

MR 1-9 Storm Drainage Summary

East Mercer Site
Development Permit
Parcels 1-3
8375 & 8383 East Mercer Way
Mercer Island, WA 98040

Minor Modifications April 13, 2018
~~Updated April 6, 2018~~

Prepared by Duffy Ellis, P.E.



General:

This storm report summarizing compliance with DOE MR 1-9 requirements is associated with the Site Development Permit for a 3 lot property (but not a plat). This permit mostly constructs a new joint use driveway, utilities, slope regrading, and detention system that will serve not only the private driveway but future parcel 1 house and driveway.

There are three associated building permits related to this Site Development permit that will construct 3 new houses on these legal lots. We have done the engineering for those also. Parcels 2 and 3 will each have their own detention system. The Architect is Ripple Design.

Following is table briefly summarizing compliance with minimum requirements MR1-9 identified below.

MR1 = Preparation of Storm Water Site Plans	See Site Development Planset
MR2 = Construction Storm Water Pollution Prevention Plan	Please see sheet C1.0 TESCP in plan set. We can prepare a separate CSWPPP if requested.
MR3 = Source Control of Pollution	See C1.0 for erosion control plan that will mitigate erosion and sediment discharge from site during construction phase. Site is mapped within potential erosion hazard area according to City Geologic Maps. Pangeo opinion is site erosion hazard can be mitigated with best management practices. See page 5 of their report for discussion of this in more detail.

MR4 = Preservation of Natural Drainage Systems and Outfalls	Project will not substantially alter drainage patterns and outfalls. All runoff ends up in East Mercer Storm/ditch system. Project will have 3 detention systems that collectively mitigate peak discharge rates from site.
MR5 = On-site Stormwater Management	<p>BMP's are currently not recommended and not proposed due to topographic and slope stability concerns clearly expressed by the Geotechnical Engineer, Pangeo. Soils lack cohesion and will require stabilization. Please read the site development permit and soils report for reference.</p> <p>See next page for brief discussion of the BMP list Approach.</p>
MR6 = Runoff Treatment	PGIS exceeds 5,000 sf. A stormfilter proposed. See C2.0 for location. See C3.7 for stormfilter detail. We coordinated stormfilter selection with Stephanie Jacobson at Contech.
MR7 = Flow Control	Detention sizing included in this report meeting the MR 5 sizing protocol for each lot. Parcel 1 sizing was custom sized using SBUH (Hydrology Studio.) Parcels 2 and 3 used Mercer Island Standard sizing table. B soil sizing required.
MR8 = Wetlands Protection	Wetlands exist on upper part of property. See separate critical area permits.
MR9 = Operations and Maintenance	Will provide maintenance sheets on request for detention and storm filter.

Soils and Infiltration Feasibility:

Geology Maps indicate site is underlain by Advanced Outwash and Lawton Clay. Groundwater encountered in several bores. BMP measures are not recommended. Soil improvement is recommended with use a aggregate pier grid.

MR 5 Proposed On-site Stormwater management:

The List Approach (List #1) selection process was applied to site:

Lawn and Landscaped Areas:

- Post-Construction Soil Quality and Depth in accordance BMP T5.13 in Chapter 5 of Volume V of the DOE Manual. Compost-Amended Soil is required.

Roofs:

- Full Dispersion:
Infeasible due to lack of 100 LF flowpath
- Downspout Full Infiltration:
Despite advanced outwash soils, full infiltration not recommended due to slope stability concerns for this site as discussed in depth in the soils report.
- Rain Garden
Not feasible to incorporate for the entry driveway being constructed with Site Development Permit.

Other Hard Surfaces:

- Full Dispersion:
Infeasible due to lack of 100 LF flowpath
- Permeable Pavement:
Not proposed for entry driveway due to 20% grade plus deep cut slopes into the Lawton Clay.

Storm Report Attachments

- Drainage Narrative
- Drainage Design Summary
- Detention Sizing Calculations Parcel 1 Tank (SBUH)
- Soils Report by Pangeo (see standalone copy)

Drainage Narrative

Site Development Permit Submittal
New Horizon Real Estate Co.
3 parcel Development with shared Access

8375 & 8383 East Mercer Way
Mercer Island, WA 98040

This narrative describes the stormwater design for the above referenced project located off East Mercer Way near the 8300 block. Subject property's lot lines were reconfigured to allow 3 single family parcels. Project is being developed by New Horizon Development LLC. Project architect is Ripple Design based out of Seattle.

Drainage design for these 3 adjacent single family projects that share a new access can best be described by this short summary:

- A site Development Permit will construct a new detention system on parcel 1 that serves parcel 1 house and shared driveway buildout (sized by custom storm routing using SBUH and correction factor)
- Parcel 2 will have its own standalone detention system (sized using MI table)
- Parcel 3 will have its own standalone detention system (sized using MI table)

Detention storage up to the 100 year storm to mitigate for increased runoff rates and volumes caused by increased impervious area. Since each project is under 1.0 acres, this project is subject to an older 1992 design standard. A SBUH program (Hydrology Studio software) was used to determine required orifice sizing and pipe diameter to attenuate peak flows to historic rates for the 2, 10, and 100 year storms. Project site has Type B (Outwash) hydrologic soils. See geotechnical report for reference. Please see the Drainage Memo Design summary that provides a summary of the input and results of SBUH hydrology and detention sizing analysis. See the output from SBUH for more detailed information on sizing including pre and post time of concentrations, runoff curve numbers, stage storage, etc. System is currently oversized for first submittal.

Currently no stormwater MR 5 BMP's are not recommended or proposed at this time due to slope stability and soil constraints. See the drainage report for reference.

Sincerely,

Duffy Ellis, P.E.

Memorandum

April 13, 2018

Re: Detention Design Summary
Parcel 1 / Site Development Permit Review
83xx East Mercer Way
Mercer Island, WA 98040

A stormwater detention system has been sized for the above referenced project in compliance with City of Mercer Stormwater Standards. The following is a summary of the system sized using SBUH and complying with the 1992 sizing requirement. Project is less than 1.0 acres.

Subject detention tank will serve the easterly parcel 2 and shared driveway access. See map for tributary area these calculations are based on.

Detention Summary

Gross Site Area	0.26 Acres (See hatched area on map for reference)
Max Impervious Area	0.21 acres
% Impervious	40% (assume max lot coverage)
Design Program for sizing	SCS / SBUH (Hydrology Studio)
Storm Events	2, 10, and 100 year
Number of Orifices	2
CN value pre-development	72 (outwash Group B, revised April 13, 2018)
CN value Post development (weighted)	96
Time of Concentration (pre)	20 minutes calculated
Time of Concentration (post)	7.5 minutes
2 year storm allowed release	0.01 cfs (B soil)
10-year storm allowed release	0.03 cfs (B soil)
100-year storm allowed release	0.07 cfs
Soil Type	Type B (revised April 2018)
Detention Pipe Diameter	60-inch diameter
Required Length	65 LF (before correction factor)
Length Current proposed	83 LF (including correction)
Orifice Sizing: lower	See appendix report output & sheet C4.1
Orifice Sizing: upper	See sheet C4.0

Respectfully,

Duffy Ellis, P.E.

DETENTION SIZING
HYDROLOGY STUDIO
SBUH
PARCEL 1
RESULTS:
ADJUSTED LENGTH=83 LF - 60" DIA

Parcel 1 Ex



Parcel 1 Proposed



Pond Report

Project Name:

Hydrology Studio v 2.0.0.52

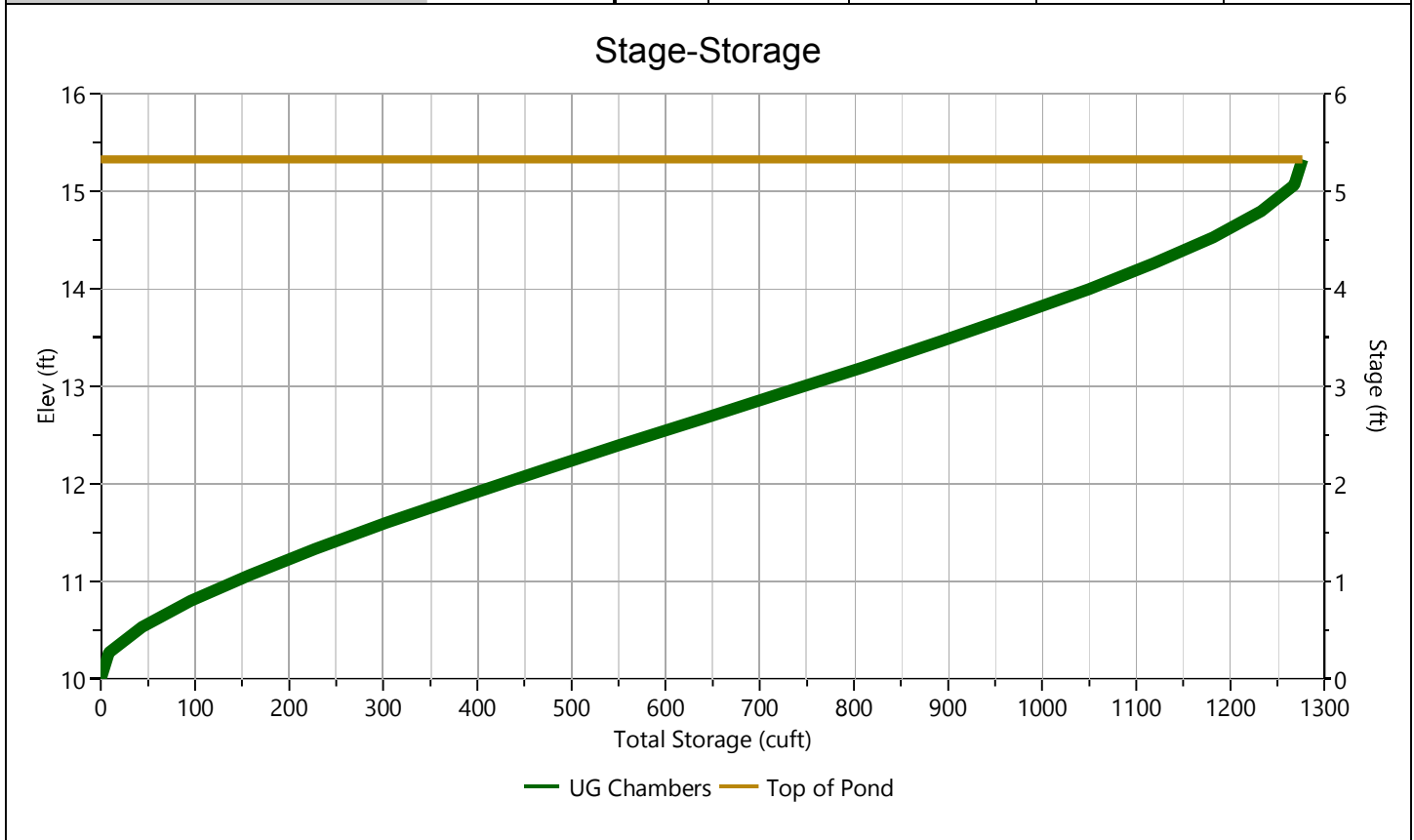
04-13-2018

60-inch Detention

LENGTH NEEDED BEFORE ADJUST.

Stage-Storage

Underground Chambers		Stage / Storage Table				
Description	Input	Stage (ft)	Elevation (ft)	Contour Area (sqft)	Incr. Storage (cuft)	Total Storage (cuft)
Invert Elev Down, ft	10.00	0.00	10.00	n/a	0.000	0.000
Chamber Rise, ft	5.00	0.27	10.27	n/a	8.68	8.68
Chamber Shape	Circular	0.53	10.53	n/a	35.0	43.7
Chamber Span, ft	5.00	0.80	10.80	n/a	51.6	95.3
Barrel Length, ft	65.00	1.07	11.07	n/a	62.2	158
No. Barrels	1	1.33	11.33	n/a	69.9	227
Barrel Slope, %	0.50	1.60	11.60	n/a	75.9	303
Headers, y/n	No	1.86	11.86	n/a	80.3	384
Stone Encasement, y/n	No	2.13	12.13	n/a	83.3	467
Encasement Bottom Elevation, ft	0.00	2.40	12.40	n/a	85.3	552
Encasement Width per Chamber, ft	0.00	2.66	12.66	n/a	86.2	638
Encasement Depth, ft	0.00	2.93	12.93	n/a	86.2	725
Encasement Voids, %	40.00	3.20	13.20	n/a	85.4	810
		3.46	13.46	n/a	83.2	893
		3.73	13.73	n/a	80.3	974
		3.99	13.99	n/a	75.8	1,049
		4.26	14.26	n/a	69.9	1,119
		4.53	14.53	n/a	62.3	1,181
		4.79	14.79	n/a	51.5	1,233
		5.06	15.06	n/a	34.9	1,268
		5.33	15.33	n/a	8.65	1,277



Pond Report

Project Name:

Hydrology Studio v 2.0.0.52

04-13-2018

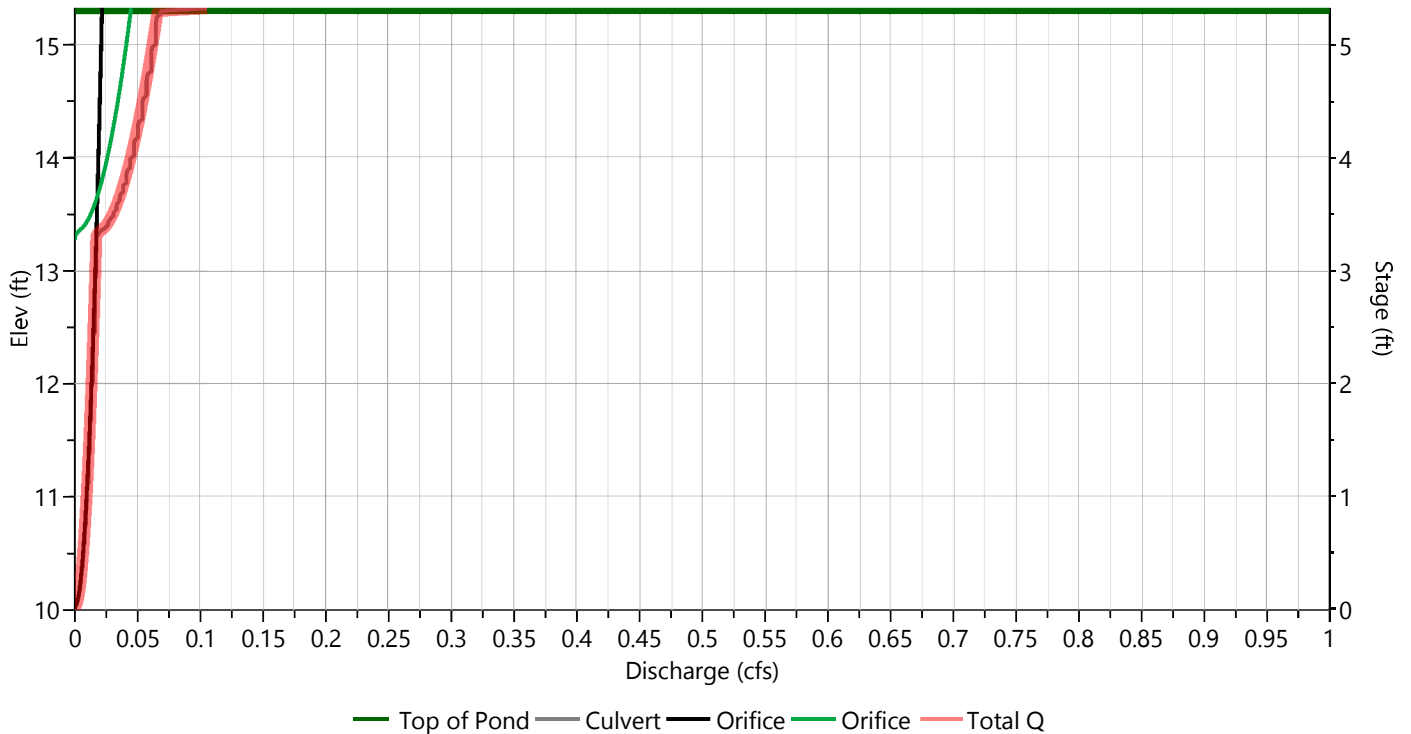
60-inch Detention

Stage-Discharge

Culvert / Orifices	Culvert	Orifices			Orifice Plate
		1*	2*	3	
Rise, in	8	.6	1.1		Orifice Rise, in
Span, in	8	.6	1.1		Orifice Span, in
No. Barrels	1	1	1		No. Orifices
Invert Elevation, ft	10	10.01	13.3		Invert Elevation, ft
Orifice Coefficient, Co	.6	.6	.6		Height, ft
Length, ft	15				Orifice Coefficient, Co
Barrel Slope, %	1				
N-Value, n	0.013				
Weirs	Riser*	Weirs			Ancillary
		1	2	3	
Shape / Type	Circular				Exfiltration, in/hr
Crest Elevation, ft	15.3				Tailwater Elevation, ft
Crest Length, ft	3				
Angle, deg					
Weir Coefficient, Cw	3.3				

*Routes through Culvert.

Stage-Discharge



Pond Report

Project Name:

Hydrology Studio v 2.0.0.52

04-13-2018

60-inch Detention

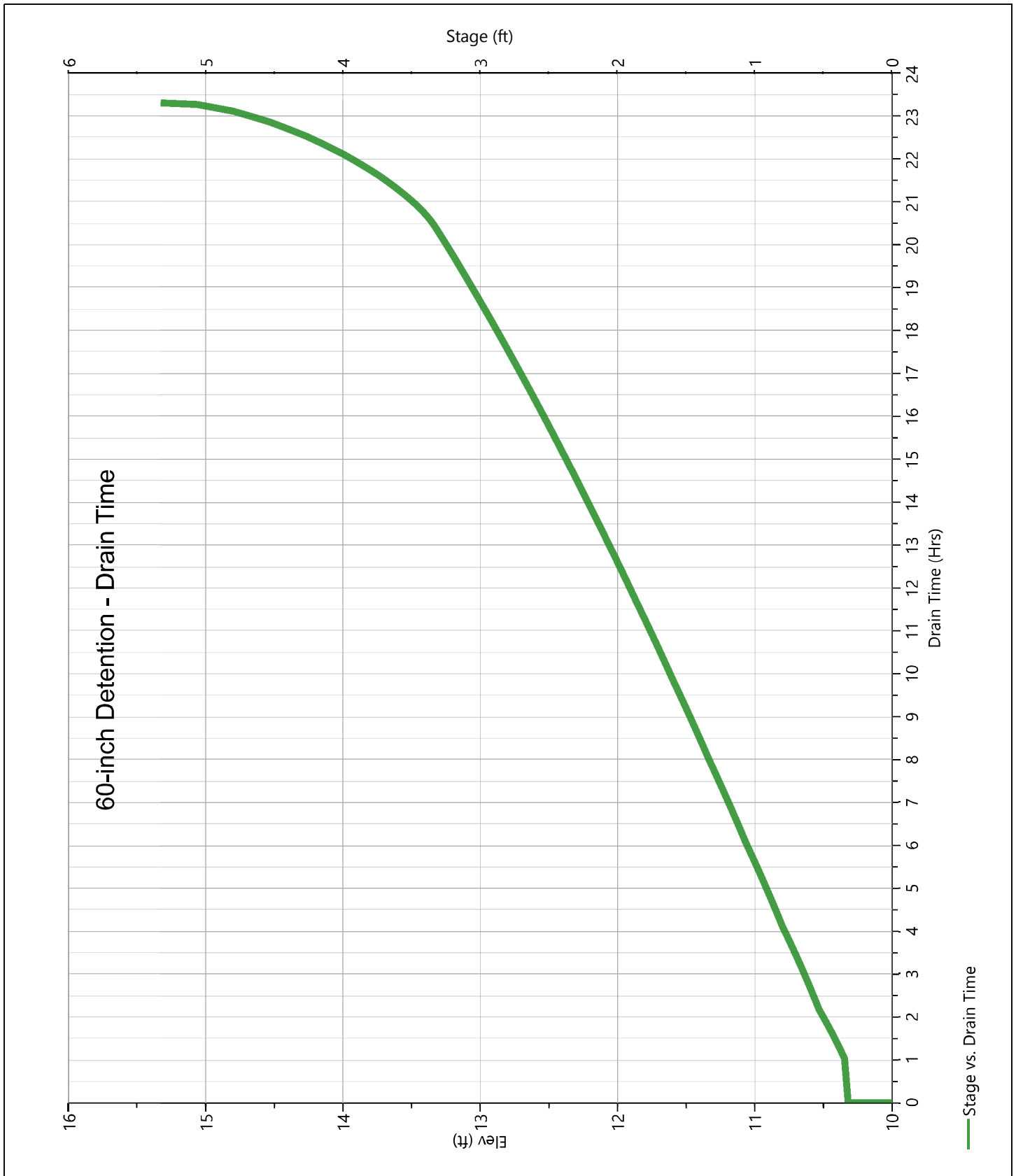
Stage-Storage-Discharge Summary

Stage (ft)	Elev. (ft)	Storage (cuft)	Culvert (cfs)	Orifices, cfs			Riser (cfs)	Weirs, cfs			Pf Riser (cfs)	Exfil (cfs)	User (cfs)	Total (cfs)
				1	2	3		1	2	3				
0.00	10.00	0.000	0.00	0.00	0.00		0.00							0.00
0.27	10.27	8.68	0.005 ic	0.005	0.00		0.00							0.005
0.53	10.53	43.7	0.007 ic	0.007	0.00		0.00							0.007
0.80	10.80	95.3	0.009 ic	0.008	0.00		0.00							0.008
1.07	11.07	158	0.010 ic	0.010	0.00		0.00							0.010
1.33	11.33	227	0.011 ic	0.011	0.00		0.00							0.011
1.60	11.60	303	0.012 ic	0.012	0.00		0.00							0.012
1.86	11.86	384	0.013 ic	0.013	0.00		0.00							0.013
2.13	12.13	467	0.014 ic	0.014	0.00		0.00							0.014
2.40	12.40	552	0.014 ic	0.014	0.00		0.00							0.014
2.66	12.66	638	0.016 ic	0.015	0.00		0.00							0.015
2.93	12.93	725	0.016 ic	0.016	0.00		0.00							0.016
3.20	13.20	810	0.017 ic	0.017	0.00		0.00							0.017
3.46	13.46	893	0.028 ic	0.017	0.011		0.00							0.028
3.73	13.73	974	0.038 ic	0.018	0.020		0.00							0.038
3.99	13.99	1,049	0.044 ic	0.019	0.026		0.00							0.044
4.26	14.26	1,119	0.050 ic	0.019	0.030		0.00							0.050
4.53	14.53	1,181	0.054 ic	0.020	0.035		0.00							0.054
4.79	14.79	1,233	0.061 ic	0.020	0.038		0.00							0.059
5.06	15.06	1,268	0.064 ic	0.021	0.042		0.00							0.063
5.33	15.33	1,277	0.105 ic	0.021	0.045		0.039							0.105

Suffix key: ic = inlet control, oc = outlet control, s = submerged weir

60-inch Detention

Pond Drawdown



Hydrograph by Return Period

Project Name:

Hydrology Studio v 2.0.0.52

04-13-2018

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Outflow (cfs)							
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	NRCS Runoff	Parcel 1 Ex		0.005			0.031			0.072
2	NRCS Runoff	Parcel 1 Proposed		0.107			0.173			0.238

EX RATES BASED
ON TYPE B SOILS

Hydrograph 2-yr Summary

Project Name:

Hydrology Studio v 2.0.0.52

04-13-2018

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Parcel 1 Ex	0.005	16.93	276	----		
2	NRCS Runoff	Parcel 1 Proposed	0.107	7.90	1,486	----		

Hydrograph Report

Project Name:

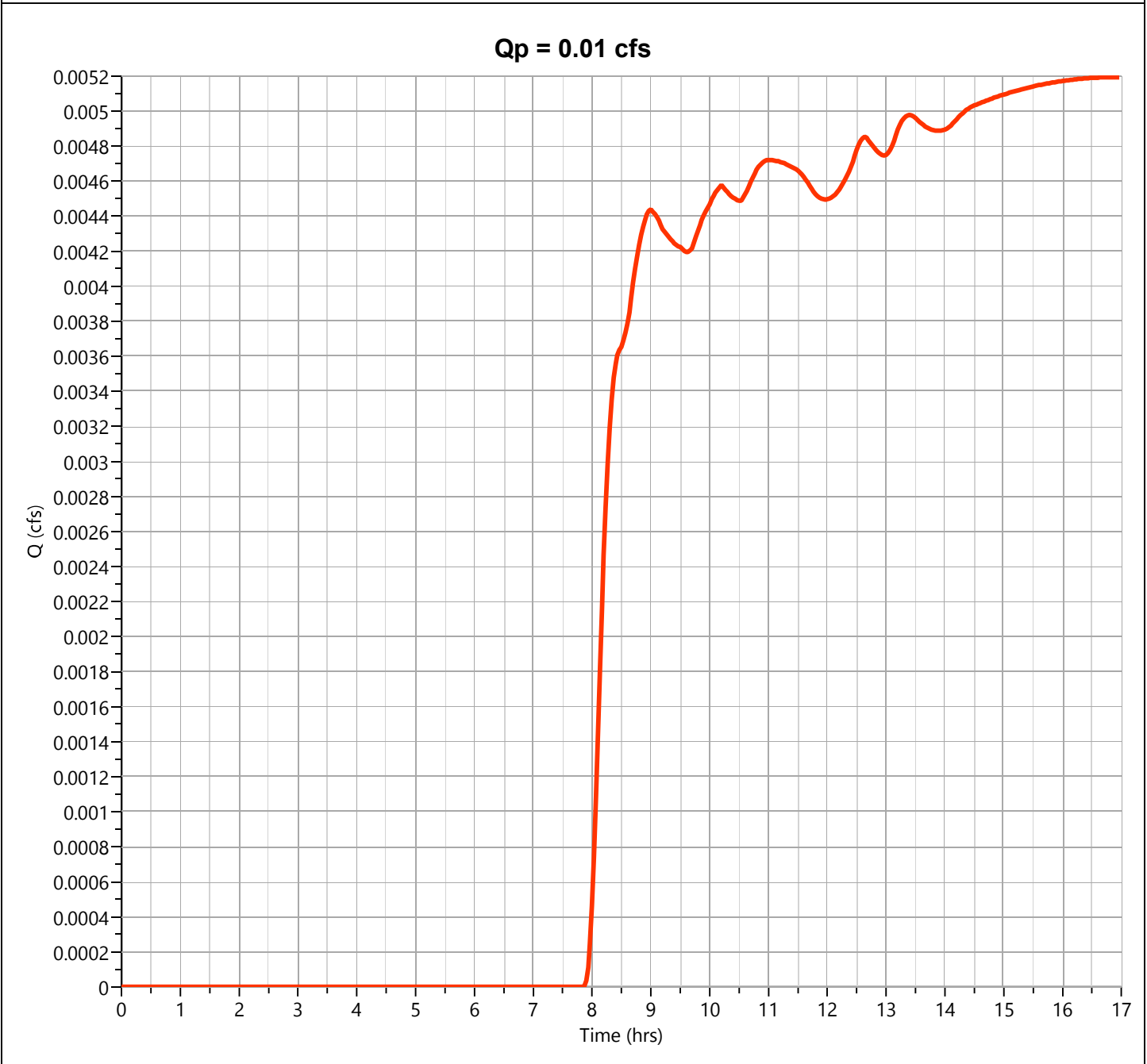
Hydrology Studio v 2.0.0.52

04-13-2018

Parcel 1 Ex

Hyd. No. 1

Hydrograph Type	= NRCS Runoff	Peak Flow	= 0.005 cfs
Storm Frequency	= 2-yr	Time to Peak	= 16.93 hrs
Time Interval	= 2 min	Runoff Volume	= 276 cuft
Drainage Area	= 0.26 ac	Curve Number	= 72
Tc Method	= User	Time of Conc. (Tc)	= 20.0 min
Total Rainfall	= 2.0000 in	Design Storm	= Type IA
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name:

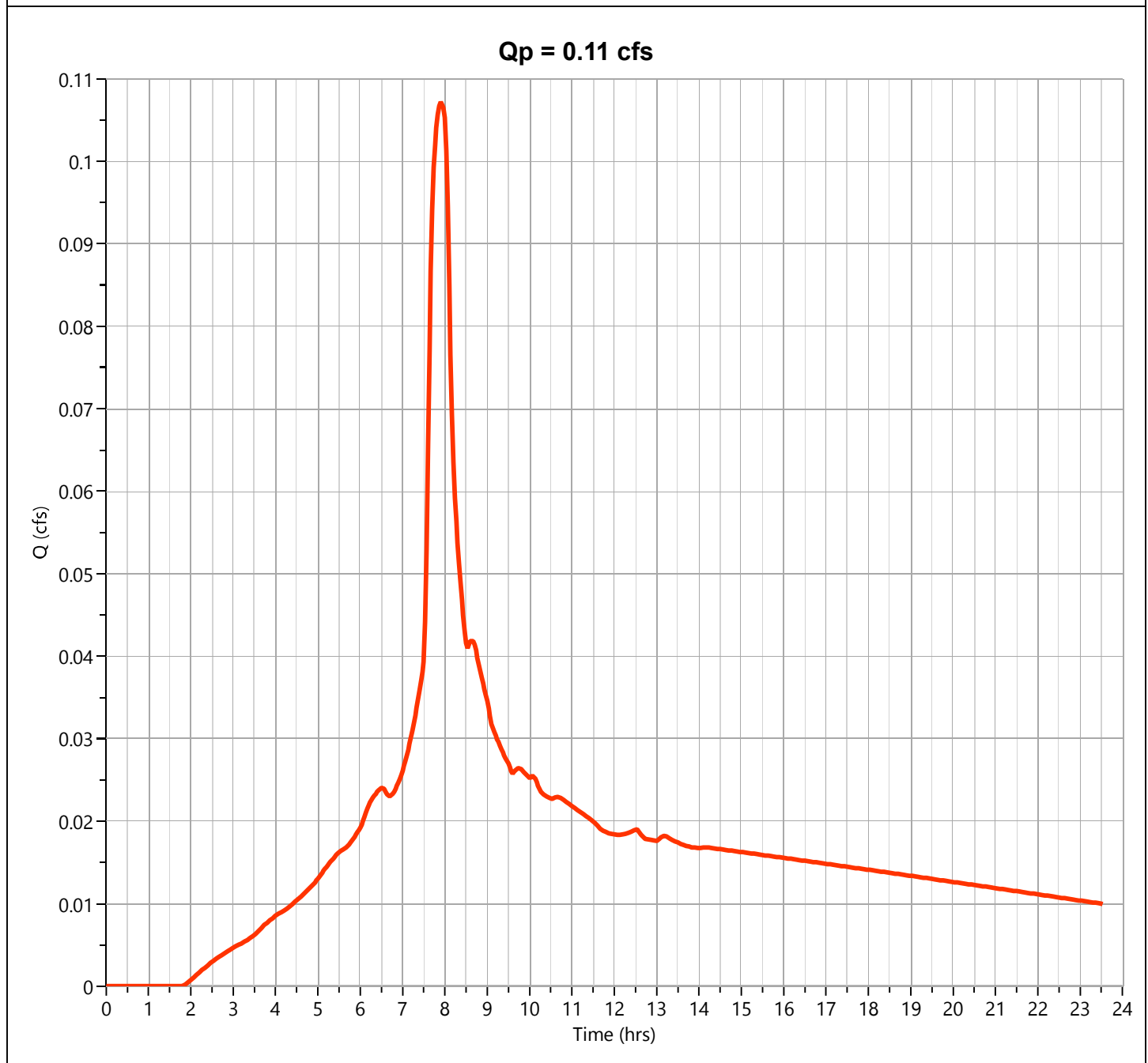
Hydrology Studio v 2.0.0.52

04-13-2018

Parcel 1 Proposed

Hyd. No. 2

Hydrograph Type	= NRCS Runoff	Peak Flow	= 0.107 cfs
Storm Frequency	= 2-yr	Time to Peak	= 7.90 hrs
Time Interval	= 2 min	Runoff Volume	= 1,486 cuft
Drainage Area	= 0.26 ac	Curve Number	= 96
Tc Method	= User	Time of Conc. (Tc)	= 7.5 min
Total Rainfall	= 2.0000 in	Design Storm	= Type IA
Storm Duration	= 24 hrs	Shape Factor	= 484



Design Storm Report

Custom Storm filename: ss.cds

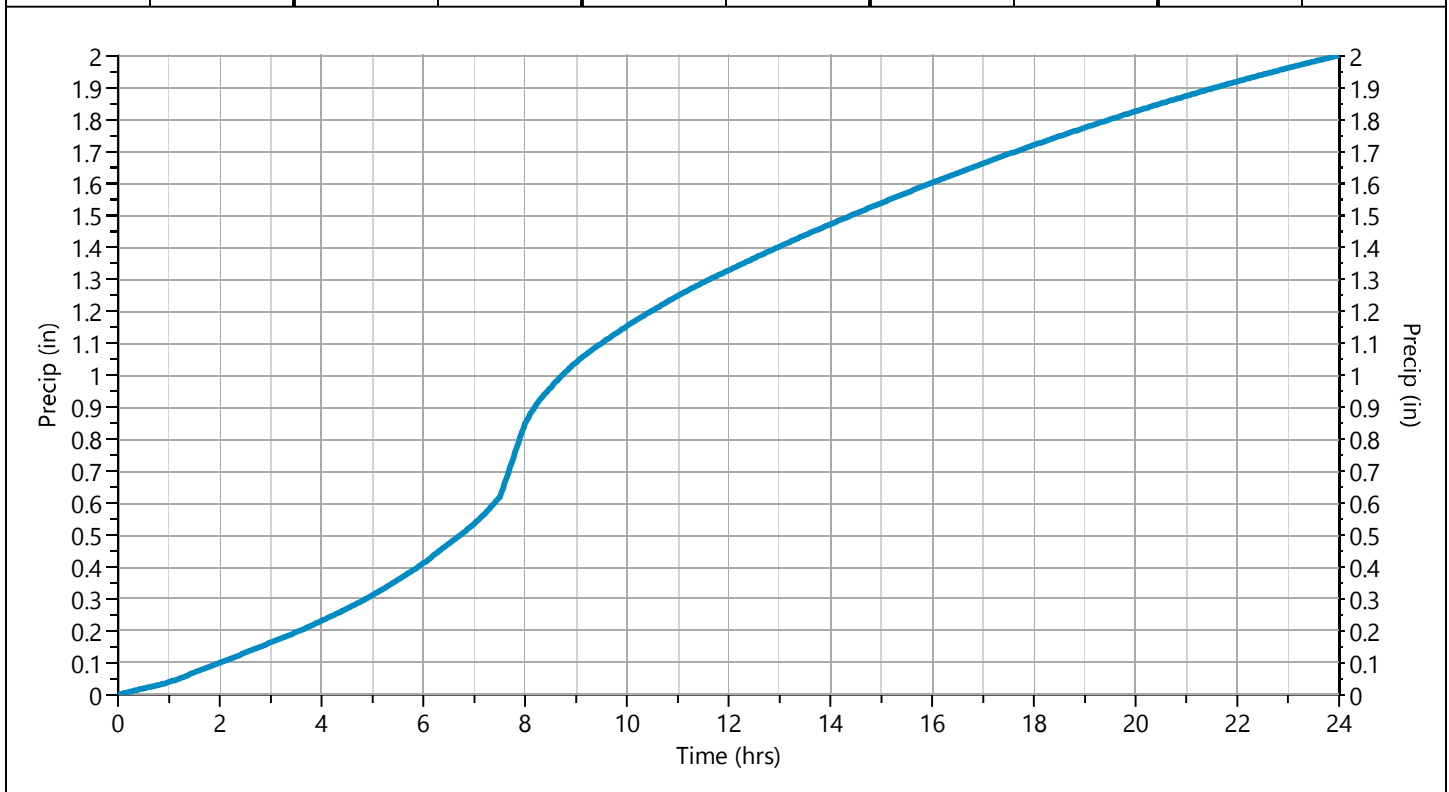
Hydrology Studio v 2.0.0.52

04-13-2018

Storm Distribution: NRCS/SCS - Type IA

Storm Duration	Total Rainfall Volume (in)								
	1-yr	√ 2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
24 hrs	0.00	2.00	0.00	0.00	3.00	3.00	0.00	4.00	

Incremental Rainfall Distribution, 2-yr									
Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
6.80	0.0041	7.17	0.0051	7.53	0.0136	7.90	0.0157	8.27	0.0071
6.83	0.0042	7.20	0.0053	7.57	0.0143	7.93	0.0154	8.30	0.0068
6.87	0.0042	7.23	0.0054	7.60	0.0148	7.97	0.0150	8.33	0.0065
6.90	0.0043	7.27	0.0055	7.63	0.0152	8.00	0.0145	8.37	0.0062
6.93	0.0044	7.30	0.0057	7.67	0.0155	8.03	0.0101	8.40	0.0060
6.97	0.0045	7.33	0.0058	7.70	0.0158	8.07	0.0096	8.43	0.0058
7.00	0.0046	7.37	0.0060	7.73	0.0160	8.10	0.0091	8.47	0.0056
7.03	0.0047	7.40	0.0062	7.77	0.0161	8.13	0.0086	8.50	0.0054
7.07	0.0048	7.43	0.0064	7.80	0.0161	8.17	0.0082	8.53	0.0066
7.10	0.0049	7.47	0.0065	7.83	0.0160	8.20	0.0078	8.57	0.0060
7.13	0.0050	7.50	0.0067	7.87	0.0159	8.23	0.0074	8.60	0.0059



Hydrograph Report

Project Name:

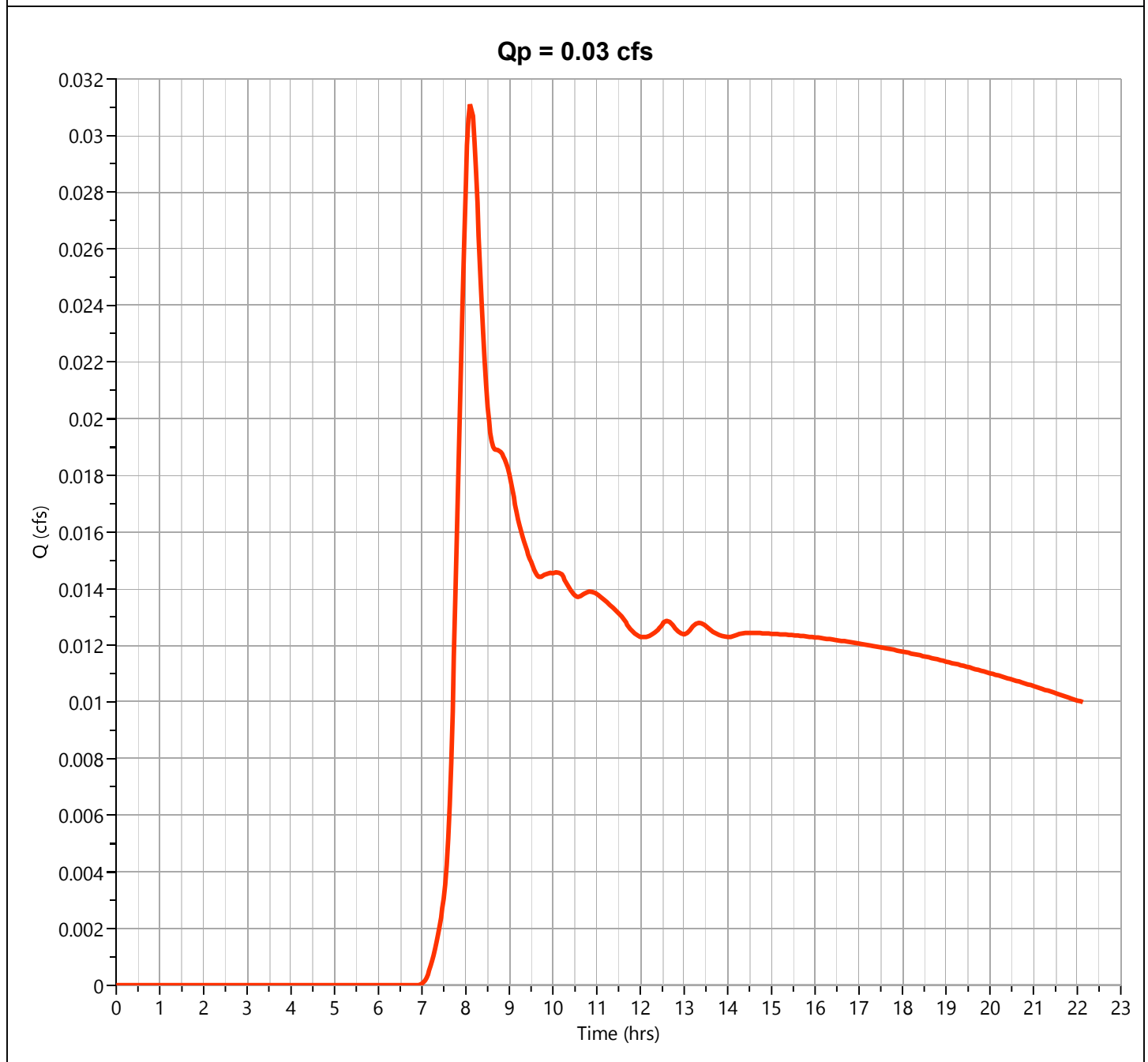
Hydrology Studio v 2.0.0.52

04-13-2018

Parcel 1 Ex

Hyd. No. 1

Hydrograph Type	= NRCS Runoff	Peak Flow	= 0.031 cfs
Storm Frequency	= 10-yr	Time to Peak	= 8.13 hrs
Time Interval	= 2 min	Runoff Volume	= 763 cuft
Drainage Area	= 0.26 ac	Curve Number	= 72
Tc Method	= User	Time of Conc. (Tc)	= 20.0 min
Total Rainfall	= 3.0000 in	Design Storm	= Type IA
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name:

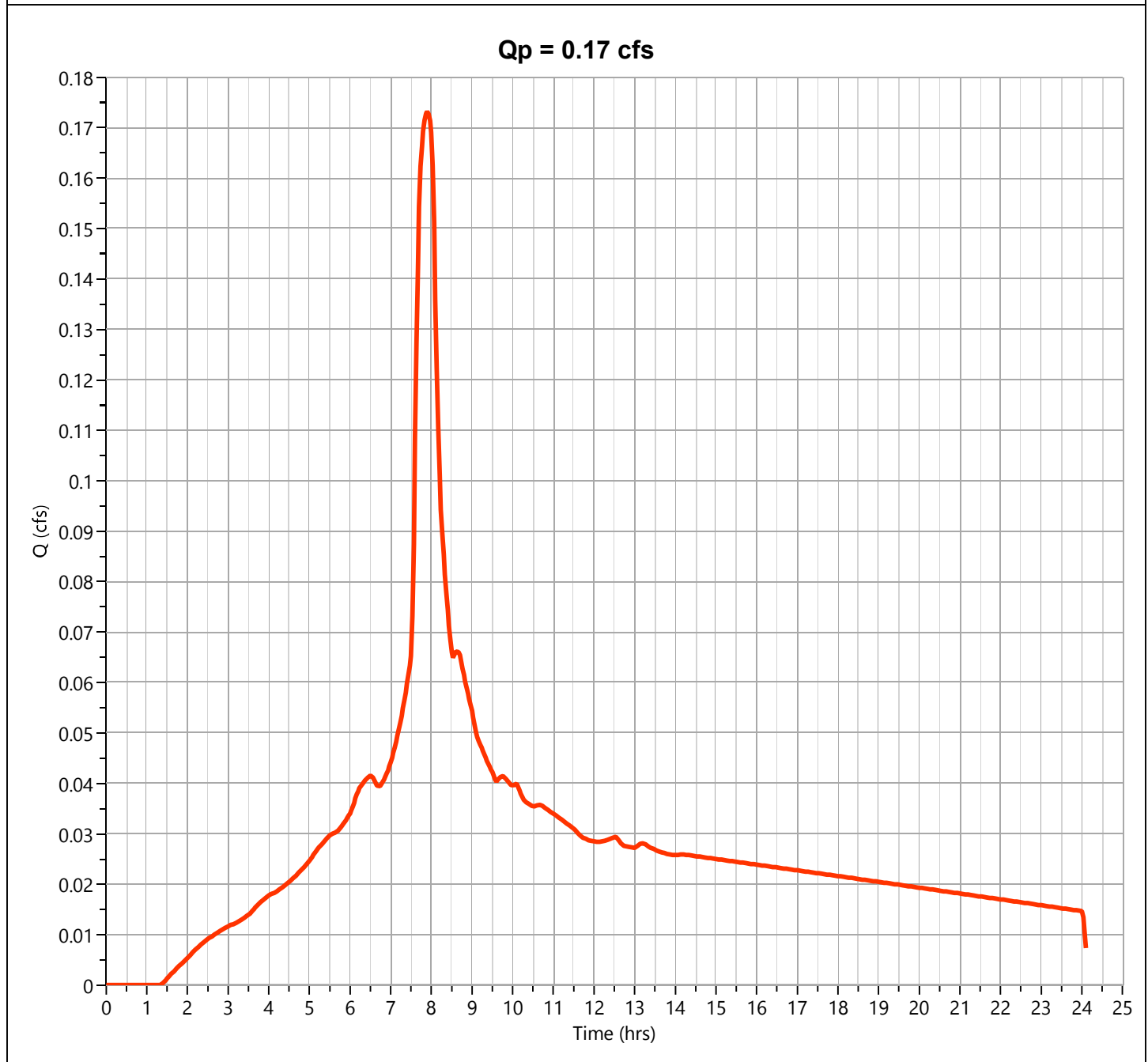
Hydrology Studio v 2.0.0.52

04-13-2018

Parcel 1 Proposed

Hyd. No. 2

Hydrograph Type	= NRCS Runoff	Peak Flow	= 0.173 cfs
Storm Frequency	= 10-yr	Time to Peak	= 7.90 hrs
Time Interval	= 2 min	Runoff Volume	= 2,409 cuft
Drainage Area	= 0.26 ac	Curve Number	= 96
Tc Method	= User	Time of Conc. (Tc)	= 7.5 min
Total Rainfall	= 3.0000 in	Design Storm	= Type IA
Storm Duration	= 24 hrs	Shape Factor	= 484

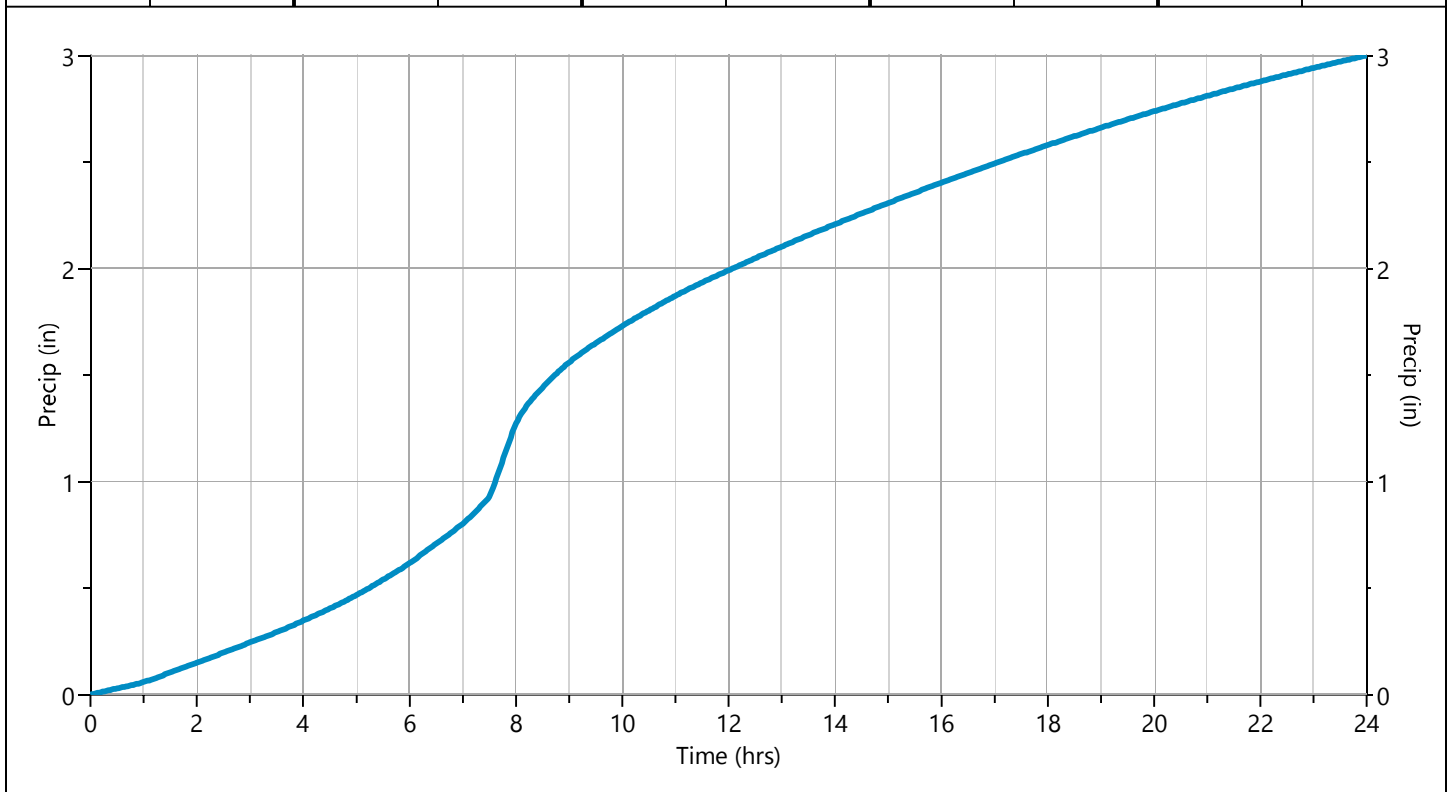


Design Storm Report

Storm Distribution: NRCS/SCS - Type IA

Storm Duration	Total Rainfall Volume (in)								
	1-yr	2-yr	3-yr	5-yr	✓ 10-yr	25-yr	50-yr	100-yr	
24 hrs	0.00	2.00	0.00	0.00	3.00	3.00	0.00	4.00	

Incremental Rainfall Distribution, 10-yr									
Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
6.80	0.0062	7.17	0.0077	7.53	0.0205	7.90	0.0235	8.27	0.0106
6.83	0.0063	7.20	0.0079	7.57	0.0215	7.93	0.0231	8.30	0.0101
6.87	0.0064	7.23	0.0081	7.60	0.0222	7.97	0.0225	8.33	0.0097
6.90	0.0065	7.27	0.0083	7.63	0.0228	8.00	0.0218	8.37	0.0093
6.93	0.0066	7.30	0.0085	7.67	0.0233	8.03	0.0152	8.40	0.0089
6.97	0.0067	7.33	0.0088	7.70	0.0237	8.07	0.0143	8.43	0.0086
7.00	0.0069	7.37	0.0090	7.73	0.0240	8.10	0.0136	8.47	0.0083
7.03	0.0070	7.40	0.0093	7.77	0.0241	8.13	0.0129	8.50	0.0081
7.07	0.0072	7.43	0.0095	7.80	0.0241	8.17	0.0123	8.53	0.0099
7.10	0.0073	7.47	0.0098	7.83	0.0240	8.20	0.0117	8.57	0.0090
7.13	0.0075	7.50	0.0101	7.87	0.0238	8.23	0.0111	8.60	0.0088



Hydrograph 100-yr Summary

Project Name:

Hydrology Studio v 2.0.0.52

04-13-2018

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	NRCS Runoff	Parcel 1 Ex	0.072	8.07	1,378	----		
2	NRCS Runoff	Parcel 1 Proposed	0.238	7.90	3,341	----		

Hydrograph Report

Project Name:

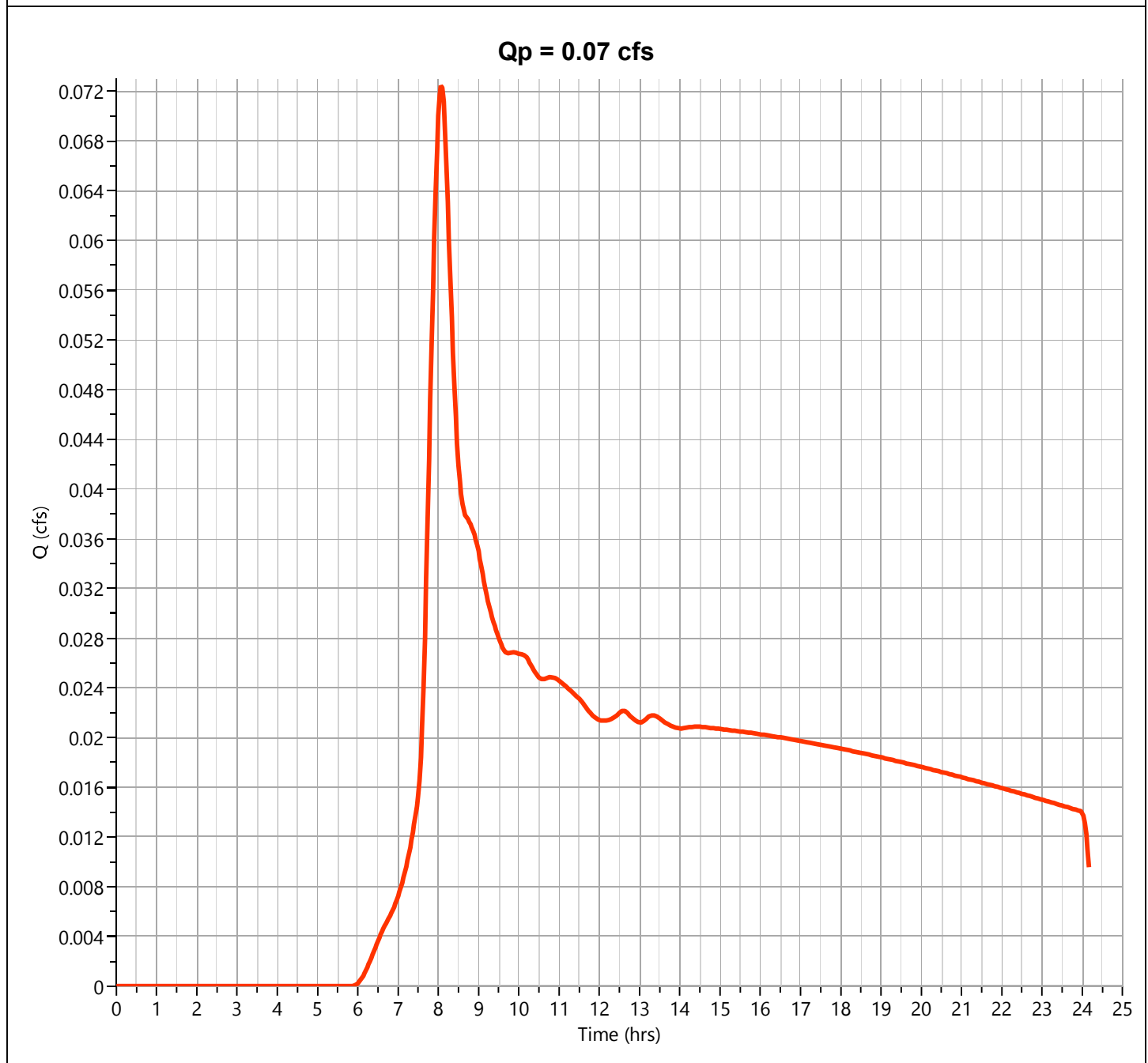
Hydrology Studio v 2.0.0.52

04-13-2018

Parcel 1 Ex

Hyd. No. 1

Hydrograph Type	= NRCS Runoff	Peak Flow	= 0.072 cfs
Storm Frequency	= 100-yr	Time to Peak	= 8.07 hrs
Time Interval	= 2 min	Runoff Volume	= 1,378 cuft
Drainage Area	= 0.26 ac	Curve Number	= 72
Tc Method	= User	Time of Conc. (Tc)	= 20.0 min
Total Rainfall	= 4.0000 in	Design Storm	= Type IA
Storm Duration	= 24 hrs	Shape Factor	= 484



Hydrograph Report

Project Name:

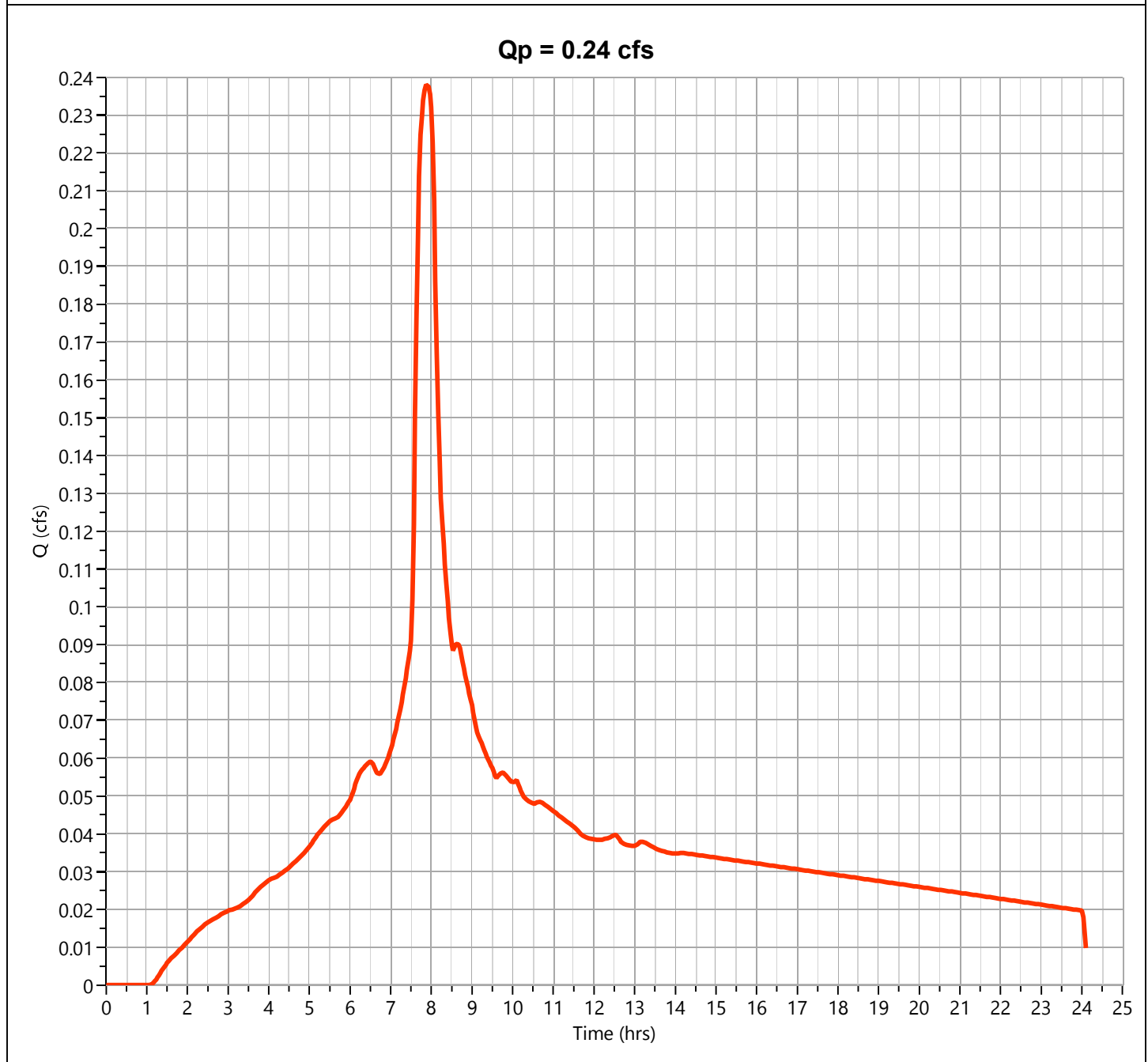
Hydrology Studio v 2.0.0.52

04-13-2018

Parcel 1 Proposed

Hyd. No. 2

Hydrograph Type	= NRCS Runoff	Peak Flow	= 0.238 cfs
Storm Frequency	= 100-yr	Time to Peak	= 7.90 hrs
Time Interval	= 2 min	Runoff Volume	= 3,341 cuft
Drainage Area	= 0.26 ac	Curve Number	= 96
Tc Method	= User	Time of Conc. (Tc)	= 7.5 min
Total Rainfall	= 4.0000 in	Design Storm	= Type IA
Storm Duration	= 24 hrs	Shape Factor	= 484

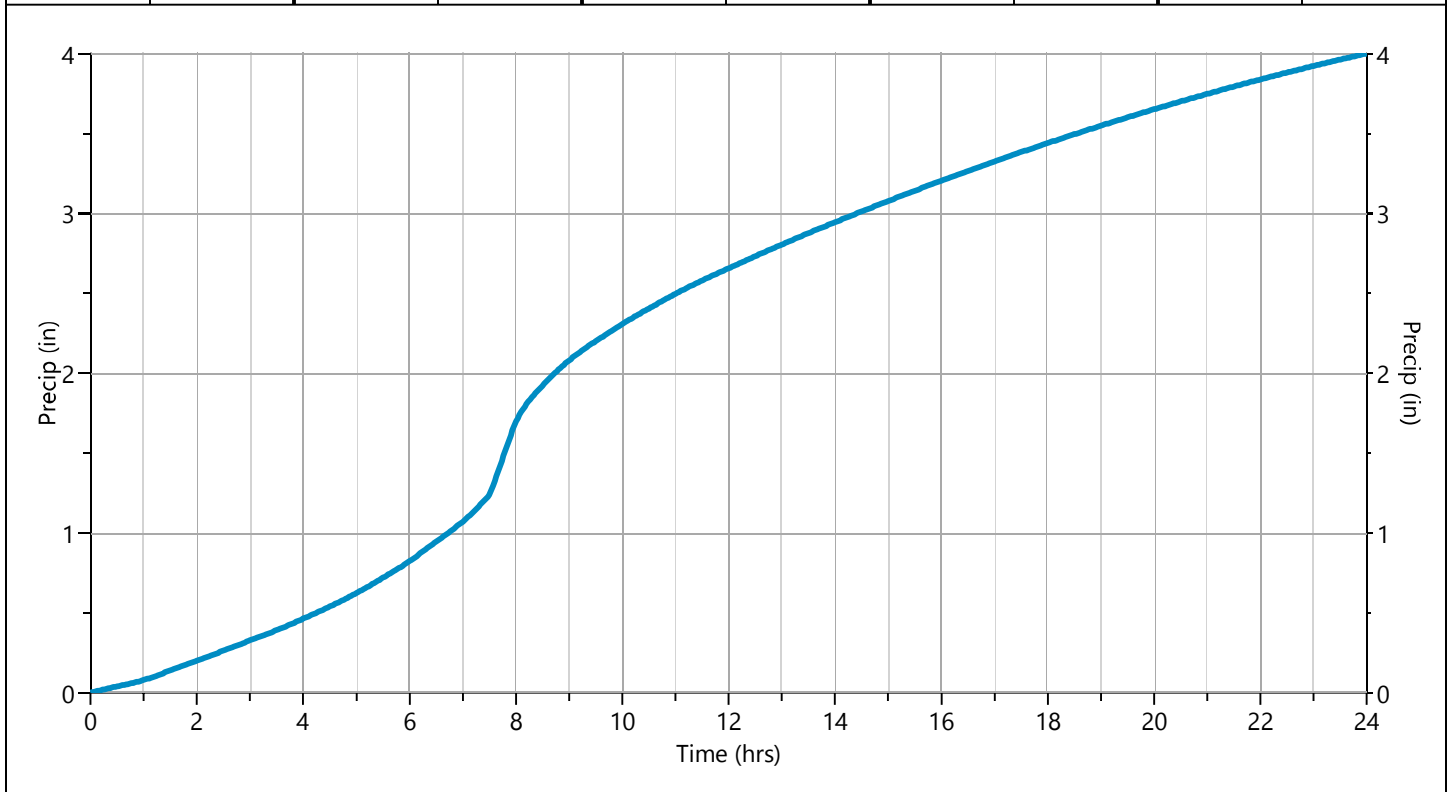


Design Storm Report

Storm Distribution: NRCS/SCS - Type IA

Storm Duration	Total Rainfall Volume (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	✓ 100-yr
24 hrs	0.00	2.00	0.00	0.00	3.00	3.00	0.00	4.00

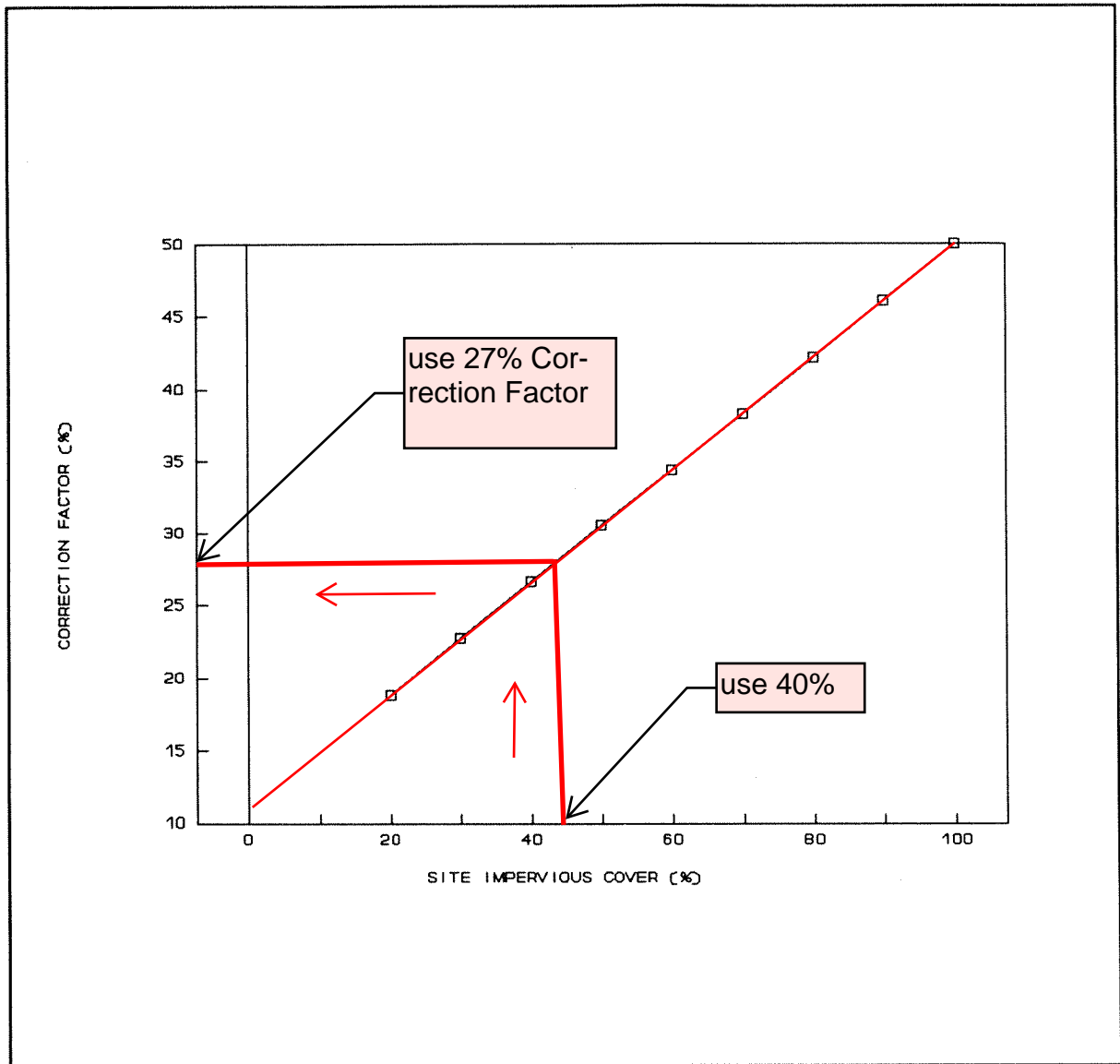
Incremental Rainfall Distribution, 100-yr									
Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)	Time (hrs)	Precip (in)
6.80	0.0082	7.17	0.0103	7.53	0.0273	7.90	0.0313	8.27	0.0142
6.83	0.0084	7.20	0.0105	7.57	0.0286	7.93	0.0307	8.30	0.0135
6.87	0.0085	7.23	0.0108	7.60	0.0296	7.97	0.0300	8.33	0.0129
6.90	0.0086	7.27	0.0111	7.63	0.0304	8.00	0.0291	8.37	0.0124
6.93	0.0088	7.30	0.0114	7.67	0.0311	8.03	0.0203	8.40	0.0119
6.97	0.0090	7.33	0.0117	7.70	0.0316	8.07	0.0191	8.43	0.0115
7.00	0.0091	7.37	0.0120	7.73	0.0319	8.10	0.0182	8.47	0.0111
7.03	0.0093	7.40	0.0124	7.77	0.0321	8.13	0.0173	8.50	0.0108
7.07	0.0096	7.43	0.0127	7.80	0.0322	8.17	0.0164	8.53	0.0132
7.10	0.0098	7.47	0.0131	7.83	0.0321	8.20	0.0156	8.57	0.0121
7.13	0.0100	7.50	0.0135	7.87	0.0318	8.23	0.0149	8.60	0.0118



volume correction factor

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FIGURE III-1.1
Volume Correction Factor to be Applied to
Streambank Erosion Control BMPs
Based on Site Impervious Cover



runoff curve number table, type C Soils

Per the City of Mercer use 100% Forested for existing conditions with a CN=81

Table 2.2					
Runoff Curve Numbers for Selected Agricultural, Suburban, and Urban Areas					
(Sources: TR 55, 1986, and Stormwater Management Manual, 1992. See Section 2.1.1 for explanation)					
		CNs for hydrologic soil group			
Cover type and hydrologic condition.	A	B	C	D	
Curve Numbers for Pre-Development Conditions					
Pasture, grassland, or range-continuous forage for grazing:					
Fair condition (ground cover 50% to 75% and not heavily grazed).	49	69	79	84	
Good condition (ground cover >75% and lightly or only occasionally grazed)	39	61	74	80	
Woods:					
Fair (Woods are grazed but not burned, and some forest litter covers the soil).	36	60	73	79	
Good (Woods are protected from grazing, and litter and brush adequately cover the soil).	30	55	70	77	
Curve Numbers for Post-Development Conditions					
Open space (lawns, parks, golf courses, cemeteries, landscaping, etc.)¹					
Fair condition (grass cover on 50% - 75% of the area).	77	85	90	92	
Good condition (grass cover on >75% of the area)	68	80	86	90	
Impervious areas:					
Open water bodies: lakes, wetlands, ponds etc.	100	100	100	100	
Paved parking lots, roofs ² , driveways, etc. (excluding right-of-way)	98	98	98	98	
Permeable Pavement (See Appendix C to decide which condition below to use)					
Landscaped area	77	85	90	92	
50% landscaped area/50% impervious	87	91	94	96	
100% impervious area	98	98	98	98	
Paved	98	98	98	98	
Gravel (including right-of-way)	76	85	89	91	
Dirt (including right-of-way)	72	82	87	89	
Pasture, grassland, or range-continuous forage for grazing:					
Poor condition (ground cover <50% or heavily grazed with no mulch).	68	79	86	89	
Fair condition (ground cover 50% to 75% and not heavily grazed).	49	69	79	84	
Good condition (ground cover >75% and lightly or only occasionally grazed)	39	61	74	80	
Woods:					
Poor (Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning).	45	66	77	83	
Fair (Woods are grazed but not burned, and some forest litter covers the soil).	36	60	73	79	
Good (Woods are protected from grazing, and litter and brush adequately cover the soil).	30	55	70	77	
Single family residential³:		Should only be used for subdivisions > 50 acres	Average Percent impervious area ^{3,4}		
Dwelling Unit/Gross Acre					
1.0 DU/GA		15	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> these values used to compute pre and post development runoff rates </div>		
1.5 DU/GA		20			
2.0 DU/GA		25			
2.5 DU/GA		30			
3.0 DU/GA		34			
3.5 DU/GA		38			
4.0 DU/GA		42			
4.5 DU/GA		46			
5.0 DU/GA		48			
5.5 DU/GA		50			
6.0 DU/GA		52			
6.5 DU/GA		54			
7.0 DU/GA		56			
7.5 DU/GA		58			
PUD's, condos, apartments, commercial businesses, industrial areas & subdivisions < 50 acres	%impervious must be computed	Separate curve numbers shall be selected for pervious and impervious portions of the site			
For a more detailed and complete description of land use curve numbers refer to chapter two (2) of the Soil Conservation Service's Technical Release No. 55, (210-VI-TR-55, Second Ed., June 1986).					

¹ Composite CN's may be computed for other combinations of open space cover type.

² Where roof runoff and driveway runoff are infiltrated or dispersed according to the requirements in Chapter 3, the average percent impervious area may be adjusted in accordance with the procedure described under "Flow Credit for Roof Downspout Infiltration" (Section 3.1.1), and "Flow Credit for Roof Downspout Dispersion" (Section 3.1.2).

³ Assumes roof and driveway runoff is directed into street/storm system.

⁴ All the remaining pervious area (lawn) are considered to be in good condition for these curve numbers.

N value, time of concentration reference

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Table III-1.4 "n" AND "k" Values Used in Time Calculations for Hydrographs

"n_s" Sheet Flow Equation Manning's Values (for the initial 300 ft. of travel) n_s

Smooth surfaces (concrete, asphalt, gravel, or bare hand packed soil)	
0.011	0.05
Fallow fields or loose soil surface (no residue)	0.06
Cultivated soil with residue cover (s ≤ 0.20 ft/ft)	0.17
Cultivated soil with residue cover (s > 0.20 ft/ft)	0.15
Short prairie grass and lawns	0.24
Dense grasses	0.41
Bermuda grass	0.13
Range (natural)	0.40
Woods or forest with light underbrush	0.80
Woods or forest with dense underbrush	0.80

Sheet flow, drive, post-dev

Sheet Flow, forested, pre-dev

*Manning values for sheet flow only, from Overton and Meadows 1976 (See TR-55, 1986)

"k" Values Used in Travel Time/Time of Concentration Calculations

Shallow Concentrated Flow (After the initial 300 ft. of sheet flow, R = 0.1) k_s

1. Forest with heavy ground litter and meadows (n = 0.10)	3
2. Brushy ground with some trees (n = 0.060)	5
3. Fallow or minimum tillage cultivation (n = 0.040)	8
4. High grass (n = 0.035)	9
5. Short grass, pasture and lawns (n = 0.030)	11
6. Nearly bare ground (n = 0.25)	13
7. Paved and gravel areas (n = 0.012)	27

Channel Flow (intermittent) (At the beginning of visible channels R = 0.2) k_c

1. Forested swale with heavy ground litter (n = 0.10)	5
2. Forested drainage course/ravine with defined channel bed (n = 0.050)	10
3. Rock-lined waterway (n = 0.035)	15
4. Grassed waterway (n = 0.030)	17
5. Earth-lined waterway (n = 0.025)	20
6. CMP pipe (n = 0.024)	21
7. Concrete pipe (0.012)	42
8. Other waterways and pipe 0.508/n	

Channel Flow (Continuous stream, R = 0.4) k_c

9. Meandering stream with some pools (n = 0.040)	20
10. Rock-lined stream (n = 0.035)	23
11. Grass-lined stream (n = 0.030)	27
12. Other streams, man-made channels and pipe 0.807/n**	