DRAINAGE CALCULATIONS

Project: Two Lot Subdivision
Kiwi Court Subdivision
Off Ashburnham State Road
Westminster, MA 01473

Applicant: BRNG, LLC
164 South Ashburnham Road
Westminster, MA 01473

Date: 4 October 2019

Trowbridge Engineering Company

Consulting Civil/Site Engineers
P.O. Box 3
Westminster, MA 01473-0733

(978) 874-5527
(FAX) 874-5265
www.trowbridgeengineering.com

DRAINAGE CALCULATIONS

Site Location: Kiwi Court Subdivision
off Ashburnham State Road
Westminster, MA 01473
Assessor's Map 28 Parcel 6

Applicant: BRNG, LLC
164 South Ashburnham Road
Westminster, MA 01473

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PROJECT NARRATIVE

The project proposes a two lot reduced standard subdivision roadway extending westerly from Ashburnham State Road. The new road will serve two new single family houses. Access to these new lots will be created by the reconstruction of an existing paved driveway. The access roadway will be approximately 740'± in length with a travelled way width of 15' and 2.5' wide shoulders.
The proposed roadway name is Kiwi Court and it will be a private way. Only the two new houses will be served by the road and the land will not be available for future subdivision without fully complying with subdivision regulations. Ownership of the road will be retained by one of the homeowners, who will continue to be responsible for the real estate taxes. Both houses will be served by onsite septic systems and wells.

DISCUSSION

A simple drainage system has been designed to mitigate additional stormwater runoff generated by the proposed two houses and drainage calculations have been prepared to model this system. The site was broken into 2 subcatchments in the pre development condition and then into 4 subcatchments in post development. The site is underlain with sandy / gravelly Hinckley soils and the 2, 10 and 100 years storms were investigated. Two design points were identified and the

following table indicated the flows (cfs) at these two points before and after the houses are built. The attached pre and post development plans show the locations of these design points.

Design Point A – Located in an existing natural swale below the house on Lot 4B.

Condition	2 year storm	10 year storm	100 year storm
Pre Development	0.07	0.47	1.36
Post Development	0.03	0.27	0.96

Design Point B – Located at the outlet of the proposed detention pond below the turn around.

Condition	2 year storm	10 year storm	100 year storm
Pre Development	0.46	1.05	1.95
Post Development	0.03	0.57	2.01

The results indicate that the drainage system works very well in the 2 and 10 years storm situations and effectively balances the peak flow in the 100 year storm.

TROWBRIDGE ENGINEERING, LLC

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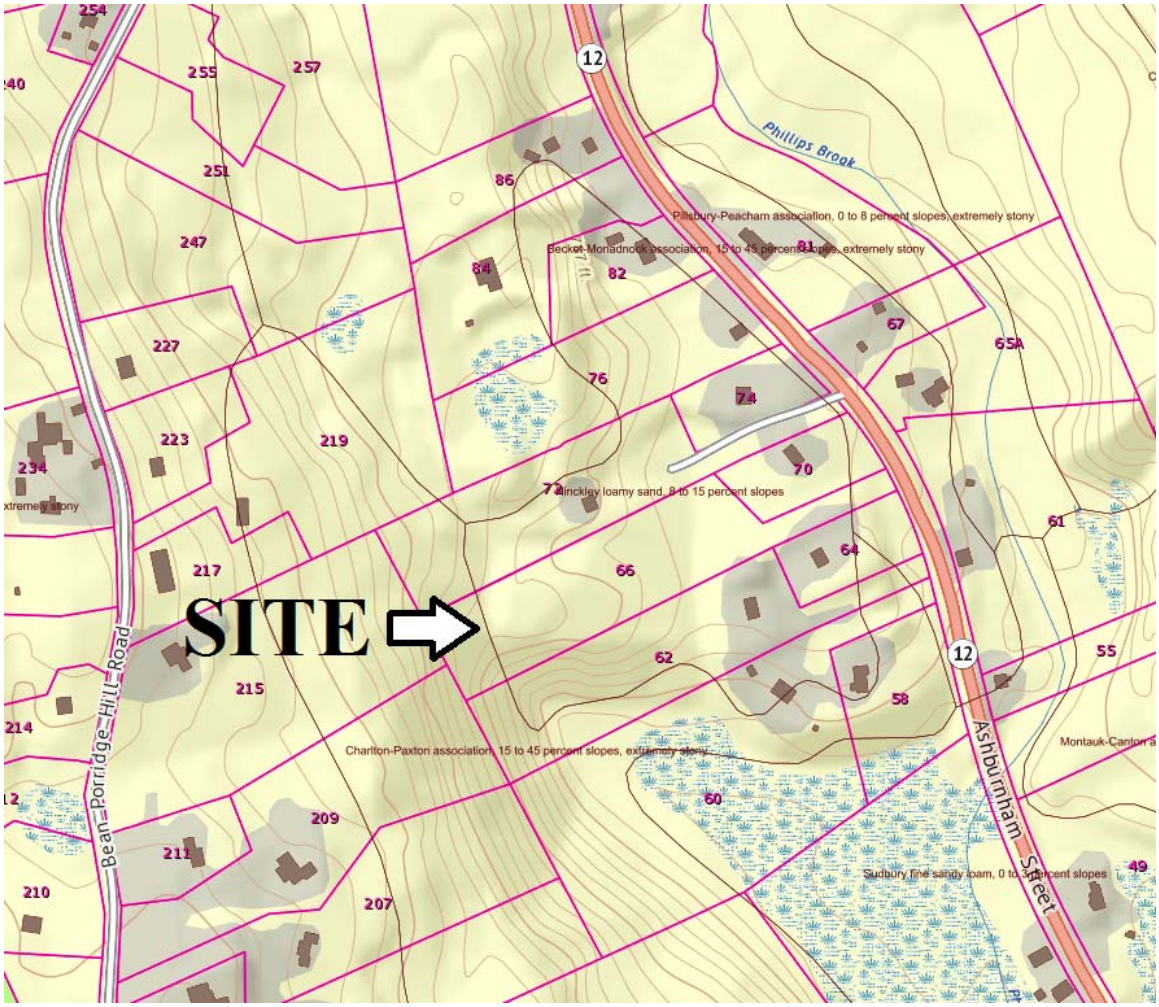
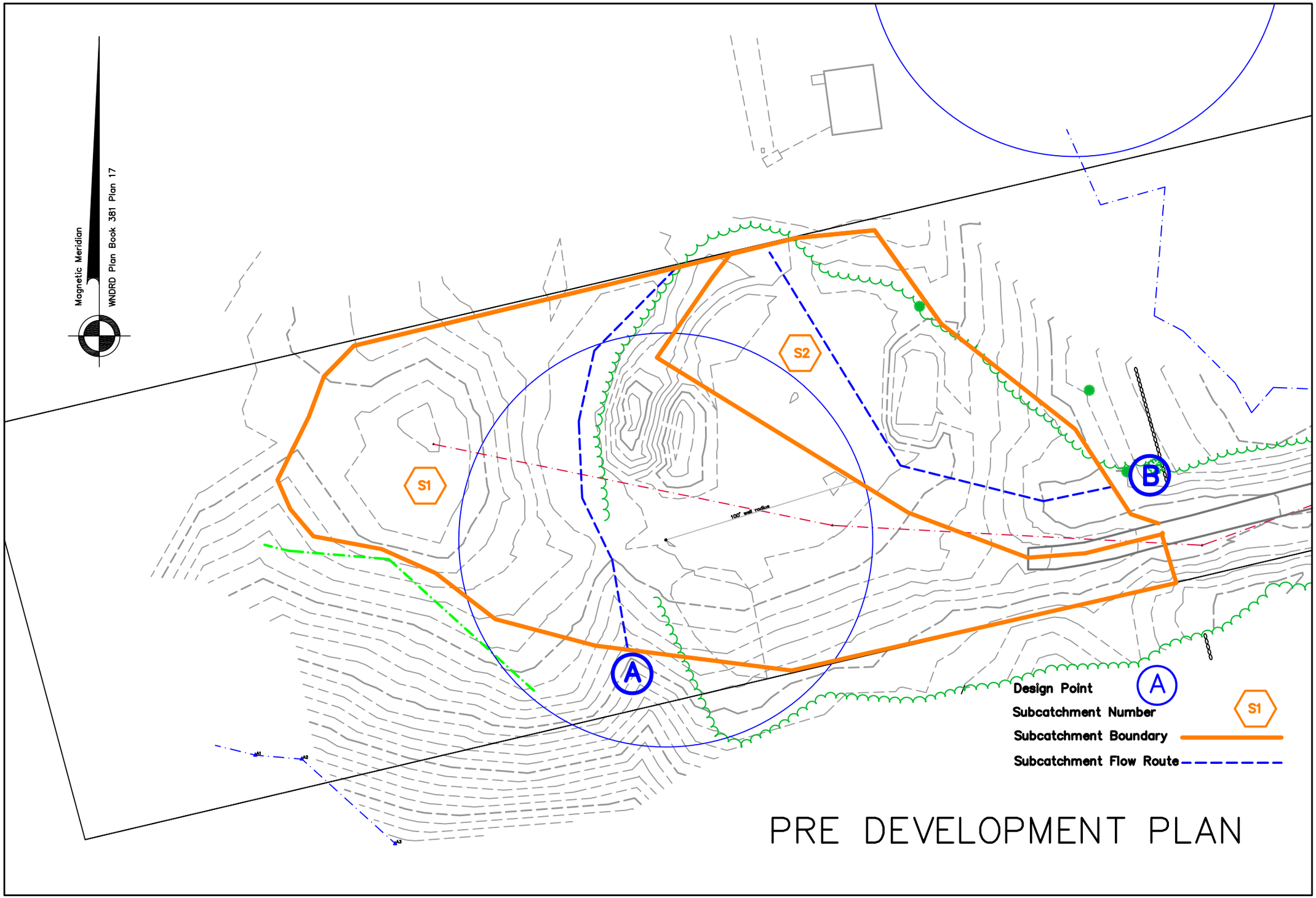
Client: BRNG, LLC
Site: Kiwi Court (off Rte. 12) Westminster, MA
Job No. M04038
Date: 4 October 2019



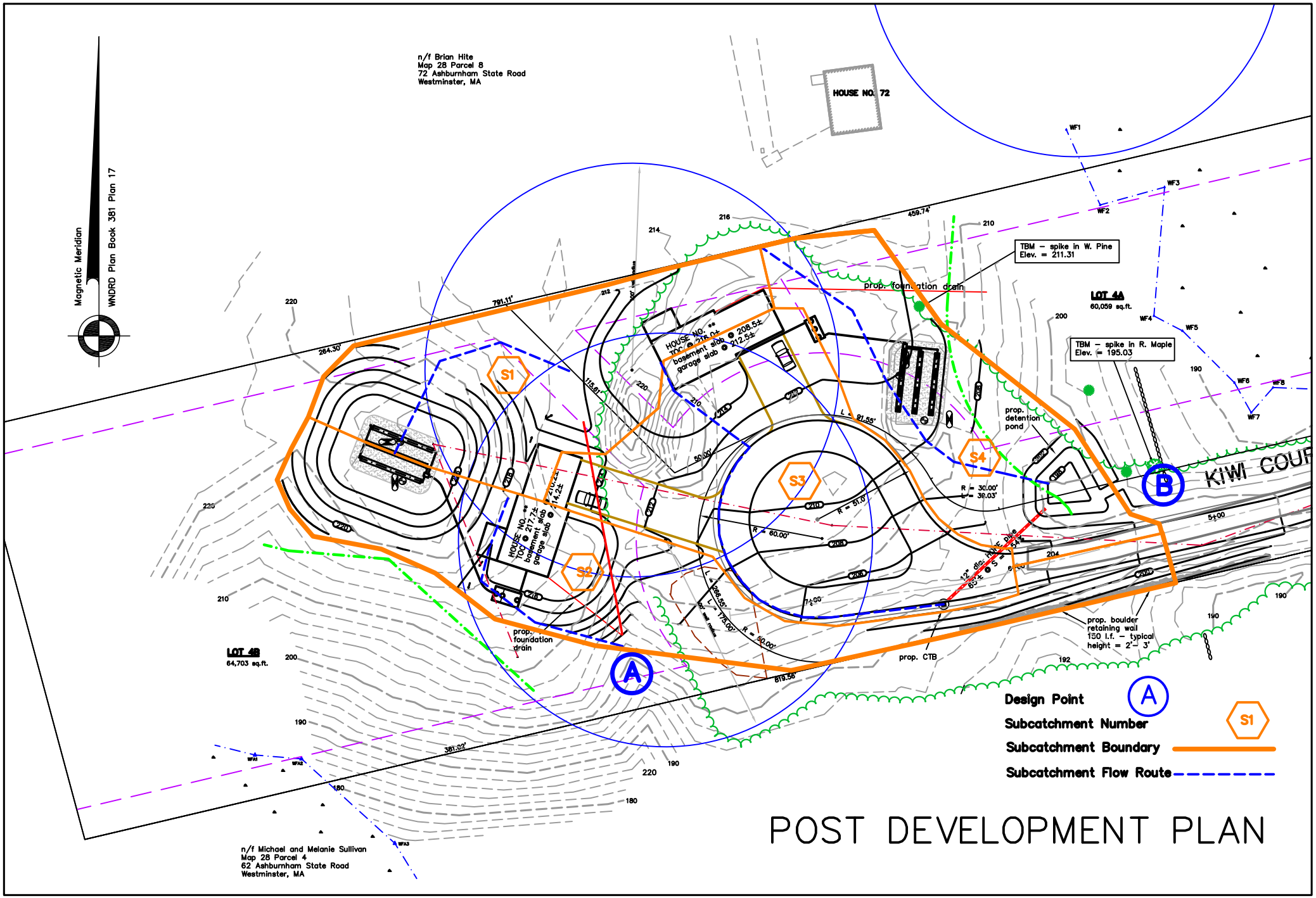
SITE LOCUS

Source: MassGIS

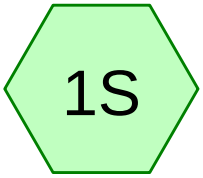
N



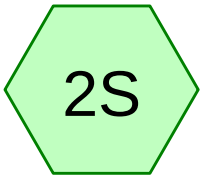
PRE DEVELOPMENT PLAN


n/f Brian Hite
Map 28 Parcel 8
72 Ashburnham State Road
Westminster, MA
HOUSE NO. 72
Magnetic Meridian
WNDRD Plan Book 381 Plan 17
TBM – spike in W. Pine
Elev. = 211.31
TBM – spike in R. Maple
Elev. = 195.03
LOT 4A
60,059 sq.ft.
LOT 4B
64,703 sq.ft.
prop. foundation drain
prop. detention pond
prop. CTB
prop. boulder retaining wall
150 l.f. – typical
height = 2'– 3'
KIWI COUR
S1
S2
S3
S4
A
B
HOUSE NO. ** TOC @ 217.7± basement slab @ 214.2± garage slab @ 214.2±
HOUSE NO. ** TOC @ 218.0± basement slab @ 208.5± garage slab @ 212.5±
791.11'
264.30'
459.74'
381.03'
819.56'
115.61'
L = 91.55'
R = 30.00'
L = 38.03'
R = 51.0'
R = 60.00'
L = 366.55'
L = 175.00'
R = 90.00'
50.00'
71.00'
54.00'
12" dia. RCP @ 0.5%
Design Point
Subcatchment Number
Subcatchment Boundary
Subcatchment Flow Route
POST DEVELOPMENT PLAN
n/f Michael and Melanie Sullivan
Map 28 Parcel 4
62 Ashburnham State Road
Westminster, MA

PRE-DEVELOPMENT DRAINAGE ANALYSIS



W'ly SC



E'ly SC

Subcat Reach Pond Link

Drainage Diagram for KiwiCourt PreDev
Prepared by Trowbridge Engineering, LLC, Printed 10/3/2019
HydroCAD® 9.10 s/n 01207 © 2010 HydroCAD Software Solutions LLC

Summary for Subcatchment 1S: W'ly SC

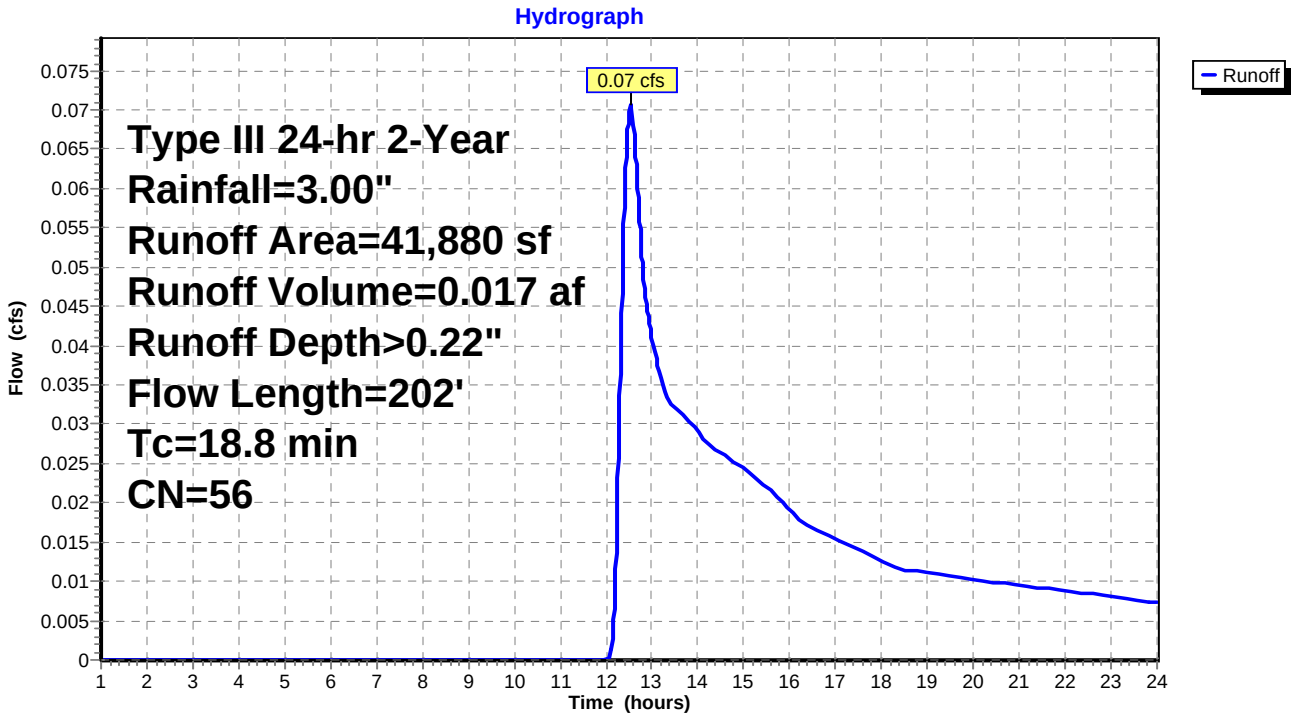
Runoff = 0.07 cfs @ 12.54 hrs, Volume= 0.017 af, Depth> 0.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Area (sf)	CN	Description
20,970	36	Woods, Fair, HSG A
20,910	77	Newly graded area, HSG A
41,880	56	Weighted Average
41,880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	50	0.0125	0.05		**Sheet Flow, SF** Woods: Light underbrush n= 0.400 P2= 3.00"
3.3	110	0.0125	0.56		**Shallow Concentrated Flow, SCF** Woodland Kv= 5.0 fps
0.1	42	0.2000	13.47	49.85	**Channel Flow, CF** Area= 3.7 sf Perim= 7.8' r= 0.47' n= 0.030 Stream, clean & straight
18.8	202	Total			

Subcatchment 1S: W'ly SC



Summary for Subcatchment 2S: E'ly SC

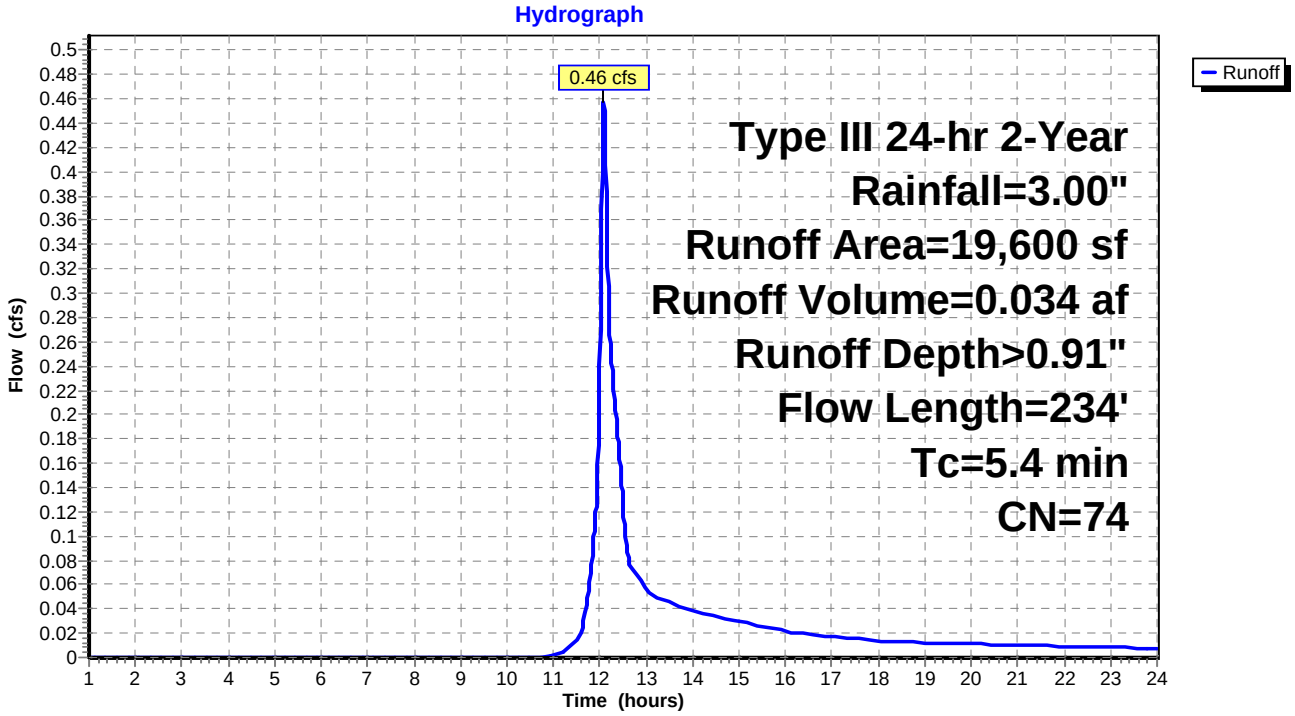
Runoff = 0.46 cfs @ 12.09 hrs, Volume= 0.034 af, Depth> 0.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Area (sf)	CN	Description
18,060	77	Newly graded area, HSG A
1,540	36	Woods, Fair, HSG A
19,600	74	Weighted Average
19,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	50	0.0170	0.32		**Sheet Flow, SCF** Fallow n= 0.050 P2= 3.00"
0.9	70	0.0170	1.30		**Shallow Concentrated Flow, SF** Nearly Bare & Untilled Kv= 10.0 fps
1.6	72	0.1110	0.74		**Sheet Flow, SF** Fallow n= 0.050 P2= 3.00"
0.3	42	0.0480	2.19		**Shallow Concentrated Flow, SF** Nearly Bare & Untilled Kv= 10.0 fps
5.4	234	Total			

Subcatchment 2S: E'ly SC



Summary for Subcatchment 1S: W'ly SC

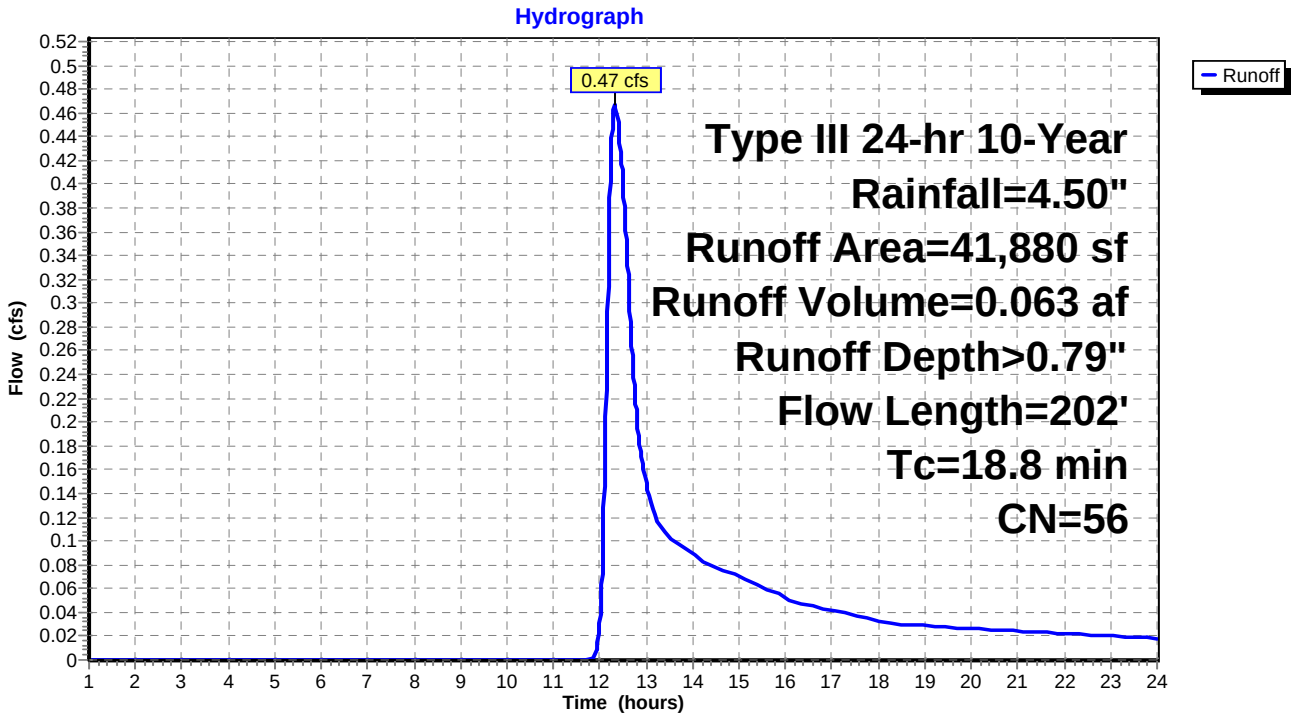
Runoff = 0.47 cfs @ 12.33 hrs, Volume= 0.063 af, Depth> 0.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
20,970	36	Woods, Fair, HSG A
20,910	77	Newly graded area, HSG A
41,880	56	Weighted Average
41,880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	50	0.0125	0.05		**Sheet Flow, SF** Woods: Light underbrush n= 0.400 P2= 3.00"
3.3	110	0.0125	0.56		**Shallow Concentrated Flow, SCF** Woodland Kv= 5.0 fps
0.1	42	0.2000	13.47	49.85	**Channel Flow, CF** Area= 3.7 sf Perim= 7.8' r= 0.47' n= 0.030 Stream, clean & straight
18.8	202	Total			

Subcatchment 1S: W'ly SC



Summary for Subcatchment 2S: E'ly SC

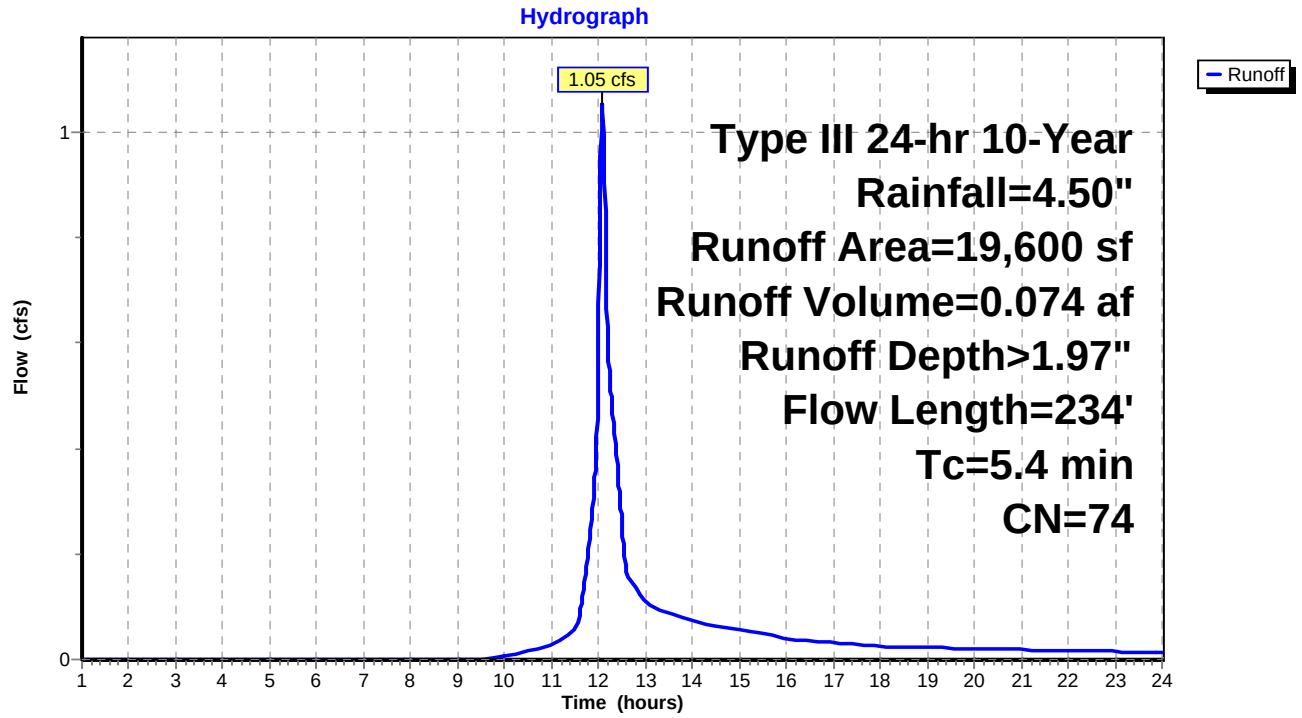
Runoff = 1.05 cfs @ 12.08 hrs, Volume= 0.074 af, Depth> 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
18,060	77	Newly graded area, HSG A
1,540	36	Woods, Fair, HSG A
19,600	74	Weighted Average
19,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	50	0.0170	0.32		**Sheet Flow, SCF** Fallow n= 0.050 P2= 3.00"
0.9	70	0.0170	1.30		**Shallow Concentrated Flow, SF** Nearly Bare & Untilled Kv= 10.0 fps
1.6	72	0.1110	0.74		**Sheet Flow, SF** Fallow n= 0.050 P2= 3.00"
0.3	42	0.0480	2.19		**Shallow Concentrated Flow, SF** Nearly Bare & Untilled Kv= 10.0 fps
5.4	234	Total			

Subcatchment 2S: E'ly SC



Summary for Subcatchment 1S: W'ly SC

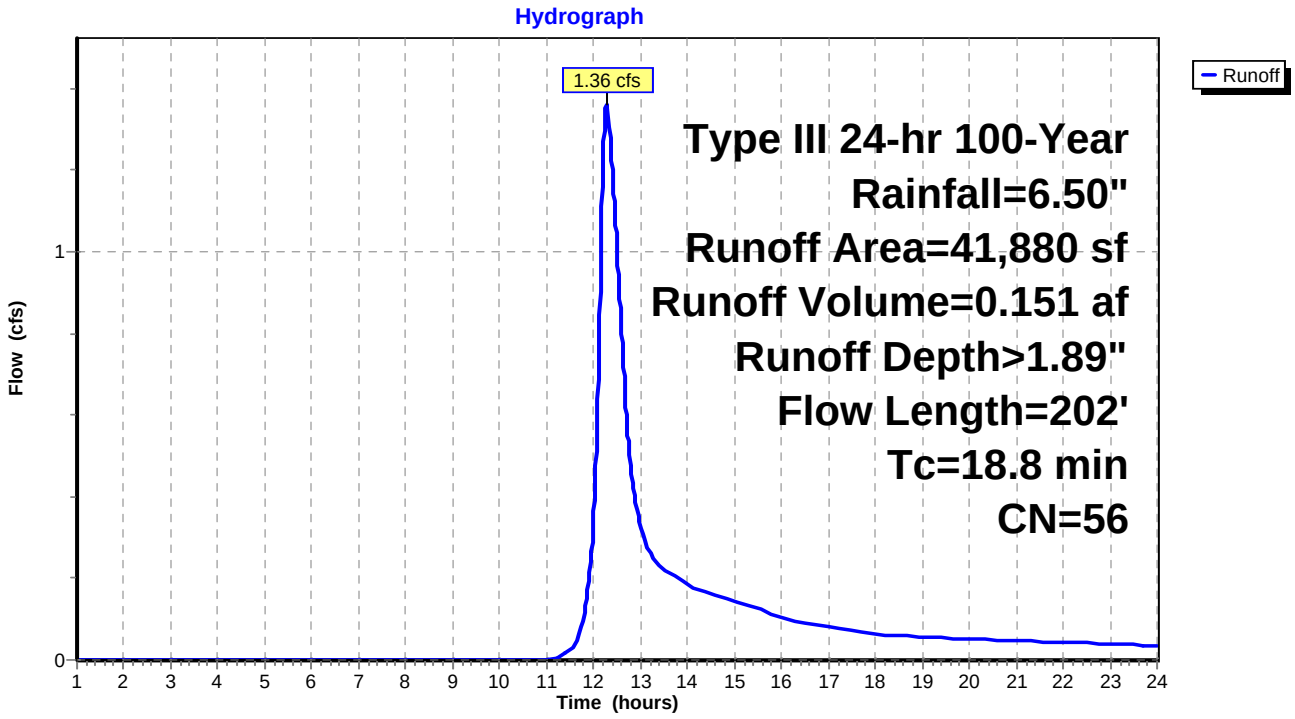
Runoff = 1.36 cfs @ 12.28 hrs, Volume= 0.151 af, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
20,970	36	Woods, Fair, HSG A
20,910	77	Newly graded area, HSG A
41,880	56	Weighted Average
41,880		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	50	0.0125	0.05		**Sheet Flow, SF** Woods: Light underbrush n= 0.400 P2= 3.00"
3.3	110	0.0125	0.56		**Shallow Concentrated Flow, SCF** Woodland Kv= 5.0 fps
0.1	42	0.2000	13.47	49.85	**Channel Flow, CF** Area= 3.7 sf Perim= 7.8' r= 0.47' n= 0.030 Stream, clean & straight
18.8	202	Total			

Subcatchment 1S: W'ly SC



Summary for Subcatchment 2S: E'ly SC

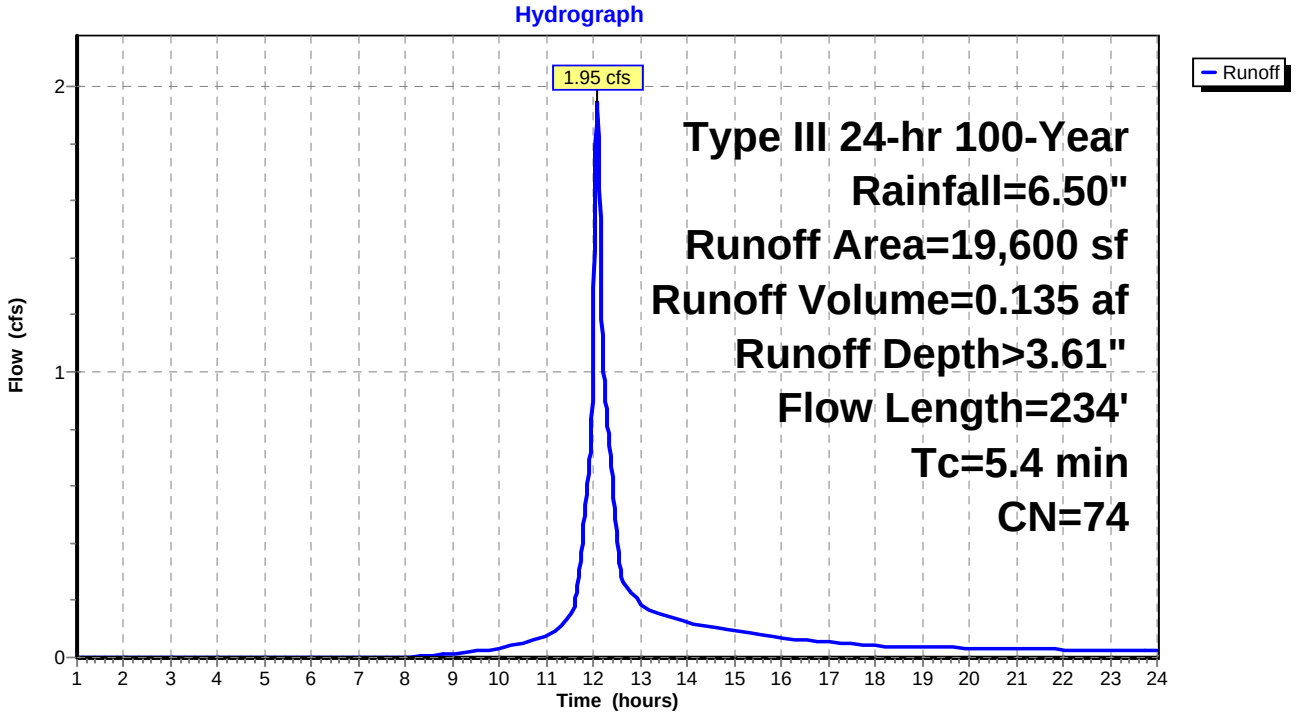
Runoff = 1.95 cfs @ 12.08 hrs, Volume= 0.135 af, Depth> 3.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

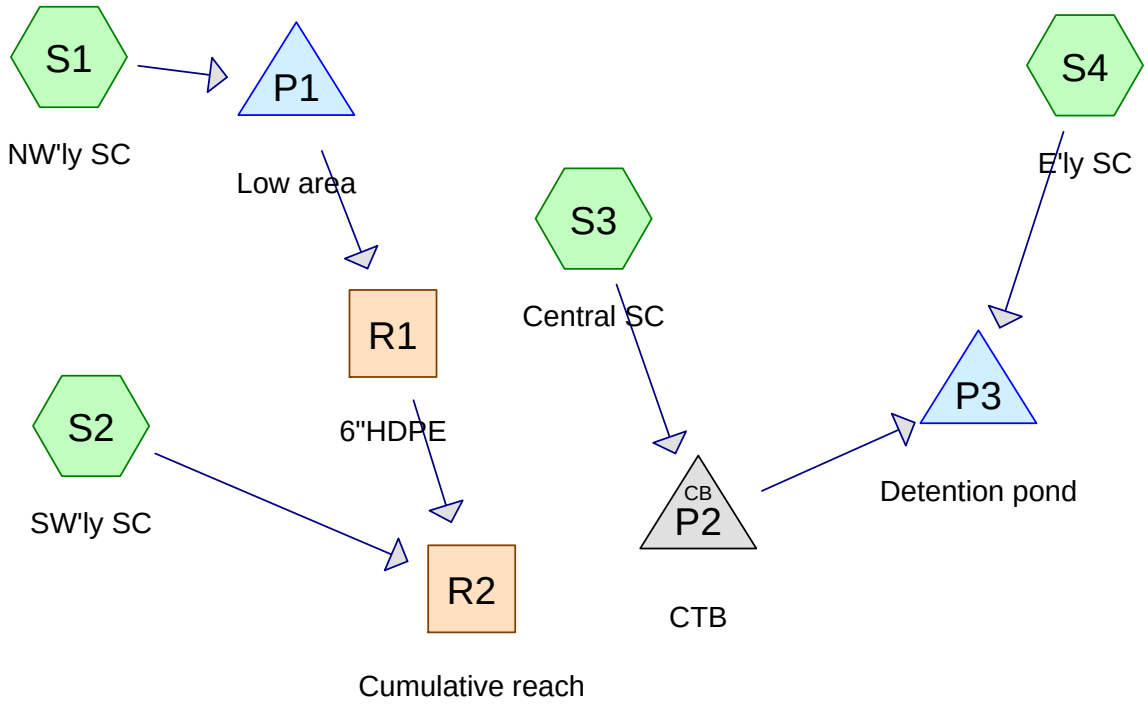
Area (sf)	CN	Description
18,060	77	Newly graded area, HSG A
1,540	36	Woods, Fair, HSG A
19,600	74	Weighted Average
19,600		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	50	0.0170	0.32		**Sheet Flow, SCF** Fallow n= 0.050 P2= 3.00"
0.9	70	0.0170	1.30		**Shallow Concentrated Flow, SF** Nearly Bare & Untilled Kv= 10.0 fps
1.6	72	0.1110	0.74		**Sheet Flow, SF** Fallow n= 0.050 P2= 3.00"
0.3	42	0.0480	2.19		**Shallow Concentrated Flow, SF** Nearly Bare & Untilled Kv= 10.0 fps
5.4	234	Total			

Subcatchment 2S: E'ly SC



POST-DEVELOPMENT DRAINAGE ANALYSIS



Subcat Reach Pond Link

Drainage Diagram for KiwiCourt PostDev
Prepared by Trowbridge Engineering, LLC, Printed 10/3/2019
HydroCAD® 9.10 s/n 01207 © 2010 HydroCAD Software Solutions LLC

Summary for Subcatchment S1: NW'ly SC

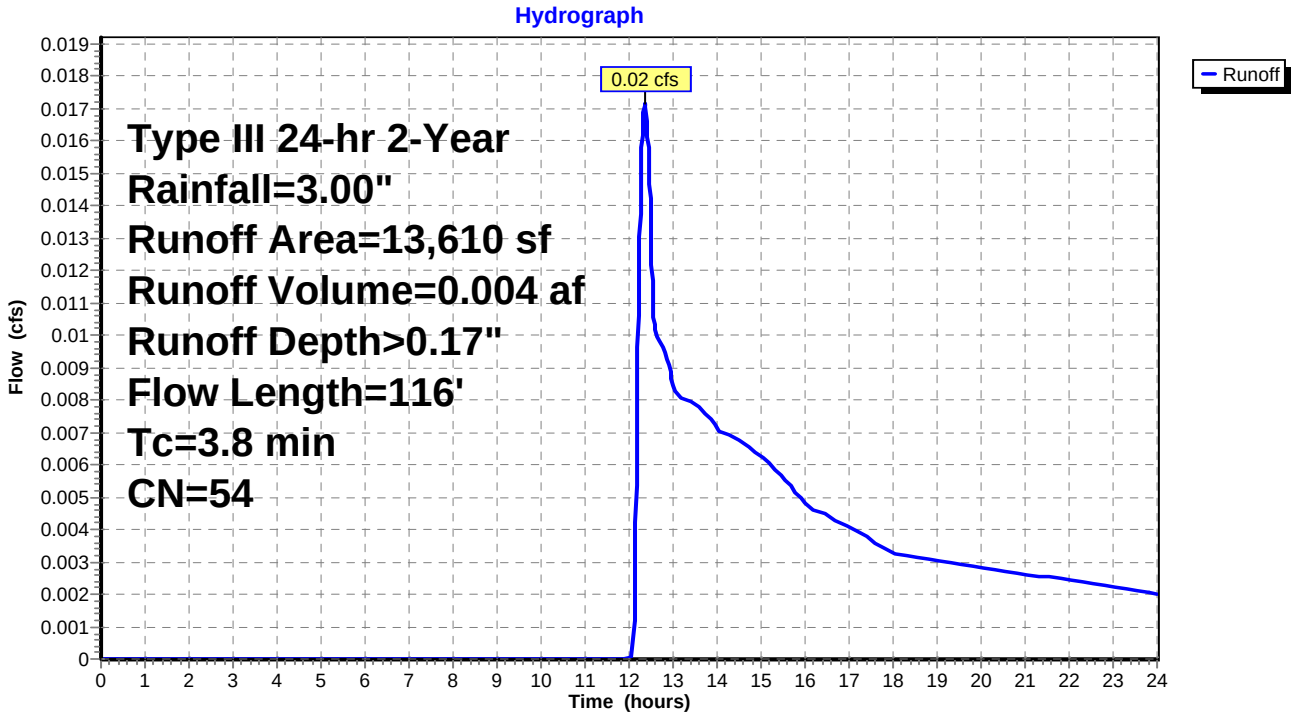
Runoff = 0.02 cfs @ 12.36 hrs, Volume= 0.004 af, Depth> 0.17"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Area (sf)	CN	Description
940	98	Roofs, HSG A
9,260	49	50-75% Grass cover, Fair, HSG A
2,435	36	Woods, Fair, HSG A
975	98	Water Surface, HSG A
13,610	54	Weighted Average
11,695		85.93% Pervious Area
1,915		14.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1200	0.29		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.2	30	0.2000	2.24		**Shallow Concentrated Flow, SC1** Woodland Kv= 5.0 fps
0.8	36	0.0200	0.71		**Shallow Concentrated Flow, SC2** Woodland Kv= 5.0 fps
3.8	116	Total			

Subcatchment S1: NW'ly SC



Summary for Subcatchment S2: SW'ly SC

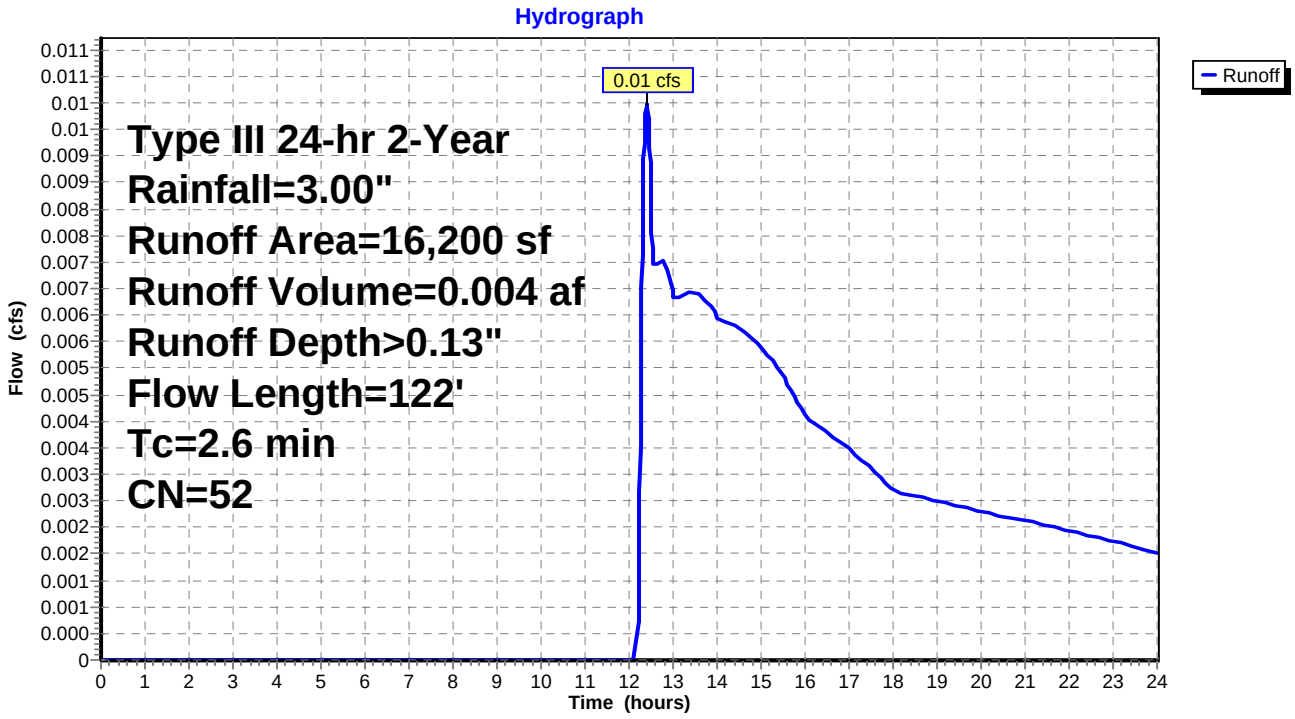
Runoff = 0.01 cfs @ 12.41 hrs, Volume= 0.004 af, Depth> 0.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Area (sf)	CN	Description
885	98	Roofs, HSG A
15,315	49	50-75% Grass cover, Fair, HSG A
16,200	52	Weighted Average
15,315		94.54% Pervious Area
885		5.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	25	0.1000	0.24		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.6	70	0.0860	2.05		**Shallow Concentrated Flow, SC1** Short Grass Pasture Kv= 7.0 fps
0.2	27	0.3000	2.74		**Shallow Concentrated Flow, SC2** Woodland Kv= 5.0 fps
2.6	122	Total			

Subcatchment S2: SW'ly SC



Summary for Subcatchment S3: Central SC

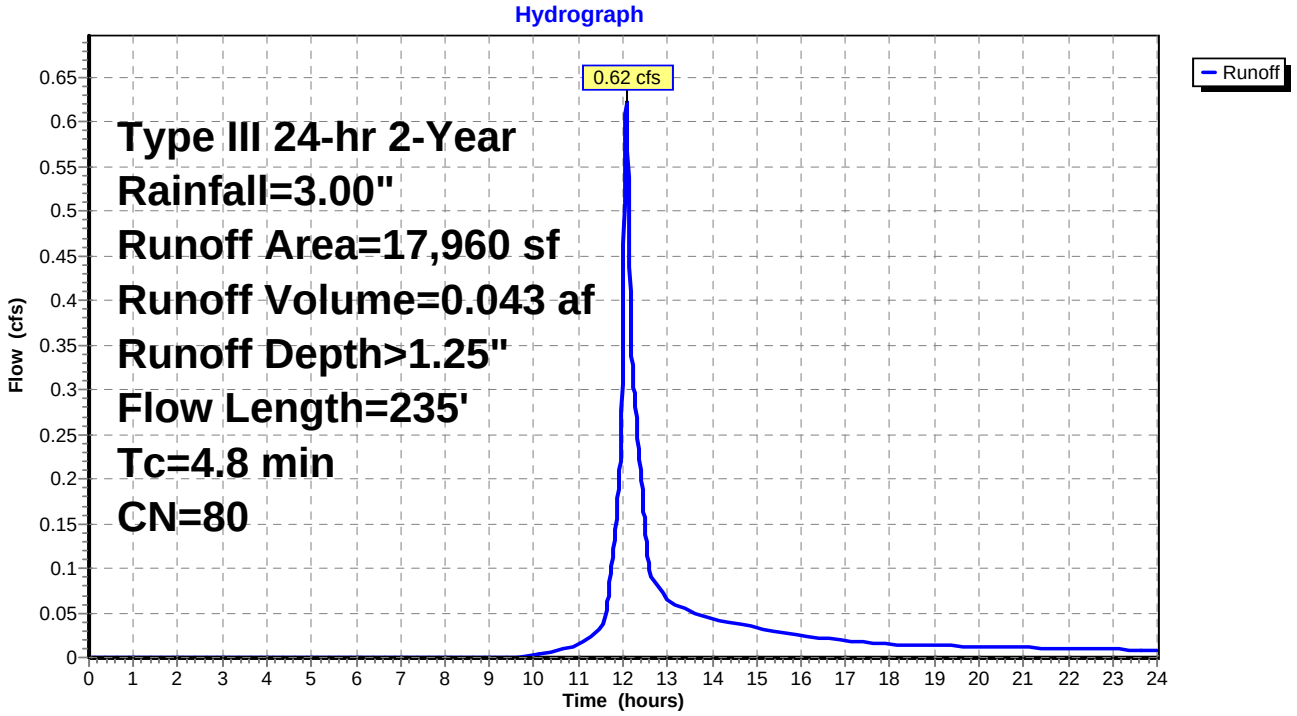
Runoff = 0.62 cfs @ 12.08 hrs, Volume= 0.043 af, Depth> 1.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Area (sf)	CN	Description
1,085	98	Roofs, HSG A
10,155	98	Paved parking, HSG A
6,720	49	50-75% Grass cover, Fair, HSG A
17,960	80	Weighted Average
6,720		37.42% Pervious Area
11,240		62.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	60	0.0670	0.24		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.3	105	0.0800	5.74		**Shallow Concentrated Flow, SC1** Paved Kv= 20.3 fps
0.4	70	0.0250	3.21		**Shallow Concentrated Flow, SCF2** Paved Kv= 20.3 fps
4.8	235	Total			

Subcatchment S3: Central SC



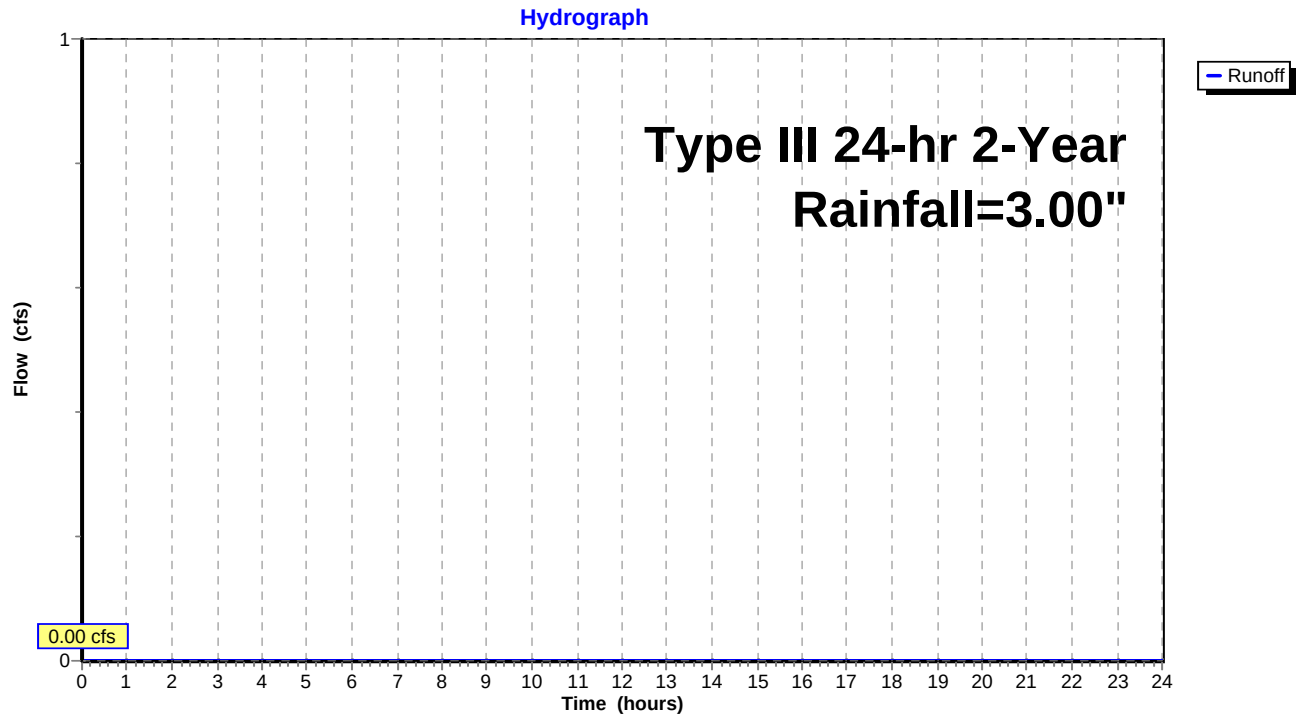
Summary for Subcatchment S4: E'ly SC

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	55	0.0360	0.18		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.8	72	0.0420	1.43		**Shallow Concentrated Flow, SCF1** Short Grass Pasture Kv= 7.0 fps
0.3	52	0.1540	2.75		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.0	12	0.3300	4.02		**Shallow Concentrated Flow, SCF** Short Grass Pasture Kv= 7.0 fps
6.1	191	Total			

Subcatchment S4: E'ly SC



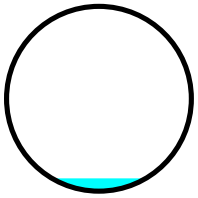
Summary for Reach R1: 6"HDPE

Inflow Area = 0.312 ac, 14.07% Impervious, Inflow Depth > 0.17" for 2-Year event
Inflow = 0.02 cfs @ 12.46 hrs, Volume= 0.004 af
Outflow = 0.02 cfs @ 12.46 hrs, Volume= 0.004 af, Atten= 0%, Lag= 0.4 min

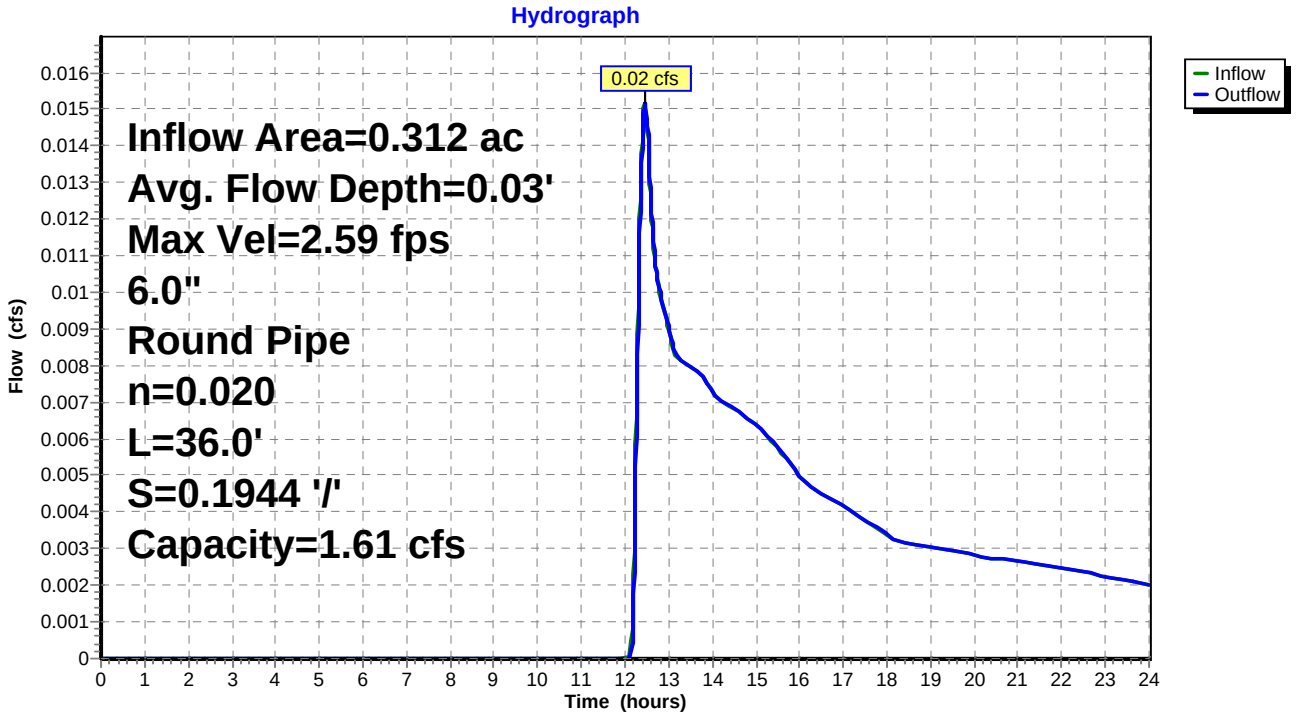
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.59 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.74 fps, Avg. Travel Time= 0.3 min

Peak Storage= 0 cf @ 12.46 hrs
Average Depth at Peak Storage= 0.03'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 1.61 cfs

6.0" Round Pipe
n= 0.020 Corrugated PE, corrugated interior
Length= 36.0' Slope= 0.1944 '/'
Inlet Invert= 210.00', Outlet Invert= 203.00'



Reach R1: 6"HDPE

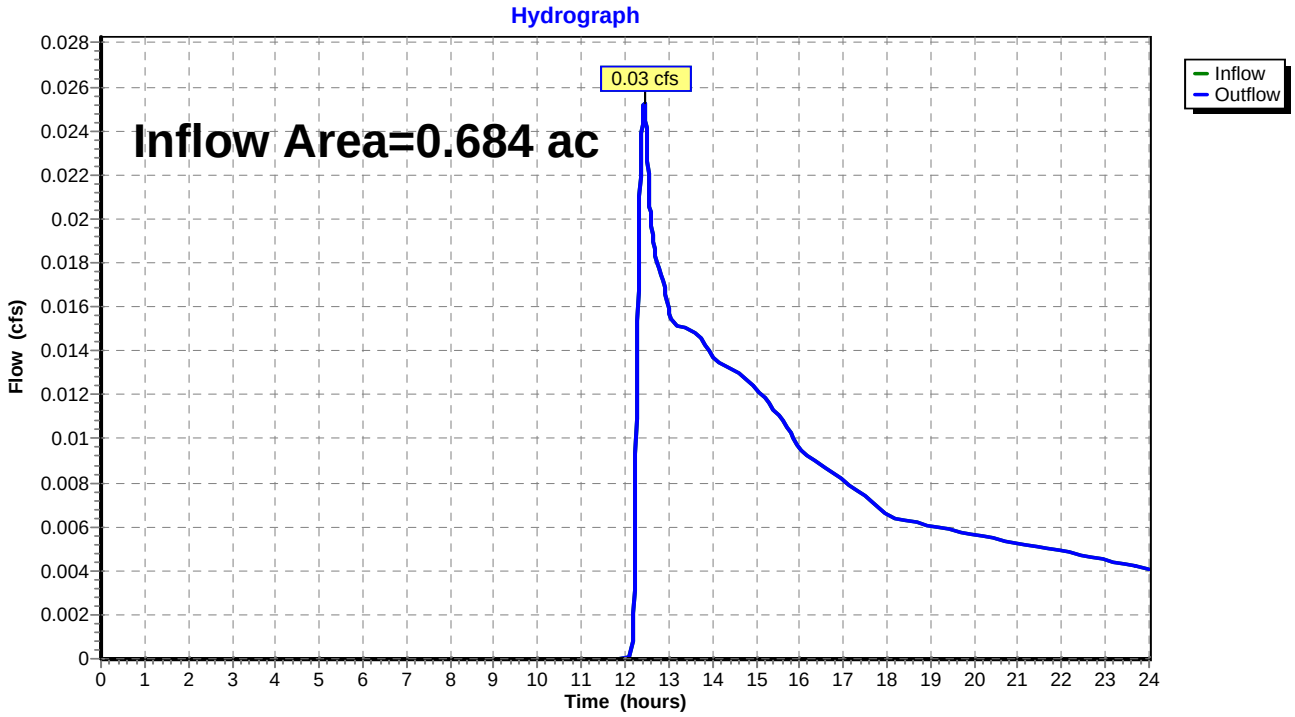


Summary for Reach R2: Cumulative reach

Inflow Area = 0.684 ac, 9.39% Impervious, Inflow Depth > 0.15" for 2-Year event
Inflow = 0.03 cfs @ 12.44 hrs, Volume= 0.008 af
Outflow = 0.03 cfs @ 12.44 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach R2: Cumulative reach



Summary for Pond P1: Low area

Inflow Area = 0.312 ac, 14.07% Impervious, Inflow Depth > 0.17" for 2-Year event
Inflow = 0.02 cfs @ 12.36 hrs, Volume= 0.004 af
Outflow = 0.02 cfs @ 12.46 hrs, Volume= 0.004 af, Atten= 12%, Lag= 5.7 min
Primary = 0.02 cfs @ 12.46 hrs, Volume= 0.004 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 211.38' @ 12.46 hrs Surf.Area= 129 sf Storage= 6 cf

Plug-Flow detention time= 8.3 min calculated for 0.004 af (99% of inflow)
Center-of-Mass det. time= 5.3 min (982.7 - 977.5)

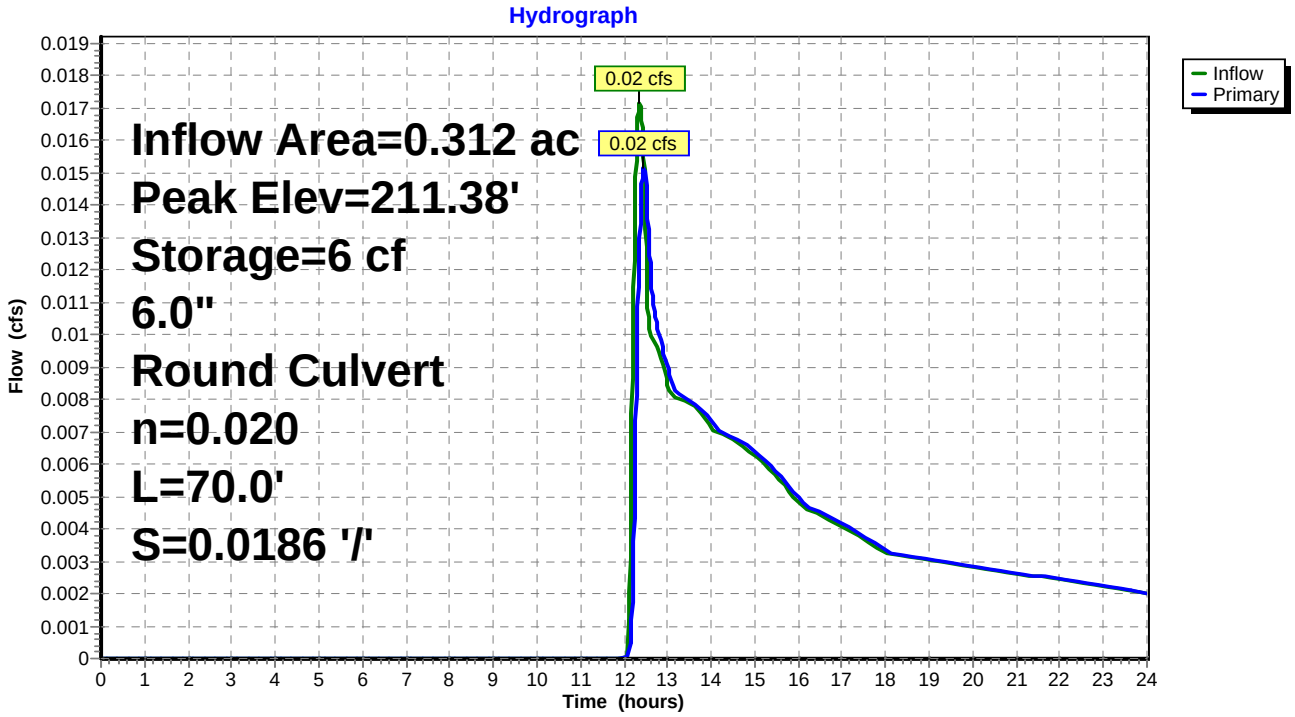
Volume	Invert	Avail.Storage	Storage Description
#1	211.30'	348 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
211.30	20	0	0
212.00	975	348	348

Device	Routing	Invert	Outlet Devices
#1	Primary	211.30'	**6.0" Round Culvert** L= 70.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 211.30' / 210.00' S= 0.0186 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior

Primary OutFlow Max=0.02 cfs @ 12.46 hrs HW=211.38' (Free Discharge)
1=Culvert (Barrel Controls 0.02 cfs @ 1.13 fps)

Pond P1: Low area



Summary for Pond P2: CTB

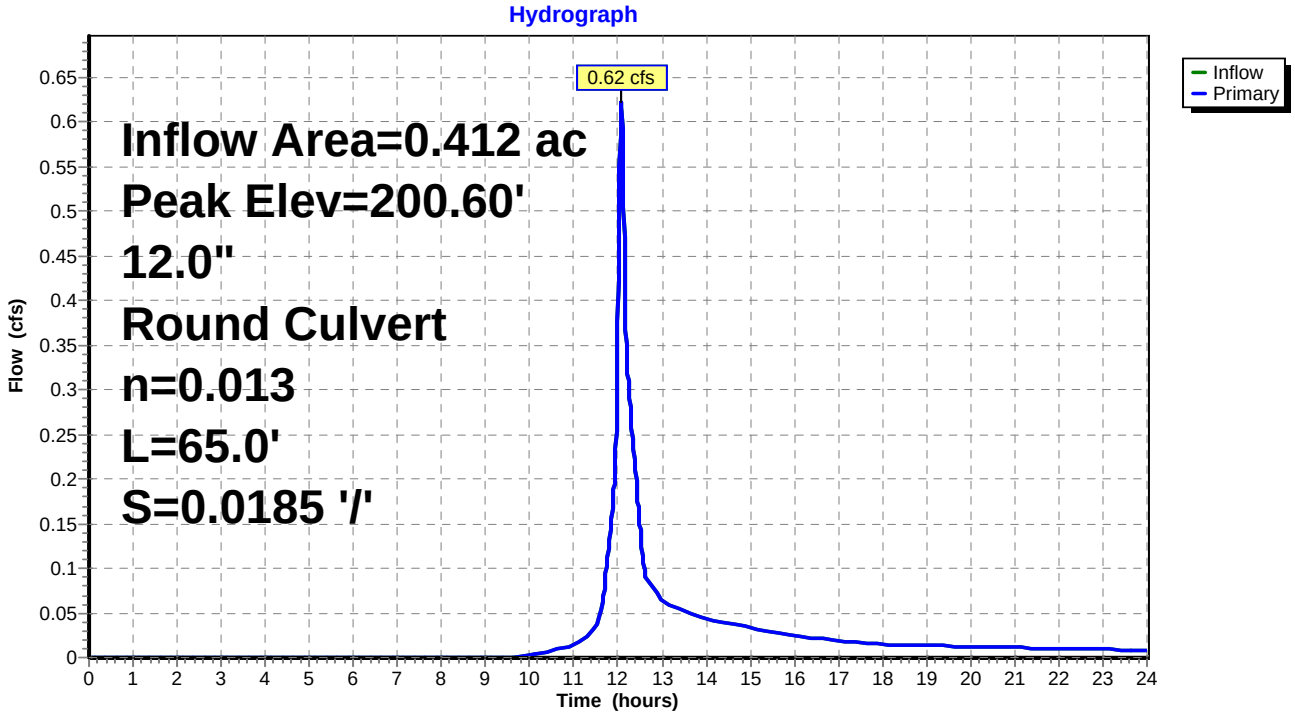
Inflow Area = 0.412 ac, 62.58% Impervious, Inflow Depth > 1.25" for 2-Year event
Inflow = 0.62 cfs @ 12.08 hrs, Volume= 0.043 af
Outflow = 0.62 cfs @ 12.08 hrs, Volume= 0.043 af, Atten= 0%, Lag= 0.0 min
Primary = 0.62 cfs @ 12.08 hrs, Volume= 0.043 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 200.60' @ 12.08 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	200.20'	**12.0" Round Culvert** L= 65.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 200.20' / 199.00' S= 0.0185 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=0.62 cfs @ 12.08 hrs HW=200.60' (Free Discharge)
└**1=Culvert** (Inlet Controls 0.62 cfs @ 2.14 fps)

Pond P2: CTB



Summary for Pond P3: Detention pond

Inflow Area = 0.412 ac, 62.58% Impervious, Inflow Depth > 1.25" for 2-Year event
Inflow = 0.62 cfs @ 12.08 hrs, Volume= 0.043 af
Outflow = 0.03 cfs @ 14.96 hrs, Volume= 0.012 af, Atten= 95%, Lag= 172.9 min
Primary = 0.03 cfs @ 14.96 hrs, Volume= 0.012 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 200.01' @ 14.96 hrs Surf.Area= 889 sf Storage= 1,345 cf

Plug-Flow detention time= 382.2 min calculated for 0.012 af (29% of inflow)
Center-of-Mass det. time= 247.5 min (1,091.9 - 844.4)

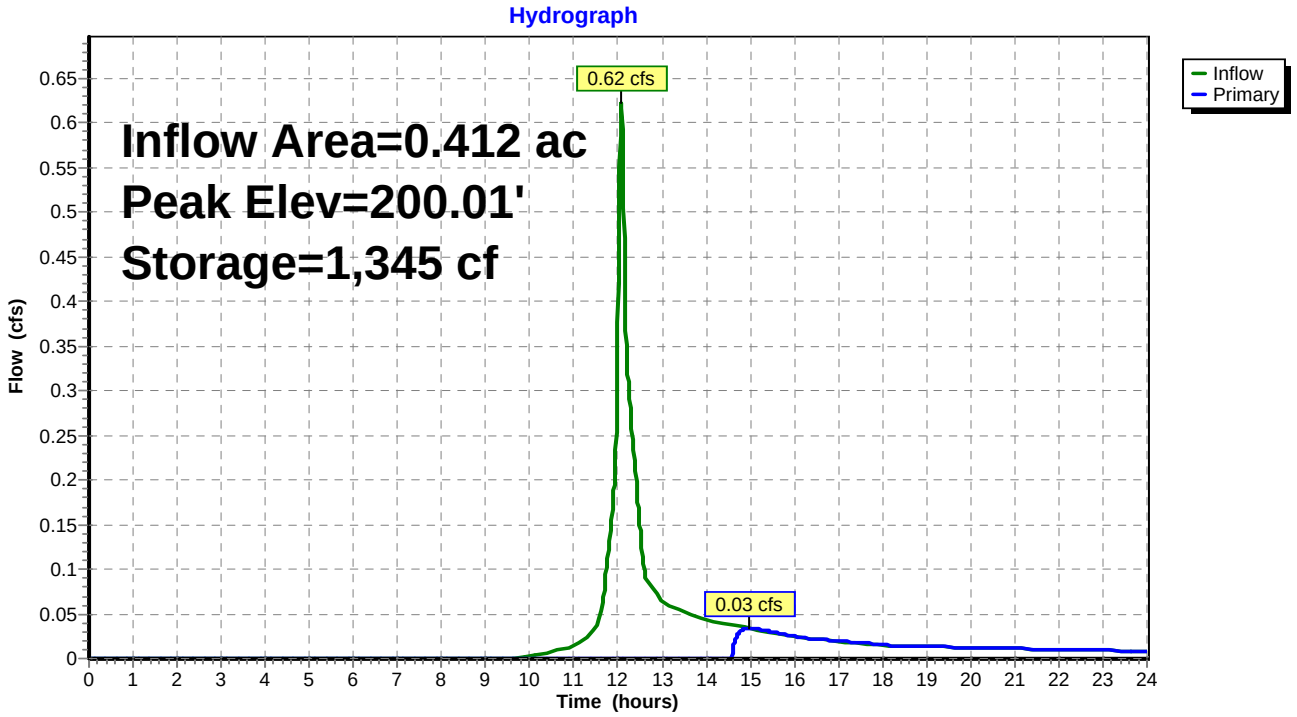
Volume	Invert	Avail.Storage	Storage Description
#1	197.00'	2,373 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.00	100	0	0
198.00	265	183	183
201.00	1,195	2,190	2,373

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**5.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.02 cfs @ 14.96 hrs HW=200.01' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.02 cfs @ 0.28 fps)

Pond P3: Detention pond



Summary for Subcatchment S1: NW'ly SC

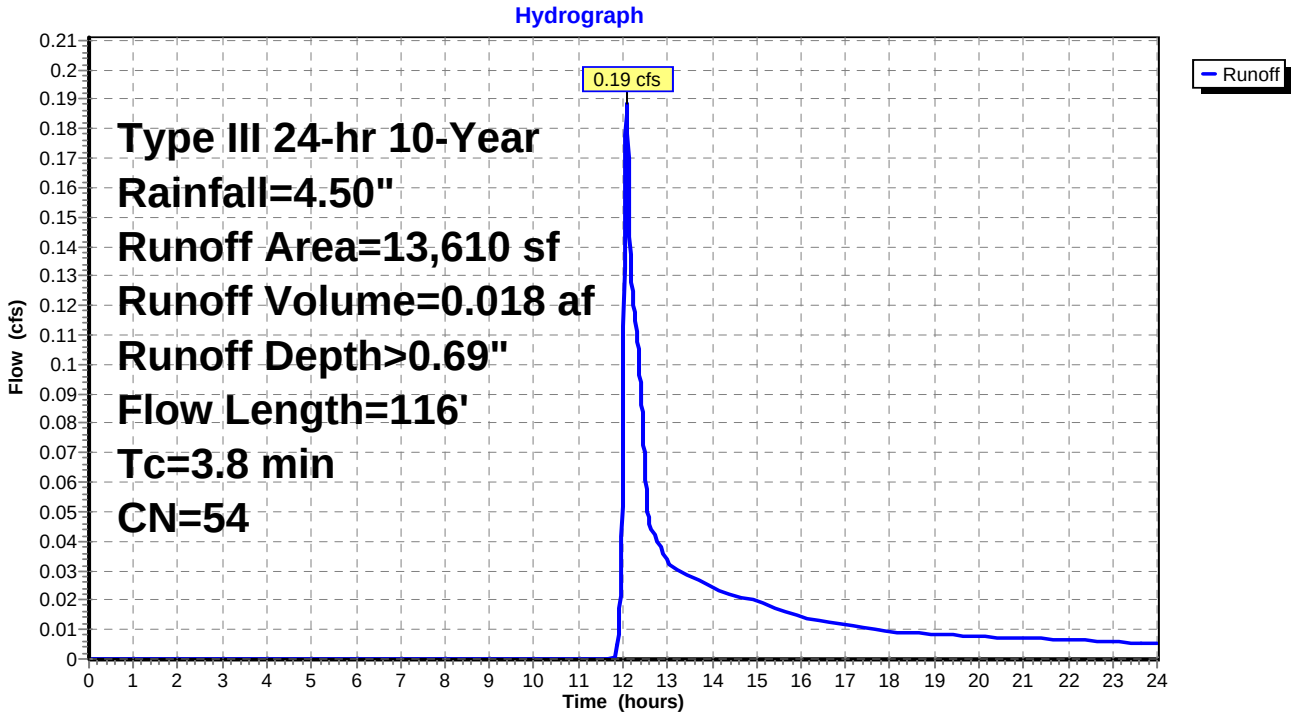
Runoff = 0.19 cfs @ 12.08 hrs, Volume= 0.018 af, Depth> 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
940	98	Roofs, HSG A
9,260	49	50-75% Grass cover, Fair, HSG A
2,435	36	Woods, Fair, HSG A
975	98	Water Surface, HSG A
13,610	54	Weighted Average
11,695		85.93% Pervious Area
1,915		14.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1200	0.29		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.2	30	0.2000	2.24		**Shallow Concentrated Flow, SC1** Woodland Kv= 5.0 fps
0.8	36	0.0200	0.71		**Shallow Concentrated Flow, SC2** Woodland Kv= 5.0 fps
3.8	116	Total			

Subcatchment S1: NW'ly SC



Summary for Subcatchment S2: SW'ly SC

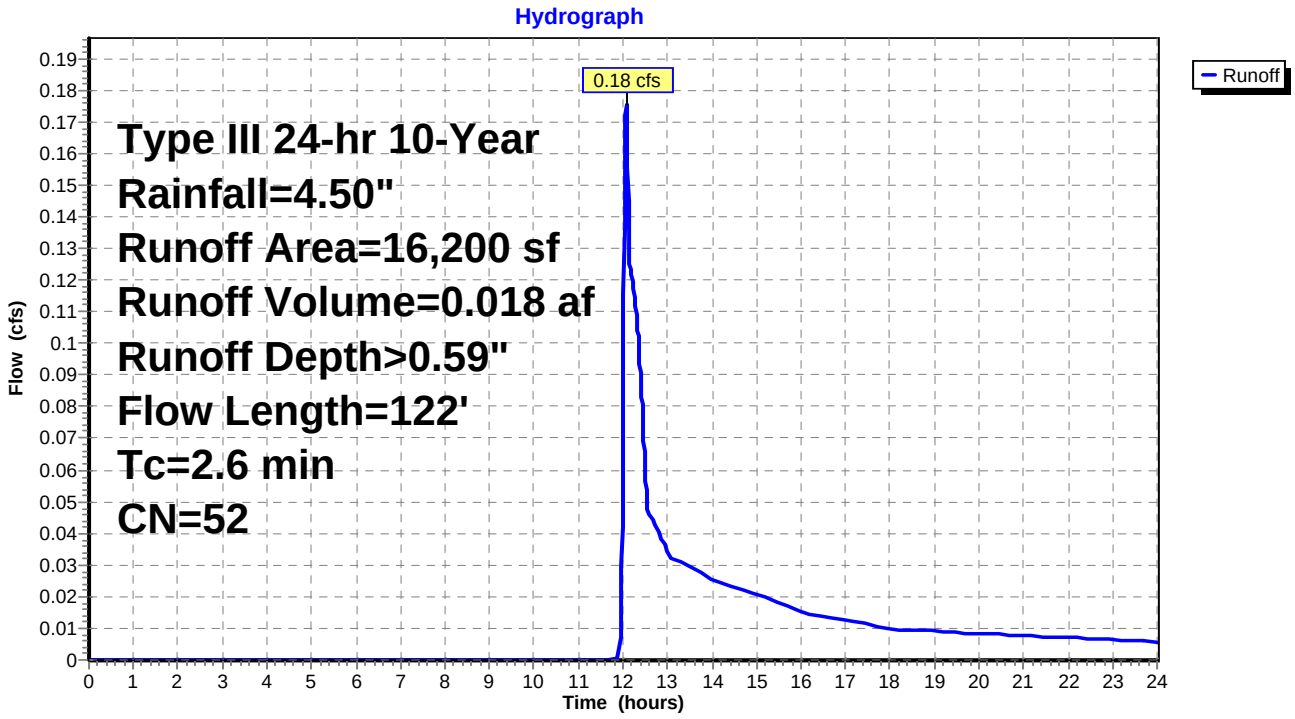
Runoff = 0.18 cfs @ 12.07 hrs, Volume= 0.018 af, Depth> 0.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
885	98	Roofs, HSG A
15,315	49	50-75% Grass cover, Fair, HSG A
16,200	52	Weighted Average
15,315		94.54% Pervious Area
885		5.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	25	0.1000	0.24		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.6	70	0.0860	2.05		**Shallow Concentrated Flow, SC1** Short Grass Pasture Kv= 7.0 fps
0.2	27	0.3000	2.74		**Shallow Concentrated Flow, SC2** Woodland Kv= 5.0 fps
2.6	122	Total			

Subcatchment S2: SW'ly SC



Summary for Subcatchment S3: Central SC

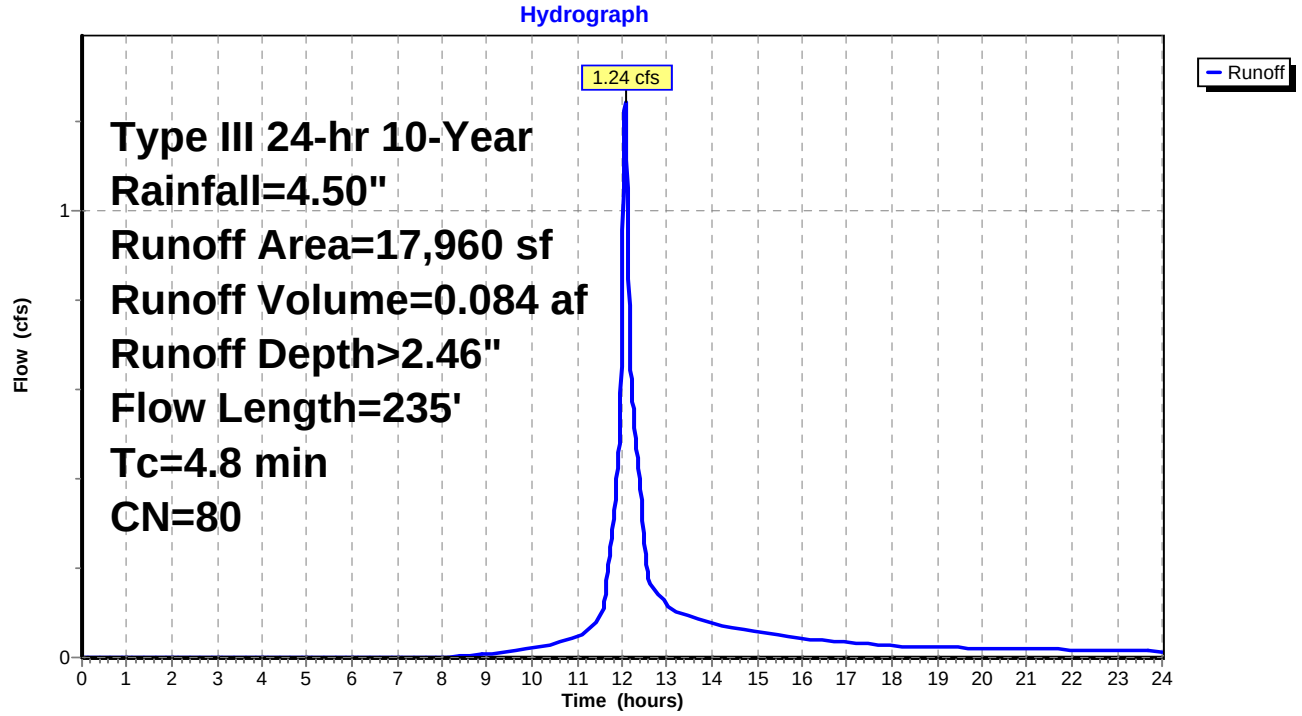
Runoff = 1.24 cfs @ 12.07 hrs, Volume= 0.084 af, Depth> 2.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
1,085	98	Roofs, HSG A
10,155	98	Paved parking, HSG A
6,720	49	50-75% Grass cover, Fair, HSG A
17,960	80	Weighted Average
6,720		37.42% Pervious Area
11,240		62.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	60	0.0670	0.24		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.3	105	0.0800	5.74		**Shallow Concentrated Flow, SC1** Paved Kv= 20.3 fps
0.4	70	0.0250	3.21		**Shallow Concentrated Flow, SCF2** Paved Kv= 20.3 fps
4.8	235	Total			

Subcatchment S3: Central SC



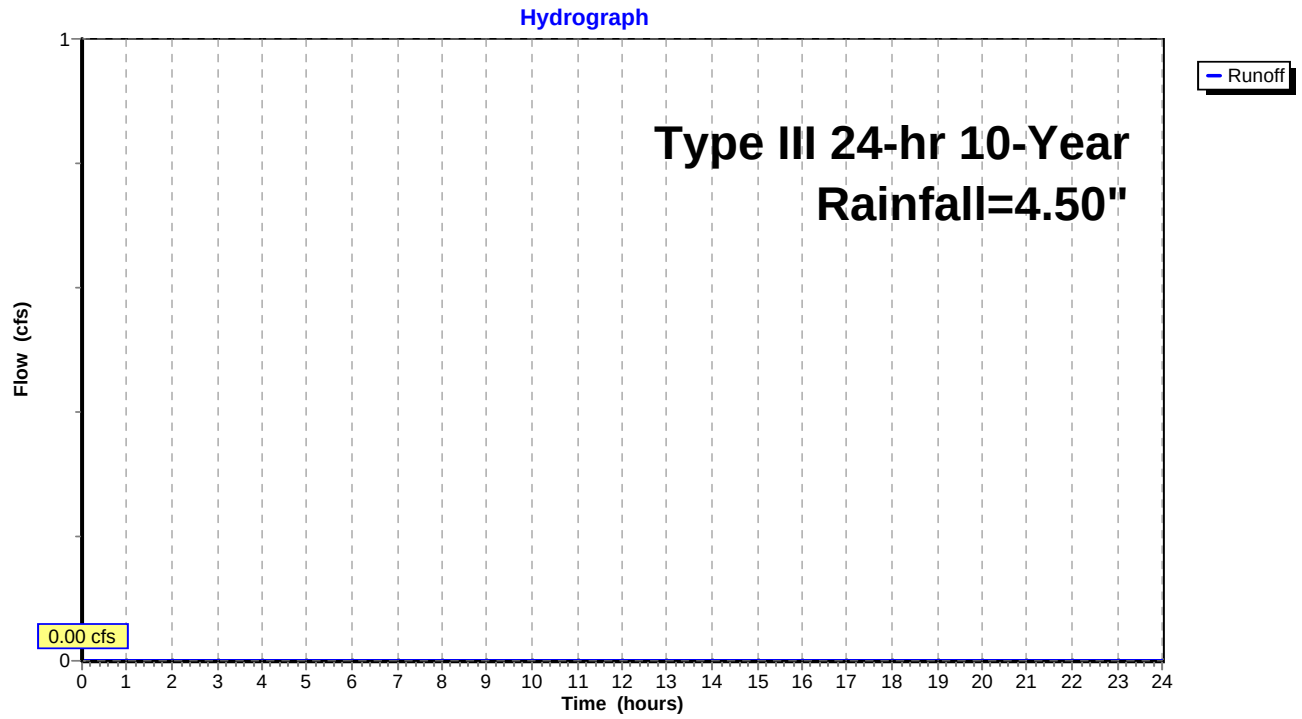
Summary for Subcatchment S4: E'ly SC

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	55	0.0360	0.18		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.8	72	0.0420	1.43		**Shallow Concentrated Flow, SCF1** Short Grass Pasture Kv= 7.0 fps
0.3	52	0.1540	2.75		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.0	12	0.3300	4.02		**Shallow Concentrated Flow, SCF** Short Grass Pasture Kv= 7.0 fps
6.1	191	Total			

Subcatchment S4: E'ly SC



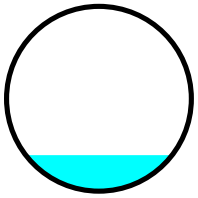
Summary for Reach R1: 6"HDPE

Inflow Area = 0.312 ac, 14.07% Impervious, Inflow Depth > 0.69" for 10-Year event
Inflow = 0.13 cfs @ 12.17 hrs, Volume= 0.018 af
Outflow = 0.13 cfs @ 12.18 hrs, Volume= 0.018 af, Atten= 0%, Lag= 0.2 min

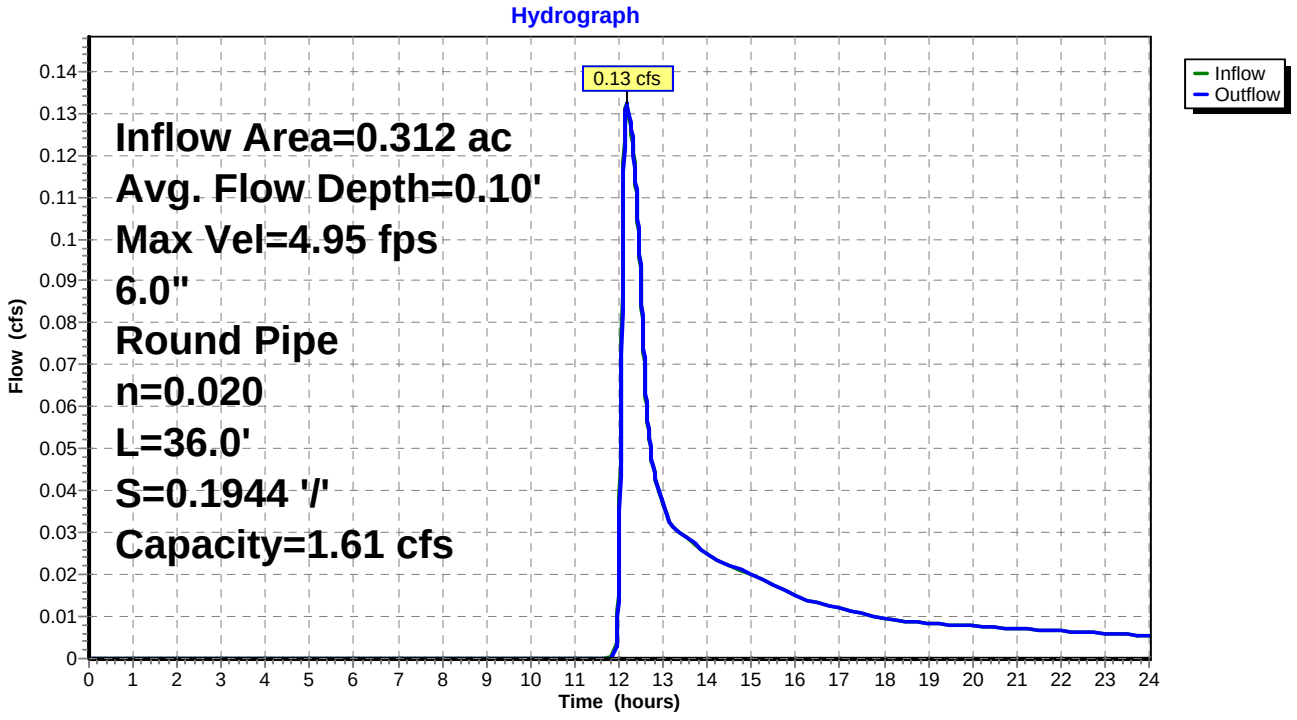
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.95 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.50 fps, Avg. Travel Time= 0.2 min

Peak Storage= 1 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 1.61 cfs

6.0" Round Pipe
n= 0.020 Corrugated PE, corrugated interior
Length= 36.0' Slope= 0.1944 '/'
Inlet Invert= 210.00', Outlet Invert= 203.00'



Reach R1: 6"HDPE

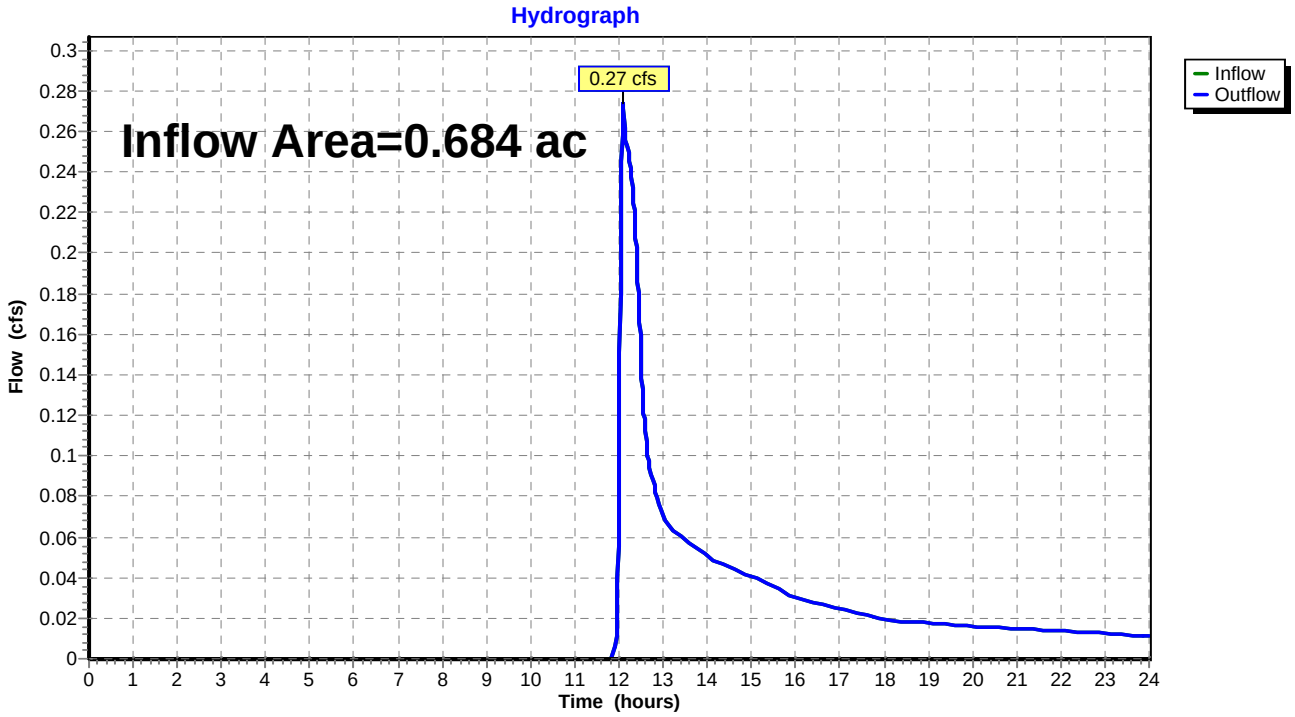


Summary for Reach R2: Cumulative reach

Inflow Area = 0.684 ac, 9.39% Impervious, Inflow Depth > 0.64" for 10-Year event
Inflow = 0.27 cfs @ 12.10 hrs, Volume= 0.036 af
Outflow = 0.27 cfs @ 12.10 hrs, Volume= 0.036 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach R2: Cumulative reach



Summary for Pond P1: Low area

Inflow Area = 0.312 ac, 14.07% Impervious, Inflow Depth > 0.69" for 10-Year event
Inflow = 0.19 cfs @ 12.08 hrs, Volume= 0.018 af
Outflow = 0.13 cfs @ 12.17 hrs, Volume= 0.018 af, Atten= 30%, Lag= 5.3 min
Primary = 0.13 cfs @ 12.17 hrs, Volume= 0.018 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 211.55' @ 12.17 hrs Surf.Area= 362 sf Storage= 48 cf

Plug-Flow detention time= 6.5 min calculated for 0.018 af (100% of inflow)
Center-of-Mass det. time= 4.7 min (910.1 - 905.4)

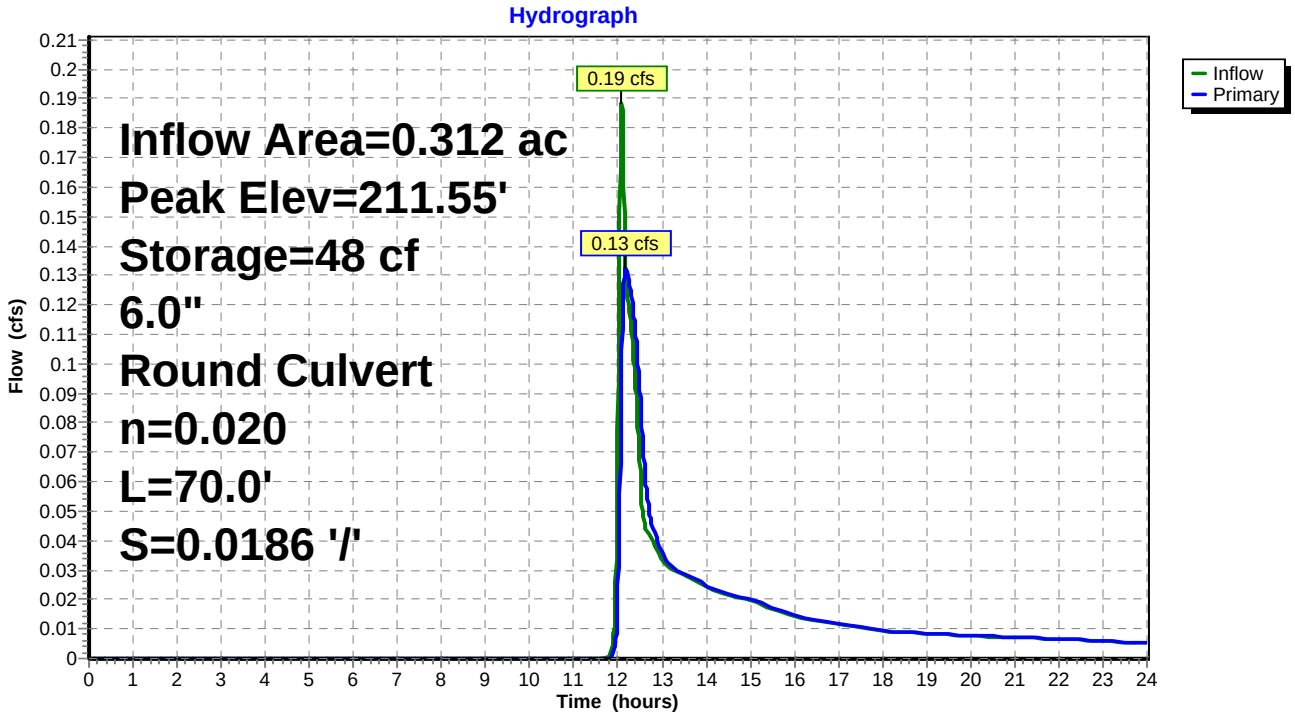
Volume	Invert	Avail.Storage	Storage Description
#1	211.30'	348 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
211.30	20	0	0
212.00	975	348	348

Device	Routing	Invert	Outlet Devices
#1	Primary	211.30'	**6.0" Round Culvert** L= 70.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 211.30' / 210.00' S= 0.0186 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior

Primary OutFlow Max=0.13 cfs @ 12.17 hrs HW=211.55' (Free Discharge)
↑**1=Culvert** (Inlet Controls 0.13 cfs @ 1.35 fps)

Pond P1: Low area



Summary for Pond P2: CTB

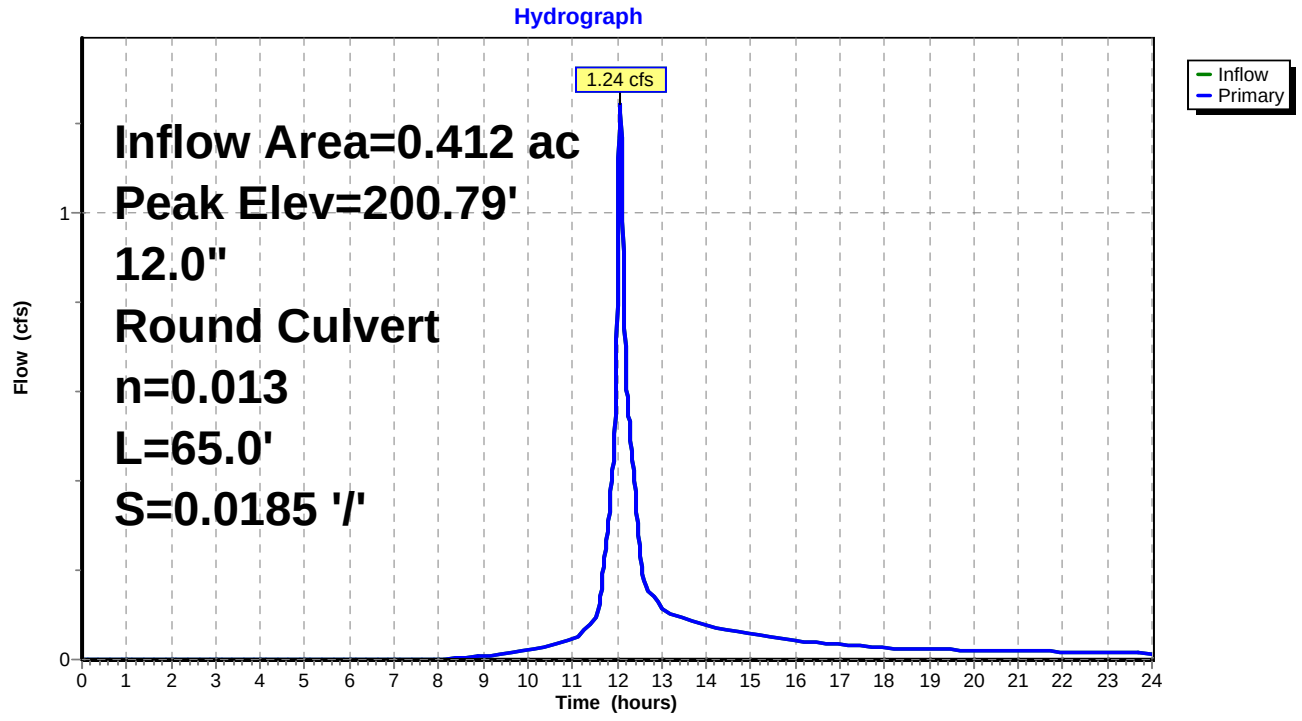
Inflow Area = 0.412 ac, 62.58% Impervious, Inflow Depth > 2.46" for 10-Year event
Inflow = 1.24 cfs @ 12.07 hrs, Volume= 0.084 af
Outflow = 1.24 cfs @ 12.07 hrs, Volume= 0.084 af, Atten= 0%, Lag= 0.0 min
Primary = 1.24 cfs @ 12.07 hrs, Volume= 0.084 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 200.79' @ 12.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	200.20'	**12.0" Round Culvert** L= 65.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 200.20' / 199.00' S= 0.0185 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=1.24 cfs @ 12.07 hrs HW=200.78' (Free Discharge)
└**1=Culvert** (Inlet Controls 1.24 cfs @ 2.60 fps)

Pond P2: CTB



Summary for Pond P3: Detention pond

Inflow Area = 0.412 ac, 62.58% Impervious, Inflow Depth > 2.46" for 10-Year event
Inflow = 1.24 cfs @ 12.07 hrs, Volume= 0.084 af
Outflow = 0.57 cfs @ 12.24 hrs, Volume= 0.054 af, Atten= 54%, Lag= 10.2 min
Primary = 0.57 cfs @ 12.24 hrs, Volume= 0.054 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 200.13' @ 12.24 hrs Surf.Area= 926 sf Storage= 1,451 cf

Plug-Flow detention time= 179.5 min calculated for 0.054 af (64% of inflow)
Center-of-Mass det. time= 75.2 min (900.0 - 824.7)

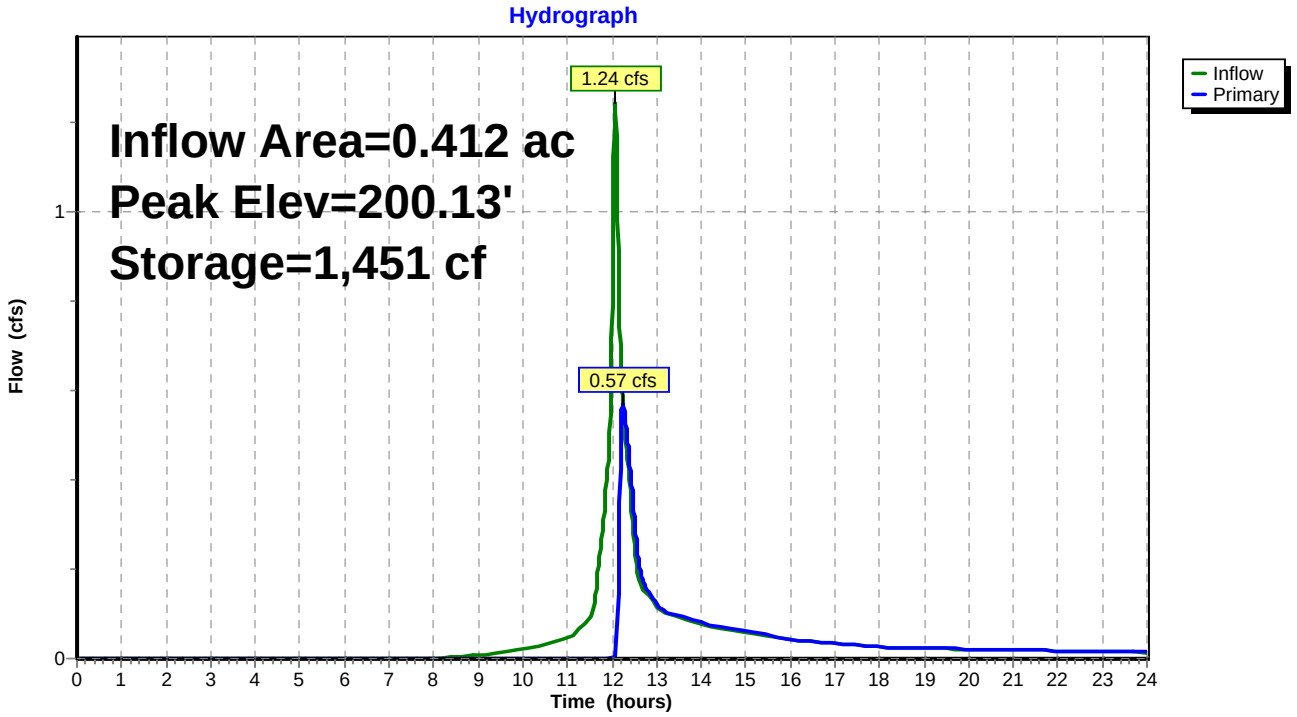
Volume	Invert	Avail.Storage	Storage Description
#1	197.00'	2,373 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.00	100	0	0
198.00	265	183	183
201.00	1,195	2,190	2,373

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**5.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.57 cfs @ 12.24 hrs HW=200.13' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 0.57 cfs @ 0.86 fps)

Pond P3: Detention pond



Summary for Subcatchment S1: NW'ly SC

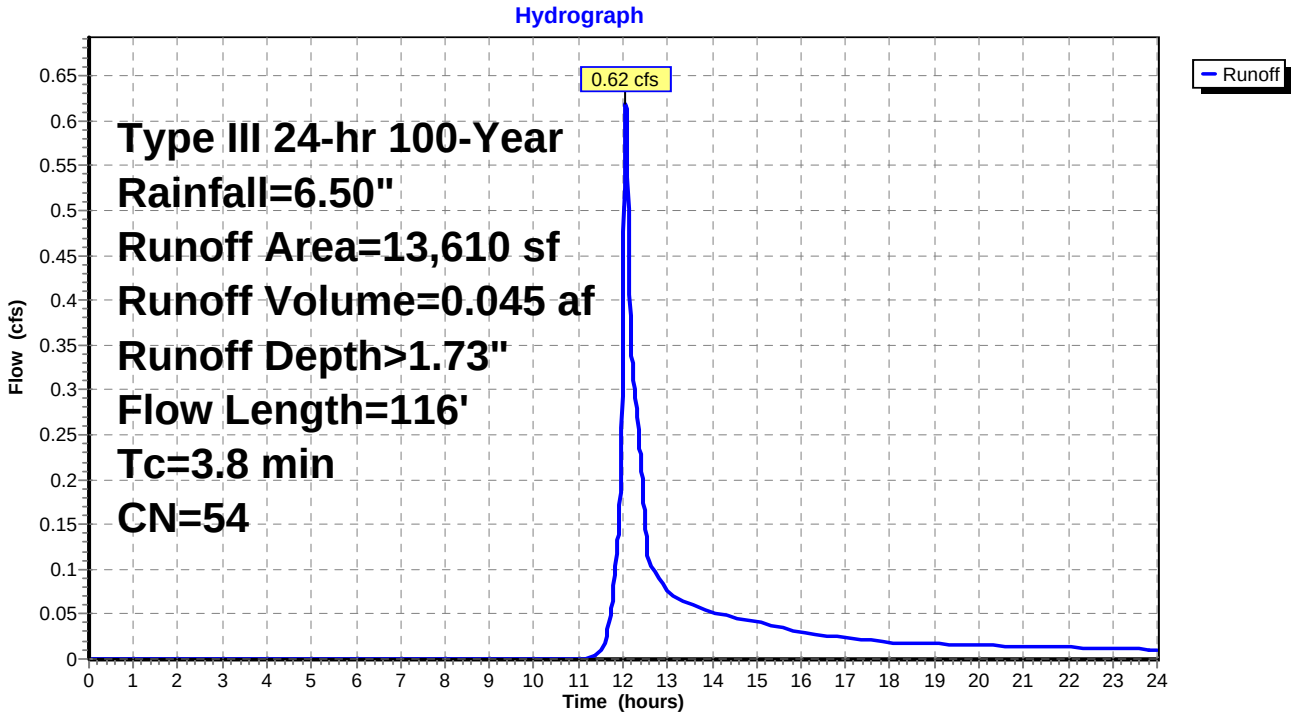
Runoff = 0.62 cfs @ 12.07 hrs, Volume= 0.045 af, Depth> 1.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
940	98	Roofs, HSG A
9,260	49	50-75% Grass cover, Fair, HSG A
2,435	36	Woods, Fair, HSG A
975	98	Water Surface, HSG A
13,610	54	Weighted Average
11,695		85.93% Pervious Area
1,915		14.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	50	0.1200	0.29		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.2	30	0.2000	2.24		**Shallow Concentrated Flow, SC1** Woodland Kv= 5.0 fps
0.8	36	0.0200	0.71		**Shallow Concentrated Flow, SC2** Woodland Kv= 5.0 fps
3.8	116	Total			

Subcatchment S1: NW'ly SC



Summary for Subcatchment S2: SW'ly SC

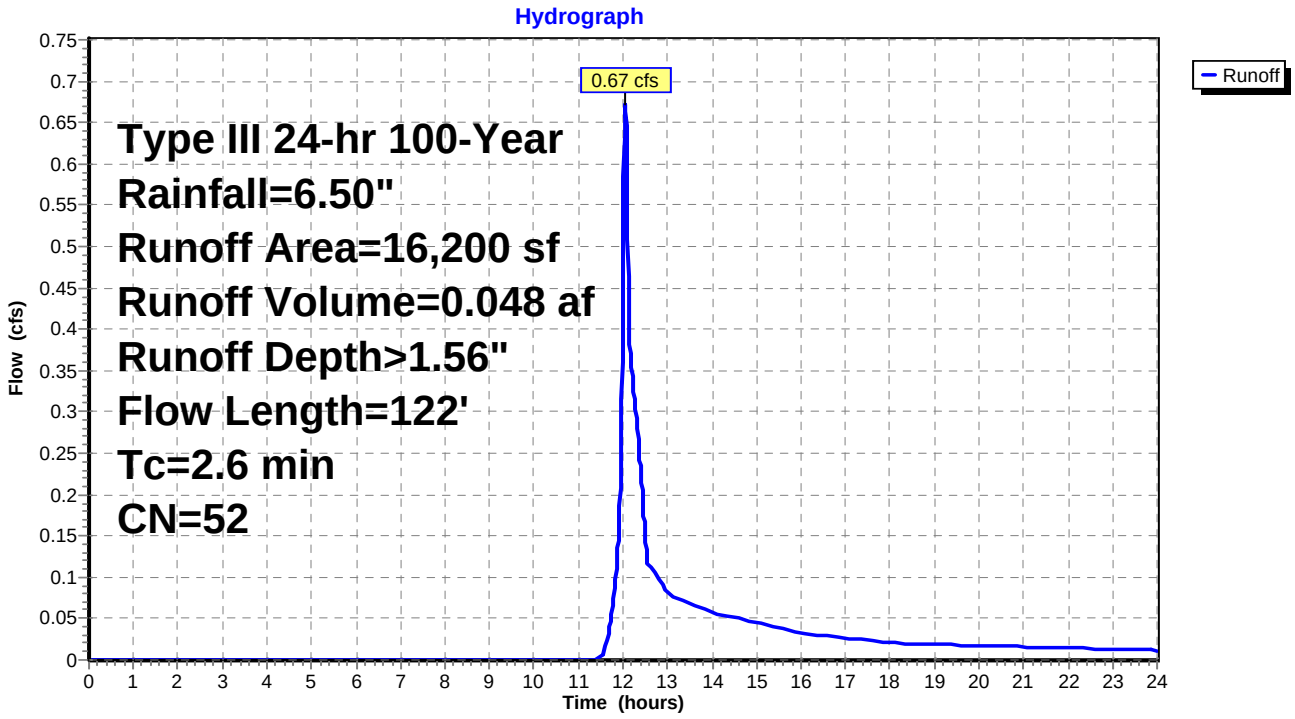
Runoff = 0.67 cfs @ 12.05 hrs, Volume= 0.048 af, Depth> 1.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
885	98	Roofs, HSG A
15,315	49	50-75% Grass cover, Fair, HSG A
16,200	52	Weighted Average
15,315		94.54% Pervious Area
885		5.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	25	0.1000	0.24		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.6	70	0.0860	2.05		**Shallow Concentrated Flow, SC1** Short Grass Pasture Kv= 7.0 fps
0.2	27	0.3000	2.74		**Shallow Concentrated Flow, SC2** Woodland Kv= 5.0 fps
2.6	122	Total			

Subcatchment S2: SW'ly SC



Summary for Subcatchment S3: Central SC

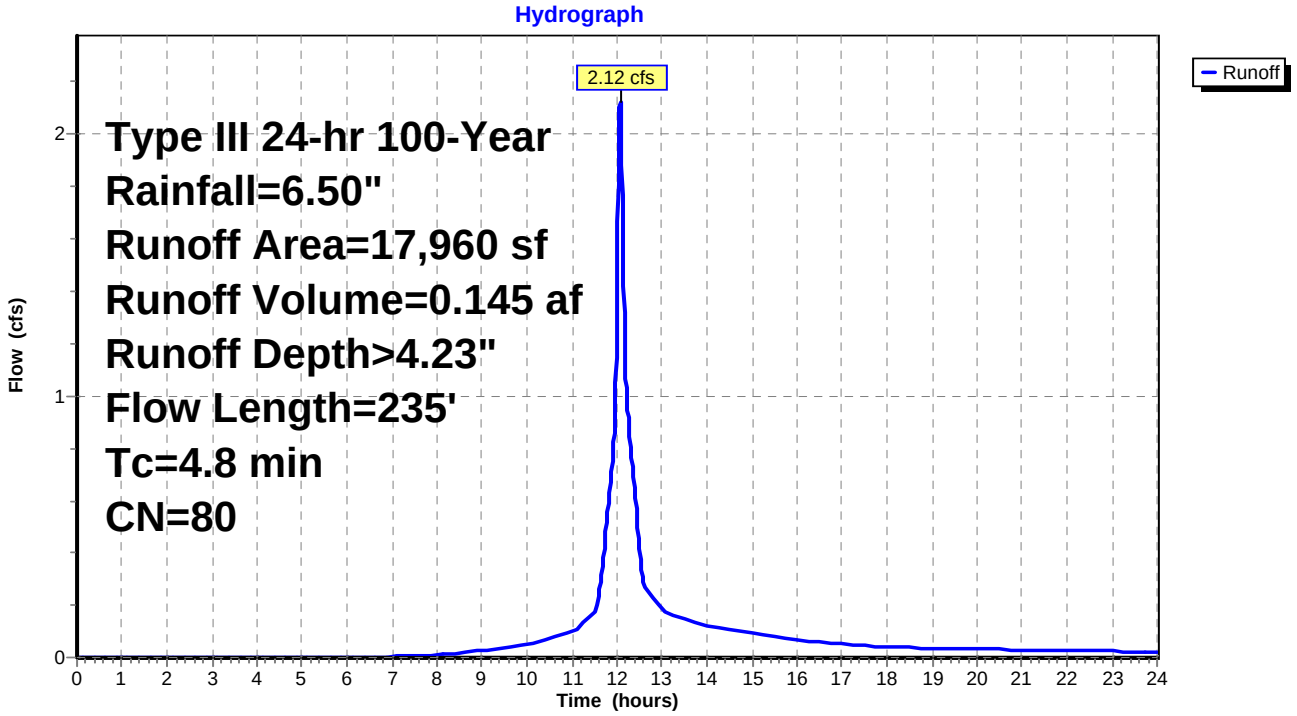
Runoff = 2.12 cfs @ 12.07 hrs, Volume= 0.145 af, Depth> 4.23"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Area (sf)	CN	Description
1,085	98	Roofs, HSG A
10,155	98	Paved parking, HSG A
6,720	49	50-75% Grass cover, Fair, HSG A
17,960	80	Weighted Average
6,720		37.42% Pervious Area
11,240		62.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.1	60	0.0670	0.24		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.3	105	0.0800	5.74		**Shallow Concentrated Flow, SC1** Paved Kv= 20.3 fps
0.4	70	0.0250	3.21		**Shallow Concentrated Flow, SCF2** Paved Kv= 20.3 fps
4.8	235	Total			

Subcatchment S3: Central SC



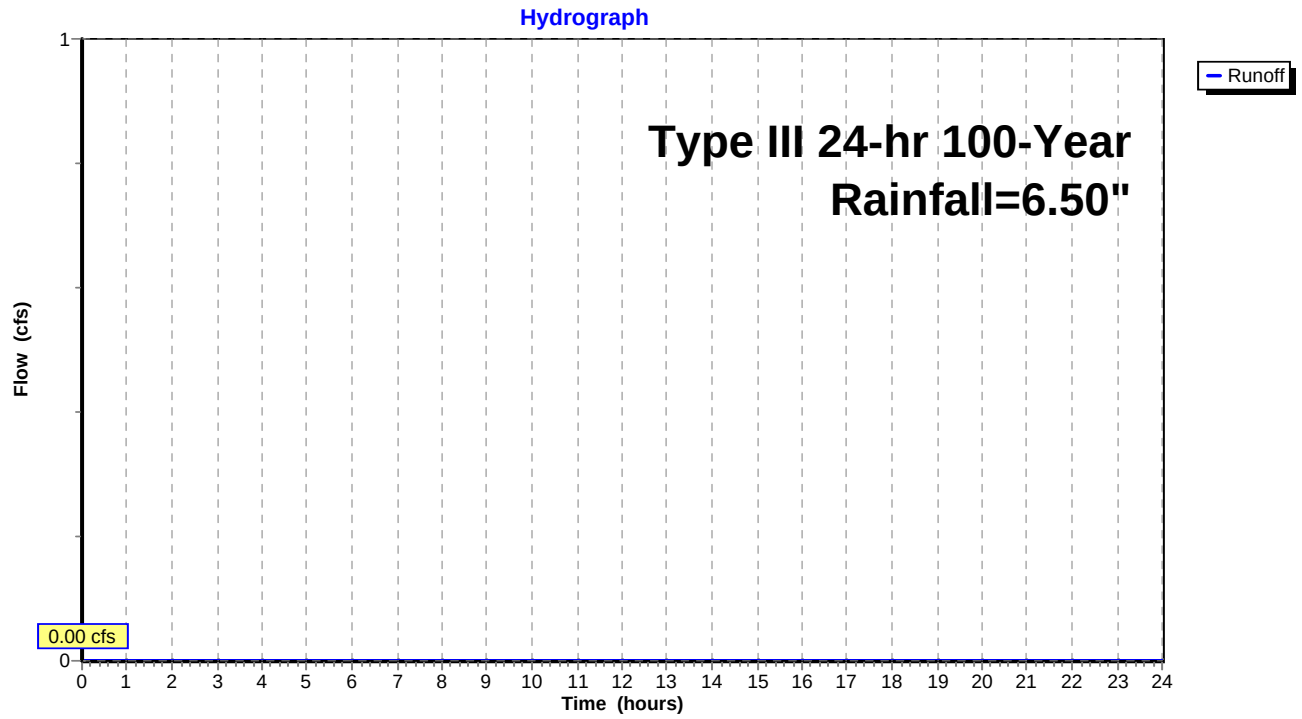
Summary for Subcatchment S4: E'ly SC

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=6.50"

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	55	0.0360	0.18		**Sheet Flow, SF** Grass: Short n= 0.150 P2= 3.00"
0.8	72	0.0420	1.43		**Shallow Concentrated Flow, SCF1** Short Grass Pasture Kv= 7.0 fps
0.3	52	0.1540	2.75		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.0	12	0.3300	4.02		**Shallow Concentrated Flow, SCF** Short Grass Pasture Kv= 7.0 fps
6.1	191	Total			

Subcatchment S4: E'ly SC



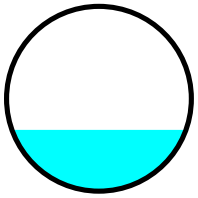
Summary for Reach R1: 6"HDPE

Inflow Area = 0.312 ac, 14.07% Impervious, Inflow Depth > 1.72" for 100-Year event
Inflow = 0.38 cfs @ 12.16 hrs, Volume= 0.045 af
Outflow = 0.38 cfs @ 12.17 hrs, Volume= 0.045 af, Atten= 0%, Lag= 0.1 min

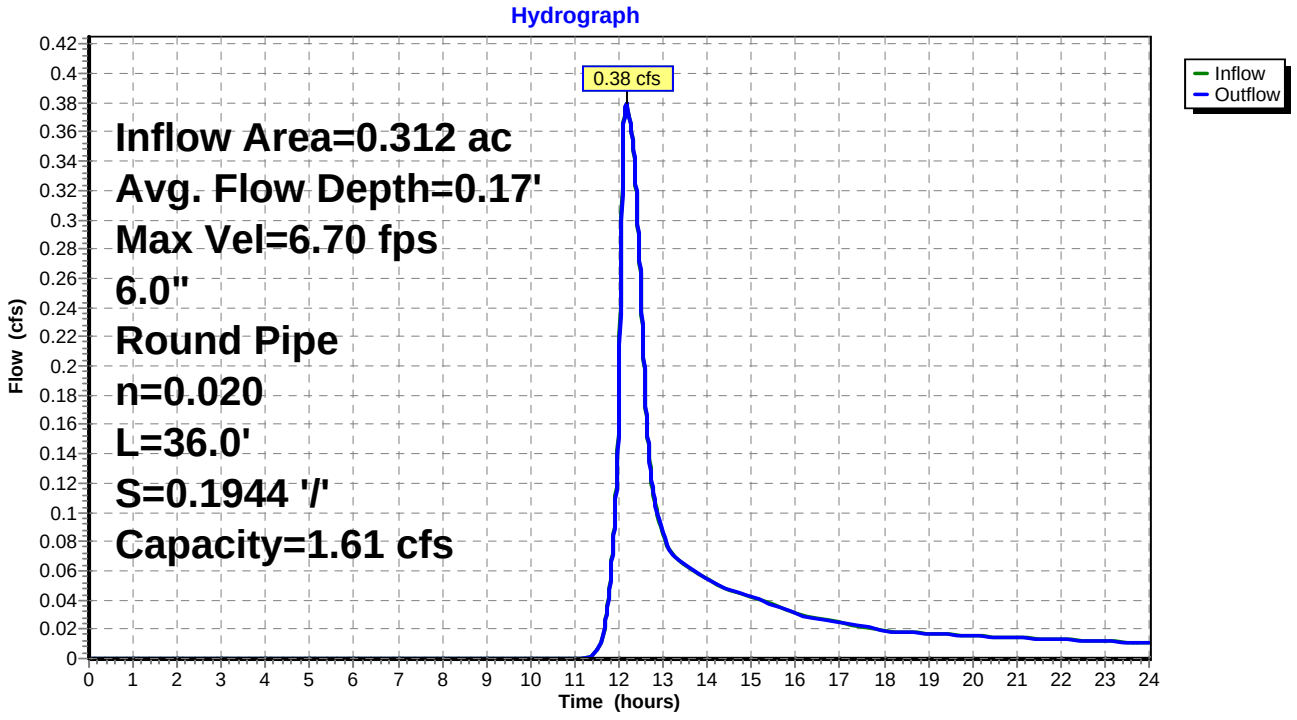
Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.70 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.14 fps, Avg. Travel Time= 0.2 min

Peak Storage= 2 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 0.50', Capacity at Bank-Full= 1.61 cfs

6.0" Round Pipe
n= 0.020 Corrugated PE, corrugated interior
Length= 36.0' Slope= 0.1944 '/'
Inlet Invert= 210.00', Outlet Invert= 203.00'



Reach R1: 6"HDPE

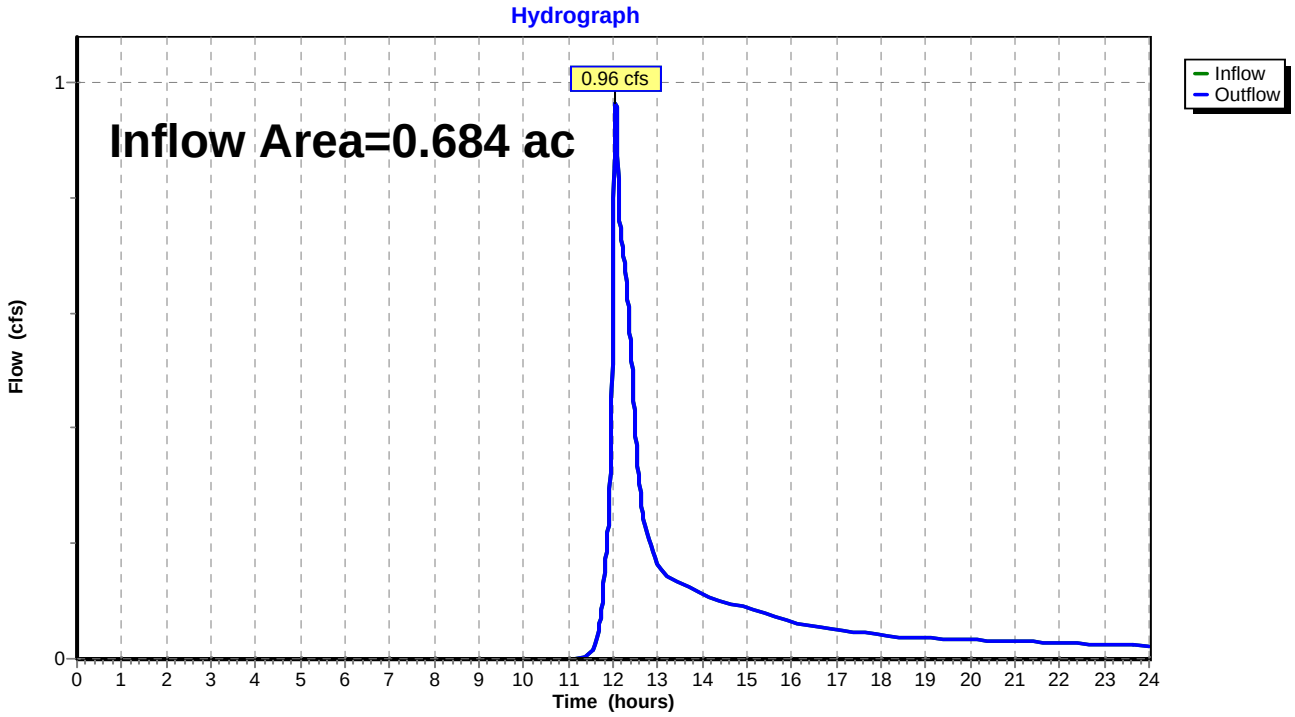


Summary for Reach R2: Cumulative reach

Inflow Area = 0.684 ac, 9.39% Impervious, Inflow Depth > 1.63" for 100-Year event
Inflow = 0.96 cfs @ 12.07 hrs, Volume= 0.093 af
Outflow = 0.96 cfs @ 12.07 hrs, Volume= 0.093 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach R2: Cumulative reach



Summary for Pond P1: Low area

Inflow Area = 0.312 ac, 14.07% Impervious, Inflow Depth > 1.73" for 100-Year event
Inflow = 0.62 cfs @ 12.07 hrs, Volume= 0.045 af
Outflow = 0.38 cfs @ 12.16 hrs, Volume= 0.045 af, Atten= 39%, Lag= 5.7 min
Primary = 0.38 cfs @ 12.16 hrs, Volume= 0.045 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 211.81' @ 12.16 hrs Surf.Area= 714 sf Storage= 187 cf

Plug-Flow detention time= 6.6 min calculated for 0.045 af (100% of inflow)
Center-of-Mass det. time= 5.3 min (876.8 - 871.5)

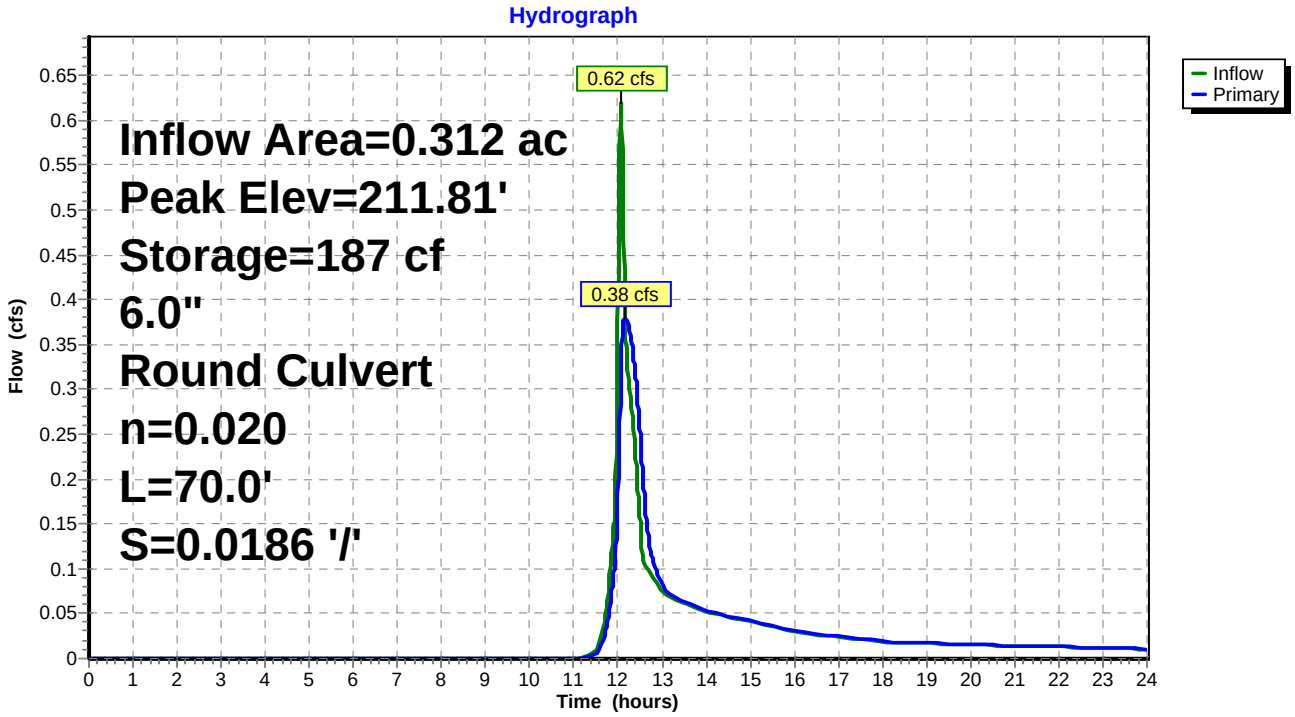
Volume	Invert	Avail.Storage	Storage Description
#1	211.30'	348 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
211.30	20	0	0
212.00	975	348	348

Device	Routing	Invert	Outlet Devices
#1	Primary	211.30'	**6.0" Round Culvert** L= 70.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 211.30' / 210.00' S= 0.0186 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior

Primary OutFlow Max=0.38 cfs @ 12.16 hrs HW=211.81' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.38 cfs @ 1.93 fps)

Pond P1: Low area



Summary for Pond P2: CTB

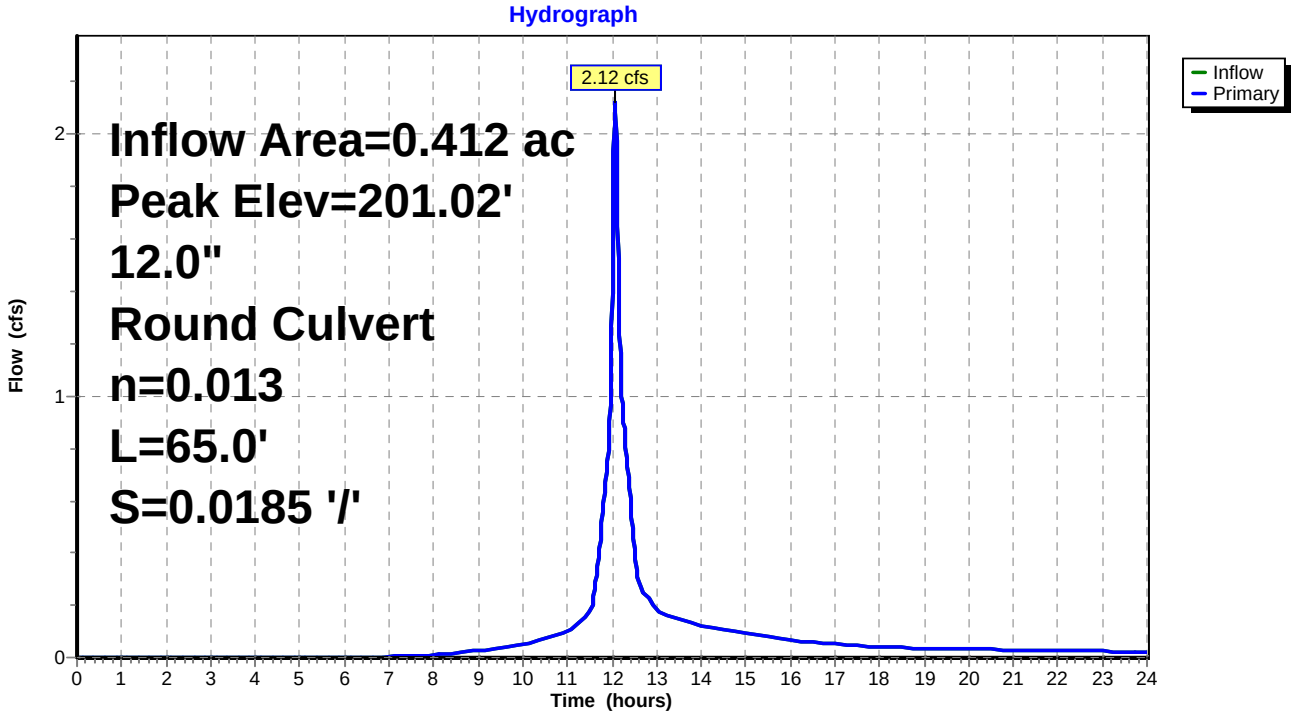
Inflow Area = 0.412 ac, 62.58% Impervious, Inflow Depth > 4.23" for 100-Year event
Inflow = 2.12 cfs @ 12.07 hrs, Volume= 0.145 af
Outflow = 2.12 cfs @ 12.07 hrs, Volume= 0.145 af, Atten= 0%, Lag= 0.0 min
Primary = 2.12 cfs @ 12.07 hrs, Volume= 0.145 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 201.02' @ 12.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	200.20'	**12.0" Round Culvert** L= 65.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 200.20' / 199.00' S= 0.0185 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=2.12 cfs @ 12.07 hrs HW=201.02' (Free Discharge)
└**1=Culvert** (Inlet Controls 2.12 cfs @ 3.08 fps)

Pond P2: CTB



Summary for Pond P3: Detention pond

Inflow Area = 0.412 ac, 62.58% Impervious, Inflow Depth > 4.23" for 100-Year event
Inflow = 2.12 cfs @ 12.07 hrs, Volume= 0.145 af
Outflow = 2.01 cfs @ 12.10 hrs, Volume= 0.115 af, Atten= 5%, Lag= 1.5 min
Primary = 2.01 cfs @ 12.10 hrs, Volume= 0.115 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 200.30' @ 12.10 hrs Surf.Area= 978 sf Storage= 1,611 cf

Plug-Flow detention time= 122.4 min calculated for 0.115 af (79% of inflow)
Center-of-Mass det. time= 43.9 min (853.2 - 809.3)

Volume	Invert	Avail.Storage	Storage Description
#1	197.00'	2,373 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
197.00	100	0	0
198.00	265	183	183
201.00	1,195	2,190	2,373

Device	Routing	Invert	Outlet Devices
#1	Primary	200.00'	**5.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=2.00 cfs @ 12.10 hrs HW=200.30' (Free Discharge)
1=Broad-Crested Rectangular Weir (Weir Controls 2.00 cfs @ 1.34 fps)

Pond P3: Detention pond