	1.17
7	0.030	0.21	0.74	0.10	0.22	0.00500	0.0707	1.43
7.5	0.030	0.23	0.84	0.11	0.23	0.00500	0.0707	1.71
8.5	0.030	0.26	1.08	0.13	0.25	0.00500	0.0707	2.39
9	0.030	0.27	1.22	0.13	0.26	0.00500	0.0707	2.79
9.5	0.030	0.29	1.35	0.14	0.27	0.00500	0.0707	3.22
10	0.030	0.30	1.50	0.15	0.28	0.00500	0.0707	3.69
10.5	0.030	0.32	1.65	0.16	0.29	0.00500	0.0707	4.21
11	0.030	0.33	1.82	0.16	0.30	0.00500	0.0707	4.76
11.5	0.030	0.35	1.98	0.17	0.31	0.00500	0.0707	5.36
12	0.030	0.36	2.16	0.18	0.32	0.00500	0.0707	6.01
12.5	0.030	0.38	2.34	0.19	0.33	0.00500	0.0707	6.70
13	0.030	0.39	2.54	0.19	0.33	0.00500	0.0707	7.44

GUTTER CAPACITY OF STREETS - 27' BC to BC

Slope = 1.50%, n = 0.012

Width (ft)	Slope	Height (ft)	Area (sf)	R	R^2/3	S	S^1/2	Q (cfs)
0.5	0.030	0.02	0.00	0.01	0.04	0.01500	0.1225	0.00
1	0.030	0.03	0.02	0.01	0.06	0.01500	0.1225	0.01
1.5	0.030	0.05	0.03	0.02	0.08	0.01500	0.1225	0.04
2	0.030	0.06	0.06	0.03	0.10	0.01500	0.1225	0.09
2.5	0.030	0.08	0.09	0.04	0.11	0.01500	0.1225	0.16
3	0.030	0.09	0.14	0.04	0.13	0.01500	0.1225	0.26
3.5	0.030	0.11	0.18	0.05	0.14	0.01500	0.1225	0.39
4	0.030	0.12	0.24	0.06	0.15	0.01500	0.1225	0.55
4.5	0.030	0.14	0.30	0.07	0.16	0.01500	0.1225	0.76
5	0.030	0.15	0.38	0.07	0.18	0.01500	0.1225	1.01
5.5	0.030	0.17	0.45	0.08	0.19	0.01500	0.1225	1.30
6	0.030	0.18	0.54	0.09	0.20	0.01500	0.1225	1.64
6.5	0.030	0.20	0.63	0.10	0.21	0.01500	0.1225	2.03
7	0.030	0.21	0.74	0.10	0.22	0.01500	0.1225	2.47
7.5	0.030	0.23	0.84	0.11	0.23	0.01500	0.1225	2.97
8.5	0.030	0.26	1.08	0.13	0.25	0.01500	0.1225	4.15
9	0.030	0.27	1.22	0.13	0.26	0.01500	0.1225	4.83
9.5	0.030	0.29	1.35	0.14	0.27	0.01500	0.1225	5.58
10	0.030	0.30	1.50	0.15	0.28	0.01500	0.1225	6.40
10.5	0.030	0.32	1.65	0.16	0.29	0.01500	0.1225	7.29
11	0.030	0.33	1.82	0.16	0.30	0.01500	0.1225	8.25
11.5	0.030	0.35	1.98	0.17	0.31	0.01500	0.1225	9.29
12	0.030	0.36	2.16	0.18	0.32	0.01500	0.1225	10.41
12.5	0.030	0.38	2.34	0.19	0.33	0.01500	0.1225	11.61
13	0.030	0.39	2.54	0.19	0.33	0.01500	0.1225	12.89

GUTTER CAPACITY OF STREETS - 27' BC to BC								
Slope = 2.67%, n = 0.012								
Width (ft)	**Slope**	**Height (ft)**	**Area (sf)**	**R**	**R^2/3**	**S**	**S^1/2**	**Q (cfs)**
0.5	0.030	0.02	0.00	0.01	0.04	0.02670	0.1634	0.00
1	0.030	0.03	0.02	0.01	0.06	0.02670	0.1634	0.02
1.5	0.030	0.05	0.03	0.02	0.08	0.02670	0.1634	0.05
2	0.030	0.06	0.06	0.03	0.10	0.02670	0.1634	0.12
2.5	0.030	0.08	0.09	0.04	0.11	0.02670	0.1634	0.21
3	0.030	0.09	0.14	0.04	0.13	0.02670	0.1634	0.34
3.5	0.030	0.11	0.18	0.05	0.14	0.02670	0.1634	0.52
4	0.030	0.12	0.24	0.06	0.15	0.02670	0.1634	0.74
4.5	0.030	0.14	0.30	0.07	0.16	0.02670	0.1634	1.01
5	0.030	0.15	0.38	0.07	0.18	0.02670	0.1634	1.34
5.5	0.030	0.17	0.45	0.08	0.19	0.02670	0.1634	1.73
6	0.030	0.18	0.54	0.09	0.20	0.02670	0.1634	2.18
6.5	0.030	0.20	0.63	0.10	0.21	0.02670	0.1634	2.70
7	0.030	0.21	0.74	0.10	0.22	0.02670	0.1634	3.29
7.5	0.030	0.23	0.84	0.11	0.23	0.02670	0.1634	3.96
8.5	0.030	0.26	1.08	0.13	0.25	0.02670	0.1634	5.53
9	0.030	0.27	1.22	0.13	0.26	0.02670	0.1634	6.44
9.5	0.030	0.29	1.35	0.14	0.27	0.02670	0.1634	7.44
10	0.030	0.30	1.50	0.15	0.28	0.02670	0.1634	8.53
10.5	0.030	0.32	1.65	0.16	0.29	0.02670	0.1634	9.72
11	0.030	0.33	1.82	0.16	0.30	0.02670	0.1634	11.01
11.5	0.030	0.35	1.98	0.17	0.31	0.02670	0.1634	12.40
12	0.030	0.36	2.16	0.18	0.32	0.02670	0.1634	13.89
12.5	0.030	0.38	2.34	0.19	0.33	0.02670	0.1634	15.49
13	0.030	0.39	2.54	0.19	0.33	0.02670	0.1634	17.20

GUTTER CAPACITY OF STREETS - 27' BC to BC								
Slope = 4.88%, n = 0.012								
Width (ft)	Slope	Height (ft)	Area (sf)	R	R^2/3	S	S^1/2	Q (cfs)
0.5	0.030	0.02	0.00	0.01	0.04	0.04880	0.2209	0.00
1	0.030	0.03	0.02	0.01	0.06	0.04880	0.2209	0.02
1.5	0.030	0.05	0.03	0.02	0.08	0.04880	0.2209	0.07
2	0.030	0.06	0.06	0.03	0.10	0.04880	0.2209	0.16
2.5	0.030	0.08	0.09	0.04	0.11	0.04880	0.2209	0.28
3	0.030	0.09	0.14	0.04	0.13	0.04880	0.2209	0.46
3.5	0.030	0.11	0.18	0.05	0.14	0.04880	0.2209	0.70
4	0.030	0.12	0.24	0.06	0.15	0.04880	0.2209	1.00
4.5	0.030	0.14	0.30	0.07	0.16	0.04880	0.2209	1.37
5	0.030	0.15	0.38	0.07	0.18	0.04880	0.2209	1.81
5.5	0.030	0.17	0.45	0.08	0.19	0.04880	0.2209	2.34
6	0.030	0.18	0.54	0.09	0.20	0.04880	0.2209	2.95
6.5	0.030	0.20	0.63	0.10	0.21	0.04880	0.2209	3.65
7	0.030	0.21	0.74	0.10	0.22	0.04880	0.2209	4.45
7.5	0.030	0.23	0.84	0.11	0.23	0.04880	0.2209	5.35
8.5	0.030	0.26	1.08	0.13	0.25	0.04880	0.2209	7.48
9	0.030	0.27	1.22	0.13	0.26	0.04880	0.2209	8.71
9.5	0.030	0.29	1.35	0.14	0.27	0.04880	0.2209	10.06
10	0.030	0.30	1.50	0.15	0.28	0.04880	0.2209	11.54
10.5	0.030	0.32	1.65	0.16	0.29	0.04880	0.2209	13.14
11	0.030	0.33	1.82	0.16	0.30	0.04880	0.2209	14.88
11.5	0.030	0.35	1.98	0.17	0.31	0.04880	0.2209	16.76
12	0.030	0.36	2.16	0.18	0.32	0.04880	0.2209	18.77
12.5	0.030	0.38	2.34	0.19	0.33	0.04880	0.2209	20.94
13	0.030	0.39	2.54	0.19	0.33	0.04880	0.2209	23.25