

603 Salem Street  
Wakefield, MA 01880  
Tel: (781) 246-2800  
Fax: (781) 246-7596

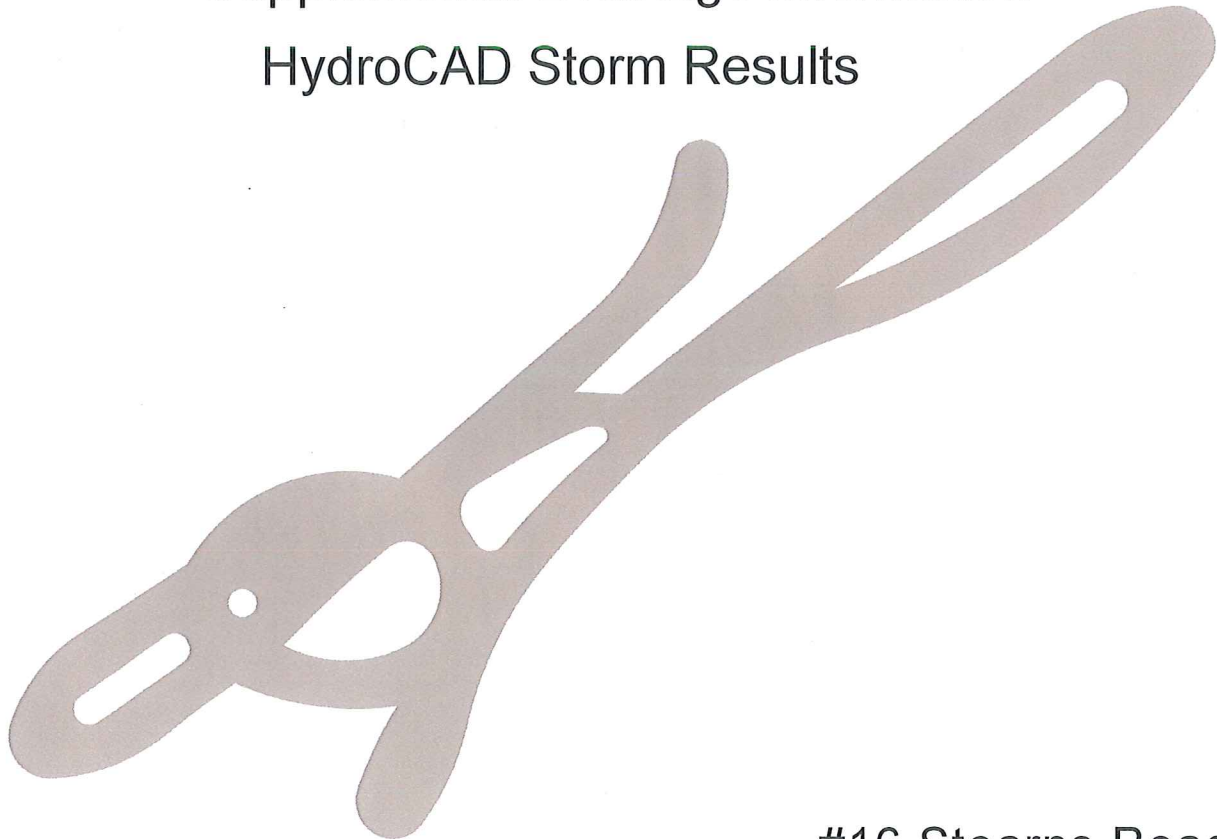
Nantucket, MA 02554  
Tel: (508) 228-7909

Refer to File No. WEL-0012

# Storm Water Management Report

Supplemental Drainage Information

HydroCAD Storm Results



#16 Stearns Road  
Wellesley, Massachusetts

December 5, 2018

Revised December 26, 2018



603 Salem Street  
Wakefield, MA 01880  
Tel: (781) 246-2800  
Fax: (781) 246-7596

# Water Quality Flow Calculation Worksheet

Nantucket, MA 02554  
Tel: (508) 228-7909

Refer to File No. WEL-0012

## For First 1/2-inch of Runoff WQV:

Impervious Surfaces to Vortsentry:

| Catchment | Time of Conc.<br>(hours) | Impervious Area<br>(acres) | Impervious Area<br>(sq. mi.) |
|-----------|--------------------------|----------------------------|------------------------------|
| P1        | 0.10                     | 0.113                      |                              |
| P2        | 0.10                     | 0.064                      |                              |
| P4        | 0.10                     | 0.074                      |                              |
| 1/3 P5    | 0.10                     | 0.113                      |                              |
| $\Sigma$  |                          | 0.363                      | 0.000567811                  |

## Time of Concentration:

Longest Catchment Tc: 0.10

$q_u$  from Figure 2, attached: 752 csm/in

## Water Quality Flow (WQF):

$$Q_{1.0} = (q_u)(A)(WQV)$$

Where:

$Q_{0.5}$  = peak flow rate associated with the first 1/2-inch of runoff;

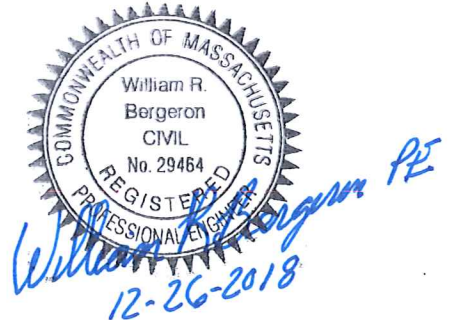
$q_u$  = the unit peak discharge, in cubic feet per second per square mile per inch;

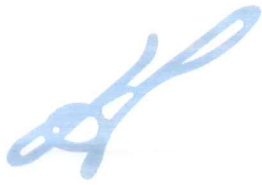
A = impervious surface in drainage area, in square miles;

WQV = water quality volume, in inches (0.5 inches)

$$Q_{0.5} = \left(752 \frac{\text{csm}}{\text{in}}\right)(0.000567811 \text{ sq. mi.})(0.5")$$

$$Q_{0.5} = 0.21 \text{ cfs}$$





### Proprietary Separator Selection:

The VortSentry HS36 will provide a presumptive removal rate of 80% for water quality flows through 0.55 cfs. See Massachusetts sizing table below:



| VortSentry HS Model | Swirl Chamber Diameter (ft) | Typical Depth Below Invert (ft) | Treatment Capacity (cfs) <sup>1</sup> | Max. Inlet/Outlet Pipe Diameter (in) | Maximum Sediment Storage Capacity (CF) |
|---------------------|-----------------------------|---------------------------------|---------------------------------------|--------------------------------------|----------------------------------------|
| VortSentry HS36*    | 3                           | 5.6                             | 0.55                                  | 18                                   | 39                                     |
| w/ 1' added sump    | 3                           | 6.6                             | 0.55                                  | 18                                   | 47                                     |
| w/ 2' added sump    | 3                           | 7.6                             | 0.55                                  | 18                                   | 54                                     |
| w/ 3' added sump    | 3                           | 8.6                             | 0.55                                  | 18                                   | 61                                     |
| w/ 4' added sump    | 3                           | 9.6                             | 0.55                                  | 18                                   | 68                                     |
| w/ 5' added sump    | 3                           | 10.6                            | 0.55                                  | 18                                   | 75                                     |
| VortSentry HS48**   | 4                           | 6.8                             | 1.2                                   | 24                                   | 85                                     |
| w/ 1' added sump    | 4                           | 7.8                             | 1.2                                   | 24                                   | 97                                     |
| w/ 2' added sump    | 4                           | 8.8                             | 1.2                                   | 24                                   | 110                                    |
| w/ 3' added sump    | 4                           | 9.8                             | 1.2                                   | 24                                   | 123                                    |
| w/ 4' added sump    | 4                           | 10.8                            | 1.2                                   | 24                                   | 135                                    |
| VortSentry HS60***  | 5                           | 8.0                             | 2.2                                   | 30                                   | 156                                    |
| w/ 1' added sump    | 5                           | 9.0                             | 2.2                                   | 30                                   | 176                                    |
| w/ 2' added sump    | 5                           | 10.0                            | 2.2                                   | 30                                   | 196                                    |
| w/ 3' added sump    | 5                           | 11.0                            | 2.2                                   | 30                                   | 215                                    |

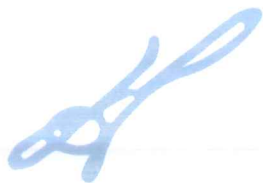
\*maintenance recommended when sediment reaches a height of 3'-7" below water surface elevation in sump.

\*\*maintenance recommended when sediment reaches a height of 4'-9" below water surface elevation in sump.

\*\*\*maintenance recommended when sediment reaches a height of 6.0' below water surface elevation in sump.

1. Design Flow Rate is based on 80% removal of particle size distribution with an average particle size of 240 micron. This flow also represents the maximum flow prior to which bypass occurs.

**Notes:** Systems can be sized based on a water quality flow (e.g. 1 inch storm) or on a net annual basis depending on the local regulatory requirement. When sizing based on a water quality storm, the required flow to be treated should be equal or less than the listed water quality flow for the selected system. Systems sized based on a water quality storm are generally more conservatively sized. Additional particle size distributions are available for sizing purposes upon request. Depth below invert is measured to the inside bottom of the system. This depth can be adjusted to meet specific storage or maintenance requirements. Contact our support staff for the most cost effective sizing for your area.



## Water Quality Flow Calculation

16 Stearns Road – Wellesley, MA

July 6, 2018 Revised October 19, 2018, December 17, 2018

The StormCeptor STC 900 will provide a presumptive removal rate of 77% for water quality flows through 0.89 cfs. See Massachusetts sizing table below:

### Massachusetts – Water Quality (Q) Flow Rate

| Stormceptor<br>STC Model | Inside<br>Diameter | Typical Depth<br>Below Inlet<br>Pipe Invert <sup>1</sup> | Water Quality<br>Flow Rate Q <sup>2</sup> | Peak Conveyance<br>Flow Rate <sup>3</sup> | Hydrocarbon<br>Capacity <sup>4</sup> | Maximum<br>Sediment<br>Capacity <sup>4</sup> |
|--------------------------|--------------------|----------------------------------------------------------|-------------------------------------------|-------------------------------------------|--------------------------------------|----------------------------------------------|
|                          | (in)               | (in)                                                     | (cfs)                                     | (cfs)                                     | (Gallons)                            | (ft <sup>3</sup> )                           |
| STC 450I                 | 4                  | 68                                                       | 0.40                                      | 5.5                                       | 86                                   | 46                                           |
| STC 900                  | 6                  | 63                                                       | 0.89                                      | 22                                        | 251                                  | 89                                           |
| STC 2400                 | 8                  | 104                                                      | 1.58                                      | 22                                        | 840                                  | 205                                          |
| STC 4800                 | 10                 | 140                                                      | 2.47                                      | 22                                        | 909                                  | 543                                          |
| STC 7200                 | 12                 | 148                                                      | 3.56                                      | 22                                        | 1,059                                | 839                                          |
| STC 11000                | 2 x 10             | 142                                                      | 4.94                                      | 48                                        | 2,792                                | 1,086                                        |
| STC 16000                | 2 x 12             | 148                                                      | 7.12                                      | 48                                        | 3,055                                | 1,677                                        |

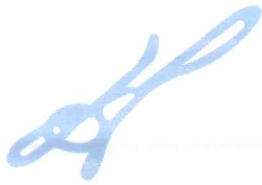
<sup>1</sup>Depth Below Pipe Inlet Invert to the Bottom of Base Slab, and Maximum Sediment Capacity <sup>4</sup>in vary to accommodate specific site designs and pollutant loads. Depths can vary to accommodate special design or site conditions. Contact your local representative for assistance.

<sup>2</sup>Water Quality Flow Rate (Q) is based on 80% annual average TSS removal of the ORF110 particle size distribution.

<sup>3</sup>Peak Conveyance Flow Rate is based upon inlet velocity of 3 feet per second and outlet pipe diameters of 18-inch, 36-inch, and 54-inch diameters.

<sup>4</sup>Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.





## Water Quality Flow Calculation

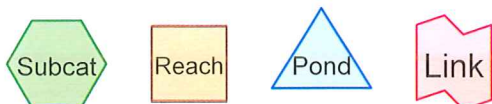
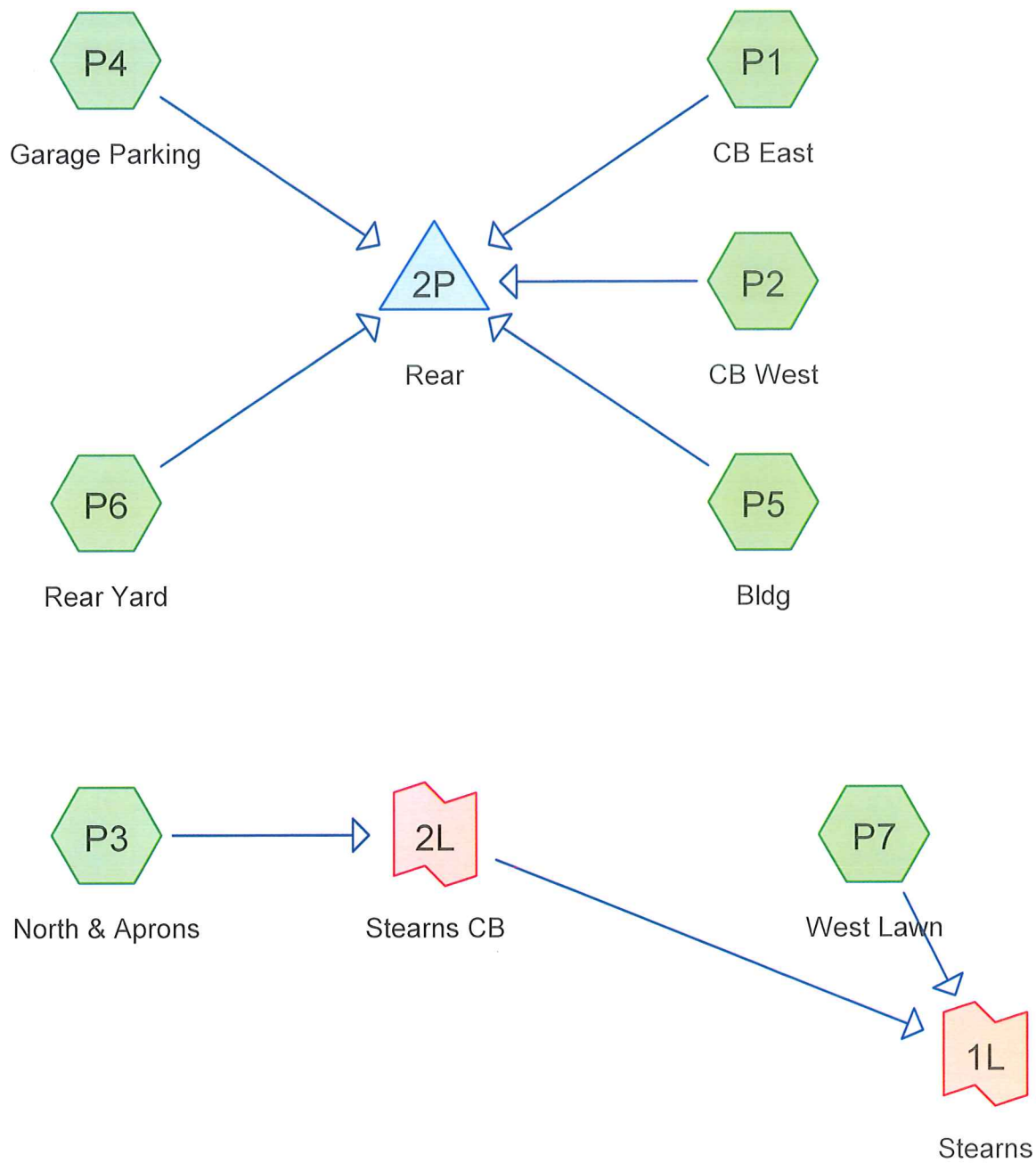
16 Stearns Road – Wellesley, MA

July 6, 2018 Revised October 19, 2018, December 17, 2018

Figure 2: For First ¼-inch of Runoff, Table of  $q_u$  values for  $I_a/P$  Curve = 0.0058, listed by  $t_c$ , for Type III Storm Distribution



| $T_c$<br>(Hours) | $q_u$<br>(csm/in) | $T_c$<br>(Hours) | $q_u$<br>(csm/in) | $T_c$<br>(Hours) | $q_u$<br>(csm/in) | $T_c$<br>(Hours) | $q_u$<br>(csm/in) |
|------------------|-------------------|------------------|-------------------|------------------|-------------------|------------------|-------------------|
| 0.01             | 821               | 1.8              | 246               | 5.3              | 116               | 8.8              | 77                |
| 0.03             | 821               | 1.9              | 238               | 5.4              | 115               | 8.9              | 76                |
| 0.05             | 813               | 2                | 230               | 5.5              | 113               | 9                | 76                |
| 0.067            | 794               | 2.1              | 223               | 5.6              | 112               | 9.1              | 75                |
| 0.083            | 773               | 2.2              | 217               | 5.7              | 110               | 9.2              | 74                |
| 0.1              | 752               | 2.3              | 211               | 5.8              | 109               | 9.3              | 74                |
| 0.116            | 733               | 2.4              | 205               | 5.9              | 107               | 9.4              | 73                |
| 0.133            | 713               | 2.5              | 200               | 6                | 106               | 9.5              | 72                |
| 0.15             | 694               | 2.6              | 194               | 6.1              | 104               | 9.6              | 72                |
| 0.167            | 677               | 2.7              | 190               | 6.2              | 103               | 9.7              | 71                |
| 0.183            | 662               | 2.8              | 185               | 6.3              | 102               | 9.8              | 70                |
| 0.2              | 646               | 2.9              | 181               | 6.4              | 100               | 9.9              | 70                |
| 0.217            | 632               | 3                | 176               | 6.5              | 99                | 10               | 69                |
| 0.233            | 619               | 3.1              | 173               | 6.6              | 98                |                  |                   |
| 0.25             | 606               | 3.2              | 169               | 6.7              | 97                |                  |                   |
| 0.3              | 572               | 3.3              | 165               | 6.8              | 96                |                  |                   |
| 0.333            | 552               | 3.4              | 162               | 6.9              | 94                |                  |                   |
| 0.35             | 542               | 3.5              | 158               | 7                | 93                |                  |                   |
| 0.4              | 516               | 3.6              | 155               | 7.1              | 92                |                  |                   |
| 0.416            | 508               | 3.7              | 152               | 7.2              | 91                |                  |                   |
| 0.5              | 472               | 3.8              | 149               | 7.3              | 90                |                  |                   |
| 0.583            | 443               | 3.9              | 147               | 7.4              | 89                |                  |                   |
| 0.6              | 437               | 4                | 144               | 7.5              | 88                |                  |                   |
| 0.667            | 417               | 4.1              | 141               | 7.6              | 87                |                  |                   |
| 0.7              | 408               | 4.2              | 139               | 7.7              | 86                |                  |                   |
| 0.8              | 383               | 4.3              | 136               | 7.8              | 85                |                  |                   |
| 0.9              | 361               | 4.4              | 134               | 7.9              | 84                |                  |                   |
| 1                | 342               | 4.5              | 132               | 8                | 84                |                  |                   |
| 1.1              | 325               | 4.6              | 130               | 8.1              | 83                |                  |                   |
| 1.2              | 311               | 4.7              | 128               | 8.2              | 82                |                  |                   |
| 1.3              | 297               | 4.8              | 126               | 8.3              | 81                |                  |                   |
| 1.4              | 285               | 4.9              | 124               | 8.4              | 80                |                  |                   |
| 1.5              | 274               | 5                | 122               | 8.5              | 79                |                  |                   |
| 1.6              | 264               | 5.1              | 120               | 8.6              | 79                |                  |                   |
| 1.7              | 254               | 5.2              | 118               | 8.7              | 78                |                  |                   |



**Area Listing (all nodes)**

| Area<br>(sq-ft) | CN        | Description<br>(subcatchment-numbers)                  |
|-----------------|-----------|--------------------------------------------------------|
| 18,863          | 39        | >75% Grass cover, Good, HSG A (P1, P2, P3, P4, P6, P7) |
| 4,375           | 35        | Brush, Fair, HSG A (P7)                                |
| 10,741          | 98        | Paved parking, HSG A (P1, P2, P3, P4)                  |
| 741             | 98        | Paved parking, HSG A (walk) (P6)                       |
| 310             | 98        | Paved parking, HSG A (wall) (P1)                       |
| 15,197          | 98        | Roofs, HSG A (P2, P5)                                  |
| 664             | 98        | Roofs, HSG A (porch) (P1, P6)                          |
| <b>50,891</b>   | <b>71</b> | <b>TOTAL AREA</b>                                      |

**Soil Listing (all nodes)**

| Area<br>(sq-ft) | Soil<br>Group | Subcatchment<br>Numbers    |
|-----------------|---------------|----------------------------|
| 50,891          | HSG A         | P1, P2, P3, P4, P5, P6, P7 |
| 0               | HSG B         |                            |
| 0               | HSG C         |                            |
| 0               | HSG D         |                            |
| 0               | Other         |                            |
| <b>50,891</b>   |               | <b>TOTAL AREA</b>          |



**Ground Covers (all nodes)**

| HSG-A<br>(sq-ft) | HSG-B<br>(sq-ft) | HSG-C<br>(sq-ft) | HSG-D<br>(sq-ft) | Other<br>(sq-ft) | Total<br>(sq-ft) | Ground<br>Cover           |
|------------------|------------------|------------------|------------------|------------------|------------------|---------------------------|
| 18,863           | 0                | 0                | 0                | 0                | 18,863           | >75% Grass<br>cover, Good |
| 4,375            | 0                | 0                | 0                | 0                | 4,375            | Brush, Fair               |
| 11,792           | 0                | 0                | 0                | 0                | 11,792           | Paved parking             |
| 15,861           | 0                | 0                | 0                | 0                | 15,861           | Roofs                     |
| <b>50,891</b>    | <b>0</b>         | <b>0</b>         | <b>0</b>         | <b>0</b>         | <b>50,891</b>    | <b>TOTAL AREA</b>         |

**PR-16stearnsR1**

Prepared by Microsoft

HydroCAD® 10.00-21 s/n 03206 © 2018 HydroCAD Software Solutions LLC

Type III 24-hr 2 Year Rainfall=3.10"

Printed 12/24/2018

Page 1

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

|                                            |                                                                                                          |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <b>Subcatchment P1: CB East</b>            | Runoff Area=8,673 sf 56.84% Impervious Runoff Depth=0.92"<br>Tc=6.0 min CN=73 Runoff=0.20 cfs 665 cf     |
| <b>Subcatchment P2: CB West</b>            | Runoff Area=3,601 sf 76.95% Impervious Runoff Depth=1.60"<br>Tc=6.0 min CN=84 Runoff=0.15 cfs 480 cf     |
| <b>Subcatchment P3: North &amp; Aprons</b> | Runoff Area=2,459 sf 37.90% Impervious Runoff Depth=0.40"<br>Tc=6.0 min CN=61 Runoff=0.02 cfs 83 cf      |
| <b>Subcatchment P4: Garage Parking</b>     | Runoff Area=4,706 sf 68.23% Impervious Runoff Depth=1.26"<br>Tc=6.0 min CN=79 Runoff=0.15 cfs 495 cf     |
| <b>Subcatchment P5: Bldg</b>               | Runoff Area=14,819 sf 100.00% Impervious Runoff Depth=2.87"<br>Tc=6.0 min CN=98 Runoff=1.00 cfs 3,542 cf |
| <b>Subcatchment P6: Rear Yard</b>          | Runoff Area=5,835 sf 16.97% Impervious Runoff Depth=0.09"<br>Tc=6.0 min CN=49 Runoff=0.00 cfs 44 cf      |
| <b>Subcatchment P7: West Lawn</b>          | Runoff Area=10,798 sf 0.00% Impervious Runoff Depth=0.00"<br>Tc=6.0 min CN=37 Runoff=0.00 cfs 0 cf       |
| <b>Pond 2P: Rear</b>                       | Peak Elev=145.25' Storage=893 cf Inflow=1.50 cfs 5,225 cf<br>Outflow=0.43 cfs 5,225 cf                   |
| <b>Link 1L: Stearns</b>                    | Inflow=0.02 cfs 83 cf<br>Primary=0.02 cfs 83 cf                                                          |
| <b>Link 2L: Stearns CB</b>                 | Inflow=0.02 cfs 83 cf<br>Primary=0.02 cfs 83 cf                                                          |

Total Runoff Area = 50,891 sf Runoff Volume = 5,308 cf Average Runoff Depth = 1.25"  
45.66% Pervious = 23,238 sf 54.34% Impervious = 27,653 sf

**Summary for Subcatchment P1: CB East**

Runoff = 0.20 cfs @ 12.10 hrs, Volume= 665 cf, Depth= 0.92"

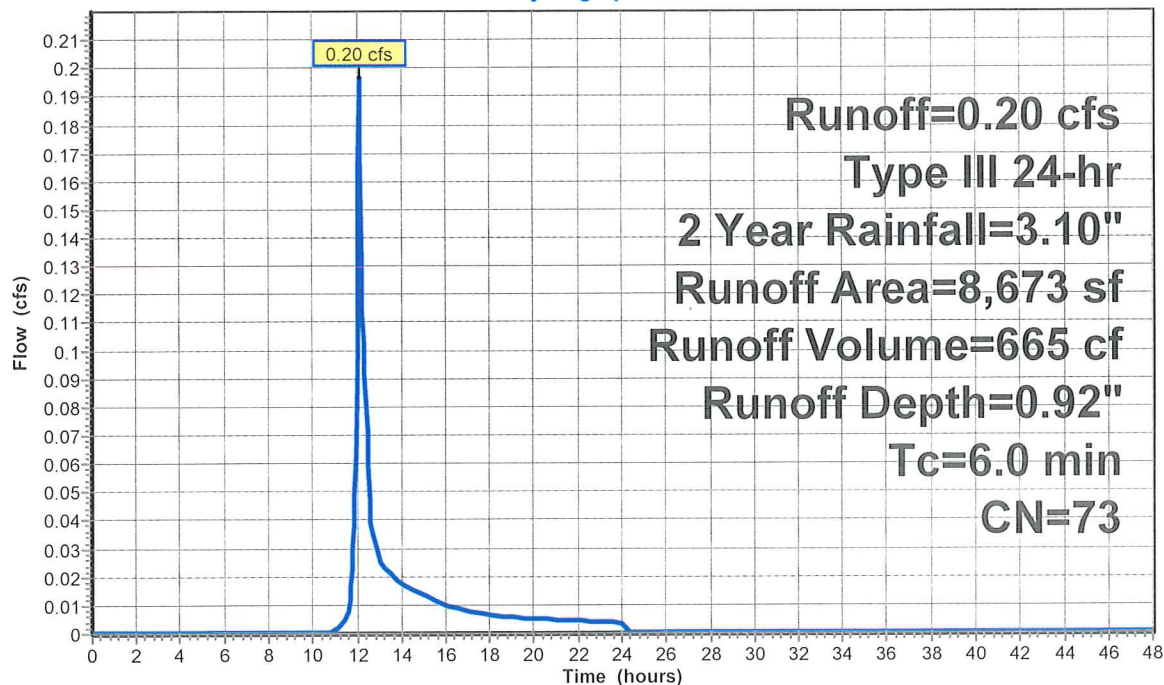
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2 Year Rainfall=3.10"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 4,205     | 98 | Paved parking, HSG A          |
| * 310     | 98 | Paved parking, HSG A (wall)   |
| * 415     | 98 | Roofs, HSG A (porch)          |
| 3,743     | 39 | >75% Grass cover, Good, HSG A |
| 8,673     | 73 | Weighted Average              |
| 3,743     |    | 43.16% Pervious Area          |
| 4,930     |    | 56.84% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P1: CB East**

Hydrograph



**Summary for Subcatchment P2: CB West**

Runoff = 0.15 cfs @ 12.09 hrs, Volume= 480 cf, Depth= 1.60"

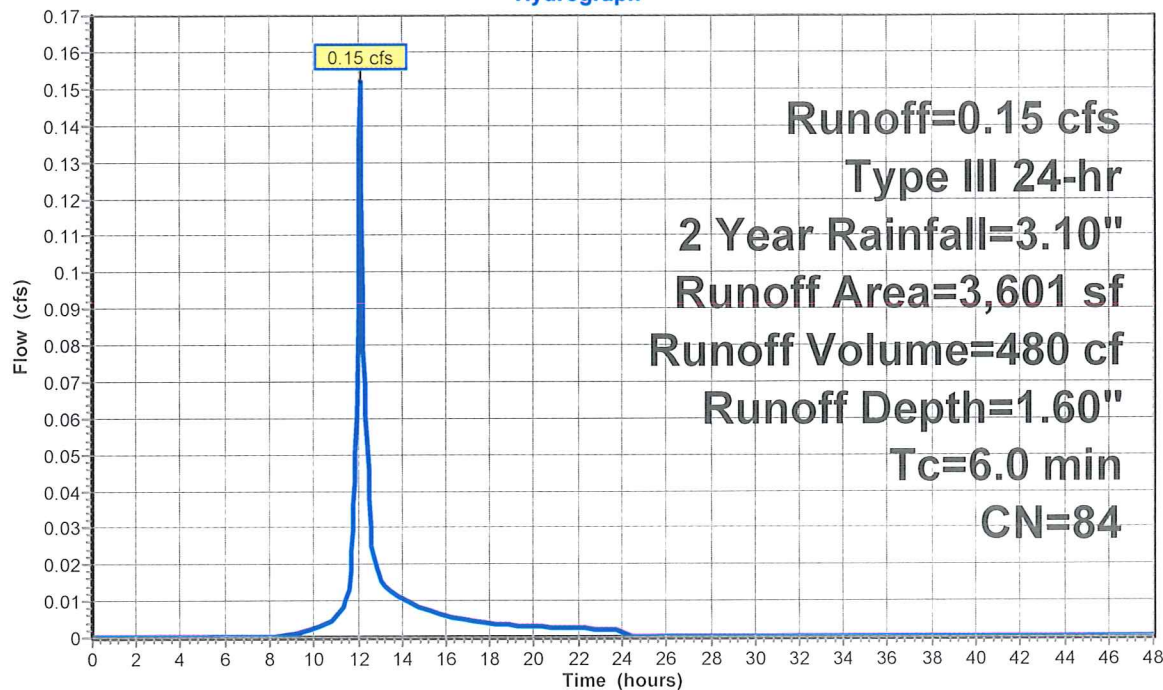
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2 Year Rainfall=3.10"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 830       | 39 | >75% Grass cover, Good, HSG A |
| 2,393     | 98 | Paved parking, HSG A          |
| 378       | 98 | Roofs, HSG A                  |
| 3,601     | 84 | Weighted Average              |
| 830       |    | 23.05% Pervious Area          |
| 2,771     |    | 76.95% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description                  |
|----------|---------------|---------------|-------------------|----------------|------------------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct calc <2 |

**Subcatchment P2: CB West**

Hydrograph



**Summary for Subcatchment P3: North & Aprons**

Runoff = 0.02 cfs @ 12.14 hrs, Volume= 83 cf, Depth= 0.40"

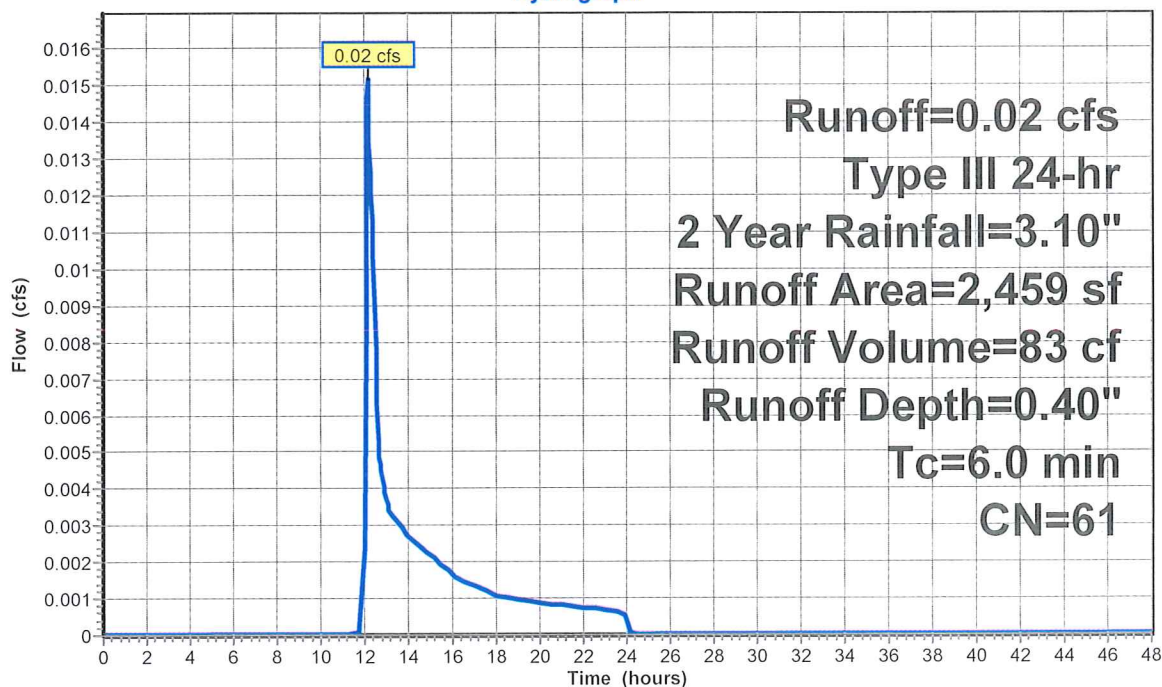
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2 Year Rainfall=3.10"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,527     | 39 | >75% Grass cover, Good, HSG A |
| 932       | 98 | Paved parking, HSG A          |
| 2,459     | 61 | Weighted Average              |
| 1,527     |    | 62.10% Pervious Area          |
| 932       |    | 37.90% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct |

**Subcatchment P3: North & Aprons**

Hydrograph





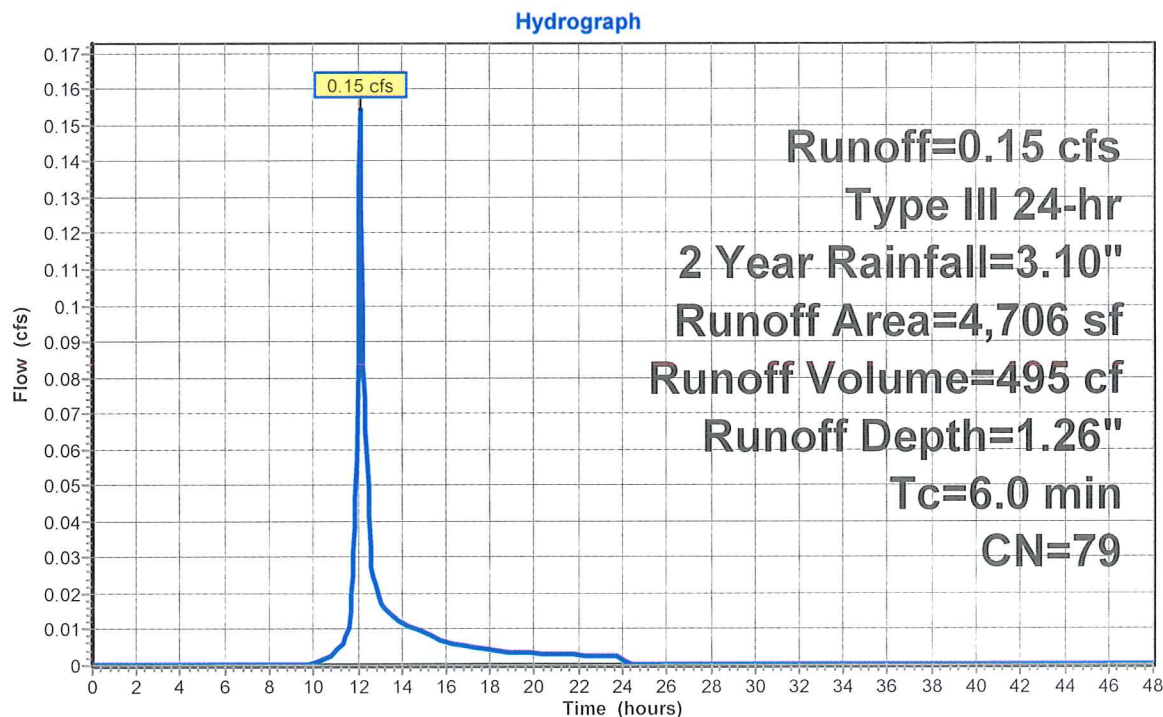
**Summary for Subcatchment P4: Garage Parking**

Runoff = 0.15 cfs @ 12.10 hrs, Volume= 495 cf, Depth= 1.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2 Year Rainfall=3.10"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,211     | 98 | Paved parking, HSG A          |
| 1,495     | 39 | >75% Grass cover, Good, HSG A |
| 4,706     | 79 | Weighted Average              |
| 1,495     |    | 31.77% Pervious Area          |
| 3,211     |    | 68.23% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P4: Garage Parking**

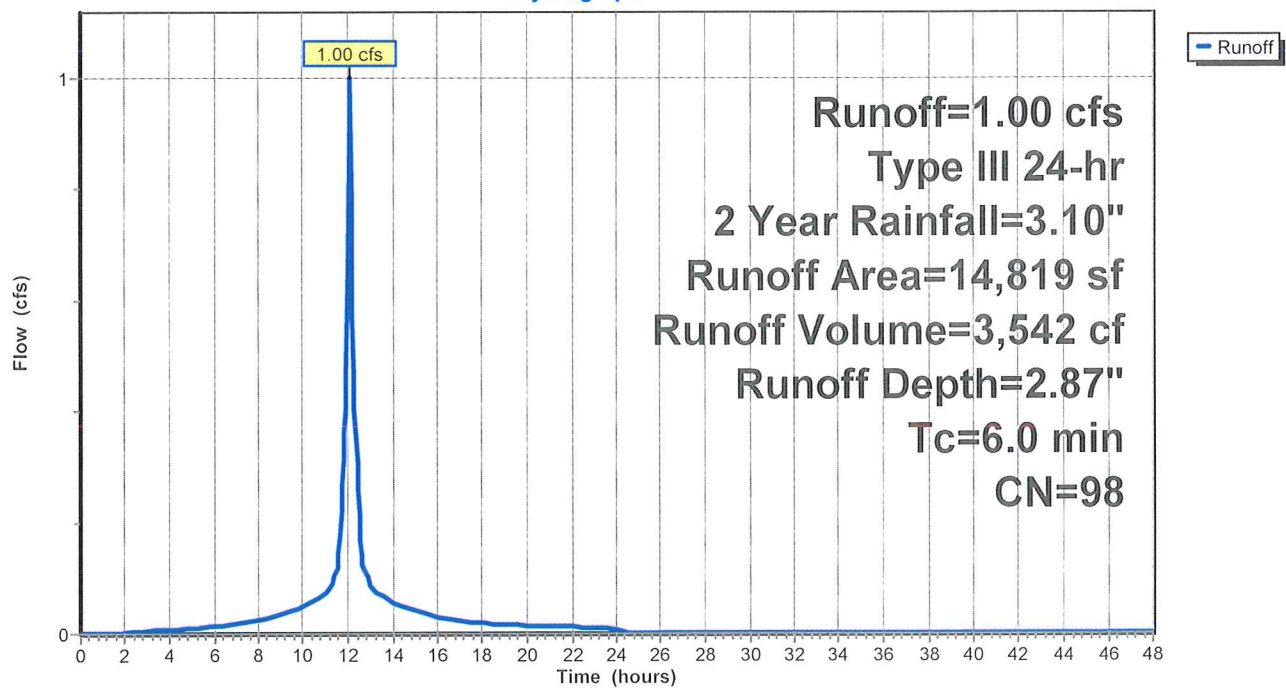
**Summary for Subcatchment P5: Bldg**

Runoff = 1.00 cfs @ 12.09 hrs, Volume= 3,542 cf, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2 Year Rainfall=3.10"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 14,819    | 98 | Roofs, HSG A            |
| 14,819    |    | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P5: Bldg****Hydrograph**

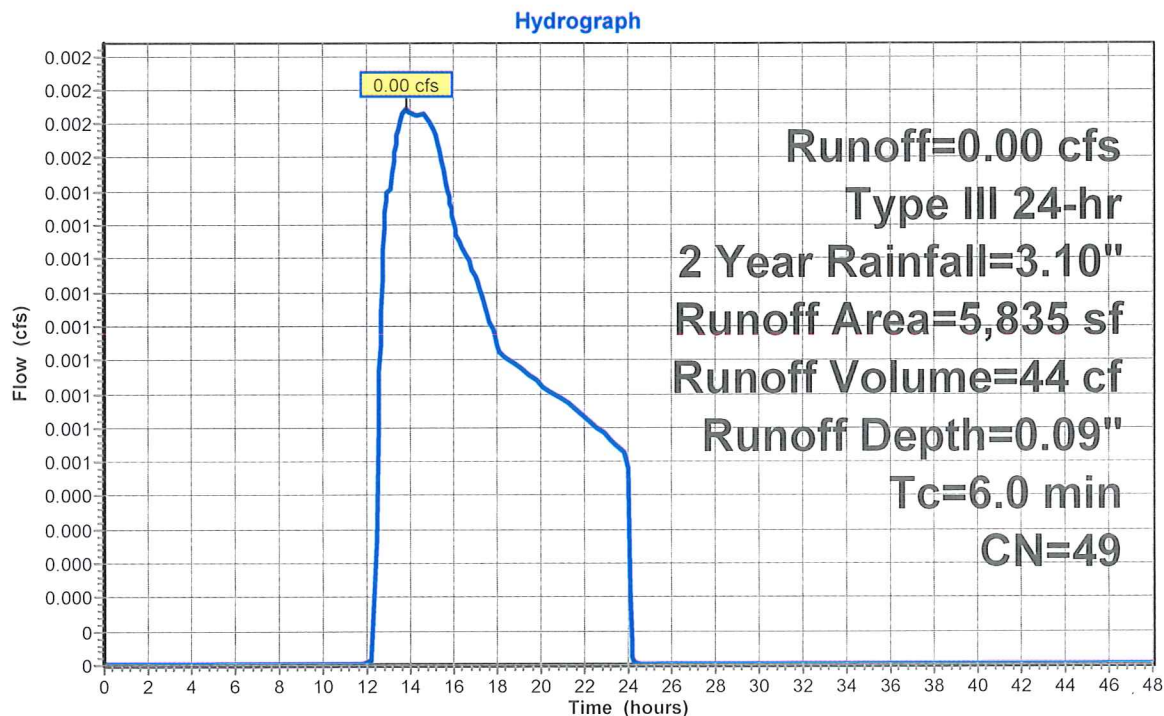
**Summary for Subcatchment P6: Rear Yard**

Runoff = 0.00 cfs @ 13.80 hrs, Volume= 44 cf, Depth= 0.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2 Year Rainfall=3.10"

|   | Area (sf) | CN | Description                   |
|---|-----------|----|-------------------------------|
| * | 249       | 98 | Roofs, HSG A (porch)          |
| * | 741       | 98 | Paved parking, HSG A (walk)   |
|   | 4,845     | 39 | >75% Grass cover, Good, HSG A |
|   | 5,835     | 49 | Weighted Average              |
|   | 4,845     |    | 83.03% Pervious Area          |
|   | 990       |    | 16.97% Impervious Area        |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P6: Rear Yard**

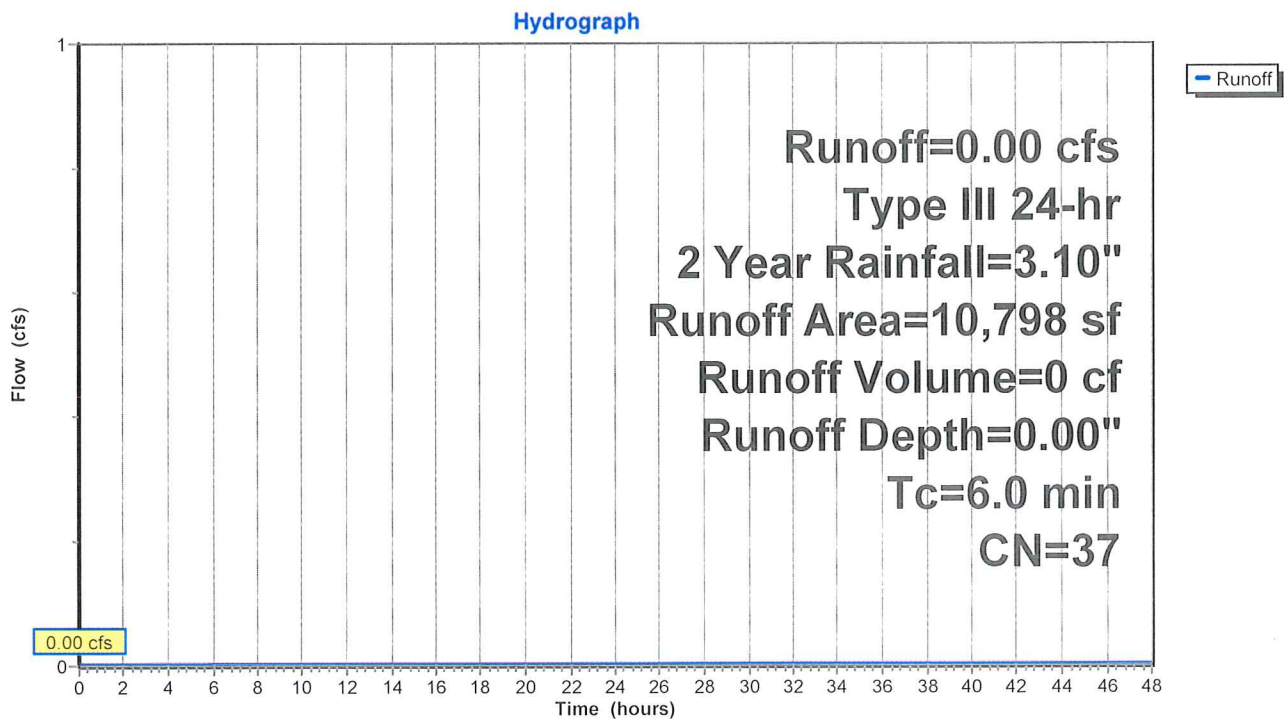
**Summary for Subcatchment P7: West Lawn**

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 2 Year Rainfall=3.10"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 6,423     | 39 | >75% Grass cover, Good, HSG A |
| 4,375     | 35 | Brush, Fair, HSG A            |
| 10,798    | 37 | Weighted Average              |
| 10,798    |    | 100.00% Pervious Area         |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P7: West Lawn**

**Summary for Pond 2P: Rear**

Inflow Area = 37,634 sf, 71.00% Impervious, Inflow Depth = 1.67" for 2 Year event  
 Inflow = 1.50 cfs @ 12.09 hrs, Volume= 5,225 cf  
 Outflow = 0.43 cfs @ 11.85 hrs, Volume= 5,225 cf, Atten= 71%, Lag= 0.0 min  
 Discarded = 0.43 cfs @ 11.85 hrs, Volume= 5,225 cf

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 145.25' @ 12.44 hrs Surf.Area= 2,269 sf Storage= 893 cf

Plug-Flow detention time= 9.9 min calculated for 5,220 cf (100% of inflow)  
 Center-of-Mass det. time= 9.8 min ( 798.7 - 788.9 )

| Volume | Invert  | Avail.Storage | Storage Description                                                                                                                                                                                                      |
|--------|---------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| #1A    | 144.50' | 2,121 cf      | <b>12.17'W x 186.50'L x 3.54'H Field A</b><br>8,036 cf Overall - 2,735 cf Embedded = 5,302 cf x 40.0% Voids                                                                                                              |
| #2A    | 145.00' | 2,735 cf      | <b>Cultec R-330XLHD x 52 Inside #1</b><br>Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf<br>Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap<br>Row Length Adjustment= +1.50' x 7.45 sf x 2 rows |
|        |         | 4,855 cf      | Total Available Storage                                                                                                                                                                                                  |

Storage Group A created with Chamber Wizard

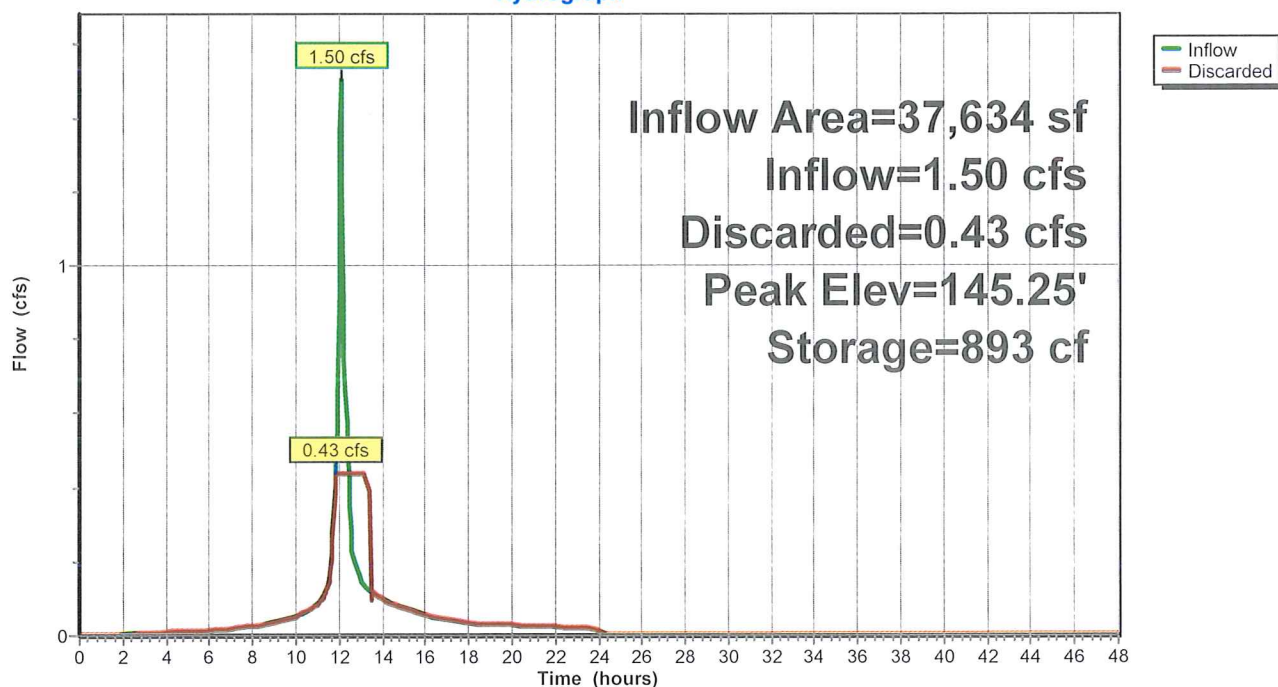
| Device | Routing   | Invert  | Outlet Devices                                    |
|--------|-----------|---------|---------------------------------------------------|
| #1     | Discarded | 144.50' | <b>8.270 in/hr Exfiltration over Surface area</b> |

**Discarded OutFlow** Max=0.43 cfs @ 11.85 hrs HW=144.54' (Free Discharge)  
 ↑1=Exfiltration (Exfiltration Controls 0.43 cfs)



## Pond 2P: Rear

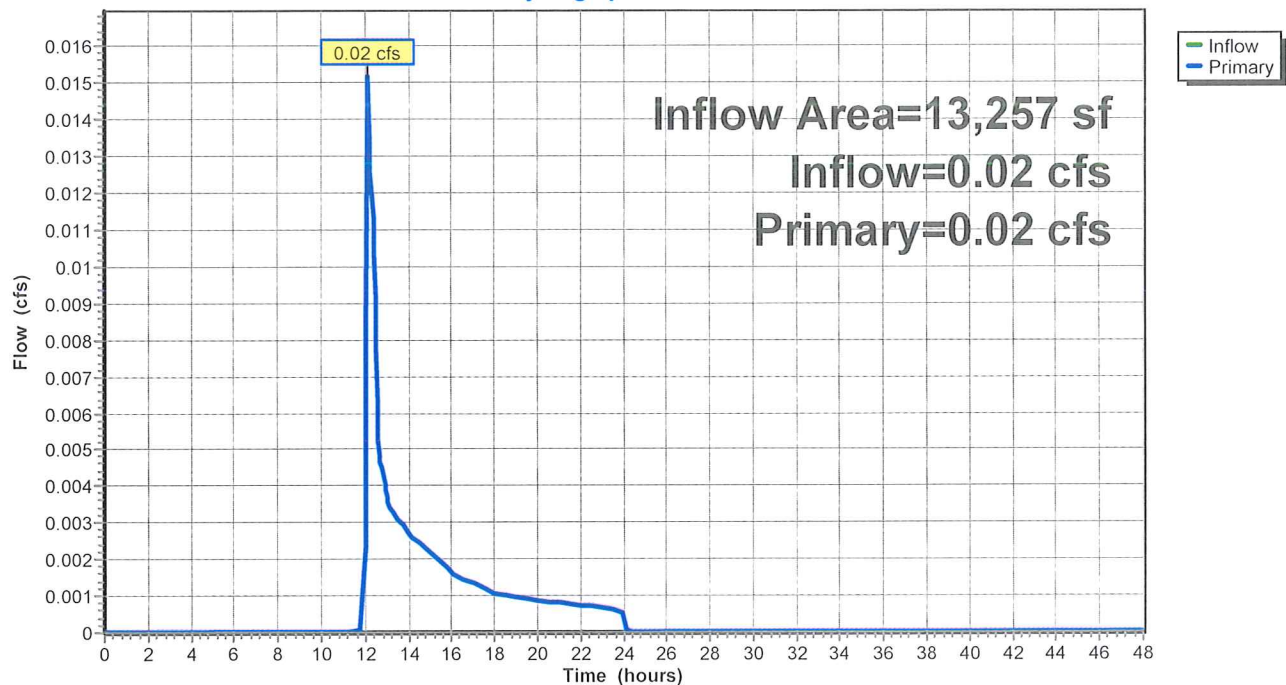
## Hydrograph



**Summary for Link 1L: Stearns**

Inflow Area = 13,257 sf, 7.03% Impervious, Inflow Depth = 0.07" for 2 Year event  
Inflow = 0.02 cfs @ 12.14 hrs, Volume= 83 cf  
Primary = 0.02 cfs @ 12.14 hrs, Volume= 83 cf, Atten= 0%, Lag= 0.0 min

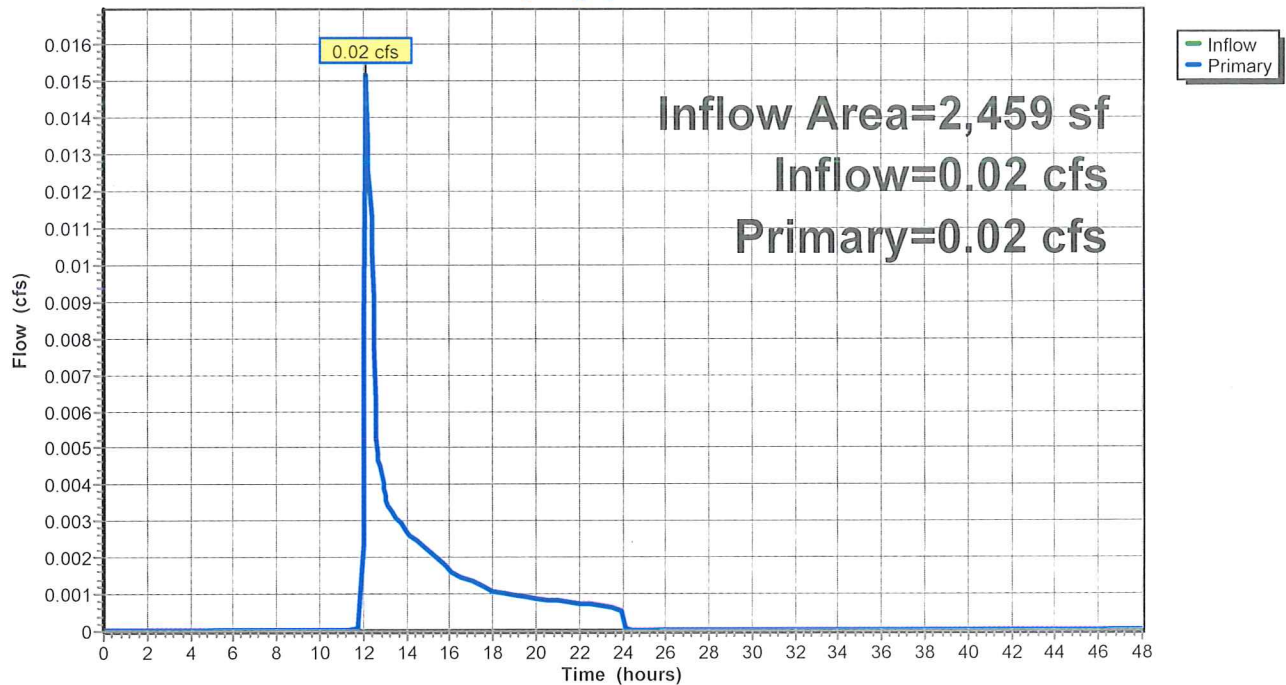
Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 1L: Stearns****Hydrograph**

**Summary for Link 2L: Stearns CB**

Inflow Area = 2,459 sf, 37.90% Impervious, Inflow Depth = 0.40" for 2 Year event  
Inflow = 0.02 cfs @ 12.14 hrs, Volume= 83 cf  
Primary = 0.02 cfs @ 12.14 hrs, Volume= 83 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 2L: Stearns CB****Hydrograph**

**PR-16stearnsR1**

Type III 24-hr 10 Year Rainfall=4.60"

Prepared by Microsoft

Printed 12/24/2018

HydroCAD® 10.00-21 s/n 03206 © 2018 HydroCAD Software Solutions LLC

Page 13

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

|                                            |                                                                                                          |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <b>Subcatchment P1: CB East</b>            | Runoff Area=8,673 sf 56.84% Impervious Runoff Depth=1.97"<br>Tc=6.0 min CN=73 Runoff=0.45 cfs 1,425 cf   |
| <b>Subcatchment P2: CB West</b>            | Runoff Area=3,601 sf 76.95% Impervious Runoff Depth=2.91"<br>Tc=6.0 min CN=84 Runoff=0.27 cfs 872 cf     |
| <b>Subcatchment P3: North &amp; Aprons</b> | Runoff Area=2,459 sf 37.90% Impervious Runoff Depth=1.14"<br>Tc=6.0 min CN=61 Runoff=0.07 cfs 233 cf     |
| <b>Subcatchment P4: Garage Parking</b>     | Runoff Area=4,706 sf 68.23% Impervious Runoff Depth=2.46"<br>Tc=6.0 min CN=79 Runoff=0.31 cfs 965 cf     |
| <b>Subcatchment P5: Bldg</b>               | Runoff Area=14,819 sf 100.00% Impervious Runoff Depth=4.36"<br>Tc=6.0 min CN=98 Runoff=1.49 cfs 5,389 cf |
| <b>Subcatchment P6: Rear Yard</b>          | Runoff Area=5,835 sf 16.97% Impervious Runoff Depth=0.49"<br>Tc=6.0 min CN=49 Runoff=0.04 cfs 239 cf     |
| <b>Subcatchment P7: West Lawn</b>          | Runoff Area=10,798 sf 0.00% Impervious Runoff Depth=0.08"<br>Tc=6.0 min CN=37 Runoff=0.00 cfs 70 cf      |
| <b>Pond 2P: Rear</b>                       | Peak Elev=146.08' Storage=2,332 cf Inflow=2.54 cfs 8,890 cf<br>Outflow=0.43 cfs 8,890 cf                 |
| <b>Link 1L: Stearns</b>                    | Inflow=0.07 cfs 303 cf<br>Primary=0.07 cfs 303 cf                                                        |
| <b>Link 2L: Stearns CB</b>                 | Inflow=0.07 cfs 233 cf<br>Primary=0.07 cfs 233 cf                                                        |

Total Runoff Area = 50,891 sf Runoff Volume = 9,193 cf Average Runoff Depth = 2.17"  
45.66% Pervious = 23,238 sf 54.34% Impervious = 27,653 sf

**Summary for Subcatchment P1: CB East**

Runoff = 0.45 cfs @ 12.10 hrs, Volume= 1,425 cf, Depth= 1.97"

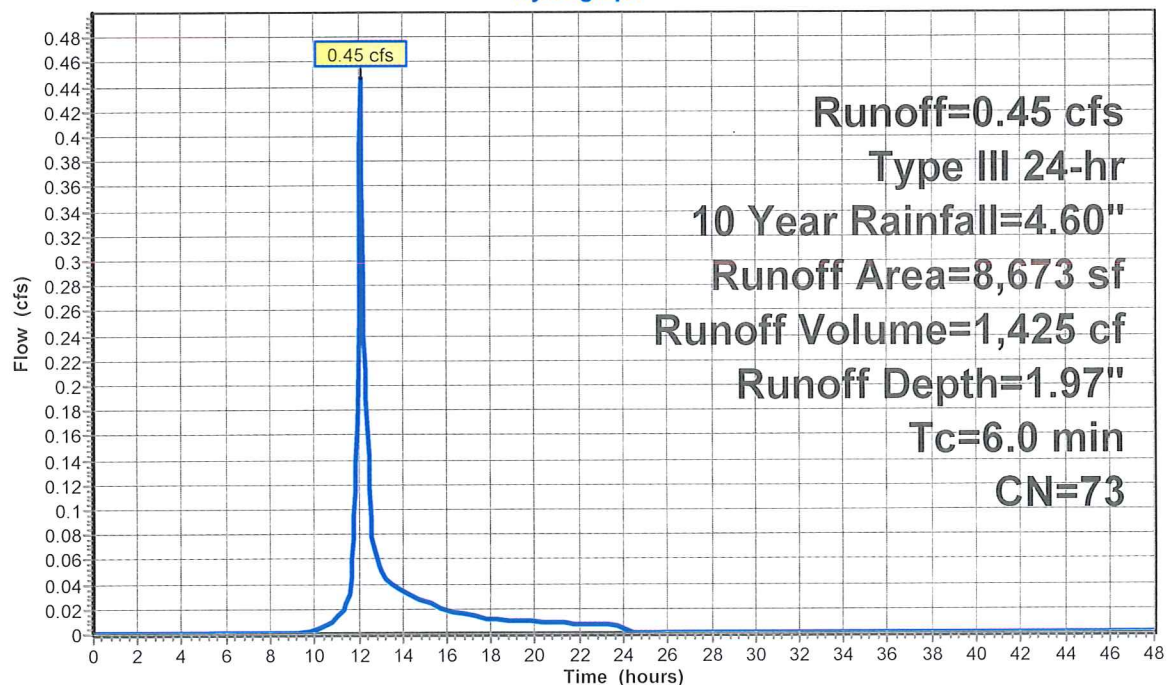
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10 Year Rainfall=4.60"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 4,205     | 98 | Paved parking, HSG A          |
| * 310     | 98 | Paved parking, HSG A (wall)   |
| * 415     | 98 | Roofs, HSG A (porch)          |
| 3,743     | 39 | >75% Grass cover, Good, HSG A |
| 8,673     | 73 | Weighted Average              |
| 3,743     |    | 43.16% Pervious Area          |
| 4,930     |    | 56.84% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P1: CB East**

Hydrograph



— Runoff



**Summary for Subcatchment P2: CB West**

Runoff = 0.27 cfs @ 12.09 hrs, Volume= 872 cf, Depth= 2.91"

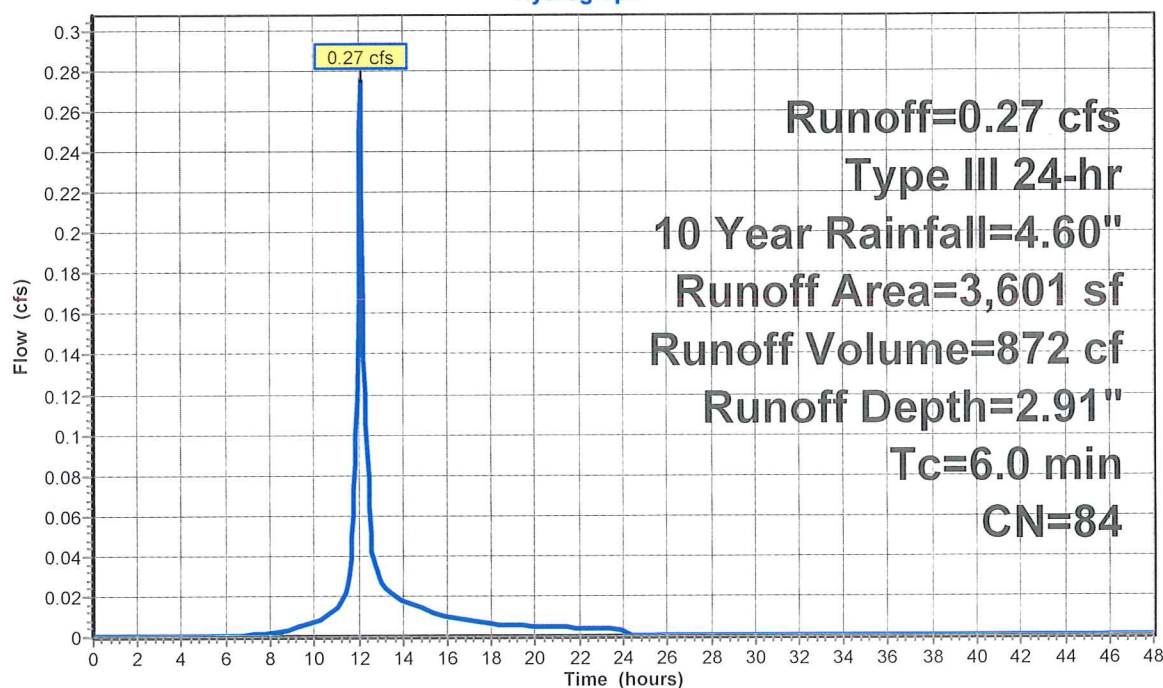
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10 Year Rainfall=4.60"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 830       | 39 | >75% Grass cover, Good, HSG A |
| 2,393     | 98 | Paved parking, HSG A          |
| 378       | 98 | Roofs, HSG A                  |
| 3,601     | 84 | Weighted Average              |
| 830       |    | 23.05% Pervious Area          |
| 2,771     |    | 76.95% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description                  |
|----------|---------------|---------------|-------------------|----------------|------------------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct calc <2 |

**Subcatchment P2: CB West**

Hydrograph



**Summary for Subcatchment P3: North & Aprons**

Runoff = 0.07 cfs @ 12.11 hrs, Volume= 233 cf, Depth= 1.14"

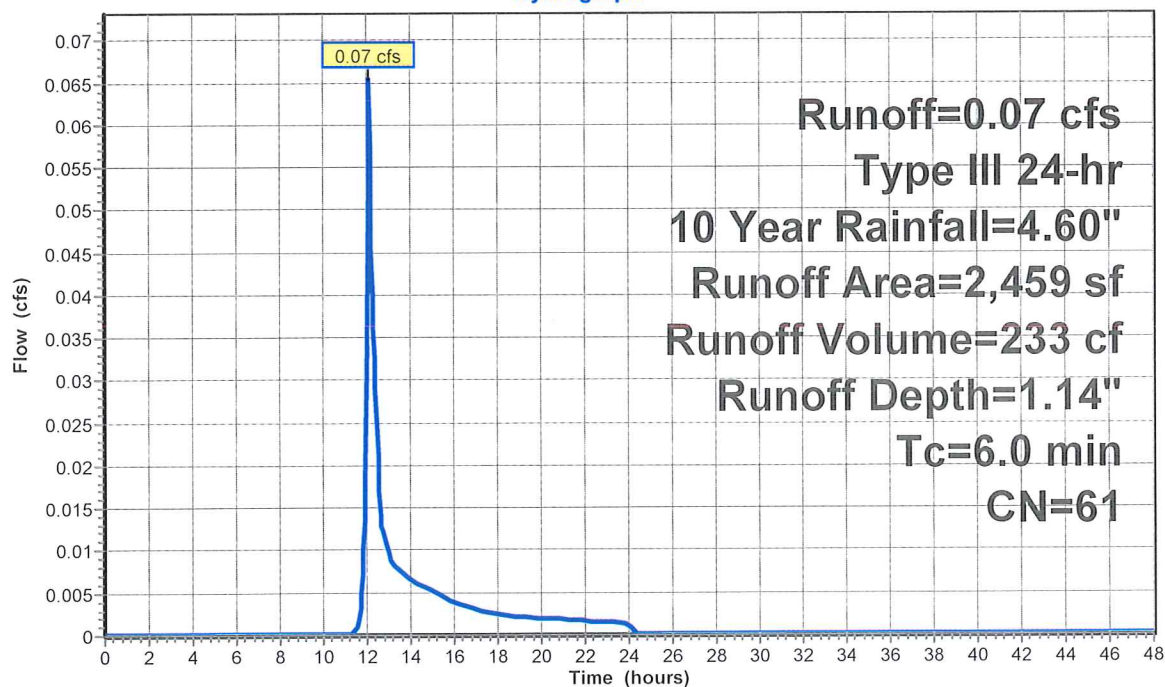
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10 Year Rainfall=4.60"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,527     | 39 | >75% Grass cover, Good, HSG A |
| 932       | 98 | Paved parking, HSG A          |
| 2,459     | 61 | Weighted Average              |
| 1,527     |    | 62.10% Pervious Area          |
| 932       |    | 37.90% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct |

**Subcatchment P3: North & Aprons**

Hydrograph



**Summary for Subcatchment P4: Garage Parking**

Runoff = 0.31 cfs @ 12.09 hrs, Volume= 965 cf, Depth= 2.46"

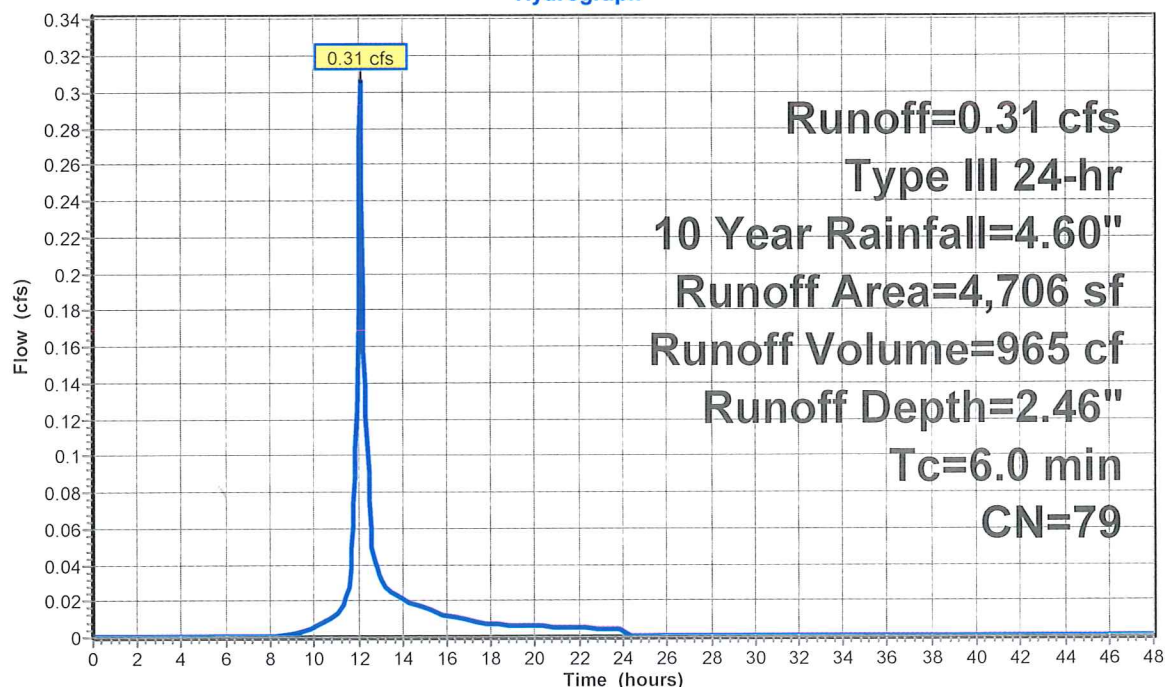
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10 Year Rainfall=4.60"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,211     | 98 | Paved parking, HSG A          |
| 1,495     | 39 | >75% Grass cover, Good, HSG A |
| 4,706     | 79 | Weighted Average              |
| 1,495     |    | 31.77% Pervious Area          |
| 3,211     |    | 68.23% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P4: Garage Parking**

Hydrograph



**Summary for Subcatchment P5: Bldg**

Runoff = 1.49 cfs @ 12.09 hrs, Volume= 5,389 cf, Depth= 4.36"

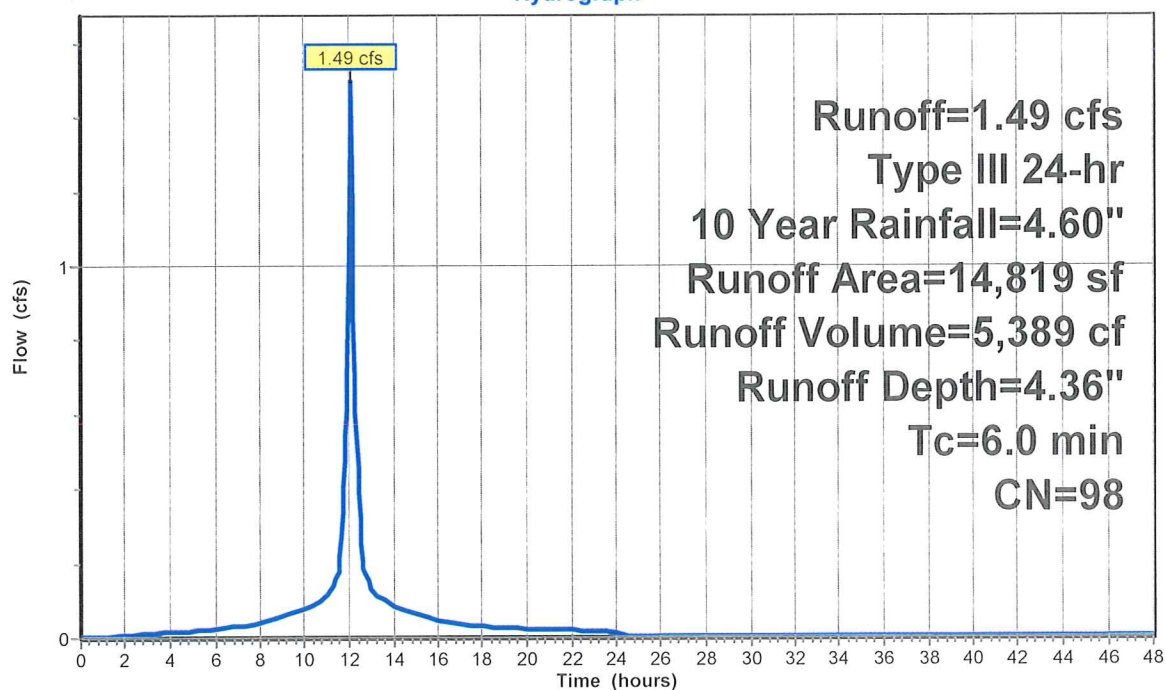
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10 Year Rainfall=4.60"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 14,819    | 98 | Roofs, HSG A            |
| 14,819    |    | 100.00% Impervious Area |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P5: Bldg**

Hydrograph





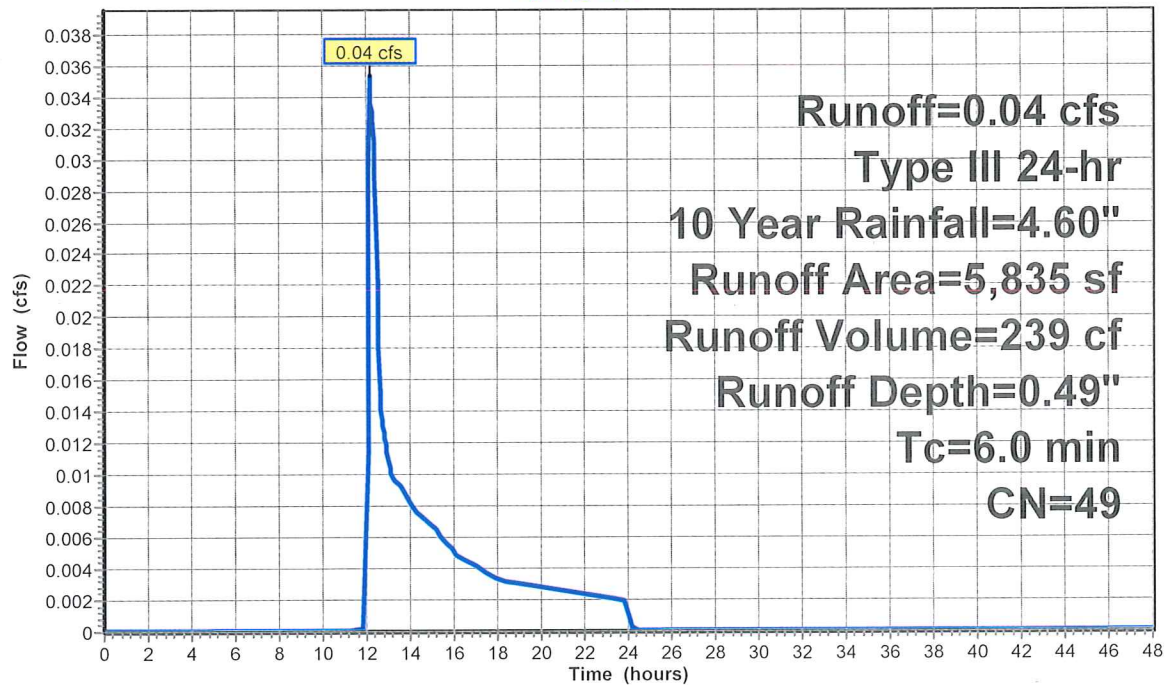
**Summary for Subcatchment P6: Rear Yard**

Runoff = 0.04 cfs @ 12.17 hrs, Volume= 239 cf, Depth= 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10 Year Rainfall=4.60"

|   | Area (sf) | CN | Description                   |
|---|-----------|----|-------------------------------|
| * | 249       | 98 | Roofs, HSG A (porch)          |
| * | 741       | 98 | Paved parking, HSG A (walk)   |
|   | 4,845     | 39 | >75% Grass cover, Good, HSG A |
|   | 5,835     | 49 | Weighted Average              |
|   | 4,845     |    | 83.03% Pervious Area          |
|   | 990       |    | 16.97% Impervious Area        |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P6: Rear Yard****Hydrograph**

— Runoff



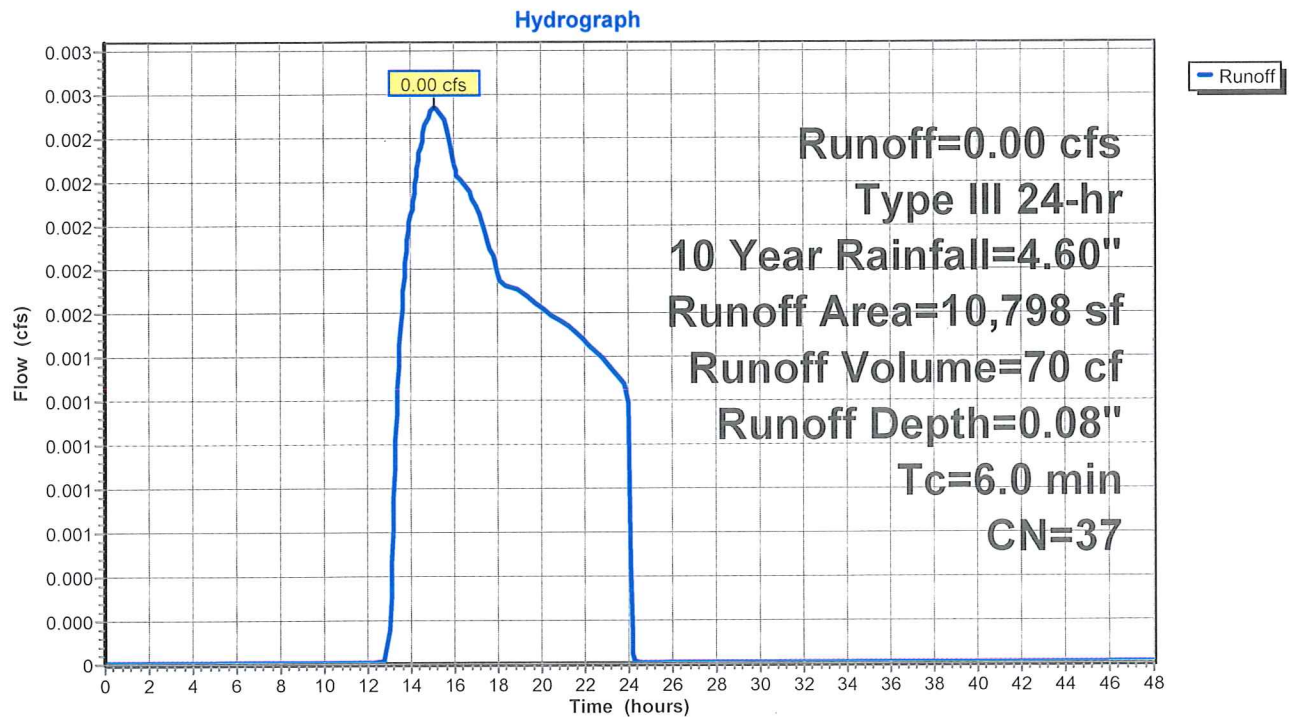
**Summary for Subcatchment P7: West Lawn**

Runoff = 0.00 cfs @ 15.12 hrs, Volume= 70 cf, Depth= 0.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 10 Year Rainfall=4.60"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 6,423     | 39 | >75% Grass cover, Good, HSG A |
| 4,375     | 35 | Brush, Fair, HSG A            |
| 10,798    | 37 | Weighted Average              |
| 10,798    |    | 100.00% Pervious Area         |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P7: West Lawn**

**Summary for Pond 2P: Rear**

Inflow Area = 37,634 sf, 71.00% Impervious, Inflow Depth = 2.83" for 10 Year event  
 Inflow = 2.54 cfs @ 12.09 hrs, Volume= 8,890 cf  
 Outflow = 0.43 cfs @ 11.70 hrs, Volume= 8,890 cf, Atten= 83%, Lag= 0.0 min  
 Discarded = 0.43 cfs @ 11.70 hrs, Volume= 8,890 cf

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 146.08' @ 12.57 hrs Surf.Area= 2,269 sf Storage= 2,332 cf

Plug-Flow detention time= 31.2 min calculated for 8,880 cf (100% of inflow)  
 Center-of-Mass det. time= 31.2 min ( 815.6 - 784.4 )

| Volume | Invert  | Avail.Storage | Storage Description                                                                                                                                                                                                      |
|--------|---------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| #1A    | 144.50' | 2,121 cf      | <b>12.17'W x 186.50'L x 3.54'H Field A</b><br>8,036 cf Overall - 2,735 cf Embedded = 5,302 cf x 40.0% Voids                                                                                                              |
| #2A    | 145.00' | 2,735 cf      | <b>Cultec R-330XLHD</b> x 52 Inside #1<br>Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf<br>Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap<br>Row Length Adjustment= +1.50' x 7.45 sf x 2 rows |
|        |         | 4,855 cf      | Total Available Storage                                                                                                                                                                                                  |

Storage Group A created with Chamber Wizard

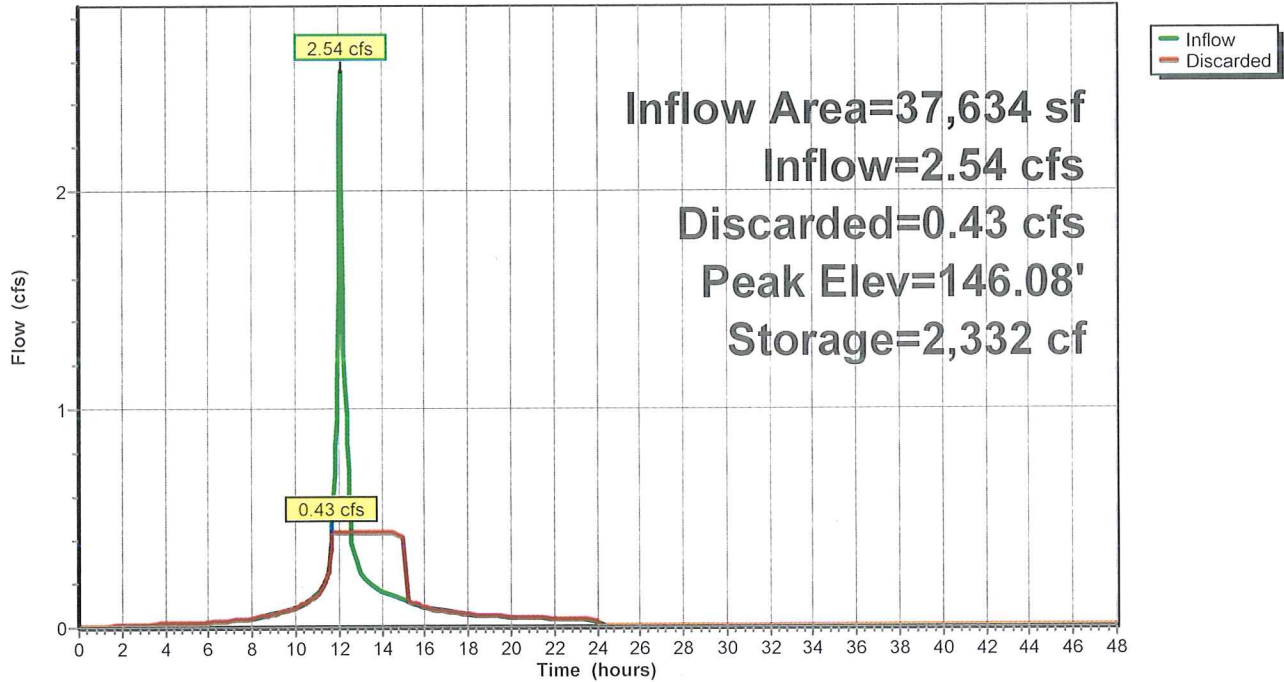
| Device | Routing   | Invert  | Outlet Devices                                    |
|--------|-----------|---------|---------------------------------------------------|
| #1     | Discarded | 144.50' | <b>8.270 in/hr Exfiltration over Surface area</b> |

**Discarded OutFlow** Max=0.43 cfs @ 11.70 hrs HW=144.54' (Free Discharge)

↑ **1=Exfiltration** (Exfiltration Controls 0.43 cfs)

Pond 2P: Rear

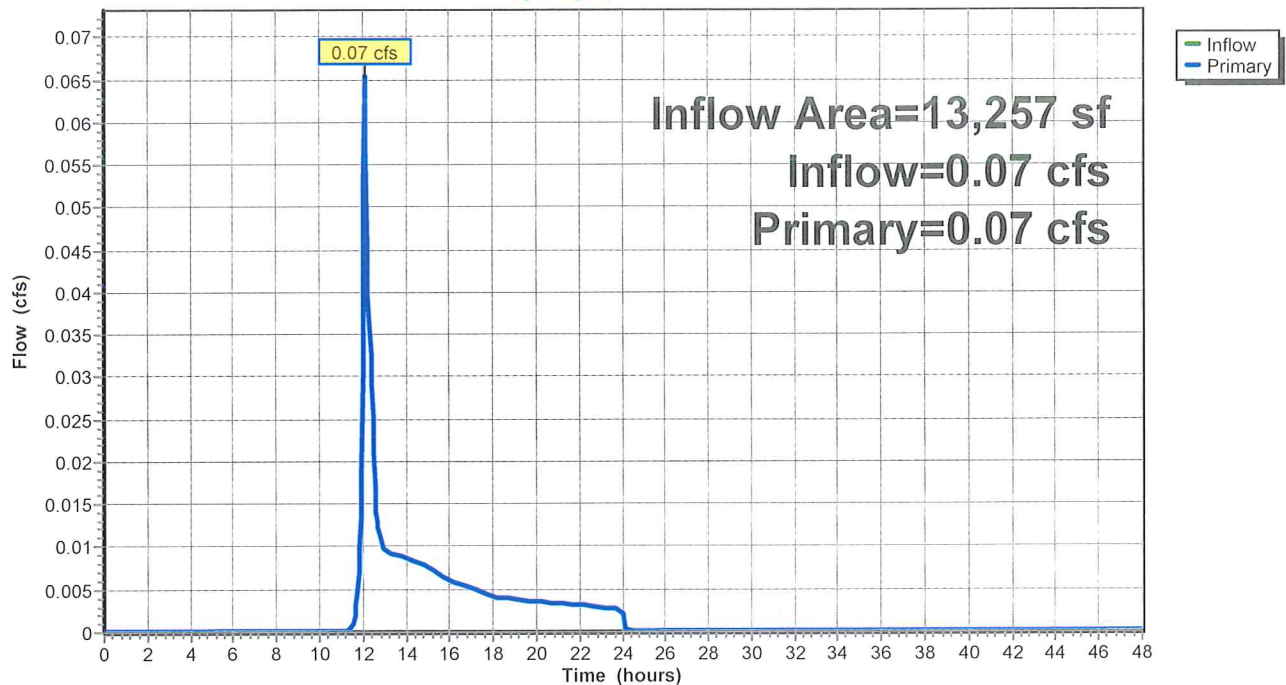
Hydrograph



**Summary for Link 1L: Stearns**

Inflow Area = 13,257 sf, 7.03% Impervious, Inflow Depth = 0.27" for 10 Year event  
Inflow = 0.07 cfs @ 12.11 hrs, Volume= 303 cf  
Primary = 0.07 cfs @ 12.11 hrs, Volume= 303 cf, Atten= 0%, Lag= 0.0 min

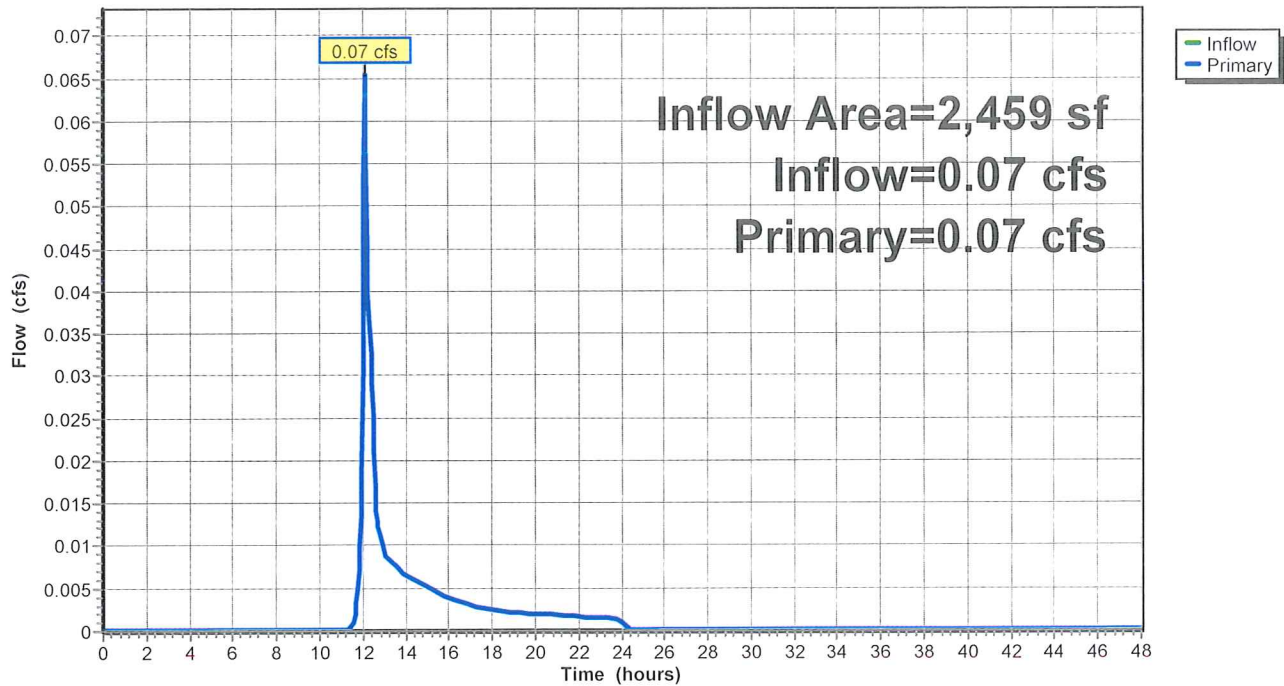
Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 1L: Stearns****Hydrograph**

**Summary for Link 2L: Stearns CB**

Inflow Area = 2,459 sf, 37.90% Impervious, Inflow Depth = 1.14" for 10 Year event  
Inflow = 0.07 cfs @ 12.11 hrs, Volume= 233 cf  
Primary = 0.07 cfs @ 12.11 hrs, Volume= 233 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 2L: Stearns CB****Hydrograph**



**PR-16stearnsR1**

Prepared by Microsoft

HydroCAD® 10.00-21 s/n 03206 © 2018 HydroCAD Software Solutions LLC

Type III 24-hr 25 Year Rainfall=5.40"

Printed 12/24/2018

Page 25

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points

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

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

|                                            |                                                                                                          |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <b>Subcatchment P1: CB East</b>            | Runoff Area=8,673 sf 56.84% Impervious Runoff Depth=2.60"<br>Tc=6.0 min CN=73 Runoff=0.59 cfs 1,878 cf   |
| <b>Subcatchment P2: CB West</b>            | Runoff Area=3,601 sf 76.95% Impervious Runoff Depth=3.64"<br>Tc=6.0 min CN=84 Runoff=0.34 cfs 1,092 cf   |
| <b>Subcatchment P3: North &amp; Aprons</b> | Runoff Area=2,459 sf 37.90% Impervious Runoff Depth=1.62"<br>Tc=6.0 min CN=61 Runoff=0.10 cfs 331 cf     |
| <b>Subcatchment P4: Garage Parking</b>     | Runoff Area=4,706 sf 68.23% Impervious Runoff Depth=3.15"<br>Tc=6.0 min CN=79 Runoff=0.39 cfs 1,235 cf   |
| <b>Subcatchment P5: Bldg</b>               | Runoff Area=14,819 sf 100.00% Impervious Runoff Depth=5.16"<br>Tc=6.0 min CN=98 Runoff=1.76 cfs 6,375 cf |
| <b>Subcatchment P6: Rear Yard</b>          | Runoff Area=5,835 sf 16.97% Impervious Runoff Depth=0.80"<br>Tc=6.0 min CN=49 Runoff=0.08 cfs 390 cf     |
| <b>Subcatchment P7: West Lawn</b>          | Runoff Area=10,798 sf 0.00% Impervious Runoff Depth=0.21"<br>Tc=6.0 min CN=37 Runoff=0.01 cfs 188 cf     |
| <b>Pond 2P: Rear</b>                       | Peak Elev=146.63' Storage=3,227 cf Inflow=3.16 cfs 10,970 cf<br>Outflow=0.43 cfs 10,970 cf               |
| <b>Link 1L: Stearns</b>                    | Inflow=0.10 cfs 519 cf<br>Primary=0.10 cfs 519 cf                                                        |
| <b>Link 2L: Stearns CB</b>                 | Inflow=0.10 cfs 331 cf<br>Primary=0.10 cfs 331 cf                                                        |

**Total Runoff Area = 50,891 sf Runoff Volume = 11,489 cf Average Runoff Depth = 2.71"**  
**45.66% Pervious = 23,238 sf 54.34% Impervious = 27,653 sf**

**Summary for Subcatchment P1: CB East**

Runoff = 0.59 cfs @ 12.09 hrs, Volume= 1,878 cf, Depth= 2.60"

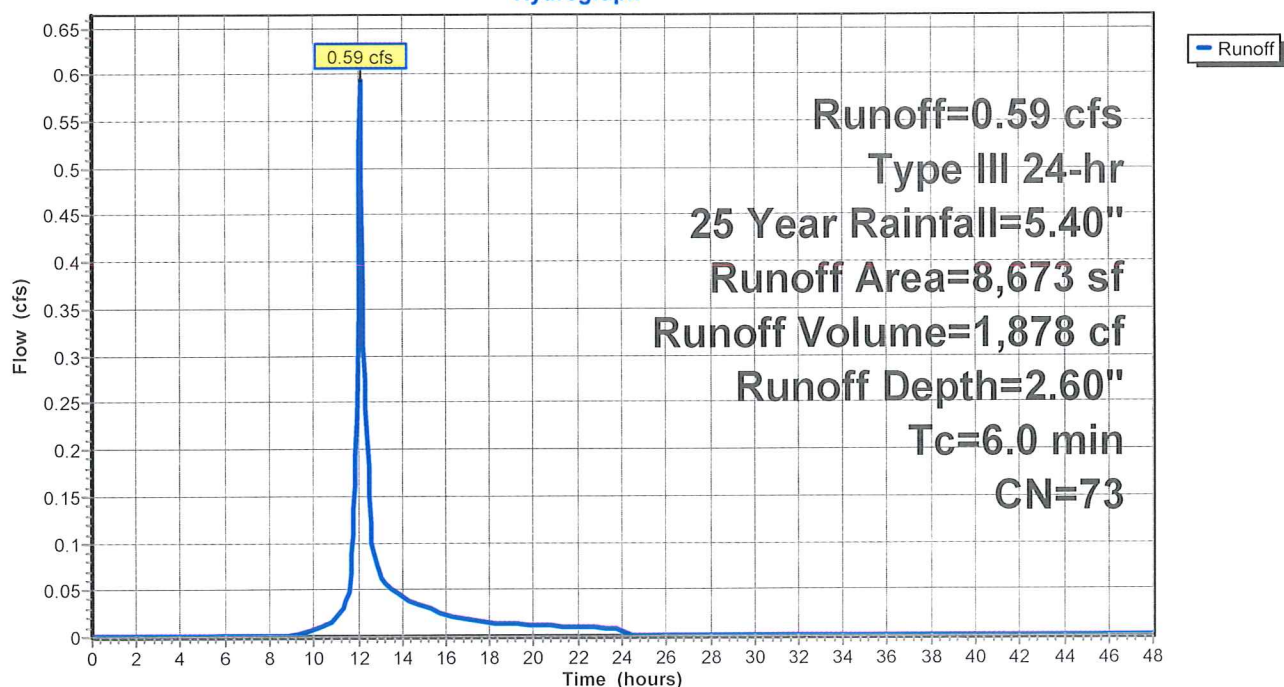
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25 Year Rainfall=5.40"

|   | Area (sf) | CN | Description                   |
|---|-----------|----|-------------------------------|
|   | 4,205     | 98 | Paved parking, HSG A          |
| * | 310       | 98 | Paved parking, HSG A (wall)   |
| * | 415       | 98 | Roofs, HSG A (porch)          |
|   | 3,743     | 39 | >75% Grass cover, Good, HSG A |
|   | 8,673     | 73 | Weighted Average              |
|   | 3,743     |    | 43.16% Pervious Area          |
|   | 4,930     |    | 56.84% Impervious Area        |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P1: CB East**

Hydrograph



**Summary for Subcatchment P2: CB West**

Runoff = 0.34 cfs @ 12.09 hrs, Volume= 1,092 cf, Depth= 3.64"

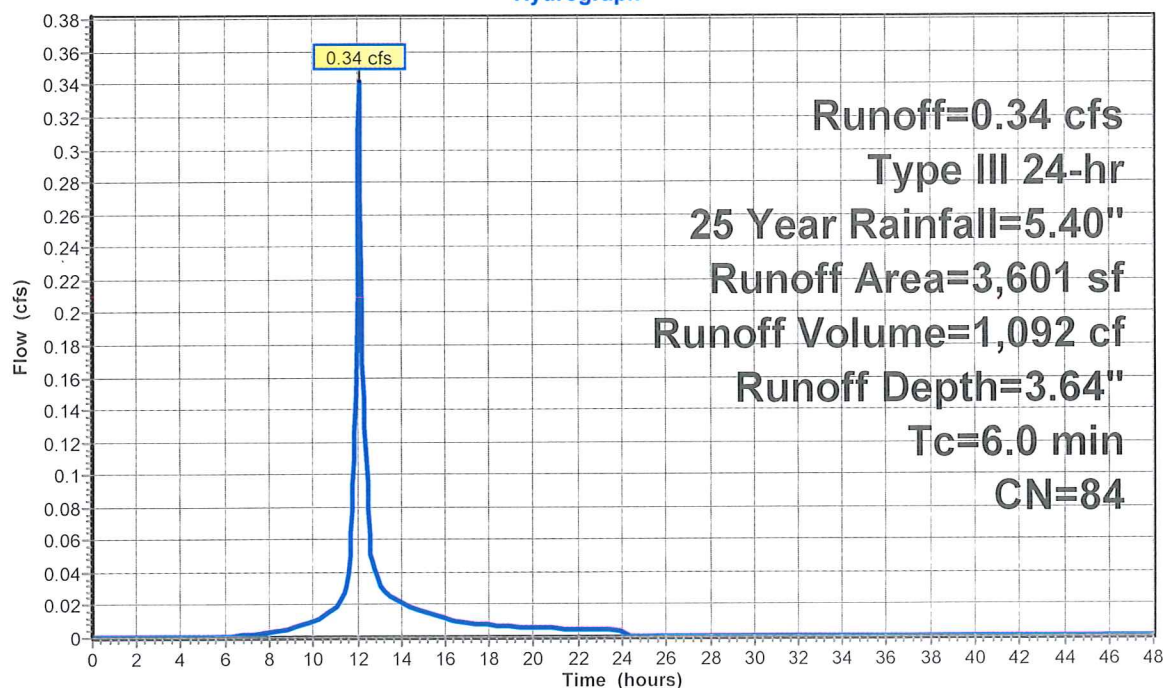
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25 Year Rainfall=5.40"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 830       | 39 | >75% Grass cover, Good, HSG A |
| 2,393     | 98 | Paved parking, HSG A          |
| 378       | 98 | Roofs, HSG A                  |
| 3,601     | 84 | Weighted Average              |
| 830       |    | 23.05% Pervious Area          |
| 2,771     |    | 76.95% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description                  |
|----------|---------------|---------------|-------------------|----------------|------------------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct calc <2 |

**Subcatchment P2: CB West**

Hydrograph



**Summary for Subcatchment P3: North & Aprons**

Runoff = 0.10 cfs @ 12.10 hrs, Volume= 331 cf, Depth= 1.62"

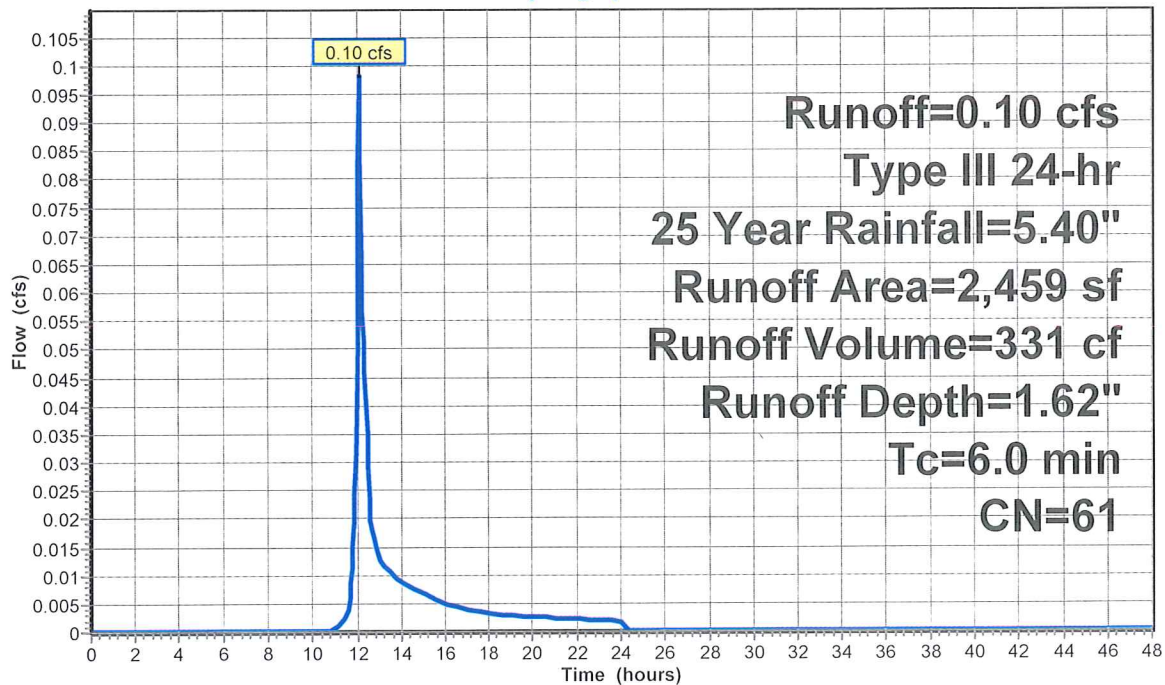
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25 Year Rainfall=5.40"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,527     | 39 | >75% Grass cover, Good, HSG A |
| 932       | 98 | Paved parking, HSG A          |
| 2,459     | 61 | Weighted Average              |
| 1,527     |    | 62.10% Pervious Area          |
| 932       |    | 37.90% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct |

**Subcatchment P3: North & Aprons**

Hydrograph





**Summary for Subcatchment P4: Garage Parking**

Runoff = 0.39 cfs @ 12.09 hrs, Volume= 1,235 cf, Depth= 3.15"

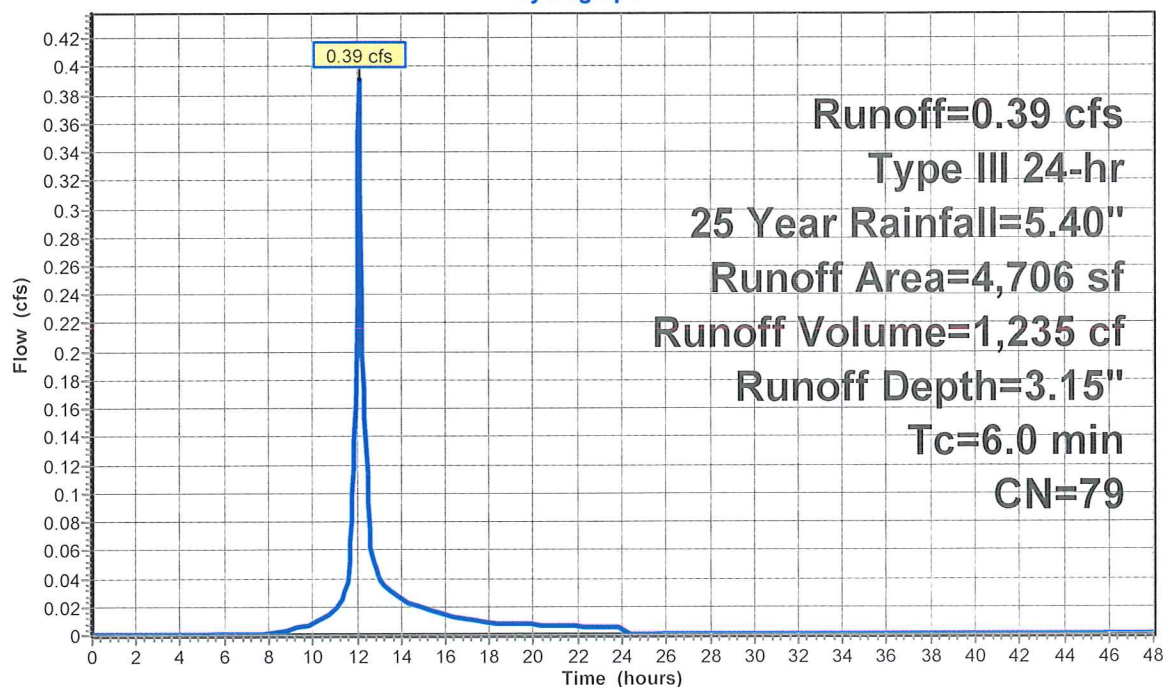
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25 Year Rainfall=5.40"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,211     | 98 | Paved parking, HSG A          |
| 1,495     | 39 | >75% Grass cover, Good, HSG A |
| 4,706     | 79 | Weighted Average              |
| 1,495     |    | 31.77% Pervious Area          |
| 3,211     |    | 68.23% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P4: Garage Parking**

Hydrograph





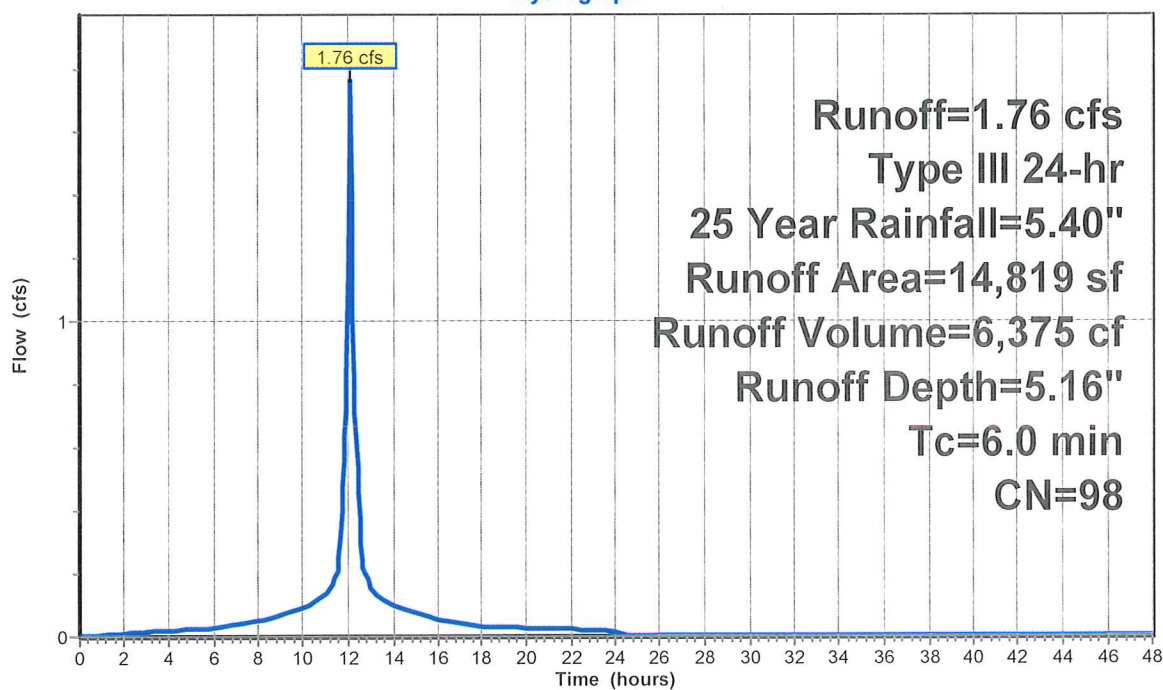
**Summary for Subcatchment P5: Bldg**

Runoff = 1.76 cfs @ 12.09 hrs, Volume= 6,375 cf, Depth= 5.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25 Year Rainfall=5.40"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 14,819    | 98 | Roofs, HSG A            |
| 14,819    |    | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P5: Bldg****Hydrograph**

**Summary for Subcatchment P6: Rear Yard**

Runoff = 0.08 cfs @ 12.12 hrs, Volume= 390 cf, Depth= 0.80"

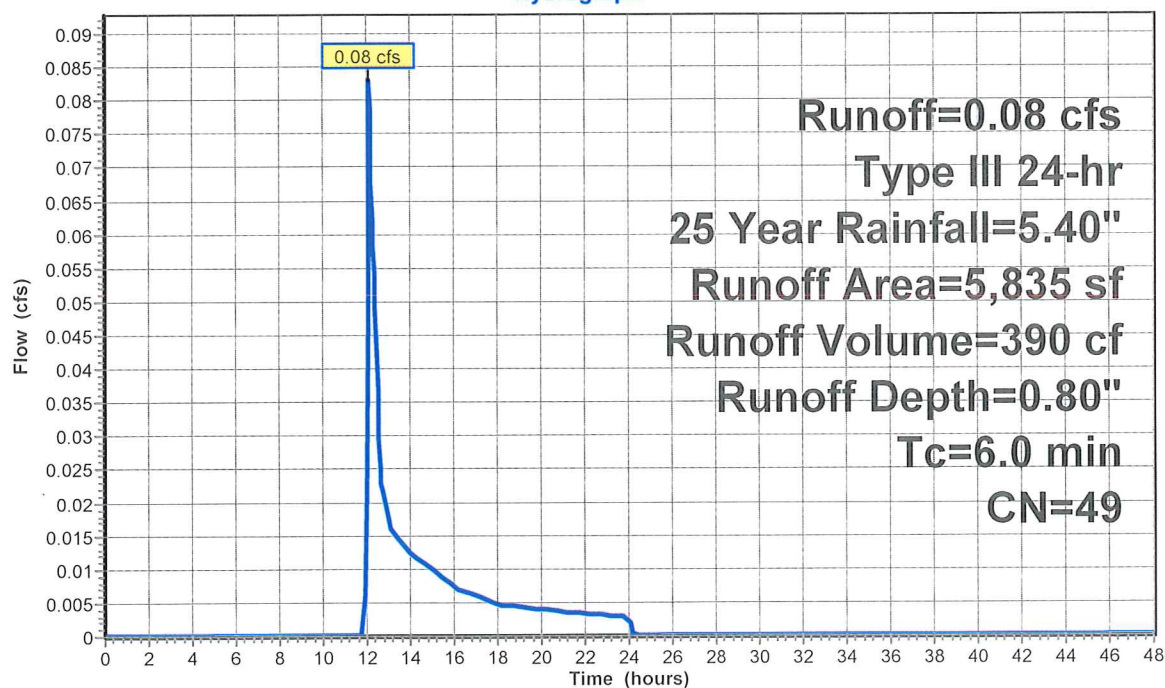
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25 Year Rainfall=5.40"

|   | Area (sf) | CN | Description                   |
|---|-----------|----|-------------------------------|
| * | 249       | 98 | Roofs, HSG A (porch)          |
| * | 741       | 98 | Paved parking, HSG A (walk)   |
|   | 4,845     | 39 | >75% Grass cover, Good, HSG A |
|   | 5,835     | 49 | Weighted Average              |
|   | 4,845     |    | 83.03% Pervious Area          |
|   | 990       |    | 16.97% Impervious Area        |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P6: Rear Yard**

Hydrograph



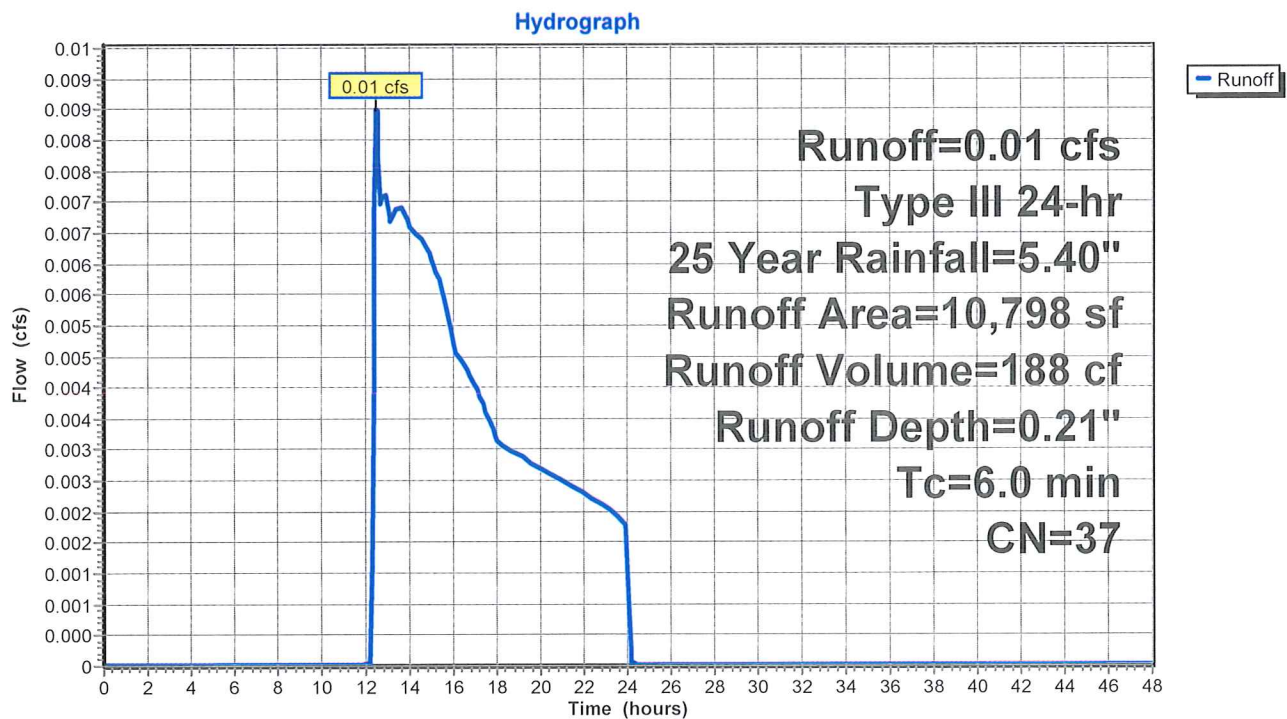
**Summary for Subcatchment P7: West Lawn**

Runoff = 0.01 cfs @ 12.49 hrs, Volume= 188 cf, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 25 Year Rainfall=5.40"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 6,423     | 39 | >75% Grass cover, Good, HSG A |
| 4,375     | 35 | Brush, Fair, HSG A            |
| 10,798    | 37 | Weighted Average              |
| 10,798    |    | 100.00% Pervious Area         |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P7: West Lawn**

**Summary for Pond 2P: Rear**

Inflow Area = 37,634 sf, 71.00% Impervious, Inflow Depth = 3.50" for 25 Year event  
 Inflow = 3.16 cfs @ 12.09 hrs, Volume= 10,970 cf  
 Outflow = 0.43 cfs @ 11.65 hrs, Volume= 10,970 cf, Atten= 86%, Lag= 0.0 min  
 Discarded = 0.43 cfs @ 11.65 hrs, Volume= 10,970 cf

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 146.63' @ 12.65 hrs Surf.Area= 2,269 sf Storage= 3,227 cf

Plug-Flow detention time= 47.6 min calculated for 10,959 cf (100% of inflow)  
 Center-of-Mass det. time= 47.6 min ( 829.9 - 782.3 )

| Volume | Invert  | Avail.Storage | Storage Description                                                                                                                                                                                                      |
|--------|---------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| #1A    | 144.50' | 2,121 cf      | <b>12.17'W x 186.50'L x 3.54'H Field A</b><br>8,036 cf Overall - 2,735 cf Embedded = 5,302 cf x 40.0% Voids                                                                                                              |
| #2A    | 145.00' | 2,735 cf      | <b>Cultec R-330XLHD x 52 Inside #1</b><br>Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf<br>Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap<br>Row Length Adjustment= +1.50' x 7.45 sf x 2 rows |
|        |         | 4,855 cf      | Total Available Storage                                                                                                                                                                                                  |

Storage Group A created with Chamber Wizard

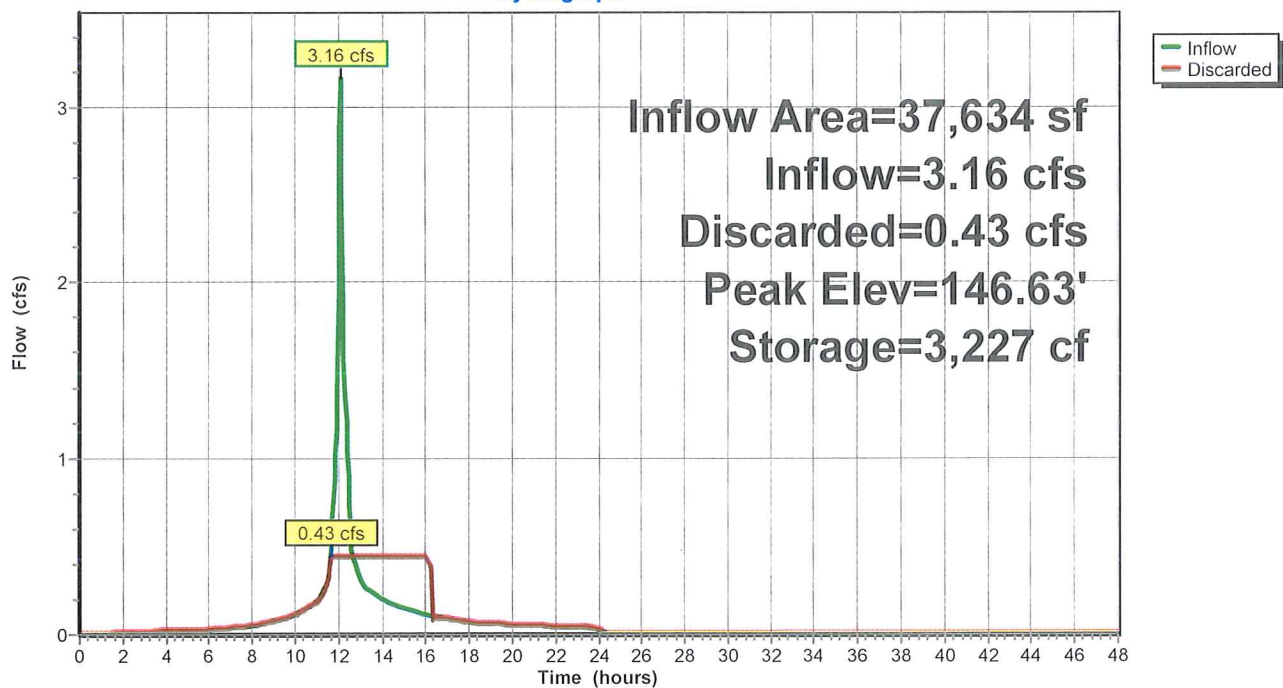
| Device | Routing   | Invert  | Outlet Devices                                    |
|--------|-----------|---------|---------------------------------------------------|
| #1     | Discarded | 144.50' | <b>8.270 in/hr Exfiltration over Surface area</b> |

**Discarded OutFlow** Max=0.43 cfs @ 11.65 hrs HW=144.54' (Free Discharge)

↑ **1=Exfiltration** (Exfiltration Controls 0.43 cfs)

## Pond 2P: Rear

## Hydrograph

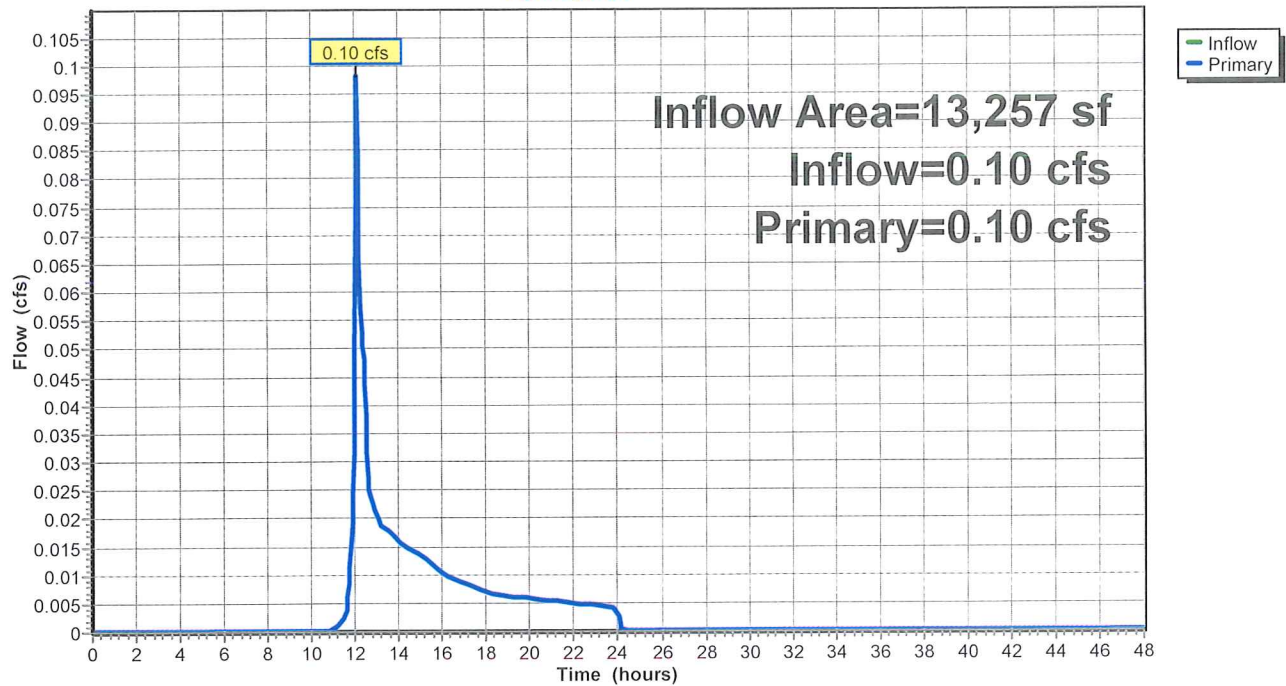




**Summary for Link 1L: Stearns**

Inflow Area = 13,257 sf, 7.03% Impervious, Inflow Depth = 0.47" for 25 Year event  
Inflow = 0.10 cfs @ 12.10 hrs, Volume= 519 cf  
Primary = 0.10 cfs @ 12.10 hrs, Volume= 519 cf, Atten= 0%, Lag= 0.0 min

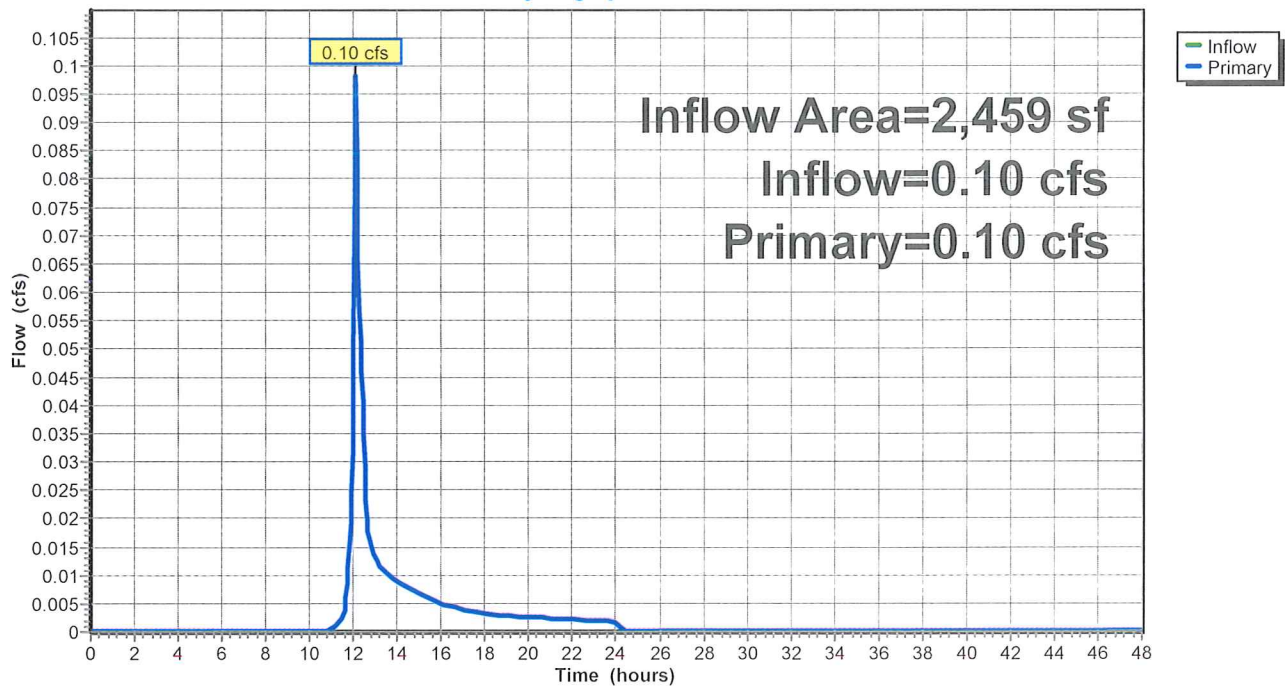
Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 1L: Stearns****Hydrograph**

**Summary for Link 2L: Stearns CB**

Inflow Area = 2,459 sf, 37.90% Impervious, Inflow Depth = 1.62" for 25 Year event  
Inflow = 0.10 cfs @ 12.10 hrs, Volume= 331 cf  
Primary = 0.10 cfs @ 12.10 hrs, Volume= 331 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 2L: Stearns CB****Hydrograph**

**PR-16stearnsR1**

Type III 24-hr 100 Year Rainfall=6.50"

Prepared by Microsoft

Printed 12/24/2018

HydroCAD® 10.00-21 s/n 03206 © 2018 HydroCAD Software Solutions LLC

Page 5

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

|                                            |                                                                                                          |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <b>Subcatchment P1: CB East</b>            | Runoff Area=8,673 sf 56.84% Impervious Runoff Depth=3.51"<br>Tc=6.0 min CN=73 Runoff=0.80 cfs 2,535 cf   |
| <b>Subcatchment P2: CB West</b>            | Runoff Area=3,601 sf 76.95% Impervious Runoff Depth=4.67"<br>Tc=6.0 min CN=84 Runoff=0.43 cfs 1,400 cf   |
| <b>Subcatchment P3: North &amp; Aprons</b> | Runoff Area=2,459 sf 37.90% Impervious Runoff Depth=2.35"<br>Tc=6.0 min CN=61 Runoff=0.15 cfs 481 cf     |
| <b>Subcatchment P4: Garage Parking</b>     | Runoff Area=4,706 sf 68.23% Impervious Runoff Depth=4.13"<br>Tc=6.0 min CN=79 Runoff=0.51 cfs 1,619 cf   |
| <b>Subcatchment P5: Bldg</b>               | Runoff Area=14,819 sf 100.00% Impervious Runoff Depth=6.26"<br>Tc=6.0 min CN=98 Runoff=2.12 cfs 7,732 cf |
| <b>Subcatchment P6: Rear Yard</b>          | Runoff Area=5,835 sf 16.97% Impervious Runoff Depth=1.32"<br>Tc=6.0 min CN=49 Runoff=0.17 cfs 640 cf     |
| <b>Subcatchment P7: West Lawn</b>          | Runoff Area=10,798 sf 0.00% Impervious Runoff Depth=0.48"<br>Tc=6.0 min CN=37 Runoff=0.05 cfs 428 cf     |
| <b>Pond 2P: Rear</b>                       | Peak Elev=147.75' Storage=4,587 cf Inflow=4.02 cfs 13,927 cf<br>Outflow=0.43 cfs 13,927 cf               |
| <b>Link 1L: Stearns</b>                    | Inflow=0.16 cfs 909 cf<br>Primary=0.16 cfs 909 cf                                                        |
| <b>Link 2L: Stearns CB</b>                 | Inflow=0.15 cfs 481 cf<br>Primary=0.15 cfs 481 cf                                                        |

**Total Runoff Area = 50,891 sf Runoff Volume = 14,837 cf Average Runoff Depth = 3.50"**  
**45.66% Pervious = 23,238 sf 54.34% Impervious = 27,653 sf**

**Summary for Subcatchment P1: CB East**

Runoff = 0.80 cfs @ 12.09 hrs, Volume= 2,535 cf, Depth= 3.51"

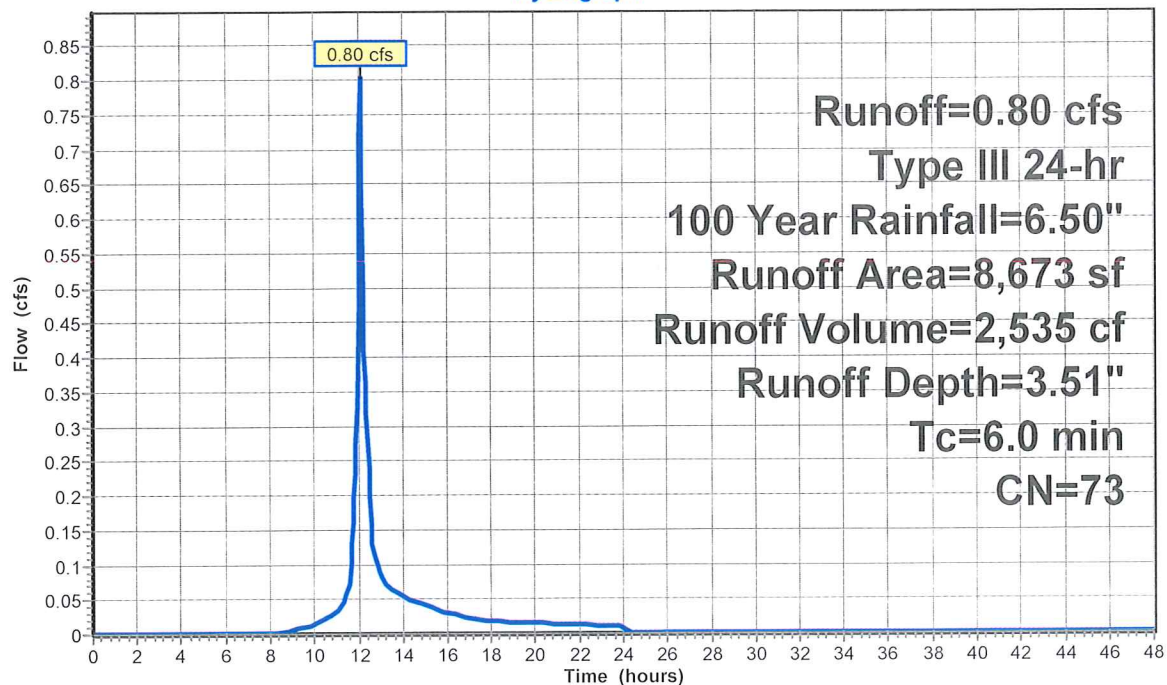
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100 Year Rainfall=6.50"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 4,205     | 98 | Paved parking, HSG A          |
| * 310     | 98 | Paved parking, HSG A (wall)   |
| * 415     | 98 | Roofs, HSG A (porch)          |
| 3,743     | 39 | >75% Grass cover, Good, HSG A |
| 8,673     | 73 | Weighted Average              |
| 3,743     |    | 43.16% Pervious Area          |
| 4,930     |    | 56.84% Impervious Area        |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P1: CB East**

Hydrograph



**Summary for Subcatchment P2: CB West**

Runoff = 0.43 cfs @ 12.09 hrs, Volume= 1,400 cf, Depth= 4.67"

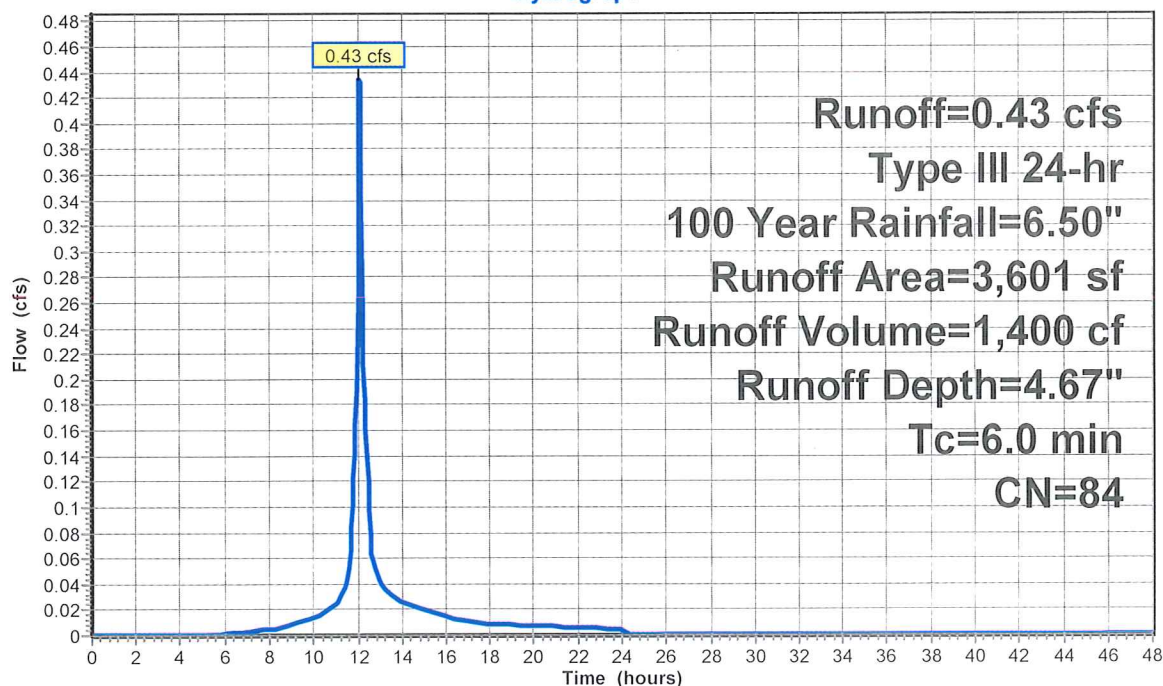
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100 Year Rainfall=6.50"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 830       | 39 | >75% Grass cover, Good, HSG A |
| 2,393     | 98 | Paved parking, HSG A          |
| 378       | 98 | Roofs, HSG A                  |
| 3,601     | 84 | Weighted Average              |
| 830       |    | 23.05% Pervious Area          |
| 2,771     |    | 76.95% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description                  |
|----------|---------------|---------------|-------------------|----------------|------------------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct calc <2 |

**Subcatchment P2: CB West**

Hydrograph





**Summary for Subcatchment P3: North & Aprons**

Runoff = 0.15 cfs @ 12.10 hrs, Volume= 481 cf, Depth= 2.35"

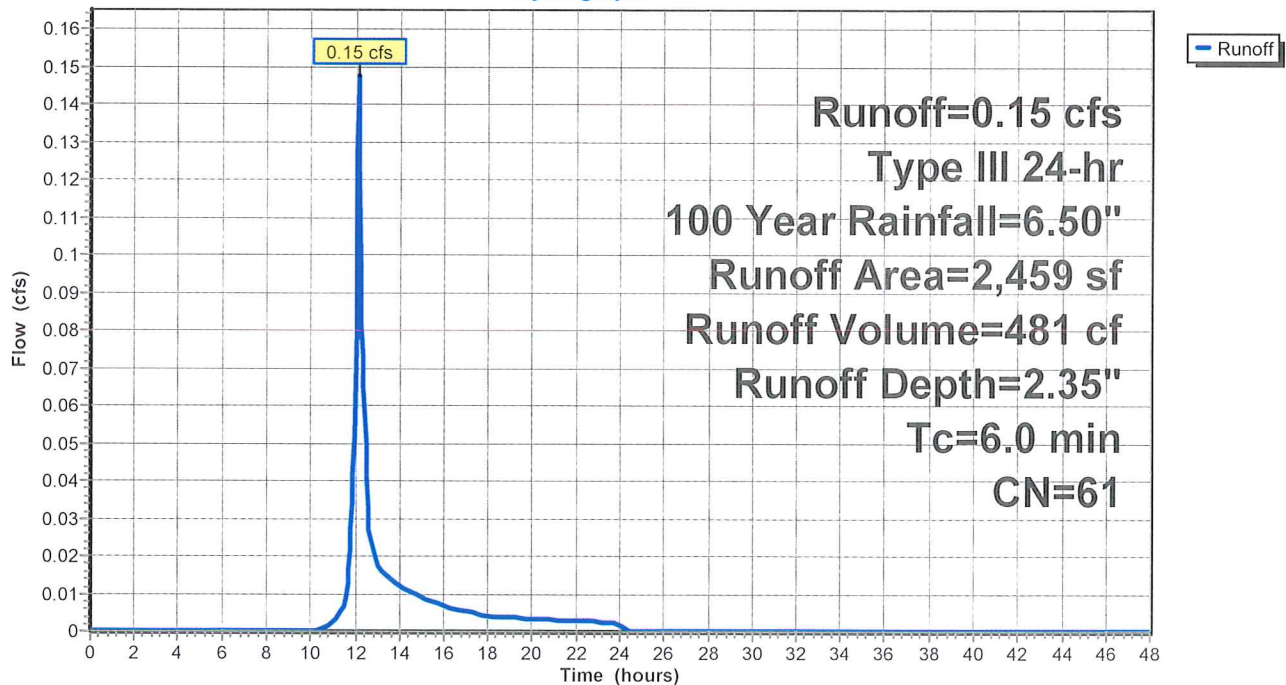
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100 Year Rainfall=6.50"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 1,527     | 39 | >75% Grass cover, Good, HSG A |
| 932       | 98 | Paved parking, HSG A          |
| 2,459     | 61 | Weighted Average              |
| 1,527     |    | 62.10% Pervious Area          |
| 932       |    | 37.90% Impervious Area        |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, direct |

**Subcatchment P3: North & Aprons**

Hydrograph



**Summary for Subcatchment P4: Garage Parking**

Runoff = 0.51 cfs @ 12.09 hrs, Volume= 1,619 cf, Depth= 4.13"

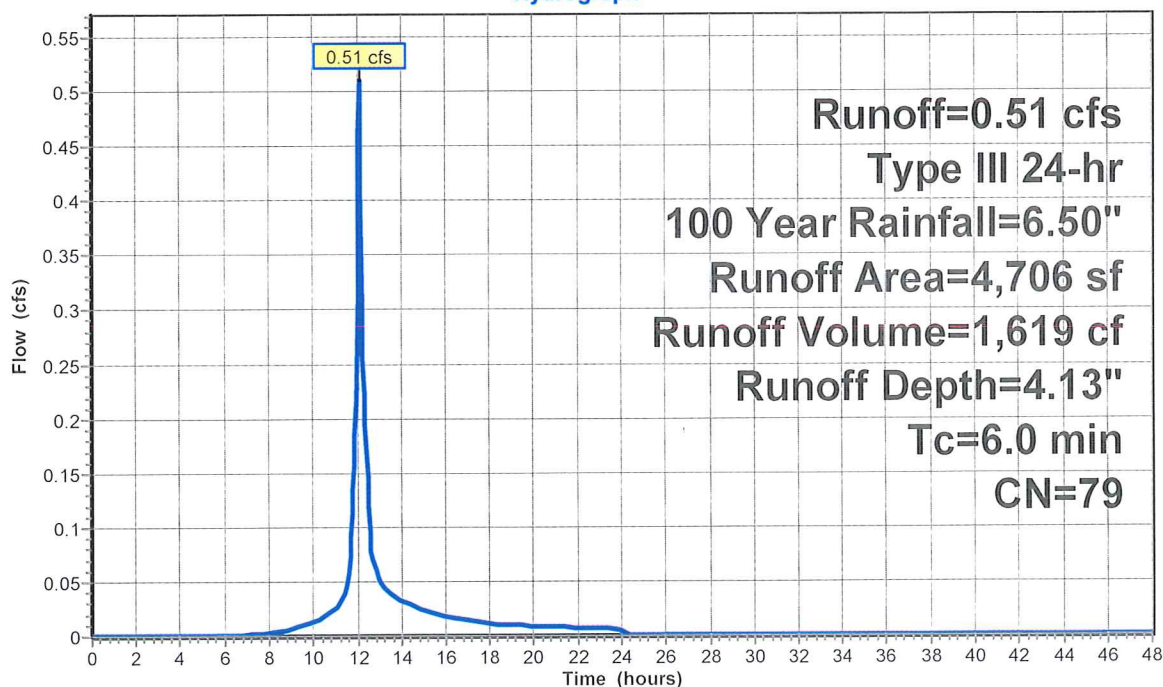
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100 Year Rainfall=6.50"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 3,211     | 98 | Paved parking, HSG A          |
| 1,495     | 39 | >75% Grass cover, Good, HSG A |
| 4,706     | 79 | Weighted Average              |
| 1,495     |    | 31.77% Pervious Area          |
| 3,211     |    | 68.23% Impervious Area        |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P4: Garage Parking**

Hydrograph



**Summary for Subcatchment P5: Bldg**

Runoff = 2.12 cfs @ 12.09 hrs, Volume= 7,732 cf, Depth= 6.26"

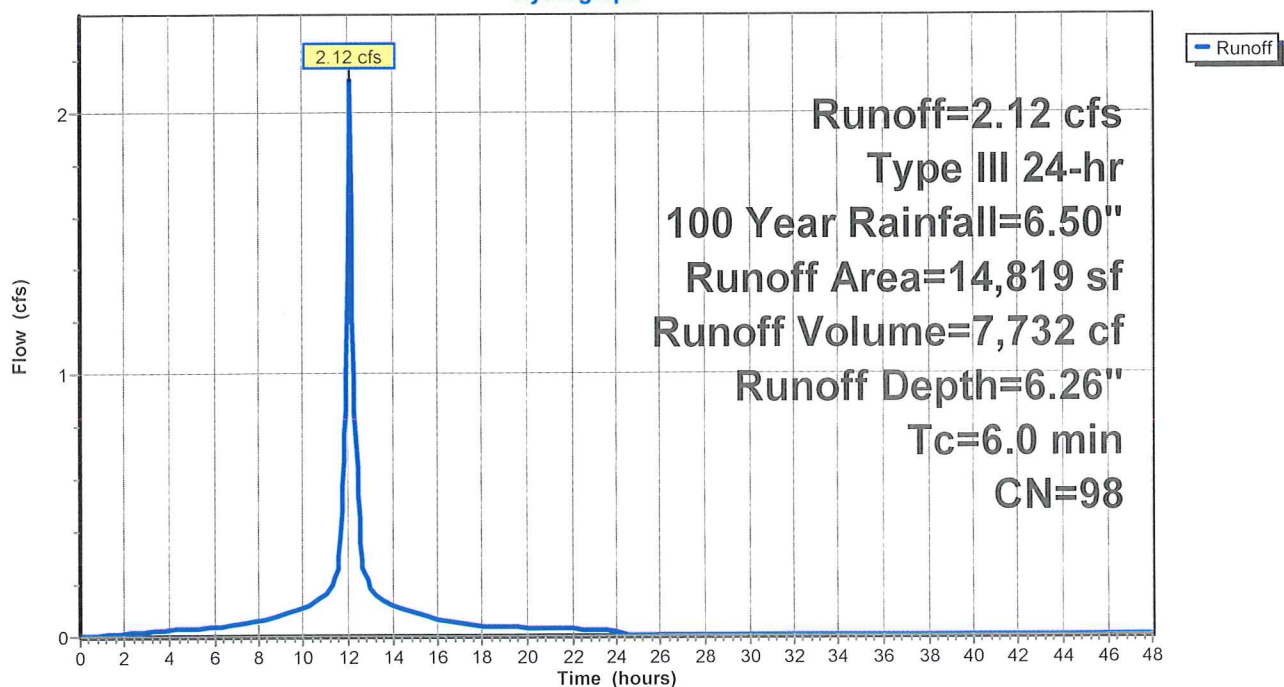
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100 Year Rainfall=6.50"

| Area (sf) | CN | Description             |
|-----------|----|-------------------------|
| 14,819    | 98 | Roofs, HSG A            |
| 14,819    |    | 100.00% Impervious Area |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P5: Bldg**

Hydrograph



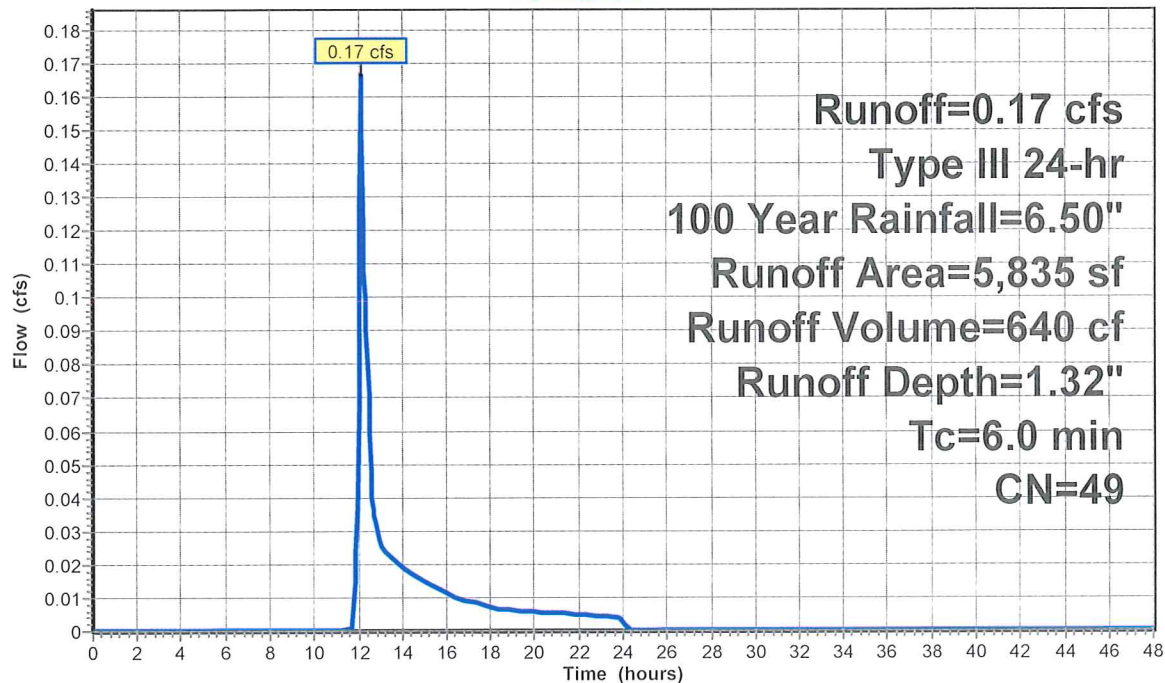
**Summary for Subcatchment P6: Rear Yard**

Runoff = 0.17 cfs @ 12.11 hrs, Volume= 640 cf, Depth= 1.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100 Year Rainfall=6.50"

|   | Area (sf) | CN | Description                   |
|---|-----------|----|-------------------------------|
| * | 249       | 98 | Roofs, HSG A (porch)          |
| * | 741       | 98 | Paved parking, HSG A (walk)   |
|   | 4,845     | 39 | >75% Grass cover, Good, HSG A |
|   | 5,835     | 49 | Weighted Average              |
|   | 4,845     |    | 83.03% Pervious Area          |
|   | 990       |    | 16.97% Impervious Area        |

| Tc<br>(min) | Length<br>(feet) | Slope<br>(ft/ft) | Velocity<br>(ft/sec) | Capacity<br>(cfs) | Description          |
|-------------|------------------|------------------|----------------------|-------------------|----------------------|
| 6.0         |                  |                  |                      |                   | Direct Entry, Direct |

**Subcatchment P6: Rear Yard****Hydrograph**



**Summary for Subcatchment P7: West Lawn**

Runoff = 0.05 cfs @ 12.35 hrs, Volume= 428 cf, Depth= 0.48"

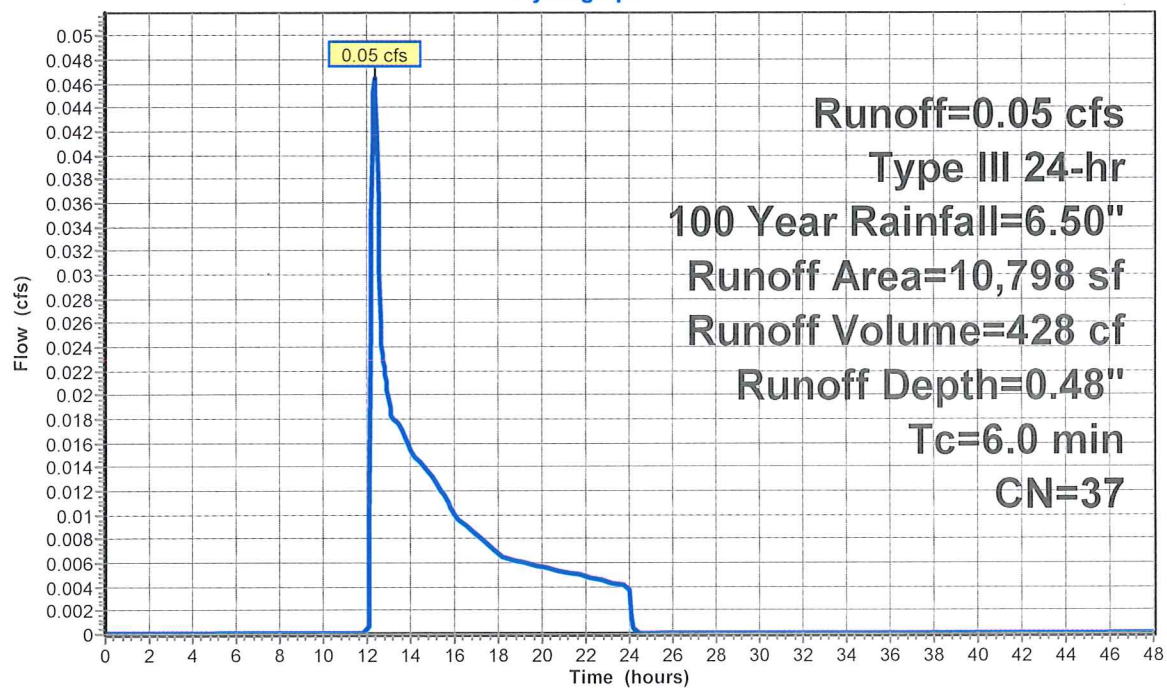
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type III 24-hr 100 Year Rainfall=6.50"

| Area (sf) | CN | Description                   |
|-----------|----|-------------------------------|
| 6,423     | 39 | >75% Grass cover, Good, HSG A |
| 4,375     | 35 | Brush, Fair, HSG A            |
| 10,798    | 37 | Weighted Average              |
| 10,798    |    | 100.00% Pervious Area         |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description          |
|----------|---------------|---------------|-------------------|----------------|----------------------|
| 6.0      |               |               |                   |                | Direct Entry, Direct |

**Subcatchment P7: West Lawn**

Hydrograph





**Summary for Pond 2P: Rear**

Inflow Area = 37,634 sf, 71.00% Impervious, Inflow Depth = 4.44" for 100 Year event  
 Inflow = 4.02 cfs @ 12.09 hrs, Volume= 13,927 cf  
 Outflow = 0.43 cfs @ 11.60 hrs, Volume= 13,927 cf, Atten= 89%, Lag= 0.0 min  
 Discarded = 0.43 cfs @ 11.60 hrs, Volume= 13,927 cf

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 147.75' @ 12.87 hrs Surf.Area= 2,269 sf Storage= 4,587 cf

Plug-Flow detention time= 74.5 min calculated for 13,913 cf (100% of inflow)  
 Center-of-Mass det. time= 74.4 min ( 854.1 - 779.7 )

| Volume | Invert  | Avail.Storage | Storage Description                                                                                                                                                                                                      |
|--------|---------|---------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| #1A    | 144.50' | 2,121 cf      | <b>12.17'W x 186.50'L x 3.54'H Field A</b><br>8,036 cf Overall - 2,735 cf Embedded = 5,302 cf x 40.0% Voids                                                                                                              |
| #2A    | 145.00' | 2,735 cf      | <b>Cultec R-330XLHD</b> x 52 Inside #1<br>Effective Size= 47.8"W x 30.0"H => 7.45 sf x 7.00'L = 52.2 cf<br>Overall Size= 52.0"W x 30.5"H x 8.50'L with 1.50' Overlap<br>Row Length Adjustment= +1.50' x 7.45 sf x 2 rows |
|        |         | 4,855 cf      | Total Available Storage                                                                                                                                                                                                  |

Storage Group A created with Chamber Wizard

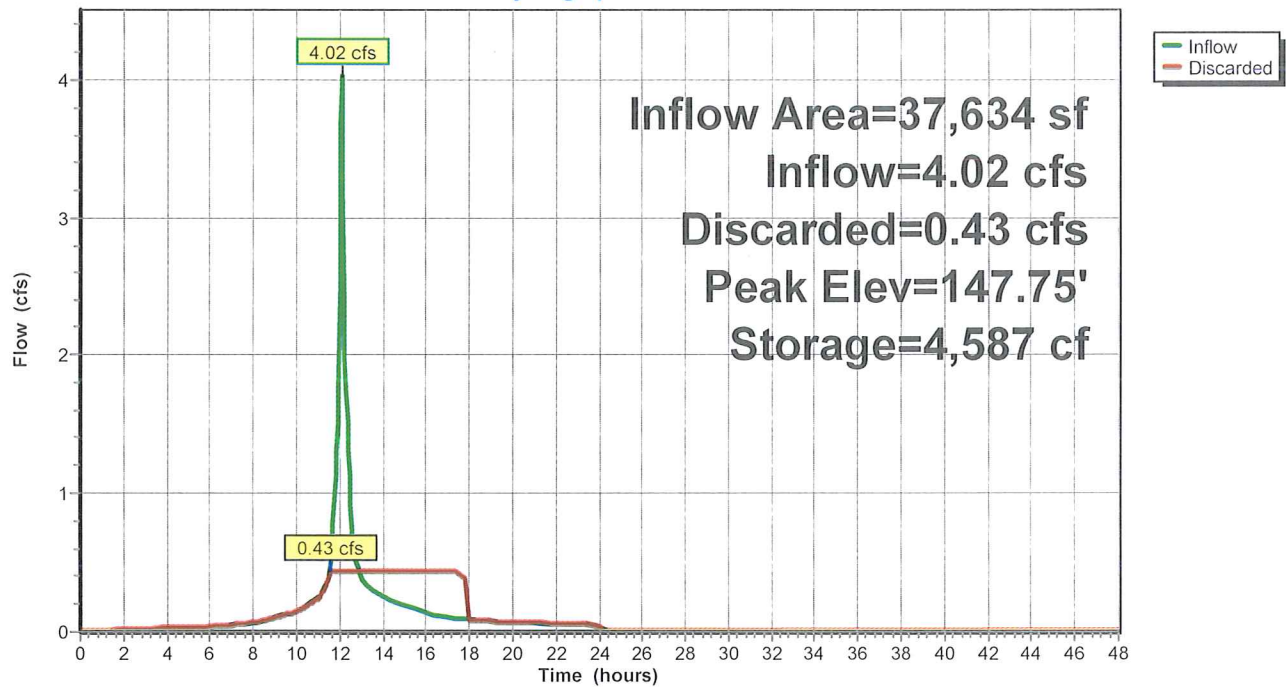
| Device | Routing   | Invert  | Outlet Devices                                    |
|--------|-----------|---------|---------------------------------------------------|
| #1     | Discarded | 144.50' | <b>8.270 in/hr Exfiltration over Surface area</b> |

**Discarded OutFlow** Max=0.43 cfs @ 11.60 hrs HW=144.54' (Free Discharge)

↑1=Exfiltration (Exfiltration Controls 0.43 cfs)

## Pond 2P: Rear

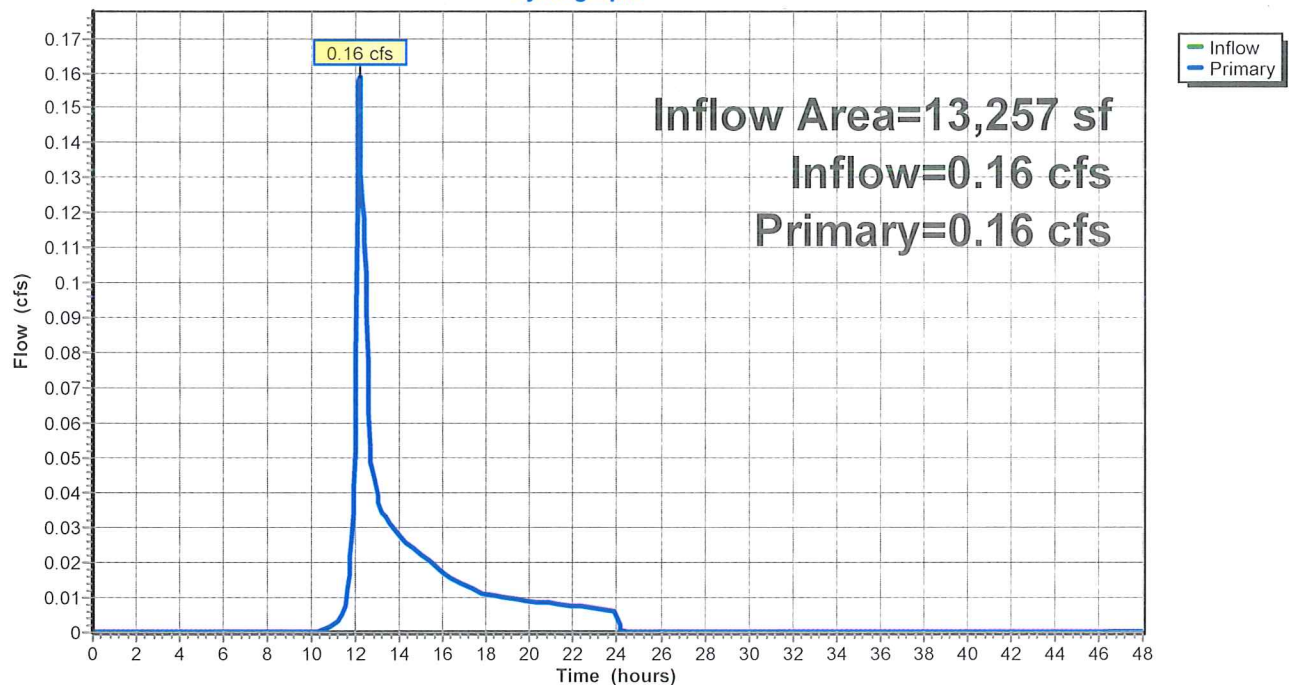
## Hydrograph



**Summary for Link 1L: Stearns**

Inflow Area = 13,257 sf, 7.03% Impervious, Inflow Depth = 0.82" for 100 Year event  
Inflow = 0.16 cfs @ 12.12 hrs, Volume= 909 cf  
Primary = 0.16 cfs @ 12.12 hrs, Volume= 909 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 1L: Stearns****Hydrograph**

**Summary for Link 2L: Stearns CB**

Inflow Area = 2,459 sf, 37.90% Impervious, Inflow Depth = 2.35" for 100 Year event  
Inflow = 0.15 cfs @ 12.10 hrs, Volume= 481 cf  
Primary = 0.15 cfs @ 12.10 hrs, Volume= 481 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

**Link 2L: Stearns CB****Hydrograph**