STORMWATER MANAGEMENT REPORT

MAY 23, 2018

PREPARED FOR:
CAROLS CORPORATION
BURGER KING
LIBERTY TOWNSHIP, OHIO

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Table of Contents

EXECUTIVE SUMMARY

Introduction

The following report presents the detailed design and analysis of the stormwater management plan for the new Carols Burger King at on Horse Shoe Bend Road, Liberty Township, OH.

Detention for the site will be provided through the use of a backwater basin and storm pipe. The disturbed area is 1.61 acres. The following designs were calculated to meet the Butler County Subdivision Regulations stormwater management criteria.

Hydrologic Analysis

All hydrologic parameters were determined using methodology described in the Butler County Subdivision Regulations. Both Pre-Development and Post-Development runoff and peak discharge amounts were calculated using HydroCAD 10.00-11 software.

Pre-Development Conditions

The existing 2.29 ac site consists of existing asphalt and concrete pavement and gravel and wooded areas. The existing site storm water drains to an existing swale that is classified as a stream on the southern portion of the site. The stream outlets to an existing 54" storm sewer on the adjacent property at the northwest corner of the site. A pre-developed number of 87 was calculated for the site as shown on Page 3 of the attached HydroCAD output. The proposed stormwater management system accounts for the disturbed 1.61 acre site. The pre-development peak runoff rates for each area are shown in Table 1.

Table 1
Pre-Development Peak Flow Rates

Storm Event (Yr.)	Peak Flow Rate[1] (cfs)
1	3.16
2	3.57
5	4.15
10	4.63
25	5.28
50	5.79
100	6.30

[1]From HydroCAD "Subcatchment 1S: Existing"

Post-Development Conditions

The proposed project consists of an approximately 3,000 square foot Burger King restaurant, a new parking lot, and the associated storm sewer system that discharges to an existing along the west side of the current property. The proposed development will reroute the existing stream and maintain the existing capacity and outlet. Refer to page 76. An orifice plate with a 7-inch diameter opening will restrict the developed flows to the required parameters. Due to the site constraints, 0.67 acres of the site will discharge directly offsite undetained. These small areas, mainly on the south and west limits of the disturbed area will maintain their existing drainage patterns. This discharge has been included in the analysis as a direct release and is included in the overall release rate. A post-developed curve number of 88 was calculated for the property as shown on Page 8 of the HydroCAD output. The post-development peak runoff rates for each area are shown in Table 2.

Analysis

The Butler County Subdivision Regulations requires the attenuation of post-developed peak site discharge in accordance with the Critical Storm Method. The Critical Storm Method requires the attenuation of the post-developed critical storm back to less than or equal to the pre-developed peak 1-year discharge rate. Additionally, for all storms greater than the critical storm, the development is required to reduce the flow rate by one storm event to the pre-development peak discharge rate.

Pre-Development 1-Year Storm Event: 0.140 af
Post-Development 1-Year Storm Event: 0.167 af
% Increase in runoff volume = 19.28% (2-year critical storm)

The post-development hydrographs were routed through the underground detention system which is restricted by an orifice to reduce the post-developed release rates. The direct release and the detained discharge hydrographs were combined to determine the actual release rates, which have been reduced to at or below the allowable rates

Post Construction Water Quality BMP

The proposed construction will disturb more than 1 acre; therefore the Ohio Environmental Protection Agency (OEPA) requires compliance with the “General Permit for Construction Storm Water Discharge”. The General Permit requires the construction of a Post-Construction Water Quality Best Management Practice (BMP). To conform to this requirement, the project will be utilizing an ADS Barracuda S-4 Water Quality Unit. Refer to page 6.

PROJECT SUMMARY

Project Name: Carols Corporation, Burger King

Location: Horse Shoe Bend Road, Liberty Township, OH

Project Description: The proposed project consists of an approximately 3,000 square foot Burger King restaurant, a new parking lot, and the associated storm sewer system

Existing Use: General Business (B-2)

Proposed Use: General Business (B-2)

Area: Disturbed area = 1.61 Ac.
Impervious Area = 0.78 Ac.

Detention Type: Dry Detention Basin

Critical Storm Event: 2 year post-developed storm event controlled to the pre-developed 1 year rate

EPA-Water Quality: ADS Barracuda S-4 Water Quality Unit

Table 2
Stormwater Management Summary Table

Storm Event (yr)	Pre-Developed Peak Flow Rates[1] (cfs)	Allowable Peak Flow Rates[2] (cfs)	Developed Flow Rates			Peak Ponding Elev. (ft)	Storage Vol. (cf)
			Detained Peak Flow[3] (cfs)	Un-detained Peak Flow[4] (cfs)	Total Peak Flow[5] (cfs)		
1	3.16	**3.16**	1.46	0.91	**2.34**	751.33	582
2	3.57	**3.16**	1.54	1.27	**2.76**	751.69	959
5	4.15	**3.57**	1.63	1.78	**3.33**	752.15	1,515
10	4.63	**4.15**	1.69	2.18	**3.78**	752.50	1,995
25	5.28	**4.63**	1.77	2.74	**4.40**	752.93	2,668
50	5.79	**5.28**	1.83	3.17	**4.88**	753.26	3,227
100	6.30	**5.79**	1.88	3.61	**5.35**	753.56	3,796

[1]From HydroCAD "Subcatchment 1S: Existing" [2]Based on 2-year critical storm. [3]From HydroCAD "Pond 3P: Detention Basin" [4]From HydroCAD "Subcatchment 4S: Undetained Runoff" [5]From HydroCAD "Link 5L: Total Discharge"

Water Quality Flow Determination

Area contributing to Alt BMP	**0.940**	**ac**
Impervious Area =	0.640	ac
Pervious Area =	0.300	
Composite Runoff Coefficient, C =	0.77	

$$C = \frac{(0.640 \times 0.90) + (0.30 \times 0.50)}{0.940} = 0.77$$

ODOT Table 1101-2

Types of Surface	C
Pavement	0.90
Berms and slopes 4:1 or flatter	0.50
Berms and slopes steeper than 4:1	0.70

Determine Q=CiA

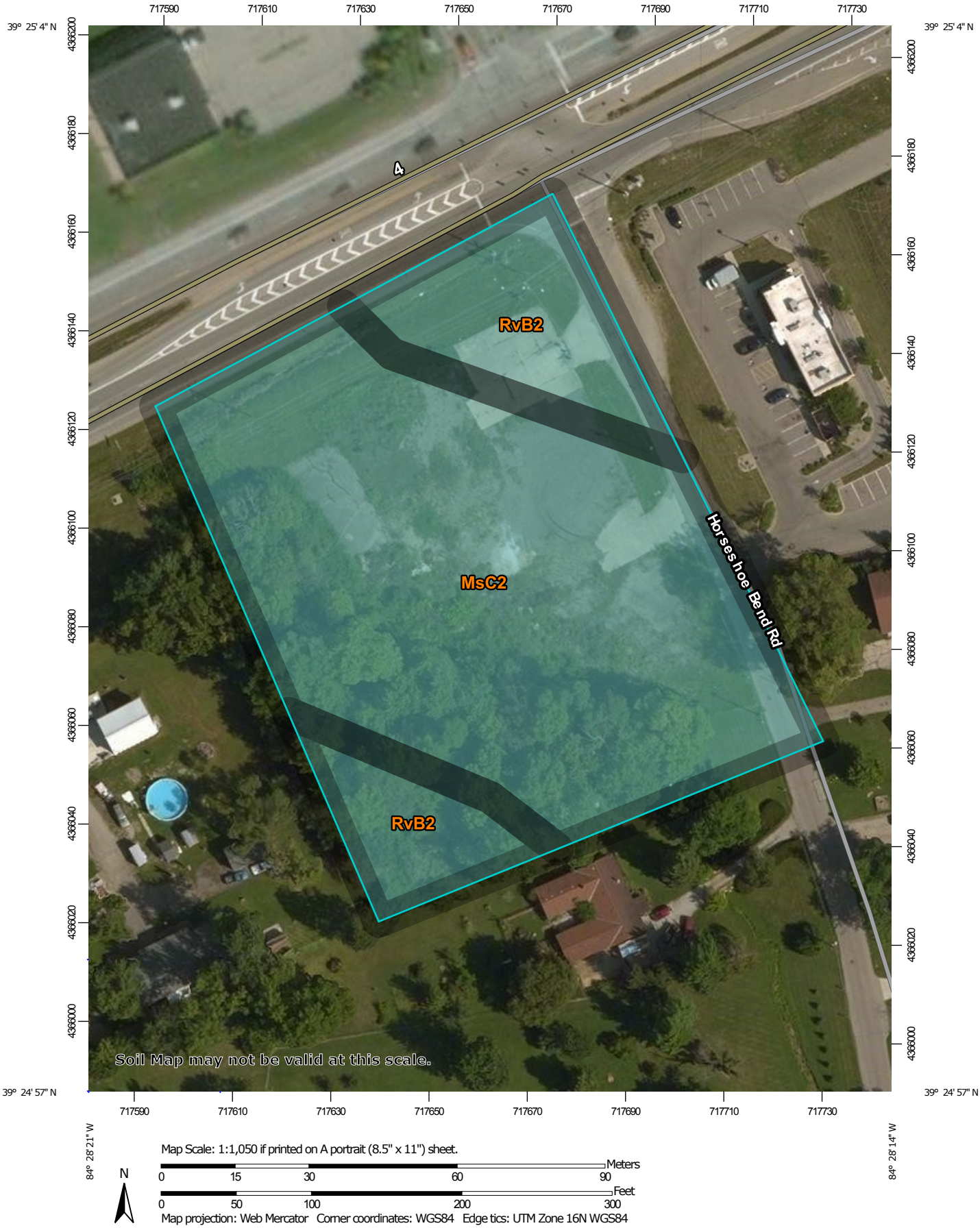
Composite Runoff Coefficient, C =	0.77	
Intensity, i =	0.65	inch/hour [from ODOT L&D Manual Vol. 2 Sect. 1115.5]
Area contributing to Alt BMP, A =	0.940	
Q =	**0.47**	cfs

Recommended Water Quality Unit: **ADS Barracuda S4**

Water Quality Unit Capacity: **1.25** cfs

Soil Map

Hydrologic Soil Group—Butler County, Ohio
(Carols BK - Liberty Twp)



Map Scale: 1:1,050 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Butler County, Ohio
Survey Area Data: Version 16, Sep 26, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 6, 2012—Oct 26, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
MsC2	Miamian-Russell silt loams, 6 to 12 percent slopes, eroded	C	2.1	76.6%
RvB2	Russell-Miamian silt loams, 2 to 6 percent slopes, moderately eroded	C	0.7	23.4%
Totals for Area of Interest			**2.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix 9: Adjusting Hydrologic Soil Group for Construction

This appendix provides hydrologic soil group (HSG) values for undisturbed Ohio soils and predictable HSG values for Ohio soils that are altered by construction practices.

Hydrologic soil groups are used to assign a Curve Number (CN) when performing runoff calculations or in hydrologic models. Soil map units have been assigned to the four Hydrologic Soil Groups in technical resources and soil resources published by the USDA Natural Resource Conservation Service[1] (NRCS). NRCS HSG values are based on undisturbed, naturally-occurring soils. In contrast, soils at development sites are typically changed dramatically by construction practices that remove topsoil, change the soil profile and compact soils with heavy equipment. The runoff potential of a site is significantly impacted by these changes and should be reflected in hydrologic modeling and runoff calculations.

The following tables contain the HSGs and predicted HSGs for post-construction that were developed by applying the HSG criteria to modeled representative post-construction soil profiles. The modeled scenario consisted of the removal of the topsoil and subsoil to a depth of 18 inches and the compaction of the zone from 0 to 6 inches at the new surface. A fuller explanation of this process is available at the end of this appendix.

Soil Map Unit Component	HSG[1]	Post-Const HSG
Aaron	C	D
Abscota Variant (Warren)	A	No Eval.
Adrian	A/D	D
Aetna	B/D	D
Alexandria	C	D
Alford	B	D
Algansee	A/D	D
Algiers	B/D	D
Allegheny	B	C
Allegheny Variant (Belmont, Pike)	B	No Eval.
Allis	D	D
Alvada	B/D	D
Amanda	C	D
Amanda Variant (Licking)	B	No Eval.
Arkport	A	A
Ashton	B	D
Atlas	D	D
Aurand	C/D	D
Ava	C	D
Avonburg	D	D
Barkcamp	A	No Eval.

Soil Map Unit Component	HSG[1]	Post-Const HSG
Barkcamp (CL surface)	A	A
Barkcamp (L surface)	A	B
Beasley	C	No Eval.
Beaucoup	C/D	D
Belmore	B	C
Belpre	C	No Eval.
Bennington	C/D	D
Berks	B	D
Bethesda	C	D
Biglick	D	D
Birkbeck	B	D
Bixler	B	D
Blairton	C	No Eval.
Blakeslee	B/D	D
Blanchester	C/D	D
Blount	C/D	D
Bogart	B/D	D
Bogart Variant (Mahoning)	C	No Eval.
Bonnell	C	D
Bonnie	C/D	D
Bono	C/D	D

Notes: CL = clay loam; L = loam; substr = substratum; limestne substr = limestone substratum; Dual classes in Ohio, such as A/D, B/D, C/D are given for drained or undrained condition; No Eval. = No evaluation performed.

1. Hydrologic Soil Groups (HSGs) for Ohio (for undisturbed naturally-occuring sites) were updated in 2008 and should be used rather than HSGs from earlier publications (http://www.oh.nrcs.usda.gov/technical/soils/OH_hsg.pdf or contact the USDA Natural Resources Conservation Service in Columbus, Ohio). You may also utilize www.OhioERIN.com to find site specific HSG (unaltered).

Soil Map Unit Component	HSG[1]	Post-Const HSG
Hoytville Variant	C/D	D
Huntington	B	D
Hyatts	C/D	D
Ionia	B	No Eval.
Iva	C/D	D
Jenera	C/D	D
Jeneva	B	No Eval.
Jessup	C	D
Jimtown	B/D	D
Johnsburg	D	D
Joliet	D	D
Jonesboro	C	D
Jules	B	No Eval.
Kanawha	B	C
Kane	B/D	D
Keene	C	D
Kendallville	C	C
Kensington	B	C/D
Kerston	C/D	D
Kibbie	B/D	D
Killbuck	C/D	D
Kings Variant	C/D	D
Kingsville	A/D	D
Kinn	B	No Eval.
Knoxdale	B	No Eval.
Kokomo	C/D	D
Kyger	A/D	D
Lakin	A	A
Lamberjack	B/D	D
Lamson	A/D	D
Landes	A	A
Lanier	A	A
Latham	D	D
Latty	C/D	D
Latty (till substr)	C/D	D
Lawshe	D	D
Lenawee	C/D	D
Lenawee Variant	C/D	D
Leoni	A	No Eval.
Lewisburg	D	D
Library Variant	C/D	D
Libre	C	No Eval.
Licking	C	D
Lily	B	D

Soil Map Unit Component	HSG[1]	Post-Const HSG
Lindside	C	D
Linwood	B/D	D
Lippincott	B/D	D
Lobdell	C	D
Lockport	D	D
Lorain	C/D	D
Lordstown	C	D
Lorenzo	A	No Eval.
Losantville	D	D
Loudon	C	D
Loudonville	C	D
Lowell	C	D
Lucas	D	D
Lumberton	B	D
Luray	C/D	D
Luray Variant (Stark)	B/D	D
Lybrand	C	D
Lykens	C	D
Mahalasville	B/D	D
Mahoning	C/D	D
Marblehead	D	D
Marengo	B/D	D
Markland	C	D
Martinsville	B	D
Martisco	B/D	D
Martisco Variant (Logan)	C/D	D
McGary	C/D	D
McGary Variant	C/D	D
McGuffey	D	D
Mechanicsburg	B	C
Medway	C	D
Medway Variant	C	D
Medway (limestne substr)	B/D	D
Melvin	B/D	D
Mentor	B	D
Mermill	C/D	D
Mermill Variant	C/D	D
Mertz	C	C
Metamora	B/D	D
Miami	C	D
Miami Variant	C	No Eval.
Miamian	C	D
Miamian Variant	C	No Eval.
Milford	C/D	D

Notes: CL = clay loam; L = loam; substr = substratum; limestne substr = limestone substratum; Dual classes in Ohio, such as A/D, B/D, C/D are given for drained or undrained condition; No Eval. = No evaluation performed.

1. Hydrologic Soil Groups (HSGs) for Ohio (for undisturbed naturally-occuring sites) were updated in 2008 and should be used rather than HSGs from earlier publications (http://www.oh.nrcs.usda.gov/technical/soils/OH_hsg.pdf or contact the USDA Natural Resources Conservation Service in Columbus, Ohio). You may also utilize www.OhioERIN.com to find site specific HSG (unaltered).

Soil Map Unit Component	HSG[1]	Post-Const HSG
Ravenna	D	D
Rawson	D	D
Red Hook	B/D	D
Reesville	B/D	D
Remsen	D	D
Rensselaer	B/D	D
Rensselaer (till substr)	B/D	D
Richland	B	D
Riddles	B	C
Rigley	A	A
Rigley Variant	A	No Eval.
Rimer	A/D	D
Rimer (deep phase)	A/D	D
Risingsun	C/D	D
Ritchey	D	D
Rittman	D	D
Rockmill	B/D	D
Rodman	A	A
Rollersville	C/D	D
Romeo	D	D
Roselms	D	D
Ross	B	C
Ross Variant	D	D
Rossburg	B	D
Rossmoyne	C	D
Roundhead	C/D	D
Rush	B	D
Russell	B	D
Russell (bedrock substr)	B	No Eval.
Sandusky	B/D	D
Sarahsville	D	D
Saranac	C/D	D
Sardinia	B	D
Savona	B/D	D
Saylesville	C	D
Schaffenaker	A	D
Schaffer	C/D	D
Scioto	B	No Eval.
Sciotoville	C	D
Sebring	C/D	D
Sebring Variant	C/D	D
Secondcreek	C/D	D
Sees	C	D
Senecaville	C/D	D

Soil Map Unit Component	HSG[1]	Post-Const HSG
Seward	A	D
Sewell	A	No Eval.
Shawtown	B	No Eval.
Sheffield	D	D
Shelocta	B	D
Shinrock	C	D
Shinrock Variant (Henry)	C/D	D
Shinrock (till substr)	C/D	D
Shoals	B/D	D
Shoals (mod deep)	C/D	D
Shoals Variant	C/D	D
Sisson	B	D
Skidmore	A	C
Skidmore Variant	A	No Eval.
Sleeth	B/D	D
Sligo	B	No Eval.
Sloan	B/D	D
Sloan (mod deep)	B/D	D
Sloan Variant	B/D	D
Sloan (limestone substr)	B/D	D
Smothers	C/D	D
Spargus	B	No Eval.
Sparta	A	No Eval.
Spinks	A	A
Spinks (deep to limestone)	A	No Eval.
St. Clair	D	D
Stafford	A/D	D
Stanhope	B/D	D
Steinsburg	B	D
Stendal	B/D	D
Stone	C/D	D
Stonelick	A	B
Strawn	D	D
Stringley	A	No Eval.
Sugarvalley	B/D	D
Summitville	C	D
Swanton	B/D	D
Switzerland	B	No Eval.
Taggart	C/D	D
Tarhollow	C	D
Tarlton	C	No Eval.
Tedrow	A/D	D
Tedrow (till substr) (Wood)	C/D	D
Teegarden	C/D	D

Notes: CL = clay loam; L = loam; substr = substratum; limestne substr = limestone substratum; Dual classes in Ohio, such as A/D, B/D, C/D are given for drained or undrained condition; No Eval. = No evaluation performed.

1. Hydrologic Soil Groups (HSGs) for Ohio (for undisturbed naturally-occuring sites) were updated in 2008 and should be used rather than HSGs from earlier publications (http://www.oh.nrcs.usda.gov/technical/soils/OH_hsg.pdf or contact the USDA Natural Resources Conservation Service in Columbus, Ohio). You may also utilize www.OhioERIN.com to find site specific HSG (unaltered).

Hydrologic Soil Groups for Post-construction Soils

Overview

Hydrologic soil groups were created as a simple means to categorize inherent soil runoff potential and are commonly used to assign an appropriate Curve Number (CN) for hydrologic modeling purposes. Soil types have been assigned to hydrologic soil groups (HSG) in soil survey publications. In Ohio the HSGs are based on undisturbed, naturally occurring soils in an agricultural field or woodland setting. Soils properties at development sites are often changed dramatically by construction practices. Topsoil is removed, soil profiles are truncated or covered by grading activities, and exposed surfaces are compacted by heavy equipment traffic. The runoff potential is significantly impacted by these changes to the soil. This project predicts changes to HSG for soils that are altered by standard construction practices by applying the HSG criteria to modeled post-construction soil profiles.

Data for soil horizons from the USDA National Soil Information System (NASIS[1]) database were used to represent pre-construction profiles. From soil series with HSG = A, B or C, 150 soil series of significant extent in Ohio were selected for evaluation. A representative component was selected from official data sets for each series from commonly occurring map units. The standard construction practices were defined as: the removal of 18 inches of soil material from the top of the soil profile and the compaction of the zone from 0 to 6 inches at the new surface. To mirror the impact of the construction practices, layer depths in the component soil moisture table data were adjusted to reflect the removal of 18 inches (46 cm.) of soil. Similar adjustments were made to layer depths for the component soil moisture (water table) table and the component restrictions (impermeable layers) table. At the new surface, the top 6-inch (15 cm.) layer was modified in the component horizon table to show changes in infiltration caused by compaction at the surface. The USDA SPAW[2] tool was used to populate infiltration rates for the compacted soils utilizing pedon transfer functions. A report generator in NASIS was programmed to assign HSG criteria to each component. A comparison of the model's pre-construction to post-construction HSG values showed that most soils are downgraded by 1 or 2 HSG classes as a result of standard construction practices.

Methods

To calculate post-construction HSG, standard construction practices were defined as: the removal of 18 inches of soil material from the top of the soil profile and the compaction of the zone from 0 to 6 inches at the new surface.

In 2008, USDA-NRCS soil scientists in Ohio revised the HSG assigned to soil map unit data in their NASIS database. HSG were revised because of changes to Part 630 Chapter 7 of the National Engineering Handbook. Criteria for assignment of HSG was revised in Chapter 7. The published data had been compiled from manual calculations of soil profile data for each map unit. The previously published HSGs were computed on a component (soil series) basis, with representative groups based on the series typical pedon description and Soil Interpretation Record (old Soil 5 form) depths. For the revi-

1 Information regarding the USDA National Soil Information System (NASIS) database is available at http://soils.usda.gov/technical/nasis/index.html.

2 SPAW is a daily hydrologic budget model for agricultural fields and ponds developed by Dr. Keith Saxton, USDA-ARS (retired). This model includes a Soil Water Characteristics Hydraulic Properties Calculator, a program developed by Saxton and Dr. Walter Rawls USDA-ARS (retired) that can be used to estimate soil water tension, conductivity and water holding capability based on soil texture, organic matter, gravel content, salinity, and compaction. The model is available at: http://hydrolab.arsusda.gov/SPAW/Index.htm (site last updated on Oct 29, 2009).

sion, they used a report generator that calculated HSGs from published soil layer data. A large number of map units had different groups when calculated with the report generator than what had been published in the official data set. The report generator, which uses the criteria from Chapter 7 of Part 630 NEH, is run on soil map units, not components (series). Because of variation in depth to restrictive features, similar map units could receive different HSG by using the report generator. The differences in HSGs were due to changes in criteria in addition to variations between map units of the same component. In 2008 and 2009, NRCS edited their official data to show the revised HSG values. From the revised HSG values, soil components (series) with HSG = A, B or C, 150 soil series of significant extent in Ohio were selected for evaluation.

Soil component data is published by county soil survey areas in Ohio. To reflect regional variations in soil properties for a single named component, each county's component data set is unique for the occurrence of that soil type in that county – and in some counties, the component data is unique for each occurrence in a map unit. For a single component soil type named, the statewide database may contain a few, several or many unique data sets. An effort was made to select a representative component data set for each component by reviewing map unit characteristics. Map unit extent and distribution was evaluated. Preference was given to map units with larger acreage and to map units centrally located to the geographic distribution.

Layer depths in the component horizon (CH) table data were adjusted to reflect the removal of 18 inches (46 cm.) of soil. Any layer where bottom depth is less than or equal to 46 cm was deleted. Any layer where the bottom depth was greater than 46 cm and the top depth was less than 46 cm, the top depth was set at 0 cm. and 46 cm. was subtracted from the bottom depth. If the resulting layer was less than 6 cm. thick, it was deleted and the top depth of the next lowest layer was set at 0 cm. Where top depth greater than 46 cm, 46 cm was subtracted from both top and bottom depth.

The depth of two soil features that influence HSG are tracked independently of the CH table: soil water tables and soil restrictive features. Depth to soil water tables is stored in the component soil moisture (CSM) table and depth to restrictive features is stored in the component restrictions (CR) table. In both tables, top and bottom layer depths for all layers were edited by subtracting 46 cm, and values less than 0 cm edited as 0 cm.

Layer depths and Ksat values in the CH table data were adjusted to reflect creation of a 6 in. (15 cm.) zone of compacted surface during construction. If the thickness of the surface layer of the cut-soil was less than or equal to 25 cm the entire layer was used to represent the compacted zone. If it was greater than 25 cm, the upper 15 cm was replicated and modified to show compaction. The surface layer of the cut soil was copied and pasted above the original layer. The depths of the pasted layer were set at top equal to 0 cm and bottom equal to 15 cm. The top depth for the copied layer was set at top equal to 15 cm.

The USDA-ARS pedon transfer function tool 'SPAW' was used to calculate the Ksat values for the compacted surface. Ksat low range values were calculated using high clay percent and low sand percent and gravel percent; and conversely Ksat high values were calculated using low clay percent and high sand and gravel percent. Organic matter and salinity were assumed to be 0 percent. The compaction level was set at 'dense' resulting in a 110 percent compaction value.

Data used in the post-construction calculations for HSG values can be viewed in NASIS.

Load data from Area Type equal to Ohio Urban; Area equal to Ohio Urban Land; and Area Symbol equal to OHUL. Legend status equal to 'non-project'. An edit setup in the MO13 directory named "Marietta Urban" was created to view layer data that was edited in the post-construction data map units. The standard report named "EXPORT HSG data;" in the MO11 Directory was used to generate HSGs.)

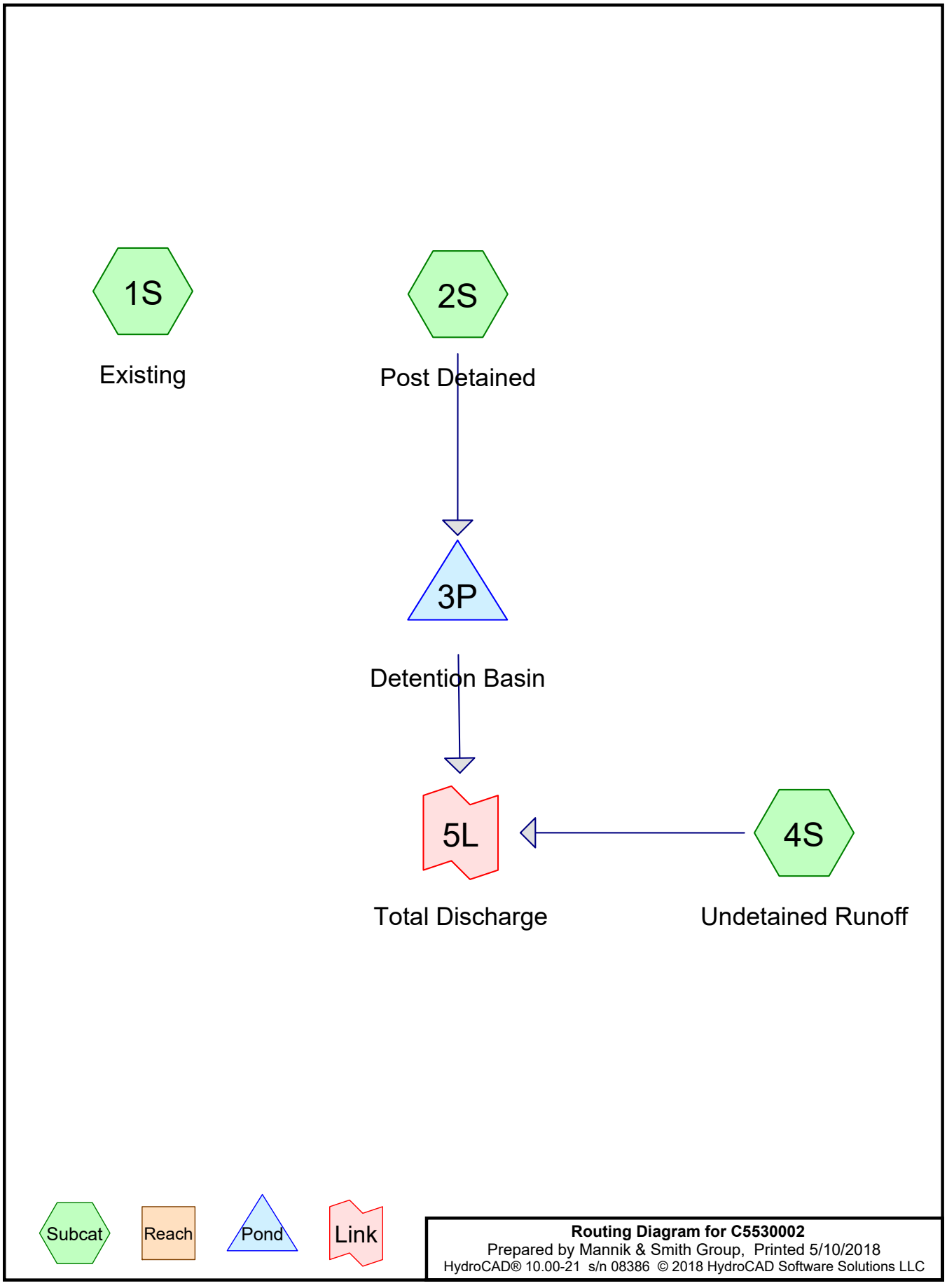
Site Data

As a companion project to the development of the post-construction data set for NASIS, ODNR-DSWC soil scientist planned to gather soil profile descriptions for post-construction soils. The goal was to see how accurately the standard construction practices, as defined in our model (the removal of 18 inches of soil material from the top of the soil profile and the compaction of the zone from 0 to 6 inches at the new surface), matched actual site data gathered from the field.

Urban sites and soil types were identified for sampling. In the field, site disturbances from construction practices were verified and profile descriptions were taken from small hand-dug pits. When site conditions permitted, adjacent, undisturbed soils were also described. The extent of sampling was curtailed by staff reductions that occurred during the project.

From 13 sites, 24 profile descriptions were collected: 14 descriptions were classified as 'post-construction' and the remaining 10 descriptions were natural soils adjacent to the construction sites. The post-construction soils were judged to be cut profiles at 4 sites; fill profiles at 9 sites and 1 site was undetermined. Compaction was evaluated at the sites with a hand held penetrometer and by physical observations. At most sites compaction was rated severe in at least one horizon. The compacted horizon was not always the surface horizon.

HydroCAD Output



Routing Diagram for C5530002
Prepared by Mannik & Smith Group, Printed 5/10/2018

Summary for Subcatchment 1S: Existing

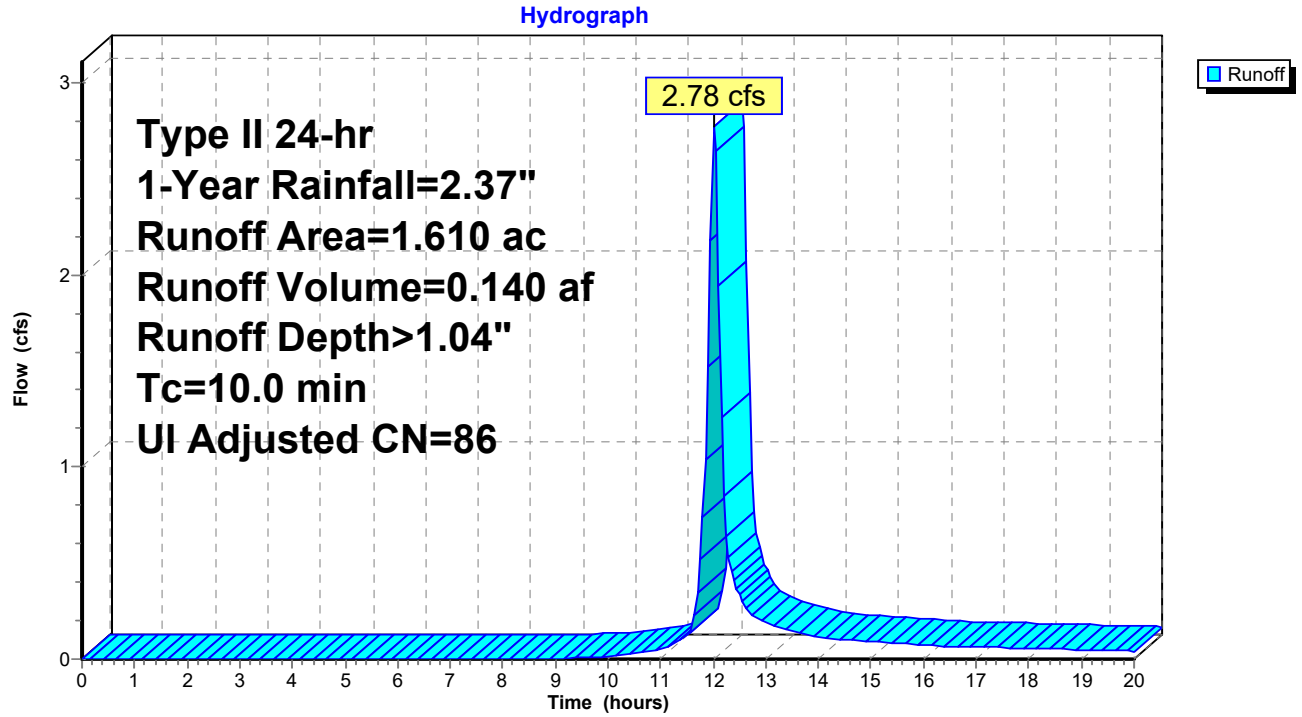
Runoff = 2.78 cfs @ 12.02 hrs, Volume= 0.140 af, Depth> 1.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=2.37"

Area (ac)	CN	Adj	Description
0.680	96		Gravel surface, HSG C
0.470	73		Woods, Fair, HSG C
0.240	98		Unconnected pavement, HSG D
0.220	80		>75% Grass cover, Good, HSG D
1.610	87	86	Weighted Average, UI Adjusted
1.370			85.09% Pervious Area
0.240			14.91% Impervious Area
0.240			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Post Detained

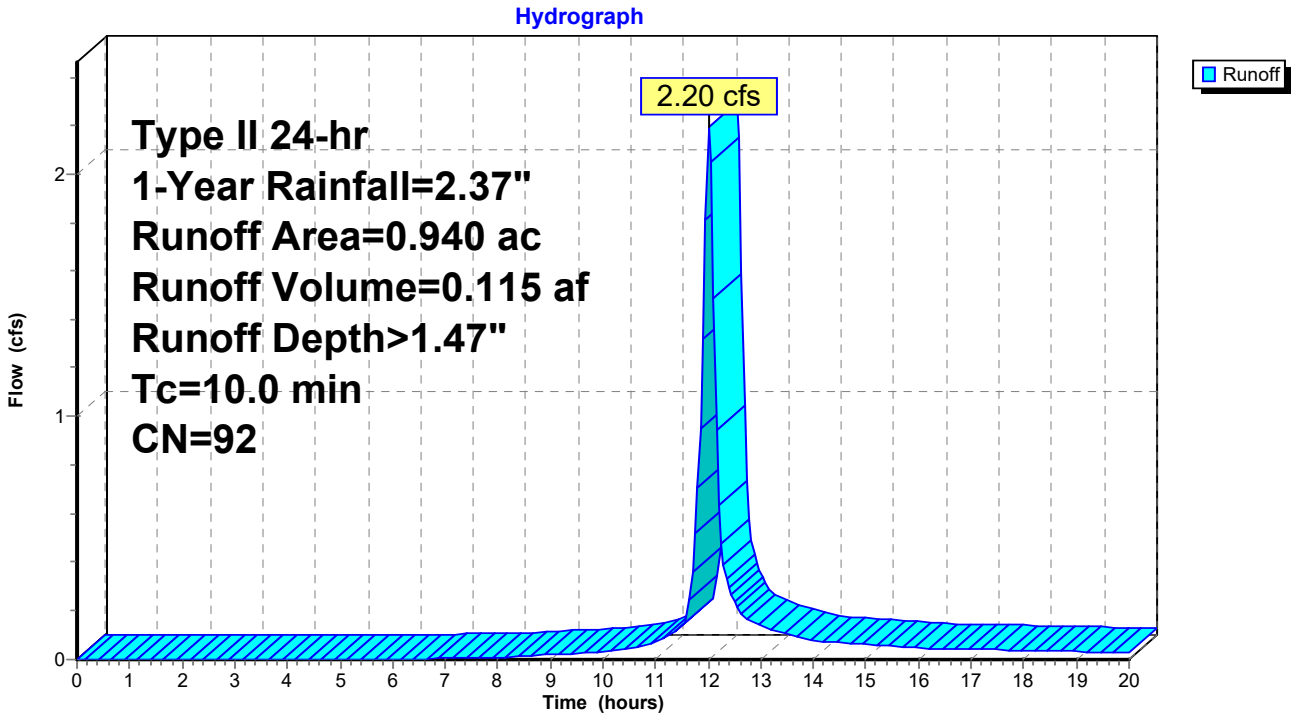
Runoff = 2.20 cfs @ 12.01 hrs, Volume= 0.115 af, Depth> 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=2.37"

Area (ac)	CN	Description
0.640	98	Paved parking, HSG C
0.300	80	>75% Grass cover, Good, HSG D
0.940	92	Weighted Average
0.300		31.91% Pervious Area
0.640		68.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 2S: Post Detained



Summary for Subcatchment 4S: Undetained Runoff

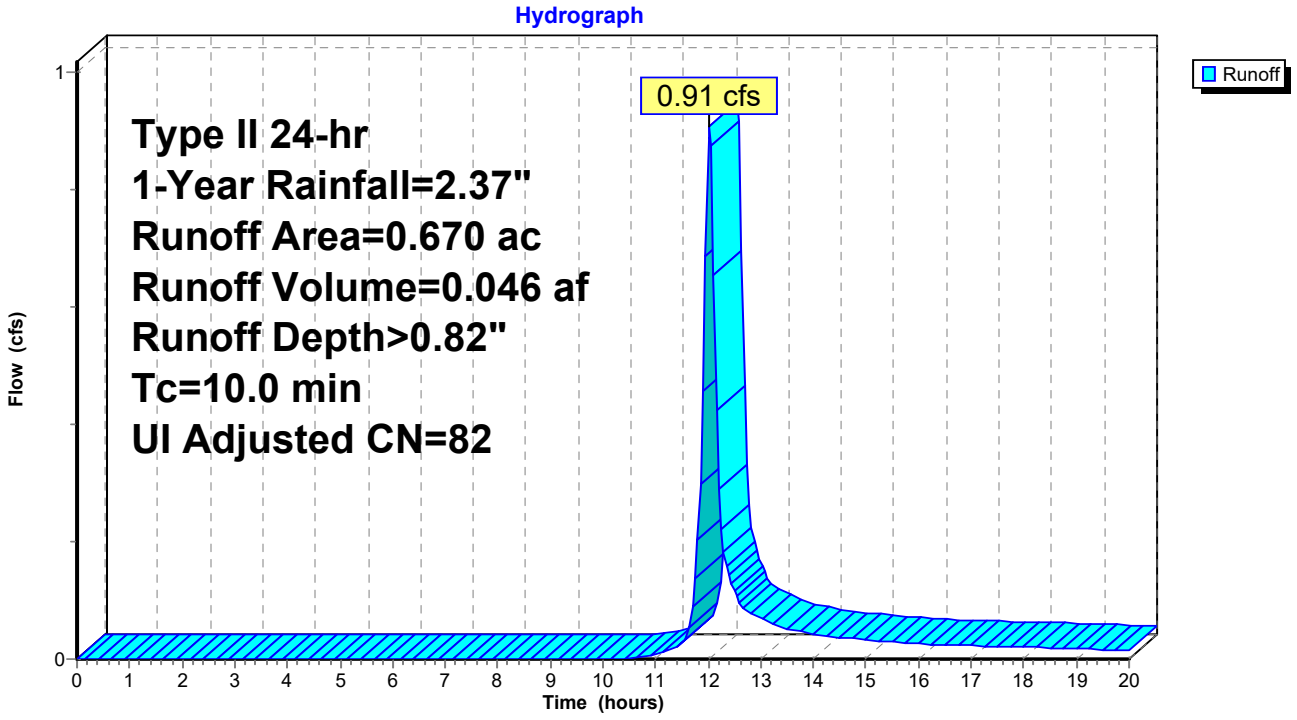
Runoff = 0.91 cfs @ 12.02 hrs, Volume= 0.046 af, Depth> 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 1-Year Rainfall=2.37"

Area (ac)	CN	Adj	Description
0.530	80		>75% Grass cover, Good, HSG D
0.140	98		Unconnected pavement, HSG D
0.670	84	82	Weighted Average, UI Adjusted
0.530			79.10% Pervious Area
0.140			20.90% Impervious Area
0.140			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 4S: Undetained Runoff



Summary for Pond 3P: Detention Basin

Inflow Area = 0.940 ac, 68.09% Impervious, Inflow Depth > 1.47" for 1-Year event
Inflow = 2.20 cfs @ 12.01 hrs, Volume= 0.115 af
Outflow = 1.46 cfs @ 12.10 hrs, Volume= 0.115 af, Atten= 34%, Lag= 5.5 min
Primary = 1.46 cfs @ 12.10 hrs, Volume= 0.115 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 751.33' @ 12.10 hrs Surf.Area= 980 sf Storage= 581 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 2.4 min (774.3 - 771.9)

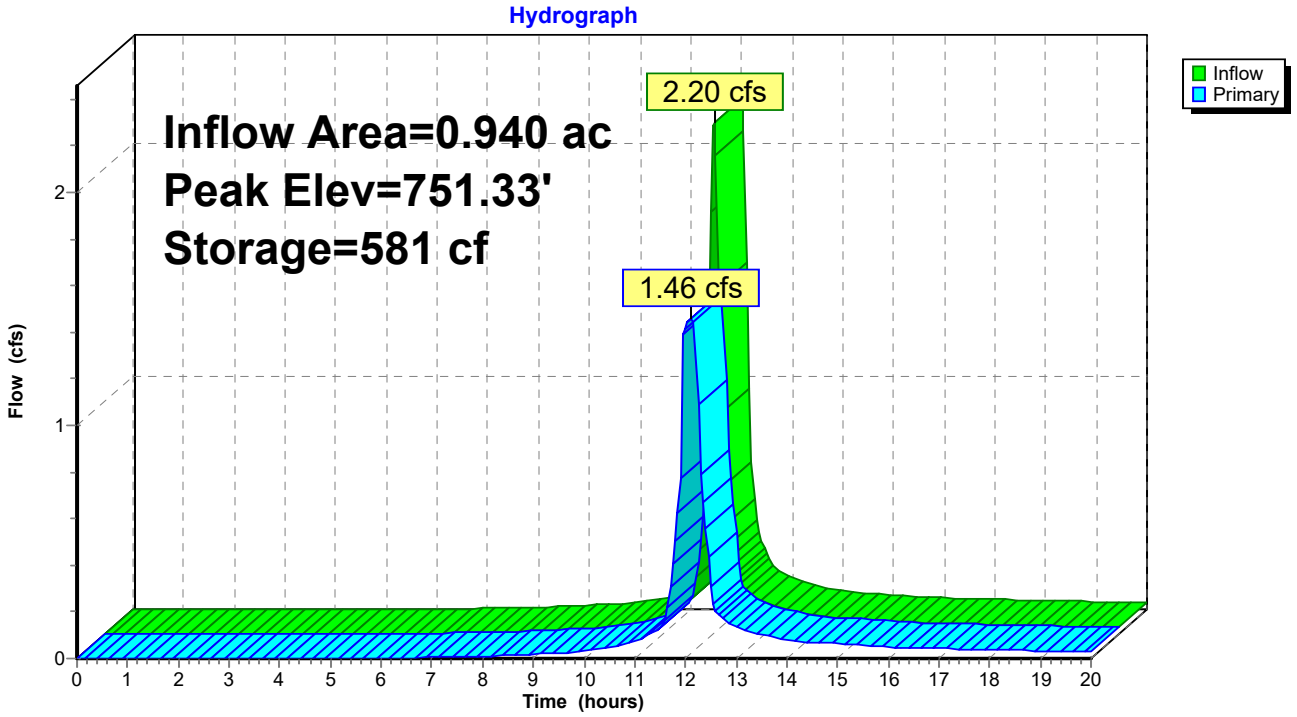
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	6,860 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	747.72'	120 cf	**18.0" Round 3-4** L= 68.0' S= 0.0056 '/'
#3	747.72'	92 cf	**15.0" Round 3-7** L= 75.0' S= 0.0068 '/'
#4	748.06'	71 cf	**18.0" Round 4-5** L= 40.0' S= 0.0052 '/'
		7,142 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	856	0	0
752.00	1,236	1,046	1,046
753.00	1,673	1,455	2,501
754.00	2,165	1,919	4,420
755.00	2,715	2,440	6,860

Device	Routing	Invert	Outlet Devices
#1	Primary	747.72'	**18.0" Round Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 747.72' / 747.64' S= 0.0053 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	747.72'	**5.5" Vert. Orifice** C= 0.600

Primary OutFlow Max=1.46 cfs @ 12.10 hrs HW=751.32' (Free Discharge)
↑**1=Culvert** (Passes 1.46 cfs of 14.37 cfs potential flow)
↑**2=Orifice** (Orifice Controls 1.46 cfs @ 8.84 fps)

Pond 3P: Detention Basin

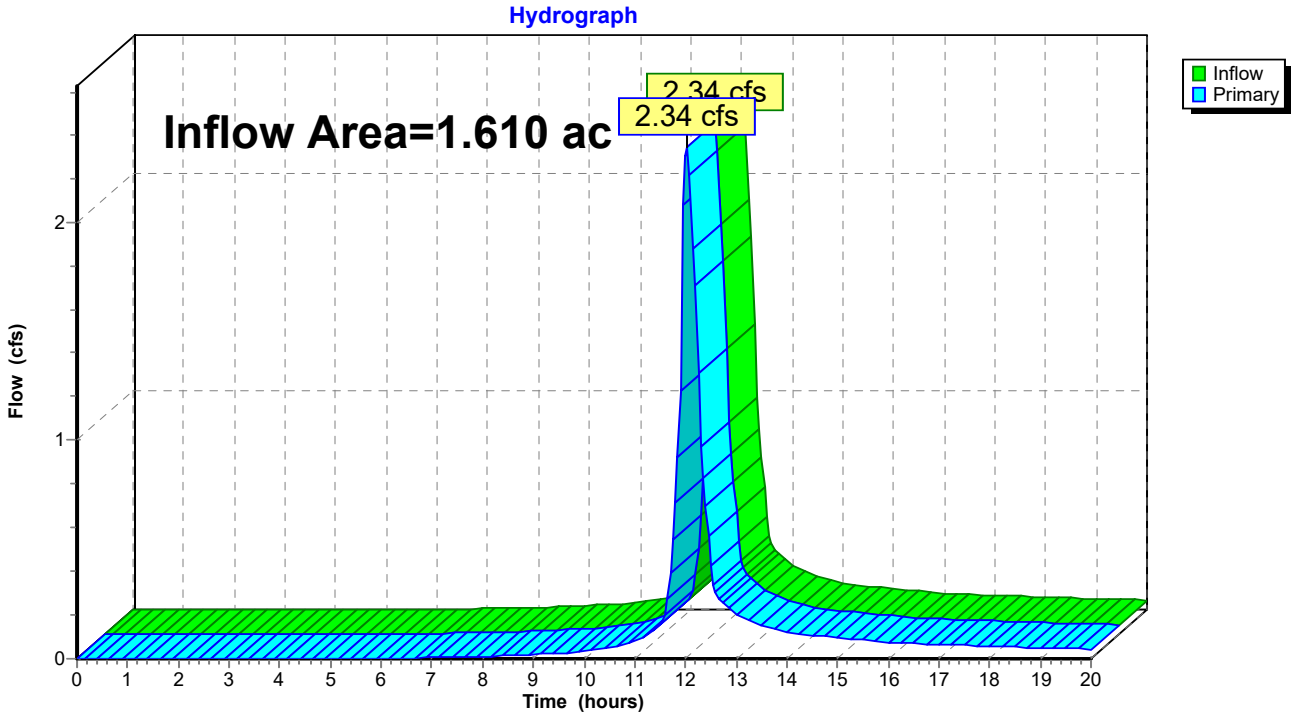


Summary for Link 5L: Total Discharge

Inflow Area = 1.610 ac, 48.45% Impervious, Inflow Depth > 1.20" for 1-Year event
Inflow = 2.34 cfs @ 12.03 hrs, Volume= 0.161 af
Primary = 2.34 cfs @ 12.03 hrs, Volume= 0.161 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 5L: Total Discharge



Summary for Subcatchment 1S: Existing

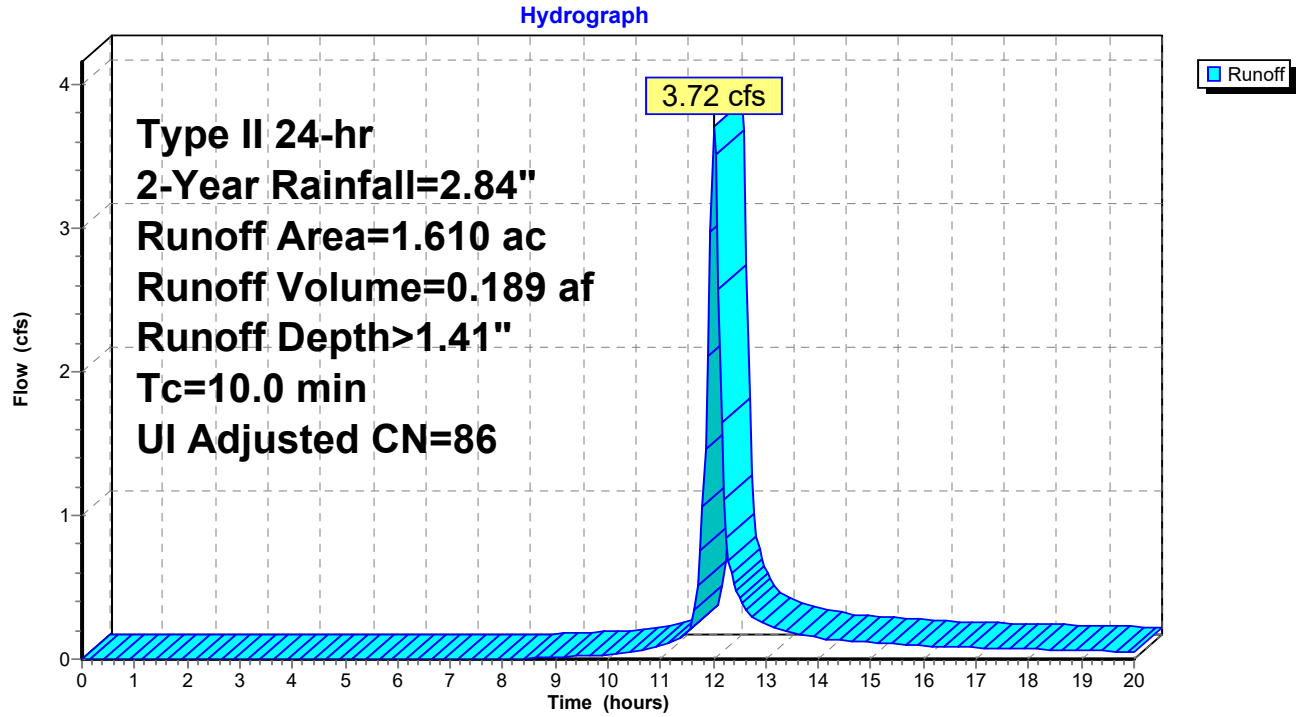
Runoff = 3.72 cfs @ 12.02 hrs, Volume= 0.189 af, Depth> 1.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=2.84"

Area (ac)	CN	Adj	Description
0.680	96		Gravel surface, HSG C
0.470	73		Woods, Fair, HSG C
0.240	98		Unconnected pavement, HSG D
0.220	80		>75% Grass cover, Good, HSG D
1.610	87	86	Weighted Average, UI Adjusted
1.370			85.09% Pervious Area
0.240			14.91% Impervious Area
0.240			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Post Detained

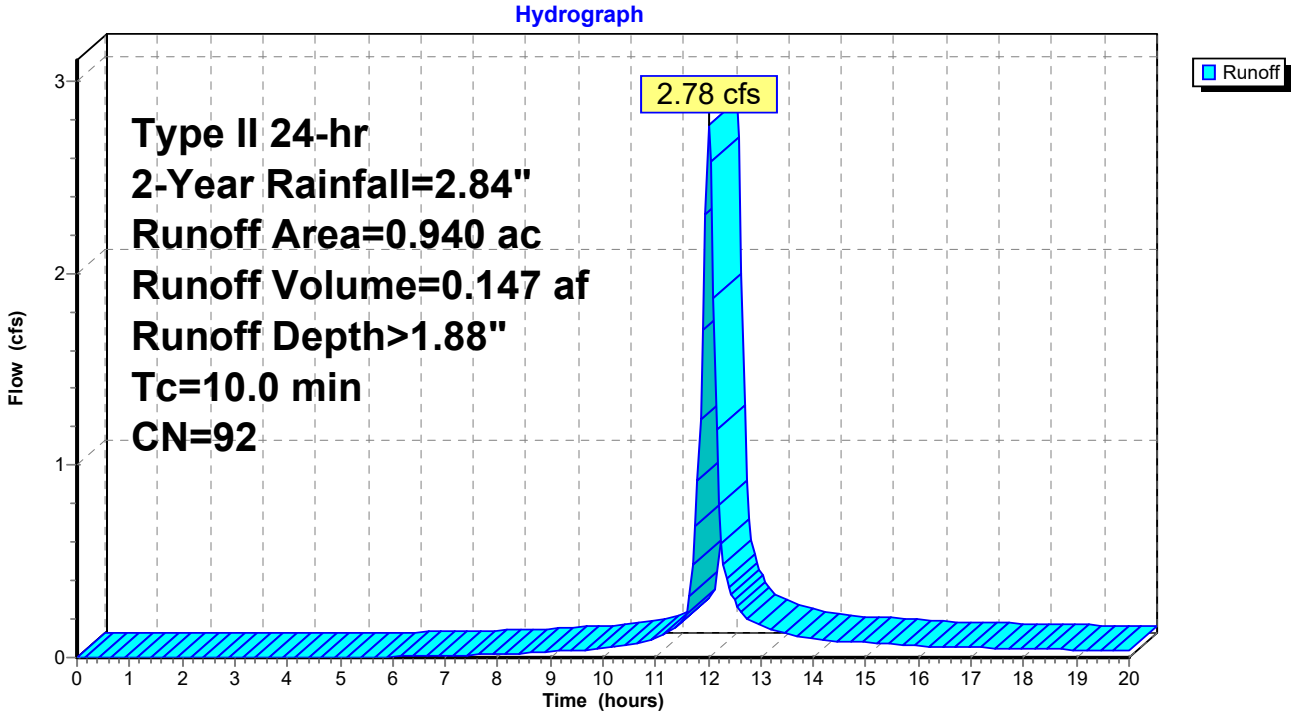
Runoff = 2.78 cfs @ 12.01 hrs, Volume= 0.147 af, Depth> 1.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=2.84"

Area (ac)	CN	Description
0.640	98	Paved parking, HSG C
0.300	80	>75% Grass cover, Good, HSG D
0.940	92	Weighted Average
0.300		31.91% Pervious Area
0.640		68.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 2S: Post Detained



Summary for Subcatchment 4S: Undetained Runoff

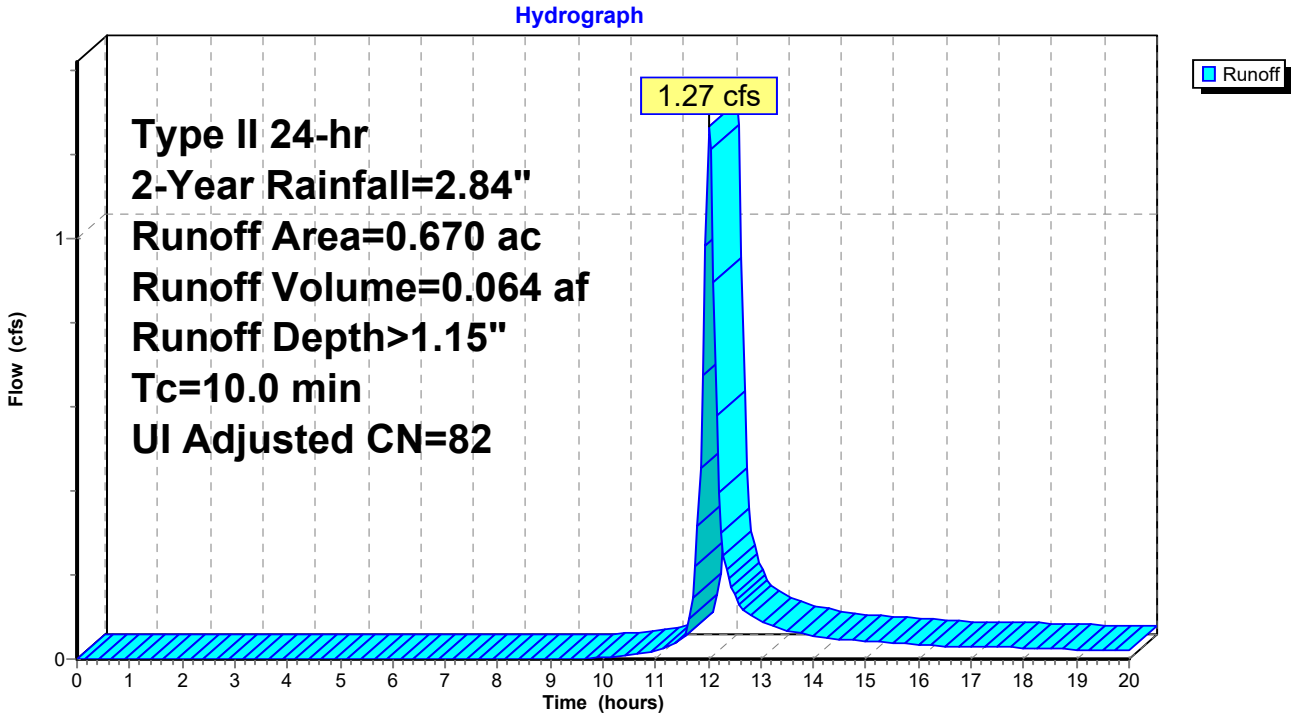
Runoff = 1.27 cfs @ 12.02 hrs, Volume= 0.064 af, Depth> 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-Year Rainfall=2.84"

Area (ac)	CN	Adj	Description
0.530	80		>75% Grass cover, Good, HSG D
0.140	98		Unconnected pavement, HSG D
0.670	84	82	Weighted Average, UI Adjusted
0.530			79.10% Pervious Area
0.140			20.90% Impervious Area
0.140			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 4S: Undetained Runoff



Summary for Pond 3P: Detention Basin

Inflow Area = 0.940 ac, 68.09% Impervious, Inflow Depth > 1.88" for 2-Year event
Inflow = 2.78 cfs @ 12.01 hrs, Volume= 0.147 af
Outflow = 1.54 cfs @ 12.12 hrs, Volume= 0.147 af, Atten= 45%, Lag= 6.8 min
Primary = 1.54 cfs @ 12.12 hrs, Volume= 0.147 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 751.69' @ 12.12 hrs Surf.Area= 1,117 sf Storage= 959 cf

Plug-Flow detention time= 3.7 min calculated for 0.147 af (100% of inflow)
Center-of-Mass det. time= 3.7 min (769.8 - 766.2)

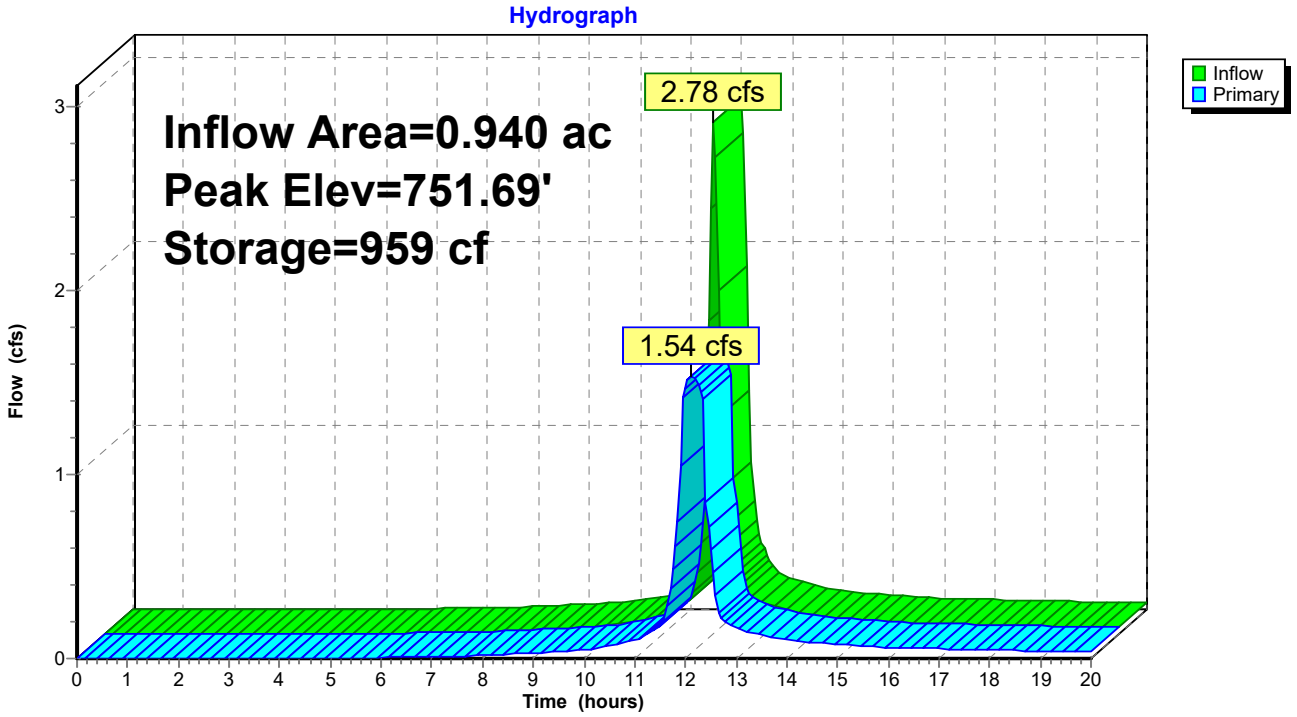
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	6,860 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	747.72'	120 cf	**18.0" Round 3-4** L= 68.0' S= 0.0056 '/'
#3	747.72'	92 cf	**15.0" Round 3-7** L= 75.0' S= 0.0068 '/'
#4	748.06'	71 cf	**18.0" Round 4-5** L= 40.0' S= 0.0052 '/'
		7,142 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	856	0	0
752.00	1,236	1,046	1,046
753.00	1,673	1,455	2,501
754.00	2,165	1,919	4,420
755.00	2,715	2,440	6,860

Device	Routing	Invert	Outlet Devices
#1	Primary	747.72'	**18.0" Round Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 747.72' / 747.64' S= 0.0053 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	747.72'	**5.5" Vert. Orifice** C= 0.600

Primary OutFlow Max=1.53 cfs @ 12.12 hrs HW=751.67' (Free Discharge)
↑**1=Culvert** (Passes 1.53 cfs of 15.22 cfs potential flow)
↑**2=Orifice** (Orifice Controls 1.53 cfs @ 9.29 fps)

Pond 3P: Detention Basin

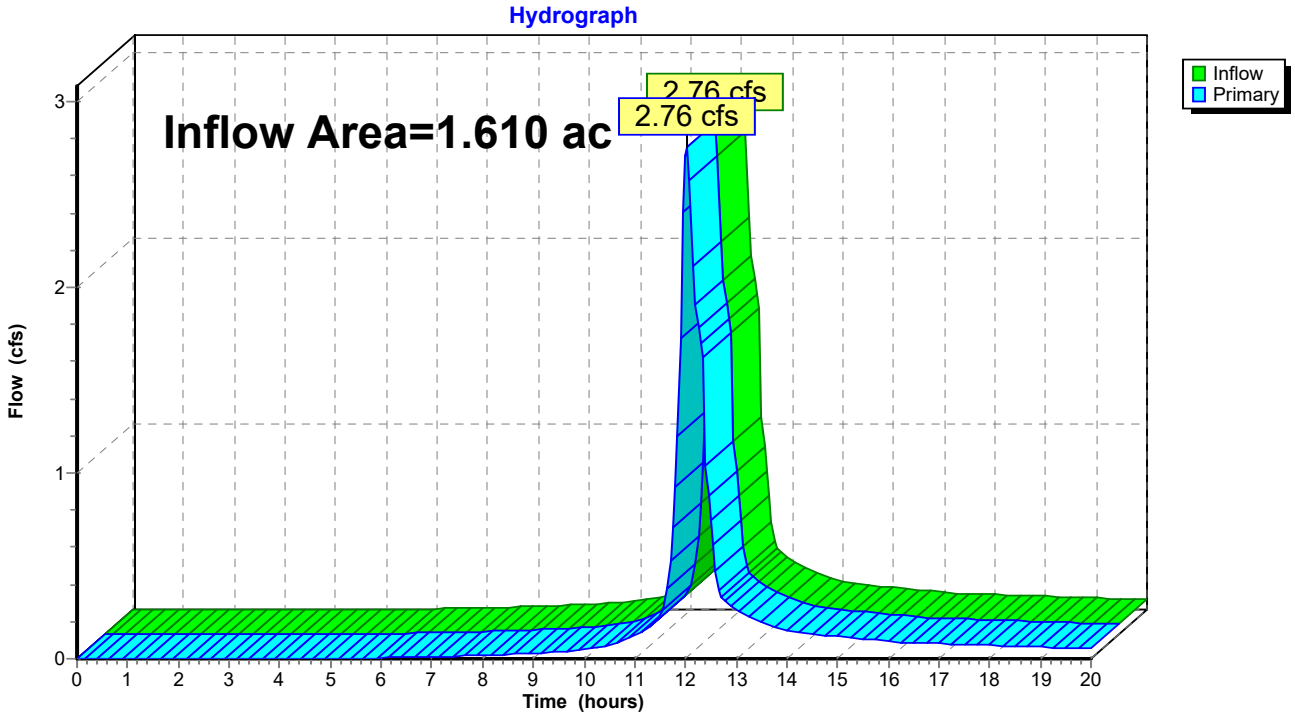


Summary for Link 5L: Total Discharge

Inflow Area = 1.610 ac, 48.45% Impervious, Inflow Depth > 1.57" for 2-Year event
Inflow = 2.76 cfs @ 12.03 hrs, Volume= 0.211 af
Primary = 2.76 cfs @ 12.03 hrs, Volume= 0.211 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 5L: Total Discharge



Summary for Subcatchment 1S: Existing

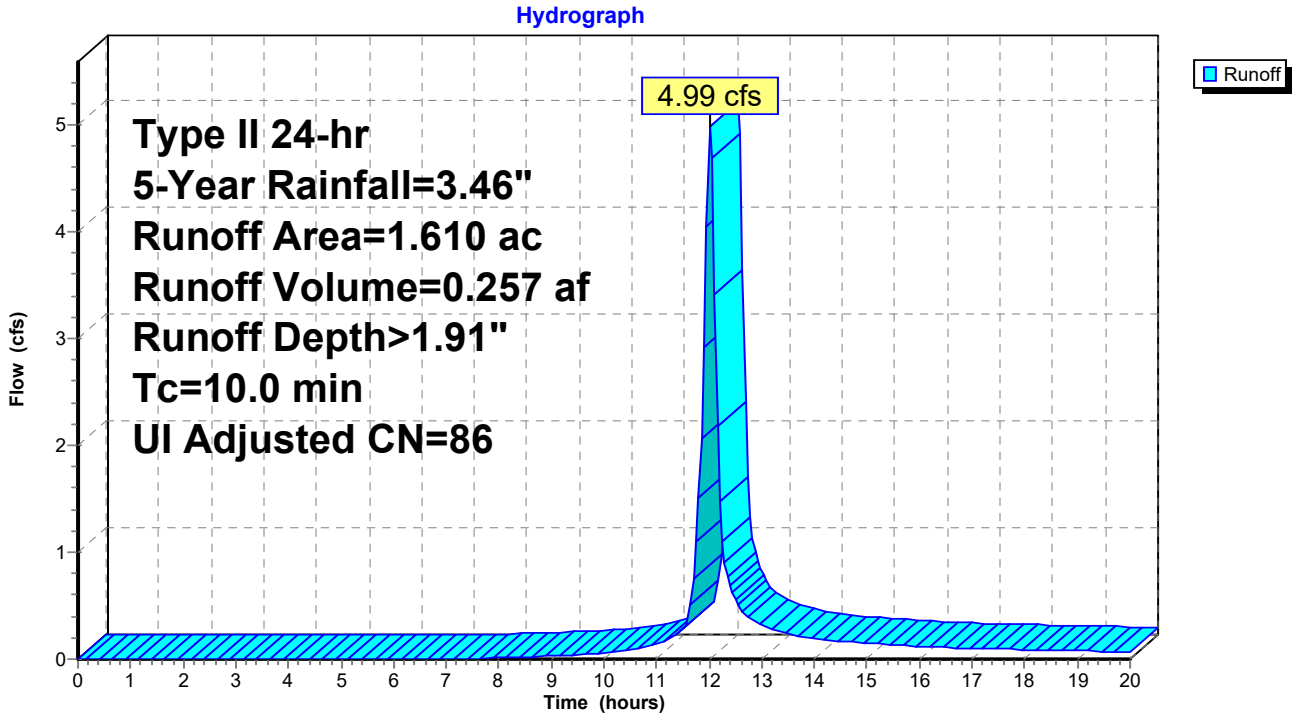
Runoff = 4.99 cfs @ 12.01 hrs, Volume= 0.257 af, Depth> 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-Year Rainfall=3.46"

Area (ac)	CN	Adj	Description
0.680	96		Gravel surface, HSG C
0.470	73		Woods, Fair, HSG C
0.240	98		Unconnected pavement, HSG D
0.220	80		>75% Grass cover, Good, HSG D
1.610	87	86	Weighted Average, UI Adjusted
1.370			85.09% Pervious Area
0.240			14.91% Impervious Area
0.240			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Post Detained

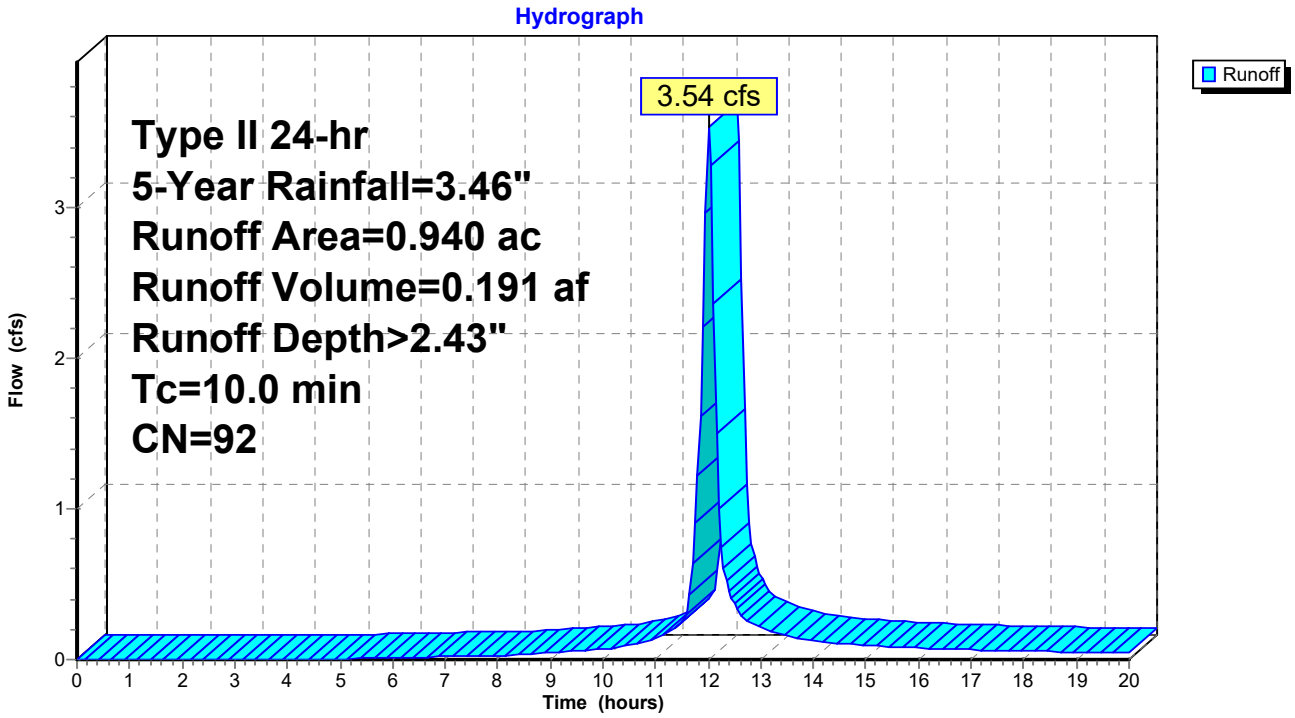
Runoff = 3.54 cfs @ 12.01 hrs, Volume= 0.191 af, Depth> 2.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-Year Rainfall=3.46"

Area (ac)	CN	Description
0.640	98	Paved parking, HSG C
0.300	80	>75% Grass cover, Good, HSG D
0.940	92	Weighted Average
0.300		31.91% Pervious Area
0.640		68.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 2S: Post Detained



Summary for Subcatchment 4S: Undetained Runoff

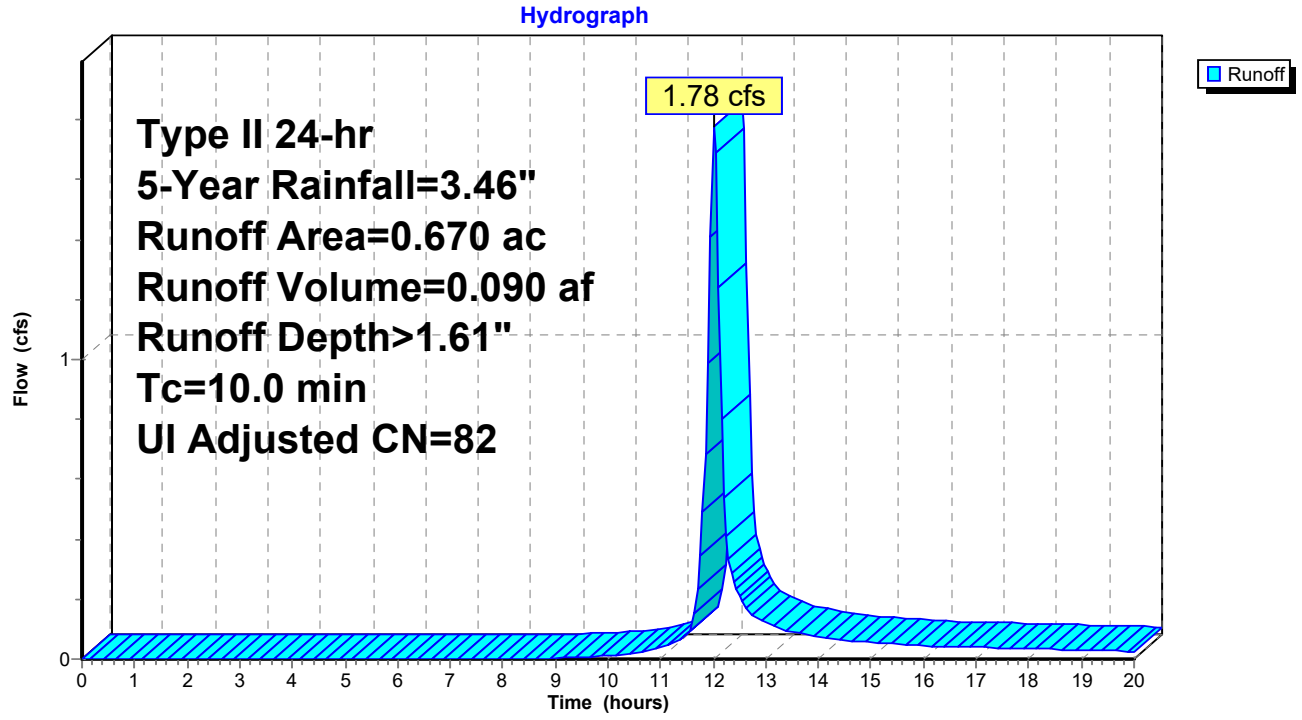
Runoff = 1.78 cfs @ 12.02 hrs, Volume= 0.090 af, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 5-Year Rainfall=3.46"

Area (ac)	CN	Adj	Description
0.530	80		>75% Grass cover, Good, HSG D
0.140	98		Unconnected pavement, HSG D
0.670	84	82	Weighted Average, UI Adjusted
0.530			79.10% Pervious Area
0.140			20.90% Impervious Area
0.140			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 4S: Undetained Runoff



Summary for Pond 3P: Detention Basin

Inflow Area = 0.940 ac, 68.09% Impervious, Inflow Depth > 2.43" for 5-Year event
Inflow = 3.54 cfs @ 12.01 hrs, Volume= 0.191 af
Outflow = 1.63 cfs @ 12.15 hrs, Volume= 0.190 af, Atten= 54%, Lag= 8.3 min
Primary = 1.63 cfs @ 12.15 hrs, Volume= 0.190 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 752.15' @ 12.15 hrs Surf.Area= 1,300 sf Storage= 1,515 cf

Plug-Flow detention time= 7.3 min calculated for 0.189 af (99% of inflow)
Center-of-Mass det. time= 5.4 min (765.4 - 760.0)

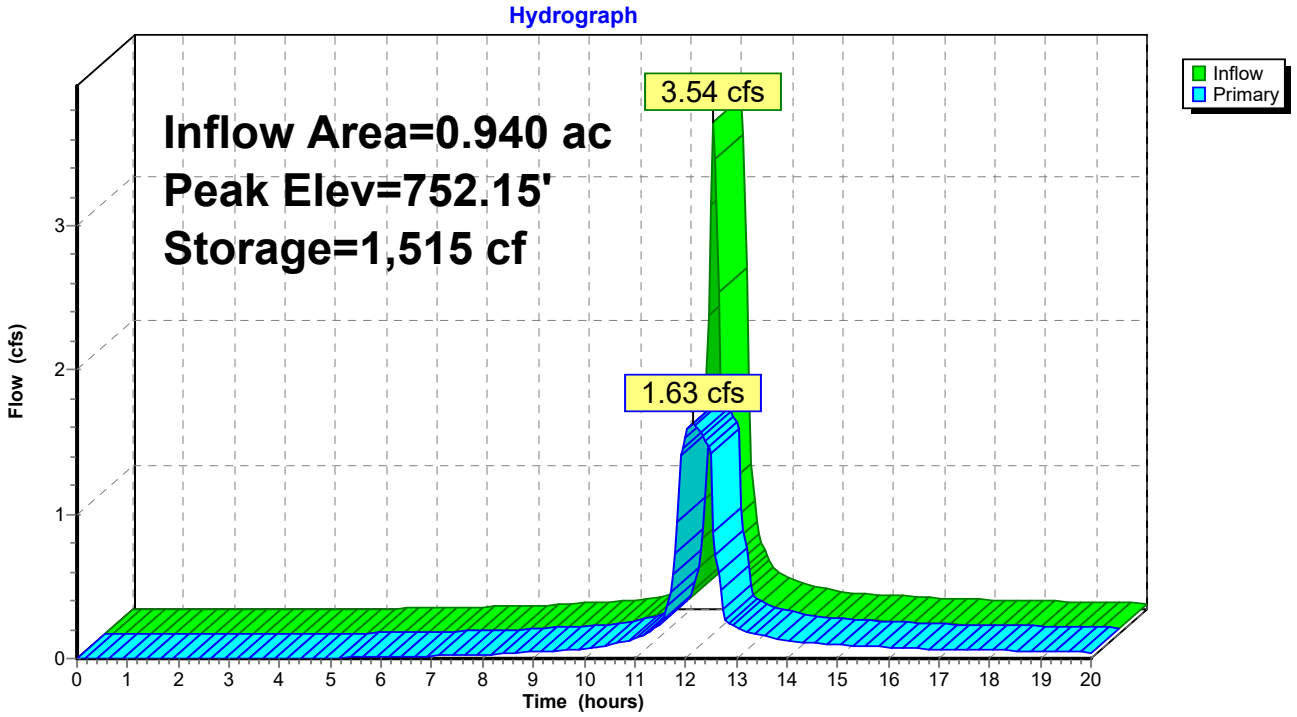
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	6,860 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	747.72'	120 cf	**18.0" Round 3-4** L= 68.0' S= 0.0056 '/'
#3	747.72'	92 cf	**15.0" Round 3-7** L= 75.0' S= 0.0068 '/'
#4	748.06'	71 cf	**18.0" Round 4-5** L= 40.0' S= 0.0052 '/'
		7,142 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	856	0	0
752.00	1,236	1,046	1,046
753.00	1,673	1,455	2,501
754.00	2,165	1,919	4,420
755.00	2,715	2,440	6,860

Device	Routing	Invert	Outlet Devices
#1	Primary	747.72'	**18.0" Round Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 747.72' / 747.64' S= 0.0053 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	747.72'	**5.5" Vert. Orifice** C= 0.600

Primary OutFlow Max=1.63 cfs @ 12.15 hrs HW=752.14' (Free Discharge)
↑**1=Culvert** (Passes 1.63 cfs of 16.31 cfs potential flow)
↑**2=Orifice** (Orifice Controls 1.63 cfs @ 9.86 fps)

Pond 3P: Detention Basin

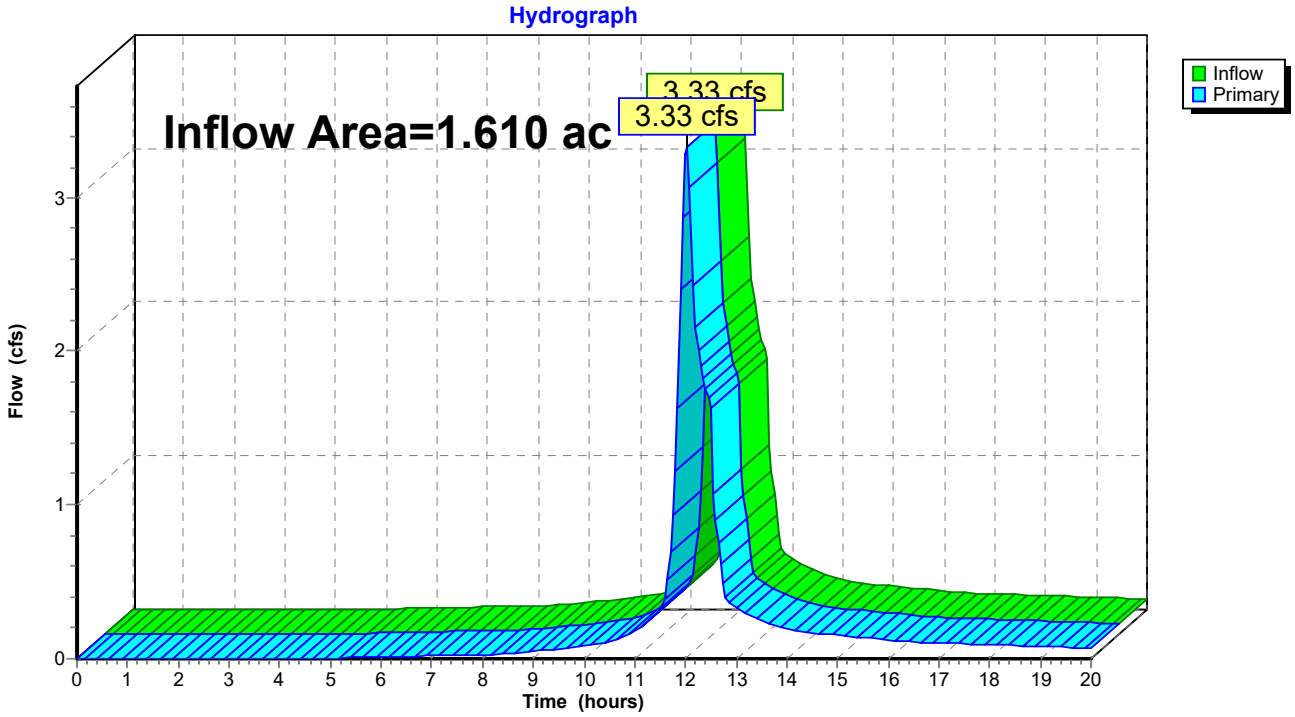


Summary for Link 5L: Total Discharge

Inflow Area = 1.610 ac, 48.45% Impervious, Inflow Depth > 2.08" for 5-Year event
Inflow = 3.33 cfs @ 12.02 hrs, Volume= 0.280 af
Primary = 3.33 cfs @ 12.02 hrs, Volume= 0.280 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 5L: Total Discharge



Summary for Subcatchment 1S: Existing

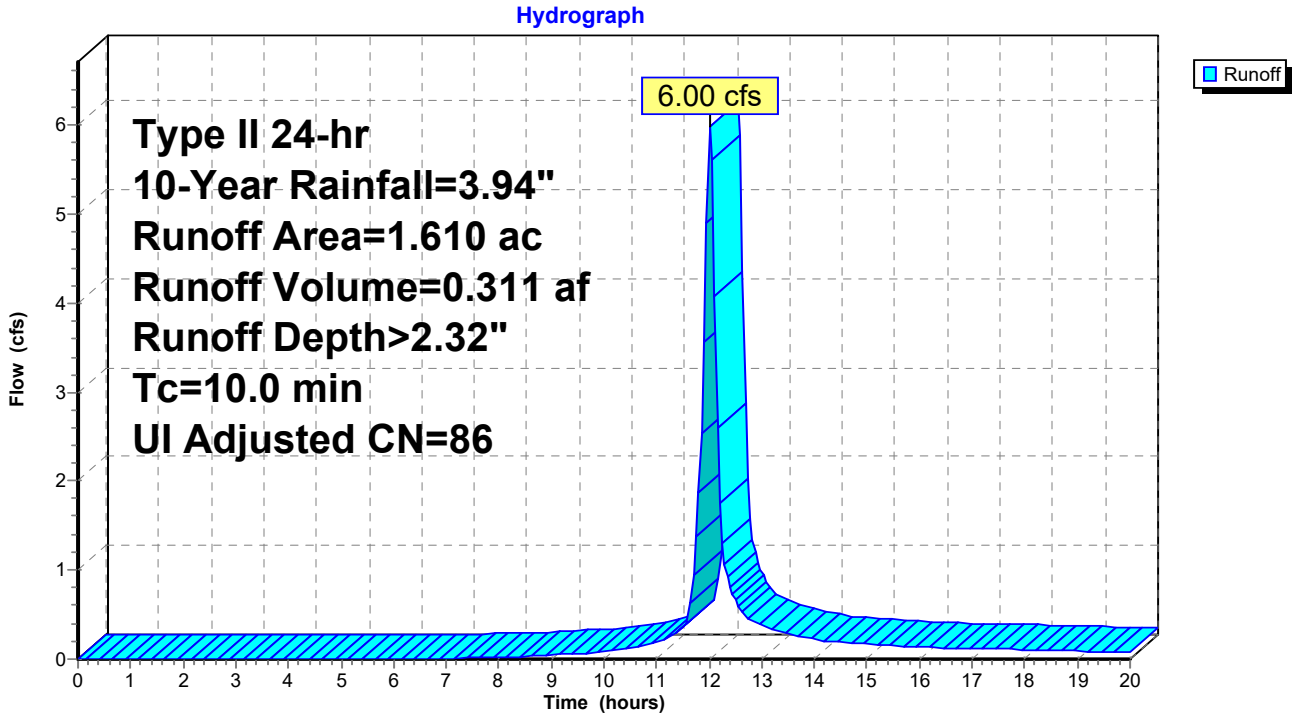
Runoff = 6.00 cfs @ 12.01 hrs, Volume= 0.311 af, Depth> 2.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=3.94"

Area (ac)	CN	Adj	Description
0.680	96		Gravel surface, HSG C
0.470	73		Woods, Fair, HSG C
0.240	98		Unconnected pavement, HSG D
0.220	80		>75% Grass cover, Good, HSG D
1.610	87	86	Weighted Average, UI Adjusted
1.370			85.09% Pervious Area
0.240			14.91% Impervious Area
0.240			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Post Detained

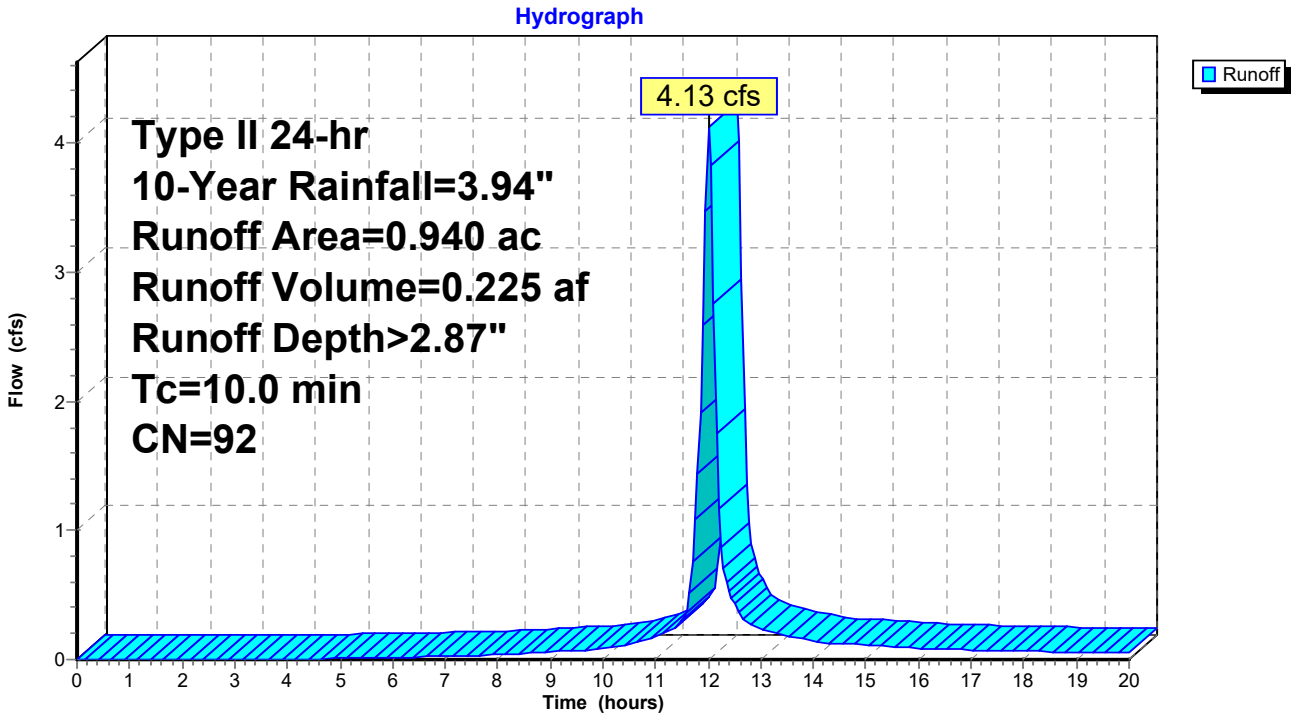
Runoff = 4.13 cfs @ 12.01 hrs, Volume= 0.225 af, Depth> 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=3.94"

Area (ac)	CN	Description
0.640	98	Paved parking, HSG C
0.300	80	>75% Grass cover, Good, HSG D
0.940	92	Weighted Average
0.300		31.91% Pervious Area
0.640		68.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 2S: Post Detained



Summary for Subcatchment 4S: Undetained Runoff

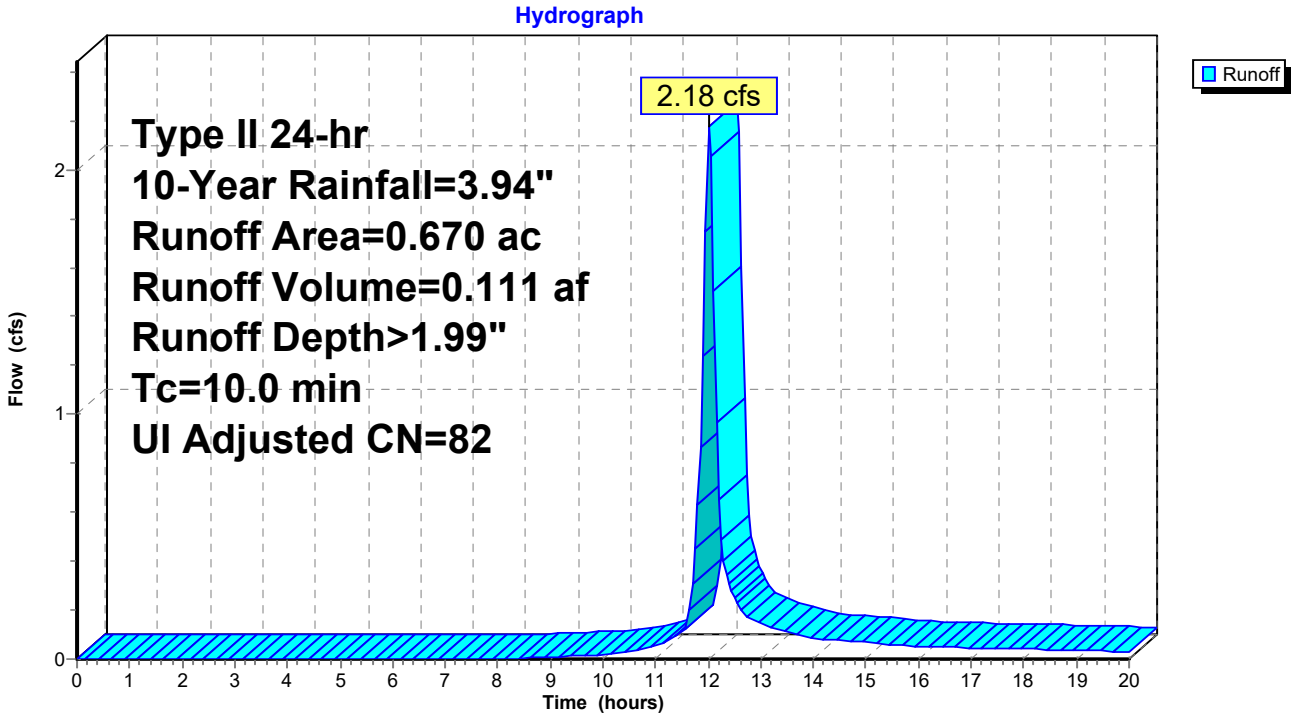
Runoff = 2.18 cfs @ 12.02 hrs, Volume= 0.111 af, Depth> 1.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-Year Rainfall=3.94"

Area (ac)	CN	Adj	Description
0.530	80		>75% Grass cover, Good, HSG D
0.140	98		Unconnected pavement, HSG D
0.670	84	82	Weighted Average, UI Adjusted
0.530			79.10% Pervious Area
0.140			20.90% Impervious Area
0.140			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 4S: Undetained Runoff



Summary for Pond 3P: Detention Basin

Inflow Area = 0.940 ac, 68.09% Impervious, Inflow Depth > 2.87" for 10-Year event
Inflow = 4.13 cfs @ 12.01 hrs, Volume= 0.225 af
Outflow = 1.69 cfs @ 12.16 hrs, Volume= 0.226 af, Atten= 59%, Lag= 9.1 min
Primary = 1.69 cfs @ 12.16 hrs, Volume= 0.226 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 752.50' @ 12.16 hrs Surf.Area= 1,452 sf Storage= 1,995 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 6.5 min (762.6 - 756.1)

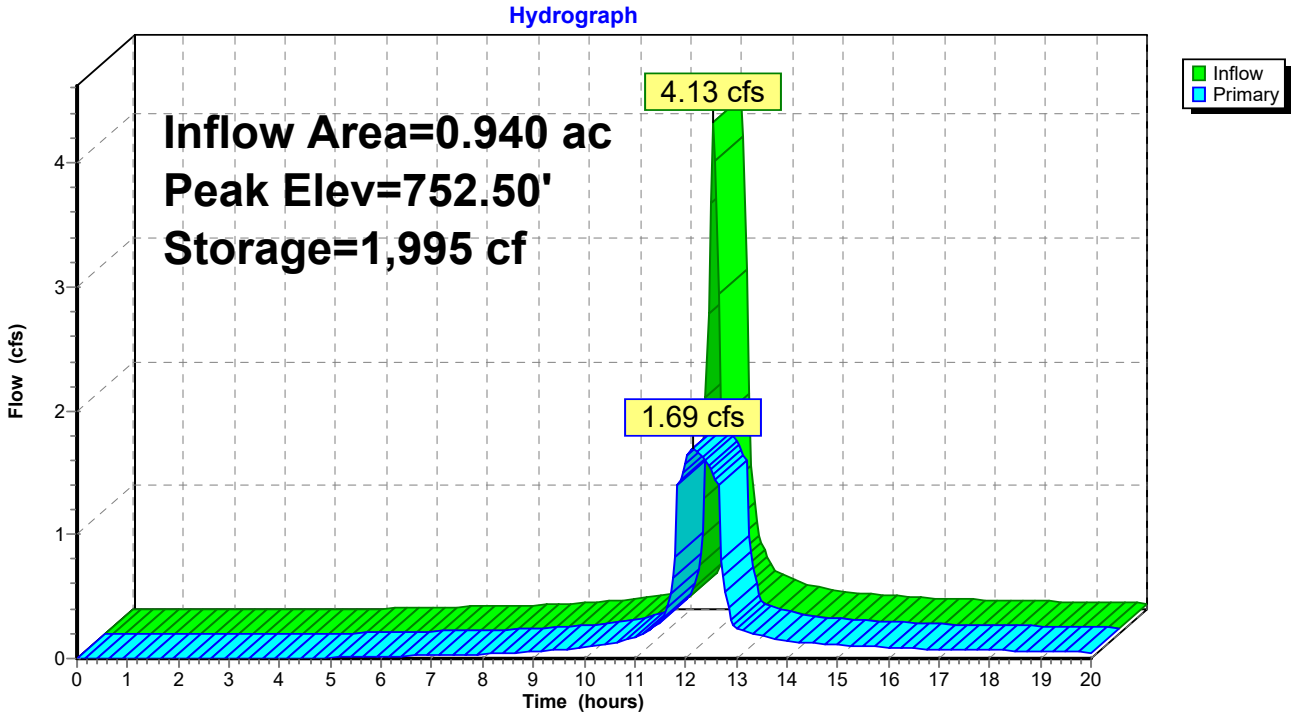
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	6,860 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	747.72'	120 cf	**18.0" Round 3-4** L= 68.0' S= 0.0056 '/'
#3	747.72'	92 cf	**15.0" Round 3-7** L= 75.0' S= 0.0068 '/'
#4	748.06'	71 cf	**18.0" Round 4-5** L= 40.0' S= 0.0052 '/'
		7,142 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	856	0	0
752.00	1,236	1,046	1,046
753.00	1,673	1,455	2,501
754.00	2,165	1,919	4,420
755.00	2,715	2,440	6,860

Device	Routing	Invert	Outlet Devices
#1	Primary	747.72'	**18.0" Round Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 747.72' / 747.64' S= 0.0053 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	747.72'	**5.5" Vert. Orifice** C= 0.600

Primary OutFlow Max=1.69 cfs @ 12.16 hrs HW=752.49' (Free Discharge)
↑**1=Culvert** (Passes 1.69 cfs of 17.05 cfs potential flow)
↑**2=Orifice** (Orifice Controls 1.69 cfs @ 10.26 fps)

Pond 3P: Detention Basin

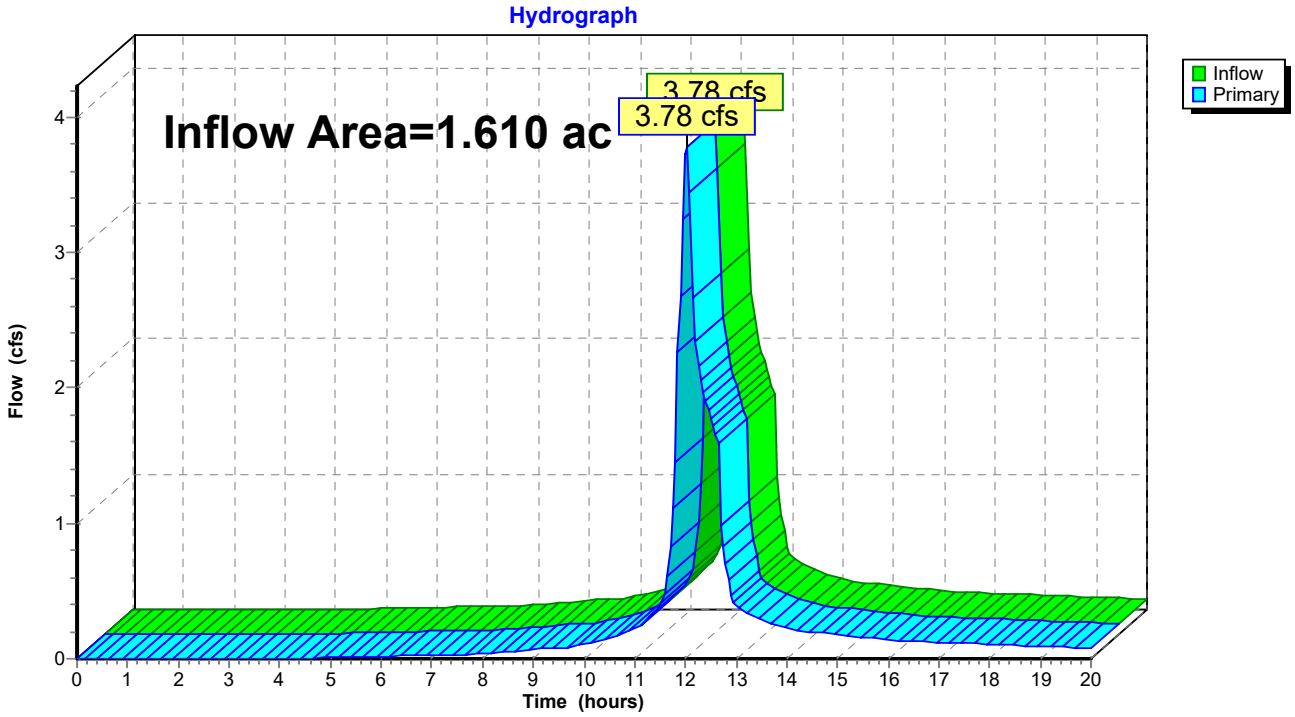


Summary for Link 5L: Total Discharge

Inflow Area = 1.610 ac, 48.45% Impervious, Inflow Depth > 2.51" for 10-Year event
Inflow = 3.78 cfs @ 12.02 hrs, Volume= 0.336 af
Primary = 3.78 cfs @ 12.02 hrs, Volume= 0.336 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 5L: Total Discharge



Summary for Subcatchment 1S: Existing

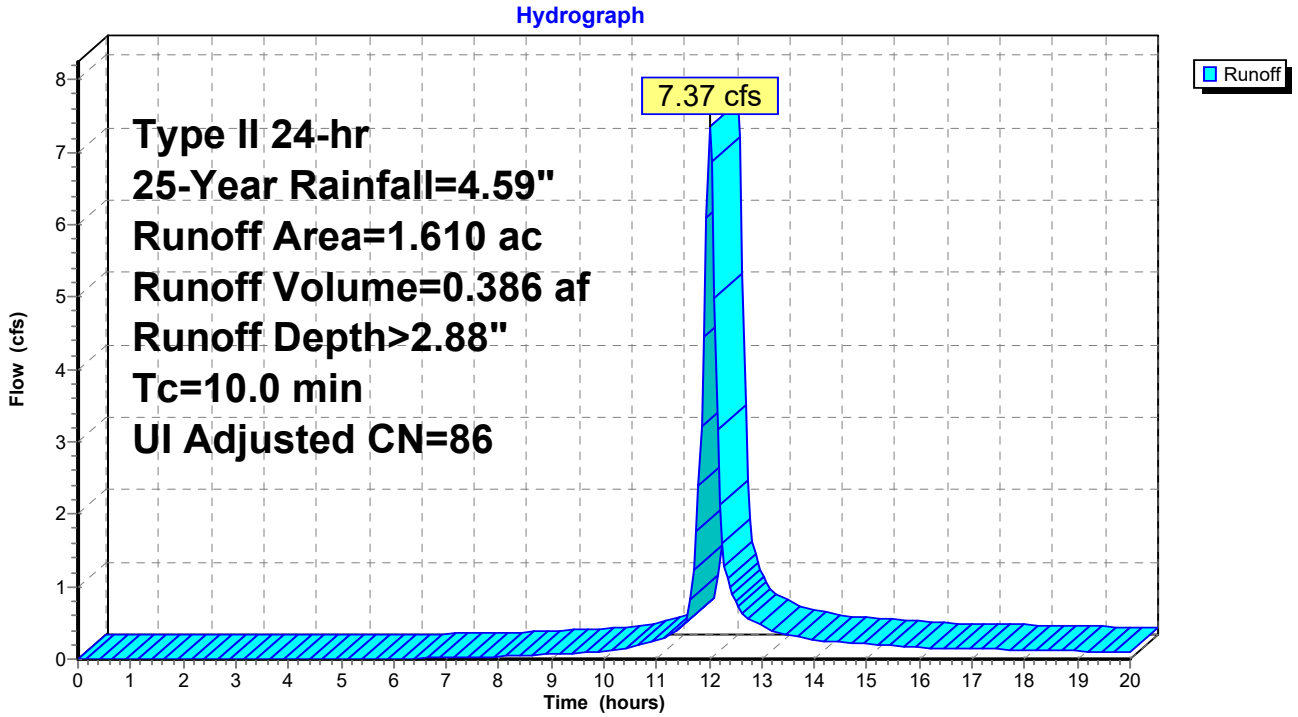
Runoff = 7.37 cfs @ 12.01 hrs, Volume= 0.386 af, Depth> 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=4.59"

Area (ac)	CN	Adj	Description
0.680	96		Gravel surface, HSG C
0.470	73		Woods, Fair, HSG C
0.240	98		Unconnected pavement, HSG D
0.220	80		>75% Grass cover, Good, HSG D
1.610	87	86	Weighted Average, UI Adjusted
1.370			85.09% Pervious Area
0.240			14.91% Impervious Area
0.240			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Post Detained

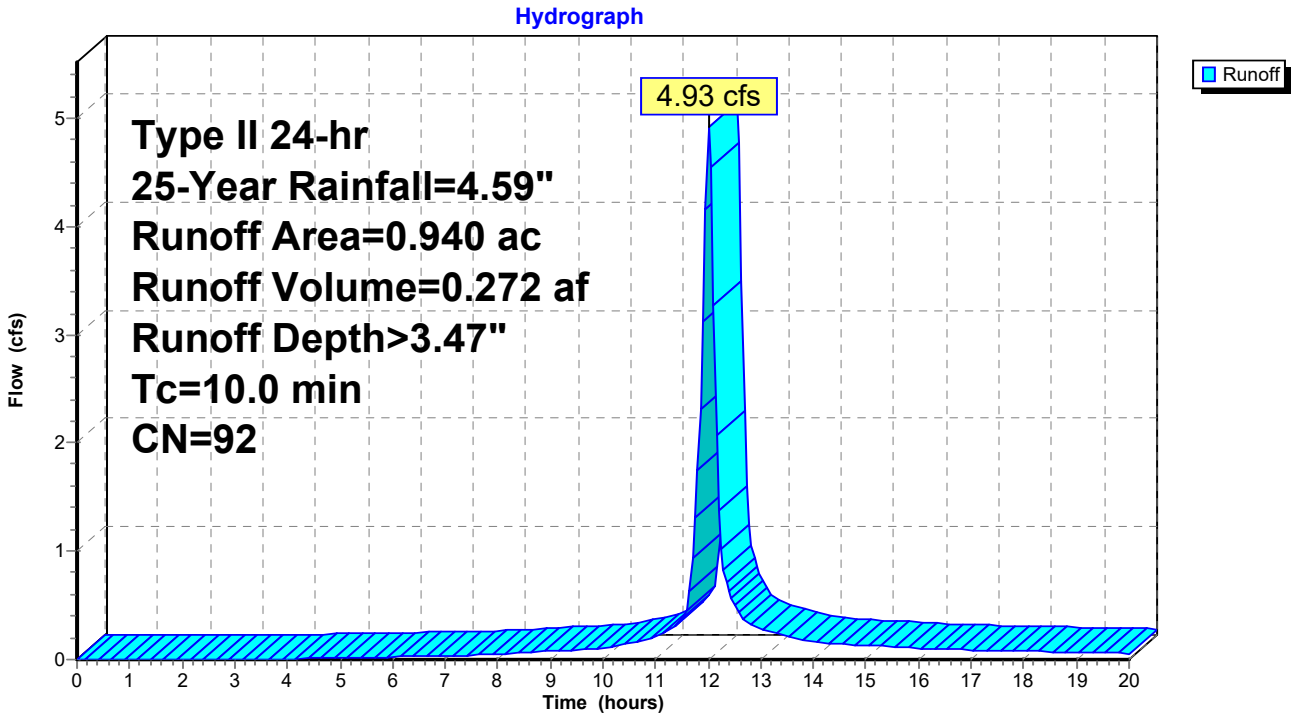
Runoff = 4.93 cfs @ 12.01 hrs, Volume= 0.272 af, Depth> 3.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=4.59"

Area (ac)	CN	Description
0.640	98	Paved parking, HSG C
0.300	80	>75% Grass cover, Good, HSG D
0.940	92	Weighted Average
0.300		31.91% Pervious Area
0.640		68.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 2S: Post Detained



Summary for Subcatchment 4S: Undetained Runoff

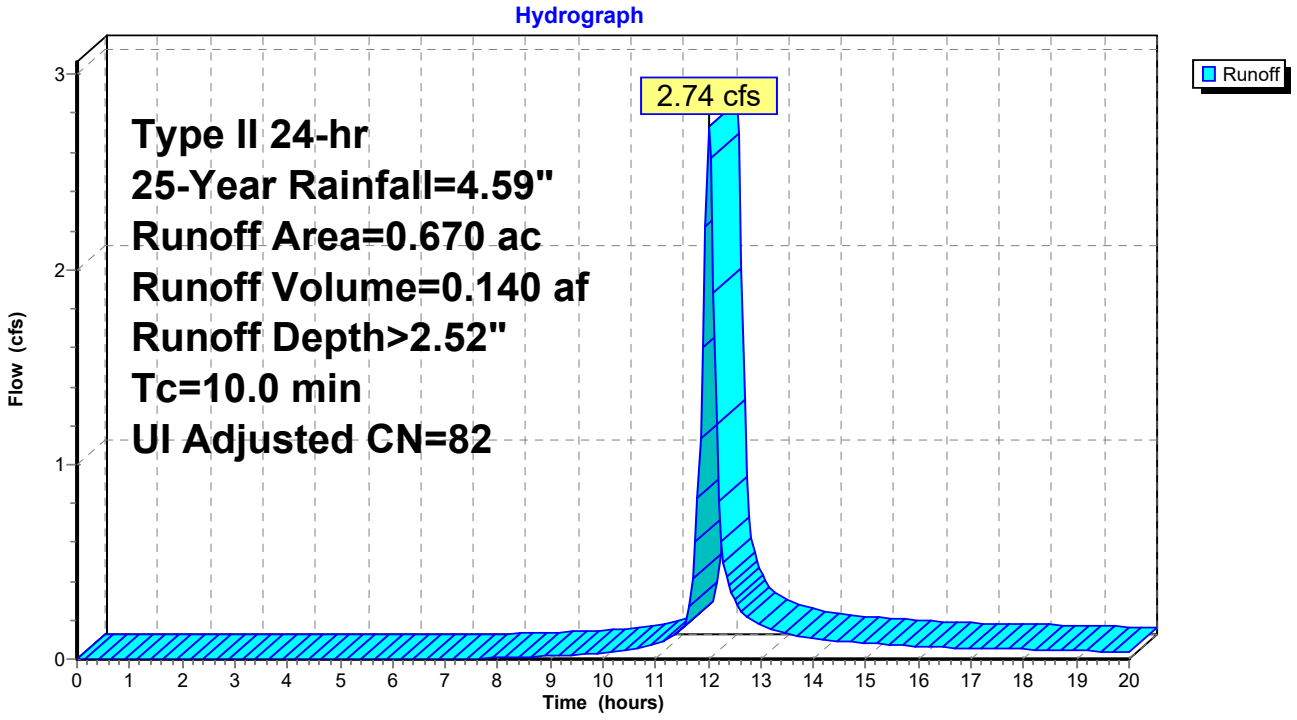
Runoff = 2.74 cfs @ 12.01 hrs, Volume= 0.140 af, Depth> 2.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-Year Rainfall=4.59"

Area (ac)	CN	Adj	Description
0.530	80		>75% Grass cover, Good, HSG D
0.140	98		Unconnected pavement, HSG D
0.670	84	82	Weighted Average, UI Adjusted
0.530			79.10% Pervious Area
0.140			20.90% Impervious Area
0.140			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 4S: Undetained Runoff



Summary for Pond 3P: Detention Basin

Inflow Area = 0.940 ac, 68.09% Impervious, Inflow Depth > 3.47" for 25-Year event
Inflow = 4.93 cfs @ 12.01 hrs, Volume= 0.272 af
Outflow = 1.77 cfs @ 12.17 hrs, Volume= 0.272 af, Atten= 64%, Lag= 9.8 min
Primary = 1.77 cfs @ 12.17 hrs, Volume= 0.272 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 752.93' @ 12.17 hrs Surf.Area= 1,643 sf Storage= 2,668 cf

Plug-Flow detention time= 8.6 min calculated for 0.272 af (100% of inflow)
Center-of-Mass det. time= 8.4 min (760.0 - 751.6)

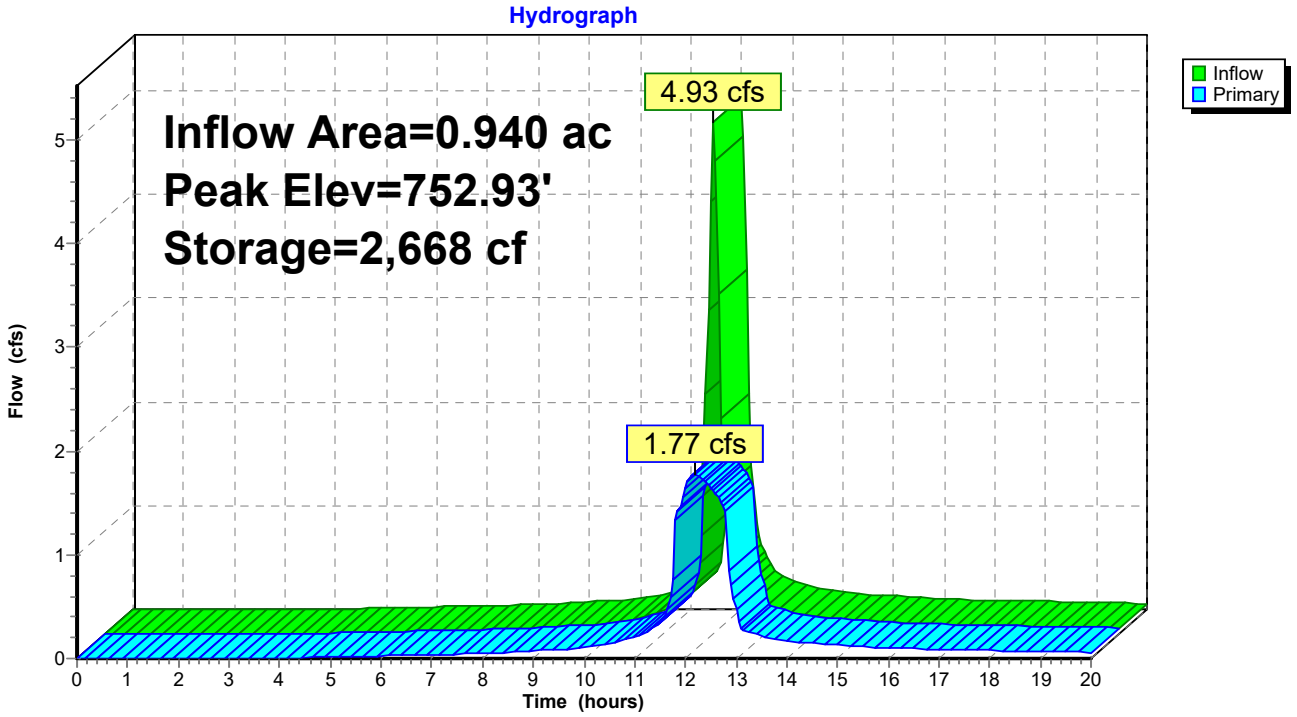
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	6,860 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	747.72'	120 cf	**18.0" Round 3-4** L= 68.0' S= 0.0056 '/'
#3	747.72'	92 cf	**15.0" Round 3-7** L= 75.0' S= 0.0068 '/'
#4	748.06'	71 cf	**18.0" Round 4-5** L= 40.0' S= 0.0052 '/'
		7,142 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	856	0	0
752.00	1,236	1,046	1,046
753.00	1,673	1,455	2,501
754.00	2,165	1,919	4,420
755.00	2,715	2,440	6,860

Device	Routing	Invert	Outlet Devices
#1	Primary	747.72'	**18.0" Round Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 747.72' / 747.64' S= 0.0053 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	747.72'	**5.5" Vert. Orifice** C= 0.600

Primary OutFlow Max=1.77 cfs @ 12.17 hrs HW=752.92' (Free Discharge)
↑**1=Culvert** (Passes 1.77 cfs of 17.94 cfs potential flow)
↑**2=Orifice** (Orifice Controls 1.77 cfs @ 10.73 fps)

Pond 3P: Detention Basin

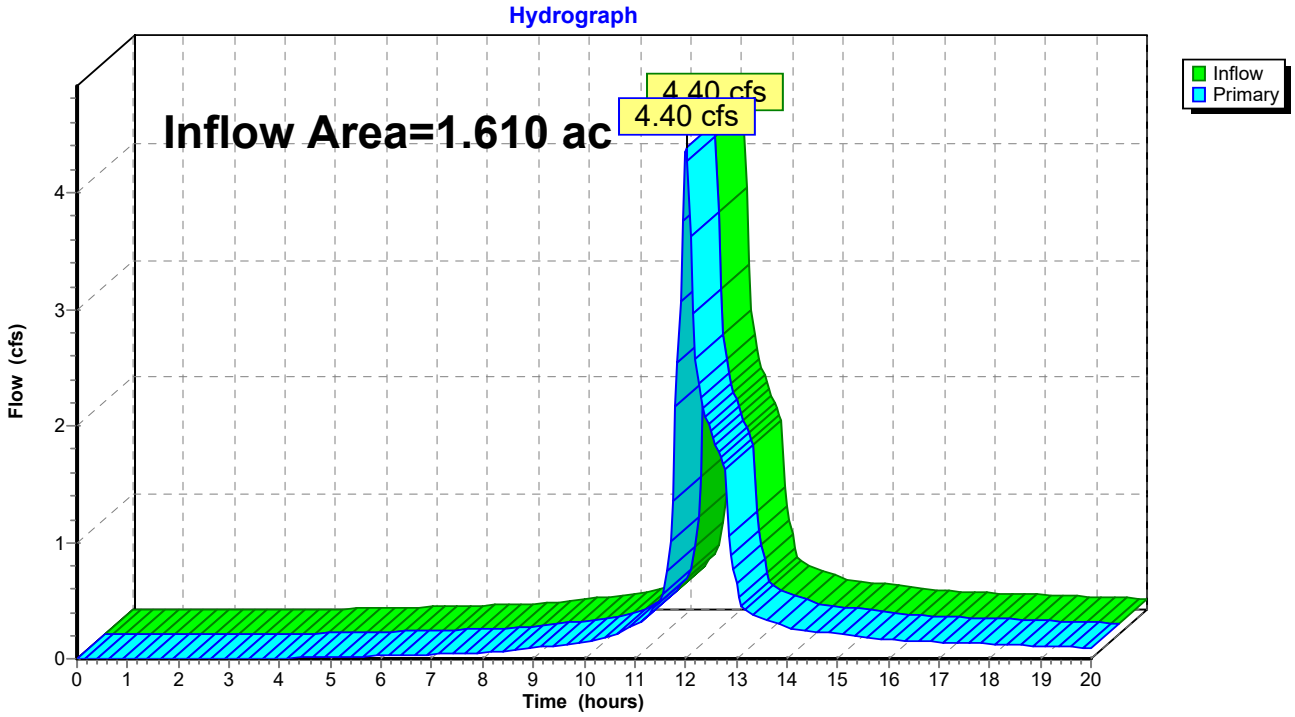


Summary for Link 5L: Total Discharge

Inflow Area = 1.610 ac, 48.45% Impervious, Inflow Depth > 3.07" for 25-Year event
Inflow = 4.40 cfs @ 12.02 hrs, Volume= 0.412 af
Primary = 4.40 cfs @ 12.02 hrs, Volume= 0.412 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 5L: Total Discharge



Summary for Subcatchment 1S: Existing

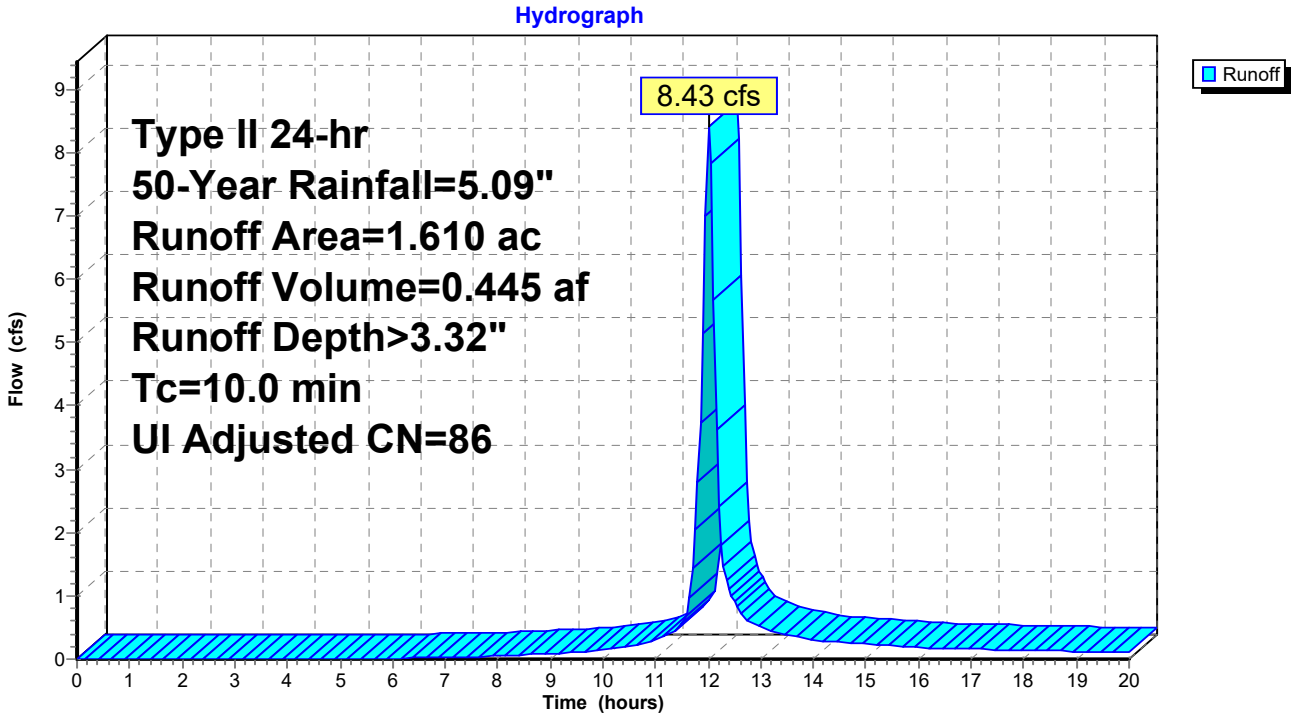
Runoff = 8.43 cfs @ 12.01 hrs, Volume= 0.445 af, Depth> 3.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-Year Rainfall=5.09"

Area (ac)	CN	Adj	Description
0.680	96		Gravel surface, HSG C
0.470	73		Woods, Fair, HSG C
0.240	98		Unconnected pavement, HSG D
0.220	80		>75% Grass cover, Good, HSG D
1.610	87	86	Weighted Average, UI Adjusted
1.370			85.09% Pervious Area
0.240			14.91% Impervious Area
0.240			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Post Detained

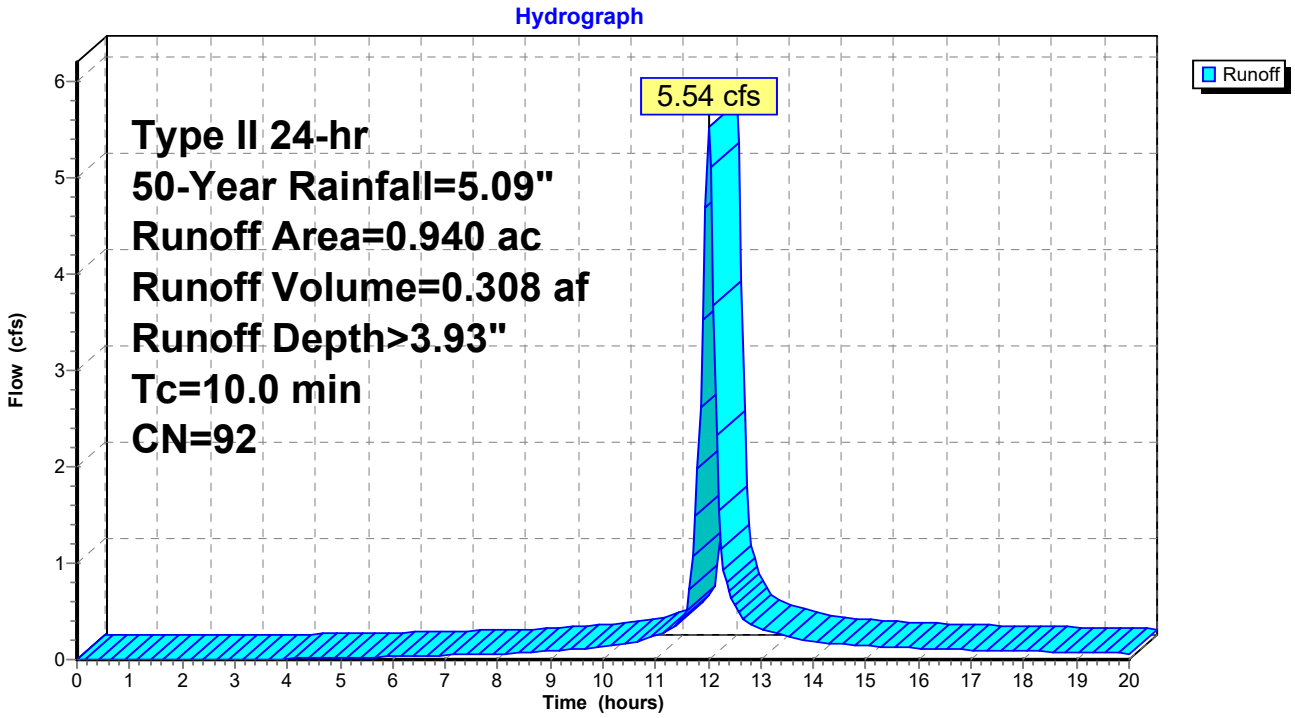
Runoff = 5.54 cfs @ 12.01 hrs, Volume= 0.308 af, Depth> 3.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-Year Rainfall=5.09"

Area (ac)	CN	Description
0.640	98	Paved parking, HSG C
0.300	80	>75% Grass cover, Good, HSG D
0.940	92	Weighted Average
0.300		31.91% Pervious Area
0.640		68.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 2S: Post Detained



Summary for Subcatchment 4S: Undetained Runoff

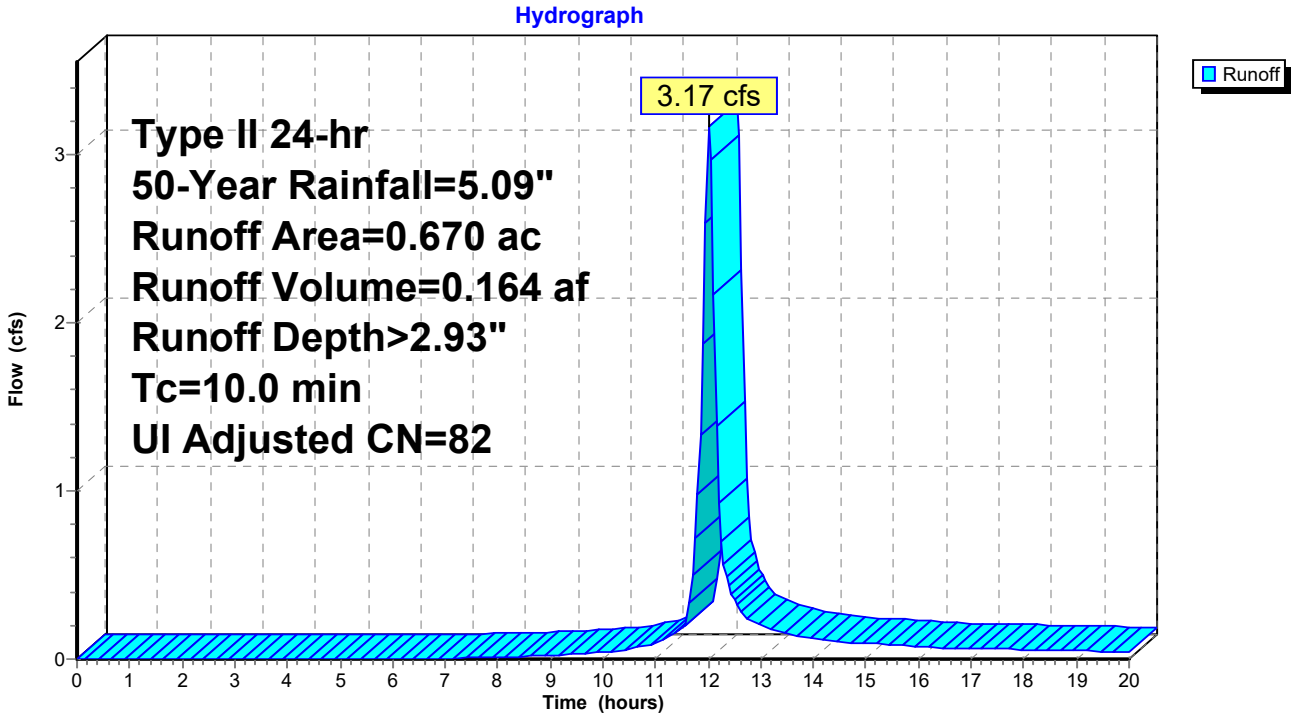
Runoff = 3.17 cfs @ 12.01 hrs, Volume= 0.164 af, Depth> 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 50-Year Rainfall=5.09"

Area (ac)	CN	Adj	Description
0.530	80		>75% Grass cover, Good, HSG D
0.140	98		Unconnected pavement, HSG D
0.670	84	82	Weighted Average, UI Adjusted
0.530			79.10% Pervious Area
0.140			20.90% Impervious Area
0.140			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 4S: Undetained Runoff



Summary for Pond 3P: Detention Basin

Inflow Area = 0.940 ac, 68.09% Impervious, Inflow Depth > 3.93" for 50-Year event
Inflow = 5.54 cfs @ 12.01 hrs, Volume= 0.308 af
Outflow = 1.83 cfs @ 12.18 hrs, Volume= 0.308 af, Atten= 67%, Lag= 10.5 min
Primary = 1.83 cfs @ 12.18 hrs, Volume= 0.308 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 753.26' @ 12.18 hrs Surf.Area= 1,799 sf Storage= 3,227 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 10.2 min (758.8 - 748.6)

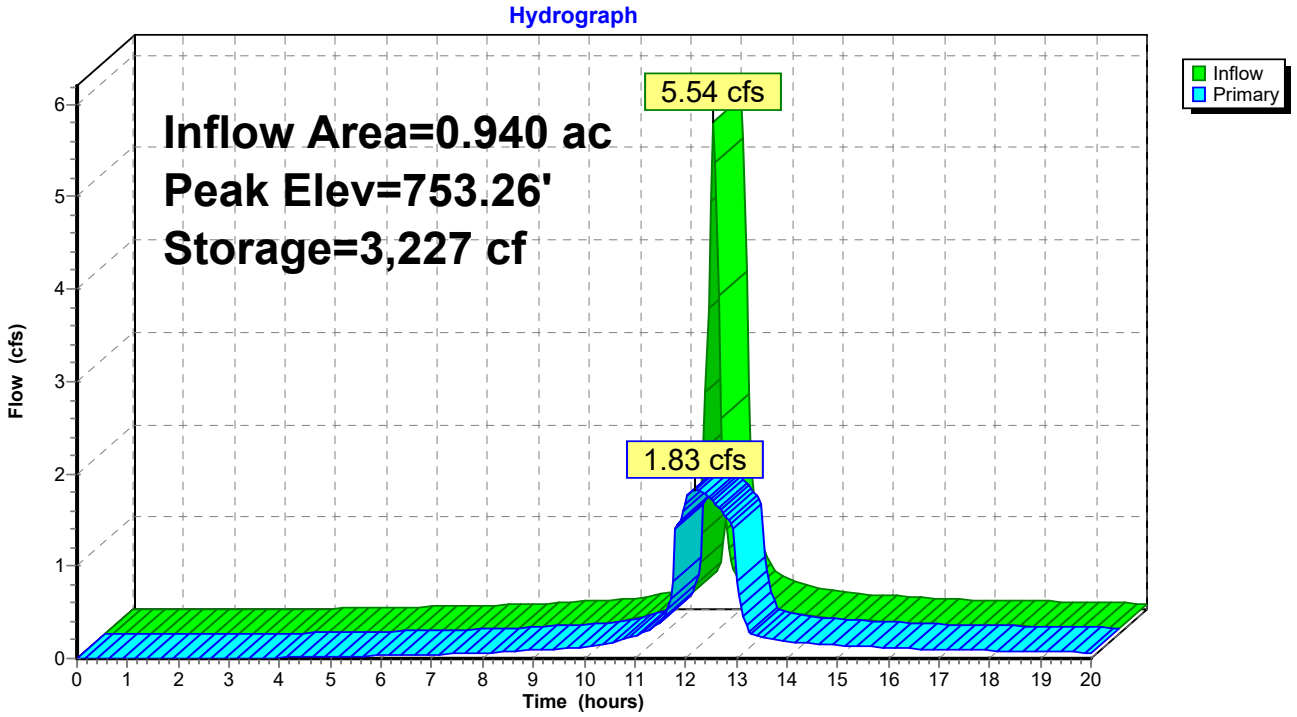
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	6,860 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	747.72'	120 cf	**18.0" Round 3-4** L= 68.0' S= 0.0056 '/'
#3	747.72'	92 cf	**15.0" Round 3-7** L= 75.0' S= 0.0068 '/'
#4	748.06'	71 cf	**18.0" Round 4-5** L= 40.0' S= 0.0052 '/'
		7,142 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	856	0	0
752.00	1,236	1,046	1,046
753.00	1,673	1,455	2,501
754.00	2,165	1,919	4,420
755.00	2,715	2,440	6,860

Device	Routing	Invert	Outlet Devices
#1	Primary	747.72'	**18.0" Round Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 747.72' / 747.64' S= 0.0053 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	747.72'	**5.5" Vert. Orifice** C= 0.600

Primary OutFlow Max=1.83 cfs @ 12.18 hrs HW=753.25' (Free Discharge)
↑**1=Culvert** (Passes 1.83 cfs of 18.60 cfs potential flow)
↑**2=Orifice** (Orifice Controls 1.83 cfs @ 11.08 fps)

Pond 3P: Detention Basin

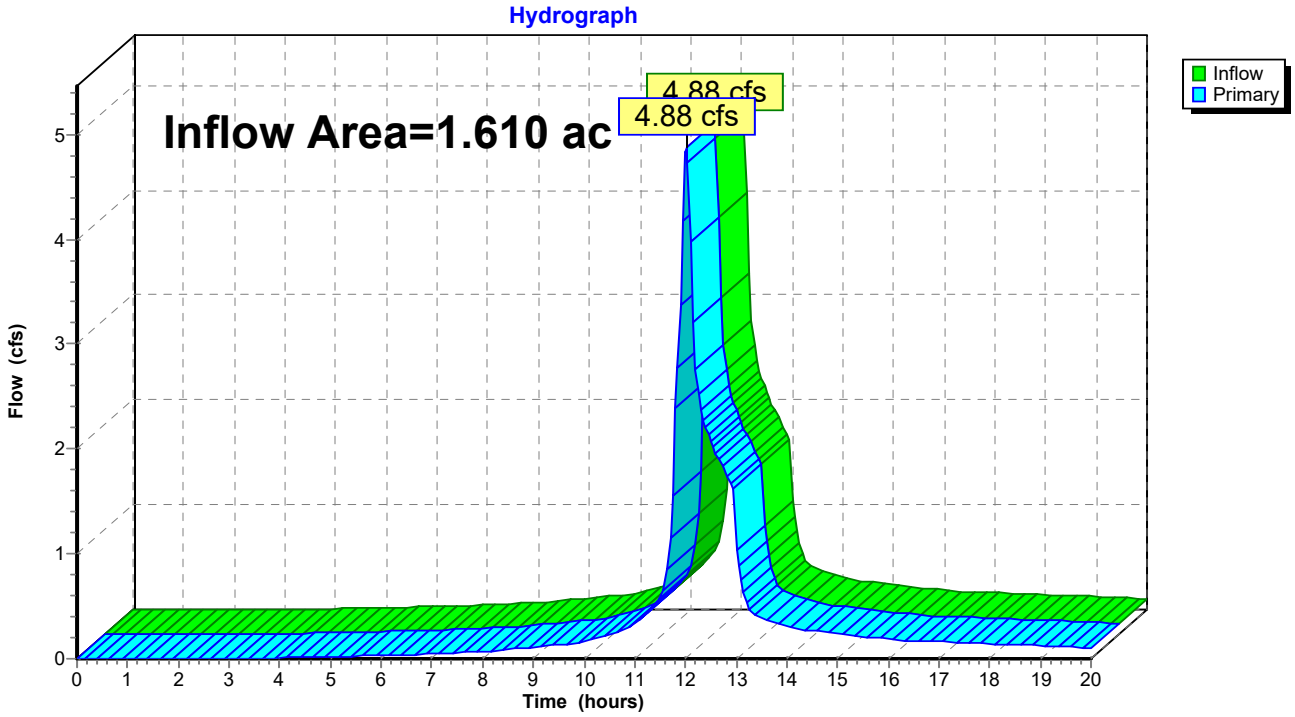


Summary for Link 5L: Total Discharge

Inflow Area = 1.610 ac, 48.45% Impervious, Inflow Depth > 3.52" for 50-Year event
Inflow = 4.88 cfs @ 12.02 hrs, Volume= 0.472 af
Primary = 4.88 cfs @ 12.02 hrs, Volume= 0.472 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 5L: Total Discharge



Summary for Subcatchment 1S: Existing

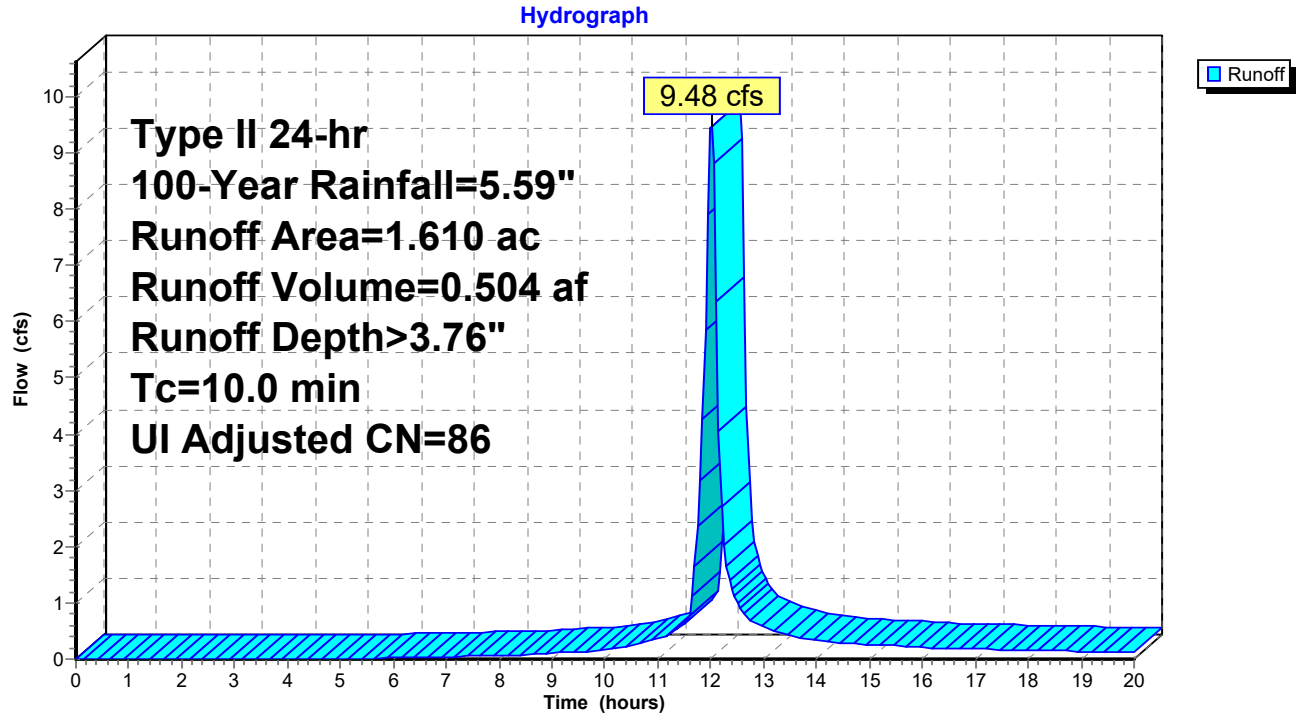
Runoff = 9.48 cfs @ 12.01 hrs, Volume= 0.504 af, Depth> 3.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=5.59"

Area (ac)	CN	Adj	Description
0.680	96		Gravel surface, HSG C
0.470	73		Woods, Fair, HSG C
0.240	98		Unconnected pavement, HSG D
0.220	80		>75% Grass cover, Good, HSG D
1.610	87	86	Weighted Average, UI Adjusted
1.370			85.09% Pervious Area
0.240			14.91% Impervious Area
0.240			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Post Detained

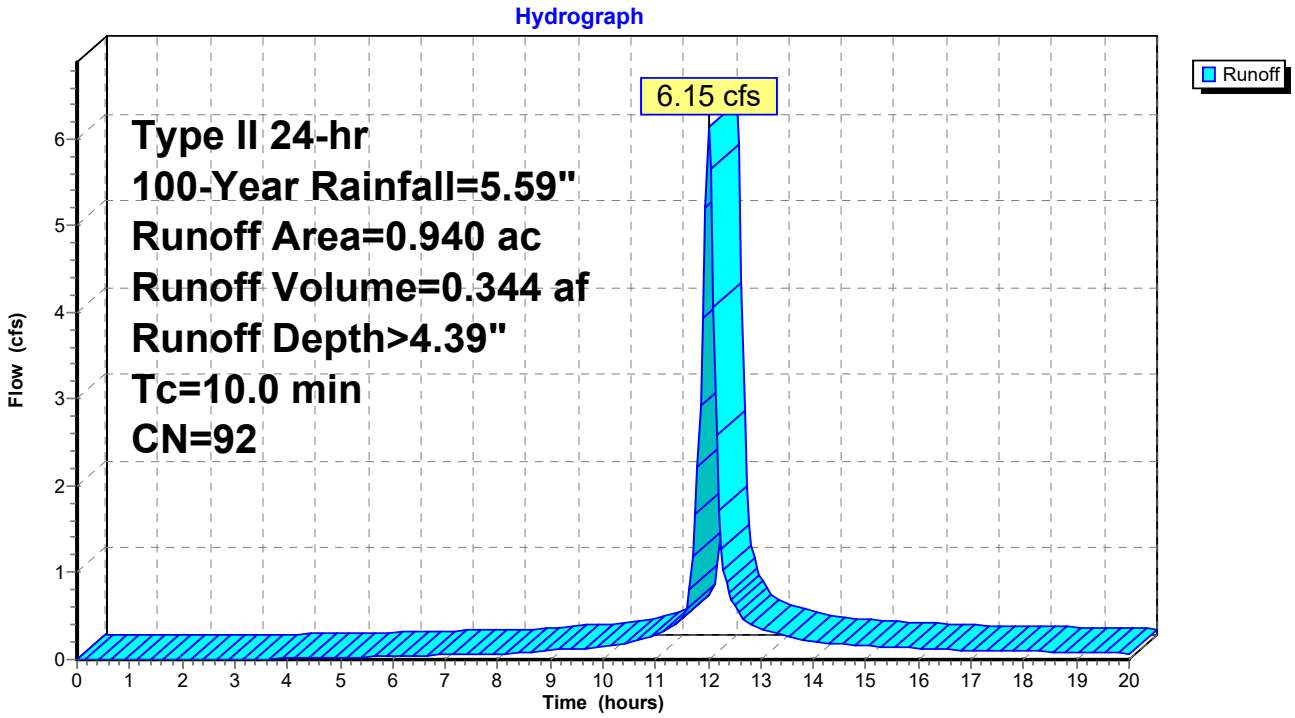
Runoff = 6.15 cfs @ 12.01 hrs, Volume= 0.344 af, Depth> 4.39"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=5.59"

Area (ac)	CN	Description
0.640	98	Paved parking, HSG C
0.300	80	>75% Grass cover, Good, HSG D
0.940	92	Weighted Average
0.300		31.91% Pervious Area
0.640		68.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 2S: Post Detained



Summary for Subcatchment 4S: Undetained Runoff

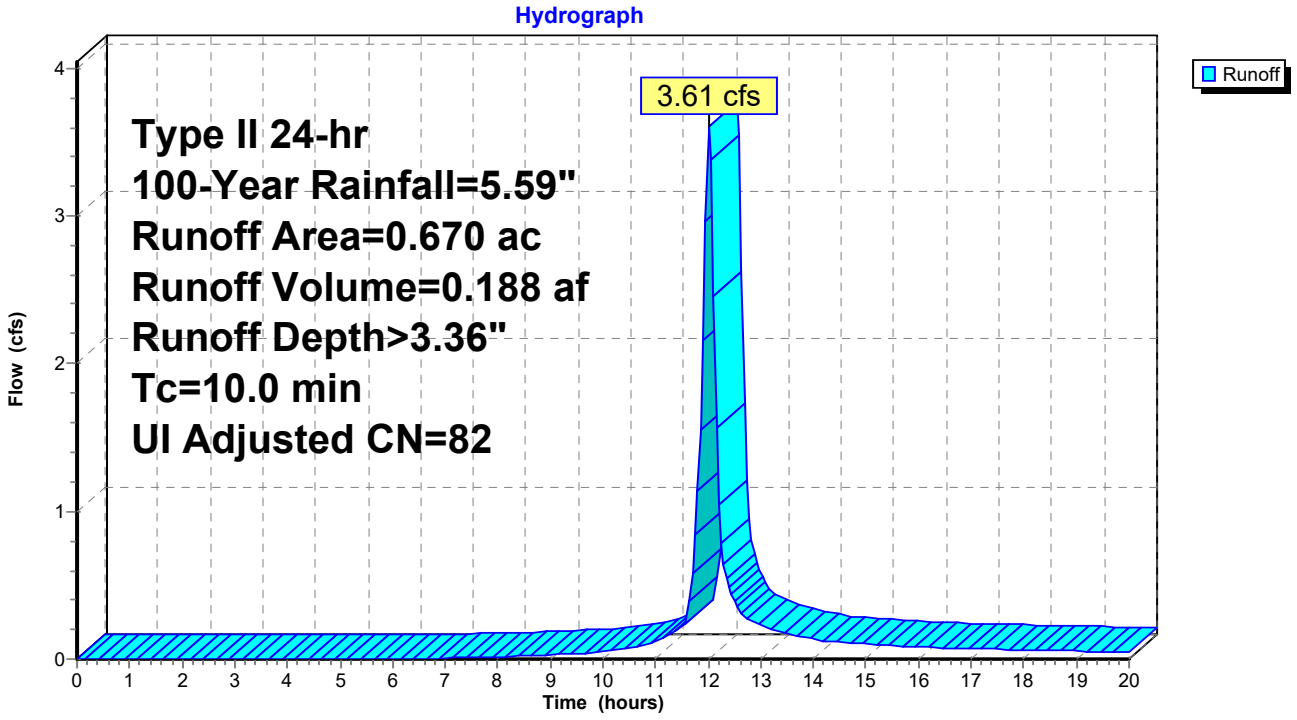
Runoff = 3.61 cfs @ 12.01 hrs, Volume= 0.188 af, Depth> 3.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-Year Rainfall=5.59"

Area (ac)	CN	Adj	Description
0.530	80		>75% Grass cover, Good, HSG D
0.140	98		Unconnected pavement, HSG D
0.670	84	82	Weighted Average, UI Adjusted
0.530			79.10% Pervious Area
0.140			20.90% Impervious Area
0.140			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Liberty TWP Min**

Subcatchment 4S: Undetained Runoff



Summary for Pond 3P: Detention Basin

Inflow Area = 0.940 ac, 68.09% Impervious, Inflow Depth > 4.39" for 100-Year event
Inflow = 6.15 cfs @ 12.01 hrs, Volume= 0.344 af
Outflow = 1.88 cfs @ 12.20 hrs, Volume= 0.344 af, Atten= 69%, Lag= 11.2 min
Primary = 1.88 cfs @ 12.20 hrs, Volume= 0.344 af

Routing by Stor-Ind method, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 753.56' @ 12.20 hrs Surf.Area= 1,948 sf Storage= 3,796 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 11.9 min (757.8 - 746.0)

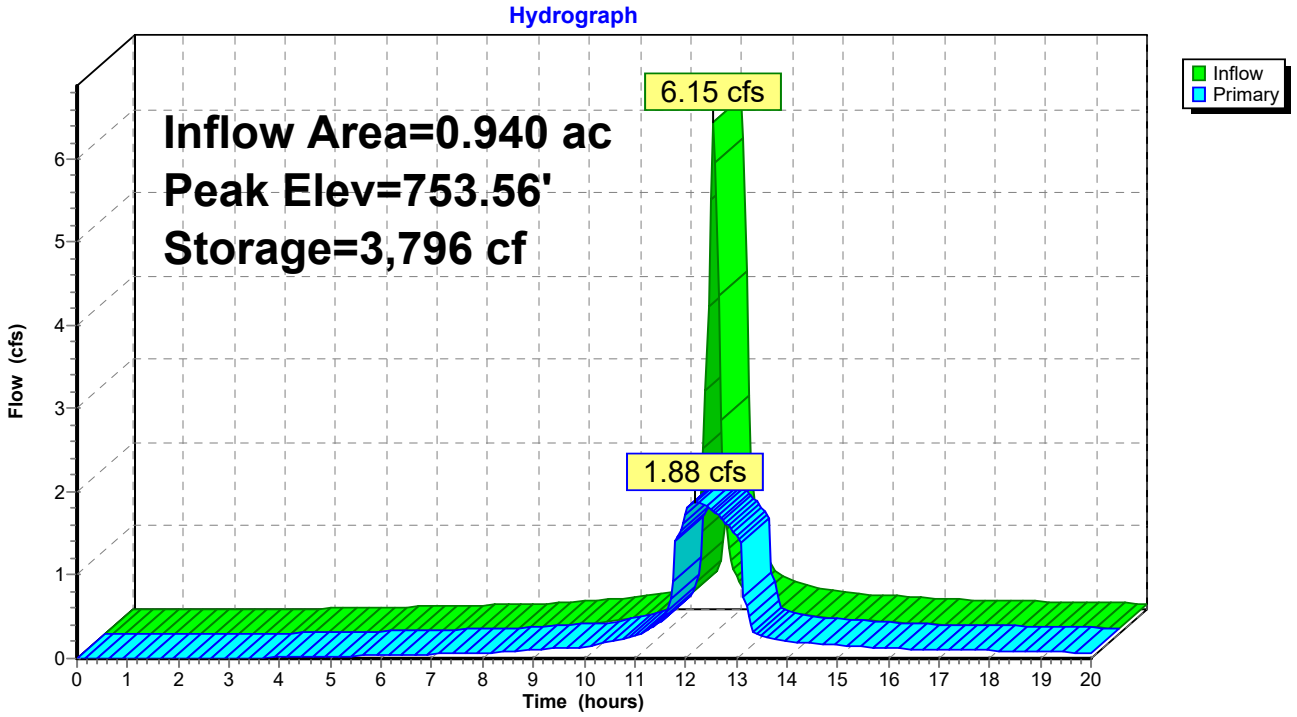
Volume	Invert	Avail.Storage	Storage Description
#1	751.00'	6,860 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)
#2	747.72'	120 cf	**18.0" Round 3-4** L= 68.0' S= 0.0056 '/'
#3	747.72'	92 cf	**15.0" Round 3-7** L= 75.0' S= 0.0068 '/'
#4	748.06'	71 cf	**18.0" Round 4-5** L= 40.0' S= 0.0052 '/'
		7,142 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
751.00	856	0	0
752.00	1,236	1,046	1,046
753.00	1,673	1,455	2,501
754.00	2,165	1,919	4,420
755.00	2,715	2,440	6,860

Device	Routing	Invert	Outlet Devices
#1	Primary	747.72'	**18.0" Round Culvert** L= 15.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 747.72' / 747.64' S= 0.0053 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 1.77 sf
#2	Device 1	747.72'	**5.5" Vert. Orifice** C= 0.600

Primary OutFlow Max=1.88 cfs @ 12.20 hrs HW=753.56' (Free Discharge)
↑**1=Culvert** (Passes 1.88 cfs of 19.19 cfs potential flow)
↑**2=Orifice** (Orifice Controls 1.88 cfs @ 11.40 fps)

Pond 3P: Detention Basin

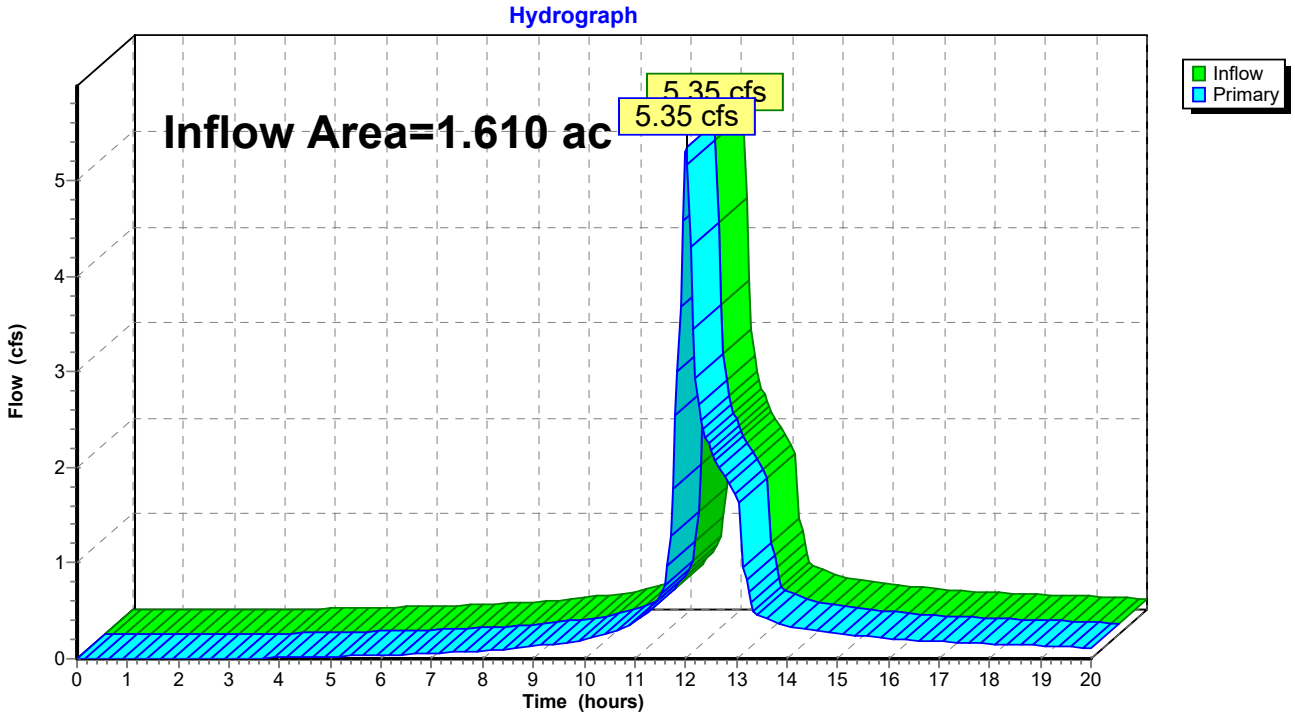


Summary for Link 5L: Total Discharge

Inflow Area = 1.610 ac, 48.45% Impervious, Inflow Depth > 3.96" for 100-Year event
Inflow = 5.35 cfs @ 12.02 hrs, Volume= 0.532 af
Primary = 5.35 cfs @ 12.02 hrs, Volume= 0.532 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-20.00 hrs, dt= 0.05 hrs

Link 5L: Total Discharge



Storm Pipe & Stream Calculations

Q(Reqd.) = CIA ; I = from IDF curves
Q(Prov.) = AV
V = (1.49/n)*R^(2/3)*S^(1/2)

STORM SEWER COMPUTATIONS
for
CAROLS BURGER KING - LIBERTY TOWNSHIP

LOCATION			AREA					TIME			Intensity	Q	DESIGN					PROFILE				5-year HGL							
Inlet	Drainage Area	Outlet	Incre. Acres	Total Acres	"C"	Incre. C x A	Sum C x A	To Inlet Ti (min)	Total Tc (min)	In Pipe Tp min	"I" in/hr 10 yr	Req. CFS	Pipe Size Inches	"n" Value	Slope %	V ft/sec	Q CFS	Pipe Length	Invert Up end	Invert Lo end	T/C	Loss Coeff. K	Minor Losses H_m	"I" in/hr 10 yr	5yr Flowrate (cfs)	Frictional Slope S_f	Major Losses = $S_f * L$	HGL Elev. Low	HGL Elev. High
6	-	5	0.20	0.20	0.87	0.17	0.17	5	5	0.6	6.92	1.20									753.42	0.25	0.0460	6.92	1.20	0.0005	0.06	748.14	748.25
													15	0.016	0.64	3.44	4.23	107.0	749.00	748.31								
5	-	4	0.13	0.33	0.91	0.12	0.29	5	5.6	0.2	6.92	2.02									753.82	0.10	0.0191	6.92	2.02	0.0006	0.02	748.10	748.14
													18	0.016	0.52	3.51	6.20	40.0	748.31	748.10								
4	-	3	0.07	0.40	0.50	0.04	0.33	5	5	0.4	6.92	2.26									750.50	0.50	0.1017	6.92	2.26	0.0007	0.05	747.95	748.10
													18	0.016	0.56	3.62	6.40	68.0	748.10	747.72								
3	-	2	0.07	0.92	0.94	0.07	0.74	5	5.4	0.1	6.92	5.12									751.76	0.50	0.0971	6.92	5.12	0.0036	0.05	747.80	747.95
													18	0.016	0.53	3.54	6.25	15.0	747.72	747.64								
2	-	1	0.00	0.92	0.00	0.00	0.74	5	5.5	0.4	6.92	5.12									750.65	0.25	0.0318	6.92	5.12	0.0036	0.23	747.54	747.80
													18	0.016	0.35	2.86	5.06	63.0	747.64	747.42								
7	-	3	0.45	0.45	0.77	0.35	0.35	5	5	0.4	6.92	2.40									752.80	0.25	0.0485	6.92	2.40	0.0021	0.16	747.82	748.03
													15	0.016	0.68	3.54	4.34	75.0	748.23	747.72								
Sidwalk Culvert	-		0.11	0.11	0.66	0.07	0.07	5	5	0.2	6.92	0.50									754.80	0.25	0.0289	6.92	0.50	0.0008	0.02	753.07	753.12
													10	0.016	0.70	2.73	1.49	23.0	753.16	753.00								

DESIGNED: KJW
REVIEWED: SEF
File: C5530002 - Storm Calcs.xlsx

Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Jan 30 2018

Bypass Ditch

Trapezoidal

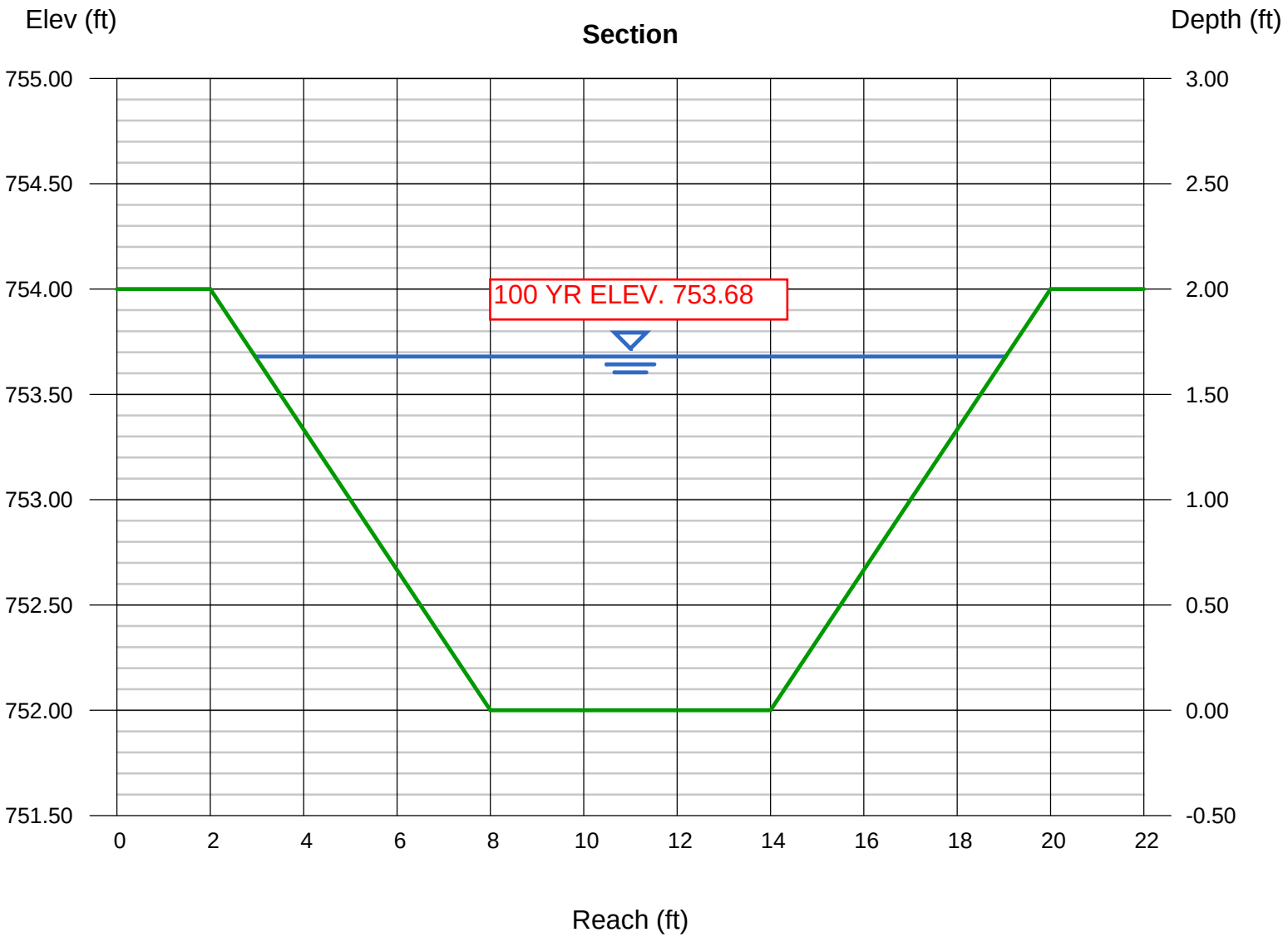
Bottom Width (ft)	= 6.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 752.00
Slope (%)	= 1.25
N-Value	= 0.015

Calculations

Compute by:	Q vs Depth
No. Increments	= 50

Highlighted

Depth (ft)	= 1.68
Q (cfs)	= 220.98
Area (sqft)	= 18.55
Velocity (ft/s)	= 11.91
Wetted Perim (ft)	= 16.63
Crit Depth, Yc (ft)	= 2.00
Top Width (ft)	= 16.08
EGL (ft)	= 3.89



StreamStats Version 3.0

Flow Statistics Ungaged Site Report

Date: Fri Dec 8, 2017 1:02:56 PM GMT-5
Study Area: Ohio
NAD 1983 Latitude: 39.4168 (39 25 01)
NAD 1983 Longitude: -84.472 (-84 28 20)
Drainage Area: 0.18 mi2

Peak Flows Basin Characteristics			
100% Peak Flow Full Model (0.18 mi2)			
Parameter	**Value**	**Regression Equation Valid Range**	
		Min	**Max**
Drainage Area (square miles) 115 acres	0.18	0.01	7422
Ohio Region C Indicator 1 if in C else 0 (dimensionless)	1	0	1
Ohio Region A Indicator 1 if in A else 0 (dimensionless)	0	0	1
Stream Slope 10 and 85 Longest Flow Path (feet per mi)	69.6	1.53	674
Percent Storage from NLCD1992 (percent)	0	0	25.8

Low Flows Basin Characteristics			
100% Low Flow Region A 2012 5138 (0.18 mi2)			
Parameter	**Value**	**Regression Equation Valid Range**	
		Min	**Max**
Drainage Area (square miles)	0.18 (below min value 1)	1	1250
Streamflow Variability Index from Grid (dimensionless)	0.57	0.24	1.12

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Probability of Zero Flow Basin Characteristics			
100% P zero Flow 2012 5138 (0.18 mi2)			
Parameter	**Value**	**Regression Equation Valid Range**	
		Min	**Max**
Drainage Area (square miles)	0.18 (below min value 1)	1	1250
Streamflow Variability Index from Grid (dimensionless)	0.57	0.24	1.12

Warning: Some parameters are outside the suggested range. Estimates will be extrapolations with unknown errors.

Mean and Percentile Basin Characteristics			
Y coordinate (latitude) of the centroid_ in decimal degrees=39.4133			
100% Low Flow LatLE 41.2 wri02 4068 (0.18 mi2)			
Parameter	**Value**	**Regression Equation Valid Range**	
		Min	**Max**
Drainage Area (square miles)	0.18	0.12	7422
Percent Forest (percent)	10.5	0	99.1
Percent Storage from NLCD1992 (percent)	0	0	19
Mean Annual Precipitation (inches)	40.1	34	43.2
Streamflow Variability Index from Grid (dimensionless)	0.57	0.25	1.13
Latitude of Basin Centroid (decimal degrees)	39.4133	38.68	41.2
Longitude of Basin Centroid (decimal degrees)	84.4668	80.53	84.6

Peak Flows Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
PK2	52.9	ft3/s	37	2.1	26	108
PK5	95.1	ft3/s	35	3.3	48.5	187
PK10	125	ft3/s	34	4.4	63.6	247
PK25	164	ft3/s	35	5.9	81.4	332
PK50	193	ft3/s	37	6.8	93	400
PK100	221	ft3/s	38	7.5	104	474
PK500	289	ft3/s	42	8.6	124	670

http://pubs.usgs.gov/sir/2006/5312/ (http://pubs.usgs.gov/sir/2006/5312/)
Koltun_ G.F._ Kula_ S.P._ and Puskas_ B.M._ 2006_ A Streamflow Statistics (StreamStats) Web Application for Ohio: U.S. Geological Survey Scientific Investigations Report 2006-5312_ 62 p.

Low Flows Statistics						
Statistic	Value	Unit	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
M1D10Y	0.00213	ft3/s				
M7D10Y	0.00276	ft3/s				
M30D10Y	0.0044	ft3/s				
M90D10Y	0.00709	ft3/s				
D80	0.0153	ft3/s				

#http://pubs.usgs.gov/sir/2012/5138/#
Koltun_ G.F._ and Kula_ S.P._ 2013_ Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012-5138_ 195 p.

Probability of Zero Flow Statistics						
Statistic	Value	Unit	Standard Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
PROB 1DAY	0.0383	dim				
PROB 7DAY	0.0167	dim				
PROB 30DAY	0.000731	dim				

#http://pubs.usgs.gov/sir/2012/5138/#
Koltun_ G.F._ and Kula_ S.P._ 2013_ Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012-5138_ 195 p.

Mean and Percentile Statistics						
Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
Q1	0.26	ft3/s	17			
Q2	0.36	ft3/s	12			
Q3	0.38	ft3/s	14			
Q4	0.37	ft3/s	11			
Q5	0.24	ft3/s	20			
Q6	0.14	ft3/s	27			
Q7	0.0793	ft3/s	28			
Q8	0.0648	ft3/s	37			
Q9	0.0361	ft3/s	44			
QA	0.19	ft3/s	11			

Q10	0.0322	ft3/s	51			
Q11	0.0827	ft3/s	38			
Q12	0.18	ft3/s	22			
QAH	0.0192	ft3/s	66			
FPS25	0.052	ft3/s	29			
FPS50	0.0984	ft3/s	40			
FPS75	0.19	ft3/s	48			

http://oh.water.usgs.gov/reports/wrir/wrir02-4068.pdf (http://oh.water.usgs.gov/reports/wrir/wrir02-4068.pdf)
Koltun_ G. F._ and Whitehead_ M. T._ 2002_ Techniques for Estimating Selected Streamflow Characteristics of Rural_ Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068_ 50 p

Appendix A
Tributary Maps

HAMILTON MIDDLETOWN ROAD (SR-4)

HORSESHOE BEND ROAD

N 64°21'30" E 267.00'

16" WATER MAIN

15' PARKING SETBACK

30' BUILDING SETBACK

FREE LINE

POSSIBLE HIGHWAY EASEMENT (PROPOSED RIGHT-OF-WAY ON ODOT PLANS DATED 12/19/56)

10' PAVING SETBACK

ASPHALT

CONCRETE

GRAVEL

N 25°38'30" W 350.00'

30' BUILDING SETBACK

10' PAVING SETBACK

S 25°38'30" E 142.80'

CONCRETE

6" WATER MAIN

50' PARKING SETBACK

TREE LINE

S 64°21'30" W 274.60'

SANITARY MANHOLE
RIM=758.76
INVERT=750.39

SANITARY MANHOLE
RIM=758.99
INVERT=749.83

OHE

SA

W

S

D

LEGEND

DISTURBED AREA:

IMPERVIOUS:

GREEN SPACE:

GRAVEL:

WOODS:

0 10 20 40

SCALE: 1 IN = 20 FT

NO.	DATE	BY	DESCRIPTION
1	2/9/2018	MSG	ZONING CERTIFICATE SUBMITTAL

1160 DUBLIN ROAD
SUITE 100
COLUMBUS, OH 43215
TEL: 614.441.4222
FAX: 888.488.7340

PROJECT DATE: 5/08/2018
PROJECT NO.: C5530002
DRAWN BY: KJW
CHECKED BY: SEF

Mannik Smith GROUP

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PREPARED FOR:
CARROLS CORPORATION

BURGER KING

HORSE SHOE BEND RD.
LIBERTY TWP, OHIO

PRE DEVELOPED MAP

1 / 2

L:\Projects\Projects A-E\C5530002\ENG\APPSC5530002 Pre-Developed Map.dwg - Last printed 5/8/2018 10:57 AM

HAMILTON MIDDLETOWN ROAD (SR-4)

HORSESHOE BEND ROAD

BUILDING ROOF DRAINS DIRECTLY TO STRUCTURE

SANITARY MANHOLE
RIM=758.76
INVERT=750.39

SANITARY MANHOLE
RIM=758.99
INVERT=749.83

LEGEND

DISTURBED AREA:

TRIBUTARY AREA:

IMPERVIOUS:

GREEN SPACE:

TRIBUTARY AREAS

	C-VALUE	AREA (AC)
STRUCTURE 3:	0.94	0.07
STRUCTURE 4:	0.50	0.07
STRUCTURE 5:	0.91	0.13
STRUCTURE 6:	0.87	0.20
STRUCTURE 7:	0.77	0.45

NOTE: ALL POST DEVELOPED SOILS ARE ADJUSTED HSG D, GOOD CONDITION.

0 10 20 40

SCALE: 1 IN = 20 FT

NO.	DATE:	BY	DESCRIPTION
1	2/9/2018	MSG	ZONING CERTIFICATE SUBMITTAL
2	5/23/2018	MSG	BUTLER COUNTY ENGINEERING SUBMITTAL

1160 DUBLIN ROAD
SUITE 100
COLUMBUS, OH 43215
TEL: 614.441.4222
FAX: 888.488.7340

PROJECT DATE: 5/22/2018
PROJECT NO.: C5530002
DRAWN BY: KJW
CHECKED BY: SEF

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PREPARED FOR:
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BURGER KING
HORSESHOE BEND RD.
LIBERTY TWP, OHIO

POST DEVELOPED MAP

2 / 2