Stormwater Management Report

Proposed Cumberland Farms Convenience Store

643 Middle Turnpike and 1660 Storrs Road
Town of Mansfield (Storrs)
Tolland County
State of Connecticut

December 9, 2011

CHA Project Number: 23016

Prepared by:

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

The proposed Cumberland Farms Convenience Store is located in the Town of Mansfield, Tolland County, Connecticut. The project watershed encompasses approximately 2.25acres and is generally bounded by CT Route 195/Storrs Road to the south, US Route 44/Middle Turnpike to the east, CT Route 320/Willington Hill Road to the west and private lands to the north (See Figure 1).

The proposed Cumberland Farms Convenience Store will have a footprint of 3,634 square feet. Associated with the store will be four gasoline/diesel fueling islands with a canopy which will have a footprint of 2,712 square feet. The proposed project is the result of a raze and rebuild of the previous Kathy Johns restaurant and gas station sites which will reduce impervious cover on the previously developed site approximately 50 percent.

1.2 EXISTING CONDITION CHARACTERISTICS

For purposes of this analysis, the extent of the hydrologic model was limited to those areas impacted by or tributary to the proposed Cumberland Farms Convenience Store site. Based on this evaluation, the contributing watershed consists of approximately 2.25 acres, all of which are located within the site property.

The topography of the project site generally conveys runoff from east to west. Elevations range from 610± feet at the northeast property corner adjacent to US Route 44 to 598± at the storm drain outlet at the southwest corner of the site adjacent to CT Route 320. The slopes for paved and unpaved surfaces vary in magnitude from 1 to 5%.

Runoff from the majority of the restaurant site is collected in a closed subsurface storm drain system that traverses the site from the east and US Route 44 to the west towards a wetland area adjacent to CT Route 320. Runoff from the majority of the gas station site flows overland into CT 195 and is collected in a closed subsurface storm drain system within the roadway.

Based on a review of the USDA NRCS Web Soil Survey of Tolland County, Connecticut, soils within the study watershed consist of urban soils adjoined by fine sandy loam. A summary of the soil composition is shown in Table 1-1 below and surficial mapping is included in Figure 1 –Soil Map.

Table 1-1
Soil Analysis Summary

USDA Map Symbol	Soil Name	Hydrologic Soil Group
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C
306	Udorthents Urban land complex	B

The USDA Natural Resource Conservation Service (NRCS), as part of their soil classification system, assigns each soil series to a hydrologic soil group (HSG). The HSG is a four-letter index (A-D) that is intended to show the relative potential for a soil to generate runoff. HSG B soils have moderate infiltration rates when thoroughly wetted, and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse texture. These soils have a moderate rate of water transmission. HSG B soils make up all of the soils within the study watershed.

2.0 DESIGN CRITERIA

The following design criteria have been established for the project, in accordance with the Town of Mansfield, Connecticut and State of Connecticut regulations:

- Reduce peak stormwater runoff rates from the site for all design storms up to and including the 100-year storm in order to reduce potential for localized flooding and erosion to downstream properties.
- Provide on-site retention and infiltration of the first inch of runoff from site impervious areas in order to provide increased groundwater recharge and enhanced stormwater quality treatment.

3.0 HYDROLOGIC EVALUATION

3.1 METHODOLOGY

To evaluate the potential impacts associated with the construction of the proposed Cumberland Farms Convenience Store, existing and post-development condition hydrographs were generated for the site using a type III rainfall distribution. The 24-hour rainfall amounts for the 1-, 2-, 10-, 25-, and 100-year design storms in Mansfield, Connecticut are 2.6, 3.2, 4.8, 5.5 and 6.9 inches, respectively.

Runoff curve numbers and times of concentration were computed using standard NRCS TR-55 methodology. Additionally, peak stormwater flows and hydrographs for the existing and post-development conditions were computed using HydroCAD (Version 9.14) stormwater modeling software.

3.2 EXISTING CONDITION HYDROLOGY

For purposes of the existing condition analysis, three design points were defined to characterize the natural drainage patterns of the watershed. Design Point 1 (DP-1) is located at the westernmost catch basin on the site subsurface storm drain system. Design Point 2 (DP-2) is located at the western most site driveway entrance on CT Route 195 Storrs Road. Design Point 3 (DP-3) is located at the 18" RCP culvert inlet adjacent to CT Route 320/Willington Hill Road just north of CT Route 195 Storrs Road (See Figure 2 – Pre-Development Drainage Plan). The results of the existing condition analysis are summarized in Table 3-1 and detailed computations are included in the Appendix B.

Table 3-1
Existing Condition Analysis Summary

Design Point	Area (ac)	Curve Number	Peak Flow Rate (cfs)				
			1-yr	2-yr	10-yr	25-yr	100-yr
DP-1	1.369	92	2.9	3.7	6.0	7.0	8.9
DP-2	0.328	95	0.8	1.0	1.5	1.7	2.2
DP-3	0.555	69	3.0	4.0	6.7	8.0	10.5

3.3 PROPOSED CONDITION HYDROLOGY

The development of the proposed Cumberland Farms Convenience Store and its associated facilities will alter the permeability of the project site by decreasing impervious cover. For purposes of the proposed condition analysis, the design points remain the same as in the existing condition analysis. (See Figure 3 – Post-Development Drainage Plan). The analysis reflects the proposed reduction in impervious cover and the construction of a new on-site stormwater management system. The results of the post-development condition analysis are shown in Table 3-2, and detailed computations are included in the Appendix C.

Table 3-2
Proposed Condition Analysis Summary

Design Point	Area (ac)	Curve Number	Peak Flow Rate (cfs)				
			1-yr	2-yr	10-yr	25-yr	100-yr
DP-1	1.818	76	0.5	1.4	4.1	5.0	7.0
DP-2	0.141	70	0.1	0.1	0.3	0.4	0.6
DP-3	0.293	58	0.5	1.4	4.3	5.4	7.6

4.0 STORMWATER MANAGEMENT PRACTICES

To reduce peak runoff flow rates and provide enhanced groundwater recharge and stormwater quality treatment, the proposed project will include the construction of a new on-site stormwater management system.

The main component in this system will be a bioretention area locates in the southwestern corner of the site adjacent to the proposed driveway entrance onto CT Route 195/Storrs Road. The available surface stormwater storage in the bioretention area from elevation 602 to 603 is greater than the WQV for the tributary impervious areas. Stormwater from these areas will flow into this bioretention area via a new closed subsurface storm drain system. Catch basins associated with the new system will have hooded outlets for stormwater pretreatment. Stormwater inflow from smaller storms will infiltrate within the bioretention area or be collected by a limited underdrain system which connects to the existing onsite sotrm drain system which traverse the site from US Route 44. Stormwater inflow from larger storms will overflow to the north via a subsurface pipe to the same existing storm drain system.

A comparison of existing and proposed condition peak runoff flow rates is shown in Table 4-1, and detailed computations are included in the Appendices B and C.

Table 4-1

Peak Runoff Flow Rate Comparison

Peak Runoff Flow Rate (cfs)										
Design Point	**1 Year**		**2 Year**		**10 Year**		**25 Year**		**100 Year**	
	Exist	**Post**	**Exist**	**Post**	**Exist**	**Post**	**Exist**	**Post**	**Exist**	**Post**
DP-1	2.9	0.5	3.7	1.4	6.0	4.1	7.0	5.0	8.9	7.0
DP-2	0.8	0.1	1.0	0.1	1.5	0.3	1.7	0.4	2.2	0.6
DP-3	3.0	0.5	4.0	1.4	6.7	4.3	8.0	5.4	10.5	7.6

5.0 FLOOD HAZARD AREA IMPACT

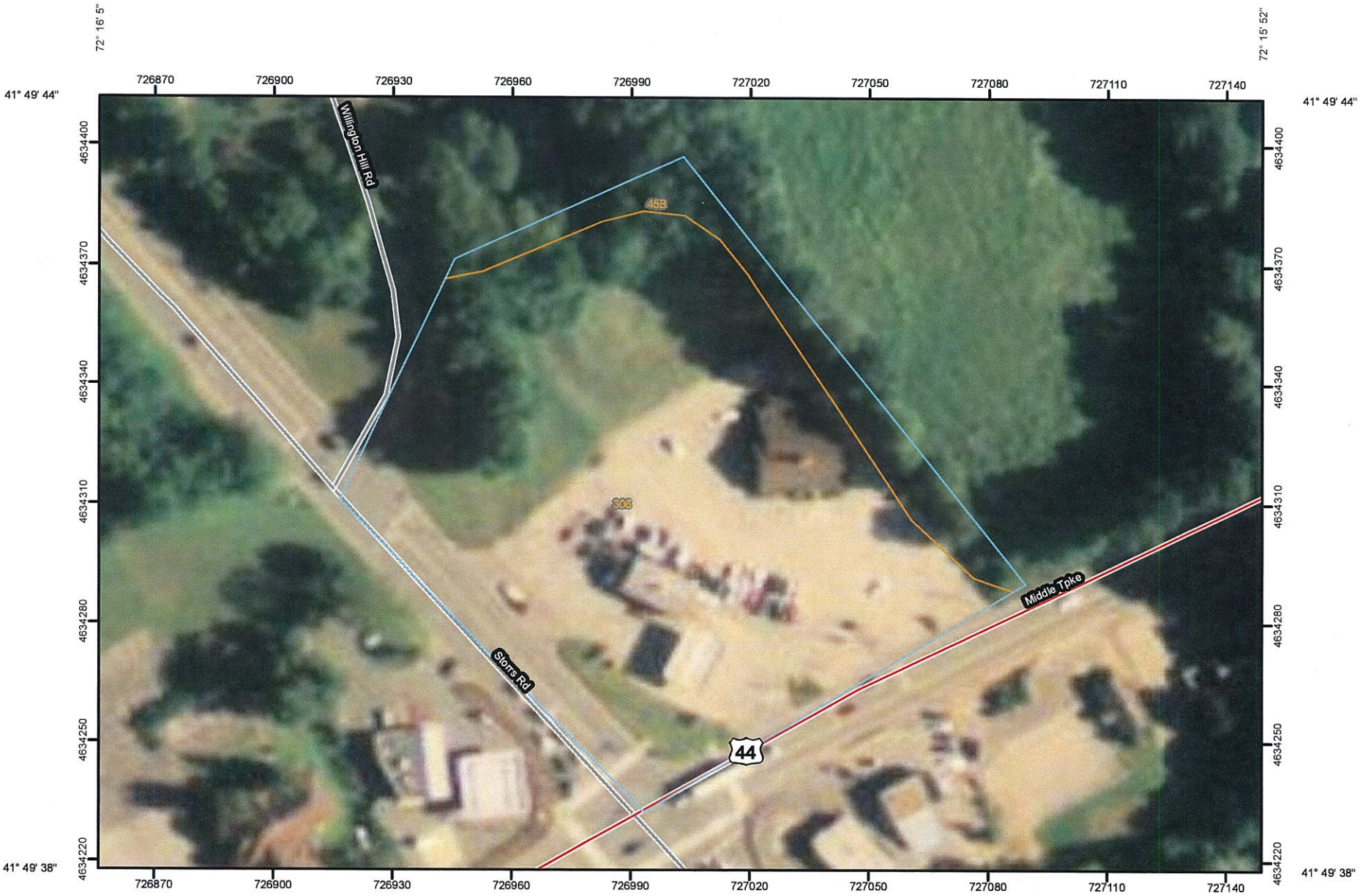
The entire project will not be constructed in flood prone areas as defined by the FEMA Flood Insurance Rate Map (FIRM) Community Panel Number 090128 0005C issued January 2, 1981. The area is identified as Zone C areas of minimal flooding.

6.0 SUMMARY AND CONCLUSIONS

Overall the site will have sizable reductions in peak flow rate and total runoff volume due to reduced impervious cover and the proposed stormwater management system. Stormwater quality treatment will be provided for the majority of impervious areas on the site.

Appendix A

Soil Map—State of Connecticut



Map Scale: 1:1,390 if printed on A size (8.5" x 11") sheet.

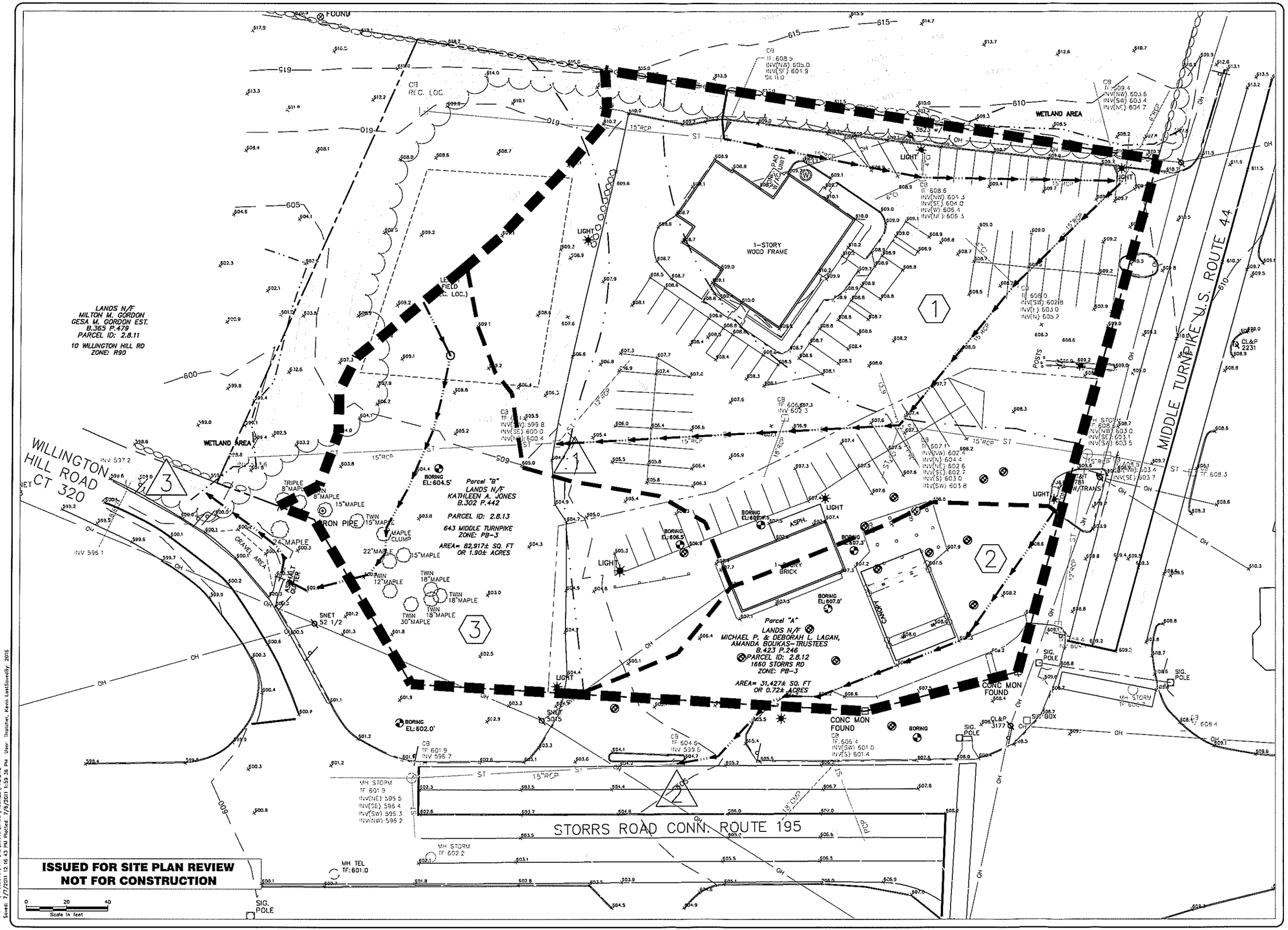
N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

USDA Natural Resources Conservation Service

Web Soil Survey
National Cooperative Soil Survey



ISSUED FOR SITE PLAN REVIEW
NOT FOR CONSTRUCTION

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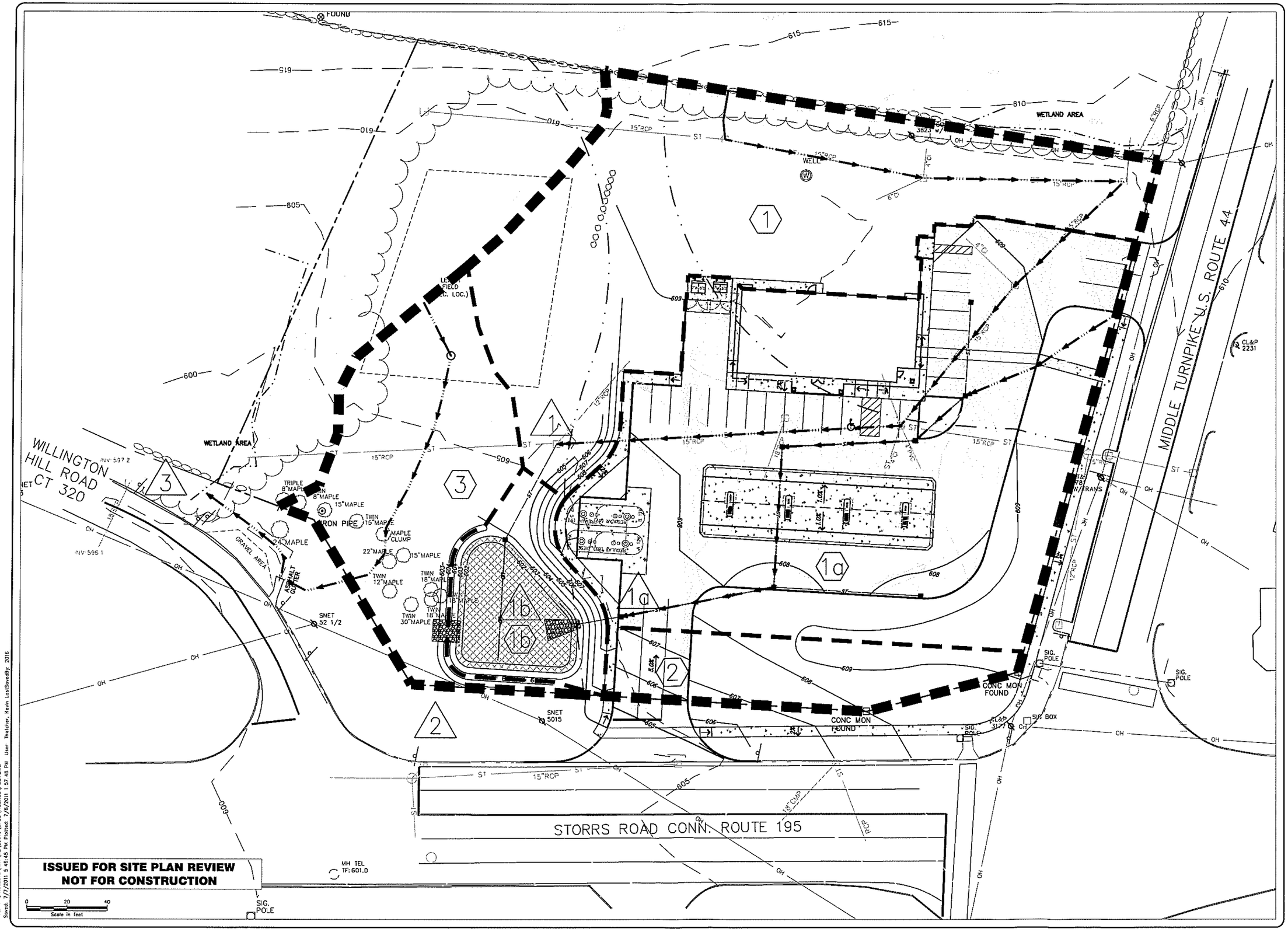
PROPOSED CONVENIENCE STORE
US 44 / CT 195 / CT 320
MANSFIELD (STORRS), CT

PRE-DEVELOPMENT DRAINAGE PLAN

Issue Date: 07/11/11 | Project No.: 23016 | Scale: AS NOTED

PRE



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0 20 40
Scale in feet

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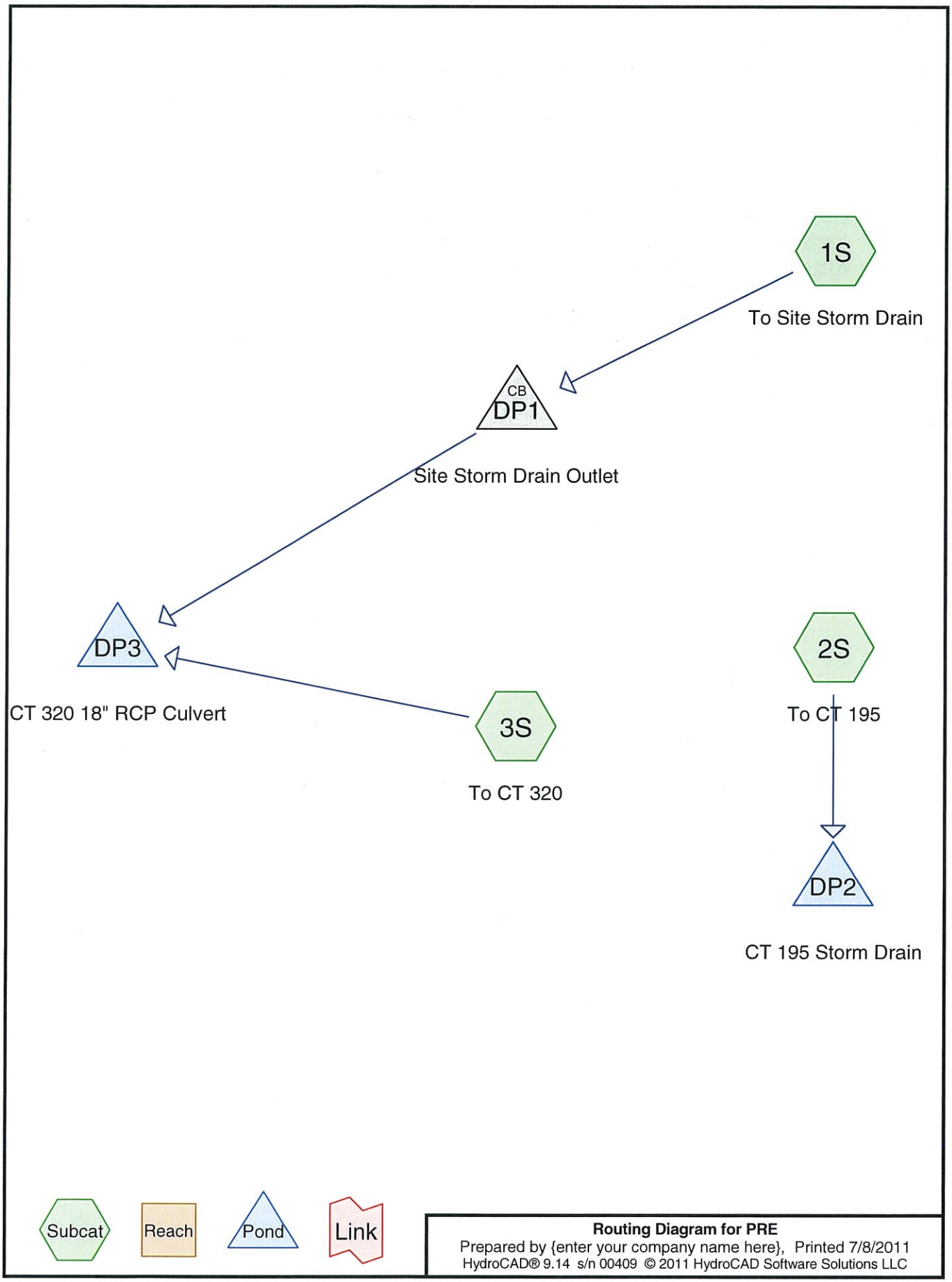
PROPOSED CONVENIENCE STORE
US 44 / CT 195 / CT 320
MANSFIELD (STORRS), CT

POST-DEVELOPMENT DRAINAGE PLAN

Issue Date: 07/11/11 | Project No.: 23016 | Scale: AS NOTED

POST

Appendix B



Routing Diagram for PRE
Prepared by {enter your company name here}, Printed 7/8/2011
HydroCAD® 9.14 s/n 00409 © 2011 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.408	58	Meadow, non-grazed, HSG B (3S)
0.222	58	Woods/grass comb., Good, HSG B (1S)
0.026	61	>75% Grass cover, Good, HSG B (2S)
0.146	98	Building (1S, 2S)
1.451	98	Pavement (1S, 2S, 3S)
2.252	**86**	**TOTAL AREA**

Summary for Subcatchment 1S: To Site Storm Drain

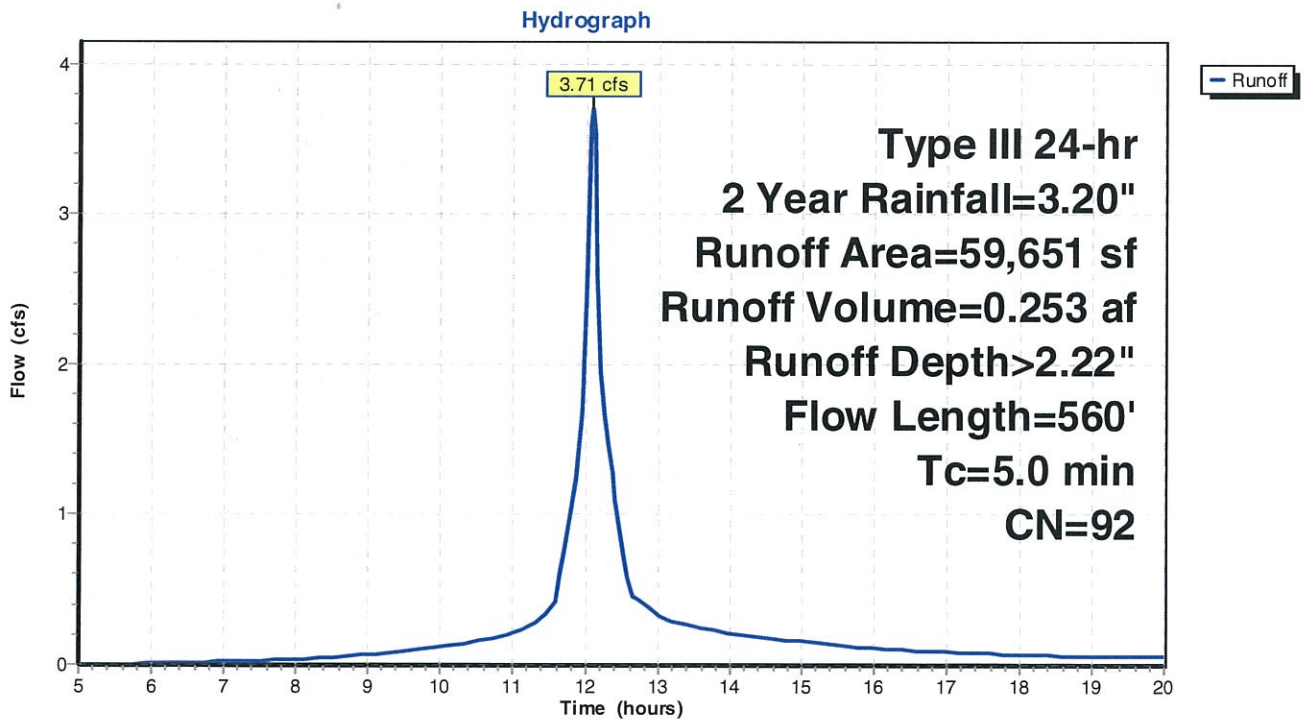
Runoff = 3.71 cfs @ 12.07 hrs, Volume= 0.253 af, Depth> 2.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

	Area (sf)	CN	Description
	9,669	58	Woods/grass comb., Good, HSG B
*	4,086	98	Building
*	45,896	98	Pavement
	59,651	92	Weighted Average
	9,669		16.21% Pervious Area
	49,982		83.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.9	15	0.2000	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.1	10	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.1	535	0.0090	4.33	5.31	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.015 Concrete sewer w/manholes & inlets
4.1	560	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1S: To Site Storm Drain



Summary for Subcatchment 2S: To CT 195

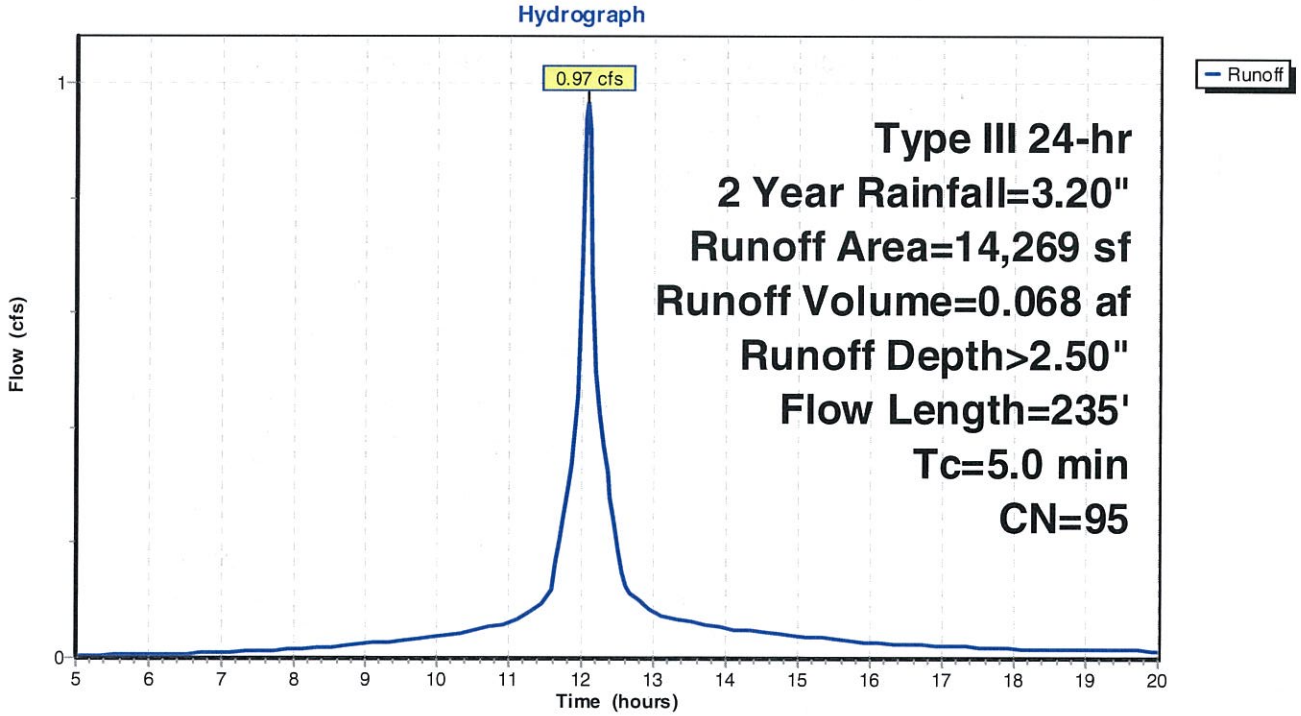
Runoff = 0.97 cfs @ 12.07 hrs, Volume= 0.068 af, Depth> 2.50"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

	Area (sf)	CN	Description
*	2,254	98	Building
	1,123	61	>75% Grass cover, Good, HSG B
*	10,892	98	Pavement
	14,269	95	Weighted Average
	1,123		7.87% Pervious Area
	13,146		92.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	75	0.0200	1.30		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.0	160	0.0169	2.64		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.0	235	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 2S: To CT 195



Summary for Subcatchment 3S: To CT 320

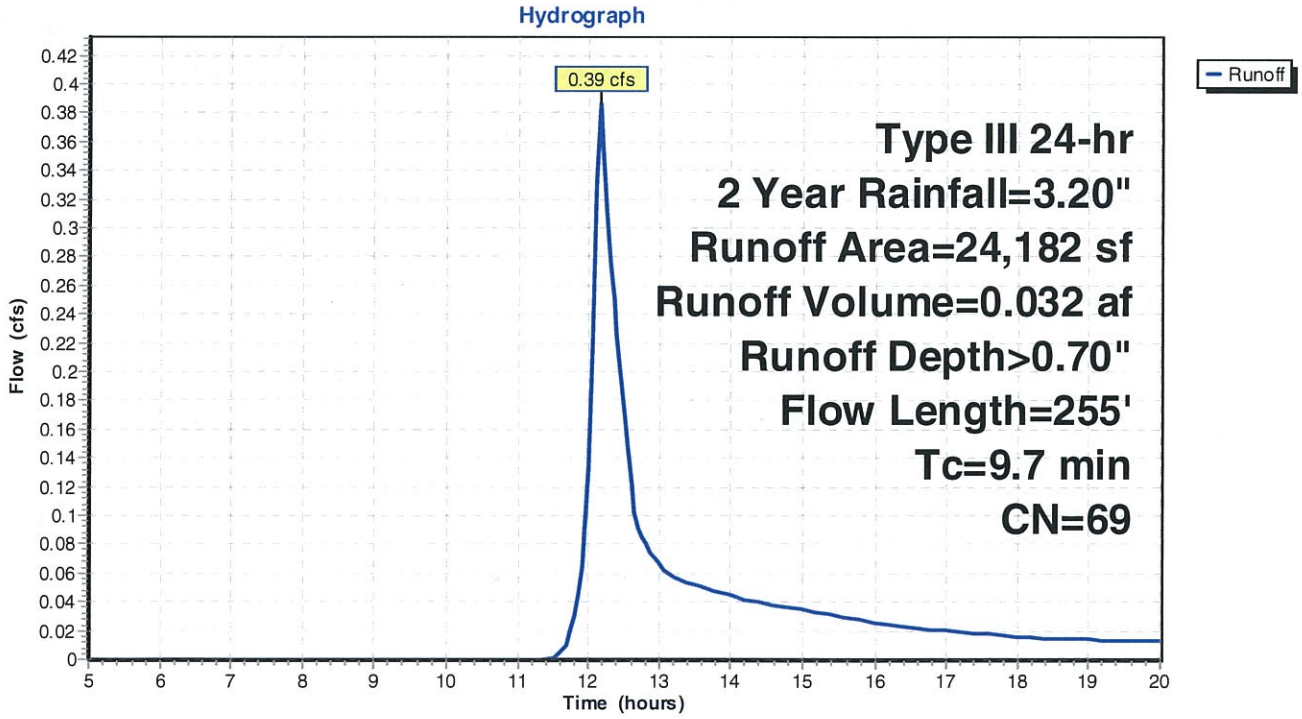
Runoff = 0.39 cfs @ 12.16 hrs, Volume= 0.032 af, Depth> 0.70"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

	Area (sf)	CN	Description
*	6,396	98	Pavement
	17,786	58	Meadow, non-grazed, HSG B
	24,182	69	Weighted Average
	17,786		73.55% Pervious Area
	6,396		26.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	30	0.0100	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.20"
2.5	225	0.0444	1.47		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	255	Total			

Subcatchment 3S: To CT 320



Summary for Pond DP1: Site Storm Drain Outlet

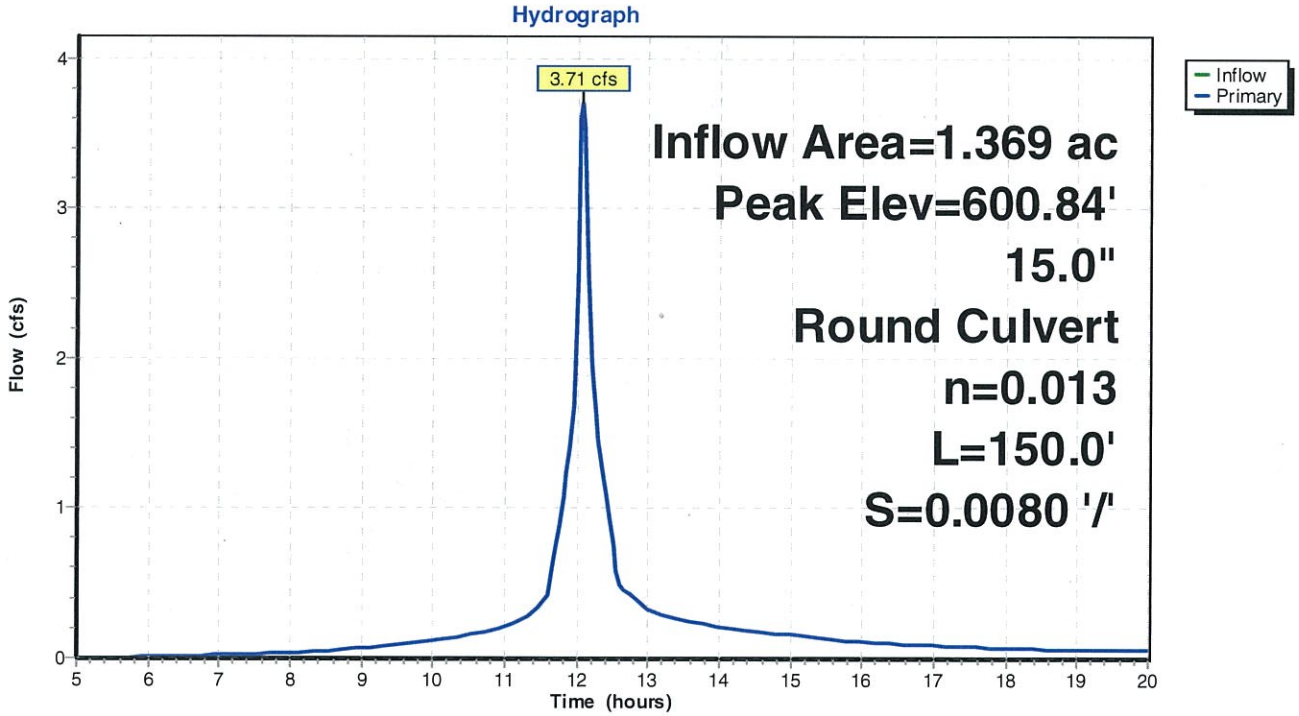
Inflow Area =	1.369 ac, 83.79% Impervious, Inflow Depth > 2.22" for 2 Year event				
Inflow =	3.71 cfs @	12.07 hrs,	Volume=	0.253 af	
Outflow =	3.71 cfs @	12.07 hrs,	Volume=	0.253 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.71 cfs @	12.07 hrs,	Volume=	0.253 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 600.84' @ 12.07 hrs
Flood Elev= 604.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	599.80'	**15.0" Round Culvert** L= 150.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 599.80' / 598.60' S= 0.0080 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf

Primary OutFlow Max=3.57 cfs @ 12.07 hrs HW=600.82' (Free Discharge)
└**1=Culvert** (Barrel Controls 3.57 cfs @ 4.56 fps)

Pond DP1: Site Storm Drain Outlet

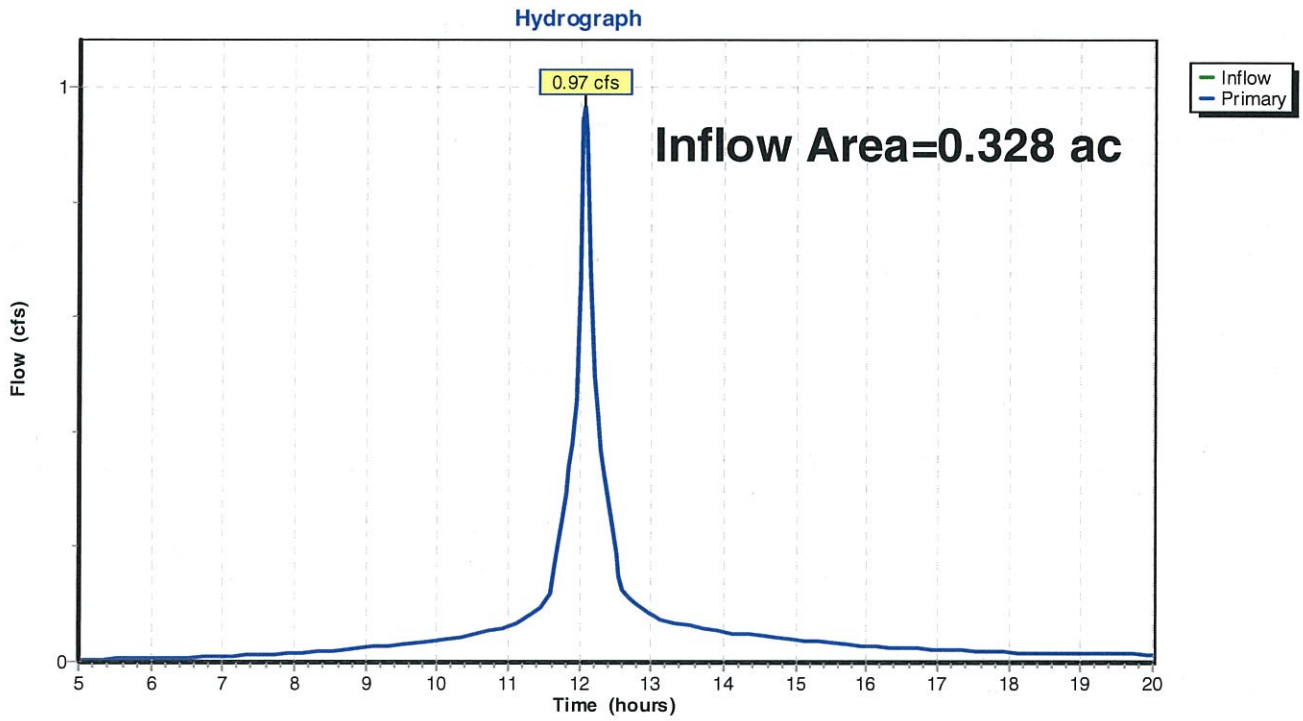


Summary for Pond DP2: CT 195 Storm Drain

Inflow Area = 0.328 ac, 92.13% Impervious, Inflow Depth > 2.50" for 2 Year event
Inflow = 0.97 cfs @ 12.07 hrs, Volume= 0.068 af
Primary = 0.97 cfs @ 12.07 hrs, Volume= 0.068 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Pond DP2: CT 195 Storm Drain



Summary for Pond DP3: CT 320 18" RCP Culvert

Inflow Area =	1.925 ac, 67.25% Impervious, Inflow Depth > 1.78" for 2 Year event				
Inflow =	3.97 cfs @	12.08 hrs,	Volume=	0.286 af	
Outflow =	3.98 cfs @	12.08 hrs,	Volume=	0.286 af,	Atten= 0%, Lag= 0.3 min
Primary =	3.98 cfs @	12.08 hrs,	Volume=	0.286 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 598.16' @ 12.08 hrs Surf.Area= 95 sf Storage= 44 cf

Plug-Flow detention time= 0.2 min calculated for 0.285 af (100% of inflow)
Center-of-Mass det. time= 0.1 min (773.7 - 773.6)

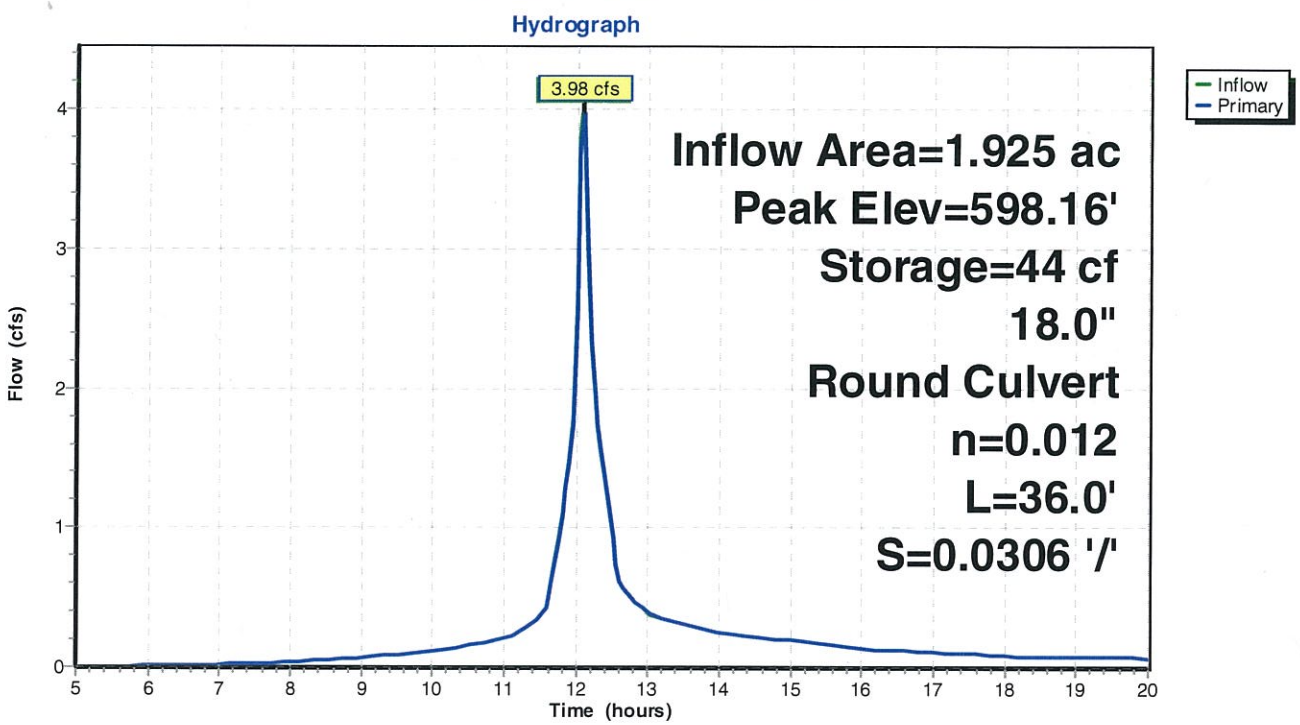
Volume	Invert	Avail.Storage	Storage Description
#1	597.20'	2,767 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
597.20	0	0	0
598.00	75	30	30
599.00	200	138	167
600.00	5,000	2,600	2,767

Device	Routing	Invert	Outlet Devices
#1	Primary	597.20'	**18.0" Round 18" RCP** L= 36.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 597.20' / 596.10' S= 0.0306 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=3.87 cfs @ 12.08 hrs HW=598.14' (Free Discharge)
└**1=18" RCP** (Inlet Controls 3.87 cfs @ 3.31 fps)

Pond DP3: CT 320 18" RCP Culvert



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Site Storm Drain Runoff Area=59,651 sf 83.79% Impervious Runoff Depth>2.22"
Flow Length=560' Tc=5.0 min CN=92 Runoff=3.71 cfs 0.253 af

Subcatchment 2S: To CT 195 Runoff Area=14,269 sf 92.13% Impervious Runoff Depth>2.50"
Flow Length=235' Tc=5.0 min CN=95 Runoff=0.97 cfs 0.068 af

Subcatchment 3S: To CT 320 Runoff Area=24,182 sf 26.45% Impervious Runoff Depth>0.70"
Flow Length=255' Tc=9.7 min CN=69 Runoff=0.39 cfs 0.032 af

Pond DP1: Site Storm Drain Outlet Peak Elev=600.84' Inflow=3.71 cfs 0.253 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=3.71 cfs 0.253 af

Pond DP2: CT 195 Storm Drain Inflow=0.97 cfs 0.068 af
Primary=0.97 cfs 0.068 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=598.16' Storage=44 cf Inflow=3.97 cfs 0.286 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=3.98 cfs 0.286 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.354 af Average Runoff Depth = 1.88"
29.13% Pervious = 0.656 ac 70.87% Impervious = 1.596 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Site Storm Drain Runoff Area=59,651 sf 83.79% Impervious Runoff Depth>3.68"
Flow Length=560' Tc=5.0 min CN=92 Runoff=5.99 cfs 0.420 af

Subcatchment 2S: To CT 195 Runoff Area=14,269 sf 92.13% Impervious Runoff Depth>3.98"
Flow Length=235' Tc=5.0 min CN=95 Runoff=1.50 cfs 0.109 af

Subcatchment 3S: To CT 320 Runoff Area=24,182 sf 26.45% Impervious Runoff Depth>1.66"
Flow Length=255' Tc=9.7 min CN=69 Runoff=1.00 cfs 0.077 af

Pond DP1: Site Storm Drain Outlet Peak Elev=601.44' Inflow=5.99 cfs 0.420 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=5.99 cfs 0.420 af

Pond DP2: CT 195 Storm Drain Inflow=1.50 cfs 0.109 af
Primary=1.50 cfs 0.109 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=598.57' Storage=93 cf Inflow=6.74 cfs 0.497 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=6.76 cfs 0.497 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.606 af Average Runoff Depth = 3.23"
29.13% Pervious = 0.656 ac 70.87% Impervious = 1.596 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Site Storm Drain Runoff Area=59,651 sf 83.79% Impervious Runoff Depth>4.33"
Flow Length=560' Tc=5.0 min CN=92 Runoff=6.97 cfs 0.494 af

Subcatchment 2S: To CT 195 Runoff Area=14,269 sf 92.13% Impervious Runoff Depth>4.62"
Flow Length=235' Tc=5.0 min CN=95 Runoff=1.73 cfs 0.126 af

Subcatchment 3S: To CT 320 Runoff Area=24,182 sf 26.45% Impervious Runoff Depth>2.14"
Flow Length=255' Tc=9.7 min CN=69 Runoff=1.30 cfs 0.099 af

Pond DP1: Site Storm Drain Outlet Peak Elev=602.33' Inflow=6.97 cfs 0.494 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=6.97 cfs 0.494 af

Pond DP2: CT 195 Storm Drain Inflow=1.73 cfs 0.126 af
Primary=1.73 cfs 0.126 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=598.82' Storage=134 cf Inflow=7.98 cfs 0.593 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=7.95 cfs 0.593 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.719 af Average Runoff Depth = 3.83"
29.13% Pervious = 0.656 ac 70.87% Impervious = 1.596 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: To Site Storm Drain Runoff Area=59,651 sf 83.79% Impervious Runoff Depth>5.62"
Flow Length=560' Tc=5.0 min CN=92 Runoff=8.94 cfs 0.641 af

Subcatchment 2S: To CT 195 Runoff Area=14,269 sf 92.13% Impervious Runoff Depth>5.91"
Flow Length=235' Tc=5.0 min CN=95 Runoff=2.20 cfs 0.161 af

Subcatchment 3S: To CT 320 Runoff Area=24,182 sf 26.45% Impervious Runoff Depth>3.18"
Flow Length=255' Tc=9.7 min CN=69 Runoff=1.94 cfs 0.147 af

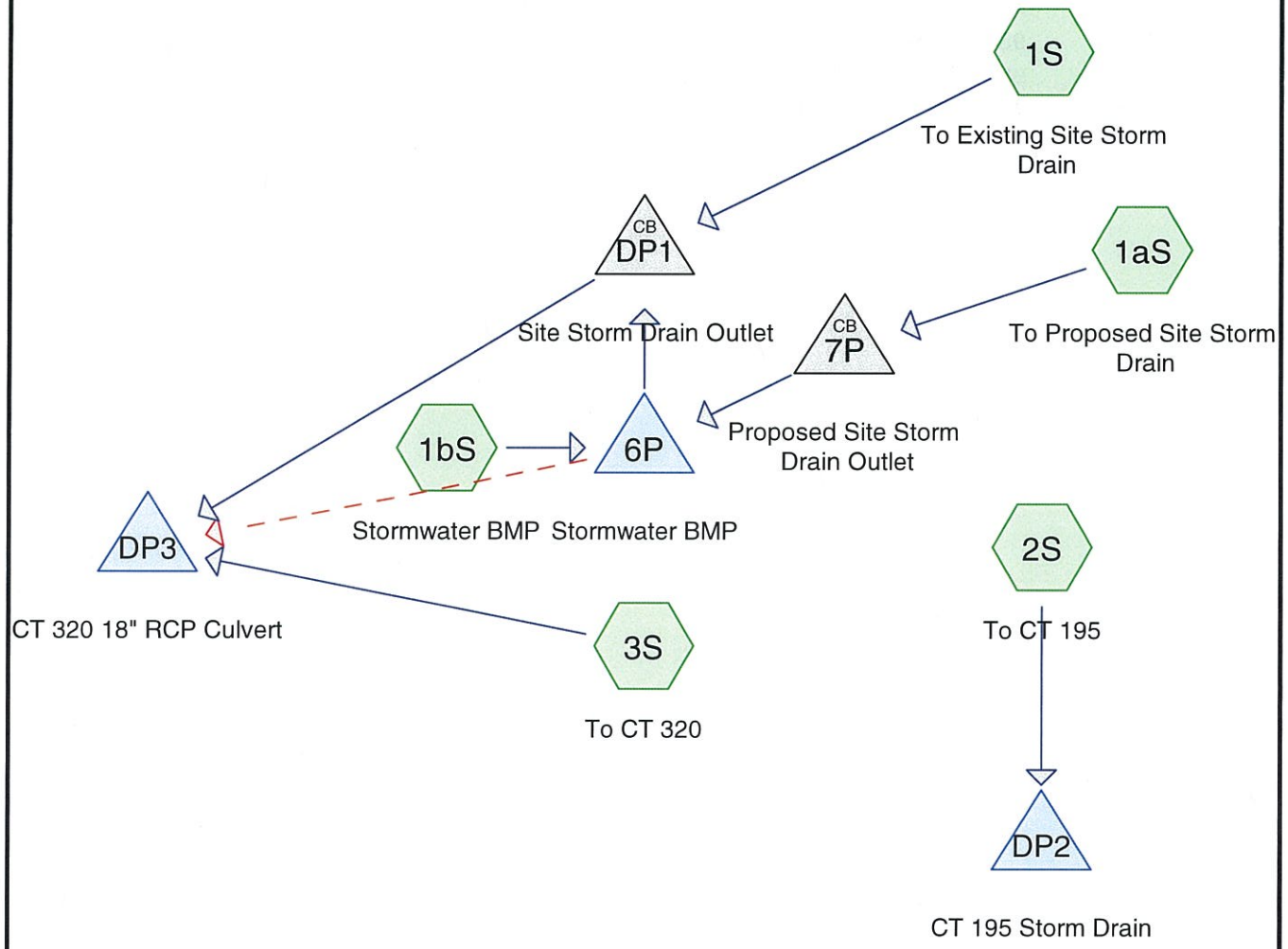
Pond DP1: Site Storm Drain Outlet Peak Elev=603.93' Inflow=8.94 cfs 0.641 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=8.94 cfs 0.641 af

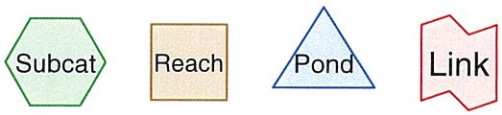
Pond DP2: CT 195 Storm Drain Inflow=2.20 cfs 0.161 af
Primary=2.20 cfs 0.161 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=599.24' Storage=357 cf Inflow=10.48 cfs 0.788 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=9.67 cfs 0.788 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.950 af Average Runoff Depth = 5.06"
29.13% Pervious = 0.656 ac 70.87% Impervious = 1.596 ac

Appendix C





Routing Diagram for POST
Prepared by {enter your company name here}, Printed 7/8/2011
HydroCAD® 9.14 s/n 00409 © 2011 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.979	58	Meadow, non-grazed, HSG B (1S, 3S)
0.468	61	>75% Grass cover, Good, HSG B (1aS, 1bS, 2S)
0.147	98	Building (1aS)
0.658	98	Pavement (1aS, 1S, 2S)
2.252	**73**	**TOTAL AREA**

Summary for Subcatchment 1aS: To Proposed Site Storm Drain

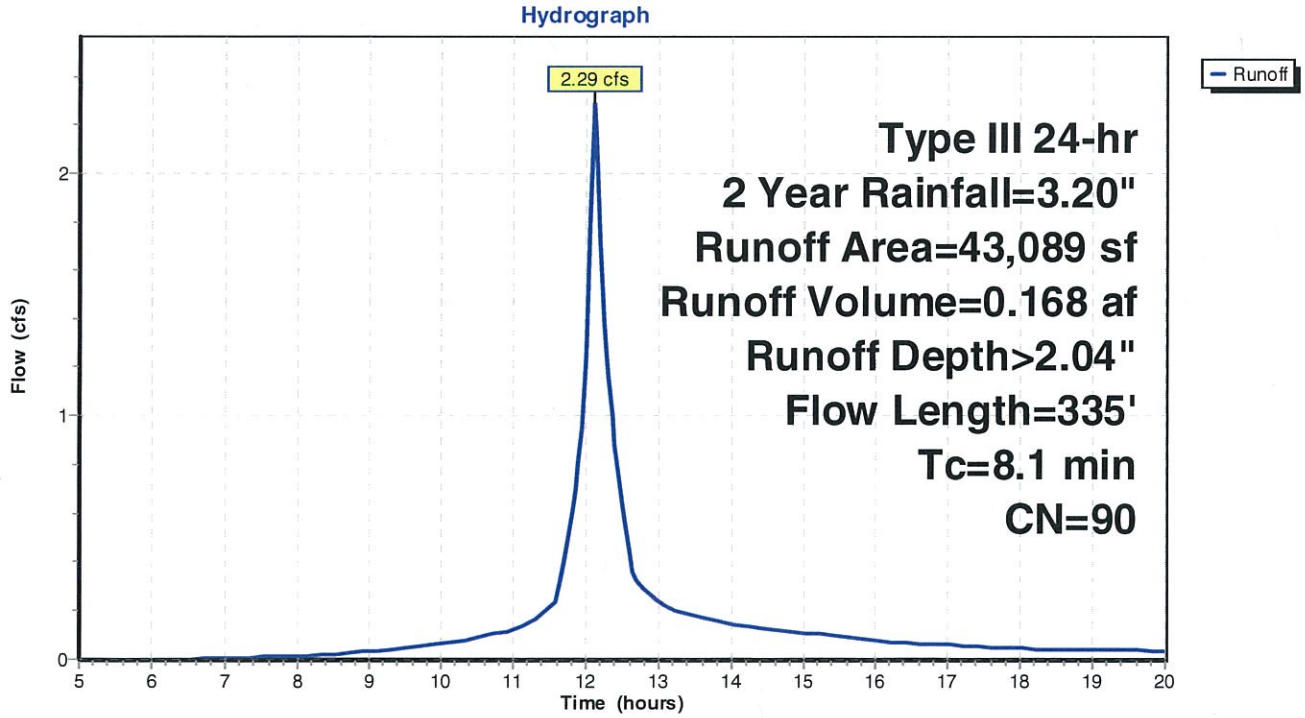
Runoff = 2.29 cfs @ 12.11 hrs, Volume= 0.168 af, Depth> 2.04"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

	Area (sf)	CN	Description
*	6,418	98	Building
*	27,015	98	Pavement
	9,656	61	>75% Grass cover, Good, HSG B
	43,089	90	Weighted Average
	9,656		22.41% Pervious Area
	33,433		77.59% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.6	50	0.0133	0.13		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.2	35	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.3	250	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
8.1	335	Total			

Subcatchment 1aS: To Proposed Site Storm Drain



Summary for Subcatchment 1bS: Stormwater BMP

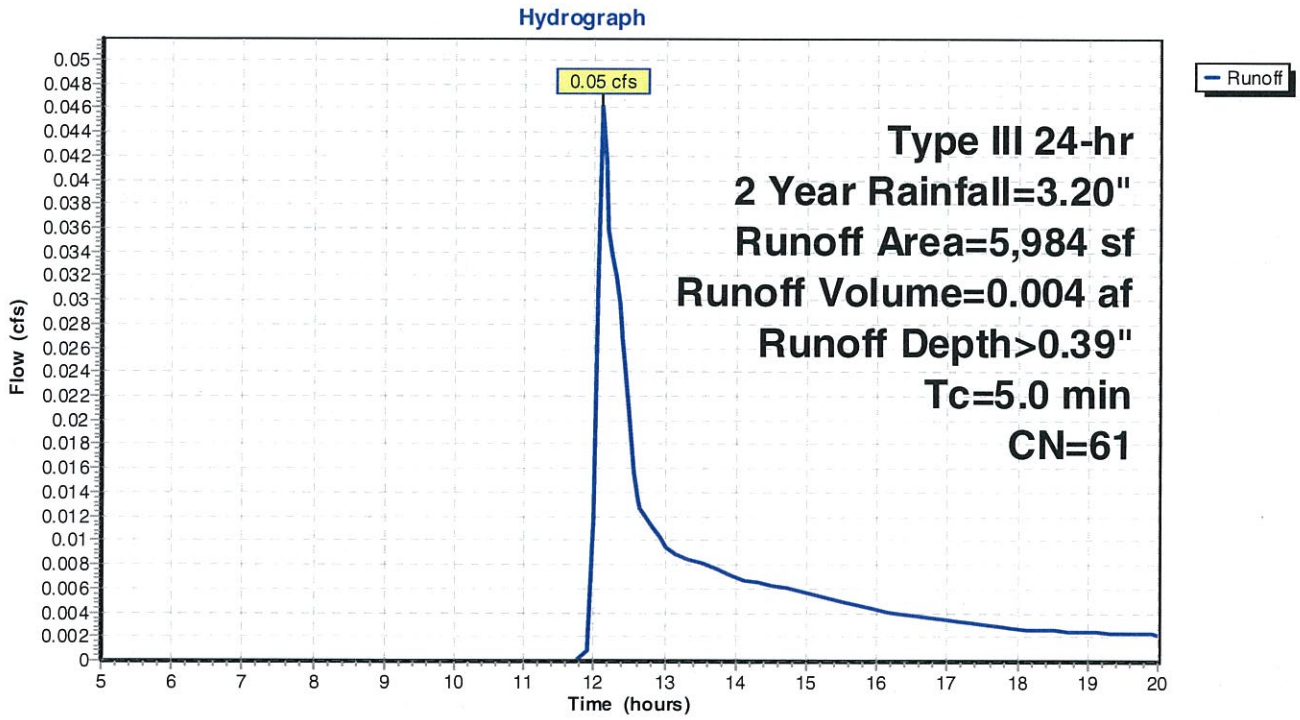
Runoff = 0.05 cfs @ 12.11 hrs, Volume= 0.004 af, Depth> 0.39"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

Area (sf)	CN	Description
5,984	61	>75% Grass cover, Good, HSG B
5,984		100.00% Pervious Area

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

Subcatchment 1bS: Stormwater BMP



Summary for Subcatchment 1S: To Existing Site Storm Drain

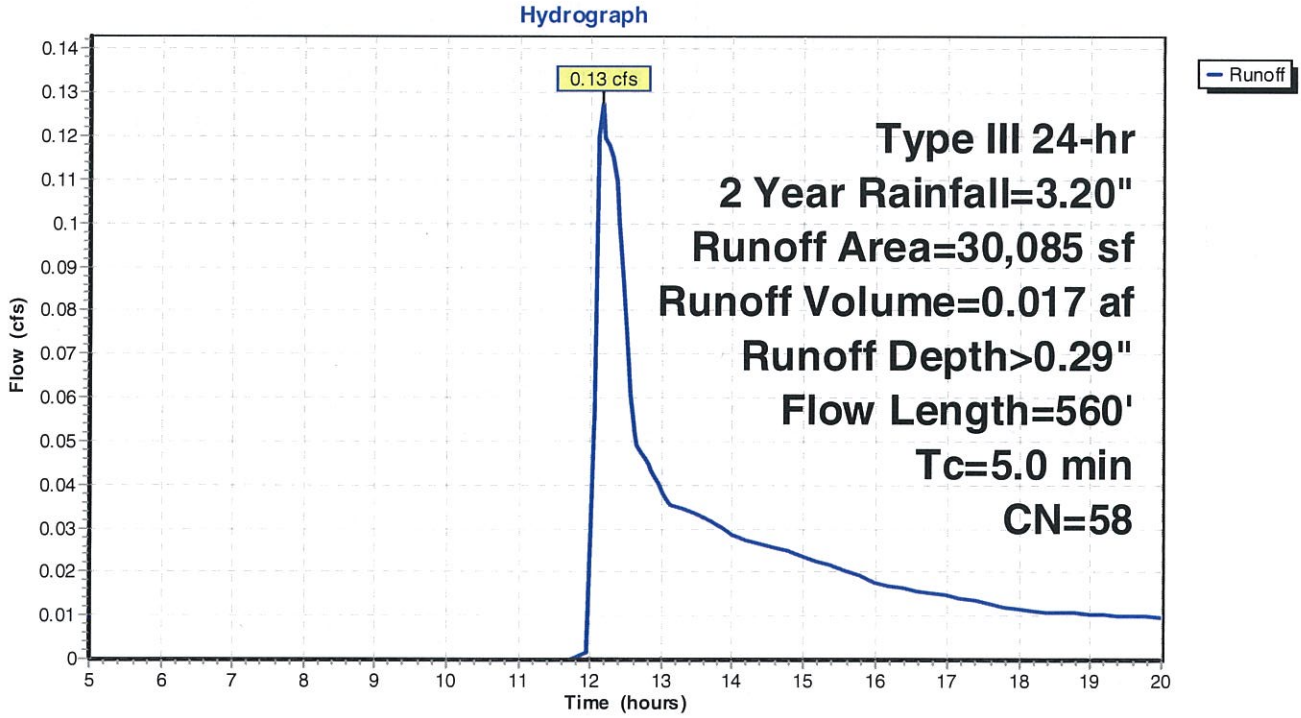
Runoff = 0.13 cfs @ 12.15 hrs, Volume= 0.017 af, Depth> 0.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

	Area (sf)	CN	Description
	29,872	58	Meadow, non-grazed, HSG B
*	213	98	Pavement
	30,085	58	Weighted Average
	29,872		99.29% Pervious Area
	213		0.71% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.9	15	0.2000	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.1	10	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.1	535	0.0090	4.33	5.31	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.015 Concrete sewer w/manholes & inlets
4.1	560	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1S: To Existing Site Storm Drain



Summary for Subcatchment 2S: To CT 195

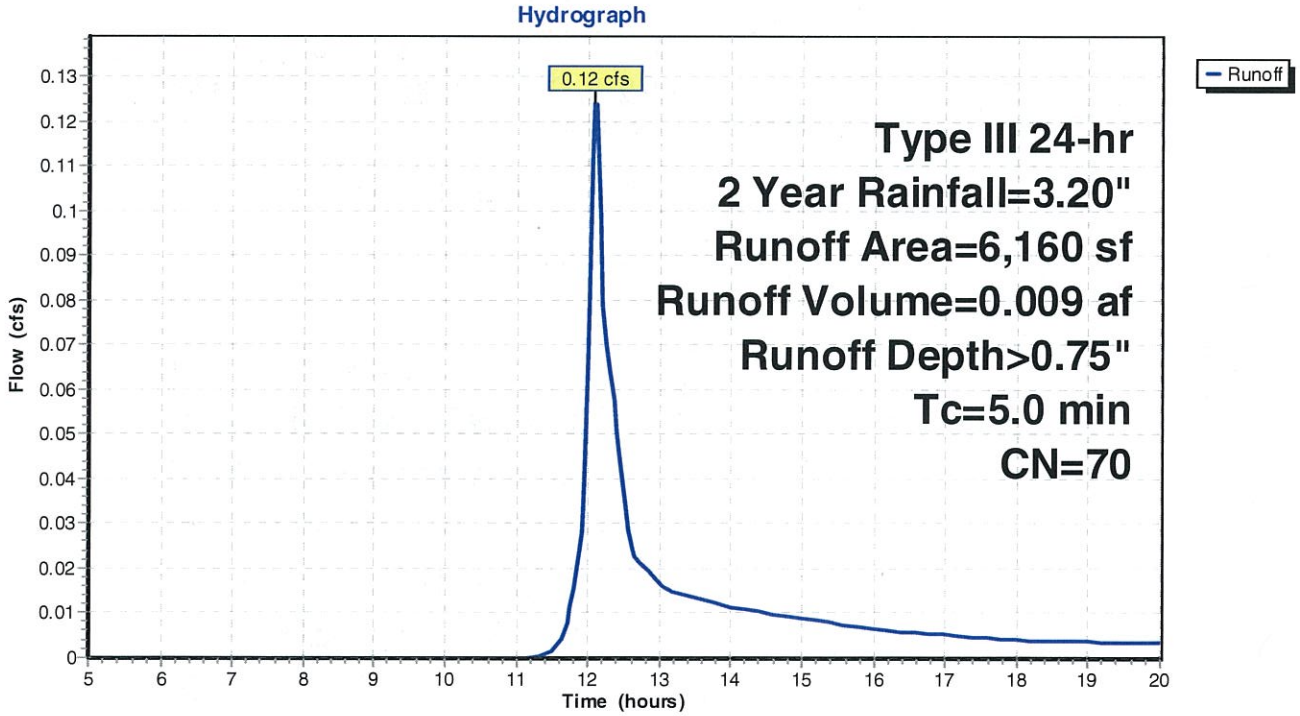
Runoff = 0.12 cfs @ 12.09 hrs, Volume= 0.009 af, Depth> 0.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

	Area (sf)	CN	Description
	4,730	61	>75% Grass cover, Good, HSG B
*	1,430	98	Pavement
	6,160	70	Weighted Average
	4,730		76.79% Pervious Area
	1,430		23.21% Impervious Area

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

Subcatchment 2S: To CT 195



Summary for Subcatchment 3S: To CT 320

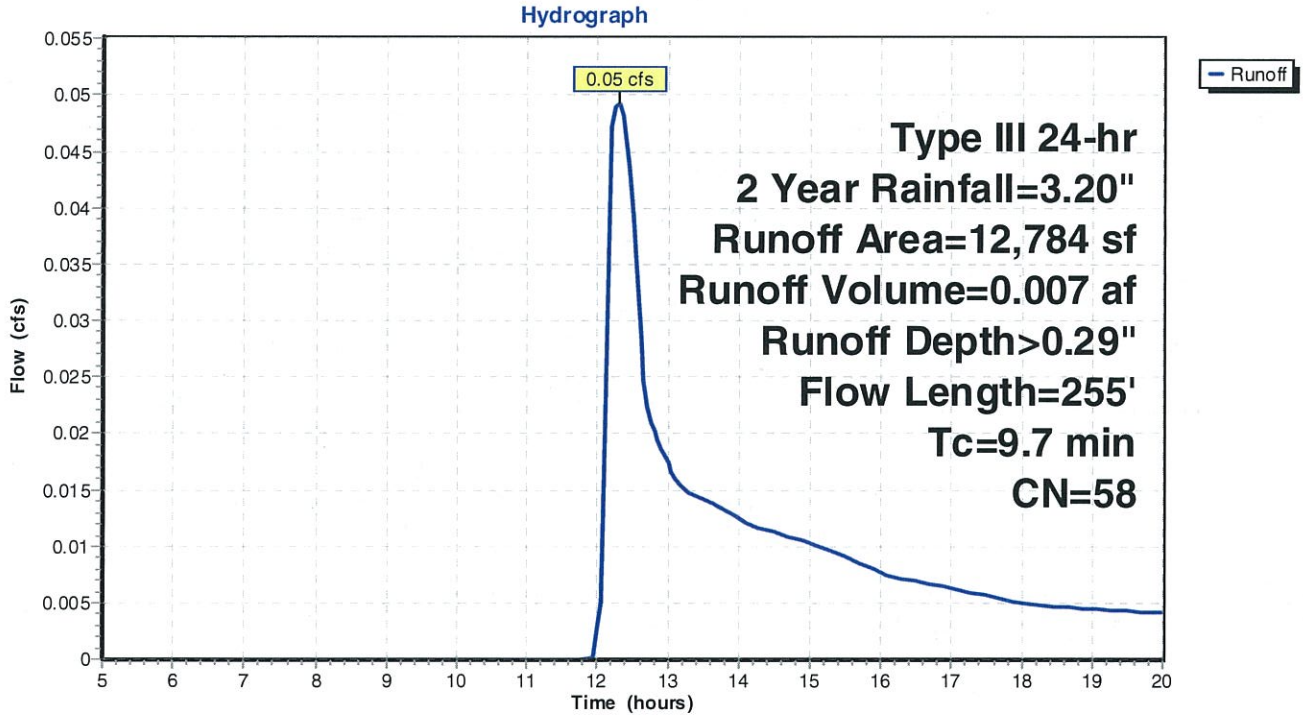
Runoff = 0.05 cfs @ 12.29 hrs, Volume= 0.007 af, Depth> 0.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 Year Rainfall=3.20"

Area (sf)	CN	Description
12,784	58	Meadow, non-grazed, HSG B
12,784		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.2	30	0.0100	0.07		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.20"
2.5	225	0.0444	1.47		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.7	255	Total			

Subcatchment 3S: To CT 320



Summary for Pond 6P: Stormwater BMP

Inflow Area =	1.127 ac, 68.13% Impervious, Inflow Depth > 1.84" for 2 Year event				
Inflow =	2.33 cfs @	12.11 hrs,	Volume=	0.172 af	
Outflow =	1.24 cfs @	12.30 hrs,	Volume=	0.107 af,	Atten= 47%, Lag= 11.1 min
Primary =	1.24 cfs @	12.30 hrs,	Volume=	0.107 af	
Secondary =	0.00 cfs @	5.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 603.16' @ 12.30 hrs Surf.Area= 3,235 sf Storage= 3,339 cf

Plug-Flow detention time= 138.7 min calculated for 0.106 af (62% of inflow)
Center-of-Mass det. time= 65.8 min (844.1 - 778.3)

Volume	Invert	Avail.Storage	Storage Description
#1	602.00'	10,437 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

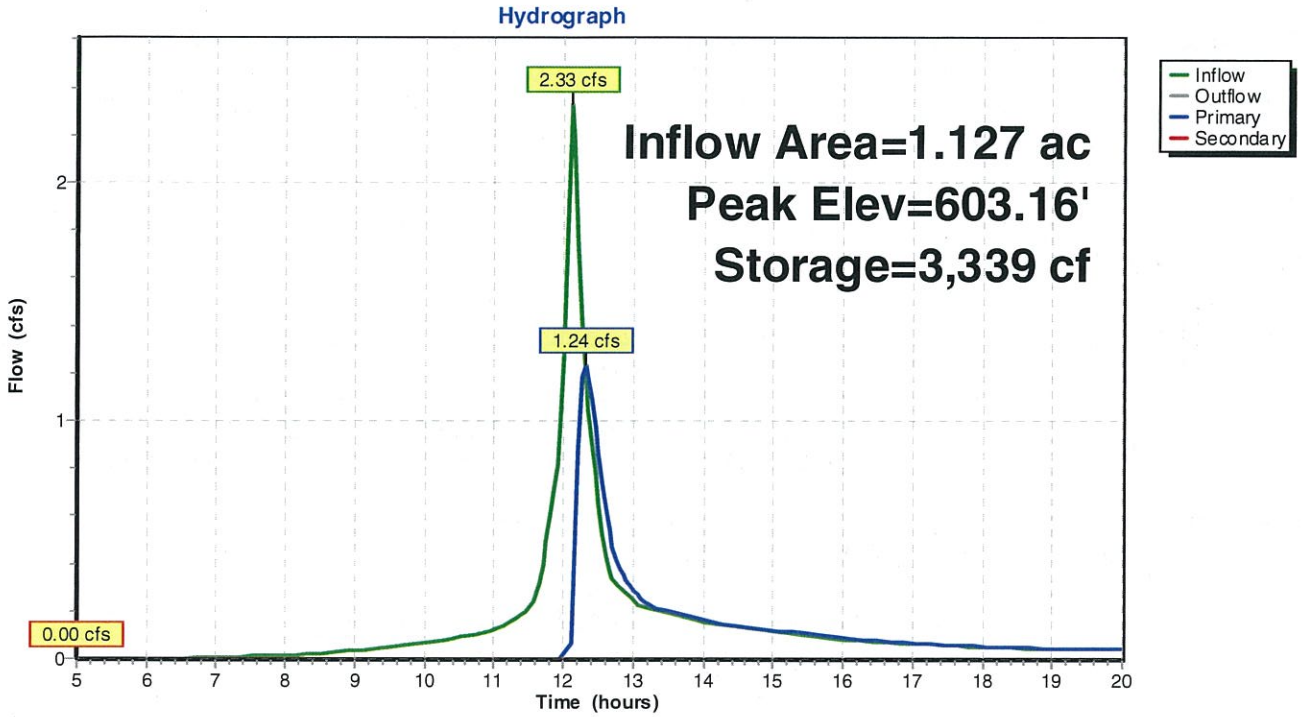
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
602.00	2,508	0	0
603.00	3,124	2,816	2,816
604.00	3,796	3,460	6,276
605.00	4,526	4,161	10,437

Device	Routing	Invert	Outlet Devices
#1	Primary	600.00'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 600.00' / 599.80' S= 0.0040 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	602.00'	**0.001 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#3	Device 1	603.00'	**17.0" x 17.0" Horiz. Neenah R-2560-E2** C= 0.600 Limited to weir flow at low heads
#4	Secondary	603.50'	**5.0' long x 5.0' 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) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=1.24 cfs @ 12.30 hrs HW=603.16' (Free Discharge)
└─**1=Culvert** (Passes 1.24 cfs of 8.77 cfs potential flow)
  ├─**2=Exfiltration** (Controls 0.00 cfs)
  └─**3=Neenah R-2560-E2** (Weir Controls 1.24 cfs @ 1.33 fps)

Secondary OutFlow Max=0.00 cfs @ 5.00 hrs HW=602.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 6P: Stormwater BMP



Summary for Pond 7P: Proposed Site Storm Drain Outlet

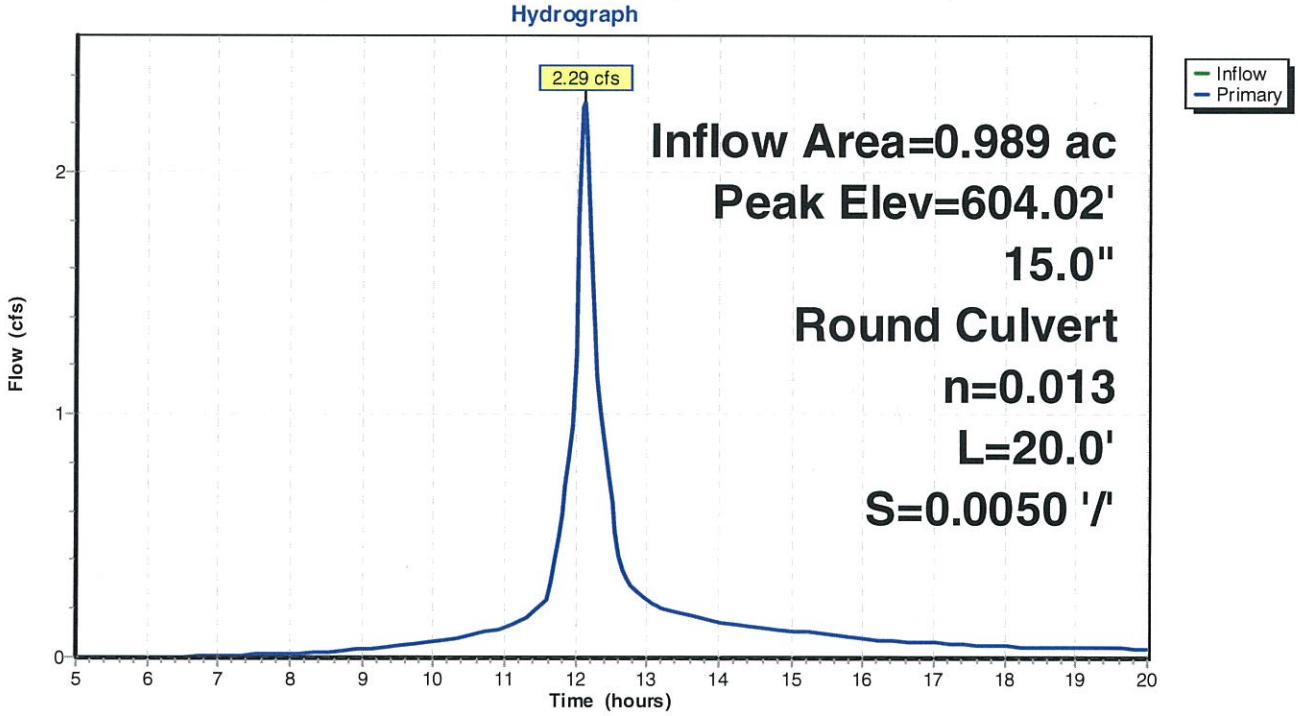
Inflow Area =	0.989 ac, 77.59% Impervious, Inflow Depth > 2.04" for 2 Year event				
Inflow =	2.29 cfs @	12.11 hrs, Volume=	0.168 af		
Outflow =	2.29 cfs @	12.11 hrs, Volume=	0.168 af, Atten= 0%, Lag= 0.0 min		
Primary =	2.29 cfs @	12.11 hrs, Volume=	0.168 af		

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 604.02' @ 12.11 hrs
Flood Elev= 606.80'

Device	Routing	Invert	Outlet Devices
#1	Primary	603.10'	**15.0" Round Culvert** L= 20.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 603.10' / 603.00' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=2.23 cfs @ 12.11 hrs HW=604.00' (Free Discharge)
└**1=Culvert** (Barrel Controls 2.23 cfs @ 3.29 fps)

Pond 7P: Proposed Site Storm Drain Outlet



Summary for Pond DP1: Site Storm Drain Outlet

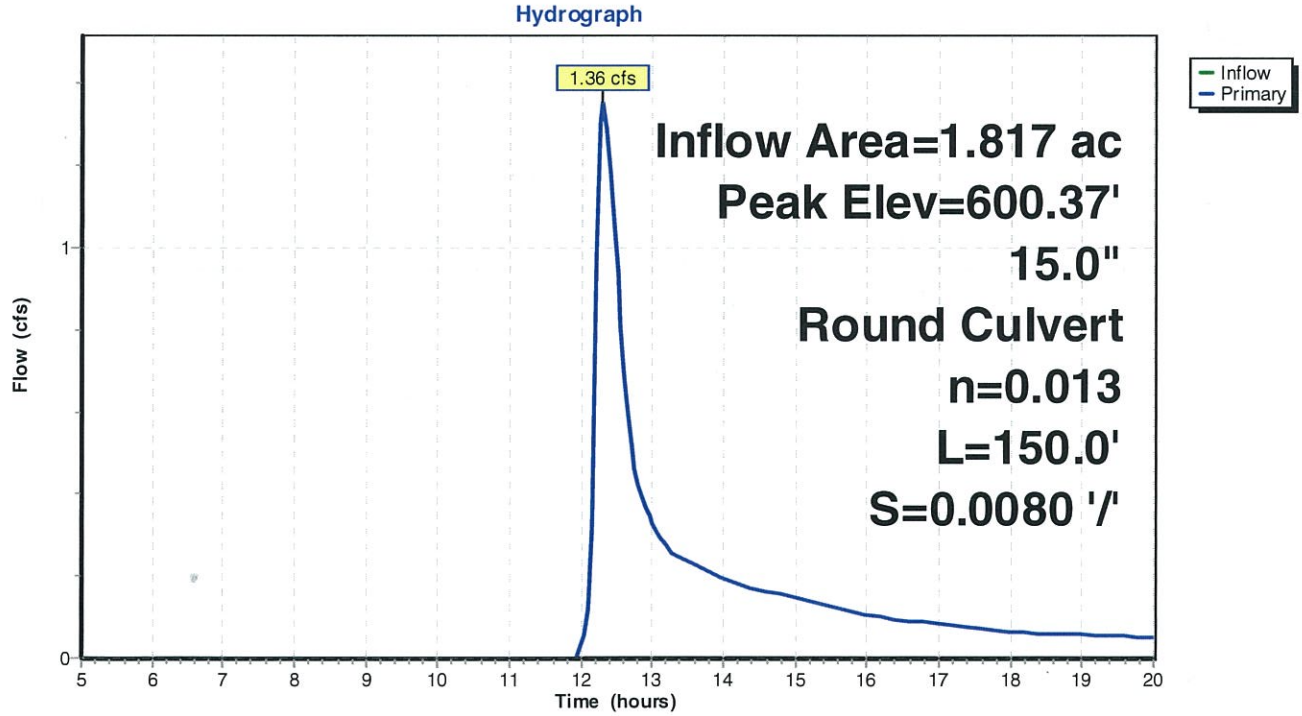
Inflow Area =	1.817 ac, 42.50% Impervious, Inflow Depth > 0.82" for 2 Year event				
Inflow =	1.36 cfs @	12.30 hrs, Volume=	0.123 af		
Outflow =	1.36 cfs @	12.30 hrs, Volume=	0.123 af, Atten= 0%, Lag= 0.0 min		
Primary =	1.36 cfs @	12.30 hrs, Volume=	0.123 af		

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 600.37' @ 12.30 hrs
Flood Elev= 604.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	599.80'	**15.0" Round Culvert** L= 150.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 599.80' / 598.60' S= 0.0080 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf

Primary OutFlow Max=1.35 cfs @ 12.30 hrs HW=600.37' (Free Discharge)
└─**1=Culvert** (Barrel Controls 1.35 cfs @ 3.64 fps)

Pond DP1: Site Storm Drain Outlet

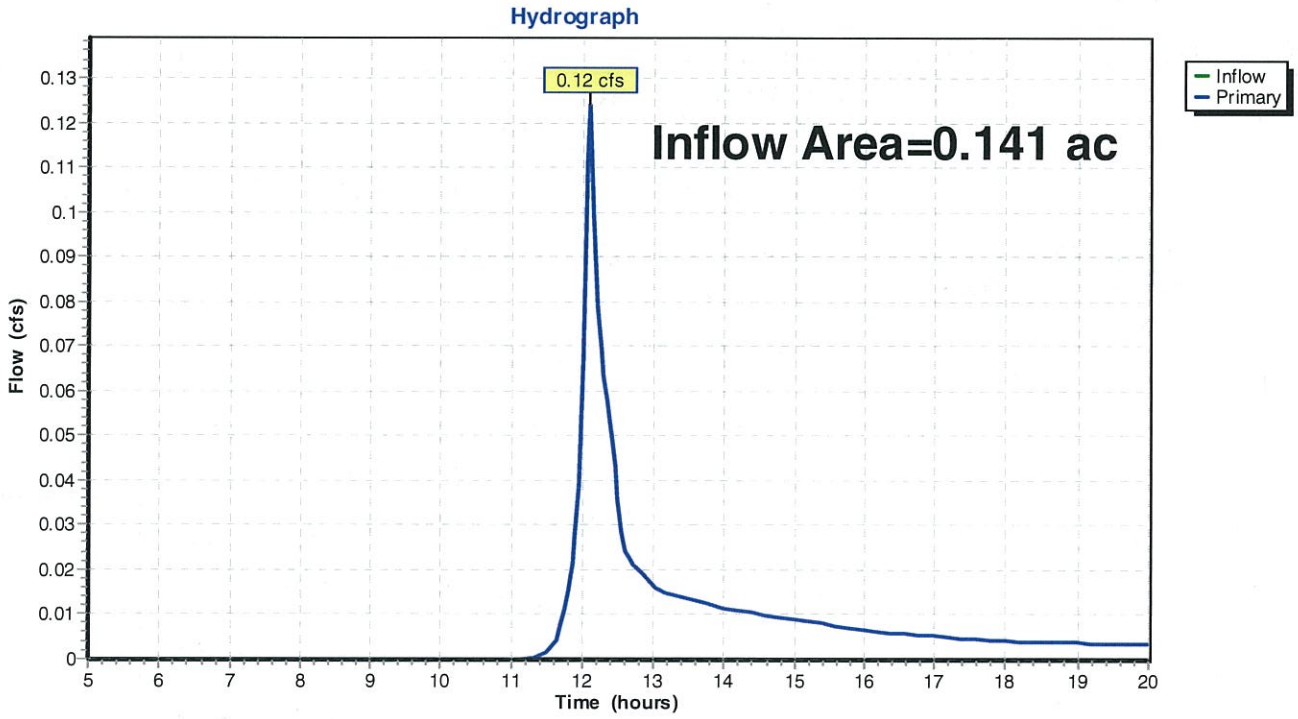


Summary for Pond DP2: CT 195 Storm Drain

Inflow Area = 0.141 ac, 23.21% Impervious, Inflow Depth > 0.75" for 2 Year event
Inflow = 0.12 cfs @ 12.09 hrs, Volume= 0.009 af
Primary = 0.12 cfs @ 12.09 hrs, Volume= 0.009 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Pond DP2: CT 195 Storm Drain



Summary for Pond DP3: CT 320 18" RCP Culvert

Inflow Area = 2.111 ac, 36.59% Impervious, Inflow Depth > 0.74" for 2 Year event
Inflow = 1.40 cfs @ 12.30 hrs, Volume= 0.131 af
Outflow = 1.39 cfs @ 12.30 hrs, Volume= 0.131 af, Atten= 1%, Lag= 0.1 min
Primary = 1.39 cfs @ 12.30 hrs, Volume= 0.131 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 597.73' @ 12.30 hrs Surf.Area= 50 sf Storage= 13 cf

Plug-Flow detention time= 0.1 min calculated for 0.130 af (100% of inflow)
Center-of-Mass det. time= 0.1 min (849.1 - 848.9)

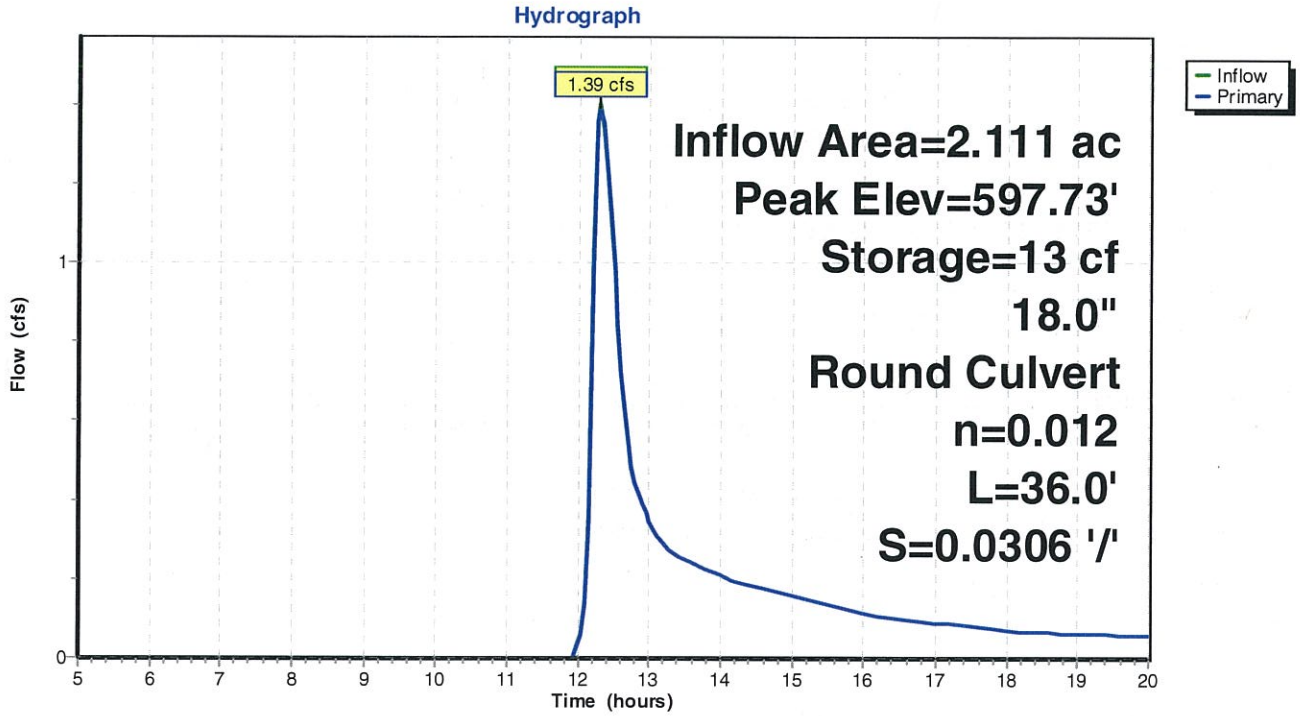
Volume	Invert	Avail.Storage	Storage Description
#1	597.20'	2,767 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
597.20	0	0	0
598.00	75	30	30
599.00	200	138	167
600.00	5,000	2,600	2,767

Device	Routing	Invert	Outlet Devices
#1	Primary	597.20'	**18.0" Round 18" RCP** L= 36.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 597.20' / 596.10' S= 0.0306 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf

Primary OutFlow Max=1.39 cfs @ 12.30 hrs HW=597.73' (Free Discharge)
└**1=18" RCP** (Inlet Controls 1.39 cfs @ 2.48 fps)

Pond DP3: CT 320 18" RCP Culvert



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1aS: To Proposed Site Runoff Area=43,089 sf 77.59% Impervious Runoff Depth>2.04"
Flow Length=335' Tc=8.1 min CN=90 Runoff=2.29 cfs 0.168 af

Subcatchment 1bS: Stormwater BMP Runoff Area=5,984 sf 0.00% Impervious Runoff Depth>0.39"
Tc=5.0 min CN=61 Runoff=0.05 cfs 0.004 af

Subcatchment 1S: To Existing Site Storm Runoff Area=30,085 sf 0.71% Impervious Runoff Depth>0.29"
Flow Length=560' Tc=5.0 min CN=58 Runoff=0.13 cfs 0.017 af

Subcatchment 2S: To CT 195 Runoff Area=6,160 sf 23.21% Impervious Runoff Depth>0.75"
Tc=5.0 min CN=70 Runoff=0.12 cfs 0.009 af

Subcatchment 3S: To CT 320 Runoff Area=12,784 sf 0.00% Impervious Runoff Depth>0.29"
Flow Length=255' Tc=9.7 min CN=58 Runoff=0.05 cfs 0.007 af

Pond 6P: Stormwater BMP Peak Elev=603.16' Storage=3,339 cf Inflow=2.33 cfs 0.172 af
Primary=1.24 cfs 0.107 af Secondary=0.00 cfs 0.000 af Outflow=1.24 cfs 0.107 af

Pond 7P: Proposed Site Storm Drain Outlet Peak Elev=604.02' Inflow=2.29 cfs 0.168 af
15.0" Round Culvert n=0.013 L=20.0' S=0.0050 '/' Outflow=2.29 cfs 0.168 af

Pond DP1: Site Storm Drain Outlet Peak Elev=600.37' Inflow=1.36 cfs 0.123 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=1.36 cfs 0.123 af

Pond DP2: CT 195 Storm Drain Inflow=0.12 cfs 0.009 af
Primary=0.12 cfs 0.009 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=597.73' Storage=13 cf Inflow=1.40 cfs 0.131 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=1.39 cfs 0.131 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.205 af Average Runoff Depth = 1.09"
64.25% Pervious = 1.447 ac 35.75% Impervious = 0.805 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1aS: To Proposed Site Runoff Area=43,089 sf 77.59% Impervious Runoff Depth>3.48"
Flow Length=335' Tc=8.1 min CN=90 Runoff=3.80 cfs 0.287 af

Subcatchment 1bS: Stormwater BMP Runoff Area=5,984 sf 0.00% Impervious Runoff Depth>1.13"
Tc=5.0 min CN=61 Runoff=0.18 cfs 0.013 af

Subcatchment 1S: To Existing Site Storm Runoff Area=30,085 sf 0.71% Impervious Runoff Depth>0.95"
Flow Length=560' Tc=5.0 min CN=58 Runoff=0.74 cfs 0.055 af

Subcatchment 2S: To CT 195 Runoff Area=6,160 sf 23.21% Impervious Runoff Depth>1.74"
Tc=5.0 min CN=70 Runoff=0.31 cfs 0.020 af

Subcatchment 3S: To CT 320 Runoff Area=12,784 sf 0.00% Impervious Runoff Depth>0.95"
Flow Length=255' Tc=9.7 min CN=58 Runoff=0.27 cfs 0.023 af

Pond 6P: Stormwater BMP Peak Elev=603.33' Storage=3,879 cf Inflow=3.98 cfs 0.300 af
Primary=3.49 cfs 0.233 af Secondary=0.00 cfs 0.000 af Outflow=3.49 cfs 0.233 af

Pond 7P: Proposed Site Storm Drain Outlet Peak Elev=604.37' Inflow=3.80 cfs 0.287 af
15.0" Round Culvert n=0.013 L=20.0' S=0.0050 '/' Outflow=3.80 cfs 0.287 af

Pond DP1: Site Storm Drain Outlet Peak Elev=600.91' Inflow=4.06 cfs 0.288 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=4.06 cfs 0.288 af

Pond DP2: CT 195 Storm Drain Inflow=0.31 cfs 0.020 af
Primary=0.31 cfs 0.020 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=598.21' Storage=49 cf Inflow=4.33 cfs 0.311 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=4.33 cfs 0.311 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.398 af Average Runoff Depth = 2.12"
64.25% Pervious = 1.447 ac 35.75% Impervious = 0.805 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1aS: To Proposed Site Runoff Area=43,089 sf 77.59% Impervious Runoff Depth>4.12"
Flow Length=335' Tc=8.1 min CN=90 Runoff=4.46 cfs 0.340 af

Subcatchment 1bS: Stormwater BMP Runoff Area=5,984 sf 0.00% Impervious Runoff Depth>1.53"
Tc=5.0 min CN=61 Runoff=0.25 cfs 0.017 af

Subcatchment 1S: To Existing Site Storm Runoff Area=30,085 sf 0.71% Impervious Runoff Depth>1.31"
Flow Length=560' Tc=5.0 min CN=58 Runoff=1.07 cfs 0.076 af

Subcatchment 2S: To CT 195 Runoff Area=6,160 sf 23.21% Impervious Runoff Depth>2.23"
Tc=5.0 min CN=70 Runoff=0.40 cfs 0.026 af

Subcatchment 3S: To CT 320 Runoff Area=12,784 sf 0.00% Impervious Runoff Depth>1.31"
Flow Length=255' Tc=9.7 min CN=58 Runoff=0.39 cfs 0.032 af

Pond 6P: Stormwater BMP Peak Elev=603.37' Storage=4,020 cf Inflow=4.71 cfs 0.357 af
Primary=4.18 cfs 0.291 af Secondary=0.00 cfs 0.000 af Outflow=4.18 cfs 0.291 af

Pond 7P: Proposed Site Storm Drain Outlet Peak Elev=604.53' Inflow=4.46 cfs 0.340 af
15.0" Round Culvert n=0.013 L=20.0' S=0.0050 '/' Outflow=4.46 cfs 0.340 af

Pond DP1: Site Storm Drain Outlet Peak Elev=601.14' Inflow=5.01 cfs 0.366 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=5.01 cfs 0.366 af

Pond DP2: CT 195 Storm Drain Inflow=0.40 cfs 0.026 af
Primary=0.40 cfs 0.026 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=598.36' Storage=66 cf Inflow=5.40 cfs 0.398 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=5.40 cfs 0.398 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.491 af Average Runoff Depth = 2.62"
64.25% Pervious = 1.447 ac 35.75% Impervious = 0.805 ac

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1aS: To Proposed Site Runoff Area=43,089 sf 77.59% Impervious Runoff Depth>5.41"
Flow Length=335' Tc=8.1 min CN=90 Runoff=5.77 cfs 0.446 af

Subcatchment 1bS: Stormwater BMP Runoff Area=5,984 sf 0.00% Impervious Runoff Depth>2.42"
Tc=5.0 min CN=61 Runoff=0.41 cfs 0.028 af

Subcatchment 1S: To Existing Site Storm Runoff Area=30,085 sf 0.71% Impervious Runoff Depth>2.14"
Flow Length=560' Tc=5.0 min CN=58 Runoff=1.82 cfs 0.123 af

Subcatchment 2S: To CT 195 Runoff Area=6,160 sf 23.21% Impervious Runoff Depth>3.29"
Tc=5.0 min CN=70 Runoff=0.59 cfs 0.039 af

Subcatchment 3S: To CT 320 Runoff Area=12,784 sf 0.00% Impervious Runoff Depth>2.14"
Flow Length=255' Tc=9.7 min CN=58 Runoff=0.67 cfs 0.052 af

Pond 6P: Stormwater BMP Peak Elev=603.45' Storage=4,282 cf Inflow=6.17 cfs 0.473 af
Primary=5.55 cfs 0.407 af Secondary=0.00 cfs 0.000 af Outflow=5.55 cfs 0.407 af

Pond 7P: Proposed Site Storm Drain Outlet Peak Elev=604.93' Inflow=5.77 cfs 0.446 af
15.0" Round Culvert n=0.013 L=20.0' S=0.0050 '/' Outflow=5.77 cfs 0.446 af

Pond DP1: Site Storm Drain Outlet Peak Elev=602.34' Inflow=6.96 cfs 0.530 af
15.0" Round Culvert n=0.013 L=150.0' S=0.0080 '/' Outflow=6.96 cfs 0.530 af

Pond DP2: CT 195 Storm Drain Inflow=0.59 cfs 0.039 af
Primary=0.59 cfs 0.039 af

Pond DP3: CT 320 18" RCP Culvert Peak Elev=598.75' Storage=121 cf Inflow=7.63 cfs 0.582 af
18.0" Round Culvert n=0.012 L=36.0' S=0.0306 '/' Outflow=7.59 cfs 0.582 af

Total Runoff Area = 2.252 ac Runoff Volume = 0.688 af Average Runoff Depth = 3.66"
64.25% Pervious = 1.447 ac 35.75% Impervious = 0.805 ac

Appendix D

Project:	Cumberland Farms - Storrs, CT
Date:	July 6, 2011
CHA Project:	23016
Client Project:	
Description	Site

	Water Quality Volume (WQV) =	**(P)(R)(A)**			
P	1" of rainfall			1	
R	Unitless runoff coefficient	= 0.05+0.9(I)		0.66	
I	% impervious cover	= $Area_{impervious}$ / $Area_{total}$		0.68	
A	$Area_{total}$			49,073	sf
	$Area_{pervious}$			15,640	sf
	$Area_{impervious}$			33,433	sf
	WQV (acre-in)		WQV=	0.747	acre-in
	WQV (acre-ft)	= WQV / 12 in per ft	**WQV=**	**0.062**	**acre-ft**
	WQV (cf)	= WQV * 43560 sq ft per ac / 12 in per ft	**WQV=**	**2,712**	**cf**

	Water Quality Flow (WQF) =	**(q_u)(WQV)**			
I_a	Initial abstraction	= 0.2S		0.991	
S	Maximum retention (in)	= (1000/CN)-10		4.957	
CN	WQV curve number	= 1000/(10+5P-10Q-10[Q^2+1.25QP]^0.5)		66.86	
P	1" of rainfall			1	
Q	WQV depth (in)	= WQV/A		0.000	
I_a / P		= I_a / P		0.991	
t_c	Time of concentration	(0.1 hours minimum)		0.10	hr
q_u	Unit peak discharge	(from TR-55 Exhibit 4-II or 4-III)		650	cfs/mi^2/in
			WQF =	486	
	WQF (cfs)	= WQF / 640 acre per square mile	**WQF =**	**0.76**	**cfs**

WQV (square feet)