

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Printed 6/6/2016

Page 1

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
158,407	61	>75% Grass cover, Good, HSG B (1aS, 1bS, 2aS, 2bS, 4aS, 5S, 6S, 7aS, 8S)
115,723	48	Brush, Good, HSG B (1aS, 2aS, 2bS, 3S, 5S, 7aS, 8S)
2,759	98	Patio & Sidewalk (2bS)
1,443	98	Patio & Sidewalks (8S)
32,287	98	Paved Area (6S)
25,194	98	Paved Areas (4aS)
8,705	98	Paved driveway & Sidewalk (1bS)
9,382	98	Paved driveways & Roofs (1aS)
28,704	98	Paved driveways and Roofs (2aS)
26,563	98	Roofs, HSG B (4bS, 7bS)
19,716	98	Water Surface, 0% imp, HSG B (4aS, 7aS)
3,279	98	Water Surface, HSG B (1bS, 6S)
36,672	98	Wetland (1aS, 2aS, 3S)
132,784	55	Woods, Good, HSG B (1aS, 2aS, 2bS, 3S, 5S, 7aS)
601,618	69	TOTAL AREA

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Printed 6/6/2016

Page 2

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
456,472	HSG B	1aS, 1bS, 2aS, 2bS, 3S, 4aS, 4bS, 5S, 6S, 7aS, 7bS, 8S
0	HSG C	
0	HSG D	
145,146	Other	1aS, 1bS, 2aS, 2bS, 3S, 4aS, 6S, 8S
601,618		TOTAL AREA

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Printed 6/6/2016

Page 3

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
0	158,407	0	0	0	158,407	>75% Grass cover, Good
0	115,723	0	0	0	115,723	Brush, Good
0	0	0	0	2,759	2,759	Patio & Sidewalk
0	0	0	0	1,443	1,443	Patio & Sidewalks
0	0	0	0	32,287	32,287	Paved Area
0	0	0	0	25,194	25,194	Paved Areas
0	0	0	0	8,705	8,705	Paved driveway & Sidewalk
0	0	0	0	9,382	9,382	Paved driveways & Roofs
0	0	0	0	28,704	28,704	Paved driveways and Roofs
0	26,563	0	0	0	26,563	Roofs
0	3,279	0	0	0	3,279	Water Surface
0	19,716	0	0	0	19,716	Water Surface, 0% imp
0	0	0	0	36,672	36,672	Wetland
0	132,784	0	0	0	132,784	Woods, Good
0	456,472	0	0	145,146	601,618	TOTAL AREA

S
N

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Printed 6/6/2016

Page 4

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	4bS	0.00	0.00	300.0	0.0050	0.013	12.0	0.0	0.0
2	6S	0.00	0.00	67.0	0.0224	0.013	12.0	0.0	0.0
3	7bS	0.00	0.00	236.0	0.0050	0.013	12.0	0.0	0.0

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 5

Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points x 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1aS: In/Into IW C	Runoff Area=120,475 sf 28.08% Impervious Runoff Depth>0.68" Flow Length=809' Tc=18.6 min CN=68 Runoff=1.27 cfs 6,778 cf
Subcatchment 1bS: Driveway	Runoff Area=13,258 sf 74.33% Impervious Runoff Depth>1.99" Flow Length=262' Tc=1.6 min CN=89 Runoff=0.79 cfs 2,199 cf
Subcatchment 2aS: In/Into IW A	Runoff Area=142,302 sf 26.58% Impervious Runoff Depth>0.68" Flow Length=935' Tc=13.9 min CN=68 Runoff=1.67 cfs 8,018 cf
Subcatchment 2bS: Into Swale	Runoff Area=34,927 sf 7.90% Impervious Runoff Depth>0.30" Flow Length=214' Tc=16.8 min CN=58 Runoff=0.11 cfs 887 cf
Subcatchment 3S: In/Into IW D	Runoff Area=46,370 sf 6.69% Impervious Runoff Depth>0.27" Flow Length=443' Tc=20.1 min CN=57 Runoff=0.11 cfs 1,061 cf
Subcatchment 4aS: Eastern	Runoff Area=49,663 sf 50.73% Impervious Runoff Depth>1.91" Tc=5.0 min CN=88 Runoff=2.60 cfs 7,888 cf
Subcatchment 4bS: Eastern Building	Runoff Area=13,477 sf 100.00% Impervious Runoff Depth>2.87" Flow Length=300' Slope=0.0050 '/ Tc=1.6 min CN=98 Runoff=1.04 cfs 3,221 cf
Subcatchment 5S: Outside Resources Areas	Runoff Area=29,198 sf 0.00% Impervious Runoff Depth>0.17" Flow Length=379' Tc=14.9 min CN=53 Runoff=0.03 cfs 417 cf
Subcatchment 6S: Cul-de-sac & Parking	Runoff Area=47,211 sf 72.90% Impervious Runoff Depth>1.91" Flow Length=369' Tc=2.3 min CN=88 Runoff=2.71 cfs 7,502 cf
Subcatchment 7aS: Western site	Runoff Area=49,439 sf 0.00% Impervious Runoff Depth>0.40" Flow Length=345' Tc=15.8 min CN=61 Runoff=0.24 cfs 1,654 cf
Subcatchment 7bS: Western Building	Runoff Area=13,086 sf 100.00% Impervious Runoff Depth>2.87" Flow Length=236' Slope=0.0050 '/ Tc=1.2 min CN=98 Runoff=1.01 cfs 3,127 cf
Subcatchment 8S: In/Into BVW B	Runoff Area=42,212 sf 3.42% Impervious Runoff Depth>0.15" Flow Length=363' Tc=6.7 min CN=52 Runoff=0.04 cfs 526 cf
Reach 1R: Grassed Swale	Avg. Flow Depth=0.23' Max Vel=2.92 fps Inflow=4.41 cfs 23,262 cf n=0.030 L=265.0' S=0.0415 '/ Capacity=102.24 cfs Outflow=4.41 cfs 23,227 cf
Pond 1P: Isolated Wetland C	Peak Elev=120.25' Inflow=1.55 cfs 8,497 cf Outflow=1.55 cfs 8,497 cf
Pond 2P: Isolated Wetland A	Peak Elev=129.16' Inflow=1.67 cfs 8,018 cf Outflow=1.67 cfs 8,018 cf
Pond 3P: Isolated Wetland D	Peak Elev=112.03' Inflow=0.11 cfs 1,061 cf Outflow=0.11 cfs 1,061 cf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 6

Pond 4P: BVW B	Inflow=4.42 cfs 23,753 cf Primary=4.42 cfs 23,753 cf
Pond 5P: Basin 1	Peak Elev=104.56' Storage=9,435 cf Inflow=3.45 cfs 11,109 cf Discarded=0.04 cfs 1,683 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 1,683 cf
Pond 6P: Basin 2	Peak Elev=104.10' Storage=4,781 cf Inflow=1.02 cfs 5,843 cf Discarded=0.03 cfs 1,061 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 1,061 cf
Pond 7P: Sediment Forebay	Peak Elev=106.84' Inflow=2.60 cfs 7,888 cf Outflow=2.60 cfs 7,888 cf
Pond BA 1: Bioretention Area A	Peak Elev=134.34' Storage=552 cf Inflow=0.79 cfs 2,199 cf Outflow=0.76 cfs 1,719 cf
Pond BA 2: Bioretention Area B	Peak Elev=125.48' Storage=2,053 cf Inflow=2.71 cfs 7,502 cf Outflow=2.39 cfs 5,861 cf
Pond POI 1: Northern Site	Inflow=4.42 cfs 24,170 cf Primary=4.42 cfs 24,170 cf

Total Runoff Area = 601,618 sf Runoff Volume = 43,277 cf Average Runoff Depth = 0.86"
70.91% Pervious = 426,630 sf 29.09% Impervious = 174,988 sf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 7

Summary for Subcatchment 1aS: In/Into IW C

Runoff = 1.27 cfs @ 12.30 hrs, Volume= 6,778 cf, Depth> 0.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
9,382	98	Paved driveways & Roofs
10,413	55	Woods, Good, HSG B
46,780	61	>75% Grass cover, Good, HSG B
29,453	48	Brush, Good, HSG B
24,447	98	Wetland
120,475	68	Weighted Average
86,646		71.92% Pervious Area
33,829		28.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	90	0.0528	0.25		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.4	10	0.0500	0.07		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
1.0	63	0.0476	1.09		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.9	174	0.0488	1.55		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.9	55	0.0273	0.99		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
6.3	417	0.0336	1.10		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
18.6	809	Total			

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

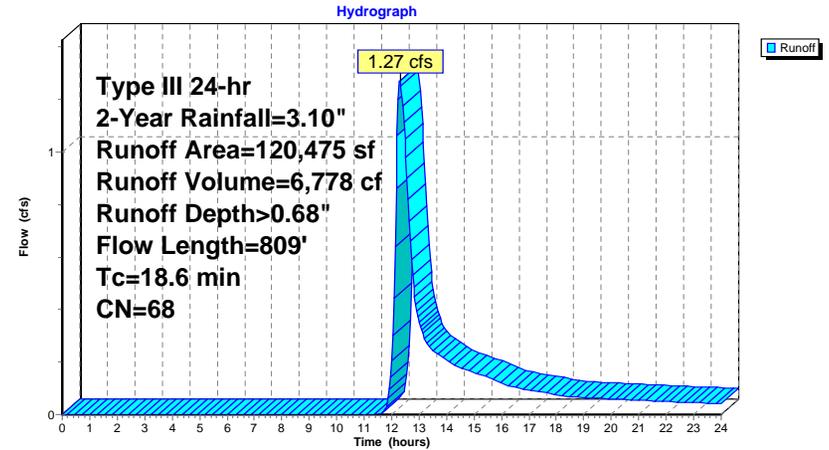
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 8

Subcatchment 1aS: In/Into IW C



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 9

Summary for Subcatchment 1bS: Driveway

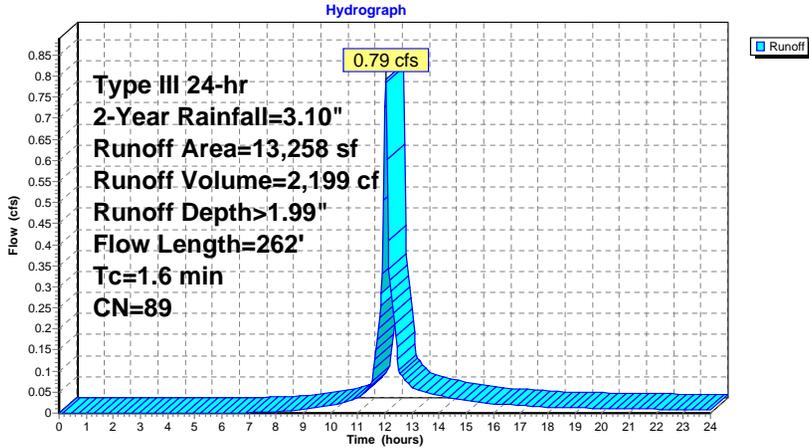
Runoff = 0.79 cfs @ 12.03 hrs, Volume= 2,199 cf, Depth > 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
8,705	98	Paved driveway & Sidewalk
3,403	61	>75% Grass cover, Good, HSG B
1,150	98	Water Surface, HSG B
13,258	89	Weighted Average
3,403		25.67% Pervious Area
9,855		74.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0350	1.72		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.6	162	0.0482	4.46		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.6	262	Total			

Subcatchment 1bS: Driveway



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 10

Summary for Subcatchment 2aS: In/Into IW A

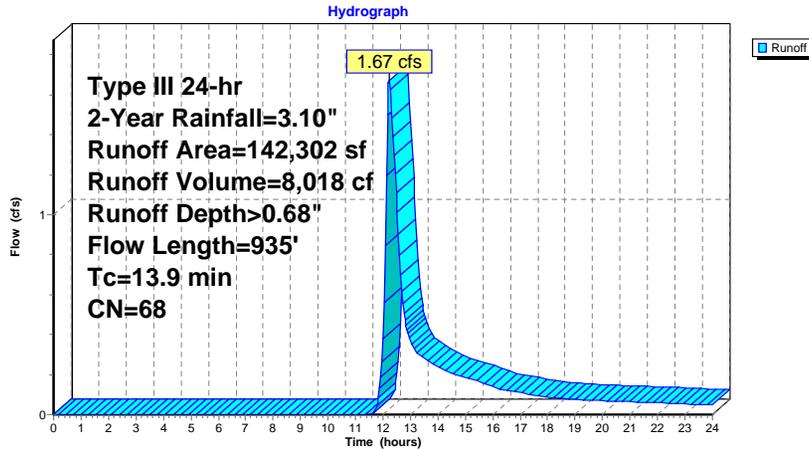
Runoff = 1.67 cfs @ 12.22 hrs, Volume= 8,018 cf, Depth > 0.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
9,125	98	Wetland
768	48	Brush, Good, HSG B
59,412	55	Woods, Good, HSG B
28,704	98	Paved driveways and Roofs
44,293	61	>75% Grass cover, Good, HSG B
142,302	68	Weighted Average
104,473		73.42% Pervious Area
37,829		26.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.38		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.8	164	0.0300	3.52		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.1	101	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
3.3	239	0.0593	1.22		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
7.5	331	0.0219	0.74		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
13.9	935	Total			

Subcatchment 2aS: In/Into IW A



Summary for Subcatchment 2bS: Into Swale

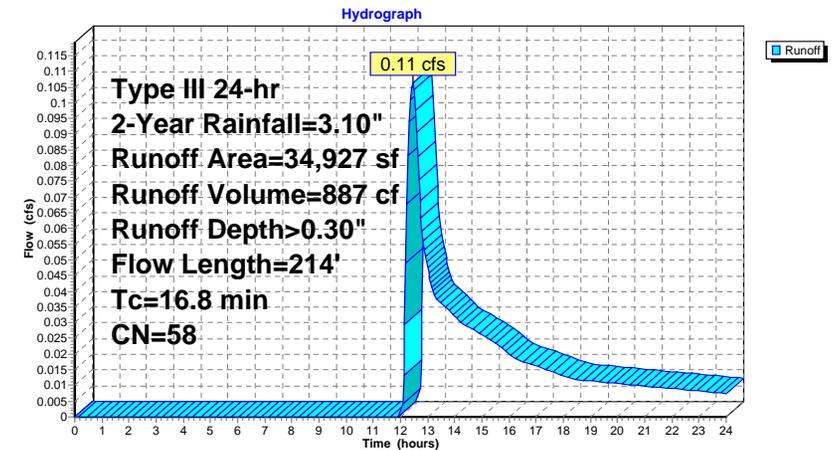
Runoff = 0.11 cfs @ 12.45 hrs, Volume= 887 cf, Depth> 0.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
2,759	98	Patio & Sidewalk
745	55	Woods, Good, HSG B
16,214	48	Brush, Good, HSG B
15,209	61	>75% Grass cover, Good, HSG B
34,927	58	Weighted Average
32,168		92.10% Pervious Area
2,759		7.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	100	0.0450	0.11		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.0	114	0.0746	1.91		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
16.8	214				Total

Subcatchment 2bS: Into Swale



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 13

Summary for Subcatchment 3S: In/Into IW D

Runoff = 0.11 cfs @ 12.52 hrs, Volume= 1,061 cf, Depth> 0.27"

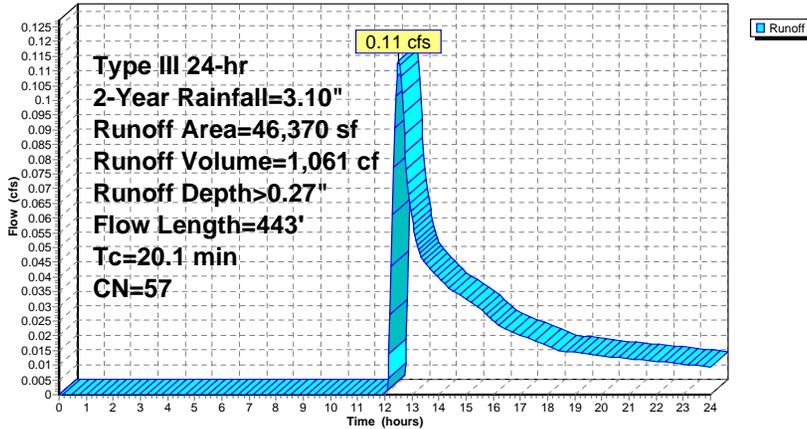
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
3,100	98	Wetland
36,667	55	Woods, Good, HSG B
6,603	48	Brush, Good, HSG B
46,370	57	Weighted Average
43,270		93.31% Pervious Area
3,100		6.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	100	0.0511	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
4.0	272	0.0511	1.13		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.4	71	0.0141	0.83		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
20.1	443				Total

Subcatchment 3S: In/Into IW D

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 14

Summary for Subcatchment 4aS: Eastern Driveway/Back Parking Area

Runoff = 2.60 cfs @ 12.08 hrs, Volume= 7,888 cf, Depth> 1.91"

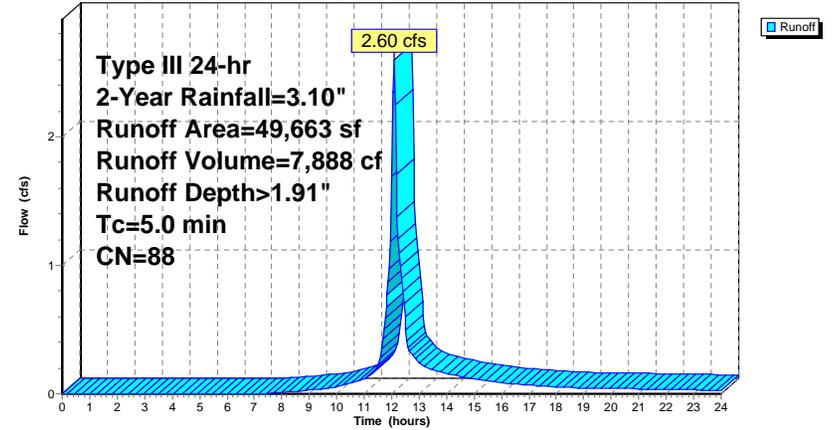
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
13,723	61	>75% Grass cover, Good, HSG B
25,194	98	Paved Areas
10,746	98	Water Surface, 0% imp, HSG B
49,663	88	Weighted Average
24,469		49.27% Pervious Area
25,194		50.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4aS: Eastern Driveway/Back Parking Area

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 15

Summary for Subcatchment 4bS: Eastern Building

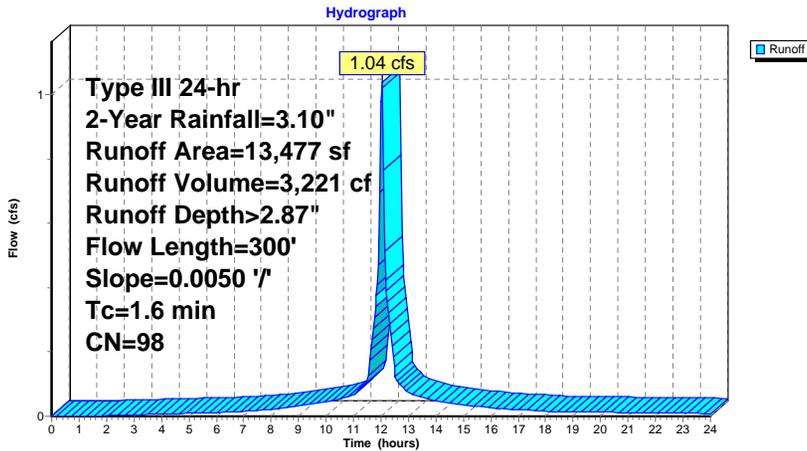
Runoff = 1.04 cfs @ 12.03 hrs, Volume= 3,221 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
13,477	98	Roofs, HSG B
13,477		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	300	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 4bS: Eastern Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 16

Summary for Subcatchment 5S: Outside Resources Areas

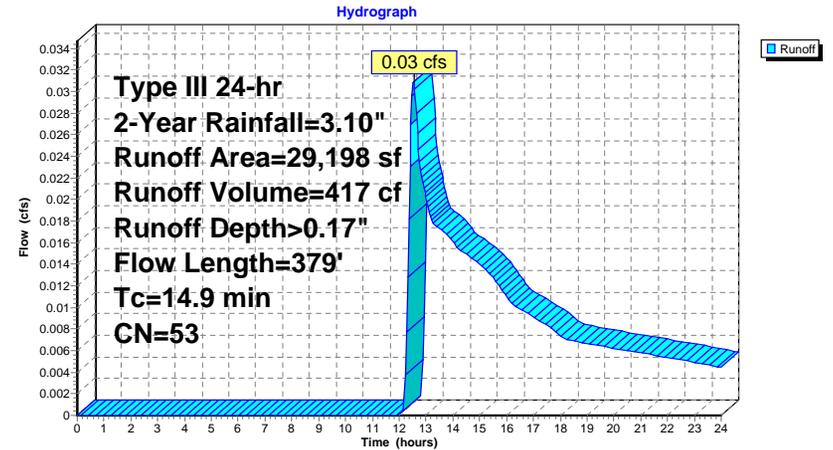
Runoff = 0.03 cfs @ 12.54 hrs, Volume= 417 cf, Depth> 0.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
9,482	55	Woods, Good, HSG B
6,631	61	>75% Grass cover, Good, HSG B
13,085	48	Brush, Good, HSG B
29,198	53	Weighted Average
29,198		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	61	0.0787	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
7.9	39	0.0385	0.08		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
2.9	253	0.0435	1.46		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
0.3	26	0.0769	1.39		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
14.9	379				Total

Subcatchment 5S: Outside Resources Areas



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 17

Summary for Subcatchment 6S: Cul-de-sac & Parking Lot

Runoff = 2.71 cfs @ 12.04 hrs, Volume= 7,502 cf, Depth> 1.91"

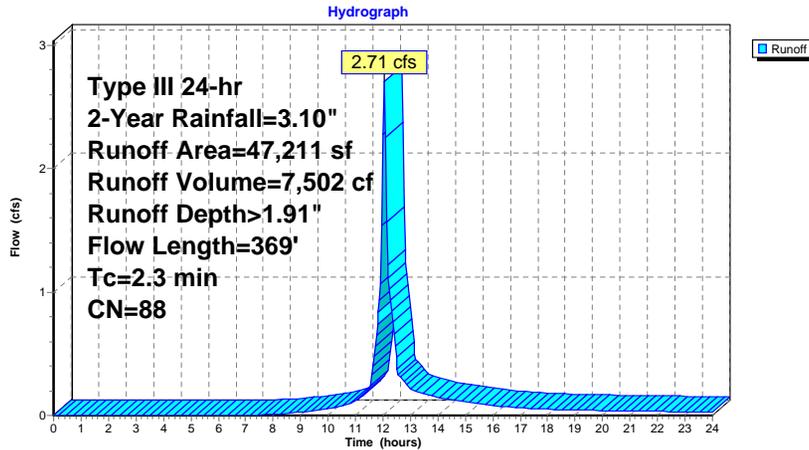
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
32,287	98	Paved Area
12,795	61	>75% Grass cover, Good, HSG B
2,129	98	Water Surface, HSG B
47,211	88	Weighted Average
12,795		27.10% Pervious Area
34,416		72.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0225	1.44		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.9	202	0.0334	3.71		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.2	67	0.0224	6.79	5.33	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

2.3 369 Total

Subcatchment 6S: Cul-de-sac & Parking Lot



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 18

Summary for Subcatchment 7aS: Western site

Runoff = 0.24 cfs @ 12.34 hrs, Volume= 1,654 cf, Depth> 0.40"

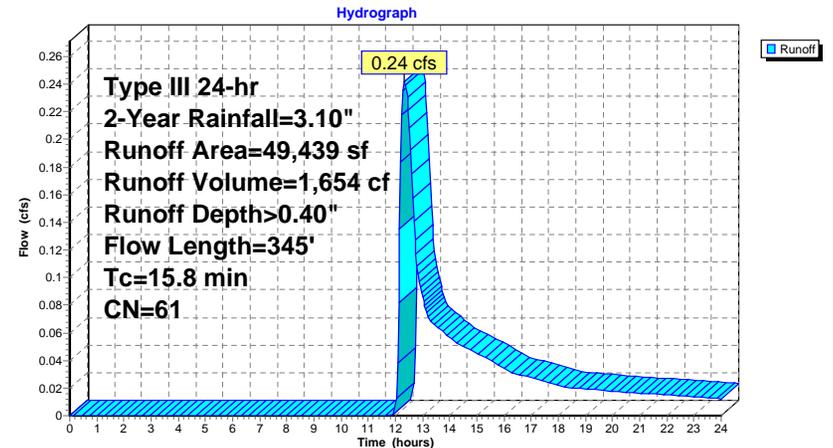
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
6,531	61	>75% Grass cover, Good, HSG B
16,065	55	Woods, Good, HSG B
17,873	48	Brush, Good, HSG B
8,970	98	Water Surface, 0% imp, HSG B
49,439	61	Weighted Average
49,439		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	100	0.0700	0.13		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.6	105	0.0238	1.08		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
1.0	140	0.0250	2.37		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps

15.8 345 Total

Subcatchment 7aS: Western site



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 19

Summary for Subcatchment 7bS: Western Building

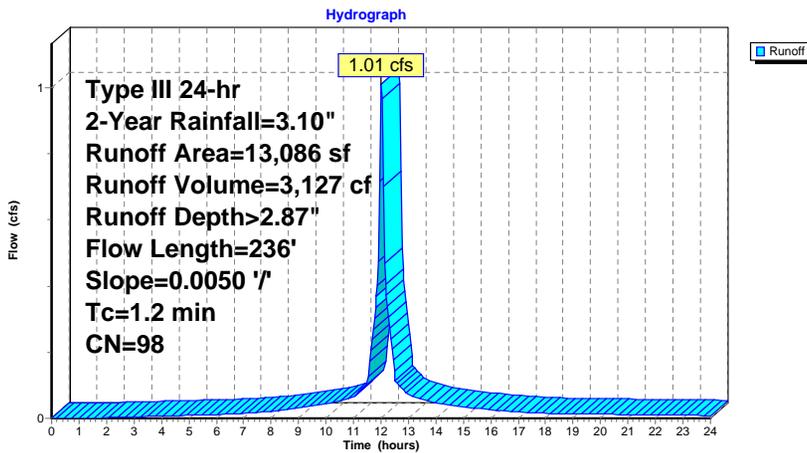
Runoff = 1.01 cfs @ 12.02 hrs, Volume= 3,127 cf, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
13,086	98	Roofs, HSG B
13,086		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	236	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 7bS: Western Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 20

Summary for Subcatchment 8S: In/Into BVW B

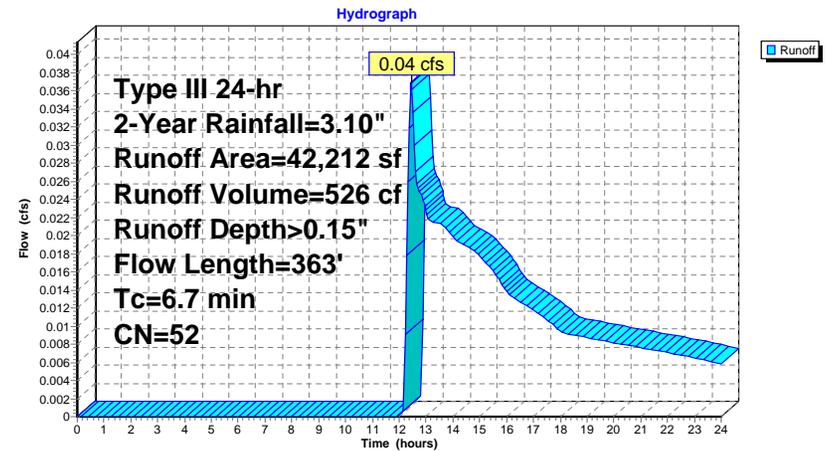
Runoff = 0.04 cfs @ 12.45 hrs, Volume= 526 cf, Depth> 0.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
1,443	98	Patio & Sidewalks
9,042	61	>75% Grass cover, Good, HSG B
31,727	48	Brush, Good, HSG B
42,212	52	Weighted Average
40,769		96.58% Pervious Area
1,443		3.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	52	0.0100	0.92		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
2.9	48	0.0937	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.9	263	0.0456	1.49		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
6.7	363				Total

Subcatchment 8S: In/Into BVW B



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 21

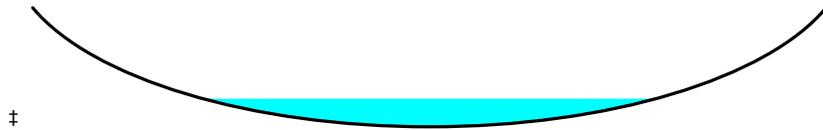
Summary for Reach 1R: Grassed Swale

Inflow Area = 358,173 sf, 33.14% Impervious, Inflow Depth > 0.78" for 2-Year event
 Inflow = 4.41 cfs @ 12.21 hrs, Volume= 23,262 cf
 Outflow = 4.41 cfs @ 12.23 hrs, Volume= 23,227 cf, Atten= 0%, Lag= 1.0 min

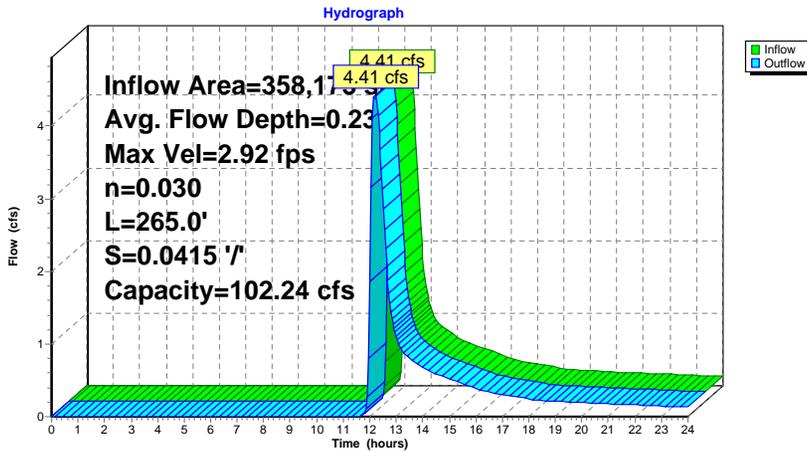
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Max. Velocity= 2.92 fps, Min. Travel Time= 1.5 min
 Avg. Velocity= 1.35 fps, Avg. Travel Time= 3.3 min

Peak Storage= 400 cf @ 12.23 hrs
 Average Depth at Peak Storage= 0.23'
 Bank-Full Depth= 1.00' Flow Area= 13.3 sf, Capacity= 102.24 cfs

20.00' x 1.00' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
 Length= 265.0' Slope= 0.0415 '/
 Inlet Invert= 120.00', Outlet Invert= 109.00'



Reach 1R: Grassed Swale



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 22

Summary for Pond 1P: Isolated Wetland C

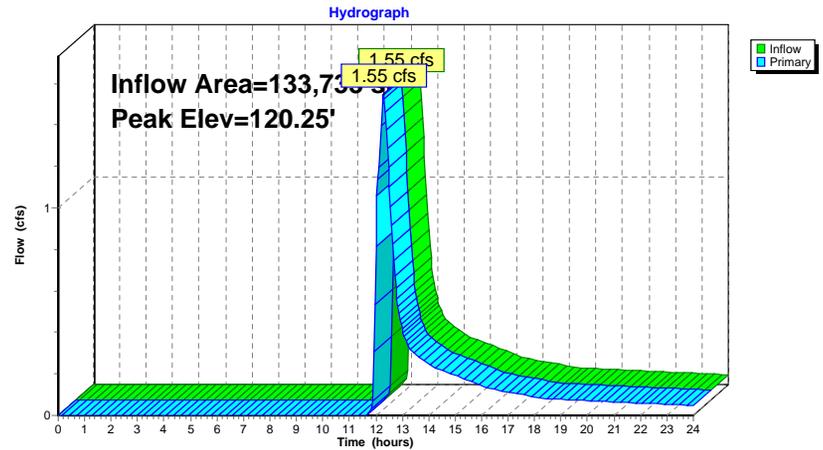
Inflow Area = 133,733 sf, 32.67% Impervious, Inflow Depth > 0.76" for 2-Year event
 Inflow = 1.55 cfs @ 12.29 hrs, Volume= 8,497 cf
 Outflow = 1.55 cfs @ 12.29 hrs, Volume= 8,497 cf, Atten= 0%, Lag= 0.0 min
 Primary = 1.55 cfs @ 12.29 hrs, Volume= 8,497 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 120.25' @ 12.26 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	120.00'	10.0' long x 57.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.54 cfs @ 12.29 hrs HW=120.25' TW=120.23' (Dynamic Tailwater)
 ←1=Broad-Crested Rectangular Weir (Weir Controls 1.54 cfs @ 0.61 fps)

Pond 1P: Isolated Wetland C



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 23

Summary for Pond 2P: Isolated Wetland A

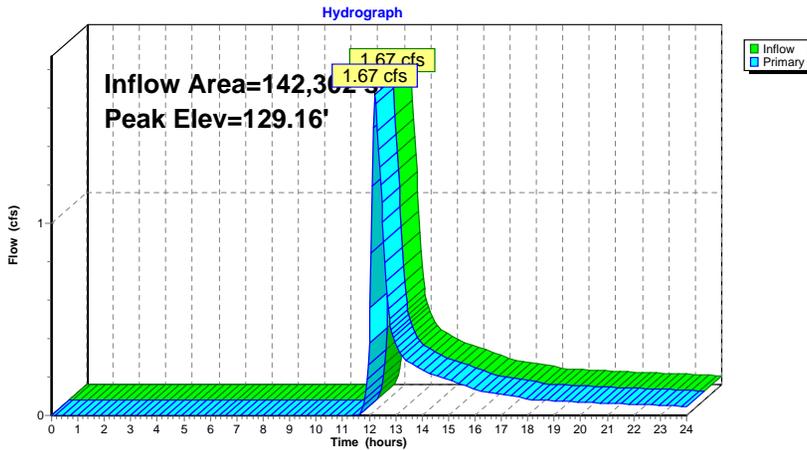
Inflow Area = 142,302 sf, 26.58% Impervious, Inflow Depth > 0.68" for 2-Year event
 Inflow = 1.67 cfs @ 12.22 hrs, Volume= 8,018 cf
 Outflow = 1.67 cfs @ 12.22 hrs, Volume= 8,018 cf, Atten= 0%, Lag= 0.0 min
 Primary = 1.67 cfs @ 12.22 hrs, Volume= 8,018 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 129.16' @ 12.22 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	129.00'	10.0' long x 214.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.66 cfs @ 12.22 hrs HW=129.16' TW=120.23' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 1.66 cfs @ 1.06 fps)

Pond 2P: Isolated Wetland A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 24

Summary for Pond 3P: Isolated Wetland D

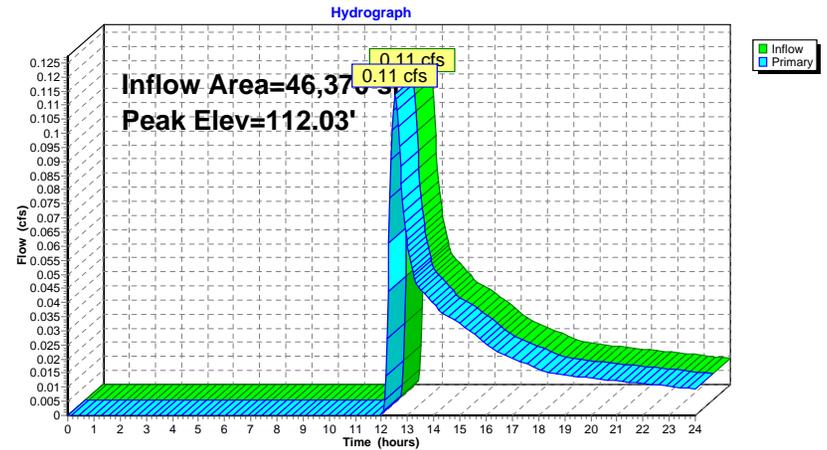
Inflow Area = 46,370 sf, 6.69% Impervious, Inflow Depth > 0.27" for 2-Year event
 Inflow = 0.11 cfs @ 12.52 hrs, Volume= 1,061 cf
 Outflow = 0.11 cfs @ 12.52 hrs, Volume= 1,061 cf, Atten= 0%, Lag= 0.0 min
 Primary = 0.11 cfs @ 12.52 hrs, Volume= 1,061 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 112.03' @ 12.52 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	10.0' long x 203.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.11 cfs @ 12.52 hrs HW=112.03' TW=103.64' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 0.11 cfs @ 0.43 fps)

Pond 3P: Isolated Wetland D



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

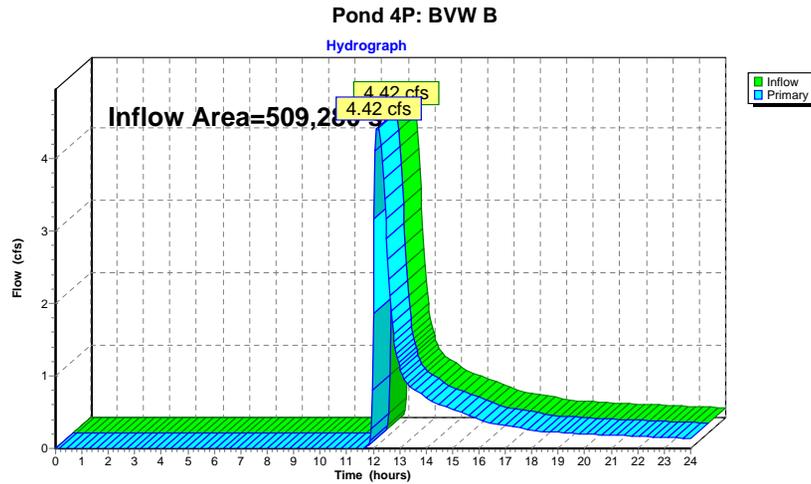
Printed 6/6/2016

Page 25

Summary for Pond 4P: BVW B

Inflow Area = 509,280 sf, 26.77% Impervious, Inflow Depth > 0.56" for 2-Year event
 Inflow = 4.42 cfs @ 12.23 hrs, Volume= 23,753 cf
 Primary = 4.42 cfs @ 12.23 hrs, Volume= 23,753 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 26

Summary for Pond 5P: Basin 1

Inflow Area = 63,140 sf, 61.25% Impervious, Inflow Depth > 2.11" for 2-Year event
 Inflow = 3.45 cfs @ 12.06 hrs, Volume= 11,109 cf
 Outflow = 0.04 cfs @ 22.99 hrs, Volume= 1,683 cf, Atten= 99%, Lag= 655.7 min
 Discarded = 0.04 cfs @ 22.99 hrs, Volume= 1,683 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 104.56' @ 22.99 hrs Surf.Area= 6,917 sf Storage= 9,435 cf

Plug-Flow detention time= 491.6 min calculated for 1,680 cf (15% of inflow)
 Center-of-Mass det. time= 284.1 min (1,081.1 - 797.0)

Volume #	Invert	Avail.Storage	Storage Description
#1	103.00'	30,720 cf	Custom Stage Data (Conic) Listed below (Recalc)
	Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)
	103.00	5,213	0
	104.00	6,258	5,728
	105.00	7,452	6,846
	106.00	9,140	8,282
	107.00	10,607	9,864
			Cum.Store (cubic-feet)
			0
			5,728
			12,574
			20,856
			30,720
			Wet.Area (sq-ft)
			5,213
			6,292
			7,521
			9,240
			10,749

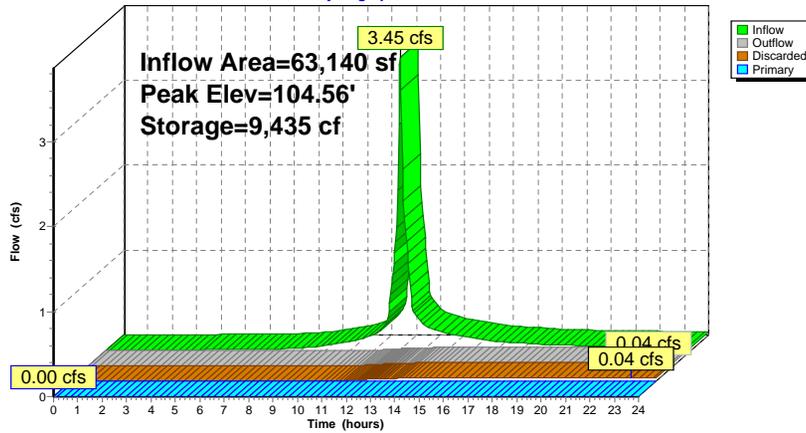
Device	Routing	Invert	Outlet Devices
#1	Primary	105.75'	10.0' long x 118.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	103.00'	1.020 in/hr Exfiltration over Surface area above 103.00' Excluded Surface area = 5,213 sf

Discarded OutFlow Max=0.04 cfs @ 22.99 hrs HW=104.56' (Free Discharge)
 ↳ **2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=103.00' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 5P: Basin 1

Hydrograph



Summary for Pond 6P: Basin 2

Inflow Area = 108,895 sf, 14.86% Impervious, Inflow Depth > 0.64" for 2-Year event
 Inflow = 1.02 cfs @ 12.02 hrs, Volume= 5,843 cf
 Outflow = 0.03 cfs @ 24.00 hrs, Volume= 1,061 cf, Atten= 97%, Lag= 718.9 min
 Discarded = 0.03 cfs @ 24.00 hrs, Volume= 1,061 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 104.10' @ 24.00 hrs Surf.Area= 5,365 sf Storage= 4,781 cf

Plug-Flow detention time= 500.4 min calculated for 1,061 cf (18% of inflow)
 Center-of-Mass det. time= 248.0 min (1,086.0 - 838.0)

Volume #	Invert	Avail.Storage	Storage Description		
#1	103.10'	25,458 cf	Custom Stage Data (Conic) Listed below (Recalc)		
	Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
	103.10	4,240	0	0	4,240
	104.00	5,256	4,265	4,265	5,279
	105.00	6,432	5,834	10,099	6,486
	106.00	7,675	7,044	17,143	7,764
	107.00	8,970	8,314	25,458	9,099

Device	Routing	Invert	Outlet Devices
#1	Discarded	103.10'	1.020 in/hr Exfiltration over Surface area above 103.10' Excluded Surface area = 4,240 sf
#2	Primary	105.50'	10.0' long x 43.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.03 cfs @ 24.00 hrs HW=104.10' (Free Discharge)
 ↳1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=103.10' TW=0.00' (Dynamic Tailwater)
 ↳2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

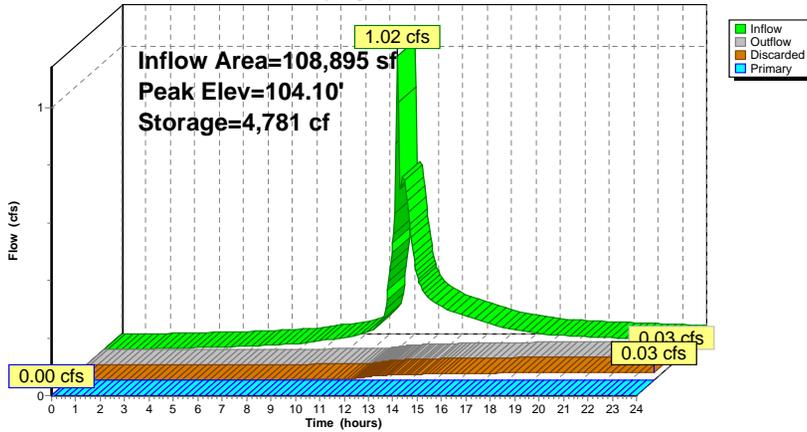
Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 29

Pond 6P: Basin 2

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 30

Summary for Pond 7P: Sediment Forebay

Inflow Area = 49,663 sf, 50.73% Impervious, Inflow Depth > 1.91" for 2-Year event
 Inflow = 2.60 cfs @ 12.08 hrs, Volume= 7,888 cf
 Outflow = 2.60 cfs @ 12.08 hrs, Volume= 7,888 cf, Atten= 0%, Lag= 0.0 min
 Primary = 2.60 cfs @ 12.08 hrs, Volume= 7,888 cf

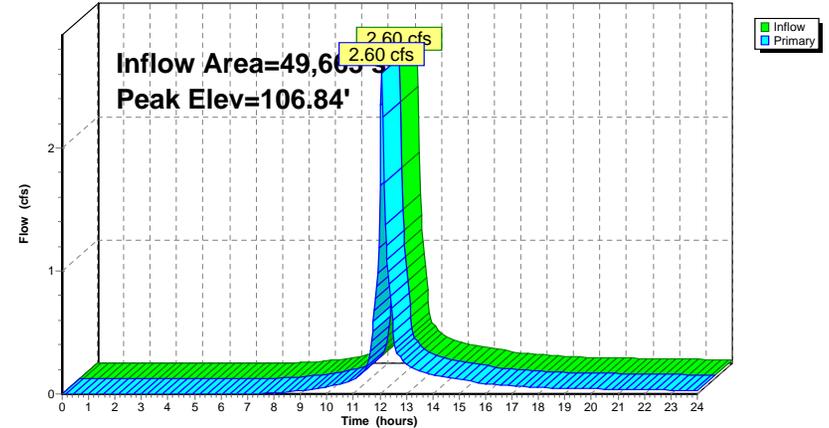
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 106.84' @ 12.08 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	106.50'	5.3' 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=2.58 cfs @ 12.08 hrs HW=106.84' TW=103.75' (Dynamic Tailwater)
 1=Broad-Crested Rectangular Weir (Weir Controls 2.58 cfs @ 1.44 fps)

Pond 7P: Sediment Forebay

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 31

Summary for Pond BA 1: Bioretention Area A

Inflow Area = 13,258 sf, 74.33% Impervious, Inflow Depth > 1.99" for 2-Year event
 Inflow = 0.79 cfs @ 12.03 hrs, Volume= 2,199 cf
 Outflow = 0.76 cfs @ 12.05 hrs, Volume= 1,719 cf, Atten= 4%, Lag= 1.1 min
 Primary = 0.76 cfs @ 12.05 hrs, Volume= 1,719 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 134.34' @ 12.05 hrs Surf.Area= 835 sf Storage= 552 cf

Plug-Flow detention time= 124.0 min calculated for 1,719 cf (78% of inflow)
 Center-of-Mass det. time= 43.9 min (852.1 - 808.2)

Volume	Invert	Avail.Storage	Storage Description	
#1	133.50'	1,201 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.50	481	0	0	481
134.00	690	291	291	694
135.00	1,150	910	1,201	1,167

Device	Routing	Invert	Outlet Devices
#1	Primary	134.25'	10.0' long x 15.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.75 cfs @ 12.05 hrs HW=134.34' TW=120.22' (Dynamic Tailwater)
 ↳=Broad-Crested Rectangular Weir (Weir Controls 0.75 cfs @ 0.81 fps)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

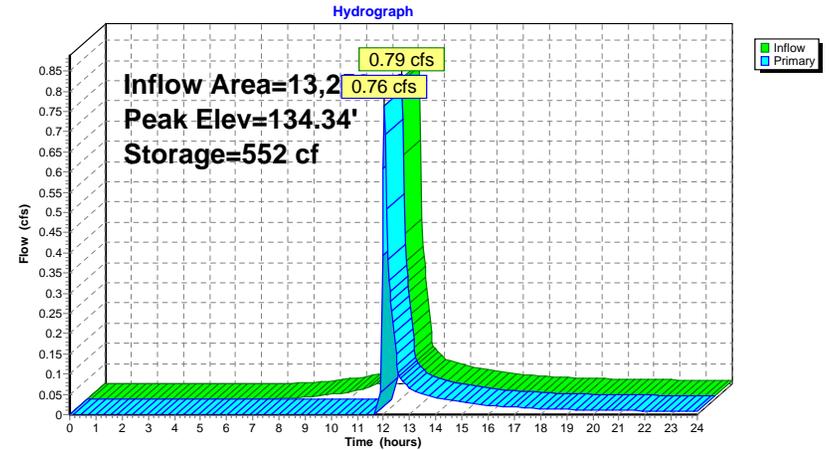
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 32

Pond BA 1: Bioretention Area A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 33

Summary for Pond BA 2: Bioretention Area B

Inflow Area = 47,211 sf, 72.90% Impervious, Inflow Depth > 1.91" for 2-Year event
 Inflow = 2.71 cfs @ 12.04 hrs, Volume= 7,502 cf
 Outflow = 2.39 cfs @ 12.08 hrs, Volume= 5,861 cf, Atten= 12%, Lag= 2.2 min
 Primary = 2.39 cfs @ 12.08 hrs, Volume= 5,861 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 125.48' @ 12.08 hrs Surf.Area= 1,970 sf Storage= 2,053 cf

Plug-Flow detention time= 124.7 min calculated for 5,851 cf (78% of inflow)
 Center-of-Mass det. time= 44.8 min (857.6 - 812.8)

Volume	Invert	Avail.Storage	Storage Description	
#1	124.00'	3,205 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
124.00	898	0	0	898
125.00	1,548	1,208	1,208	1,560
126.00	2,482	1,997	3,205	2,507

Device	Routing	Invert	Outlet Devices
#1	Primary	125.25'	8.0' long x 75.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.36 cfs @ 12.08 hrs HW=125.48' TW=120.22' (Dynamic Tailwater)
 ↳=Broad-Crested Rectangular Weir (Weir Controls 2.36 cfs @ 1.29 fps)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

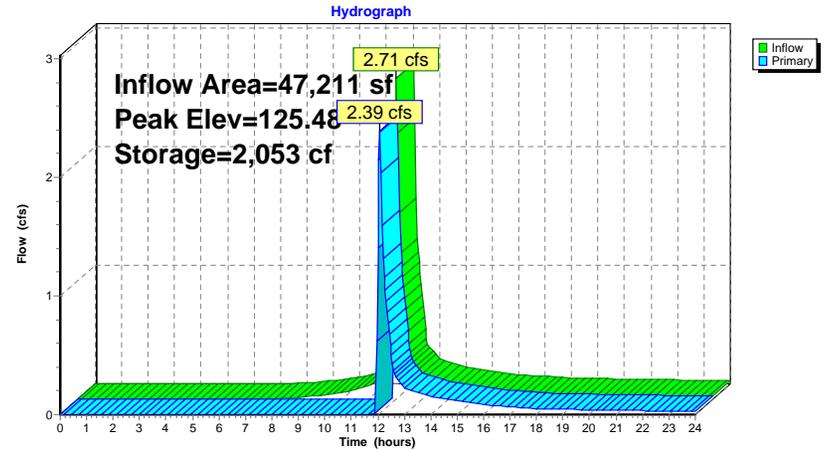
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

Page 34

Pond BA 2: Bioretention Area B



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.10"

Printed 6/6/2016

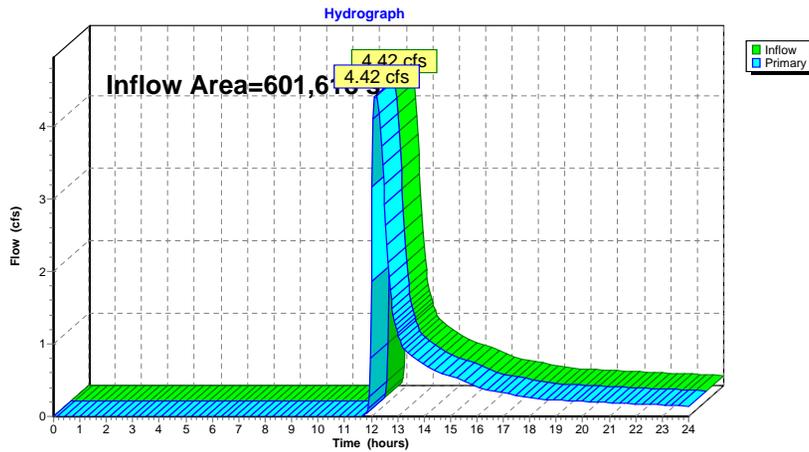
Page 35

Summary for Pond POI 1: Northern Site

Inflow Area = 601,618 sf, 29.09% Impervious, Inflow Depth > 0.48" for 2-Year event
 Inflow = 4.42 cfs @ 12.23 hrs, Volume= 24,170 cf
 Primary = 4.42 cfs @ 12.23 hrs, Volume= 24,170 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Pond POI 1: Northern Site



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 36

Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points x 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1aS: In/Into IW C	Runoff Area=120,475 sf 28.08% Impervious Runoff Depth>1.53" Flow Length=809' Tc=18.6 min CN=68 Runoff=3.27 cfs 15,314 cf
Subcatchment 1bS: Driveway	Runoff Area=13,258 sf 74.33% Impervious Runoff Depth>3.29" Flow Length=262' Tc=1.6 min CN=89 Runoff=1.29 cfs 3,640 cf
Subcatchment 2aS: In/Into IW A	Runoff Area=142,302 sf 26.58% Impervious Runoff Depth>1.53" Flow Length=935' Tc=13.9 min CN=68 Runoff=4.33 cfs 18,112 cf
Subcatchment 2bS: Into Swale	Runoff Area=34,927 sf 7.90% Impervious Runoff Depth>0.90" Flow Length=214' Tc=16.8 min CN=58 Runoff=0.49 cfs 2,620 cf
Subcatchment 3S: In/Into IW D	Runoff Area=46,370 sf 6.69% Impervious Runoff Depth>0.84" Flow Length=443' Tc=20.1 min CN=57 Runoff=0.56 cfs 3,260 cf
Subcatchment 4aS: Eastern	Runoff Area=49,663 sf 50.73% Impervious Runoff Depth>3.19" Tc=5.0 min CN=88 Runoff=4.29 cfs 13,219 cf
Subcatchment 4bS: Eastern Building	Runoff Area=13,477 sf 100.00% Impervious Runoff Depth>4.26" Flow Length=300' Slope=0.0050 '/' Tc=1.6 min CN=98 Runoff=1.52 cfs 4,789 cf
Subcatchment 5S: Outside Resources Areas	Runoff Area=29,198 sf 0.00% Impervious Runoff Depth>0.64" Flow Length=379' Tc=14.9 min CN=53 Runoff=0.25 cfs 1,552 cf
Subcatchment 6S: Cul-de-sac & Parking	Runoff Area=47,211 sf 72.90% Impervious Runoff Depth>3.20" Flow Length=369' Tc=2.3 min CN=88 Runoff=4.46 cfs 12,572 cf
Subcatchment 7aS: Western site	Runoff Area=49,439 sf 0.00% Impervious Runoff Depth>1.07" Flow Length=345' Tc=15.8 min CN=61 Runoff=0.92 cfs 4,426 cf
Subcatchment 7bS: Western Building	Runoff Area=13,086 sf 100.00% Impervious Runoff Depth>4.26" Flow Length=236' Slope=0.0050 '/' Tc=1.2 min CN=98 Runoff=1.48 cfs 4,650 cf
Subcatchment 8S: In/Into BVW B	Runoff Area=42,212 sf 3.42% Impervious Runoff Depth>0.59" Flow Length=363' Tc=6.7 min CN=52 Runoff=0.39 cfs 2,080 cf
Reach 1R: Grassed Swale	Avg. Flow Depth=0.35' Max Vel=3.79 fps Inflow=10.30 cfs 50,129 cf n=0.030 L=265.0' S=0.0415 '/' Capacity=102.24 cfs Outflow=10.28 cfs 50,077 cf
Pond 1P: Isolated Wetland C	Peak Elev=120.40' Inflow=3.72 cfs 18,474 cf Outflow=3.72 cfs 18,474 cf
Pond 2P: Isolated Wetland A	Peak Elev=129.30' Inflow=4.33 cfs 18,112 cf Outflow=4.33 cfs 18,112 cf
Pond 3P: Isolated Wetland D	Peak Elev=112.08' Inflow=0.56 cfs 3,260 cf Outflow=0.56 cfs 3,260 cf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 37

Pond 4P: BVW B

Inflow=10.60 cfs 52,158 cf
Primary=10.60 cfs 52,158 cf

Pond 5P: Basin 1

Peak Elev=105.35' Storage=15,254 cf Inflow=5.52 cfs 18,008 cf
Discarded=0.07 cfs 2,794 cf Primary=0.00 cfs 0 cf Outflow=0.07 cfs 2,794 cf

Pond 6P: Basin 2

Peak Elev=105.02' Storage=10,244 cf Inflow=1.89 cfs 12,337 cf
Discarded=0.05 cfs 2,093 cf Primary=0.00 cfs 0 cf Outflow=0.05 cfs 2,093 cf

Pond 7P: Sediment Forebay

Peak Elev=106.96' Inflow=4.29 cfs 13,219 cf
Outflow=4.29 cfs 13,219 cf

Pond BA 1: Bioretention Area A

Peak Elev=134.38' Storage=583 cf Inflow=1.29 cfs 3,640 cf
Outflow=1.25 cfs 3,159 cf

Pond BA 2: Bioretention Area B

Peak Elev=125.58' Storage=2,249 cf Inflow=4.46 cfs 12,572 cf
Outflow=4.05 cfs 10,924 cf

Pond POI 1: Northern Site

Inflow=10.84 cfs 53,709 cf
Primary=10.84 cfs 53,709 cf

Total Runoff Area = 601,618 sf Runoff Volume = 86,235 cf Average Runoff Depth = 1.72"
70.91% Pervious = 426,630 sf 29.09% Impervious = 174,988 sf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 38

Summary for Subcatchment 1aS: In/Into IW C

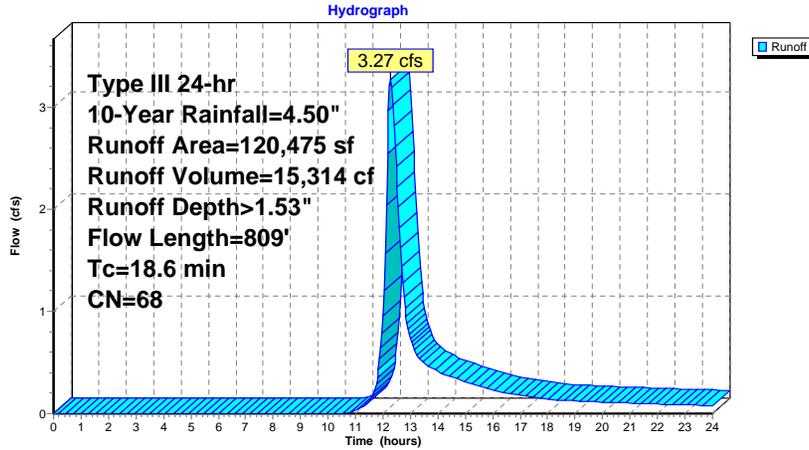
Runoff = 3.27 cfs @ 12.28 hrs, Volume= 15,314 cf, Depth> 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

	Area (sf)	CN	Description
*	9,382	98	Paved driveways & Roofs
	10,413	55	Woods, Good, HSG B
	46,780	61	>75% Grass cover, Good, HSG B
	29,453	48	Brush, Good, HSG B
*	24,447	98	Wetland
	120,475	68	Weighted Average
	86,646		71.92% Pervious Area
	33,829		28.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	90	0.0528	0.25		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.4	10	0.0500	0.07		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
1.0	63	0.0476	1.09		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.9	174	0.0488	1.55		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.9	55	0.0273	0.99		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
6.3	417	0.0336	1.10		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
18.6	809				Total

Subcatchment 1aS: In/Into IW C



Summary for Subcatchment 1bS: Driveway

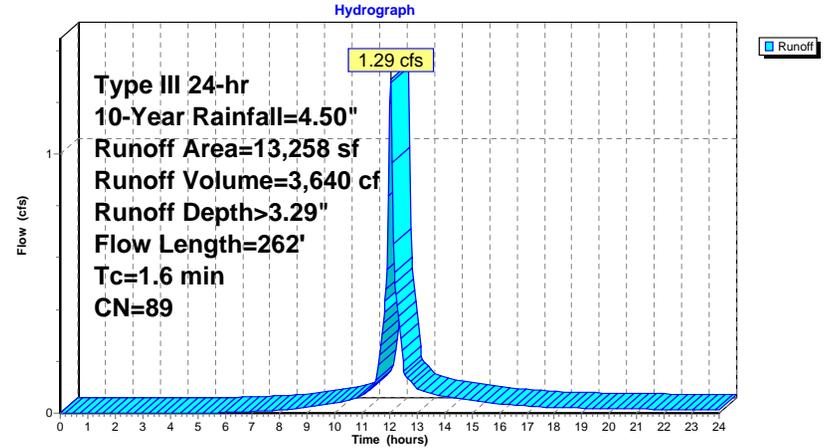
Runoff = 1.29 cfs @ 12.03 hrs, Volume= 3,640 cf, Depth> 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
8,705	98	Paved driveway & Sidewalk
3,403	61	>75% Grass cover, Good, HSG B
1,150	98	Water Surface, HSG B
13,258	89	Weighted Average
3,403		25.67% Pervious Area
9,855		74.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0350	1.72		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.6	162	0.0482	4.46		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.6	262				Total

Subcatchment 1bS: Driveway



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 41

Summary for Subcatchment 2aS: In/Into IW A

Runoff = 4.33 cfs @ 12.21 hrs, Volume= 18,112 cf, Depth > 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
* 9,125	98	Wetland
768	48	Brush, Good, HSG B
59,412	55	Woods, Good, HSG B
* 28,704	98	Paved driveways and Roofs
44,293	61	>75% Grass cover, Good, HSG B
142,302	68	Weighted Average
104,473		73.42% Pervious Area
37,829		26.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.38		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.8	164	0.0300	3.52		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.1	101	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
3.3	239	0.0593	1.22		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
7.5	331	0.0219	0.74		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
13.9	935	Total			

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

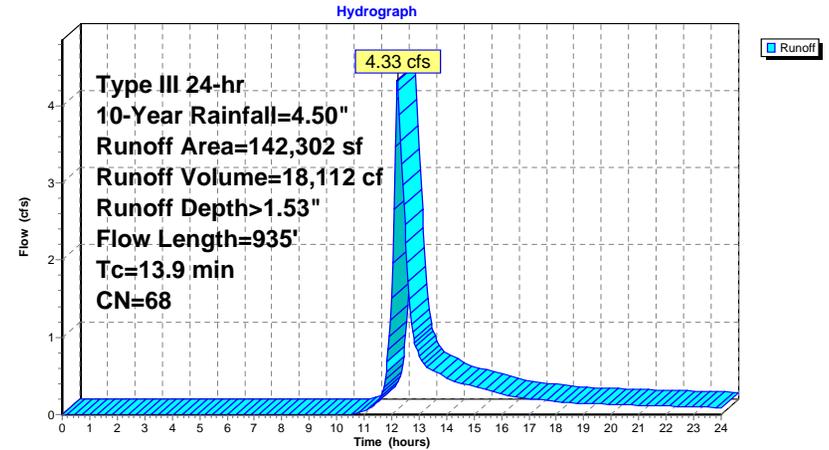
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 42

Subcatchment 2aS: In/Into IW A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 43

Summary for Subcatchment 2bS: Into Swale

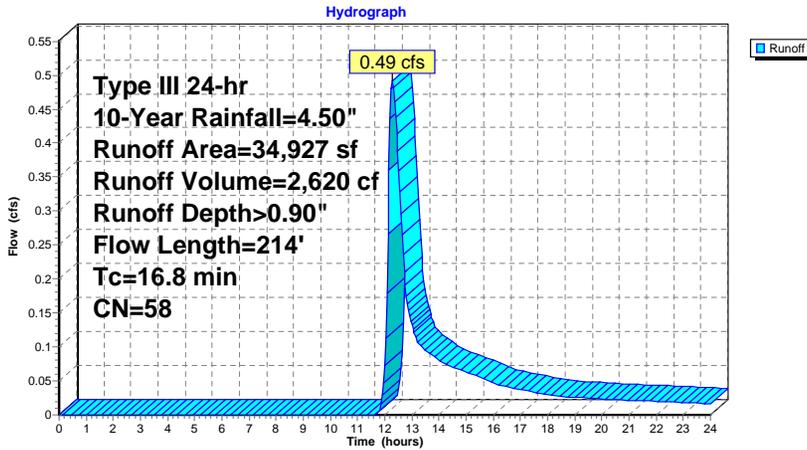
Runoff = 0.49 cfs @ 12.28 hrs, Volume= 2,620 cf, Depth> 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
* 2,759	98	Patio & Sidewalk
745	55	Woods, Good, HSG B
16,214	48	Brush, Good, HSG B
15,209	61	>75% Grass cover, Good, HSG B
34,927	58	Weighted Average
32,168		92.10% Pervious Area
2,759		7.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	100	0.0450	0.11		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.0	114	0.0746	1.91		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
16.8	214	Total			

Subcatchment 2bS: Into Swale



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 44

Summary for Subcatchment 3S: In/Into IW D

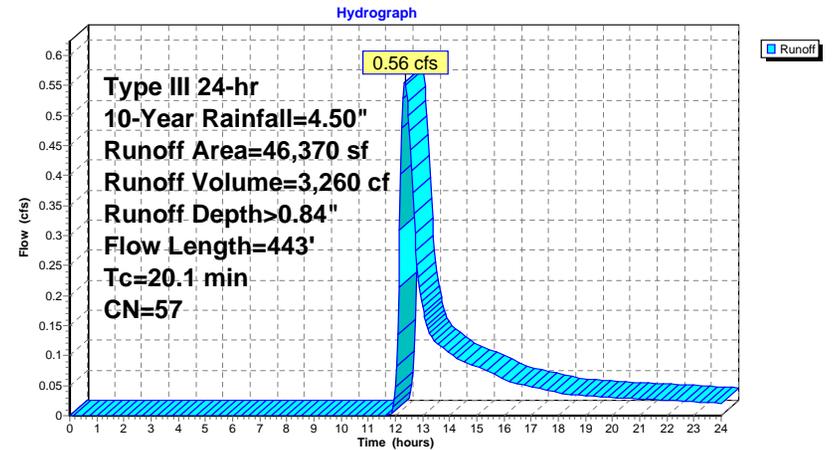
Runoff = 0.56 cfs @ 12.35 hrs, Volume= 3,260 cf, Depth> 0.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
* 3,100	98	Wetland
36,667	55	Woods, Good, HSG B
6,603	48	Brush, Good, HSG B
46,370	57	Weighted Average
43,270		93.31% Pervious Area
3,100		6.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	100	0.0511	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
4.0	272	0.0511	1.13		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.4	71	0.0141	0.83		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
20.1	443	Total			

Subcatchment 3S: In/Into IW D



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 45

Summary for Subcatchment 4aS: Eastern Driveway/Back Parking Area

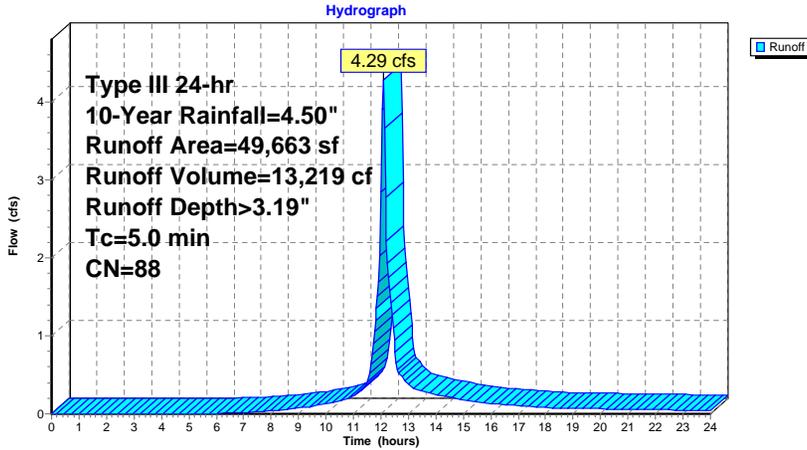
Runoff = 4.29 cfs @ 12.08 hrs, Volume= 13,219 cf, Depth> 3.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
13,723	61	>75% Grass cover, Good, HSG B
* 25,194	98	Paved Areas
10,746	98	Water Surface, 0% imp, HSG B
49,663	88	Weighted Average
24,469		49.27% Pervious Area
25,194		50.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4aS: Eastern Driveway/Back Parking Area



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 46

Summary for Subcatchment 4bS: Eastern Building

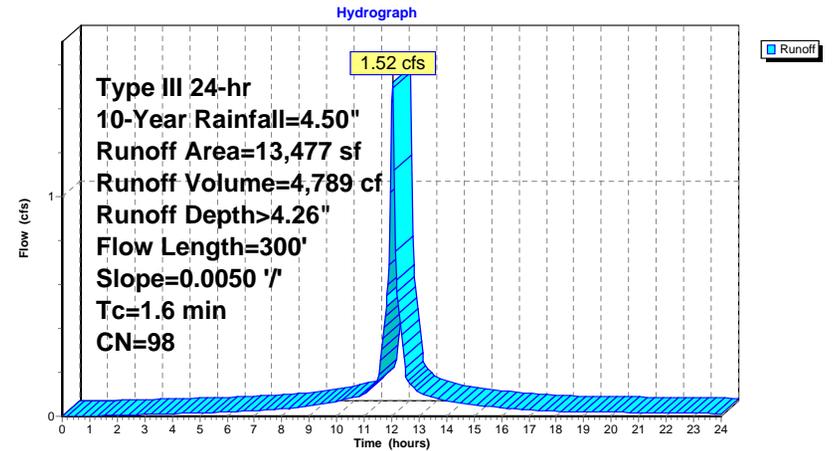
Runoff = 1.52 cfs @ 12.03 hrs, Volume= 4,789 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
13,477	98	Roofs, HSG B
13,477		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	300	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 4bS: Eastern Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 47

Summary for Subcatchment 5S: Outside Resources Areas

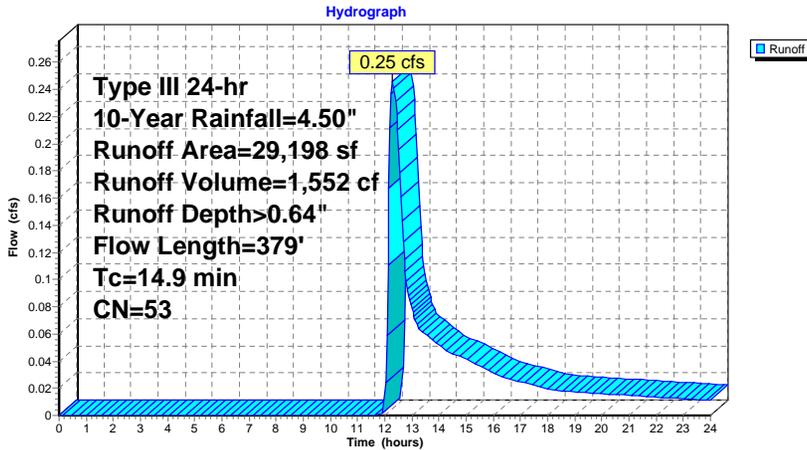
Runoff = 0.25 cfs @ 12.29 hrs, Volume= 1,552 cf, Depth> 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
9,482	55	Woods, Good, HSG B
6,631	61	>75% Grass cover, Good, HSG B
13,085	48	Brush, Good, HSG B
29,198	53	Weighted Average
29,198		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	61	0.0787	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
7.9	39	0.0385	0.08		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
2.9	253	0.0435	1.46		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
0.3	26	0.0769	1.39		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
14.9	379	Total			

Subcatchment 5S: Outside Resources Areas



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 48

Summary for Subcatchment 6S: Cul-de-sac & Parking Lot

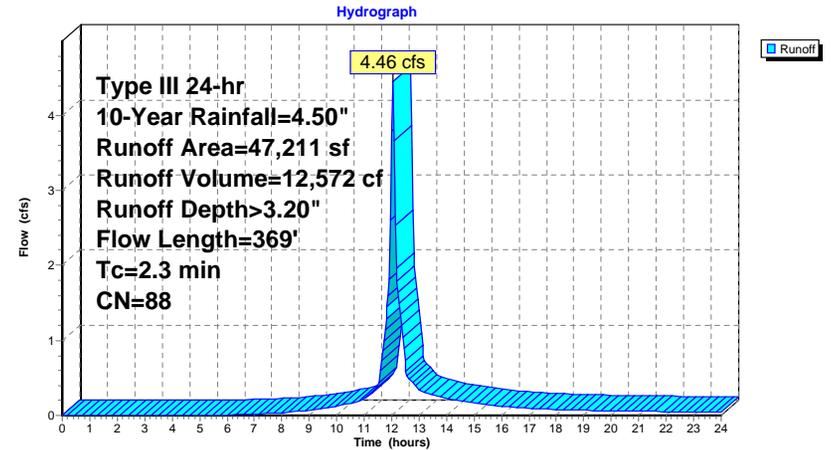
Runoff = 4.46 cfs @ 12.04 hrs, Volume= 12,572 cf, Depth> 3.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
32,287	98	Paved Area
12,795	61	>75% Grass cover, Good, HSG B
2,129	98	Water Surface, HSG B
47,211	88	Weighted Average
12,795		27.10% Pervious Area
34,416		72.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0225	1.44		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.9	202	0.0334	3.71		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.2	67	0.0224	6.79	5.33	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
2.3	369	Total			

Subcatchment 6S: Cul-de-sac & Parking Lot



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 49

Summary for Subcatchment 7aS: Western site

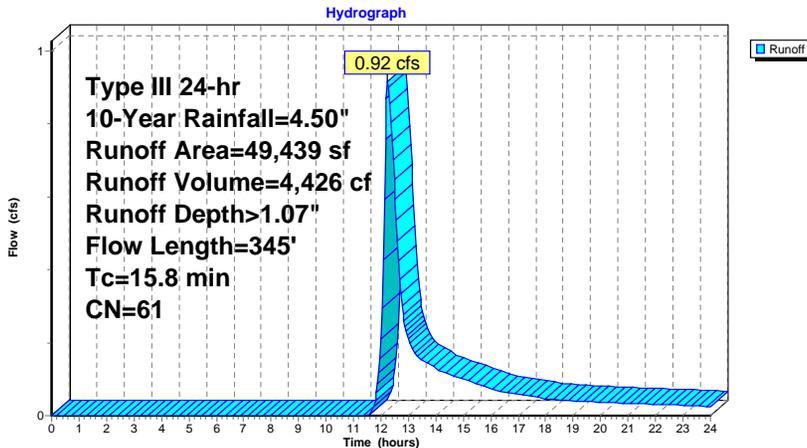
Runoff = 0.92 cfs @ 12.25 hrs, Volume= 4,426 cf, Depth> 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
6,531	61	>75% Grass cover, Good, HSG B
16,065	55	Woods, Good, HSG B
17,873	48	Brush, Good, HSG B
8,970	98	Water Surface, 0% imp, HSG B
49,439	61	Weighted Average
49,439		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	100	0.0700	0.13		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.6	105	0.0238	1.08		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
1.0	140	0.0250	2.37		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps
15.8	345				Total

Subcatchment 7aS: Western site



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 50

Summary for Subcatchment 7bS: Western Building

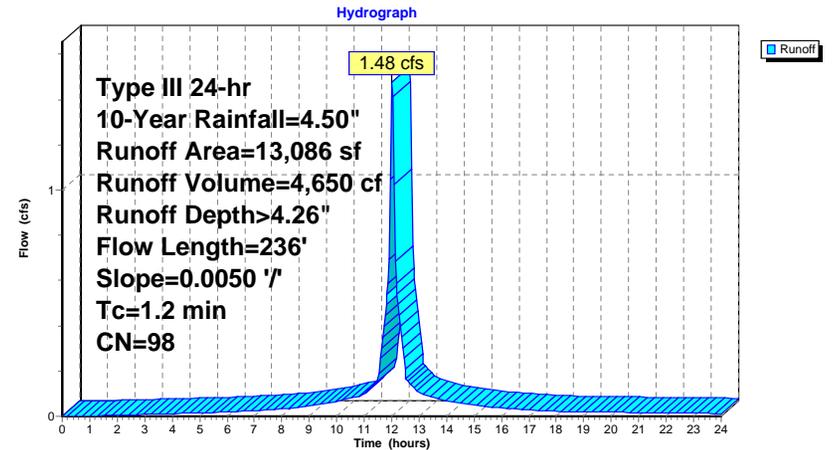
Runoff = 1.48 cfs @ 12.02 hrs, Volume= 4,650 cf, Depth> 4.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
13,086	98	Roofs, HSG B
13,086		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	236	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 7bS: Western Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 51

Summary for Subcatchment 8S: In/Into BVW B

Runoff = 0.39 cfs @ 12.14 hrs, Volume= 2,080 cf, Depth> 0.59"

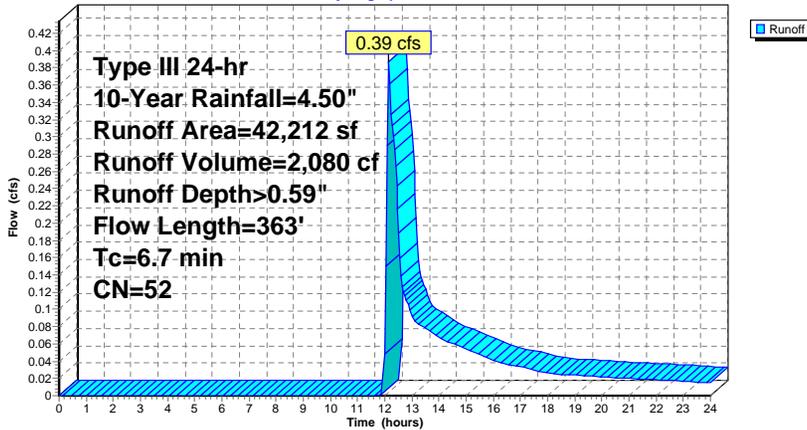
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
1,443	98	Patio & Sidewalks
9,042	61	>75% Grass cover, Good, HSG B
31,727	48	Brush, Good, HSG B
42,212	52	Weighted Average
40,769		96.58% Pervious Area
1,443		3.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	52	0.0100	0.92		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
2.9	48	0.0937	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.9	263	0.0456	1.49		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
6.7	363	Total			

Subcatchment 8S: In/Into BVW B

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 52

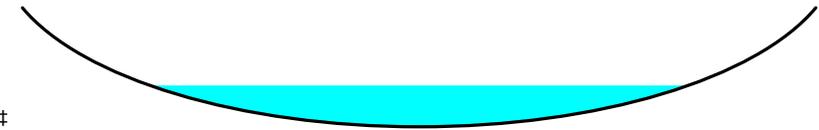
Summary for Reach 1R: Grassed Swale

Inflow Area = 358,173 sf, 33.14% Impervious, Inflow Depth > 1.68" for 10-Year event
Inflow = 10.30 cfs @ 12.21 hrs, Volume= 50,129 cf
Outflow = 10.28 cfs @ 12.22 hrs, Volume= 50,077 cf, Atten= 0%, Lag= 0.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
Max. Velocity= 3.79 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.61 fps, Avg. Travel Time= 2.7 min

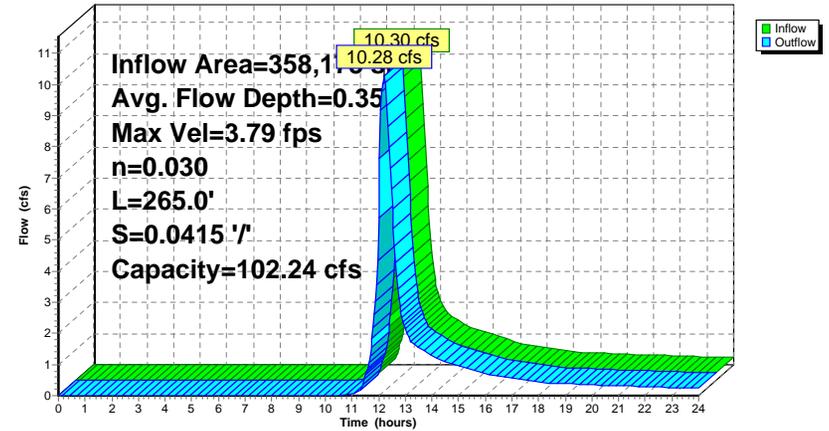
Peak Storage= 719 cf @ 12.22 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.00' Flow Area= 13.3 sf, Capacity= 102.24 cfs

20.00' x 1.00' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
Length= 265.0' Slope= 0.0415 '/
Inlet Invert= 120.00', Outlet Invert= 109.00'



Reach 1R: Grassed Swale

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 53

Summary for Pond 1P: Isolated Wetland C

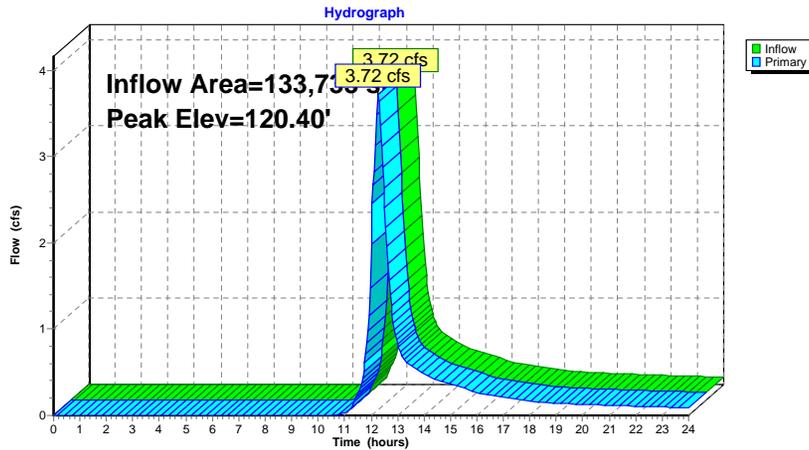
Inflow Area = 133,733 sf, 32.67% Impervious, Inflow Depth > 1.66" for 10-Year event
 Inflow = 3.72 cfs @ 12.27 hrs, Volume= 18,474 cf
 Outflow = 3.72 cfs @ 12.27 hrs, Volume= 18,474 cf, Atten= 0%, Lag= 0.0 min
 Primary = 3.72 cfs @ 12.27 hrs, Volume= 18,474 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 120.40' @ 12.25 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	120.00'	10.0' long x 57.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=3.70 cfs @ 12.27 hrs HW=120.40' TW=120.34' (Dynamic Tailwater)
 1=Broad-Crested Rectangular Weir (Weir Controls 3.70 cfs @ 0.93 fps)

Pond 1P: Isolated Wetland C



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 54

Summary for Pond 2P: Isolated Wetland A

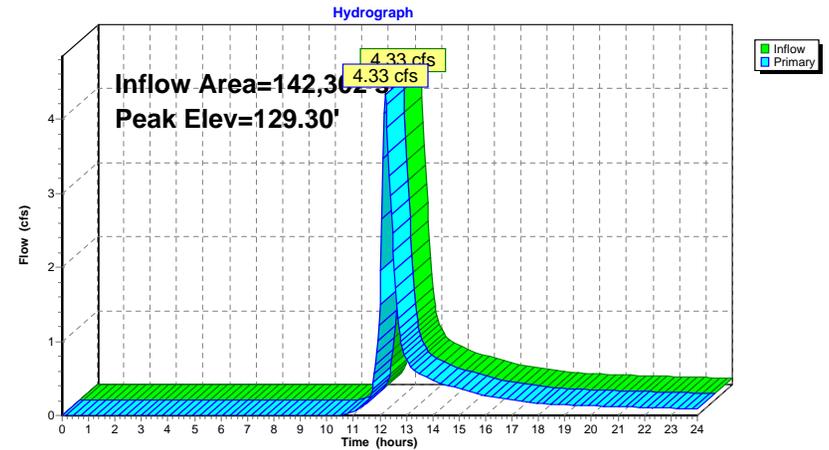
Inflow Area = 142,302 sf, 26.58% Impervious, Inflow Depth > 1.53" for 10-Year event
 Inflow = 4.33 cfs @ 12.21 hrs, Volume= 18,112 cf
 Outflow = 4.33 cfs @ 12.21 hrs, Volume= 18,112 cf, Atten= 0%, Lag= 0.0 min
 Primary = 4.33 cfs @ 12.21 hrs, Volume= 18,112 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 129.30' @ 12.21 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	129.00'	10.0' long x 214.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=4.30 cfs @ 12.21 hrs HW=129.29' TW=120.35' (Dynamic Tailwater)
 1=Broad-Crested Rectangular Weir (Weir Controls 4.30 cfs @ 1.46 fps)

Pond 2P: Isolated Wetland A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 55

Summary for Pond 3P: Isolated Wetland D

Inflow Area = 46,370 sf, 6.69% Impervious, Inflow Depth > 0.84" for 10-Year event
 Inflow = 0.56 cfs @ 12.35 hrs, Volume= 3,260 cf
 Outflow = 0.56 cfs @ 12.35 hrs, Volume= 3,260 cf, Atten= 0%, Lag= 0.0 min
 Primary = 0.56 cfs @ 12.35 hrs, Volume= 3,260 cf

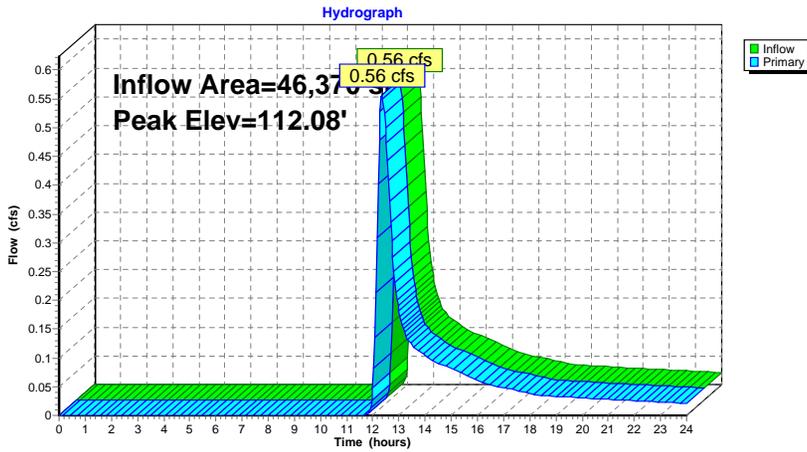
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Peak Elev= 112.08' @ 12.35 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	10.0' long x 203.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.56 cfs @ 12.35 hrs HW=112.08' TW=104.00' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 0.56 cfs @ 0.74 fps)

Pond 3P: Isolated Wetland D



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

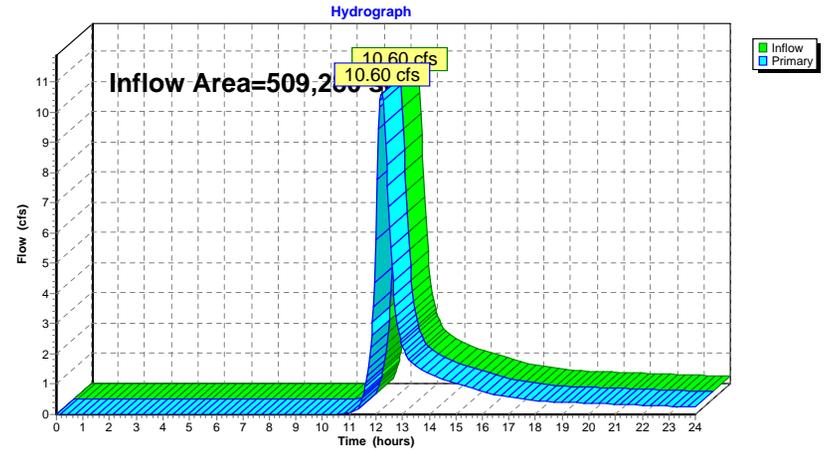
Page 56

Summary for Pond 4P: BVW B

Inflow Area = 509,280 sf, 26.77% Impervious, Inflow Depth > 1.23" for 10-Year event
 Inflow = 10.60 cfs @ 12.22 hrs, Volume= 52,158 cf
 Primary = 10.60 cfs @ 12.22 hrs, Volume= 52,158 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Pond 4P: BVW B



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 57

Summary for Pond 5P: Basin 1

Inflow Area = 63,140 sf, 61.25% Impervious, Inflow Depth > 3.42" for 10-Year event
 Inflow = 5.52 cfs @ 12.06 hrs, Volume= 18,008 cf
 Outflow = 0.07 cfs @ 22.21 hrs, Volume= 2,794 cf, Atten= 99%, Lag= 609.3 min
 Discarded = 0.07 cfs @ 22.21 hrs, Volume= 2,794 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 105.35' @ 22.21 hrs Surf.Area= 8,018 sf Storage= 15,254 cf

Plug-Flow detention time= 512.7 min calculated for 2,794 cf (16% of inflow)
 Center-of-Mass det. time= 291.5 min (1,077.3 - 785.9)

Volume	Invert	Avail.Storage	Storage Description	
#1	103.00'	30,720 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
103.00	5,213	0	0	5,213
104.00	6,258	5,728	5,728	6,292
105.00	7,452	6,846	12,574	7,521
106.00	9,140	8,282	20,856	9,240
107.00	10,607	9,864	30,720	10,749

Device	Routing	Invert	Outlet Devices
#1	Primary	105.75'	10.0' long x 118.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	103.00'	1.020 in/hr Exfiltration over Surface area above 103.00' Excluded Surface area = 5,213 sf

Discarded OutFlow Max=0.07 cfs @ 22.21 hrs HW=105.35' (Free Discharge)
 ↳ **2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=103.00' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

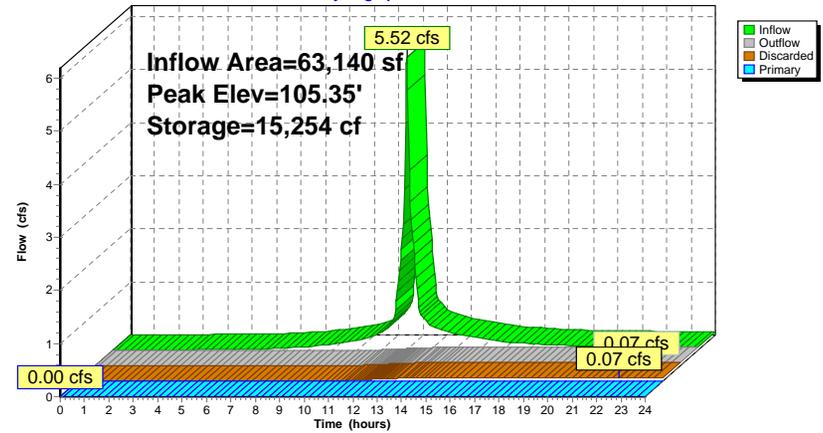
Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 58

Pond 5P: Basin 1

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 59

Summary for Pond 6P: Basin 2

Inflow Area = 108,895 sf, 14.86% Impervious, Inflow Depth > 1.36" for 10-Year event
 Inflow = 1.89 cfs @ 12.25 hrs, Volume= 12,337 cf
 Outflow = 0.05 cfs @ 24.00 hrs, Volume= 2,093 cf, Atten= 97%, Lag= 704.7 min
 Discarded = 0.05 cfs @ 24.00 hrs, Volume= 2,093 cf
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 105.02' @ 24.00 hrs Surf.Area= 6,459 sf Storage= 10,244 cf

Plug-Flow detention time= 482.7 min calculated for 2,089 cf (17% of inflow)
 Center-of-Mass det. time= 250.1 min (1,088.3 - 838.2)

Volume	Invert	Avail.Storage	Storage Description	
#1	103.10'	25,458 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
103.10	4,240	0	0	4,240
104.00	5,256	4,265	4,265	5,279
105.00	6,432	5,834	10,099	6,486
106.00	7,675	7,044	17,143	7,764
107.00	8,970	8,314	25,458	9,099

Device	Routing	Invert	Outlet Devices
#1	Discarded	103.10'	1.020 in/hr Exfiltration over Surface area above 103.10' Excluded Surface area = 4,240 sf
#2	Primary	105.50'	10.0' long x 43.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.05 cfs @ 24.00 hrs HW=105.02' (Free Discharge)
 ↳1=Exfiltration (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=103.10' TW=0.00' (Dynamic Tailwater)
 ↳2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

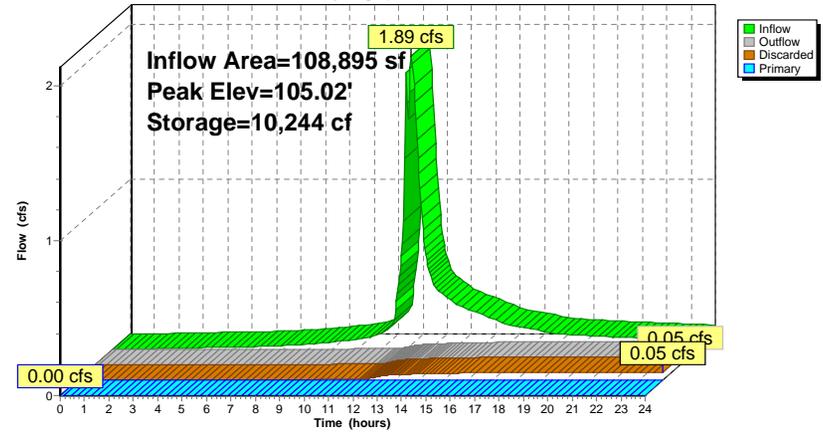
Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 60

Pond 6P: Basin 2

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 61

Summary for Pond 7P: Sediment Forebay

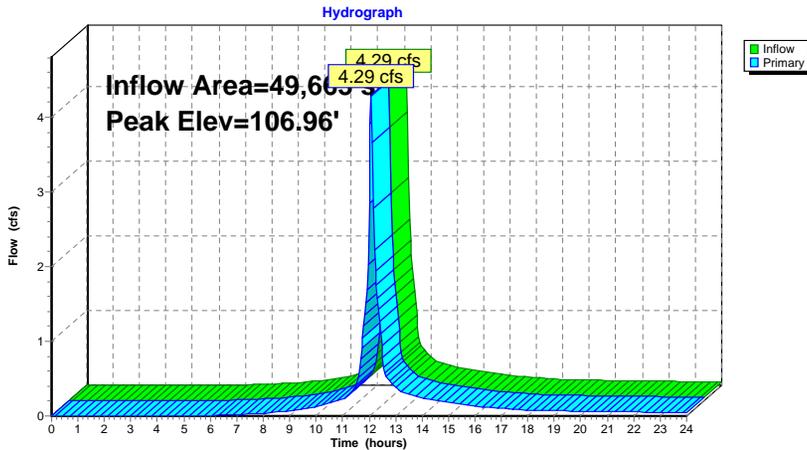
Inflow Area = 49,663 sf, 50.73% Impervious, Inflow Depth > 3.19" for 10-Year event
 Inflow = 4.29 cfs @ 12.08 hrs, Volume= 13,219 cf
 Outflow = 4.29 cfs @ 12.08 hrs, Volume= 13,219 cf, Atten= 0%, Lag= 0.0 min
 Primary = 4.29 cfs @ 12.08 hrs, Volume= 13,219 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 106.96' @ 12.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	106.50'	5.3' 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 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=4.24 cfs @ 12.08 hrs HW=106.96' TW=104.23' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 4.24 cfs @ 1.75 fps)

Pond 7P: Sediment Forebay



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 10-Year Rainfall=4.50"

Printed 6/6/2016

Page 62

Summary for Pond BA 1: Bioretention Area A

Inflow Area = 13,258 sf, 74.33% Impervious, Inflow Depth > 3.29" for 10-Year event
 Inflow = 1.29 cfs @ 12.03 hrs, Volume= 3,640 cf
 Outflow = 1.25 cfs @ 12.04 hrs, Volume= 3,159 cf, Atten= 3%, Lag= 1.0 min
 Primary = 1.25 cfs @ 12.04 hrs, Volume= 3,159 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 134.38' @ 12.04 hrs Surf.Area= 851 sf Storage= 583 cf

Plug-Flow detention time= 91.1 min calculated for 3,154 cf (87% of inflow)
 Center-of-Mass det. time= 33.1 min (827.1 - 794.0)

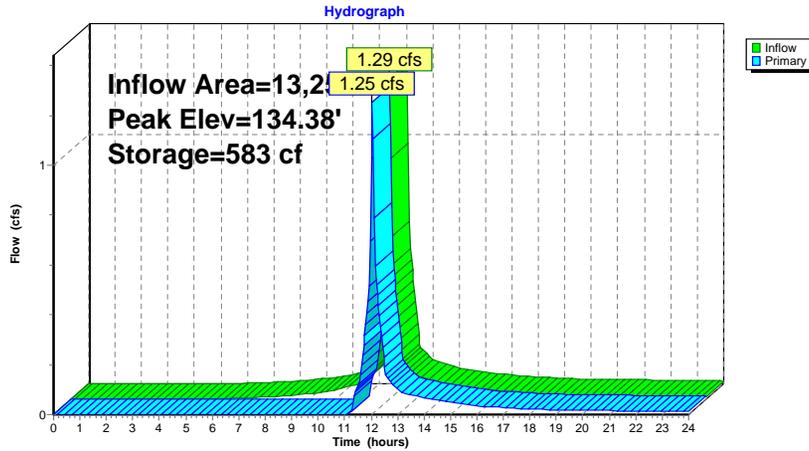
Volume	Invert	Avail.Storage	Storage Description
#1	133.50'	1,201 cf	Custom Stage Data (Conic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.50	481	0	0	481
134.00	690	291	291	694
135.00	1,150	910	1,201	1,167

Device	Routing	Invert	Outlet Devices
#1	Primary	134.25'	10.0' long x 15.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.23 cfs @ 12.04 hrs HW=134.38' TW=120.34' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 1.23 cfs @ 0.96 fps)

Pond BA 1: Bioretention Area A



Summary for Pond BA 2: Bioretention Area B

Inflow Area = 47,211 sf, 72.90% Impervious, Inflow Depth > 3.20" for 10-Year event
 Inflow = 4.46 cfs @ 12.04 hrs, Volume= 12,572 cf
 Outflow = 4.05 cfs @ 12.07 hrs, Volume= 10,924 cf, Atten= 9%, Lag= 1.8 min
 Primary = 4.05 cfs @ 12.07 hrs, Volume= 10,924 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 125.58' @ 12.07 hrs Surf.Area= 2,061 sf Storage= 2,249 cf

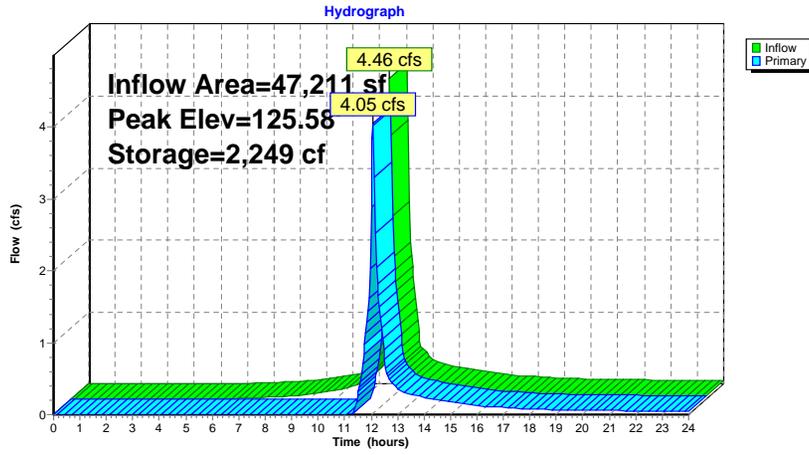
Plug-Flow detention time= 91.0 min calculated for 10,906 cf (87% of inflow)
 Center-of-Mass det. time= 33.2 min (831.4 - 798.2)

Volume #1	Invert	Avail.Storage	Storage Description	
#1	124.00'	3,205 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
124.00	898	0	0	898
125.00	1,548	1,208	1,208	1,560
126.00	2,482	1,997	3,205	2,507

Device	Routing	Invert	Outlet Devices
#1	Primary	125.25'	8.0' long x 75.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=3.96 cfs @ 12.07 hrs HW=125.57' TW=120.32' (Dynamic Tailwater)
 ↳=Broad-Crested Rectangular Weir (Weir Controls 3.96 cfs @ 1.53 fps)

Pond BA 2: Bioretention Area B

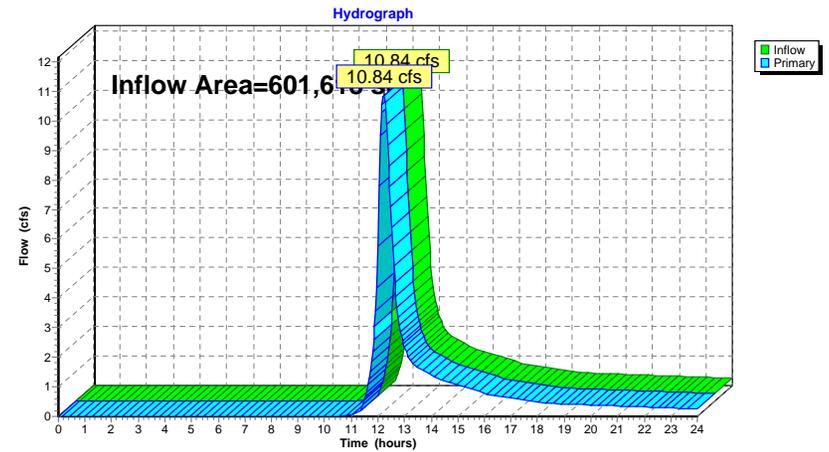


Summary for Pond POI 1: Northern Site

Inflow Area = 601,618 sf, 29.09% Impervious, Inflow Depth > 1.07" for 10-Year event
Inflow = 10.84 cfs @ 12.22 hrs, Volume= 53,709 cf
Primary = 10.84 cfs @ 12.22 hrs, Volume= 53,709 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Pond POI 1: Northern Site



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 67

Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points x 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1aS: In/Into IW C	Runoff Area=120,475 sf 28.08% Impervious Runoff Depth>2.16" Flow Length=809' Tc=18.6 min CN=68 Runoff=4.75 cfs 21,686 cf
Subcatchment 1bS: Driveway	Runoff Area=13,258 sf 74.33% Impervious Runoff Depth>4.16" Flow Length=262' Tc=1.6 min CN=89 Runoff=1.60 cfs 4,591 cf
Subcatchment 2aS: In/Into IW A	Runoff Area=142,302 sf 26.58% Impervious Runoff Depth>2.16" Flow Length=935' Tc=13.9 min CN=68 Runoff=6.29 cfs 25,645 cf
Subcatchment 2bS: Into Swale	Runoff Area=34,927 sf 7.90% Impervious Runoff Depth>1.39" Flow Length=214' Tc=16.8 min CN=58 Runoff=0.84 cfs 4,042 cf
Subcatchment 3S: In/Into IW D	Runoff Area=46,370 sf 6.69% Impervious Runoff Depth>1.32" Flow Length=443' Tc=20.1 min CN=57 Runoff=0.97 cfs 5,087 cf
Subcatchment 4aS: Eastern	Runoff Area=49,663 sf 50.73% Impervious Runoff Depth>4.05" Tc=5.0 min CN=88 Runoff=5.38 cfs 16,751 cf
Subcatchment 4bS: Eastern Building	Runoff Area=13,477 sf 100.00% Impervious Runoff Depth>5.16" Flow Length=300' Slope=0.0050 '/' Tc=1.6 min CN=98 Runoff=1.83 cfs 5,798 cf
Subcatchment 5S: Outside Resources Areas	Runoff Area=29,198 sf 0.00% Impervious Runoff Depth>1.05" Flow Length=379' Tc=14.9 min CN=53 Runoff=0.49 cfs 2,549 cf
Subcatchment 6S: Cul-de-sac & Parking	Runoff Area=47,211 sf 72.90% Impervious Runoff Depth>4.05" Flow Length=369' Tc=2.3 min CN=88 Runoff=5.59 cfs 15,931 cf
Subcatchment 7aS: Western site	Runoff Area=49,439 sf 0.00% Impervious Runoff Depth>1.61" Flow Length=345' Tc=15.8 min CN=61 Runoff=1.47 cfs 6,628 cf
Subcatchment 7bS: Western Building	Runoff Area=13,086 sf 100.00% Impervious Runoff Depth>5.16" Flow Length=236' Slope=0.0050 '/' Tc=1.2 min CN=98 Runoff=1.78 cfs 5,630 cf
Subcatchment 8S: In/Into BVW B	Runoff Area=42,212 sf 3.42% Impervious Runoff Depth>0.99" Flow Length=363' Tc=6.7 min CN=52 Runoff=0.83 cfs 3,469 cf
Reach 1R: Grassed Swale	Avg. Flow Depth=0.41' Max Vel=4.22 fps Inflow=14.62 cfs 69,762 cf n=0.030 L=265.0' S=0.0415 '/' Capacity=102.24 cfs Outflow=14.57 cfs 69,701 cf
Pond 1P: Isolated Wetland C	Peak Elev=120.49' Inflow=5.32 cfs 25,796 cf Outflow=5.32 cfs 25,796 cf
Pond 2P: Isolated Wetland A	Peak Elev=129.38' Inflow=6.29 cfs 25,645 cf Outflow=6.29 cfs 25,645 cf
Pond 3P: Isolated Wetland D	Peak Elev=112.11' Inflow=0.97 cfs 5,087 cf Outflow=0.97 cfs 5,087 cf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 68

Pond 4P: BVW B	Inflow=15.21 cfs 74,231 cf Primary=15.21 cfs 74,231 cf
Pond 5P: Basin 1	Peak Elev=105.76' Storage=18,732 cf Inflow=6.87 cfs 22,549 cf Discarded=0.08 cfs 3,562 cf Primary=0.04 cfs 403 cf Outflow=0.12 cfs 3,965 cf
Pond 6P: Basin 2	Peak Elev=105.52' Storage=13,603 cf Inflow=2.95 cfs 17,345 cf Discarded=0.07 cfs 2,768 cf Primary=0.07 cfs 1,061 cf Outflow=0.14 cfs 3,830 cf
Pond 7P: Sediment Forebay	Peak Elev=107.03' Inflow=5.38 cfs 16,751 cf Outflow=5.38 cfs 16,751 cf
Pond BA 1: Bioretention Area A	Peak Elev=134.40' Storage=601 cf Inflow=1.60 cfs 4,591 cf Outflow=1.57 cfs 4,110 cf
Pond BA 2: Bioretention Area B	Peak Elev=125.63' Storage=2,362 cf Inflow=5.59 cfs 15,931 cf Outflow=5.11 cfs 14,279 cf
Pond POI 1: Northern Site	Inflow=15.69 cfs 77,183 cf Primary=15.69 cfs 77,183 cf

Total Runoff Area = 601,618 sf Runoff Volume = 117,807 cf Average Runoff Depth = 2.35"
70.91% Pervious = 426,630 sf 29.09% Impervious = 174,988 sf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 69

Summary for Subcatchment 1aS: In/Into IW C

Runoff = 4.75 cfs @ 12.27 hrs, Volume= 21,686 cf, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
* 9,382	98	Paved driveways & Roofs
10,413	55	Woods, Good, HSG B
46,780	61	>75% Grass cover, Good, HSG B
29,453	48	Brush, Good, HSG B
* 24,447	98	Wetland
120,475	68	Weighted Average
86,646		71.92% Pervious Area
33,829		28.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	90	0.0528	0.25		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.4	10	0.0500	0.07		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
1.0	63	0.0476	1.09		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.9	174	0.0488	1.55		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.9	55	0.0273	0.99		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
6.3	417	0.0336	1.10		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
18.6	809	Total			

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

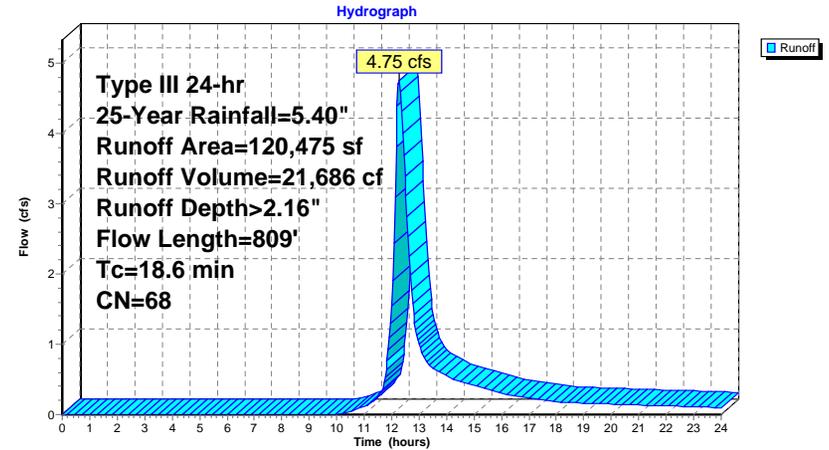
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 70

Subcatchment 1aS: In/Into IW C



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 71

Summary for Subcatchment 1bS: Driveway

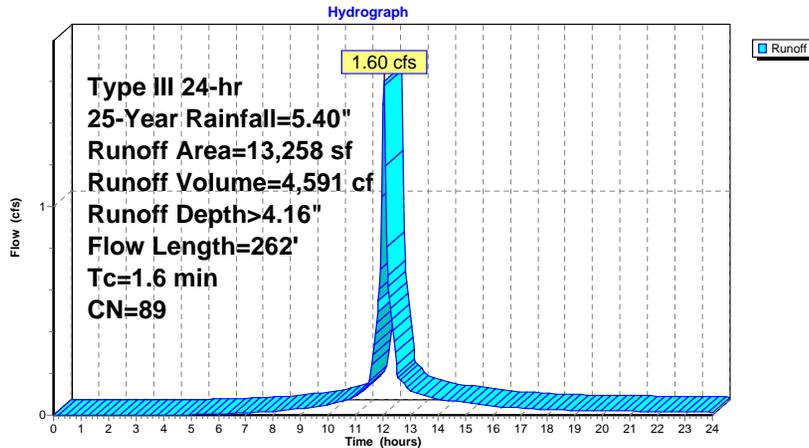
Runoff = 1.60 cfs @ 12.03 hrs, Volume= 4,591 cf, Depth> 4.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
* 8,705	98	Paved driveway & Sidewalk
3,403	61	>75% Grass cover, Good, HSG B
1,150	98	Water Surface, HSG B
13,258	89	Weighted Average
3,403		25.67% Pervious Area
9,855		74.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0350	1.72		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.6	162	0.0482	4.46		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.6	262	Total			

Subcatchment 1bS: Driveway



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 72

Summary for Subcatchment 2aS: In/Into IW A

Runoff = 6.29 cfs @ 12.20 hrs, Volume= 25,645 cf, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
* 9,125	98	Wetland
768	48	Brush, Good, HSG B
59,412	55	Woods, Good, HSG B
28,704	98	Paved driveways and Roofs
44,293	61	>75% Grass cover, Good, HSG B
142,302	68	Weighted Average
104,473		73.42% Pervious Area
37,829		26.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.38		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.8	164	0.0300	3.52		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.1	101	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
3.3	239	0.0593	1.22		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
7.5	331	0.0219	0.74		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
13.9	935	Total			

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

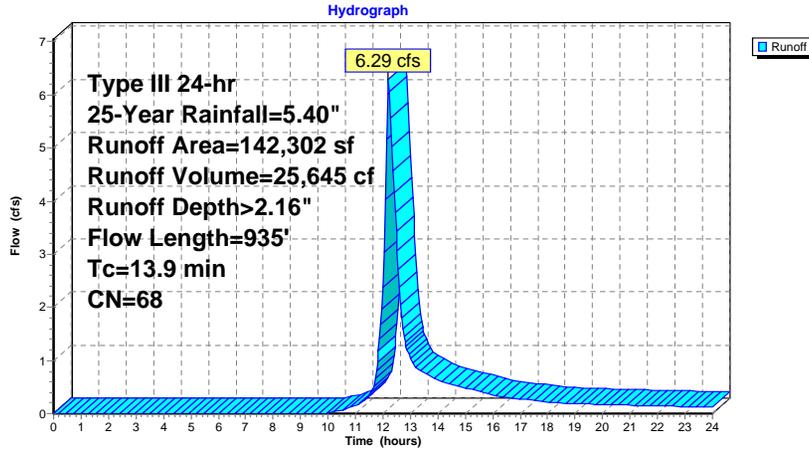
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 73

Subcatchment 2aS: In/Into IW A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 74

Summary for Subcatchment 2bS: Into Swale

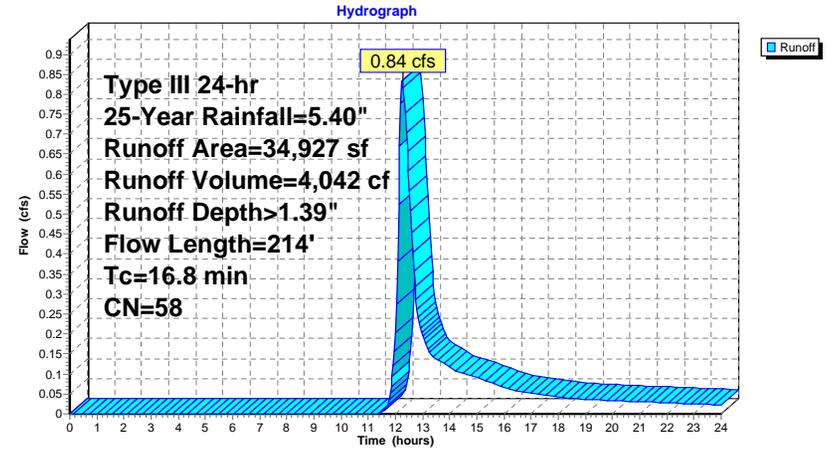
Runoff = 0.84 cfs @ 12.26 hrs, Volume= 4,042 cf, Depth> 1.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
2,759	98	Patio & Sidewalk
745	55	Woods, Good, HSG B
16,214	48	Brush, Good, HSG B
15,209	61	>75% Grass cover, Good, HSG B
34,927	58	Weighted Average
32,168		92.10% Pervious Area
2,759		7.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	100	0.0450	0.11		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.0	114	0.0746	1.91		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
16.8	214				Total

Subcatchment 2bS: Into Swale



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 75

Summary for Subcatchment 3S: In/Into IW D

Runoff = 0.97 cfs @ 12.32 hrs, Volume= 5,087 cf, Depth> 1.32"

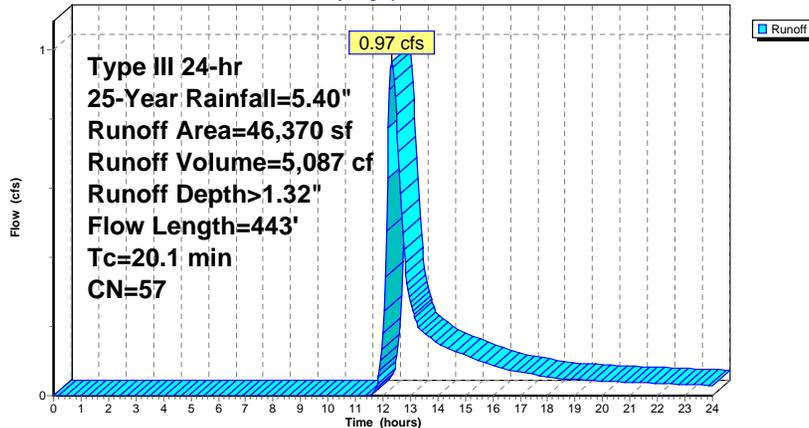
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
3,100	98	Wetland
36,667	55	Woods, Good, HSG B
6,603	48	Brush, Good, HSG B
46,370	57	Weighted Average
43,270		93.31% Pervious Area
3,100		6.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	100	0.0511	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
4.0	272	0.0511	1.13		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.4	71	0.0141	0.83		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
20.1	443				Total

Subcatchment 3S: In/Into IW D

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 76

Summary for Subcatchment 4aS: Eastern Driveway/Back Parking Area

Runoff = 5.38 cfs @ 12.07 hrs, Volume= 16,751 cf, Depth> 4.05"

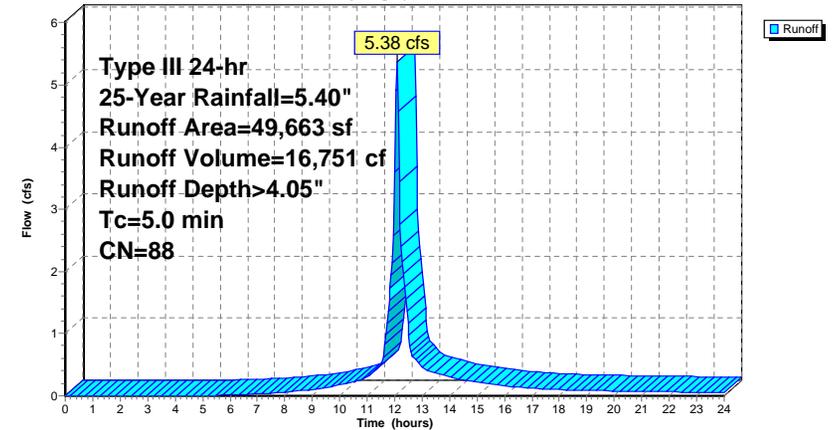
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
13,723	61	>75% Grass cover, Good, HSG B
25,194	98	Paved Areas
10,746	98	Water Surface, 0% imp, HSG B
49,663	88	Weighted Average
24,469		49.27% Pervious Area
25,194		50.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4aS: Eastern Driveway/Back Parking Area

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 77

Summary for Subcatchment 4bS: Eastern Building

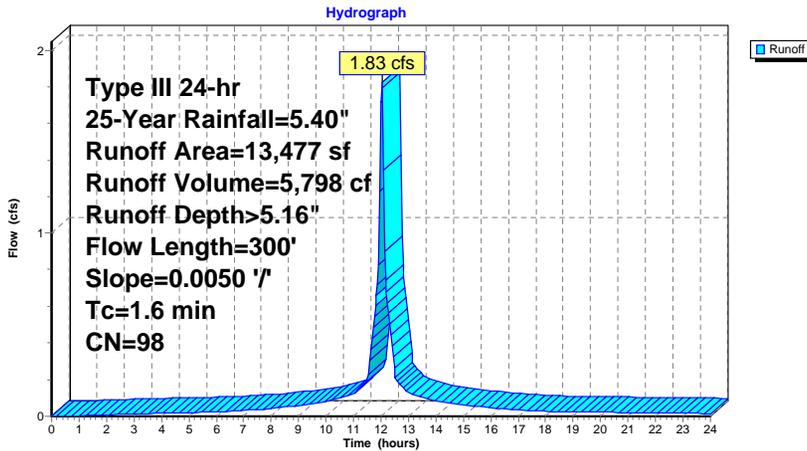
Runoff = 1.83 cfs @ 12.03 hrs, Volume= 5,798 cf, Depth> 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
13,477	98	Roofs, HSG B
13,477		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	300	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 4bS: Eastern Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 78

Summary for Subcatchment 5S: Outside Resources Areas

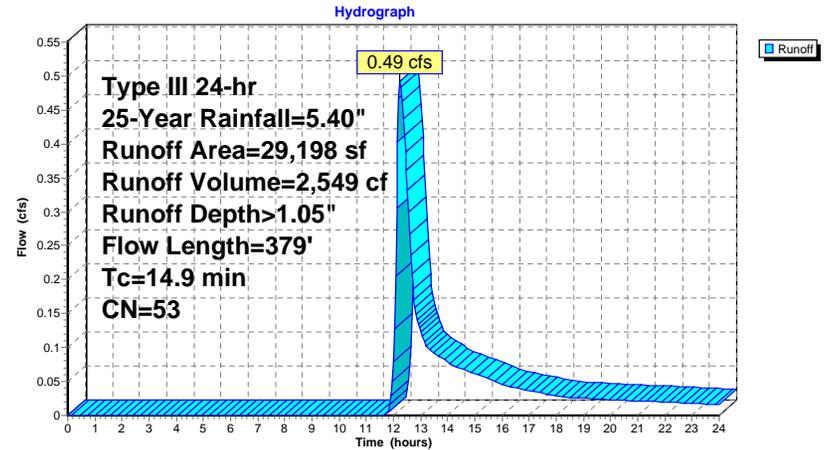
Runoff = 0.49 cfs @ 12.25 hrs, Volume= 2,549 cf, Depth> 1.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
9,482	55	Woods, Good, HSG B
6,631	61	>75% Grass cover, Good, HSG B
13,085	48	Brush, Good, HSG B
29,198	53	Weighted Average
29,198		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	61	0.0787	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
7.9	39	0.0385	0.08		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
2.9	253	0.0435	1.46		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
0.3	26	0.0769	1.39		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
14.9	379				Total

Subcatchment 5S: Outside Resources Areas



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 79

Summary for Subcatchment 6S: Cul-de-sac & Parking Lot

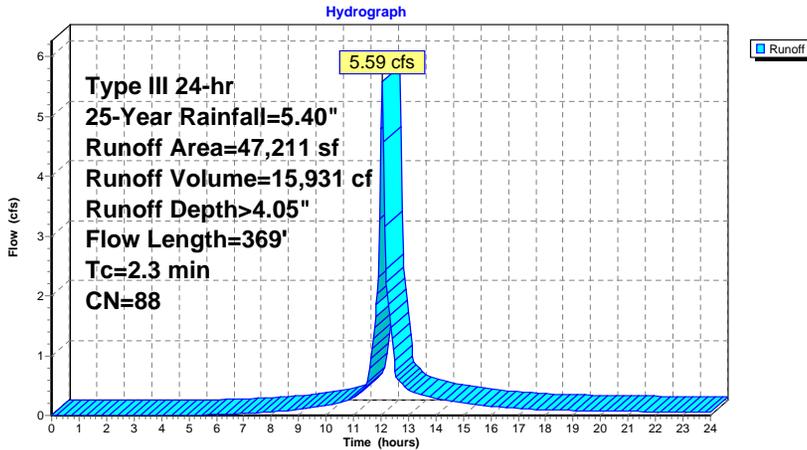
Runoff = 5.59 cfs @ 12.04 hrs, Volume= 15,931 cf, Depth> 4.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
32,287	98	Paved Area
12,795	61	>75% Grass cover, Good, HSG B
2,129	98	Water Surface, HSG B
47,211	88	Weighted Average
12,795		27.10% Pervious Area
34,416		72.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0225	1.44		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.9	202	0.0334	3.71		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.2	67	0.0224	6.79	5.33	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
2.3	369				Total

Subcatchment 6S: Cul-de-sac & Parking Lot



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 80

Summary for Subcatchment 7aS: Western site

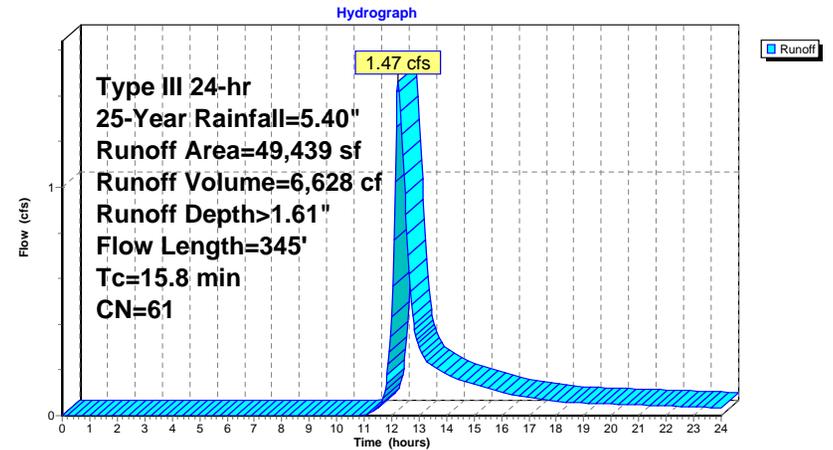
Runoff = 1.47 cfs @ 12.24 hrs, Volume= 6,628 cf, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
6,531	61	>75% Grass cover, Good, HSG B
16,065	55	Woods, Good, HSG B
17,873	48	Brush, Good, HSG B
8,970	98	Water Surface, 0% imp, HSG B
49,439	61	Weighted Average
49,439		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	100	0.0700	0.13		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.6	105	0.0238	1.08		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
1.0	140	0.0250	2.37		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps
15.8	345				Total

Subcatchment 7aS: Western site



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 81

Summary for Subcatchment 7bS: Western Building

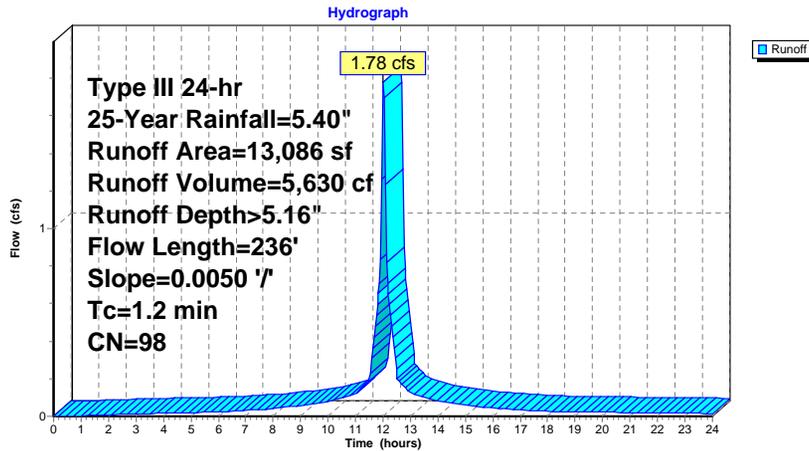
Runoff = 1.78 cfs @ 12.02 hrs, Volume= 5,630 cf, Depth> 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
13,086	98	Roofs, HSG B
13,086		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	236	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 7bS: Western Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 82

Summary for Subcatchment 8S: In/Into BVW B

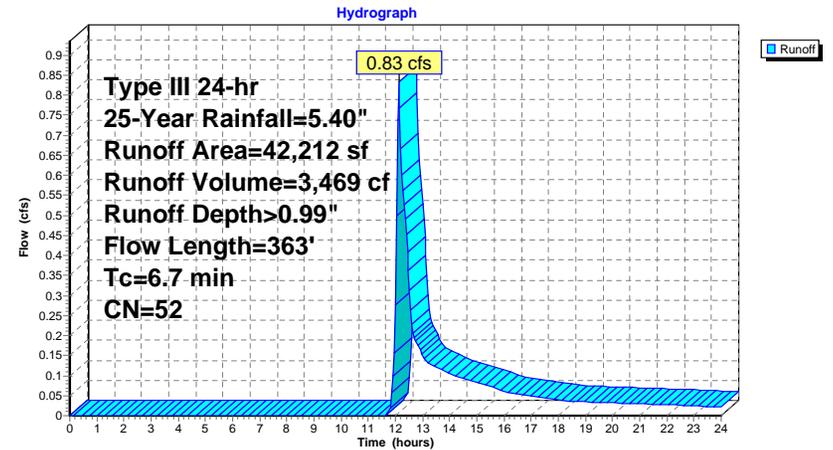
Runoff = 0.83 cfs @ 12.12 hrs, Volume= 3,469 cf, Depth> 0.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 25-Year Rainfall=5.40"

Area (sf)	CN	Description
1,443	98	Patio & Sidewalks
9,042	61	>75% Grass cover, Good, HSG B
31,727	48	Brush, Good, HSG B
42,212	52	Weighted Average
40,769		96.58% Pervious Area
1,443		3.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	52	0.0100	0.92		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
2.9	48	0.0937	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.9	263	0.0456	1.49		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
6.7	363	Total			

Subcatchment 8S: In/Into BVW B



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 83

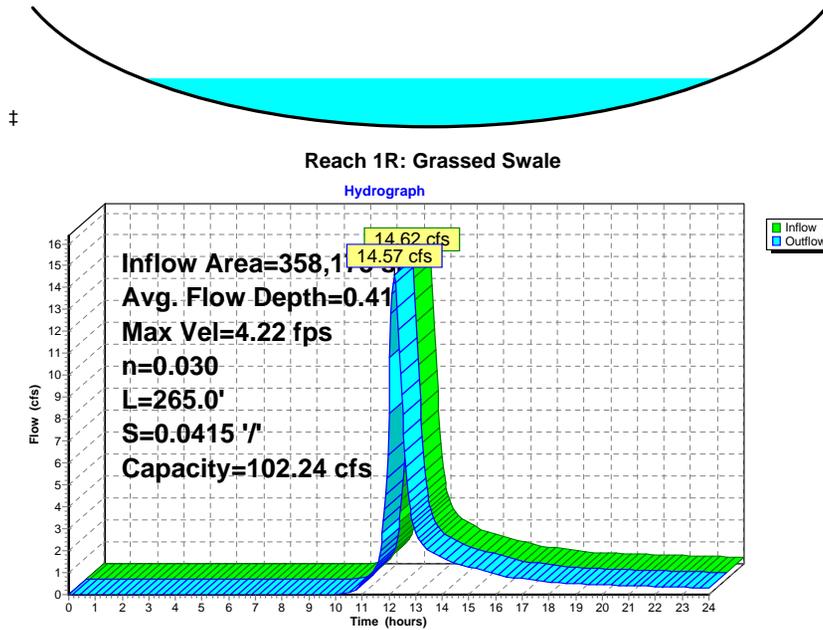
Summary for Reach 1R: Grassed Swale

Inflow Area = 358,173 sf, 33.14% Impervious, Inflow Depth > 2.34" for 25-Year event
 Inflow = 14.62 cfs @ 12.20 hrs, Volume= 69,762 cf
 Outflow = 14.57 cfs @ 12.22 hrs, Volume= 69,701 cf, Atten= 0%, Lag= 0.8 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Max. Velocity= 4.22 fps, Min. Travel Time= 1.0 min
 Avg. Velocity = 1.74 fps, Avg. Travel Time= 2.5 min

Peak Storage= 915 cf @ 12.22 hrs
 Average Depth at Peak Storage= 0.41'
 Bank-Full Depth= 1.00' Flow Area= 13.3 sf, Capacity= 102.24 cfs

20.00' x 1.00' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
 Length= 265.0' Slope= 0.0415 '/
 Inlet Invert= 120.00', Outlet Invert= 109.00'



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 84

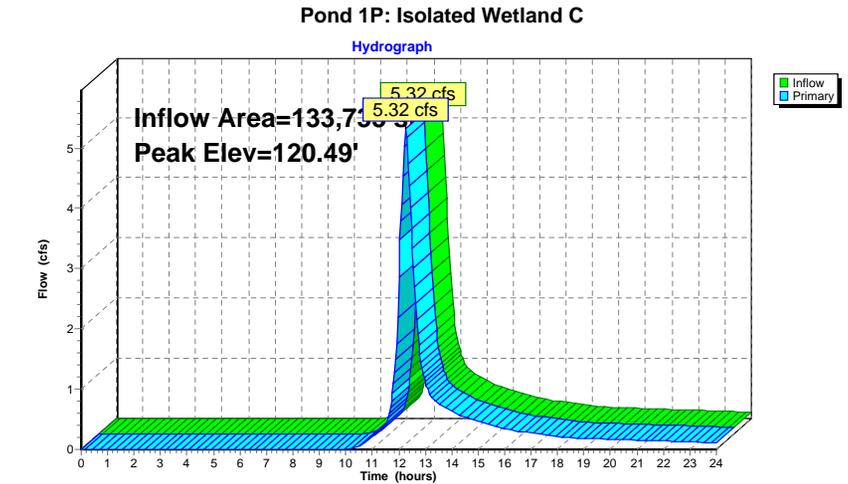
Summary for Pond 1P: Isolated Wetland C

Inflow Area = 133,733 sf, 32.67% Impervious, Inflow Depth > 2.31" for 25-Year event
 Inflow = 5.32 cfs @ 12.26 hrs, Volume= 25,796 cf
 Outflow = 5.32 cfs @ 12.26 hrs, Volume= 25,796 cf, Atten= 0%, Lag= 0.0 min
 Primary = 5.32 cfs @ 12.26 hrs, Volume= 25,796 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 120.49' @ 12.24 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	120.00'	10.0' long x 57.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=5.29 cfs @ 12.26 hrs HW=120.48' TW=120.40' (Dynamic Tailwater)
 #1=Broad-Crested Rectangular Weir (Weir Controls 5.29 cfs @ 1.09 fps)



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 85

Summary for Pond 2P: Isolated Wetland A

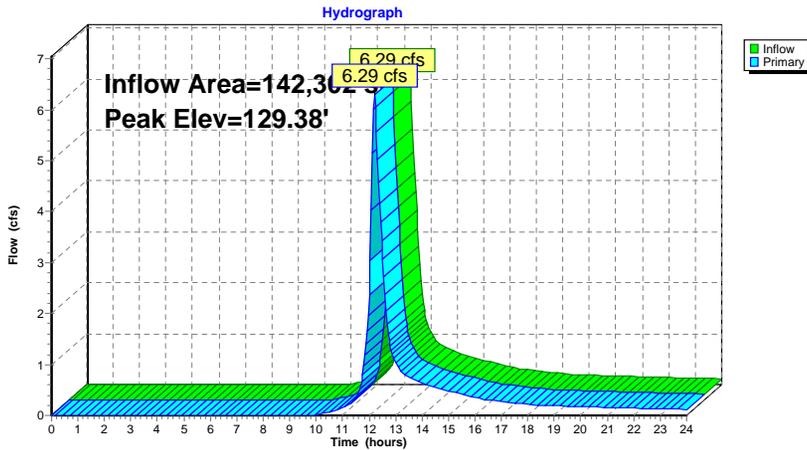
Inflow Area = 142,302 sf, 26.58% Impervious, Inflow Depth > 2.16" for 25-Year event
 Inflow = 6.29 cfs @ 12.20 hrs, Volume= 25,645 cf
 Outflow = 6.29 cfs @ 12.20 hrs, Volume= 25,645 cf, Atten= 0%, Lag= 0.0 min
 Primary = 6.29 cfs @ 12.20 hrs, Volume= 25,645 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 129.38' @ 12.20 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	129.00'	10.0' long x 214.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=6.28 cfs @ 12.20 hrs HW=129.38' TW=120.41' (Dynamic Tailwater)
 1=Broad-Crested Rectangular Weir (Weir Controls 6.28 cfs @ 1.66 fps)

Pond 2P: Isolated Wetland A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 86

Summary for Pond 3P: Isolated Wetland D

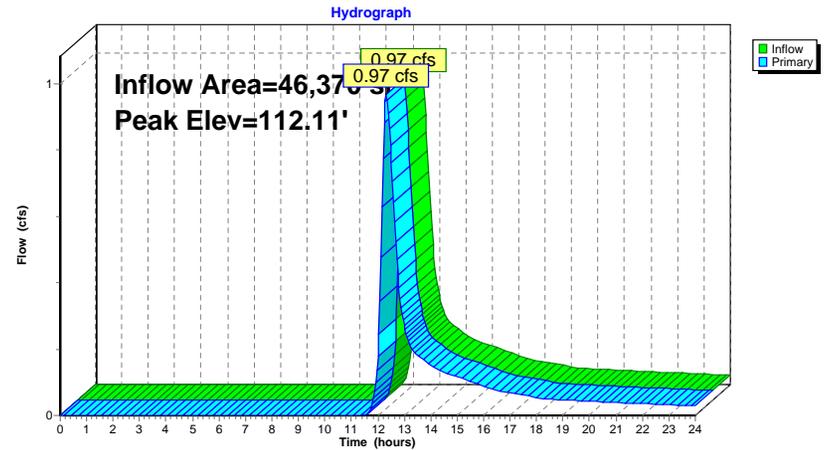
Inflow Area = 46,370 sf, 6.69% Impervious, Inflow Depth > 1.32" for 25-Year event
 Inflow = 0.97 cfs @ 12.32 hrs, Volume= 5,087 cf
 Outflow = 0.97 cfs @ 12.32 hrs, Volume= 5,087 cf, Atten= 0%, Lag= 0.0 min
 Primary = 0.97 cfs @ 12.32 hrs, Volume= 5,087 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 112.11' @ 12.32 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	10.0' long x 203.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=0.97 cfs @ 12.32 hrs HW=112.11' TW=104.29' (Dynamic Tailwater)
 1=Broad-Crested Rectangular Weir (Weir Controls 0.97 cfs @ 0.89 fps)

Pond 3P: Isolated Wetland D



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 87

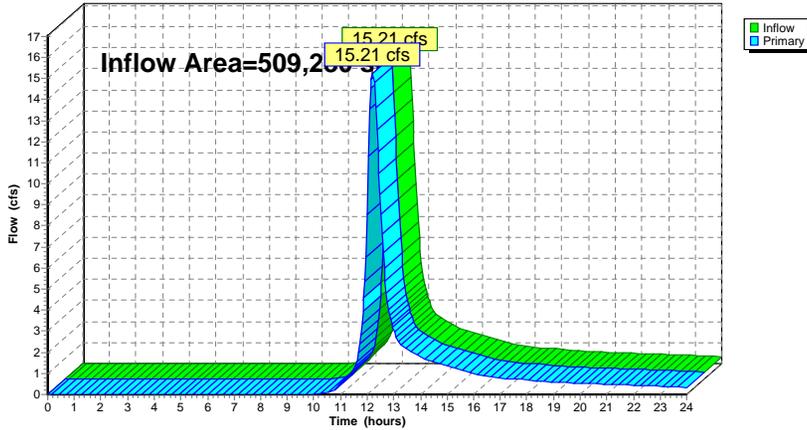
Summary for Pond 4P: BVW B

Inflow Area = 509,280 sf, 26.77% Impervious, Inflow Depth > 1.75" for 25-Year event
 Inflow = 15.21 cfs @ 12.21 hrs, Volume= 74,231 cf
 Primary = 15.21 cfs @ 12.21 hrs, Volume= 74,231 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Pond 4P: BVW B

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 88

Summary for Pond 5P: Basin 1

Inflow Area = 63,140 sf, 61.25% Impervious, Inflow Depth > 4.29" for 25-Year event
 Inflow = 6.87 cfs @ 12.06 hrs, Volume= 22,549 cf
 Outflow = 0.12 cfs @ 18.26 hrs, Volume= 3,965 cf, Atten= 98%, Lag= 372.0 min
 Discarded = 0.08 cfs @ 18.26 hrs, Volume= 3,562 cf
 Primary = 0.04 cfs @ 18.26 hrs, Volume= 403 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 105.76' @ 18.26 hrs Surf.Area= 8,723 sf Storage= 18,732 cf

Plug-Flow detention time= 515.2 min calculated for 3,958 cf (18% of inflow)
 Center-of-Mass det. time= 300.8 min (1,081.4 - 780.7)

Volume #1	Invert	Avail.Storage	Storage Description	
	103.00'	30,720 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
103.00	5,213	0	0	5,213
104.00	6,258	5,728	5,728	6,292
105.00	7,452	6,846	12,574	7,521
106.00	9,140	8,282	20,856	9,240
107.00	10,607	9,864	30,720	10,749

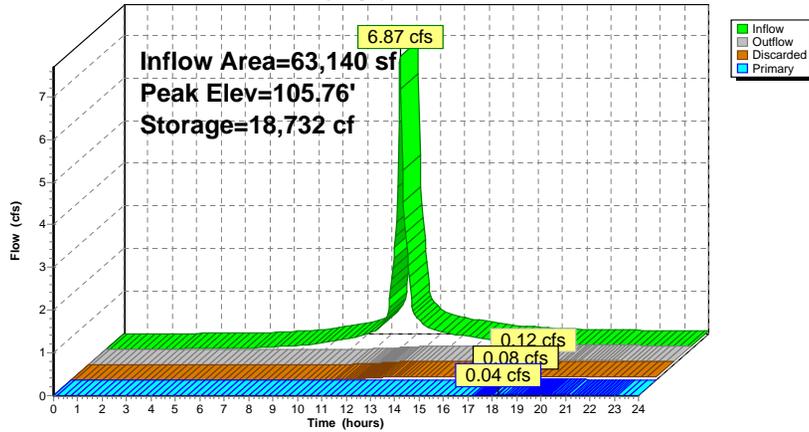
Device	Routing	Invert	Outlet Devices
#1	Primary	105.75'	10.0' long x 118.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	103.00'	1.020 in/hr Exfiltration over Surface area above 103.00' Excluded Surface area = 5,213 sf

Discarded OutFlow Max=0.08 cfs @ 18.26 hrs HW=105.76' (Free Discharge)
 ↳ **2=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.04 cfs @ 18.26 hrs HW=105.76' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Broad-Crested Rectangular Weir** (Weir Controls 0.04 cfs @ 0.30 fps)

Pond 5P: Basin 1

Hydrograph



Summary for Pond 6P: Basin 2

Inflow Area = 108,895 sf, 14.86% Impervious, Inflow Depth > 1.91" for 25-Year event
 Inflow = 2.95 cfs @ 12.25 hrs, Volume= 17,345 cf
 Outflow = 0.14 cfs @ 18.13 hrs, Volume= 3,830 cf, Atten= 95%, Lag= 353.0 min
 Discarded = 0.07 cfs @ 18.13 hrs, Volume= 2,768 cf
 Primary = 0.07 cfs @ 18.13 hrs, Volume= 1,061 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 105.52' @ 18.13 hrs Surf.Area= 7,064 sf Storage= 13,603 cf

Plug-Flow detention time= 475.7 min calculated for 3,830 cf (22% of inflow)
 Center-of-Mass det. time= 280.6 min (1,116.1 - 835.5)

Volume #	Invert	Avail.Storage	Storage Description		
#1	103.10'	25,458 cf	Custom Stage Data (Conic) Listed below (Recalc)		
	Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
	103.10	4,240	0	0	4,240
	104.00	5,256	4,265	4,265	5,279
	105.00	6,432	5,834	10,099	6,486
	106.00	7,675	7,044	17,143	7,764
	107.00	8,970	8,314	25,458	9,099

Device	Routing	Invert	Outlet Devices
#1	Discarded	103.10'	1.020 in/hr Exfiltration over Surface area above 103.10' Excluded Surface area = 4,240 sf
#2	Primary	105.50'	10.0' long x 43.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.07 cfs @ 18.13 hrs HW=105.52' (Free Discharge)
 ↳1=Exfiltration (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.07 cfs @ 18.13 hrs HW=105.52' TW=0.00' (Dynamic Tailwater)
 ↳2=Broad-Crested Rectangular Weir (Weir Controls 0.07 cfs @ 0.37 fps)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

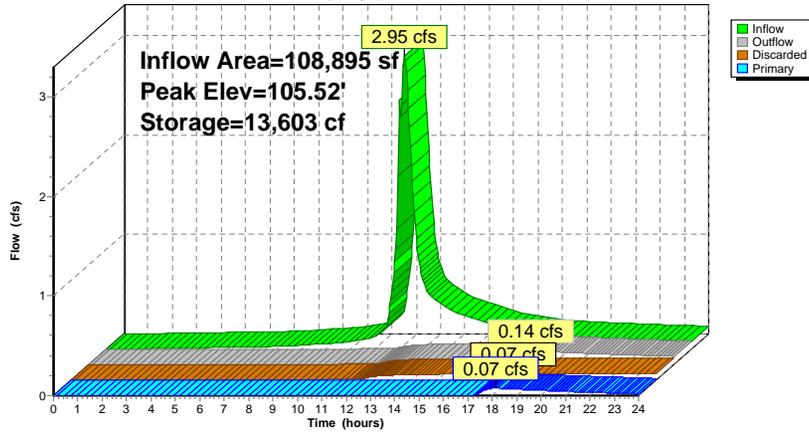
Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 91

Pond 6P: Basin 2

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 92

Summary for Pond 7P: Sediment Forebay

Inflow Area = 49,663 sf, 50.73% Impervious, Inflow Depth > 4.05" for 25-Year event
 Inflow = 5.38 cfs @ 12.07 hrs, Volume= 16,751 cf
 Outflow = 5.38 cfs @ 12.07 hrs, Volume= 16,751 cf, Atten= 0%, Lag= 0.0 min
 Primary = 5.38 cfs @ 12.07 hrs, Volume= 16,751 cf

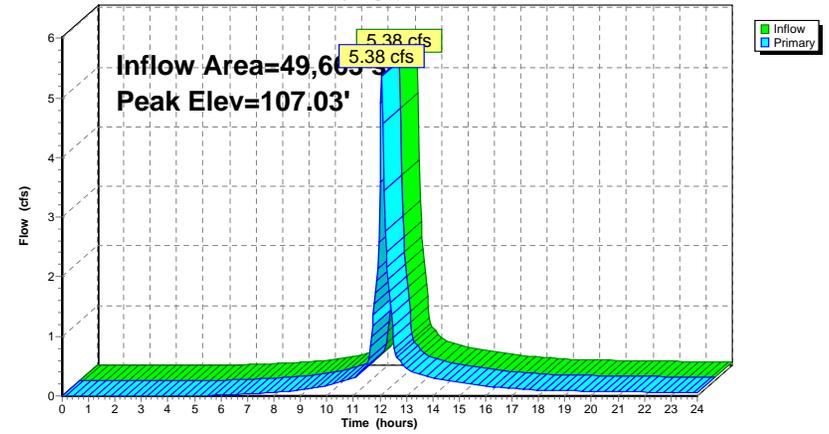
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 107.03' @ 12.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	106.50'	5.3' 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=5.31 cfs @ 12.07 hrs HW=107.02' TW=104.54' (Dynamic Tailwater)
 1=Broad-Crested Rectangular Weir (Weir Controls 5.31 cfs @ 1.91 fps)

Pond 7P: Sediment Forebay

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 93

Summary for Pond BA 1: Bioretention Area A

Inflow Area = 13,258 sf, 74.33% Impervious, Inflow Depth > 4.16" for 25-Year event
 Inflow = 1.60 cfs @ 12.03 hrs, Volume= 4,591 cf
 Outflow = 1.57 cfs @ 12.04 hrs, Volume= 4,110 cf, Atten= 2%, Lag= 0.9 min
 Primary = 1.57 cfs @ 12.04 hrs, Volume= 4,110 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 134.40' @ 12.04 hrs Surf.Area= 860 sf Storage= 601 cf

Plug-Flow detention time= 79.4 min calculated for 4,103 cf (89% of inflow)
 Center-of-Mass det. time= 29.9 min (817.5 - 787.6)

Volume	Invert	Avail.Storage	Storage Description	
#1	133.50'	1,201 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.50	481	0	0	481
134.00	690	291	291	694
135.00	1,150	910	1,201	1,167

Device	Routing	Invert	Outlet Devices
#1	Primary	134.25'	10.0' long x 15.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.55 cfs @ 12.04 hrs HW=134.40' TW=120.40' (Dynamic Tailwater)
 ↳=Broad-Crested Rectangular Weir (Weir Controls 1.55 cfs @ 1.04 fps)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

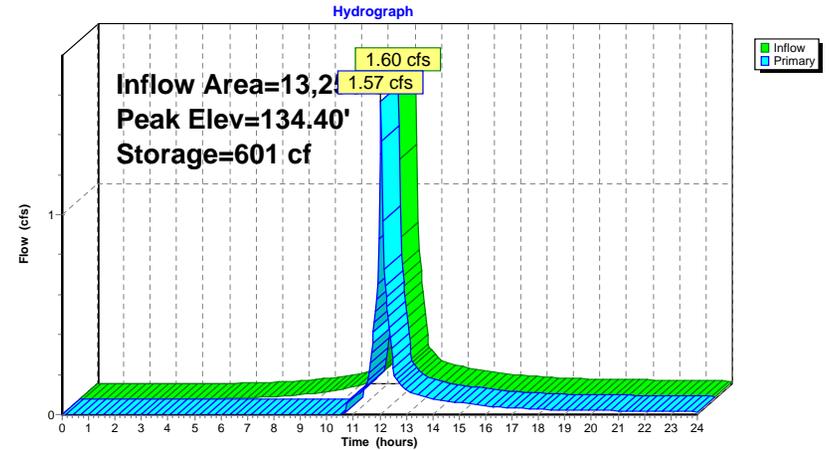
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 94

Pond BA 1: Bioretention Area A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 95

Summary for Pond BA 2: Bioretention Area B

Inflow Area = 47,211 sf, 72.90% Impervious, Inflow Depth > 4.05" for 25-Year event
 Inflow = 5.59 cfs @ 12.04 hrs, Volume= 15,931 cf
 Outflow = 5.11 cfs @ 12.07 hrs, Volume= 14,279 cf, Atten= 9%, Lag= 1.7 min
 Primary = 5.11 cfs @ 12.07 hrs, Volume= 14,279 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 125.63' @ 12.07 hrs Surf.Area= 2,114 sf Storage= 2,362 cf

Plug-Flow detention time= 79.1 min calculated for 14,255 cf (89% of inflow)
 Center-of-Mass det. time= 30.1 min (821.7 - 791.6)

Volume	Invert	Avail.Storage	Storage Description
#1	124.00'	3,205 cf	Custom Stage Data (Conic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet) Wet.Area (sq-ft)
124.00	898	0	0 898
125.00	1,548	1,208	1,208 1,560
126.00	2,482	1,997	3,205 2,507

Device	Routing	Invert	Outlet Devices
#1	Primary	125.25'	8.0' long x 75.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=4.98 cfs @ 12.07 hrs HW=125.63' TW=120.37' (Dynamic Tailwater)
 ↳=Broad-Crested Rectangular Weir (Weir Controls 4.98 cfs @ 1.65 fps)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

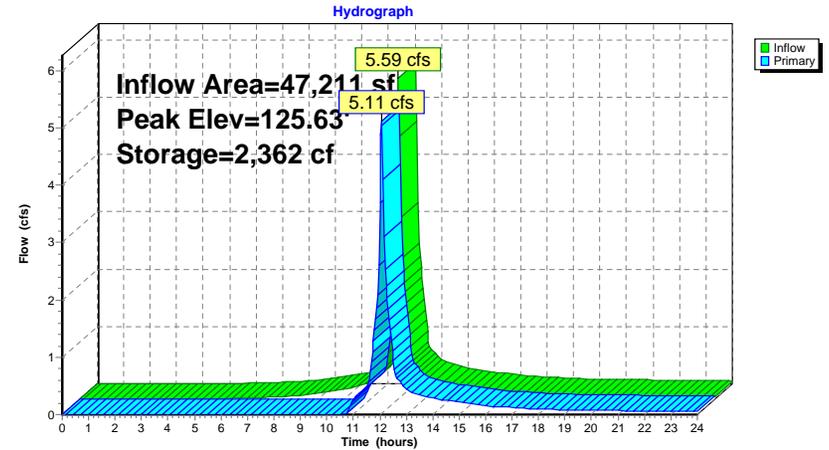
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 96

Pond BA 2: Bioretention Area B



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 25-Year Rainfall=5.40"

Printed 6/6/2016

Page 97

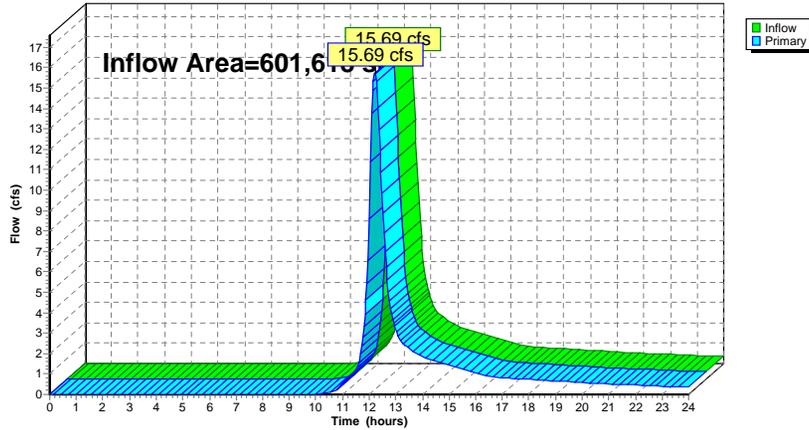
Summary for Pond POI 1: Northern Site

Inflow Area = 601,618 sf, 29.09% Impervious, Inflow Depth > 1.54" for 25-Year event
 Inflow = 15.69 cfs @ 12.21 hrs, Volume= 77,183 cf
 Primary = 15.69 cfs @ 12.21 hrs, Volume= 77,183 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Pond POI 1: Northern Site

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 98

Time span=0.00-24.00 hrs, dt=0.04 hrs, 601 points x 3

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1aS: In/Into IW C	Runoff Area=120,475 sf 28.08% Impervious Runoff Depth>4.29" Flow Length=809' Tc=18.6 min CN=68 Runoff=9.67 cfs 43,037 cf
Subcatchment 1bS: Driveway	Runoff Area=13,258 sf 74.33% Impervious Runoff Depth>6.76" Flow Length=262' Tc=1.6 min CN=89 Runoff=2.54 cfs 7,474 cf
Subcatchment 2aS: In/Into IW A	Runoff Area=142,302 sf 26.58% Impervious Runoff Depth>4.29" Flow Length=935' Tc=13.9 min CN=68 Runoff=12.77 cfs 50,886 cf
Subcatchment 2bS: Into Swale	Runoff Area=34,927 sf 7.90% Impervious Runoff Depth>3.16" Flow Length=214' Tc=16.8 min CN=58 Runoff=2.09 cfs 9,191 cf
Subcatchment 3S: In/Into IW D	Runoff Area=46,370 sf 6.69% Impervious Runoff Depth>3.04" Flow Length=443' Tc=20.1 min CN=57 Runoff=2.48 cfs 11,765 cf
Subcatchment 4aS: Eastern	Runoff Area=49,663 sf 50.73% Impervious Runoff Depth>6.64" Tc=5.0 min CN=88 Runoff=8.59 cfs 27,491 cf
Subcatchment 4bS: Eastern Building	Runoff Area=13,477 sf 100.00% Impervious Runoff Depth>7.84" Flow Length=300' Slope=0.0050 '/' Tc=1.6 min CN=98 Runoff=2.74 cfs 8,805 cf
Subcatchment 5S: Outside Resources Areas	Runoff Area=29,198 sf 0.00% Impervious Runoff Depth>2.61" Flow Length=379' Tc=14.9 min CN=53 Runoff=1.46 cfs 6,354 cf
Subcatchment 6S: Cul-de-sac & Parking	Runoff Area=47,211 sf 72.90% Impervious Runoff Depth>6.65" Flow Length=369' Tc=2.3 min CN=88 Runoff=8.92 cfs 26,144 cf
Subcatchment 7aS: Western site	Runoff Area=49,439 sf 0.00% Impervious Runoff Depth>3.49" Flow Length=345' Tc=15.8 min CN=61 Runoff=3.39 cfs 14,394 cf
Subcatchment 7bS: Western Building	Runoff Area=13,086 sf 100.00% Impervious Runoff Depth>7.84" Flow Length=236' Slope=0.0050 '/' Tc=1.2 min CN=98 Runoff=2.67 cfs 8,549 cf
Subcatchment 8S: In/Into BVW B	Runoff Area=42,212 sf 3.42% Impervious Runoff Depth>2.51" Flow Length=363' Tc=6.7 min CN=52 Runoff=2.58 cfs 8,826 cf
Reach 1R: Grassed Swale	Avg. Flow Depth=0.56' Max Vel=5.19 fps Inflow=28.76 cfs 134,588 cf n=0.030 L=265.0' S=0.0415 '/' Capacity=102.24 cfs Outflow=28.69 cfs 134,500 cf
Pond 1P: Isolated Wetland C	Peak Elev=120.72' Inflow=10.55 cfs 50,028 cf Outflow=10.55 cfs 50,028 cf
Pond 2P: Isolated Wetland A	Peak Elev=129.61' Inflow=12.77 cfs 50,886 cf Outflow=12.77 cfs 50,886 cf
Pond 3P: Isolated Wetland D	Peak Elev=112.20' Inflow=2.48 cfs 11,765 cf Outflow=2.48 cfs 11,765 cf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 99

Pond 4P: BVW B

Inflow=30.49 cfs 161,335 cf
Primary=30.49 cfs 161,335 cf

Pond 5P: Basin 1

Peak Elev=105.98' Storage=20,630 cf Inflow=10.86 cfs 36,295 cf
Discarded=0.09 cfs 3,959 cf Primary=2.87 cfs 13,630 cf Outflow=2.96 cfs 17,589 cf

Pond 6P: Basin 2

Peak Elev=105.75' Storage=15,240 cf Inflow=6.65 cfs 34,708 cf
Discarded=0.07 cfs 3,092 cf Primary=3.29 cfs 18,009 cf Outflow=3.36 cfs 21,101 cf

Pond 7P: Sediment Forebay

Peak Elev=107.21' Inflow=8.59 cfs 27,491 cf
Outflow=8.59 cfs 27,491 cf

Pond BA 1: Bioretention Area A

Peak Elev=134.46' Storage=649 cf Inflow=2.54 cfs 7,474 cf
Outflow=2.49 cfs 6,991 cf

Pond BA 2: Bioretention Area B

Peak Elev=125.78' Storage=2,675 cf Inflow=8.92 cfs 26,144 cf
Outflow=8.23 cfs 24,482 cf

Pond POI 1: Northern Site

Inflow=32.86 cfs 181,319 cf
Primary=32.86 cfs 181,319 cf

Total Runoff Area = 601,618 sf Runoff Volume = 222,917 cf Average Runoff Depth = 4.45"
70.91% Pervious = 426,630 sf 29.09% Impervious = 174,988 sf

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 100

Summary for Subcatchment 1aS: In/Into IW C

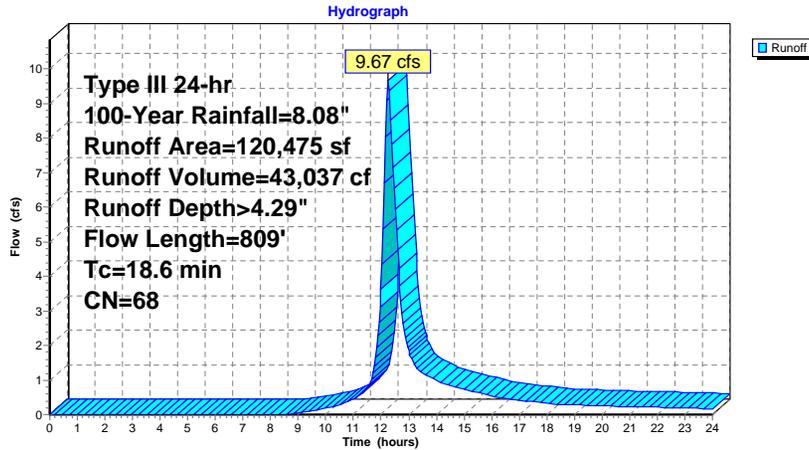
Runoff = 9.67 cfs @ 12.26 hrs, Volume= 43,037 cf, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
9,382	98	Paved driveways & Roofs
10,413	55	Woods, Good, HSG B
46,780	61	>75% Grass cover, Good, HSG B
29,453	48	Brush, Good, HSG B
24,447	98	Wetland
120,475	68	Weighted Average
86,646		71.92% Pervious Area
33,829		28.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	90	0.0528	0.25		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.4	10	0.0500	0.07		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
1.0	63	0.0476	1.09		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.9	174	0.0488	1.55		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.9	55	0.0273	0.99		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
6.3	417	0.0336	1.10		Shallow Concentrated Flow, Heavy Brush Kv= 6.0 fps
18.6	809				Total

Subcatchment 1aS: In/Into IW C



Summary for Subcatchment 1bS: Driveway

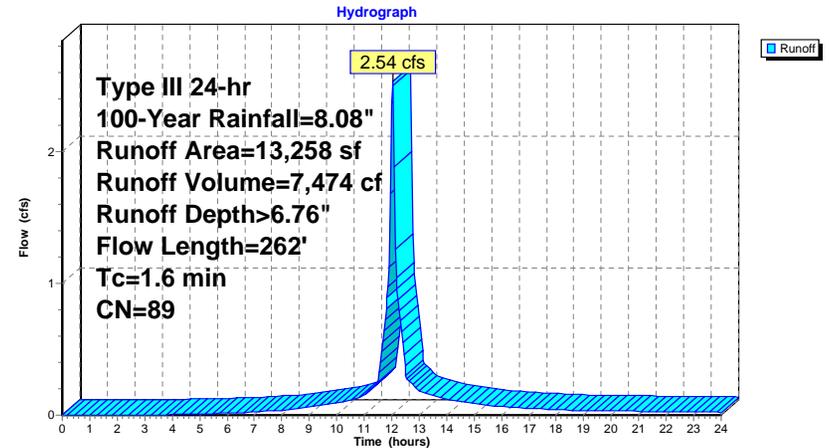
Runoff = 2.54 cfs @ 12.03 hrs, Volume= 7,474 cf, Depth> 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
8,705	98	Paved driveway & Sidewalk
3,403	61	>75% Grass cover, Good, HSG B
1,150	98	Water Surface, HSG B
13,258	89	Weighted Average
3,403		25.67% Pervious Area
9,855		74.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	100	0.0350	1.72		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.6	162	0.0482	4.46		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.6	262				Total

Subcatchment 1bS: Driveway



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 103

Summary for Subcatchment 2aS: In/Into IW A

Runoff = 12.77 cfs @ 12.20 hrs, Volume= 50,886 cf, Depth> 4.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
* 9,125	98	Wetland
768	48	Brush, Good, HSG B
59,412	55	Woods, Good, HSG B
* 28,704	98	Paved driveways and Roofs
44,293	61	>75% Grass cover, Good, HSG B
142,302	68	Weighted Average
104,473		73.42% Pervious Area
37,829		26.58% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0200	1.38		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.8	164	0.0300	3.52		Shallow Concentrated Flow, Paved Kv= 20.3 fps
1.1	101	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
3.3	239	0.0593	1.22		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
7.5	331	0.0219	0.74		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
13.9	935	Total			

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

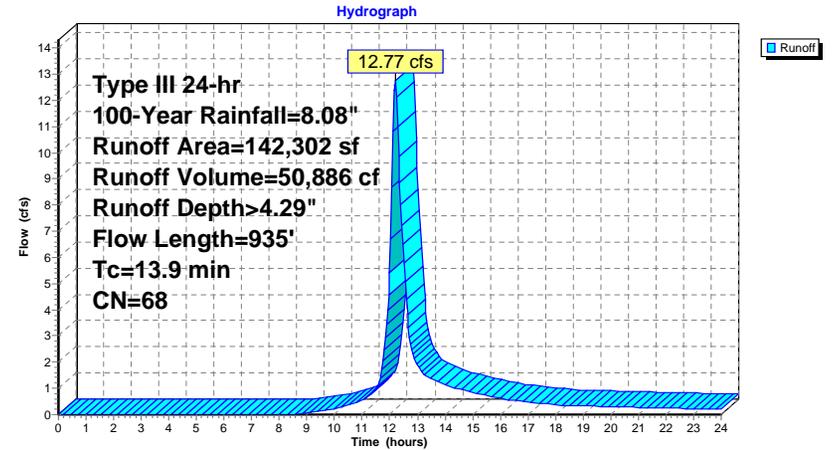
HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 104

Subcatchment 2aS: In/Into IW A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 105

Summary for Subcatchment 2bS: Into Swale

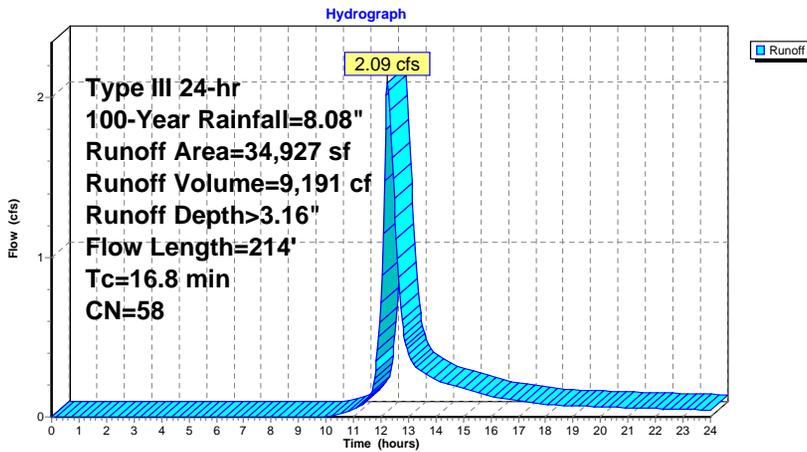
Runoff = 2.09 cfs @ 12.24 hrs, Volume= 9,191 cf, Depth> 3.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
* 2,759	98	Patio & Sidewalk
745	55	Woods, Good, HSG B
16,214	48	Brush, Good, HSG B
15,209	61	>75% Grass cover, Good, HSG B
34,927	58	Weighted Average
32,168		92.10% Pervious Area
2,759		7.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	100	0.0450	0.11		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.0	114	0.0746	1.91		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
16.8	214	Total			

Subcatchment 2bS: Into Swale



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 106

Summary for Subcatchment 3S: In/Into IW D

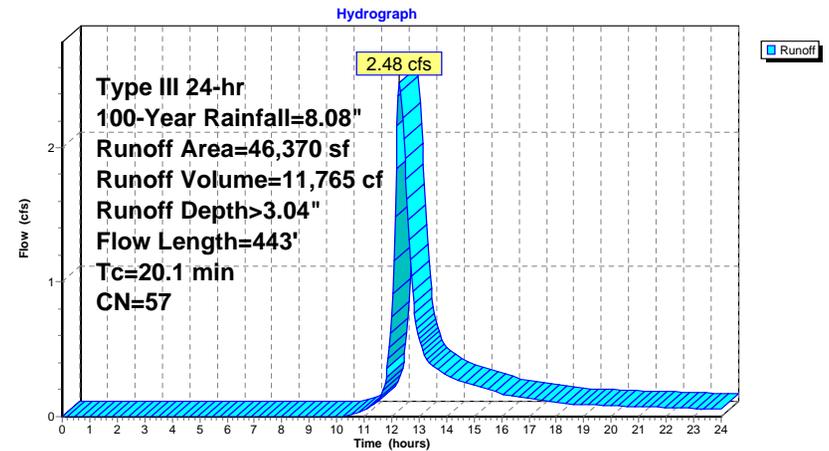
Runoff = 2.48 cfs @ 12.29 hrs, Volume= 11,765 cf, Depth> 3.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
* 3,100	98	Wetland
36,667	55	Woods, Good, HSG B
6,603	48	Brush, Good, HSG B
46,370	57	Weighted Average
43,270		93.31% Pervious Area
3,100		6.69% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.7	100	0.0511	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.21"
4.0	272	0.0511	1.13		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
1.4	71	0.0141	0.83		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
20.1	443	Total			

Subcatchment 3S: In/Into IW D



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 107

Summary for Subcatchment 4aS: Eastern Driveway/Back Parking Area

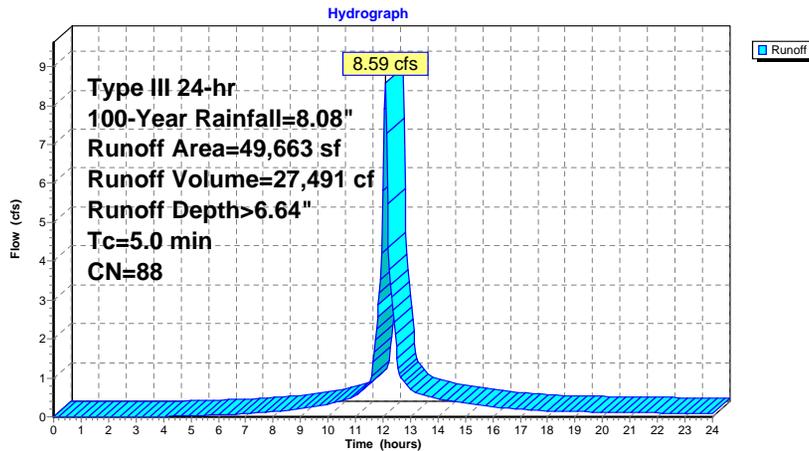
Runoff = 8.59 cfs @ 12.07 hrs, Volume= 27,491 cf, Depth> 6.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
13,723	61	>75% Grass cover, Good, HSG B
* 25,194	98	Paved Areas
10,746	98	Water Surface, 0% imp, HSG B
49,663	88	Weighted Average
24,469		49.27% Pervious Area
25,194		50.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4aS: Eastern Driveway/Back Parking Area



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 108

Summary for Subcatchment 4bS: Eastern Building

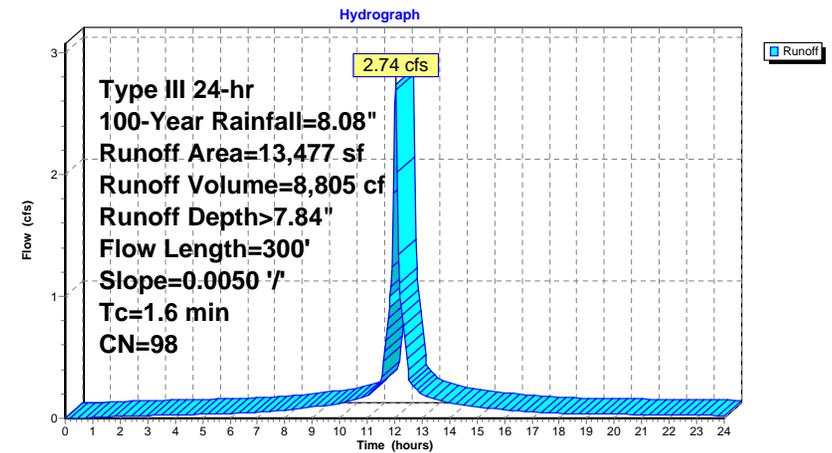
Runoff = 2.74 cfs @ 12.03 hrs, Volume= 8,805 cf, Depth> 7.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
13,477	98	Roofs, HSG B
13,477		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	300	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 4bS: Eastern Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 109

Summary for Subcatchment 5S: Outside Resources Areas

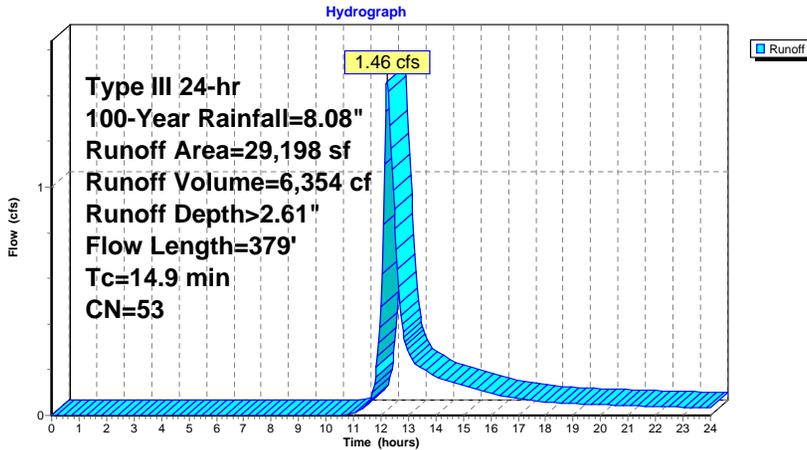
Runoff = 1.46 cfs @ 12.22 hrs, Volume= 6,354 cf, Depth> 2.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
9,482	55	Woods, Good, HSG B
6,631	61	>75% Grass cover, Good, HSG B
13,085	48	Brush, Good, HSG B
29,198	53	Weighted Average
29,198		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	61	0.0787	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
7.9	39	0.0385	0.08		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
2.9	253	0.0435	1.46		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
0.3	26	0.0769	1.39		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
14.9	379	Total			

Subcatchment 5S: Outside Resources Areas



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 110

Summary for Subcatchment 6S: Cul-de-sac & Parking Lot

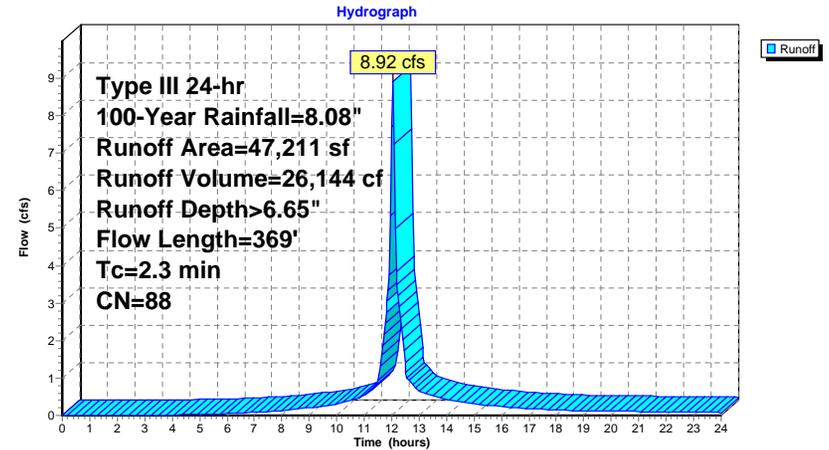
Runoff = 8.92 cfs @ 12.04 hrs, Volume= 26,144 cf, Depth> 6.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
32,287	98	Paved Area
12,795	61	>75% Grass cover, Good, HSG B
2,129	98	Water Surface, HSG B
47,211	88	Weighted Average
12,795		27.10% Pervious Area
34,416		72.90% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	100	0.0225	1.44		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
0.9	202	0.0334	3.71		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.2	67	0.0224	6.79	5.33	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
2.3	369	Total			

Subcatchment 6S: Cul-de-sac & Parking Lot



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 111

Summary for Subcatchment 7aS: Western site

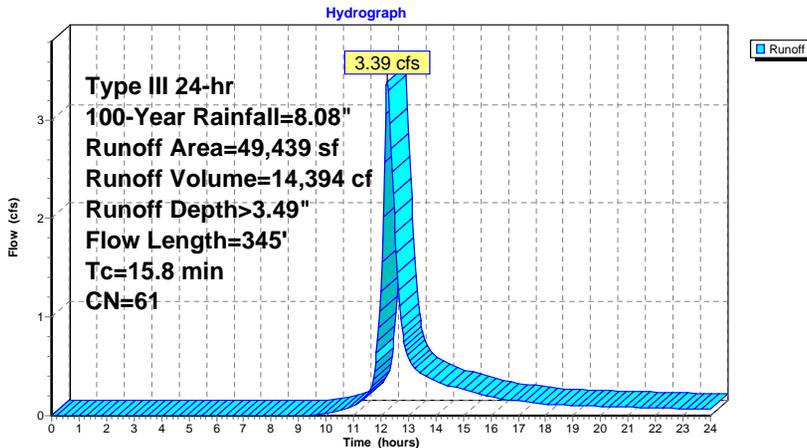
Runoff = 3.39 cfs @ 12.23 hrs, Volume= 14,394 cf, Depth> 3.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
6,531	61	>75% Grass cover, Good, HSG B
16,065	55	Woods, Good, HSG B
17,873	48	Brush, Good, HSG B
8,970	98	Water Surface, 0% imp, HSG B
49,439	61	Weighted Average
49,439		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	100	0.0700	0.13		Sheet Flow, Grass: Bermuda n= 0.410 P2= 3.21"
1.6	105	0.0238	1.08		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
1.0	140	0.0250	2.37		Shallow Concentrated Flow, Grassed Waterway Kv= 15.0 fps
15.8	345				Total

Subcatchment 7aS: Western site



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 112

Summary for Subcatchment 7bS: Western Building

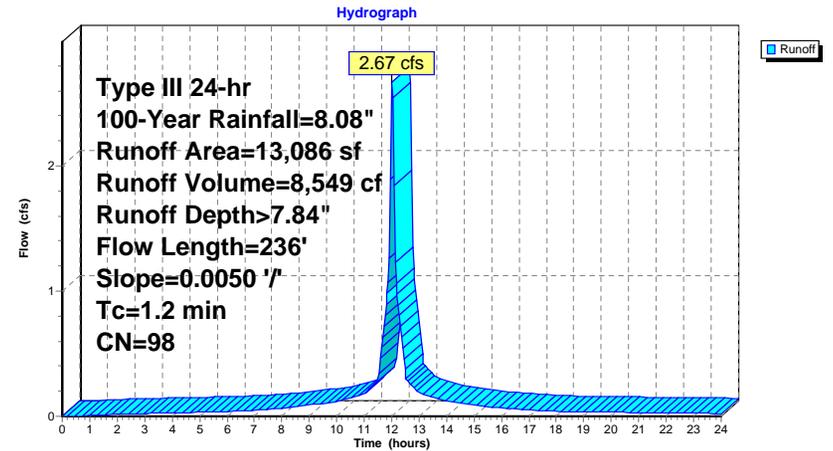
Runoff = 2.67 cfs @ 12.02 hrs, Volume= 8,549 cf, Depth> 7.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
13,086	98	Roofs, HSG B
13,086		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	236	0.0050	3.21	2.52	Pipe Channel, 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior

Subcatchment 7bS: Western Building



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 113

Summary for Subcatchment 8S: In/Into BVW B

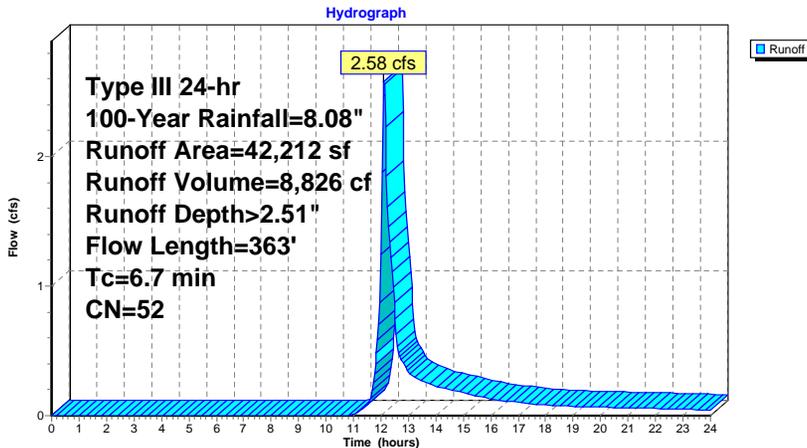
Runoff = 2.58 cfs @ 12.11 hrs, Volume= 8,826 cf, Depth> 2.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs
Type III 24-hr 100-Year Rainfall=8.08"

Area (sf)	CN	Description
1,443	98	Patio & Sidewalks
9,042	61	>75% Grass cover, Good, HSG B
31,727	48	Brush, Good, HSG B
42,212	52	Weighted Average
40,769		96.58% Pervious Area
1,443		3.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	52	0.0100	0.92		Sheet Flow, Smooth surfaces n= 0.011 P2= 3.21"
2.9	48	0.0937	0.27		Sheet Flow, Grass: Short n= 0.150 P2= 3.21"
2.9	263	0.0456	1.49		Shallow Concentrated Flow, Heavy Brush Kv= 7.0 fps
6.7	363	Total			

Subcatchment 8S: In/Into BVW B



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 114

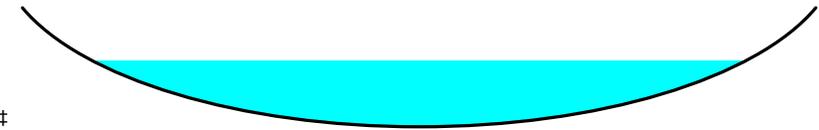
Summary for Reach 1R: Grassed Swale

Inflow Area = 358,173 sf, 33.14% Impervious, Inflow Depth > 4.51" for 100-Year event
Inflow = 28.76 cfs @ 12.20 hrs, Volume= 134,588 cf
Outflow = 28.69 cfs @ 12.21 hrs, Volume= 134,500 cf, Atten= 0%, Lag= 0.6 min

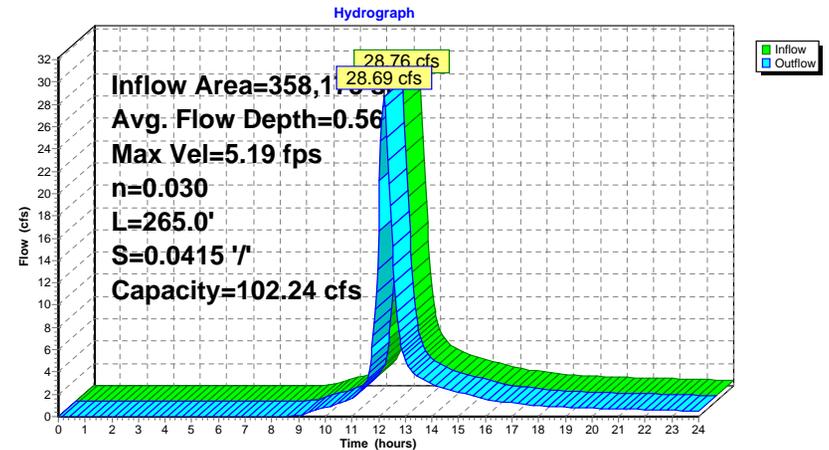
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
Max. Velocity= 5.19 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 2.04 fps, Avg. Travel Time= 2.2 min

Peak Storage= 1,464 cf @ 12.21 hrs
Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 1.00' Flow Area= 13.3 sf, Capacity= 102.24 cfs

20.00' x 1.00' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
Length= 265.0' Slope= 0.0415 '/
Inlet Invert= 120.00', Outlet Invert= 109.00'



Reach 1R: Grassed Swale



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 115

Summary for Pond 1P: Isolated Wetland C

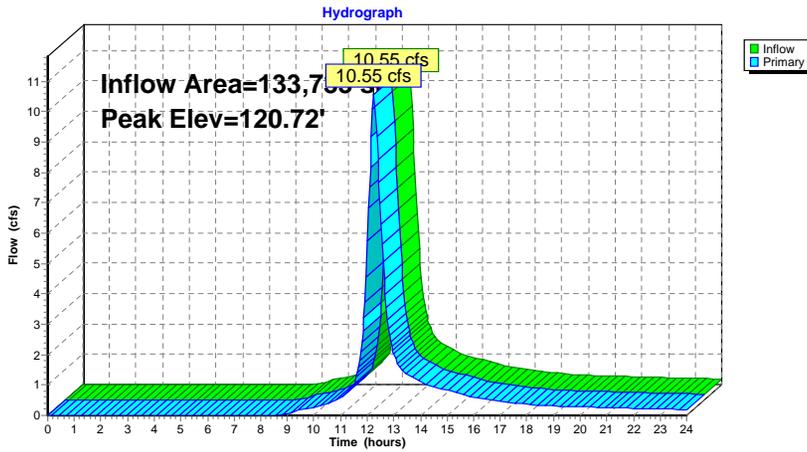
Inflow Area = 133,733 sf, 32.67% Impervious, Inflow Depth > 4.49" for 100-Year event
 Inflow = 10.55 cfs @ 12.25 hrs, Volume= 50,028 cf
 Outflow = 10.55 cfs @ 12.25 hrs, Volume= 50,028 cf, Atten= 0%, Lag= 0.0 min
 Primary = 10.55 cfs @ 12.25 hrs, Volume= 50,028 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 120.72' @ 12.24 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	120.00'	10.0' long x 57.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=10.49 cfs @ 12.25 hrs HW=120.72' TW=120.55' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 10.49 cfs @ 1.47 fps)

Pond 1P: Isolated Wetland C



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 116

Summary for Pond 2P: Isolated Wetland A

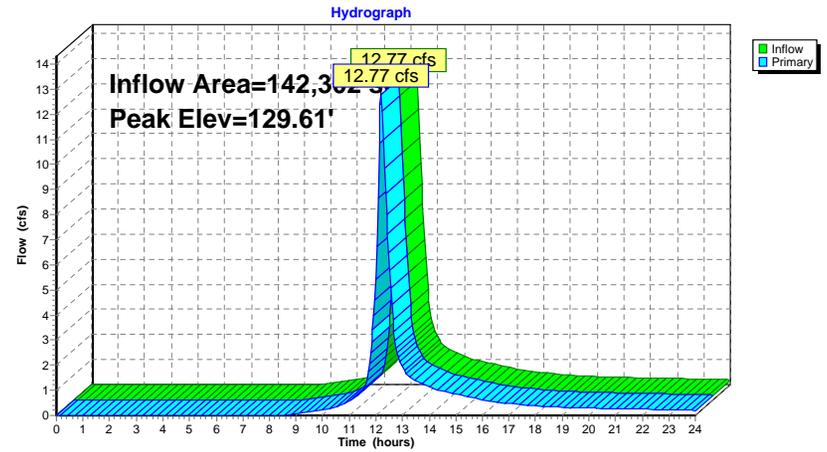
Inflow Area = 142,302 sf, 26.58% Impervious, Inflow Depth > 4.29" for 100-Year event
 Inflow = 12.77 cfs @ 12.20 hrs, Volume= 50,886 cf
 Outflow = 12.77 cfs @ 12.20 hrs, Volume= 50,886 cf, Atten= 0%, Lag= 0.0 min
 Primary = 12.77 cfs @ 12.20 hrs, Volume= 50,886 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 129.61' @ 12.20 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	129.00'	10.0' long x 214.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=12.72 cfs @ 12.20 hrs HW=129.61' TW=120.55' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 12.72 cfs @ 2.10 fps)

Pond 2P: Isolated Wetland A



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 117

Summary for Pond 3P: Isolated Wetland D

Inflow Area = 46,370 sf, 6.69% Impervious, Inflow Depth > 3.04" for 100-Year event
 Inflow = 2.48 cfs @ 12.29 hrs, Volume= 11,765 cf
 Outflow = 2.48 cfs @ 12.29 hrs, Volume= 11,765 cf, Atten= 0%, Lag= 0.0 min
 Primary = 2.48 cfs @ 12.29 hrs, Volume= 11,765 cf

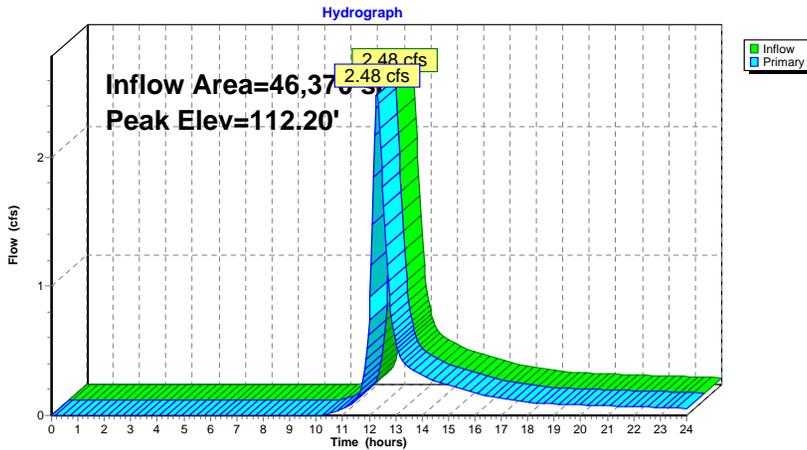
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Peak Elev= 112.20' @ 12.29 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	10.0' long x 203.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.47 cfs @ 12.29 hrs HW=112.20' TW=105.29' (Dynamic Tailwater)
 ←1=Broad-Crested Rectangular Weir (Weir Controls 2.47 cfs @ 1.21 fps)

Pond 3P: Isolated Wetland D



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

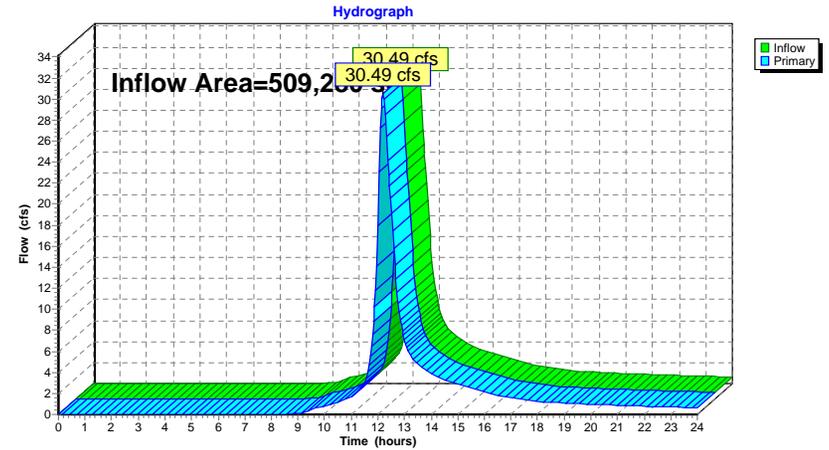
Page 118

Summary for Pond 4P: BVW B

Inflow Area = 509,280 sf, 26.77% Impervious, Inflow Depth > 3.80" for 100-Year event
 Inflow = 30.49 cfs @ 12.20 hrs, Volume= 161,335 cf
 Primary = 30.49 cfs @ 12.20 hrs, Volume= 161,335 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Pond 4P: BVW B



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 119

Summary for Pond 5P: Basin 1

Inflow Area = 63,140 sf, 61.25% Impervious, Inflow Depth > 6.90" for 100-Year event
 Inflow = 10.86 cfs @ 12.06 hrs, Volume= 36,295 cf
 Outflow = 2.96 cfs @ 12.41 hrs, Volume= 17,589 cf, Atten= 73%, Lag= 20.9 min
 Discarded = 0.09 cfs @ 12.41 hrs, Volume= 3,959 cf
 Primary = 2.87 cfs @ 12.41 hrs, Volume= 13,630 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 105.98' @ 12.41 hrs Surf.Area= 9,096 sf Storage= 20,630 cf

Plug-Flow detention time= 255.6 min calculated for 17,560 cf (48% of inflow)
 Center-of-Mass det. time= 134.6 min (904.5 - 769.9)

Volume	Invert	Avail.Storage	Storage Description	
#1	103.00'	30,720 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
103.00	5,213	0	0	5,213
104.00	6,258	5,728	5,728	6,292
105.00	7,452	6,846	12,574	7,521
106.00	9,140	8,282	20,856	9,240
107.00	10,607	9,864	30,720	10,749

Device	Routing	Invert	Outlet Devices
#1	Primary	105.75'	10.0' long x 118.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63
#2	Discarded	103.00'	1.020 in/hr Exfiltration over Surface area above 103.00' Excluded Surface area = 5,213 sf

Discarded OutFlow Max=0.09 cfs @ 12.41 hrs HW=105.97' (Free Discharge)
 ↳ **2=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=2.86 cfs @ 12.41 hrs HW=105.97' TW=0.00' (Dynamic Tailwater)
 ↳ **1=Broad-Crested Rectangular Weir** (Weir Controls 2.86 cfs @ 1.27 fps)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

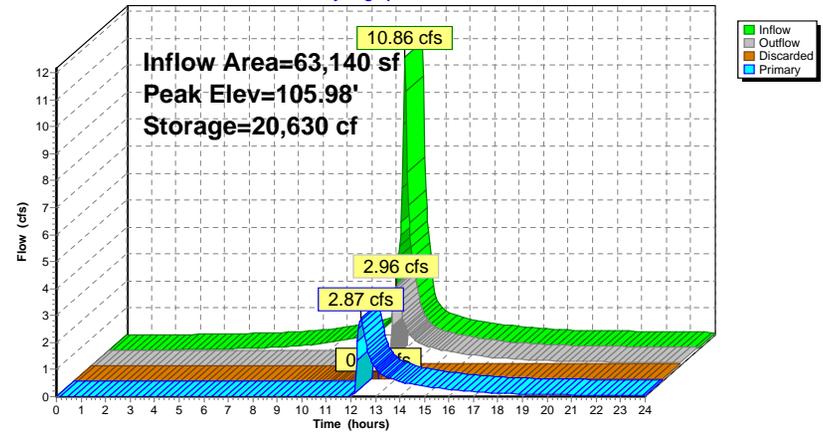
Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 120

Pond 5P: Basin 1

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 121

Summary for Pond 6P: Basin 2

Inflow Area = 108,895 sf, 14.86% Impervious, Inflow Depth > 3.82" for 100-Year event
 Inflow = 6.65 cfs @ 12.24 hrs, Volume= 34,708 cf
 Outflow = 3.36 cfs @ 12.58 hrs, Volume= 21,101 cf, Atten= 49%, Lag= 20.5 min
 Discarded = 0.07 cfs @ 12.58 hrs, Volume= 3,092 cf
 Primary = 3.29 cfs @ 12.58 hrs, Volume= 18,009 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 105.75' @ 12.58 hrs Surf.Area= 7,350 sf Storage= 15,240 cf

Plug-Flow detention time= 213.3 min calculated for 21,101 cf (61% of inflow)
 Center-of-Mass det. time= 98.2 min (924.8 - 826.5)

Volume	Invert	Avail.Storage	Storage Description	
#1	103.10'	25,458 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
103.10	4,240	0	0	4,240
104.00	5,256	4,265	4,265	5,279
105.00	6,432	5,834	10,099	6,486
106.00	7,675	7,044	17,143	7,764
107.00	8,970	8,314	25,458	9,099

Device	Routing	Invert	Outlet Devices
#1	Discarded	103.10'	1.020 in/hr Exfiltration over Surface area above 103.10' Excluded Surface area = 4,240 sf
#2	Primary	105.50'	10.0' long x 43.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.07 cfs @ 12.58 hrs HW=105.75' (Free Discharge)
 ↳1=Exfiltration (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=3.27 cfs @ 12.58 hrs HW=105.75' TW=0.00' (Dynamic Tailwater)
 ↳2=Broad-Crested Rectangular Weir (Weir Controls 3.27 cfs @ 1.33 fps)

Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

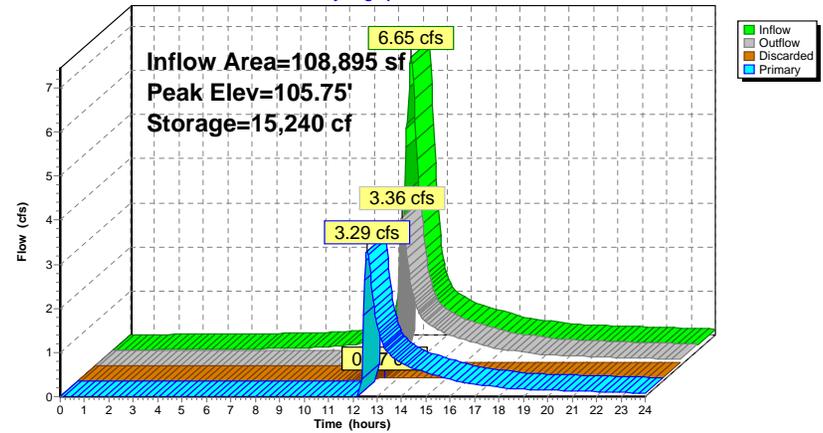
Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 122

Pond 6P: Basin 2

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 123

Summary for Pond 7P: Sediment Forebay

Inflow Area = 49,663 sf, 50.73% Impervious, Inflow Depth > 6.64" for 100-Year event
 Inflow = 8.59 cfs @ 12.07 hrs, Volume= 27,491 cf
 Outflow = 8.59 cfs @ 12.07 hrs, Volume= 27,491 cf, Atten= 0%, Lag= 0.0 min
 Primary = 8.59 cfs @ 12.07 hrs, Volume= 27,491 cf

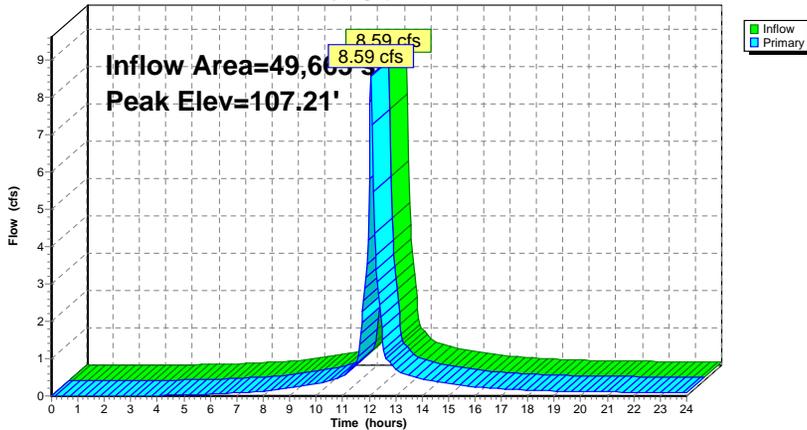
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 107.21' @ 12.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	106.50'	5.3' 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 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=8.46 cfs @ 12.07 hrs HW=107.21' TW=105.41' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 8.46 cfs @ 2.26 fps)

Pond 7P: Sediment Forebay

Hydrograph



Haverhill Proposed Model 160525

Prepared by Weston & Sampson

HydroCAD® 10.00-11 s/n 00455 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 100-Year Rainfall=8.08"

Printed 6/6/2016

Page 124

Summary for Pond BA 1: Bioretention Area A

Inflow Area = 13,258 sf, 74.33% Impervious, Inflow Depth > 6.76" for 100-Year event
 Inflow = 2.54 cfs @ 12.03 hrs, Volume= 7,474 cf
 Outflow = 2.49 cfs @ 12.04 hrs, Volume= 6,991 cf, Atten= 2%, Lag= 0.8 min
 Primary = 2.49 cfs @ 12.04 hrs, Volume= 6,991 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 134.46' @ 12.04 hrs Surf.Area= 885 sf Storage= 649 cf

Plug-Flow detention time= 58.4 min calculated for 6,979 cf (93% of inflow)
 Center-of-Mass det. time= 24.0 min (798.7 - 774.6)

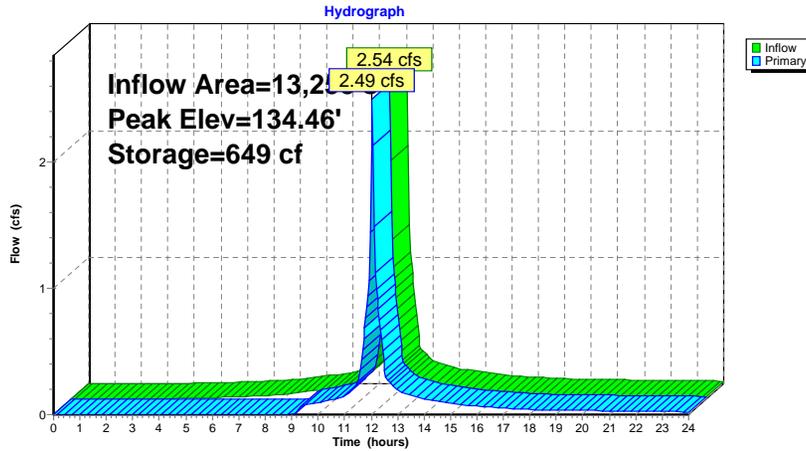
Volume	Invert	Avail.Storage	Storage Description
#1	133.50'	1,201 cf	Custom Stage Data (Conic) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
133.50	481	0	0	481
134.00	690	291	291	694
135.00	1,150	910	1,201	1,167

Device	Routing	Invert	Outlet Devices
#1	Primary	134.25'	10.0' long x 15.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.49 cfs @ 12.04 hrs HW=134.46' TW=120.58' (Dynamic Tailwater)
 ↳1=Broad-Crested Rectangular Weir (Weir Controls 2.49 cfs @ 1.21 fps)

Pond BA 1: Bioretention Area A



Summary for Pond BA 2: Bioretention Area B

Inflow Area = 47,211 sf, 72.90% Impervious, Inflow Depth > 6.65" for 100-Year event
 Inflow = 8.92 cfs @ 12.04 hrs, Volume= 26,144 cf
 Outflow = 8.23 cfs @ 12.06 hrs, Volume= 24,482 cf, Atten= 8%, Lag= 1.5 min
 Primary = 8.23 cfs @ 12.06 hrs, Volume= 24,482 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3
 Peak Elev= 125.78' @ 12.06 hrs Surf.Area= 2,254 sf Storage= 2,675 cf

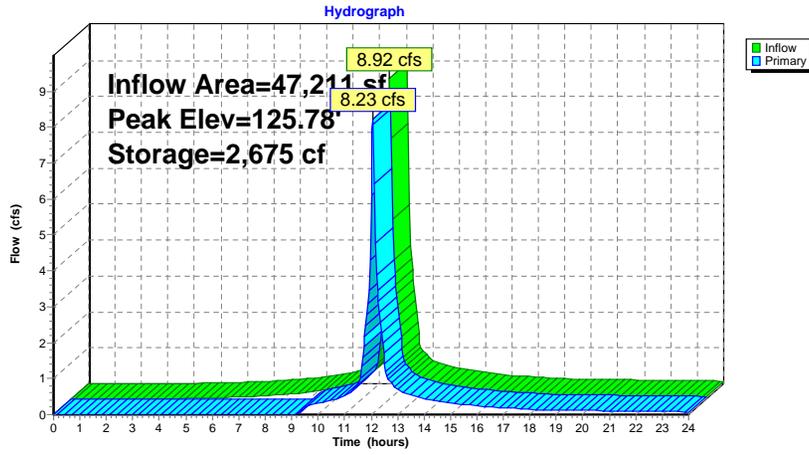
Plug-Flow detention time= 58.5 min calculated for 24,482 cf (94% of inflow)
 Center-of-Mass det. time= 24.2 min (802.5 - 778.2)

Volume	Invert	Avail.Storage	Storage Description	
#1	124.00'	3,205 cf	Custom Stage Data (Conic) Listed below (Recalc)	
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
124.00	898	0	0	898
125.00	1,548	1,208	1,208	1,560
126.00	2,482	1,997	3,205	2,507

Device	Routing	Invert	Outlet Devices
#1	Primary	125.25'	8.0' long x 75.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=8.02 cfs @ 12.06 hrs HW=125.77' TW=120.50' (Dynamic Tailwater)
 ↳=Broad-Crested Rectangular Weir (Weir Controls 8.02 cfs @ 1.94 fps)

Pond BA 2: Bioretention Area B



Summary for Pond POI 1: Northern Site

Inflow Area = 601,618 sf, 29.09% Impervious, Inflow Depth > 3.62" for 100-Year event
 Inflow = 32.86 cfs @ 12.23 hrs, Volume= 181,319 cf
 Primary = 32.86 cfs @ 12.23 hrs, Volume= 181,319 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.04 hrs / 3

Pond POI 1: Northern Site

