4^{th} Street Commons
7-Lot Subdivision

Preliminary Storm Water Calculations

March 7, 2017
Revised October, 17, 2017

Prepared By:
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Job #17-016

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RENEWAL DATE: 12/31/2018

Project Summary

The project site is located on the southwest corner of NE 4th Street and NE Beach Avenue it is Tax Lot 6900, Map 1S, 3E, 10BD. The site is currently vacant and is relatively flat. The adjacent Beach Avenue has recently been improved with new curbs, pavers and planters. There is an existing curb along the NE 4th Street frontage.

The proposed project is a 7-Lot subdivision for attached townhouse construction. This project is proposing the construction of two new structures, Building 1 and 2. Building 1 will consist of 5 attached residential dwelling units (townhouses) that will face Beach Avenue. The proposed roof area is 3,655 sf. Building 2 will consist of 2 attached residential dwelling units (townhouses) that will face 4th Street. The proposed roof area is 2,572 sf. The total roof area is 6,227 sf. A new pervious court yard will be constructed between the two buildings to provide garage access to all of the units.

There is an existing 15" public storm sewer line in NE 4th Street approximately 160' East of the site. A new public storm sewer will need to be extended to the site. The proposed stormwater improvements on site will be designed as a "Low Impact Development". The roof water will be managed in a Stormwater Planter on the south end of building 2. This planter will be sized to treat the roof water from Building 1 and 2 and will also function as a detention system. A shallow pipe will be installed from this planter to the new public storm line in NE 4th Street.

The driveway court yard area will be paved with pervious pavers or other suitable pervious material. The parking area will be graded to drain to the north where a catchbasin will be installed to collect any excess stormwater.

Stormwater Planter Design:

The stormwater planter for the proposed roof area is designed based on from SIM found in the City of Gresham "Green Development Practices for Stormwater Management" dated July 2007. This form requires the planter to be a minimum of 5% of the total roof area. As mentioned above the total roof area is 6,227 sf. The minimum planter area is 312 SF (6,227 x 0.05). See the attached typical stormwater planter detail.

Storm Water Detention Design:

The proposed detention system has been design to release on-site, post-developed storm water from the new roof tops at or below pre-developed release rates for the required storm events (2-yr, 5-yr, 10-yr, and 25-yr). The minimum storage volume for detention is 196 CF (see the Detention System Summary). The top 0.63 feet of the planter can hold the required volume of 196 CF. The detention volume is designed to be above the 9-inch dead storage elevation.

Pervious Pavement Design:

As stated above the driveway / court yard area will be constructed with pervious pavers or other suitable pervious material. Due to the slow infiltration rate of the soils in this area, an underdrain system has been designed under the new pervious pavement. In addition to the pervious pavement a catchbasin will be installed at the low point to collect surface flows from heavy storm events. See the pervious pavement section below.

NOTES:

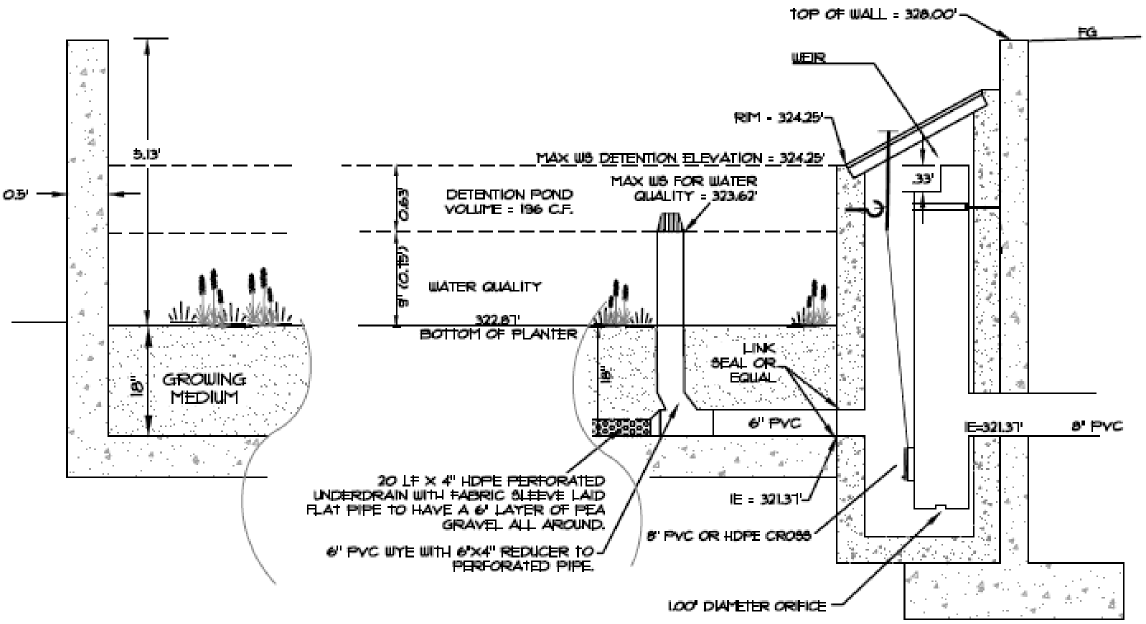
1) SEE ARCHITECTURAL PLANS FOR DOWNSPOUT LOCATIONS FROM ROOF. ALL NEW ROOF DRAIN DOWNSPOUTS TO OUTFALL INTO PLANTER BOX. INSTALL 2' X 2' X 8" THICK LAYER OF 4" - 8" RIVER ROCK AT ALL DOWNSPOUTS TO PREVENT EROSION. PLACE ROCK FLUSH WITH FINISH GRADE.

2) SEE ARCHITECTURAL AND STRUCTURAL PLANS FOR CONCRETE PLANTER BOX DETAILS.

3) SEE LANDSCAPE PLANS FOR PLANTINGS INSIDE OF BOX

4) GROWING MEDIUM PER SPECIFICATIONS IN APPENDIX B OF THE "GREEN DEVELOPMENT PRACTICES FOR STORMWATER MANAGEMENT" MANUAL.

5) INSTALL OVERFLOW GRATE BY ADVANCED DRAINAGE 0663SDG ATRIUM GRATE (OR APPROVED EQUAL)



FILTRATION PLANTER / DETENTION POND DETAIL

TYPE "D" FLOW CONTROL STRUCTURE

A
C4

NTS

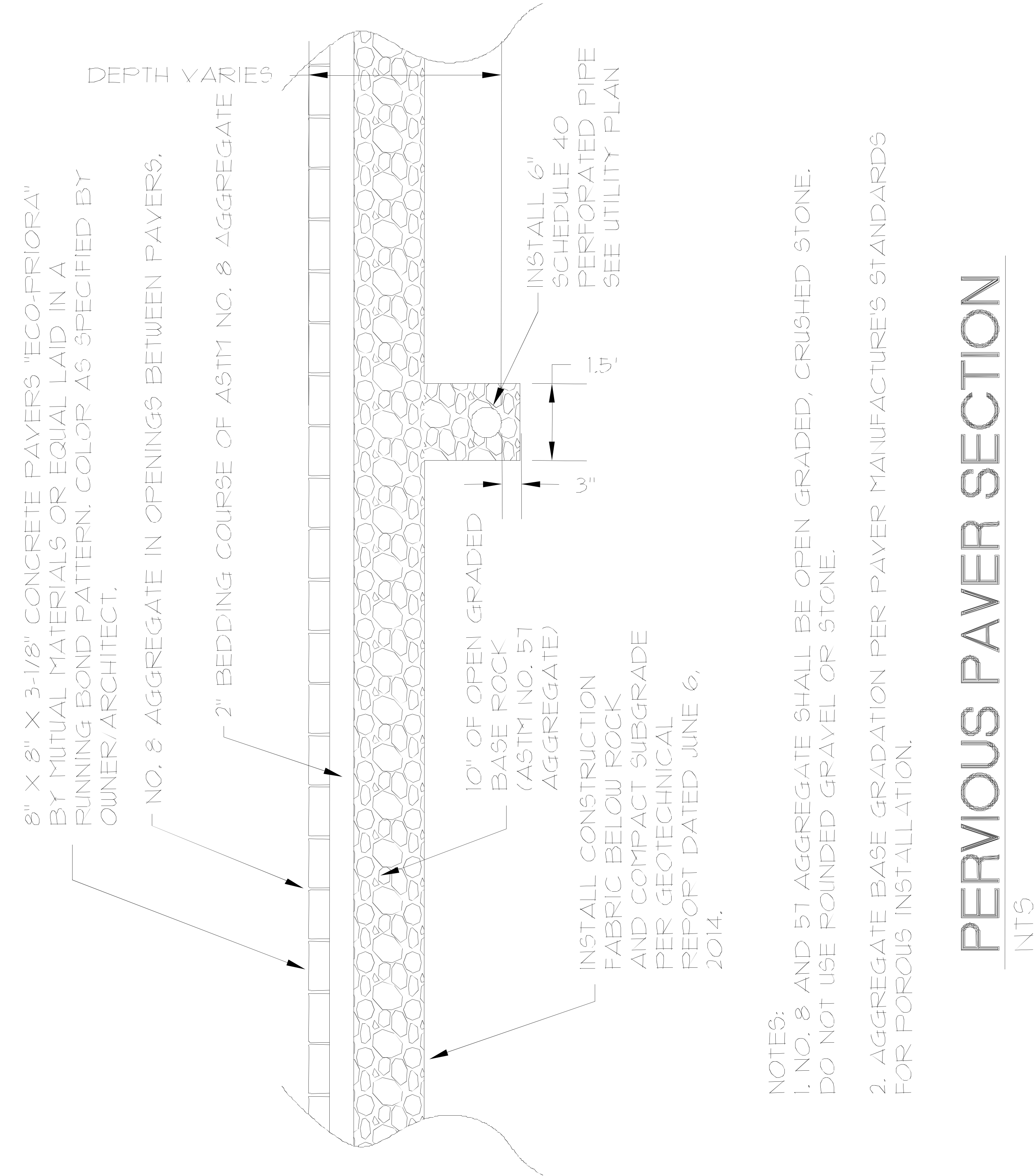

DEPTH VARIES
8" X 8" X 3-1/8" CONCRETE PAVERS "ECO-PRIORA" BY MUTUAL MATERIALS OR EQUAL LAID IN A RUNNING BOND PATTERN, COLOR AS SPECIFIED BY OWNER/ARCHITECT.
NO. 8 AGGREGATE IN OPENINGS BETWEEN PAVERS.
2" BEDDING COURSE OF ASTM NO. 8 AGGREGATE
INSTALL 6" SCHEDULE 40 PERFORATED PIPE SEE UTILITY PLAN
1.5'
3'
10" OF OPEN GRADED BASE ROCK (ASTM NO. 57 AGGREGATE)
INSTALL CONSTRUCTION FABRIC BELOW ROCK AND COMPACT SUBGRADE PER GEOTECHNICAL REPORT DATED JUNE 6, 2014.
NOTES:
1. NO. 8 AND 57 AGGREGATE SHALL BE OPEN GRADED, CRUSHED STONE. DO NOT USE ROUNDED GRAVEL OR STONE.
2. AGGREGATE BASE GRADATION PER PAVER MANUFACTURE'S STANDARDS FOR POROUS INSTALLATION.
PERVIOUS PAVER SECTION
NTS

Exhibit A

(Detailed Storm Detention Calculations)

SCS RUNOFF CURVE NUMBERS (CN)

For Selected Land Uses

LAND USE DESCRIPTION			RUNOFF CURVE NUMBERS (CN) BY HYDROLOGIC SOIL GROUP A	B	C	D
Cultivated land (1):	winter condition		86	91	94	95
Mountain open areas:	low growing brush and grasslands		74	82	89	92
Meadow or pasture:			65	78	85	89
Wood or forest land:	undisturbed or older second growth		42	64	76	81
Wood or forest land:	young second growth or brush		55	72	81	86
Orchard:	with cover crop		81	88	92	94
Open spaces, lawns, parks, golf courses, cemetaries, landscaping						
Good condition:	grass cover on 75% or more of the area		68	80	86	90
Fair condition:	grass cover on 50% to 75% of the area		77	85	90	92
Gravel roads and parking lots			76	85	89	91
Dirt Roads and parking lots			72	82	87	89
Impervious surfaces:	pavement, roof, etc.		98	98	98	98
Open water bodies:	lakes, wetlands, ponds, etc.		100	100	100	100
Single Family Residential (2)			Select separate curve numbers for the pervious and impervious portion of the site or basin.			
Dwelling Unit/Gross Acre (DU/GA)		% Impervious (3)				
1.0		15				
2.0		25				
3.0		34				
4.0		42				
5.0		48				
6.0		52				
7.0		56				
Planned unit developments, condominiums, apartments, commercial businesses and industrial areas.		Use actual impervious area.				

(1) Detailed information relating to specific agricultural land uses is available in the National Engineering Engineering Handbook, Section 4, Hydrology, chapter 9, August 1972.

(2) Assume site drains to storm system.

(3) For this land use, the remaining pervious areas are assumed to be lawn in good condition.

COEFFICIENTS

Ns =	= Manning's coefficient (sheet flow)
	n values are for sheet flow only
Design Value	
0.011	Concrete or asphalt
0.010	Bare soil
0.020	Graveled surface
0.020	Bare clay - loam (eroded)
0.150	Grass (short prairie)
0.240	Grass (dense lawn)
0.410	Grass (bermuda)
0.400	Woods (light underbrush)
0.800	Woods (dense underbrush)

k =	= time of concentration velocity factor (ft/s)
Design Value	
3	Forest with heavy ground cover and meadows (n=0.10)
5	Brushy ground with some trees (n=0.060)
8	Fallow or cultivation (n=0.040)
9	High grass (n=0.035)
11	Short grass, pasture or lawns (n=0.030)
13	Nearly bare ground (n=0.025)
27	Paved and gravel areas (n=0.012)

n =	= Manning's coefficient (channel)
Design Value	
	CONSTRUCTED CHANNELS
	A. Earth, straight and uniform
0.018	Earth (straight and uniform)
0.025	Gravel (straight and uniform)
0.027	Grass (with weeds)
	B. Earth, winding and sluggish
0.025	Earth (no vegetation)
0.030	Grass (some weeds)
0.035	Dense weeds (deep channel)
0.030	Earth (rubble bottom and sides)
0.035	Stony bottom and weedy banks
0.040	Cobble bottom with clean sides
	C. Rock lined
0.035	Smooth and uniform
0.040	Jagged and irregular
	D. Channels not maintained (weeds and brush uncut)
0.050	Dense weeds (high as flow depth)
0.050	Clean bottom (brush on sides)
0.100	Dense brush (high stage)
0.200	Water quality swales (mowed regulary)
	NATURAL STREAMS
0.029	Clean (straight no pools)
0.035	Clean (straight no pools with weeds and stones)
0.039	Clean (winding pools)
0.042	Clean (winding pools weeds and stones)
0.052	Clean (winding pools weeds and large stones)
0.065	Weedy (sluggish with deep pools)
0.112	Very weedy (sluggish with deep pools)

Standard formulas used for the Time of Concentration Calculations

Overland Flow (max 300' total)

$$\frac{(0.42)[(Ns)(L)]^{0.8}}{(P_2)^{0.5}(S_0)^{0.4}}$$

Tc	= time of concentration for less than 300' of travel (minute
Ns	= sheet flow Manning's effective roughness coefficient
L	= flow length (ft)
P2	= 2-year, 24 hour rainfall (in)
So	= slope of hydraulic grade line (land slope, ft/ft)

Shallow Concentrated Flow (after initial 300')

$$T = \frac{L}{(60)(k\sqrt{S_0})}$$

T	= travel time for sheet flow (min)
L	= flow length (ft)
So	= slope of hydraulic grade line (land slope, ft/ft)
k	= time of concentration velocity factor (ft/s)

Flow in Swales

Q = (1.486/n) x A x R^2/3 x S^1/2 (Manning's Equation)

Tc	= time of concentration for gutter flow (minutes)
A	= area of flow (sf)
R	= hydraulic radius (ft)
Ls	= side slope
Q	= quantity of flow (ft^3/sec)
V	= average velocity of flow (ft/sec)
L	= length of flow
Ve	= vertical length of side slope
Ho	= horizontal length of side slope
Bw	= base width (in)
D	= depth (in)
S	= slope (ft/ft)
n	= Manning's n

Flow in gutters

$$V = \frac{1.12}{n}(S)^{\wedge}0.5(Sx)^{\wedge}.67(T)^{\wedge}0.67$$

Tc	= time of concentration for gutter flow (minutes)
V	= average velocity of flow (ft/sec)
Q	= quantity of flow (ft^3/sec)
S	= street longitudinal slope (ft/ft)
Sx	= street cross slope (ft/ft)
T	= total width of flow in the gutter (ft)
n	= sheet flow Manning's (pavement = 0.018)
L	= Length of flow (ft)

Flow in pipes

Mannings Equation

Tc	= time of concentration in pipe (minutes)
V	= calculated velocity pipe full (ft/sec)
Q	= quantity of flow (ft^3/sec)
n	= Manning's n
D	= pipe Diameter (in)
S	= slope (ft/ft)
L	= length of pipe

Project Name: 4th Street Commons

PRE-DEVELOPED - TIME OF CONCENTRATION CALCULATIONS

Job # 17-016

Date: 10/17/2017

14.8	= Total Tc (min)

Overland Flow (max 300' total)

					total	
Tc =	12.1	2.7			14.8	= travel time for less than 300' (min)
Ns =	0.24	0.24				= Manning's coefficient (sheet flow)
L =	54	21			75	= flow length (ft)
P2 =	2.7	2.7				= 2-year, 24 hour rainfall (in)
So =	1.10%	7.00%				= slope of the land (%)

Shallow Concentrated Flow (after initial 300')

					total	
T =	0.0				0.0	= travel time for sheet flow (min)
L =	0				0	= flow length (ft)
So =	13.00%					= slope of the land (%)
k =	11					= time of concentration velocity factor (ft/s)

Flow in Swales

					total	
Tc =	0.00				0.0	= travel time in swale (min)
A =	6.00					= area of flow (sf)
R =	0.59					= hydraulic radius (ft)
Ls =	4.12					= side slope wet (ft)
Q =	3.12					= quantity of flow (ft^3/sec)
V =	0.52					= velocity
L =	0				0	= flow length (ft)
Ve =	1					= vertical distance of side
Ho =	4					= horizontal distance of side
Bw =	24					= base width of swale (in)
D =	12					= depth of flow ESTIMATE (in)
S =	1.00%					= slope of the swale (%)
n =	0.2					= Manning's coefficient (channel)

Flow in Gutters

					total	
Tc =	0.0				0.0	= travel time in gutter (min)
fps =	0.02					= average velocity of flow (ft/sec)
T =	0.0					= calculated width of flow in the gutter (ft)
Qc =	0.00					= quantity of flow (as calc. Q=CIA) (ft^3/sec)
C =	0.90					= runoff coef. for rational method (paved=0.9)
I =	2.75					= rainfall intensity (assume 5 min tc)
W =	18.00					= width of pavement draining to CB
S =	8.00%					= street longitudinal slope (%)
Sx =	2.50%					= street cross slope (%)
n =	0.016					= Manning's coefficient (pavement = 0.016)
L =	0.0				0	= length of flow and drainage basin (ft)

Flow in Pipes

					total	
Tc =	0.0				0.0	= travel time in pipe (min)
V =	10.15					= calculated velocity pipe full (ft/sec)
Q =	7.96					= quantity of flow (ft^3/sec)
n =	0.013					= Manning's coefficient (pipe)
D =	12					= pipe diameter (in)
S =	5.00%					= slope of pipe (%)
L =	0.0				0	= length of pipe (ft)

Project Name: 4th Street Commons
Hydrograph Analysis Summary

Job # 17-016
Date: 10/17/2017

Rainfall (year)	Rainfall (inches)
2	2.80
5	3.20
10	3.50
25	4.00
100	0.00

Pre-Developed		
Pervious		
Area =	0.143	acres
CN =	85	na
Impervious		
Area =	0	acres
CN =	98	na
Tc =	14.8	min
Total A =	0.143	acres

Developed		
Pervious		
Area =	0	acres
CN =	85	na
Impervious		
Area =	0.143	acres
CN =	98	na
Tc =	5	min
Total A =	0.143	acres

Note: The hydrographs shown are based on the S.C.S. Type - 1A, 24 hour storm using the SBUH method based on the King County Model.

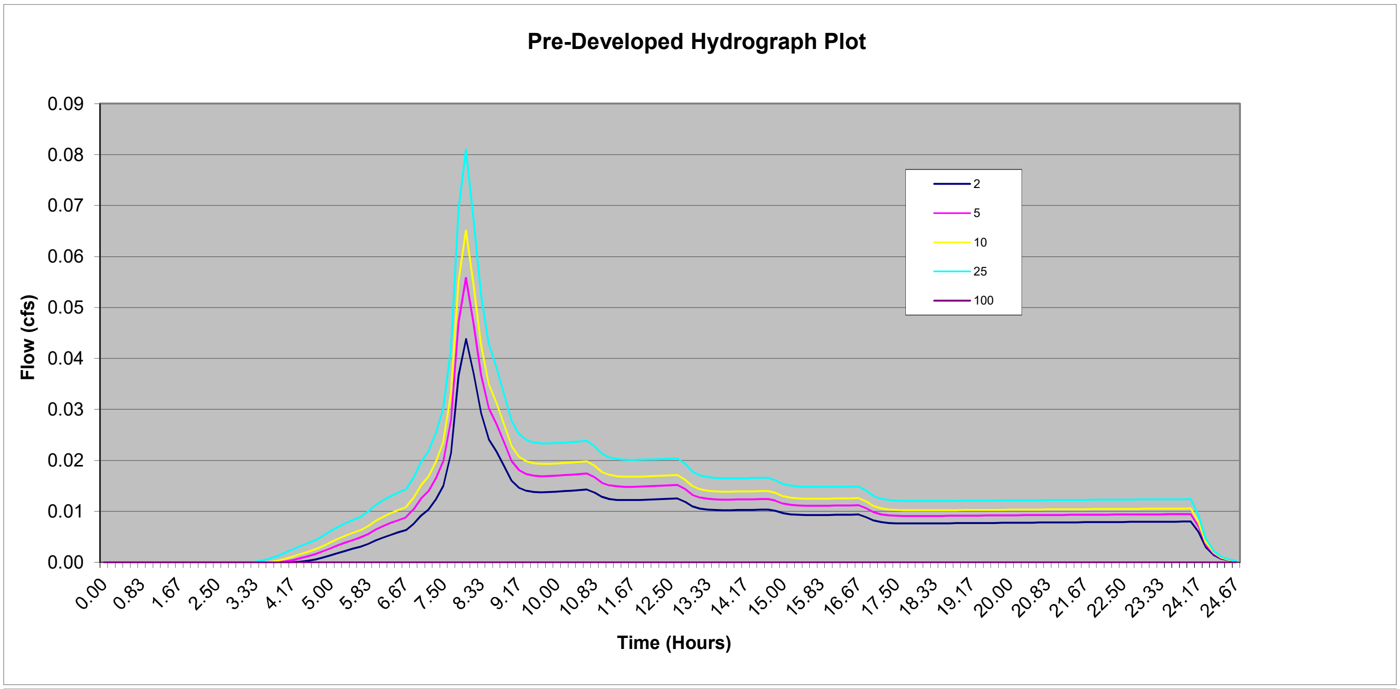
		Pre-Developed Hydrographs					Developed Hydrographs				
Year	=======>	**2**	**5**	**10**	**25**	**100**	**2**	**5**	**10**	**25**	**100**
Qpeak	cfs =>	**0.04**	**0.06**	**0.07**	**0.08**	**0.00**	**0.10**	**0.12**	**0.13**	**0.15**	**0.00**
Volume	cf =>	738	912	1,046	1,275	-	1,333	1,540	1,695	1,954	-
Tpeak	min =>	480	480	480	480	10	470	470	470	470	10
Tpeak	hr =>	8.00	8.00	8.00	8.00	0.17	7.83	7.83	7.83	7.83	0.17
Hydrograph Name=>		2	5	10	25	100	2	5	10	25	100
Time (min)	Time (hr)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)	Hyd (cfs)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
40	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
50	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
80	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
90	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
100	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00
110	1.83	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00
120	2.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
130	2.17	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
140	2.33	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
150	2.50	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
160	2.67	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00
170	2.83	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.00
180	3.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.00
190	3.17	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.00
200	3.33	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.00
210	3.50	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00
220	3.67	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.00
230	3.83	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.00
240	4.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.00
250	4.17	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.00
260	4.33	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.00
270	4.50	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.00
280	4.67	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.00
290	4.83	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.02	0.02	0.00
300	5.00	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.02	0.03	0.00
310	5.17	0.00	0.00	0.00	0.01	0.00	0.02	0.02	0.02	0.03	0.00
320	5.33	0.00	0.00	0.01	0.01	0.00	0.02	0.02	0.02	0.03	0.00
330	5.50	0.00	0.00	0.01	0.01	0.00	0.02	0.02	0.02	0.03	0.00
340	5.67	0.00	0.00	0.01	0.01	0.00	0.02	0.02	0.02	0.03	0.00
350	5.83	0.00	0.01	0.01	0.01	0.00	0.02	0.02	0.03	0.03	0.00
360	6.00	0.00	0.01	0.01	0.01	0.00	0.02	0.02	0.03	0.03	0.00
370	6.17	0.00	0.01	0.01	0.01	0.00	0.02	0.02	0.03	0.03	0.00
380	6.33	0.01	0.01	0.01	0.01	0.00	0.02	0.02	0.03	0.03	0.00
390	6.50	0.01	0.01	0.01	0.01	0.00	0.02	0.02	0.03	0.03	0.00
400	6.67	0.01	0.01	0.01	0.01	0.00	0.02	0.03	0.03	0.03	0.00
410	6.83	0.01	0.01	0.01	0.02	0.00	0.03	0.03	0.03	0.04	0.00
420	7.00	0.01	0.01	0.02	0.02	0.00	0.03	0.04	0.04	0.04	0.00
430	7.17	0.01	0.01	0.02	0.02	0.00	0.03	0.04	0.04	0.04	0.00
440	7.33	0.01	0.02	0.02	0.03	0.00	0.04	0.04	0.05	0.05	0.00
450	7.50	0.02	0.02	0.02	0.03	0.00	0.04	0.05	0.05	0.06	0.00
460	7.67	0.02	0.03	0.03	0.04	0.00	0.06	0.07	0.08	0.09	0.00
470	7.83	0.04	0.05	0.06	0.07	0.00	0.10	0.12	0.13	0.15	0.00
480	8.00	0.04	0.06	0.07	0.08	0.00	0.10	0.11	0.12	0.14	0.00
490	8.17	0.04	0.05	0.05	0.07	0.00	0.05	0.06	0.07	0.08	0.00
500	8.33	0.03	0.04	0.04	0.05	0.00	0.04	0.04	0.05	0.05	0.00
510	8.50	0.02	0.03	0.03	0.04	0.00	0.03	0.04	0.04	0.05	0.00

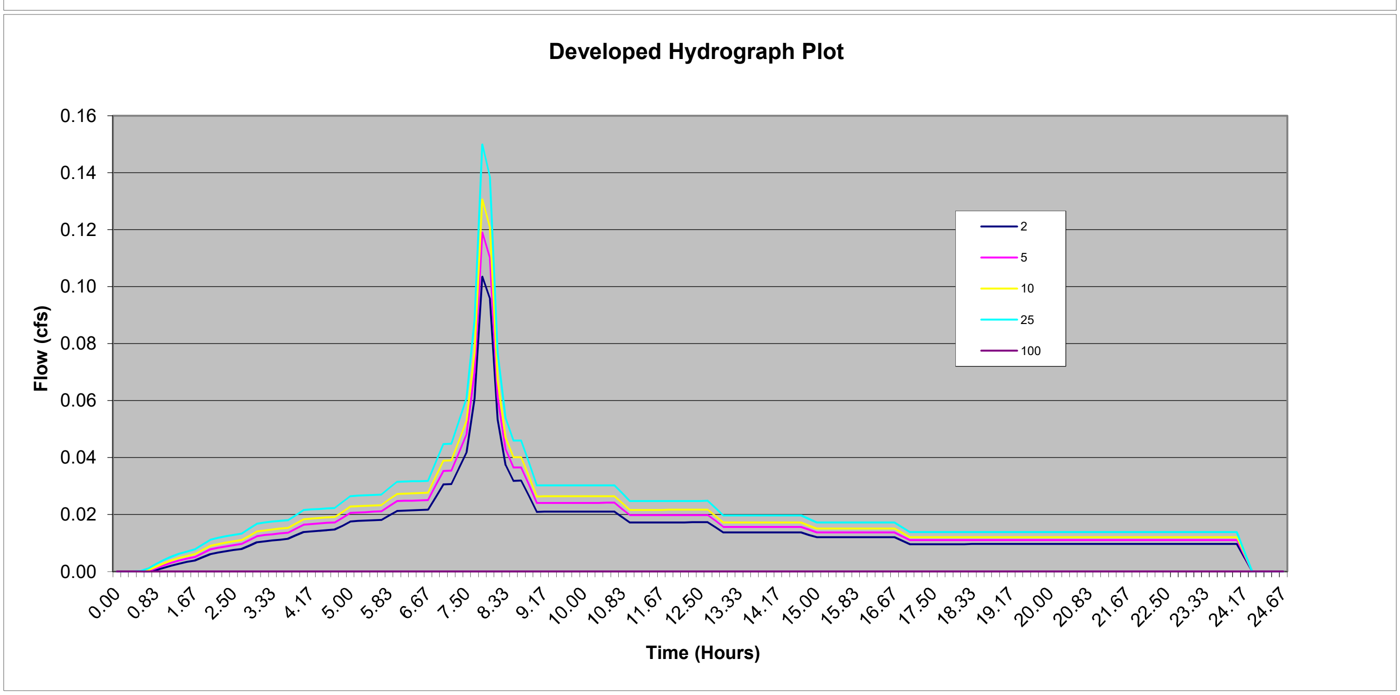
		Pre-Developed Hydrographs					Developed Hydrographs				
Year	=======>	**2**	**5**	**10**	**25**	**100**	**2**	**5**	**10**	**25**	**100**
Qpeak	cfs =>	**0.04**	**0.06**	**0.07**	**0.08**	**0.00**	**0.10**	**0.12**	**0.13**	**0.15**	**0.00**
Volume	cf =>	738	912	1,046	1,275	-	1,333	1,540	1,695	1,954	-
Tpeak	min =>	480	480	480	480	10	470	470	470	470	10
Tpeak	hr =>	8.00	8.00	8.00	8.00	0.17	7.83	7.83	7.83	7.83	0.17
Hydrograph Name=>		2	5	10	25	100	2	5	10	25	100
Time	Time	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd
(min)	(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
520	8.67	0.02	0.03	0.03	0.04	0.00	0.03	0.04	0.04	0.05	0.00
530	8.83	0.02	0.02	0.03	0.03	0.00	0.03	0.03	0.03	0.04	0.00
540	9.00	0.02	0.02	0.02	0.03	0.00	0.02	0.02	0.03	0.03	0.00
550	9.17	0.01	0.02	0.02	0.03	0.00	0.02	0.02	0.03	0.03	0.00
560	9.33	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
570	9.50	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
580	9.67	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
590	9.83	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
600	10.00	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
610	10.17	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
620	10.33	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
630	10.50	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
640	10.67	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.03	0.03	0.00
650	10.83	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.03	0.00
660	11.00	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
670	11.17	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
680	11.33	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
690	11.50	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
700	11.67	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
710	11.83	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
720	12.00	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
730	12.17	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
740	12.33	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
750	12.50	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
760	12.67	0.01	0.02	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
770	12.83	0.01	0.01	0.02	0.02	0.00	0.02	0.02	0.02	0.02	0.00
780	13.00	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
790	13.17	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
800	13.33	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
810	13.50	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
820	13.67	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
830	13.83	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
840	14.00	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
850	14.17	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
860	14.33	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
870	14.50	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
880	14.67	0.01	0.01	0.01	0.02	0.00	0.01	0.02	0.02	0.02	0.00
890	14.83	0.01	0.01	0.01	0.02	0.00	0.01	0.01	0.02	0.02	0.00
900	15.00	0.01	0.01	0.01	0.02	0.00	0.01	0.01	0.02	0.02	0.00
910	15.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
920	15.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
930	15.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
940	15.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
950	15.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
960	16.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
970	16.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
980	16.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
990	16.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
1000	16.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.02	0.02	0.00
1010	16.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.00
1020	17.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1030	17.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1040	17.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1050	17.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1060	17.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1070	17.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1080	18.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1090	18.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1100	18.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1110	18.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1120	18.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1130	18.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1140	19.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1150	19.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1160	19.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1170	19.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1180	19.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1190	19.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1200	20.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1210	20.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00

		Pre-Developed Hydrographs					Developed Hydrographs				
Year	=======>	**2**	**5**	**10**	**25**	**100**	**2**	**5**	**10**	**25**	**100**
Qpeak	cfs =>	**0.04**	**0.06**	**0.07**	**0.08**	**0.00**	**0.10**	**0.12**	**0.13**	**0.15**	**0.00**
Volume	cf =>	738	912	1,046	1,275	-	1,333	1,540	1,695	1,954	-
Tpeak	min =>	480	480	480	480	10	470	470	470	470	10
Tpeak	hr =>	8.00	8.00	8.00	8.00	0.17	7.83	7.83	7.83	7.83	0.17
Hydrograph Name=>		2	5	10	25	100	2	5	10	25	100
Time	Time	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd
(min)	(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
1220	20.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1230	20.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1240	20.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1250	20.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1260	21.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1270	21.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1280	21.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1290	21.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1300	21.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1310	21.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1320	22.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1330	22.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1340	22.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1350	22.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1360	22.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1370	22.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1380	23.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1390	23.17	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1400	23.33	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1410	23.50	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1420	23.67	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1430	23.83	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1440	24.00	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.00
1450	24.17	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00
1460	24.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1470	24.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1480	24.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1490	24.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1500	24.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

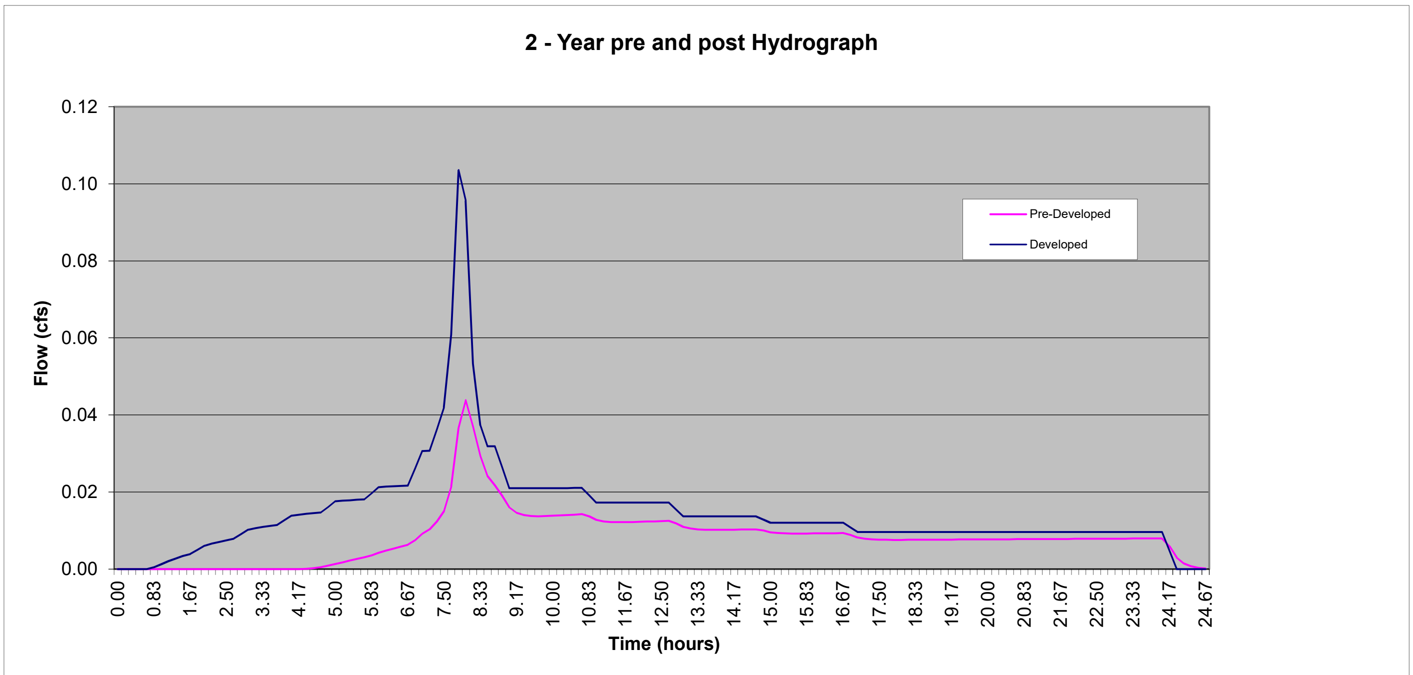
		Pre-Developed Hydrographs				
Year	=======>	**2**	**5**	**10**	**25**	**100**
Qpeak	cfs =>	**0.04**	**0.06**	**0.07**	**0.08**	**0.00**
Volume	cf =>	738	912	1,046	1,275	-
Tpeak	min =>	480	480	480	480	10
Tpeak	hr =>	8.00	8.00	8.00	8.00	0.17
Hydrograph Name=>		2	5	10	25	100
Time	Time	Hyd	Hyd	Hyd	Hyd	Hyd
(min)	(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)

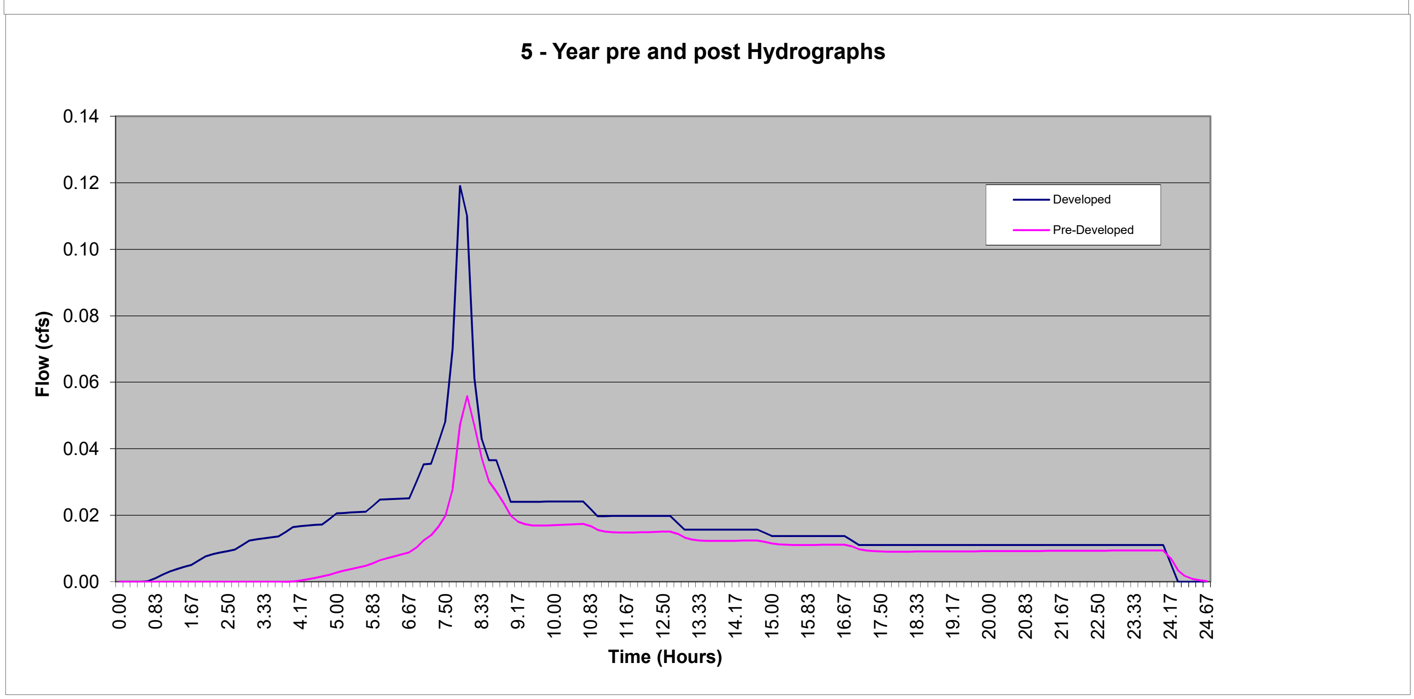
Developed Hydrographs				
2	**5**	**10**	**25**	**100**
0.10	**0.12**	**0.13**	**0.15**	**0.00**
1,333	1,540	1,695	1,954	-
470	470	470	470	10
7.83	7.83	7.83	7.83	0.17
2	5	10	25	100
Hyd	Hyd	Hyd	Hyd	Hyd
(cfs)	(cfs)	(cfs)	(cfs)	(cfs)



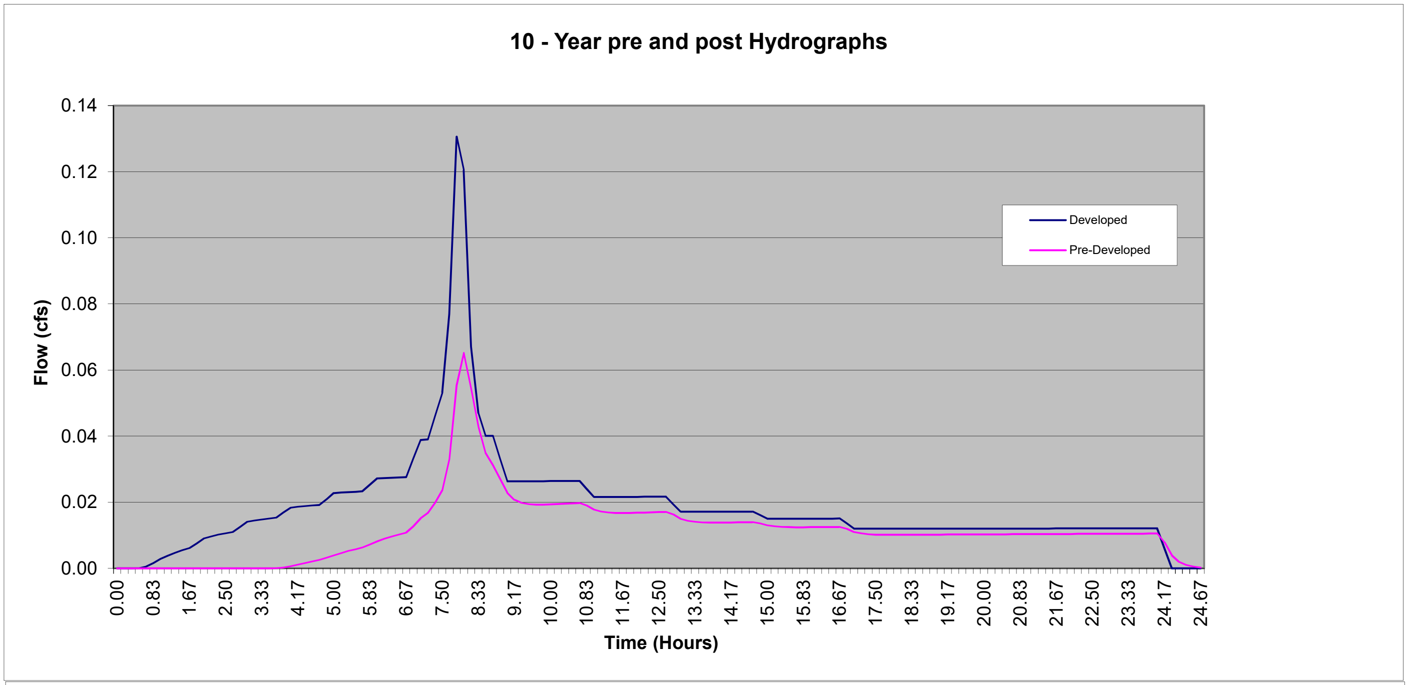


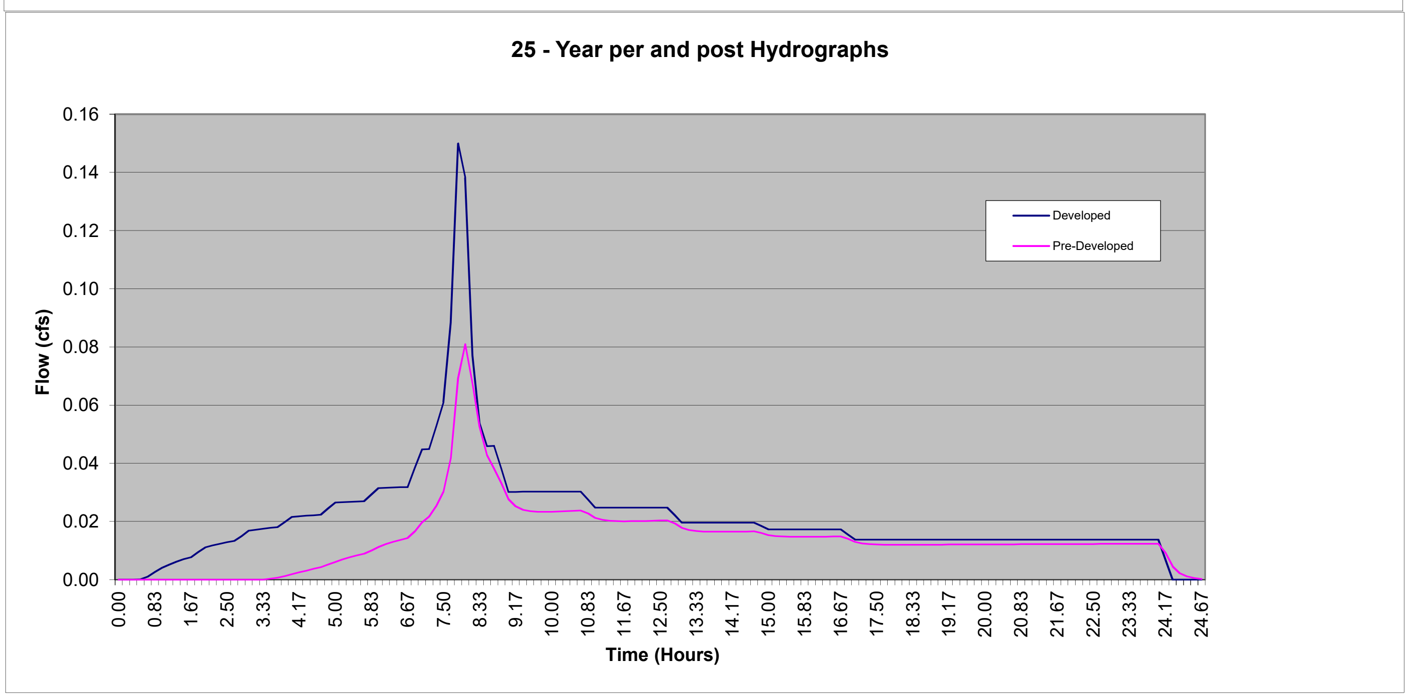
		Pre-Developed Hydrographs					Developed Hydrographs				
Year	=======>	**2**	**5**	**10**	**25**	**100**	**2**	**5**	**10**	**25**	**100**
Qpeak	cfs =>	**0.04**	**0.06**	**0.07**	**0.08**	**0.00**	**0.10**	**0.12**	**0.13**	**0.15**	**0.00**
Volume	cf =>	738	912	1,046	1,275	-	1,333	1,540	1,695	1,954	-
Tpeak	min =>	480	480	480	480	10	470	470	470	470	10
Tpeak	hr =>	8.00	8.00	8.00	8.00	0.17	7.83	7.83	7.83	7.83	0.17
Hydrograph Name=>		2	5	10	25	100	2	5	10	25	100
Time	Time	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd	Hyd
(min)	(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)





		Pre-Developed Hydrographs						Developed Hydrographs				
Year	=======>	**2**	**5**	**10**	**25**	**100**		**2**	**5**	**10**	**25**	**100**
Qpeak	cfs =>	**0.04**	**0.06**	**0.07**	**0.08**	**0.00**		**0.10**	**0.12**	**0.13**	**0.15**	**0.00**
Volume	cf =>	738	912	1,046	1,275	-		1,333	1,540	1,695	1,954	-
Tpeak	min =>	480	480	480	480	10		470	470	470	470	10
Tpeak	hr =>	8.00	8.00	8.00	8.00	0.17		7.83	7.83	7.83	7.83	0.17
Hydrograph Name=>		2	5	10	25	100		2	5	10	25	100
Time	Time	Hyd	Hyd	Hyd	Hyd	Hyd		Hyd	Hyd	Hyd	Hyd	Hyd
(min)	(hr)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)		(cfs)	(cfs)	(cfs)	(cfs)	(cfs)





Project Name: 4th Street Commons
Detention System Summary

Job # 17-016
Date: 10/17/2017

Note: The detention system design is based on the King County Model "Facility Design Routine".

1) Detention Facility Design Input:

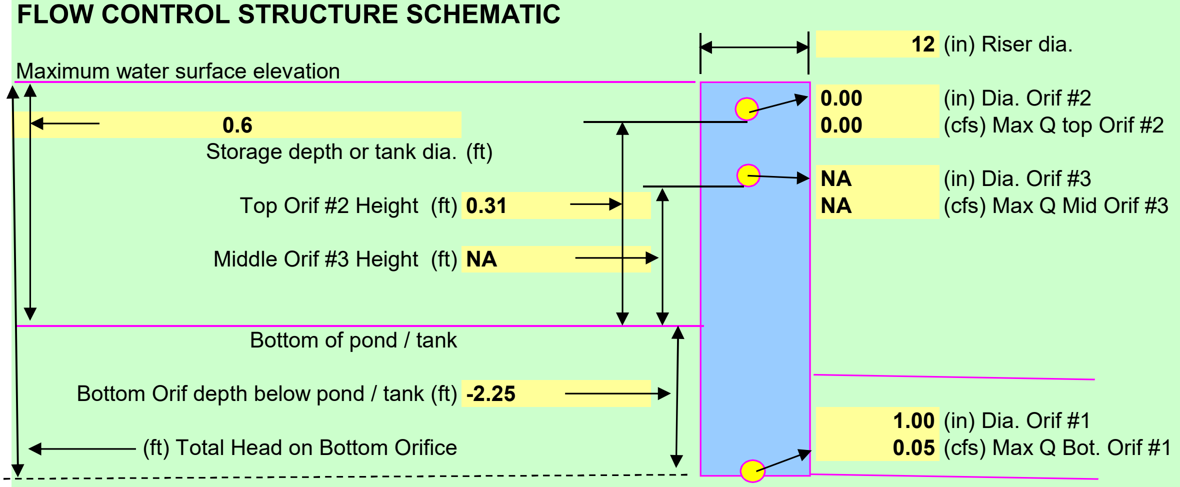
2) Type of facility:	USER	
3) Pond side slopes:	3 NA in USER mode	
4) Pond storage depth:	**0.63 ft (from bottom of pond to overflow)**	
5) Vertical permeability	0 min/in	
6) Number of orifices:	2	
7) Riser dia. =>	12 in	
8) Orifice coefficient	0.62 (typically 0.62)	
9) IE - bottom orifice:	-2.25 ft (distance below bottom of pond - Negative #)	
10) Max Q Bottom Orif. #1	0.05 cfs	
11) Top Orif #2 Height =	0.305 ft	
12) Max Q Mid Orif. #3	0.00 cfs	Orifice not being used
13) Mid Orif #3 Height =	0.00 ft	Orifice not being used

Detention Facility Design Results:

Performance year	Developed Inflow cfs	Pre-Developed Outflow cfs	**Actual Outflow cfs**	Peak Stage ft	Storage cf
100	0	0	**0**	0	-
25	0.15	0.08	**0.05**	0.63	196
10	0.13	0.07	**0.05**	0.47	145
5	0.12	0.06	**0.04**	0.38	119
2	0.10	0.04	**0.04**	0.28	86
			Required Storage ====:		196

	Bottom Orif.	Middle Orif.	Top Orif.	Optional Weir Design (for top orifice)
Total Q =	0.05	0.00	0.00	
Head (ft) =	2.88	0.00	0.33	0.13 La (ft)
Dist. from bottom of pond (ft) =	-2.25	NA	0.31	14.90 < deg.
Orif. Dia. (in) =	1.00	0.00	0.00	Weir is an option

FLOW CONTROL STRUCTURE SCHEMATIC



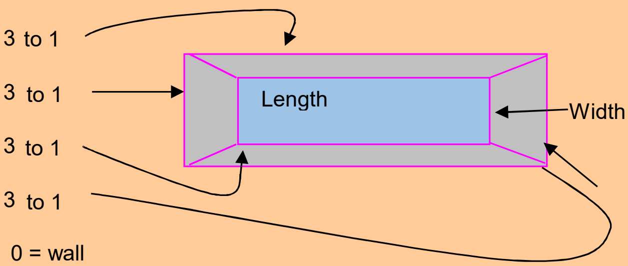
Project Name: 4th Street Commons
Detention Facility Type
Job # 17-016
Date: 10/17/2017

Detention Facility Type:

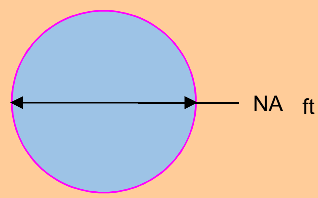
USER

L =	**NA ft**
W =	**NA ft**
D =	**0.6 ft**
Pond Area =	**NA sf**

DETENTION POND
NA



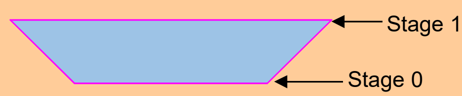
DETENTION TANK
NA

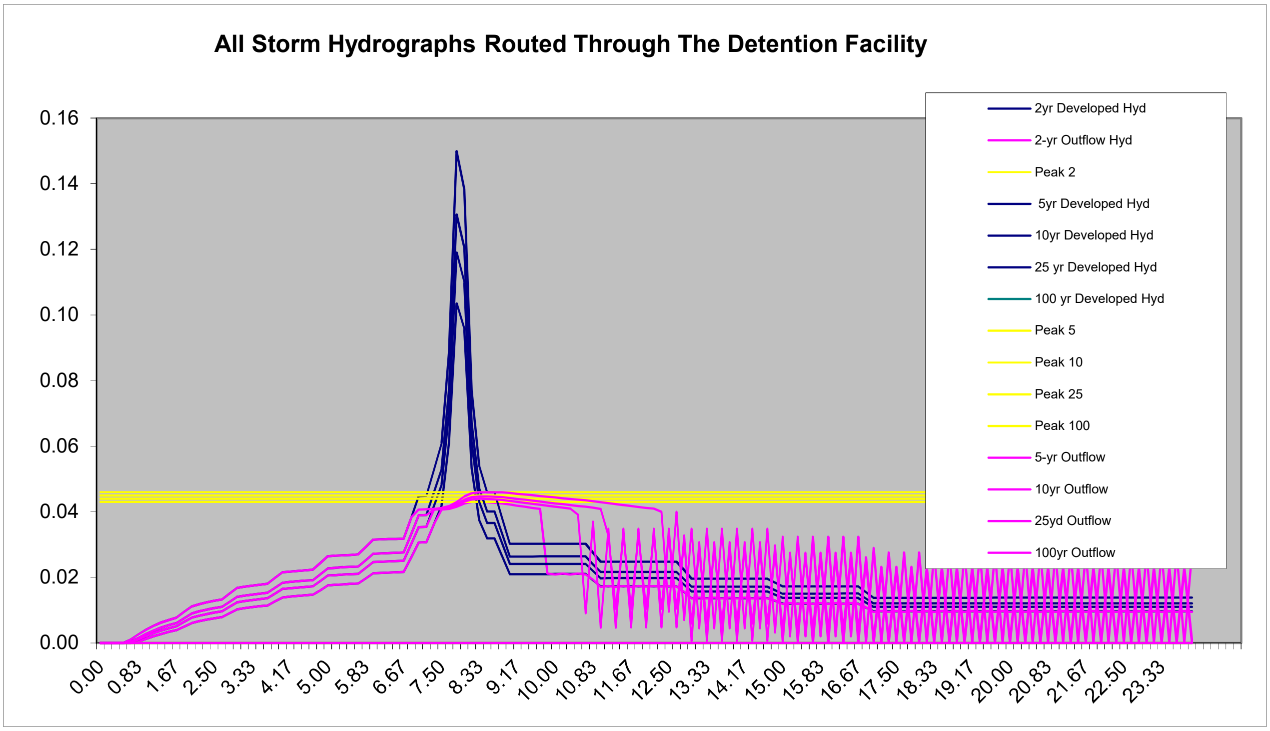


USER DEFINED POND

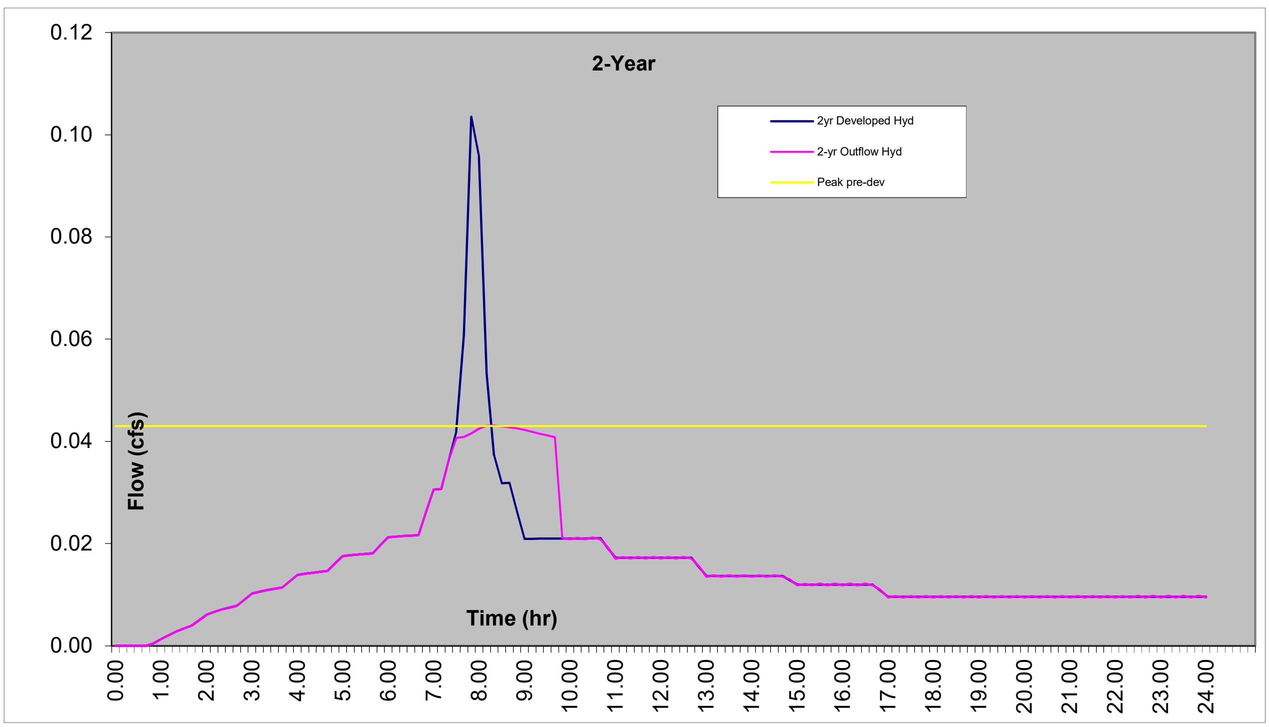
Pond Geometry

Stage (ft)	Area (sf)
0	312
1	312
2	312
3	312
4	312
5	312
6	312
7	312
8	312
9	312
10	312
11	312
12	312
13	312
14	312
15	312

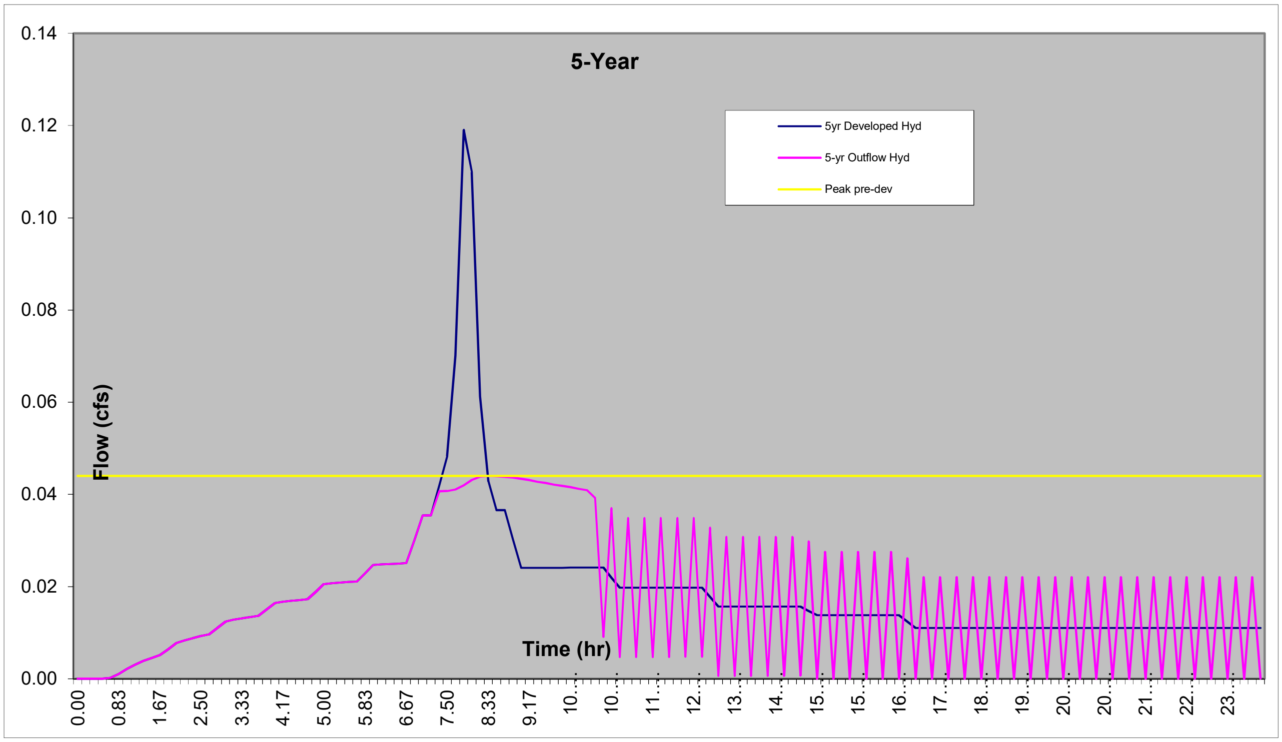


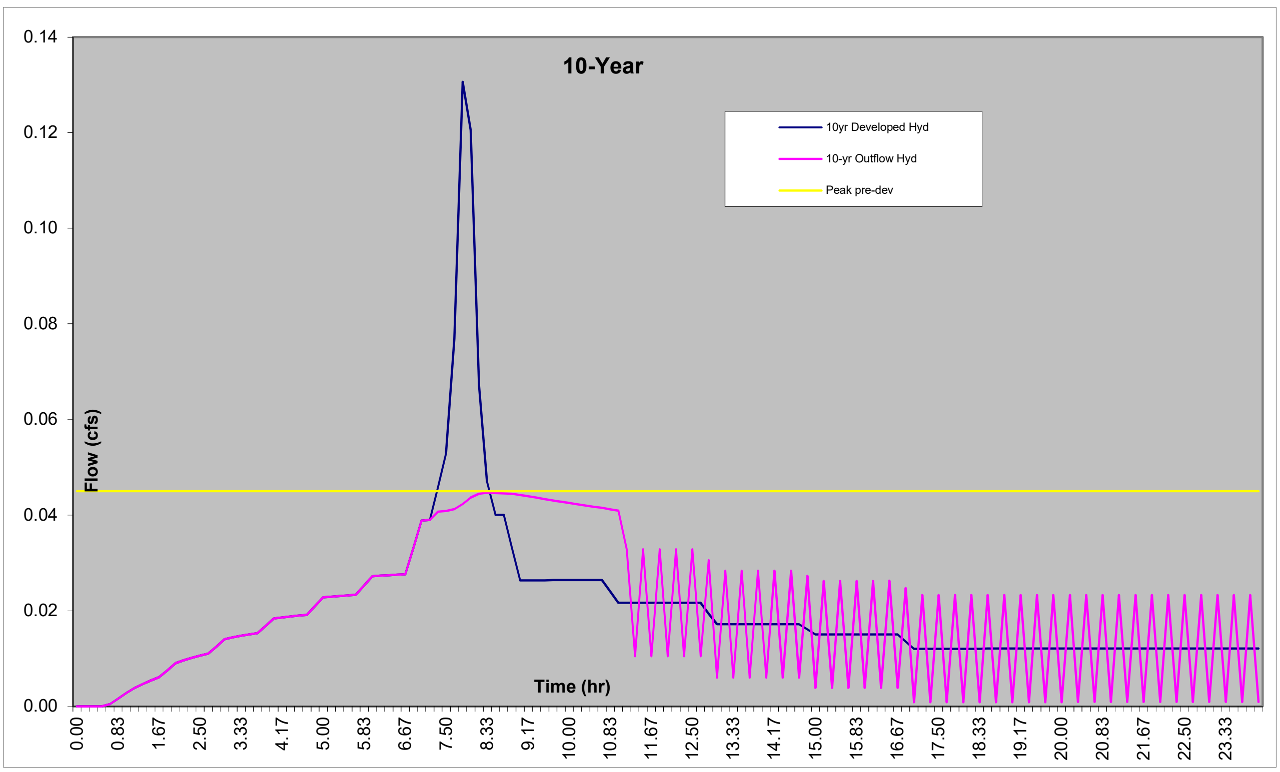


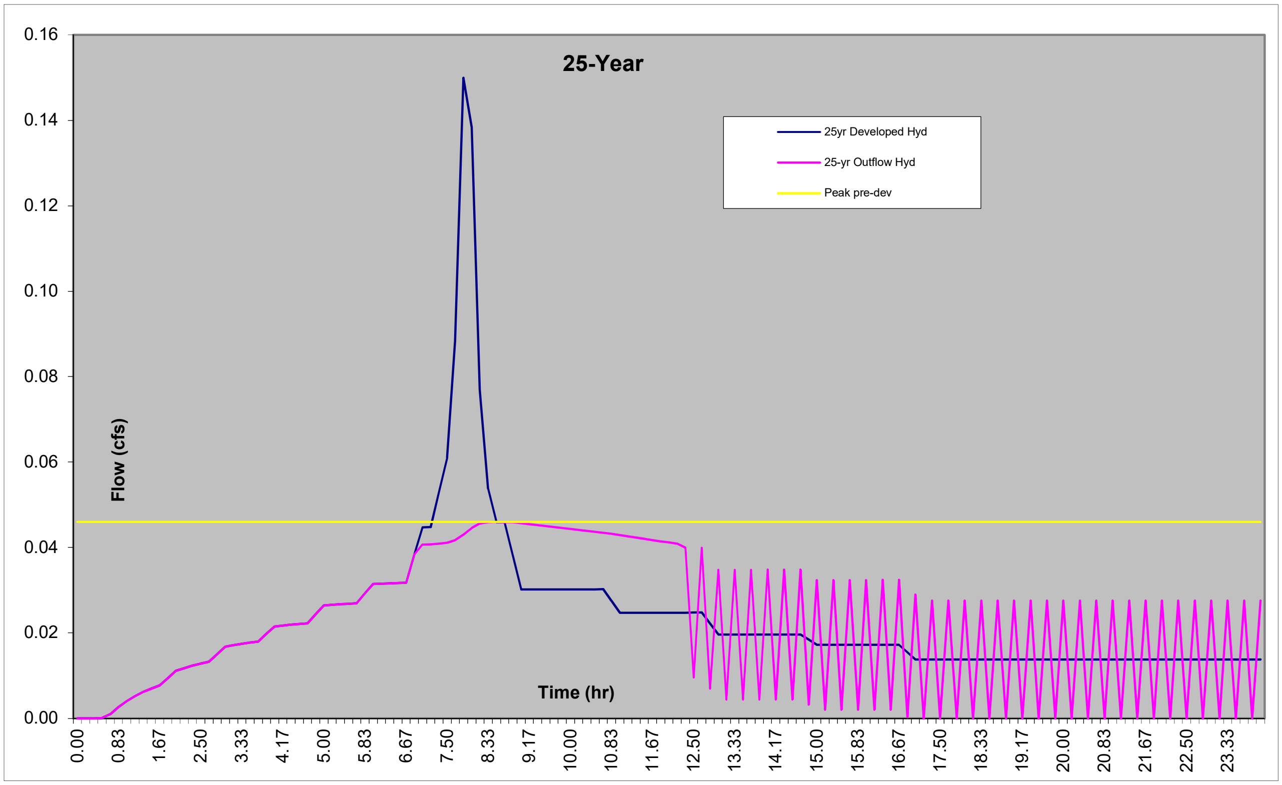
All Storm Hydrographs Routed Through The Detention Facility
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.00
0.83
1.67
2.50
3.33
4.17
5.00
5.83
6.67
7.50
8.33
9.17
10.00
10.83
11.67
12.50
13.33
14.17
15.00
15.83
16.67
17.50
18.33
19.17
20.00
20.83
21.67
22.50
23.33
2yr Developed Hyd
2-yr Outflow Hyd
Peak 2
5yr Developed Hyd
10yr Developed Hyd
25 yr Developed Hyd
100 yr Developed Hyd
Peak 5
Peak 10
Peak 25
Peak 100
5-yr Outflow
10yr Outflow
25yd Outflow
100yr Outflow

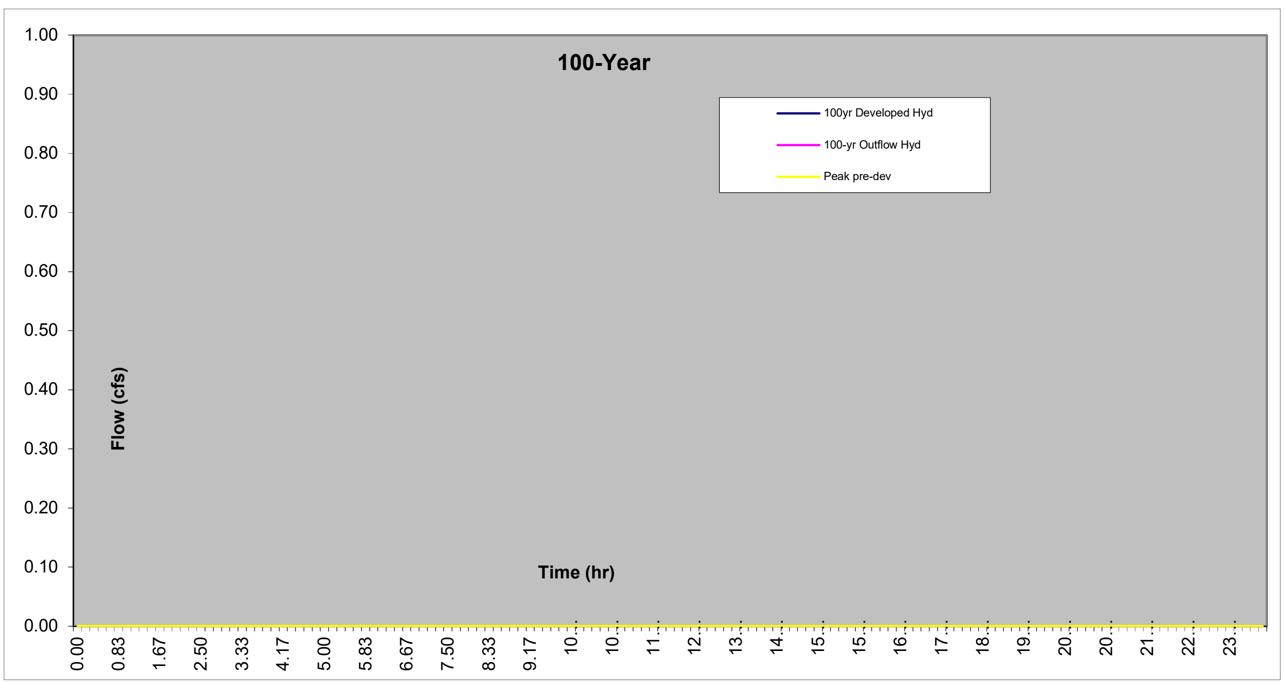


2-Year
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Flow (cfs)
Time (hr)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00
11.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
21.00
22.00
23.00
24.00
2yr Developed Hyd
2-yr Outflow Hyd
Peak pre-dev


5-Year
5yr Developed Hyd
5-yr Outflow Hyd
Peak pre-dev
Flow (cfs)
Time (hr)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.00
0.83
1.67
2.50
3.33
4.17
5.00
5.83
6.67
7.50
8.33
9.17


10-Year
10yr Developed Hyd
10-yr Outflow Hyd
Peak pre-dev
Flow (cfs)
Time (hr)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.00
0.83
1.67
2.50
3.33
4.17
5.00
5.83
6.67
7.50
8.33
9.17
10.00
10.83
11.67
12.50
13.33
14.17
15.00
15.83
16.67
17.50
18.33
19.17
20.00
20.83
21.67
22.50
23.33

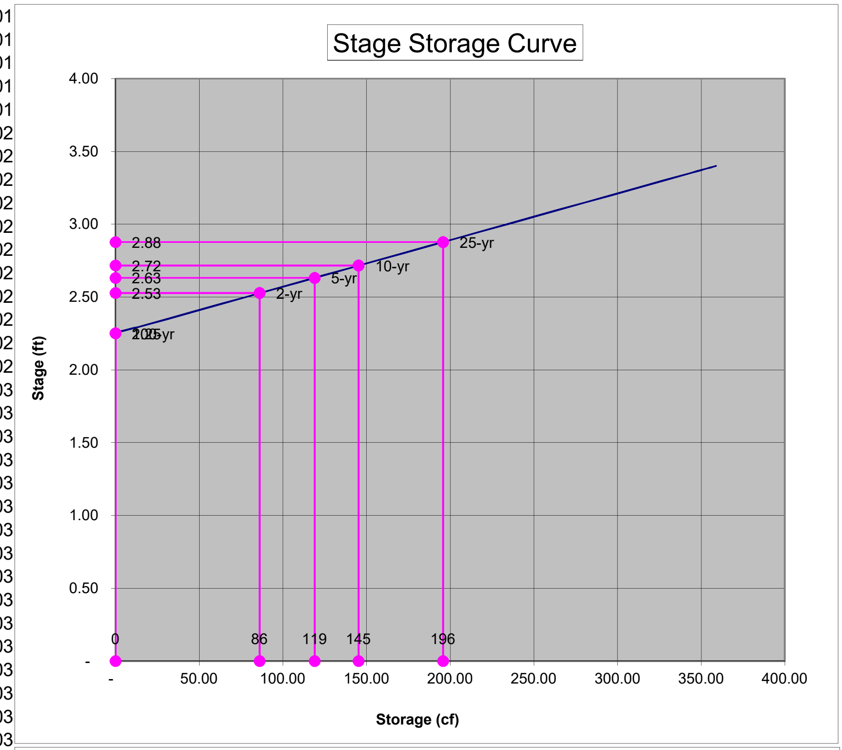

25-Year
25yr Developed Hyd
25-yr Outflow Hyd
Peak pre-dev
Flow (cfs)
Time (hr)
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0.00 0.83 1.67 2.50 3.33 4.17 5.00 5.83 6.67 7.50 8.33 9.17 10.00 10.83 11.67 12.50 13.33 14.17 15.00 15.83 16.67 17.50 18.33 19.17 20.00 20.83 21.67 22.50 23.33

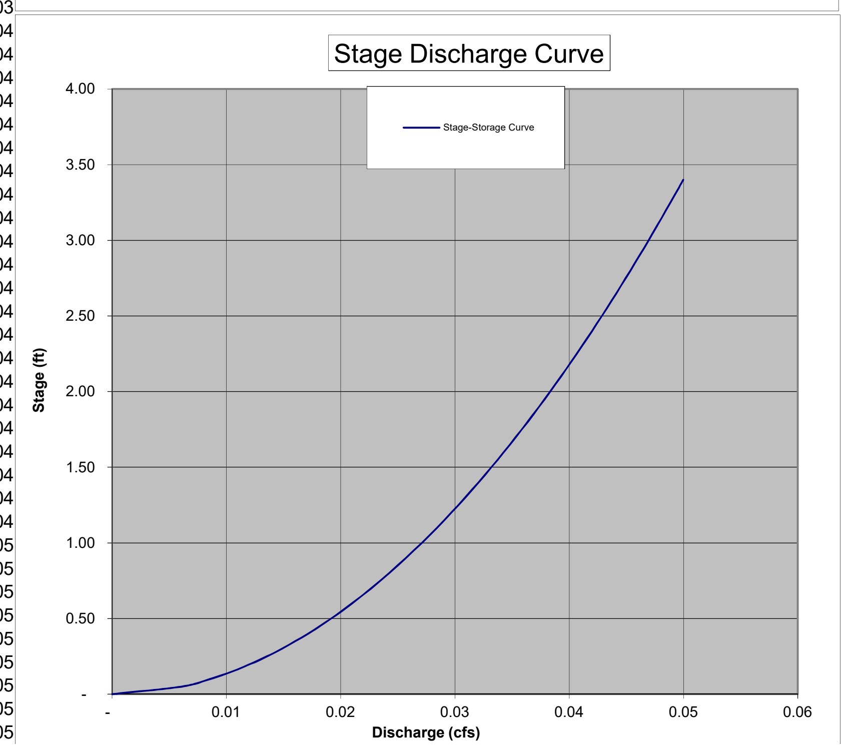

100-Year
100yr Developed Hyd
100-yr Outflow Hyd
Peak pre-dev
Flow (cfs)
Time (hr)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00 0.83 1.67 2.50 3.33 4.17 5.00 5.83 6.67 7.50 8.33 9.17

Project Name: 4th Street Commons
Stage Storage Summary

Job # 17-016
Date: 10/17/2017

Stage ft	Storage cf	Discharge cfs
-	-	-
0.05	-	0.01
0.10	-	0.01
0.15	-	0.01
0.20	-	0.01
0.25	-	0.01
0.30	-	0.01
0.35	-	0.02
0.40	-	0.02
0.45	-	0.02
0.50	-	0.02
0.55	-	0.02
0.60	-	0.02
0.65	-	0.02
0.70	-	0.02
0.75	-	0.02
0.80	-	0.02
0.85	-	0.02
0.90	-	0.03
0.95	-	0.03
1.00	-	0.03
1.05	-	0.03
1.10	-	0.03
1.15	-	0.03
1.20	-	0.03
1.25	-	0.03
1.30	-	0.03
1.35	-	0.03
1.40	-	0.03
1.45	-	0.03
1.50	-	0.03
1.55	-	0.03
1.60	-	0.03
1.65	-	0.03
1.70	-	0.04
1.75	-	0.04
1.80	-	0.04
1.85	-	0.04
1.90	-	0.04
1.95	-	0.04
2.00	-	0.04
2.05	-	0.04
2.10	-	0.04
2.15	-	0.04
2.20	-	0.04
2.25	-	0.04
2.30	15.60	0.04
2.35	31.20	0.04
2.40	46.80	0.04
2.45	62.40	0.04
2.50	78.00	0.04
2.55	93.60	0.04
2.60	109.20	0.04
2.65	124.80	0.04
2.70	140.40	0.04
2.75	156.00	0.04
2.80	171.60	0.05
2.85	187.20	0.05
2.90	202.80	0.05
2.95	218.40	0.05
3.00	234.00	0.05
3.05	249.60	0.05
3.10	265.20	0.05
3.15	280.80	0.05
3.20	296.40	0.05





Stage ft	Storage cf	Discharge cfs
3.25	312.00	0.05
3.30	327.60	0.05
3.35	343.20	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
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3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05
3.40	358.80	0.05

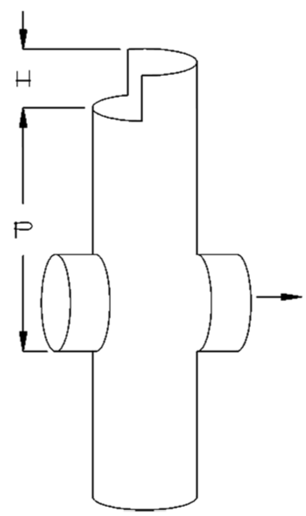
Project Name: 4th Street Commons
Rectangular, Sharp Crested Weir Calculations
Job #	17-016
Date:	10/17/2017

Weir Equation: $Q = C(L-0.2H)H^{3/2}$

Q	= Flow over weir (cfs)
C	= 3.27 + 0.40 H/P (ft)
L	= Adjusted length of weir (La - 0.1H x 2) this is to account for side constraints
La	= Actual length of weir along pipes interior circumference (ft)
H	= Distance from bottom of weir to maximum head (ft)
P	= Distance from bottom of weir to outfall invert elevation (ft)
D	= Inside riser pipe diameter (in)
<	= Angle of opening for weir (maximum 180 degrees)

Given:

Q	0.00	cfs
H	0.33	ft
P	2.56	ft
D	8	in



Find:

C	3.32	ft
L	0.07	ft
La	**0.13**	**ft**
<	**22**	**degrees**