# STORMWATER TECHNICAL INFORMATION REPORT

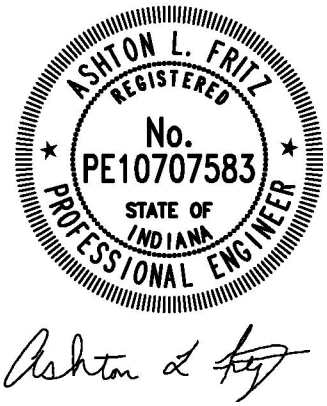
## BDH REALTY CARWASH

Project Location:

2140 N. Morton Street
Franklin, IN 46131

Prepared For:

BDH REALTY
8220 S. US 31
Indianapolis, IN 46227




Date:

APRIL 4, 2021
Last Revised:

Fritz Engineering Services, LLC

- CIVIL ENGINEERS
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- DRAINAGE CONSULTANTS
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# TABLE OF CONTENTS

## PROJECT DESCRIPTION

BDH Realty is proposing a new Commercial Subdivision including the vacant parcel at the southwest corner of Simon Road and N. Morton Street and the existing Hubler Ford dealership site at the northwest corner of N. Morton Street and Ransdell St in Franklin, Indiana. The subdivision will create 5 commercial development lots along with associated utility services, private drives and associated infrastructure. In total the overall development is approximately 12 acres. It is anticipated that the four new commercial lots will be developed along with redevelopment of the 6 acre automotive dealership, car wash and a mixture of office and retail buildings. Access to the site will be provided from two existing entrances on N. Morton Street and a new proposed entrance on Simon Road.

This analysis is provided as part of the Carwash Development Plan application for the above referenced commercial subdivision. This includes mass grading for the commercial outlots as well as design and construction of Detention Pond 1 in the southwest corner of the commercial development. Final design of the stormwater management components for the new dealership site will be provided with the Construction Plan application and/or the final Development Plan application for that site. Other than the carwash site, storm sewer design for the various outlots will be provided at the Development Plan application for each. However, connection points for drainage to each lot are provided with this design.

For reference, the project site is located at approximately latitude 39°30’10"N and longitude 86º04’10”W.

## FEMA MAP OVERVIEW

The project site is located within the FEMA Community Panel Map #18081C0139D dated August 2, 2007. Review of the map indicates the site is located within the Flood Designation ‘Zone X’ (unshaded). Therefore, the site is not subject to Flood Control Ordinance requirements. The FEMA Map is included in Appendix B.

## WATERSHED DESCRIPTION

The project site is located within the ‘Youngs Creek-Brewers/Canary Ditches‘ watershed as provided on the IndianaMap GIS system. The 14-digit Hydrologic Unit Codes (HUC) for this watershed Is 05120204090030.

## SOILS OVERVIEW

The project site contains the soils listed in the following **Table**. The Hydrologic Soil Group (HSG) for each soil is also provided. The appropriate limits of each soil type are depicted in the Soils Map provided in Appendix C.

**TABLE 1 – PROJECT SOILS**

| Soil Symbol | Soil Name, Description | HSG |
|---|---|---|
| YbvA, UbaA & Br | Brookston silty clay loam, Urban land complex | B |
| YcIA, UcfA, & CrA | Crosby silty loam | C |

## ZONING INFORMATION

The site is within the corporate limits of the City of Franklin, Indiana. The underlying Zoning Classification is MXC and the site is located within the Gateway Overlay zone. The proposed uses are permitted in the noted Zoning District.

## DEVELOPMENT STANDARDS

The project site is located within the City of Franklin, Johnson County, Indiana. Therefore, the proposed drainage improvements are subject to the standards of design and construction of the City of Franklin. Runoff and detention sizing will be modeled using HydroCAD version 10.00-24 utilizing the Type II rainfall distribution and rainfall depths from NOAA Precipitation Atlas. In accordance with the City of Franklin Subdivision Control Ordinance, the following shall be used as the basis of design:

**TABLE 2 – FRANKLIN STORMWATER MANAGEMENT DESIGN PARAMETERS**

| | Franklin Subdivision Control Ordinance Design Parameter |
|---|---|
| **Stormwater Measure** | |
| **Storm Sewers** | • 10 year Peak Flow, Rational Method<br>• Minimum pipe size, 12”<br>• Minimum full flow velocity, 2.5 ft/s<br>• Maximum full flow velocity, 15 ft/s<br>• Preferred pipe material, RCP Class III |
| **Detention** | • 10 yr post developed released at 2 yr predeveloped<br>• 100 yr post developed released at 10 yr predeveloped,<br>• SCS Hydrograph Methods for storm durations of 1hr, 2hr, 3hr, 6hr, 12hr and 24hr<br>• Dry Detention must have 1% bottom slope with underdrains<br>• Max. bank slope of 4H:1V<br>• Wet Pond<br>  ○ minimum water surface area of 0.5 acres<br>  ○ 6’ safety ledge 18 inches below normal pool<br>  ○ 25% of surface area shall have depth of 10’<br>• Spillways required to pass 125% of 100 yr design storm peak inflow. |

| | Franklin Subdivision Control Ordinance Design Parameter |
|---|---|
| **Inlets** | • 10 yr Peak Flow, Rational Method<br>• 50% clogged in sag conditions<br>• No greater than 6 inches of ponding above grate |
| **Swales** | • Minimum of 1% flow line slope<br>• Maximum of 7% flow line slope<br>• Bank slopes of 4H:1V maximum |

In addition to the above Franklin Standards, the proposed stormwater management systems will discharge into the N. Morton Street roadside ditch. This section of N. Morton Street is also US 31 and under Indiana Department of Transportation jurisdiction. As such, INDOT stormwater detention standards shall also apply as follows:

**TABLE 3 – INDOT STORMWATER MANAGEMENT DESIGN PARAMETERS**

| | INDOT Design Parameter from Indiana Design Manual, Section 203.5 |
|---|---|
| **Stormwater Measure** | |
| **Detention** | • 100 yr post developed released at 10 yr predeveloped,<br>• Minimum 1' of Freeboard above 100 yr peak stage<br>• Detention Volume shall be entirely drained within 72hr |

The combination of the two, Franklin & INDOT, will be used for the basis of this project's stormwater management design.

## EXISTING CONDITIONS

The proposed development site is currently generally developed with a Hubler Ford dealership on the southern half the project site and undeveloped on the northern half. Most of BTP is located within Zionsville to the west of this site.

Runoff from the current conditions is conveyed predominantly via overland flow in four generally directions to offsite drainage facilities as described below.

EX1 - sheet drains most of the site to the east and into the N. Morton Street/US 31 roadside ditch.

EX2 - sheet drains the northwest corner of the project area north to the Simon Road roadside ditch which flows east and into the N. Morton Street roadside ditch.

EX3 - sheet drains southwest onto the adjoining residential neighborhood. It is understood that this area is collected in the neighborhood stormwater collection system and conveyed to the existing detention pond southeast of the Mustang Road cul-de-sac. This pond is immediately to the west of the existing Hubler Ford Dealership.

EX4 - sheet drains the west and directly into the neighborhood pond noted above. It is comprised of the rear paved area of the existing dealership and the unimproved/grassed areas to the west of the pavement.

Following is a summary of the peak existing runoff/discharge rates from each of the noted existing condition basins.

**TABLE 4 – EXISTING PEAK DISCHARGE RATES**

| | Peak Runoff Rate, cfs | | | | |
|---|---|---|---|---|---|
| **Basin Name** | **2 yr** | **10 yr** | **25 yr** | **50 yr** | **100 yr** |
| **EX1** | 15.93 | 23.99 | 29.55 | 35.06 | 41.34 |
| **EX2** | 0.91 | 1.84 | 2.45 | 2.95 | 3.54 |
| **SUBTOTAL TO US 31 DITCH** | 16.80 | 25.76 | 32.04 | 37.85 | 44.66 |
| **EX3** | 0.71 | 1.49 | 1.98 | 2.39 | 2.86 |
| **EX4** | 6.05 | 9.43 | 11.86 | 14.12 | 16.85 |
| **TOTAL TO EX. POND** | 6.36 | 10.35 | 13.11 | 15.55 | 18.47 |

For clarity, a map of the existing drainage sheds and infrastructure is illustrated in Appendix D along with the HydroCAD modeling data.

## PROPOSED CONDITIONS

BDH Realty is proposing a new commercial subdivision and development along the west side of N. Morton Street/US 31 between Simon Road and Ransdell Drive in Franklin, Indiana. The subdivision will create 5 commercial development lots along with associated utility services, private drives and associated infrastructure. In total the overall development is approximately 12 acres. It is anticipated that the existing dealership on the southern 6 acres will be redeveloped and the four new commercial lots will be developed individually. This project includes the design of a new car wash on Lot 2 of the proposed subdivision. Access to the site will be provided from two existing entrances on N. Morton Street and a new proposed entrance on Simon Road.

The following sections demonstrate how the proposed improvements are consistent with the City of Franklin Subdivision Control Ordinance and stormwater management standards. Runoff calculations for the proposed conditions are computed in Appendix using the minimum 5-minute Time of Concentration. A map of the proposed basins is provided in Appendix E.

## STORMWATER DETENTION

As noted above, the development will require the implementation of stormwater detention in accordance with INDOT and the City of Franklin design standards. There are two proposed stormwater detention basins. The first is a wet detention basin located in the southwest corner of the north half of the overall development. This basin will accept runoff

from the four commercial outlots including the proposed car wash. The second detention basin is located in the southeast corner of the site and will accept runoff from the auto dealership development. The full design and construction of the dealership detention basin will be performed when the redevelopment of the dealership is proposed. For masterplanning purposes, the detention basin is included in this analysis to ensure the overall discharge limitations to the US 31 roadside ditch are met. There is a small area that will direct discharge to the US 31 ditch and a small area that will continue to convey runoff to the existing neighborhood pond to the west. However, each of these direct discharges are significantly less than existing conditions and therefore, no negative impacts are anticipated.

The following table summarizes the allowable outflows from the onsite stormwater management system to the respective downstream receiving drainage system.

**TABLE 5 – PROPOSED CONDITION ALLOWABLE DETENTION OUTFLOW**

| Basin Name | Discharge, cfs |
|---|---|
| **10 YR ALLOWABLE TO US 31 DITCH** | **16.80 (2yr Pre)** |
| **100yr Allowable to US 31 Ditch** | **25.76 (10yr Pre)** |

The proposed developed conditions have been modeled using HydroCAD to demonstrate the allowable release rates have been met. Following is a summary of the proposed runoff/release rates to the respective downstream drainage systems.

**TABLE 6 – PROPOSED CONDITION DISCHARGE SUMMARY**

| | Peak Runoff/Discharge Rate, cfs | | | | |
|---|---|---|---|---|---|
| **Discharge Location/Basin Name** | **2 yr** | **10 yr** | **25 yr** | **50 yr** | **100 yr** |
| **US 31 DITCH** (includes Det Basin 1, Det Basin 2, and PR-East) | 9.83 | 14.28 | 17.01 | 19.16 | 21.52 |
| **PR3** | 0.57 | 1.12 | 1.48 | 1.77 | 2.14 |

The above demonstrates that the stormwater detention system has been sufficiently sized to meet the required parameters. As a result, no further detention is required. Reference Appendix E for the model and proposed conditions drainage calculations.

## STORMWATER PIPE DESIGN

Calculations for onsite stormwater infrastructure including pipe sizing for the 10-year Rational Method peak runoffs are provided for the commercial outlots in Appendix E. The pipe sizing calculations for each outlot will be provided at the time of development however, connection points to each lot have been provided to convey runoff from each developed lot to the detention pond. The stormwater management for the car dealership site will be prepared at the time of redevelopment.

The proposed infrastructure improvements will have master planned pipe networks that will convey runoff from the various commercial outlots to one of the two detention basins. Final design of the pipe network will be provided with the final Construction Plans.

## SUMMARY

BDH Realty is proposing a new commercial subdivision and development along the west side of N. Morton Street/US 31 between Simon Road and Ransdell Drive in Franklin, Indiana. The subdivision will create 4 commercial development lots along with associated utility services, private drives and associated infrastructure. In total the overall development is approximately 12 acres. It is anticipated that the four new commercial lots will be developed with a 6 acre automotive dealership, car wash and a mixture of office and retail buildings. Access to the site will be provided from two existing entrances on N. Morton Street and a new proposed entrance on Simon Road.

This report demonstrates that the proposed project improvements meet the stormwater design parameters, and no further stormwater detention or water quality measures are necessary.

As a result of the onsite drainage analysis, the proposed improvements are not anticipated to have adverse impacts on the surrounding or downstream drainage systems.

## REFERENCES

1. Johnson County Soils Map (Web Soil Survey)
2. FEMA Flood Insurance Rate Maps, FEMA Website
3. Indiana Drainage Handbook
4. Franklin Subdivision Control Ordinance & Stormwater Technical Standards
5. INDOT – Indiana Design Manual

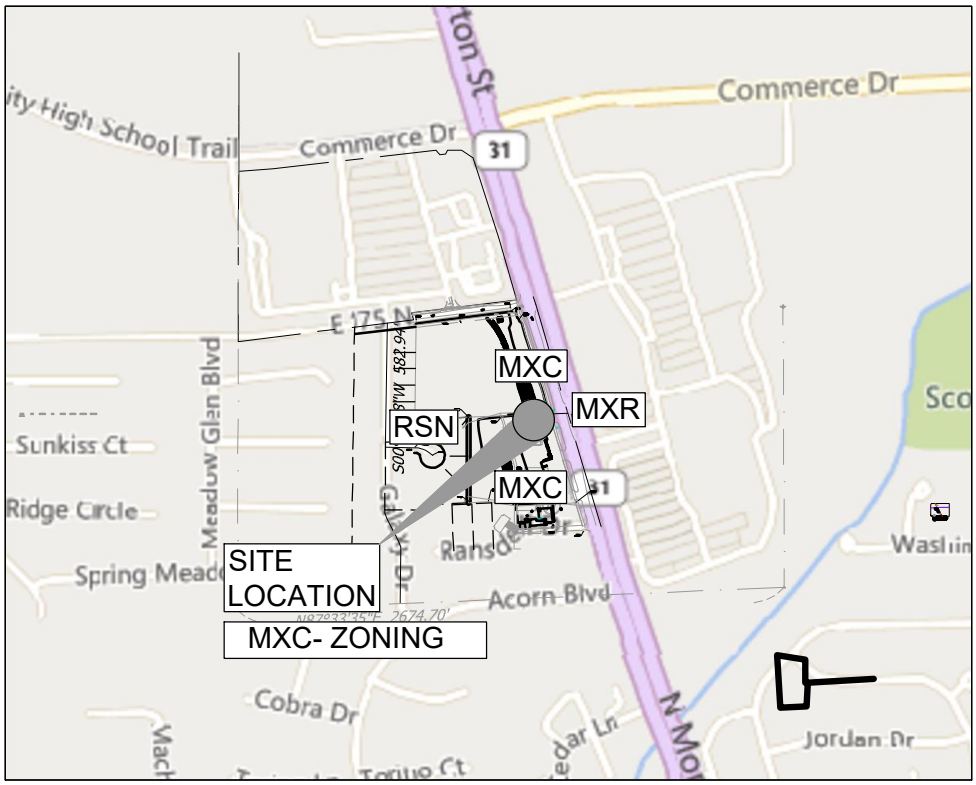
# APPENDICES

# *APPENDIX A – LOCATION MAP*


NOT TO SCALE

## SITE LOCATION MAP

N




## SITE VICINITY & ZONING MAP

N

# *APPENDIX B – FEMA MAP*

# National Flood Hazard Layer FIRMette



86°4'30"W 39°30'27"N


86°3'52"W 39°29'59"N

Feet 1:6,000

0 250 500 1,000 1,500 2,000

*Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020*

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

**SPECIAL FLOOD HAZARD AREAS**
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

**OTHER AREAS OF FLOOD HAZARD**
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

**OTHER AREAS**
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

**GENERAL STRUCTURES**
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

**OTHER FEATURES**
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

**MAP PANELS**
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/27/2021 at 4:24 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

# *APPENDIX C – SOILS DATA & MAP*

Soil Map—Johnson County, Indiana
(BDH REALTY)


Map Scale: 1:1,920 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 25 50 100 150

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 Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**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: Johnson County, Indiana
Survey Area Data: Version 28, Jun 4, 2020

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

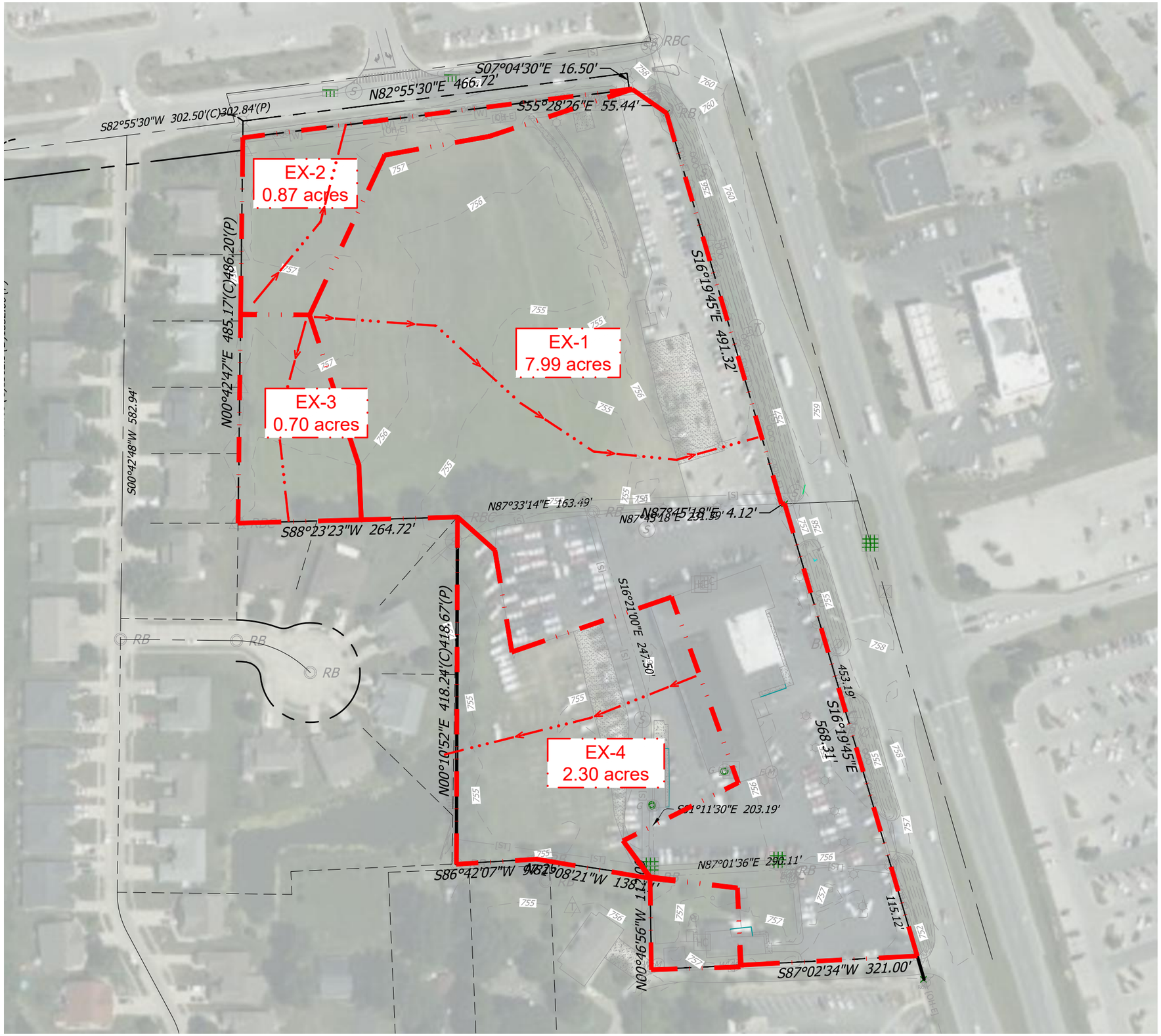
Date(s) aerial images were photographed: Jul 27, 2019—Sep 26, 2019

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.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| Br | Brookston silty clay loam, 0 to 2 percent slopes | 2.1 | 18.6% |
| CrA | Crosby silt loam, fine-loamy subsoil, 0 to 2 percent slopes | 2.0 | 17.9% |
| UbaA | Urban land-Brookston complex, 0 to 2 percent slopes | 3.0 | 26.1% |
| UcfA | Urban land-Crosby silt loam complex, fine-loamy subsoil, 0 to 2 percent slopes | 3.2 | 27.8% |
| YbvA | Brookston silty clay loam-Urban land complex, 0 to 2 percent slopes | 1.0 | 8.9% |
| YclA | Crosby silt loam, fine-loamy subsoil-Urban land complex, 0 to 2 percent slopes | 0.1 | 0.8% |
| **Totals for Area of Interest** | | **11.4** | **100.0%** |

# *APPENDIX D – EXISTING DRAINAGE ANALYSIS*

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SHEET NAME / NO.

**EXISTING BASIN MAP**

# EXH-1

**Existing Conditions** *Type II 24-hr 100yr-24hr Rainfall=5.91"*
Prepared by Fritz Engineering Printed 4/1/2021

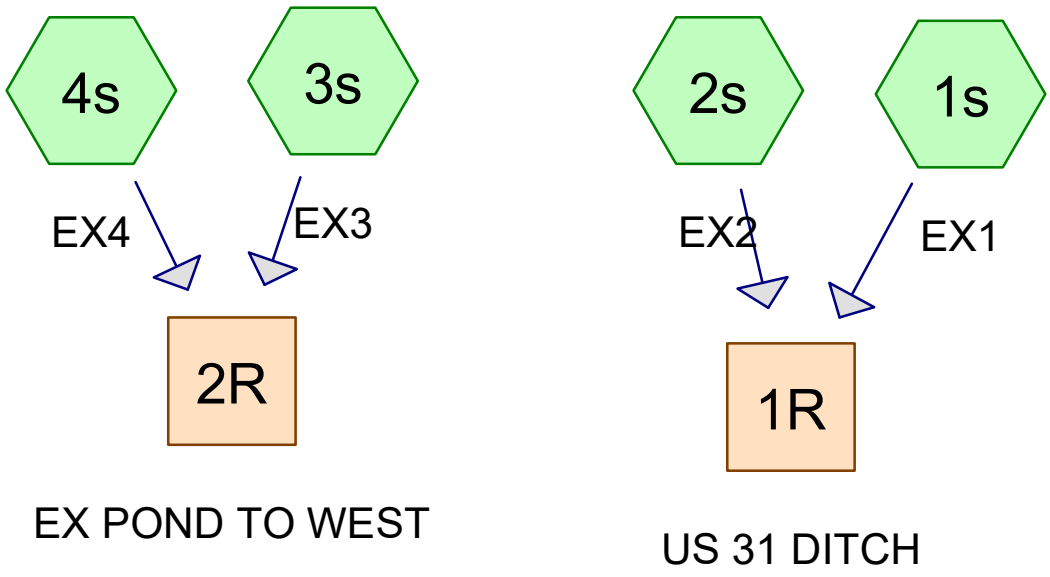

## Events for Reach 1R: US 31 DITCH

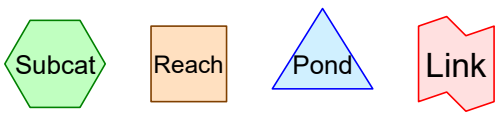
| Event | Inflow (cfs) | Outflow (cfs) | Elevation (feet) | Storage (cubic-feet) |
|---|---|---|---|---|
| 002yr-01hr | 7.95 | 7.95 | **0.00** | **0** |
| 002yr-02hr | 9.48 | 9.48 | 0.00 | 0 |
| 002yr-03hr | 9.82 | 9.82 | 0.00 | 0 |
| 002yr-06hr | 16.80 | 16.80 | 0.00 | 0 |
| 002yr-12hr | 13.71 | 13.71 | 0.00 | 0 |
| 002yr-24hr | 15.52 | 15.52 | 0.00 | 0 |
| 010yr-01hr | 16.90 | 16.90 | 0.00 | 0 |
| 010yr-02hr | 19.79 | 19.79 | 0.00 | 0 |
| 010yr-03hr | 20.10 | 20.10 | 0.00 | 0 |
| 010yr-06hr | 23.16 | 23.16 | 0.00 | 0 |
| 010yr-12hr | 24.63 | 24.63 | 0.00 | 0 |
| 010yr-24hr | 25.76 | 25.76 | 0.00 | 0 |
| 025yr-01hr | 23.10 | 23.10 | 0.00 | 0 |
| 025yr-02hr | 26.76 | 26.76 | 0.00 | 0 |
| 025yr-03hr | 27.28 | 27.28 | 0.00 | 0 |
| 025yr-06hr | 30.86 | 30.86 | 0.00 | 0 |
| 025yr-12hr | 31.78 | 31.78 | 0.00 | 0 |
| 025yr-24hr | 32.04 | 32.04 | 0.00 | 0 |
| 050yr-01hr | 28.15 | 28.15 | 0.00 | 0 |
| 050yr-02hr | 32.61 | 32.61 | 0.00 | 0 |
| 050yr-03hr | 33.42 | 33.42 | 0.00 | 0 |
| 050yr-06hr | 37.47 | 37.47 | 0.00 | 0 |
| 050yr-12hr | 37.85 | 37.85 | 0.00 | 0 |
| 050yr-24hr | 37.01 | 37.01 | 0.00 | 0 |
| 100yr-01hr | 33.54 | 33.54 | 0.00 | 0 |
| 100yr-02hr | 39.23 | 39.23 | 0.00 | 0 |
| 100yr-03hr | 40.11 | 40.11 | 0.00 | 0 |
| 100yr-06hr | **44.66** | **44.66** | 0.00 | 0 |
| 100yr-12hr | 44.18 | 44.18 | 0.00 | 0 |
| 100yr-24hr | 42.17 | 42.17 | 0.00 | 0 |

**Existing Conditions** *Type II 24-hr 100yr-24hr Rainfall=5.91"*
Prepared by Fritz Engineering Printed 4/1/2021


## Events for Reach 2R: EX POND TO WEST

| Event | Inflow (cfs) | Outflow (cfs) | Elevation (feet) | Storage (cubic-feet) |
|---|---|---|---|---|
| 002yr-01hr | 2.82 | 2.82 | **0.00** | **0** |
| 002yr-02hr | 3.43 | 3.43 | 0.00 | 0 |
| 002yr-03hr | 3.52 | 3.52 | 0.00 | 0 |
| 002yr-06hr | 6.36 | 6.36 | 0.00 | 0 |
| 002yr-12hr | 5.09 | 5.09 | 0.00 | 0 |
| 002yr-24hr | 5.91 | 5.91 | 0.00 | 0 |
| 010yr-01hr | 6.64 | 6.64 | 0.00 | 0 |
| 010yr-02hr | 7.71 | 7.71 | 0.00 | 0 |
| 010yr-03hr | 7.78 | 7.78 | 0.00 | 0 |
| 010yr-06hr | 9.07 | 9.07 | 0.00 | 0 |
| 010yr-12hr | 9.75 | 9.75 | 0.00 | 0 |
| 010yr-24hr | 10.35 | 10.35 | 0.00 | 0 |
| 025yr-01hr | 9.28 | 9.28 | 0.00 | 0 |
| 025yr-02hr | 10.70 | 10.70 | 0.00 | 0 |
| 025yr-03hr | 10.86 | 10.86 | 0.00 | 0 |
| 025yr-06hr | 12.40 | 12.40 | 0.00 | 0 |
| 025yr-12hr | 12.88 | 12.88 | 0.00 | 0 |
| 025yr-24hr | 13.11 | 13.11 | 0.00 | 0 |
| 050yr-01hr | 11.49 | 11.49 | 0.00 | 0 |
| 050yr-02hr | 13.24 | 13.24 | 0.00 | 0 |
| 050yr-03hr | 13.52 | 13.52 | 0.00 | 0 |
| 050yr-06hr | 15.30 | 15.30 | 0.00 | 0 |
| 050yr-12hr | 15.55 | 15.55 | 0.00 | 0 |
| 050yr-24hr | 15.32 | 15.32 | 0.00 | 0 |
| 100yr-01hr | 13.87 | 13.87 | 0.00 | 0 |
| 100yr-02hr | 16.13 | 16.13 | 0.00 | 0 |
| 100yr-03hr | 16.45 | 16.45 | 0.00 | 0 |
| 100yr-06hr | **18.47** | **18.47** | 0.00 | 0 |
| 100yr-12hr | 18.36 | 18.36 | 0.00 | 0 |
| 100yr-24hr | 17.62 | 17.62 | 0.00 | 0 |




**Routing Diagram for Existing Conditions**
Prepared by Fritz Engineering, Printed 4/1/2021

## Project Notes

Rainfall events imported from "Proposed Conditions.hcp"

## Rainfall Events Listing (selected events)

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 002yr-06hr | Type II 24-hr | | Trim | 6.00 | 1 | 2.50 | 2 |
| 2 | 010yr-24hr | Type II 24-hr | | Default | 24.00 | 1 | 4.09 | 2 |
| 3 | 025yr-24hr | Type II 24-hr | | Default | 24.00 | 1 | 4.79 | 2 |
| 4 | 050yr-12hr | Type II 24-hr | | Trim | 12.00 | 1 | 4.78 | 2 |
| 5 | 100yr-06hr | Type II 24-hr | | Trim | 6.00 | 1 | 4.77 | 2 |

## Area Listing (all nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 6.954 | 74 | >75% Grass cover, Good, HSG C (1s, 2s, 3s, 4s) |
| 4.269 | 98 | Paved parking, HSG C (1s, 4s) |
| 0.636 | 98 | Roofs, HSG C (1s, 4s) |
| **11.858** | **84** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (acres) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0.000 | HSG A | |
| 0.000 | HSG B | |
| 11.858 | HSG C | 1s, 2s, 3s, 4s |
| 0.000 | HSG D | |
| 0.000 | Other | |
| **11.858** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (acres) | HSG-B (acres) | HSG-C (acres) | HSG-D (acres) | Other (acres) | Total (acres) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 6.954 | 0.000 | 0.000 | 6.954 | >75% Grass cover, Good | 1s, 2s, 3s, 4s |
| 0.000 | 0.000 | 4.269 | 0.000 | 0.000 | 4.269 | Paved parking | 1s, 4s |
| 0.000 | 0.000 | 0.636 | 0.000 | 0.000 | 0.636 | Roofs | 1s, 4s |
| **0.000** | **0.000** | **11.858** | **0.000** | **0.000** | **11.858** | **TOTAL AREA** | |

Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1s: EX1** Runoff Area=347,870 sf 51.27% Impervious Runoff Depth=1.24"
Flow Length=600' Slope=0.0100 '/' Tc=18.7 min CN=86 Runoff=15.93 cfs 0.828 af

**Subcatchment 2s: EX2** Runoff Area=37,950 sf 0.00% Impervious Runoff Depth=0.61"
Flow Length=248' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=0.88 cfs 0.044 af

**Subcatchment 3s: EX3** Runoff Area=30,680 sf 0.00% Impervious Runoff Depth=0.61"
Flow Length=246' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=0.71 cfs 0.036 af

**Subcatchment 4s: EX4** Runoff Area=100,045 sf 35.28% Impervious Runoff Depth=1.00"
Flow Length=318' Slope=0.0100 '/' Tc=5.0 min CN=82 Runoff=6.05 cfs 0.191 af

**Reach 1R: US 31 DITCH** Inflow=16.80 cfs 0.872 af
Outflow=16.80 cfs 0.872 af

**Reach 2R: EX POND TO WEST** Inflow=6.36 cfs 0.227 af
Outflow=6.36 cfs 0.227 af

**Total Runoff Area = 11.858 ac Runoff Volume = 1.098 af Average Runoff Depth = 1.11"**
**58.64% Pervious = 6.954 ac 41.36% Impervious = 4.905 ac**

## Summary for Subcatchment 1s: EX1

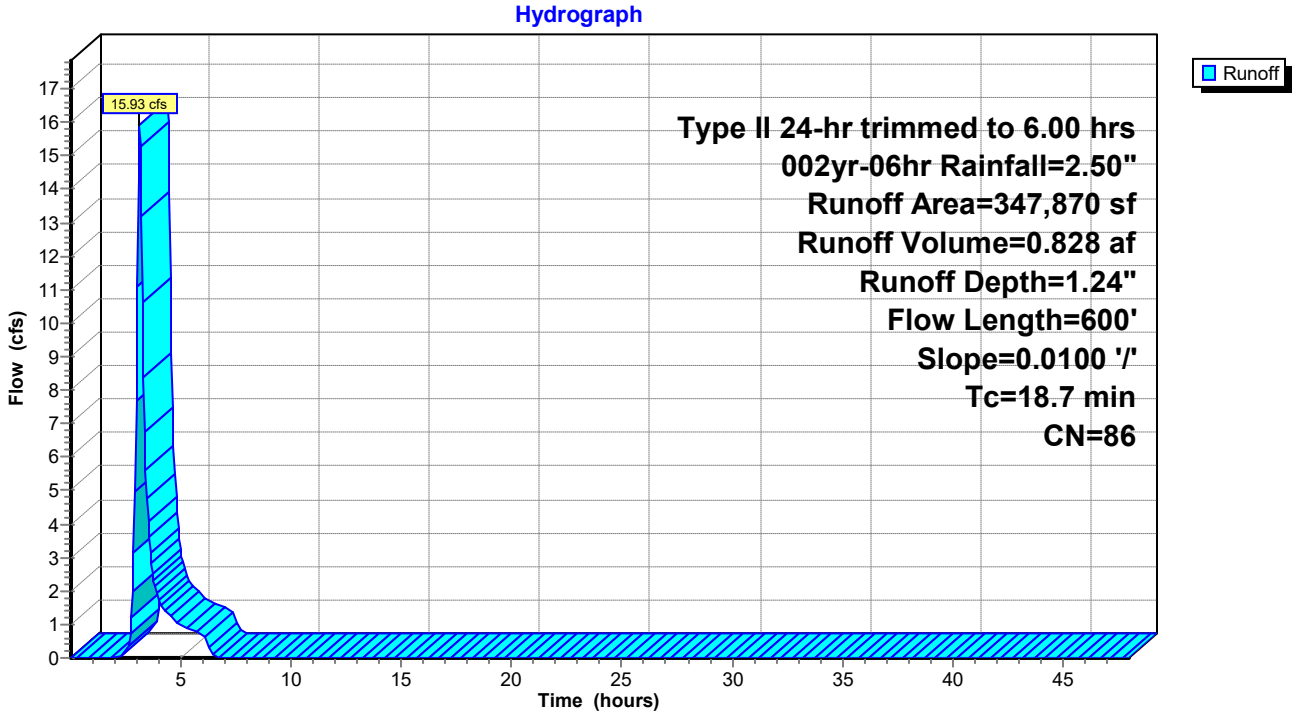
Runoff = 15.93 cfs @ 3.12 hrs, Volume= 0.828 af, Depth= 1.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 002yr-06hr Rainfall=2.50"

| Area (sf) | CN | Description |
|---|---|---|
| 169,520 | 74 | >75% Grass cover, Good, HSG C |
| 158,000 | 98 | Paved parking, HSG C |
| 20,350 | 98 | Roofs, HSG C |
| 347,870 | 86 | Weighted Average |
| 169,520 | | 48.73% Pervious Area |
| 178,350 | | 51.27% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow** n= 0.150 P2= 2.92" |
| 5.2 | 500 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 18.7 | 600 | Total | | | |

## Subcatchment 1s: EX1



## Summary for Subcatchment 2s: EX2

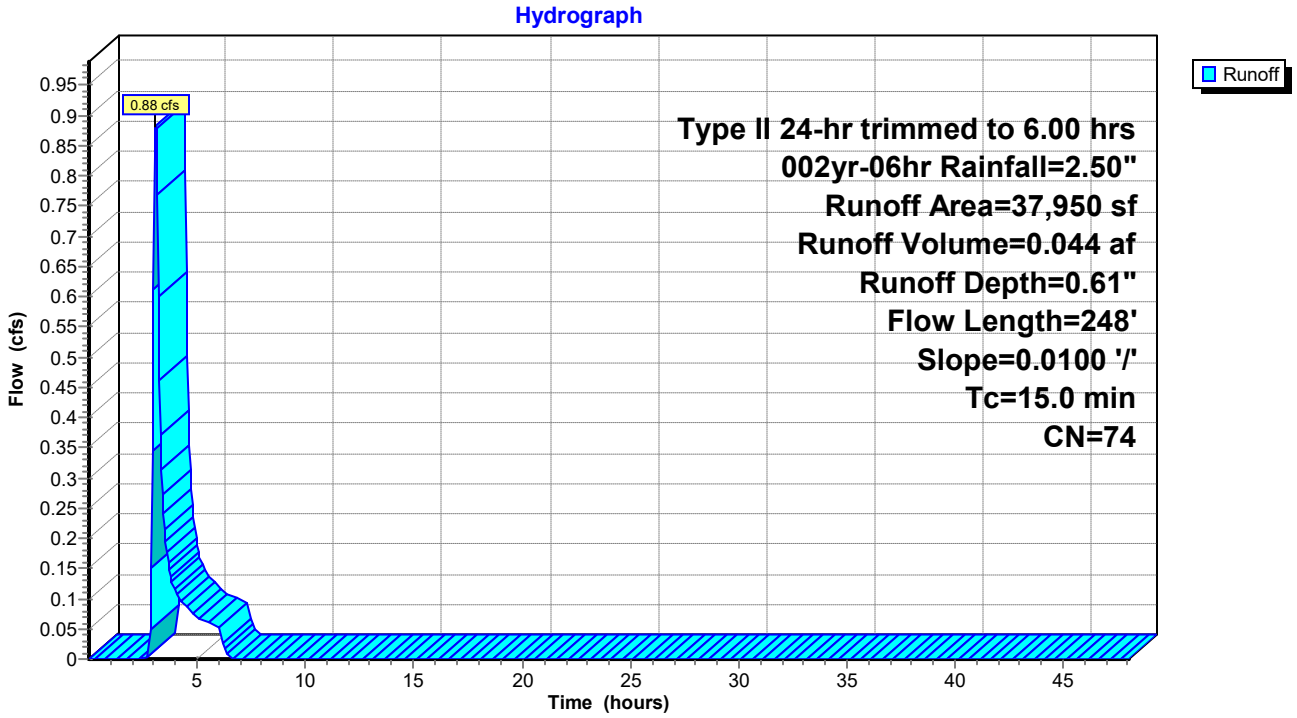
Runoff = 0.88 cfs @ 3.10 hrs, Volume= 0.044 af, Depth= 0.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 002yr-06hr Rainfall=2.50"

| Area (sf) | CN | Description |
|---|---|---|
| 37,950 | 74 | >75% Grass cover, Good, HSG C |
| 37,950 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 148 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 248 | Total | | | |

## Subcatchment 2s: EX2



## Summary for Subcatchment 3s: EX3

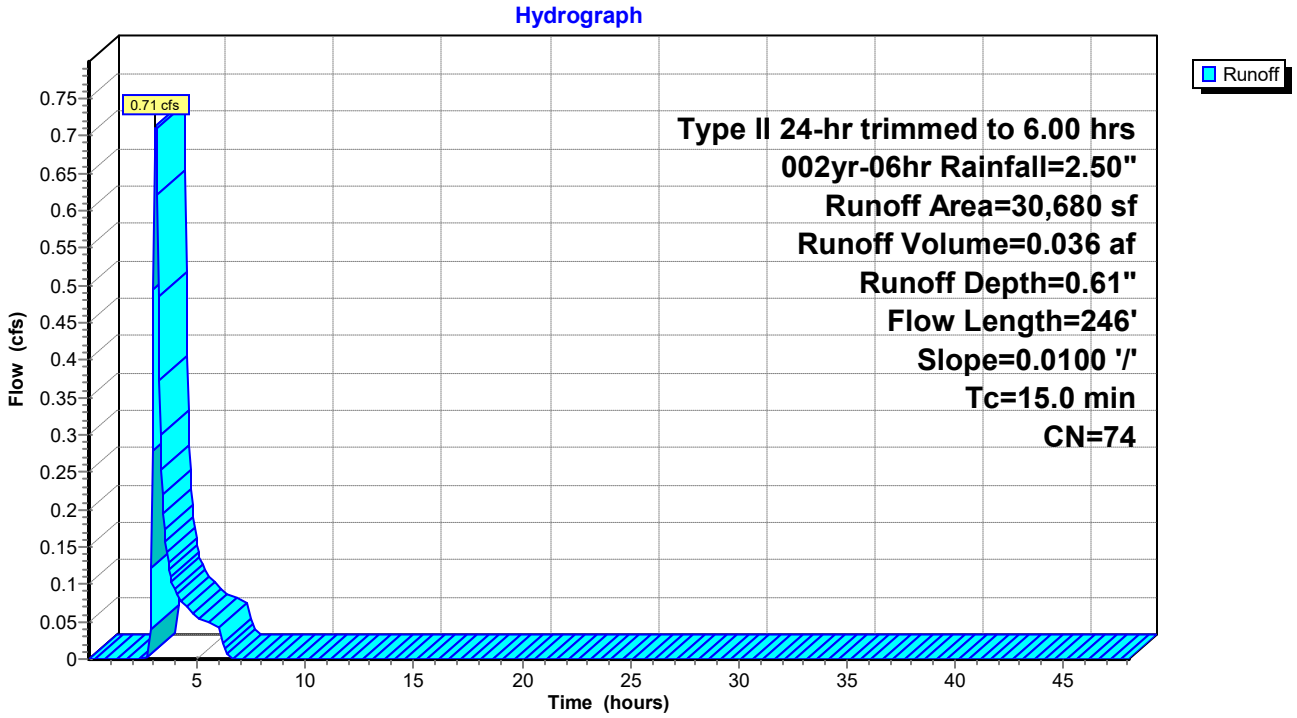
Runoff = 0.71 cfs @ 3.10 hrs, Volume= 0.036 af, Depth= 0.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 002yr-06hr Rainfall=2.50"

| Area (sf) | CN | Description |
|---|---|---|
| 30,680 | 74 | >75% Grass cover, Good, HSG C |
| 30,680 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 146 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 246 | Total | | | |

## Subcatchment 3s: EX3



## Summary for Subcatchment 4s: EX4

[49] Hint: Tc<2dt may require smaller dt

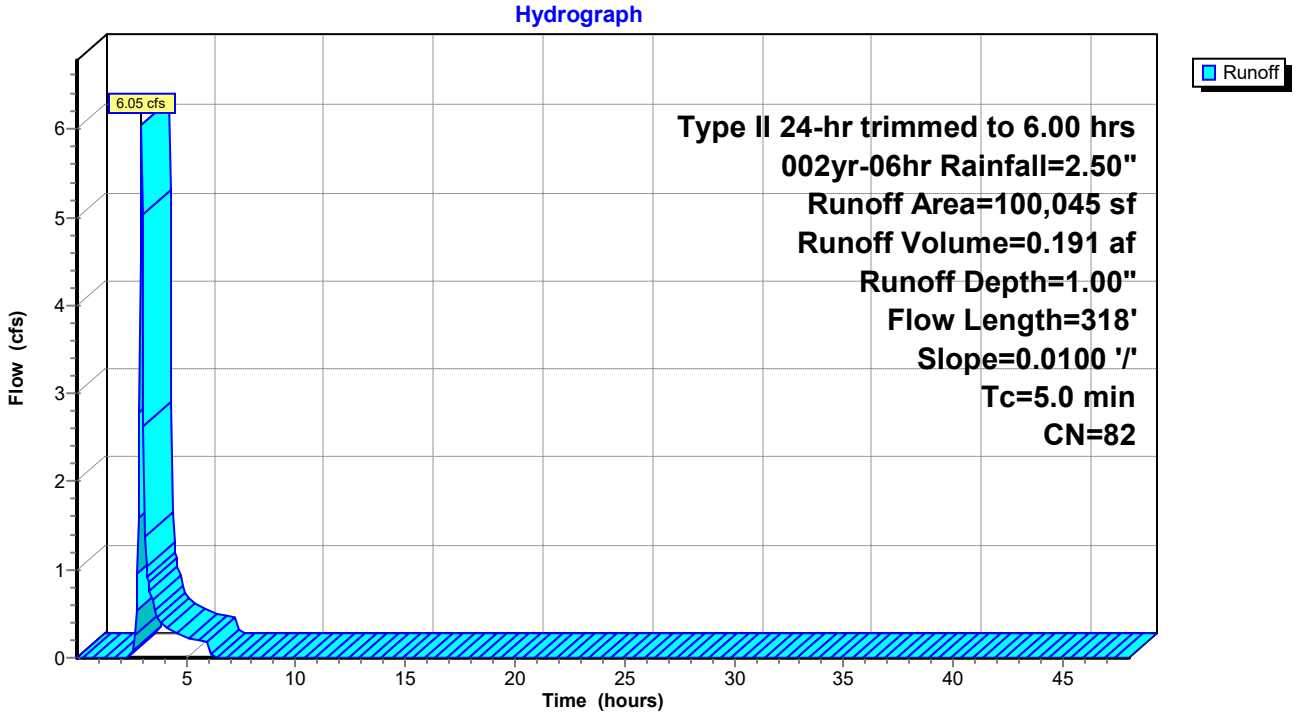
Runoff = 6.05 cfs @ 2.97 hrs, Volume= 0.191 af, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 002yr-06hr Rainfall=2.50"

| Area (sf) | CN | Description |
|---|---|---|
| 64,745 | 74 | >75% Grass cover, Good, HSG C |
| 27,940 | 98 | Paved parking, HSG C |
| 7,360 | 98 | Roofs, HSG C |
| 100,045 | 82 | Weighted Average |
| 64,745 | | 64.72% Pervious Area |
| 35,300 | | 35.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.7 | 100 | 0.0100 | 1.00 | | **Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.92" |
| 2.3 | 218 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 4.0 | 318 | Total, Increased to minimum Tc = 5.0 min | | | |

## Subcatchment 4s: EX4



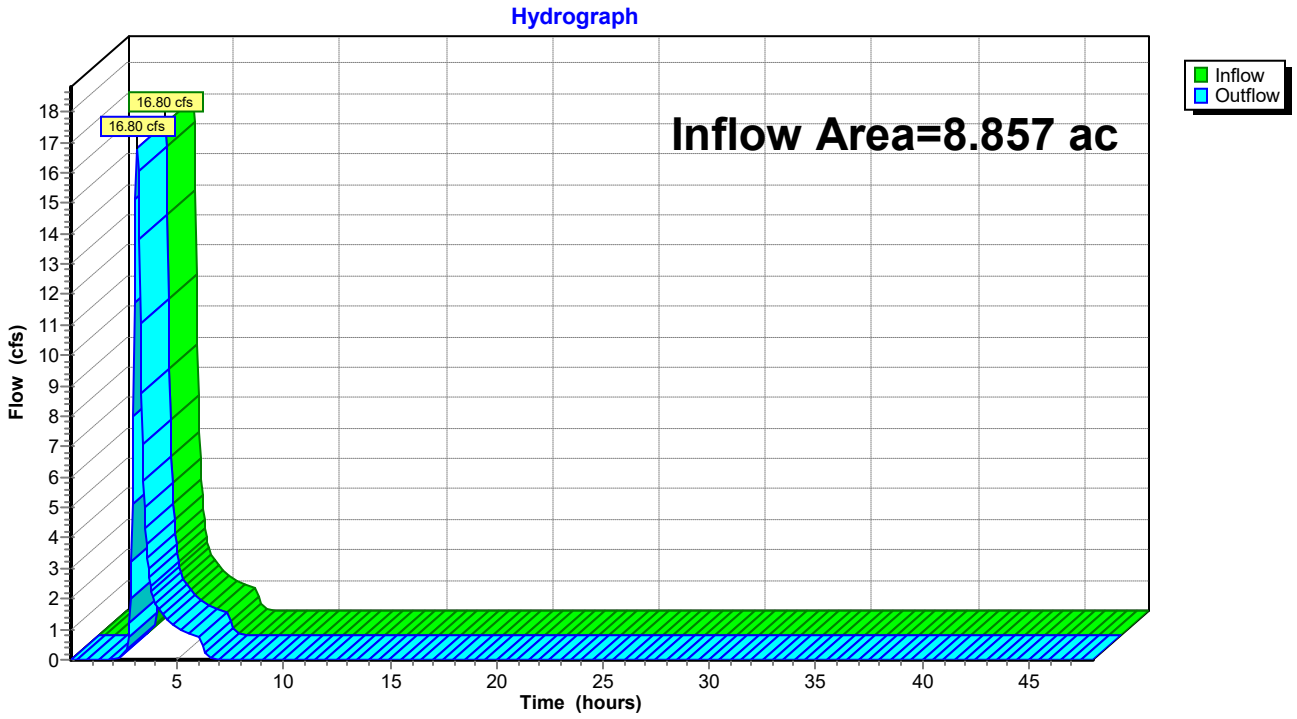
## Summary for Reach 1R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.857 ac, 46.23% Impervious, Inflow Depth = 1.18" for 002yr-06hr event
Inflow = 16.80 cfs @ 3.12 hrs, Volume= 0.872 af
Outflow = 16.80 cfs @ 3.12 hrs, Volume= 0.872 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 1R: US 31 DITCH



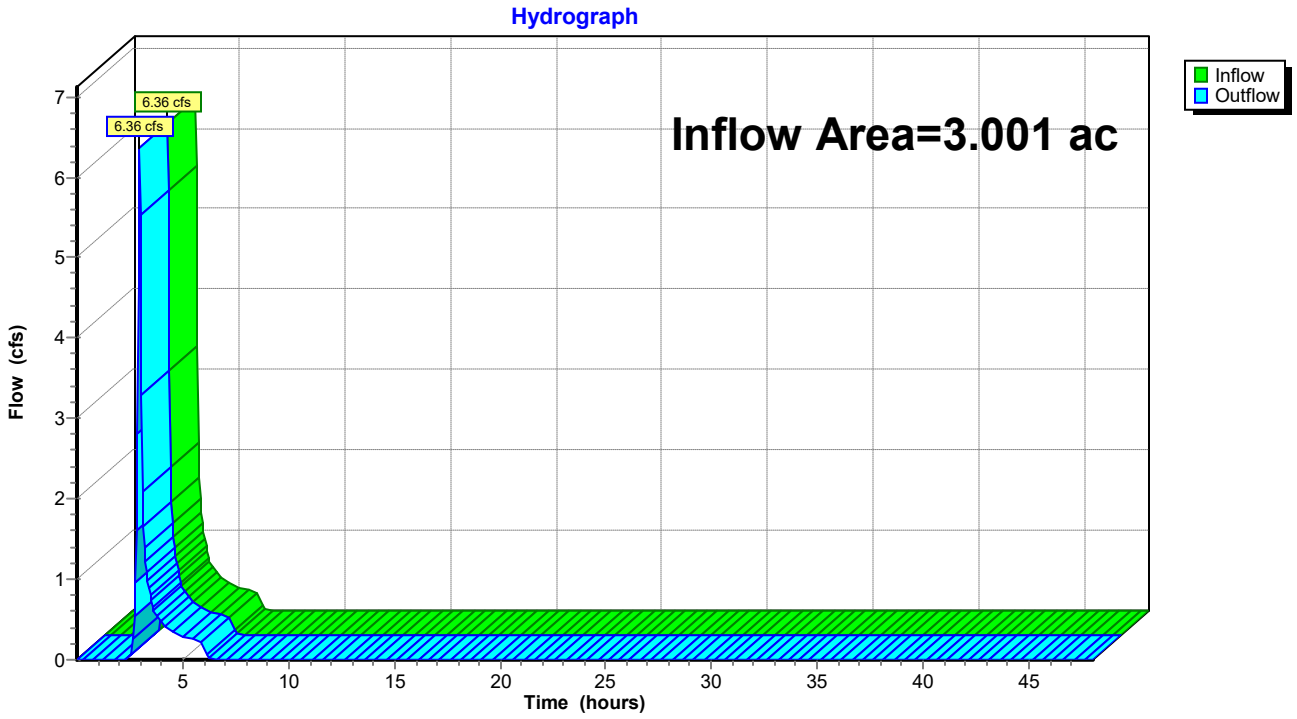
## Summary for Reach 2R: EX POND TO WEST

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.001 ac, 27.00% Impervious, Inflow Depth = 0.91" for 002yr-06hr event
Inflow = 6.36 cfs @ 2.97 hrs, Volume= 0.227 af
Outflow = 6.36 cfs @ 2.97 hrs, Volume= 0.227 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 2R: EX POND TO WEST



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1s: EX1** Runoff Area=347,870 sf 51.27% Impervious Runoff Depth=2.63"
Flow Length=600' Slope=0.0100 '/' Tc=18.7 min CN=86 Runoff=23.99 cfs 1.749 af

**Subcatchment 2s: EX2** Runoff Area=37,950 sf 0.00% Impervious Runoff Depth=1.66"
Flow Length=248' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=1.84 cfs 0.121 af

**Subcatchment 3s: EX3** Runoff Area=30,680 sf 0.00% Impervious Runoff Depth=1.66"
Flow Length=246' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=1.49 cfs 0.098 af

**Subcatchment 4s: EX4** Runoff Area=100,045 sf 35.28% Impervious Runoff Depth=2.28"
Flow Length=318' Slope=0.0100 '/' Tc=5.0 min CN=82 Runoff=9.43 cfs 0.436 af

**Reach 1R: US 31 DITCH** Inflow=25.76 cfs 1.870 af
Outflow=25.76 cfs 1.870 af

**Reach 2R: EX POND TO WEST** Inflow=10.35 cfs 0.534 af
Outflow=10.35 cfs 0.534 af

**Total Runoff Area = 11.858 ac Runoff Volume = 2.404 af Average Runoff Depth = 2.43"**
**58.64% Pervious = 6.954 ac 41.36% Impervious = 4.905 ac**

## Summary for Subcatchment 1s: EX1

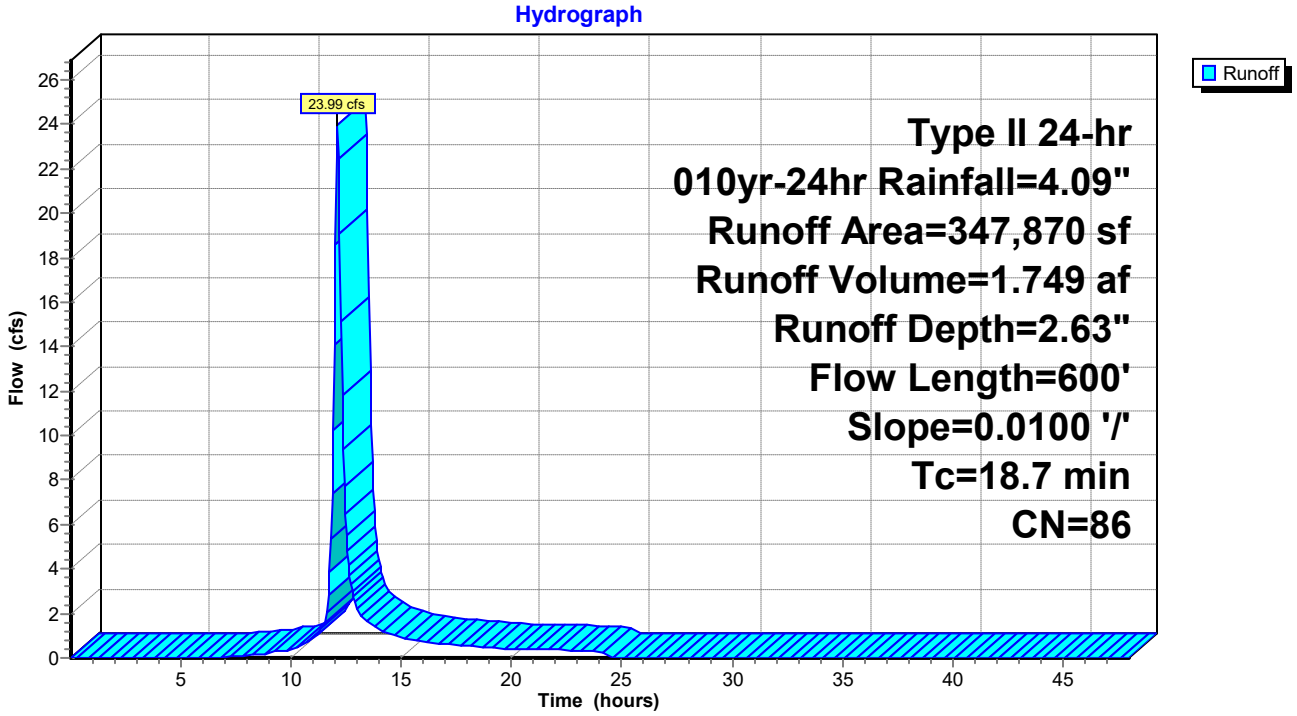
Runoff = 23.99 cfs @ 12.11 hrs, Volume= 1.749 af, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (sf) | CN | Description |
|---|---|---|
| 169,520 | 74 | >75% Grass cover, Good, HSG C |
| 158,000 | 98 | Paved parking, HSG C |
| 20,350 | 98 | Roofs, HSG C |
| 347,870 | 86 | Weighted Average |
| 169,520 | | 48.73% Pervious Area |
| 178,350 | | 51.27% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow** n= 0.150 P2= 2.92" |
| 5.2 | 500 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 18.7 | 600 | Total | | | |

### Subcatchment 1s: EX1



## Summary for Subcatchment 2s: EX2

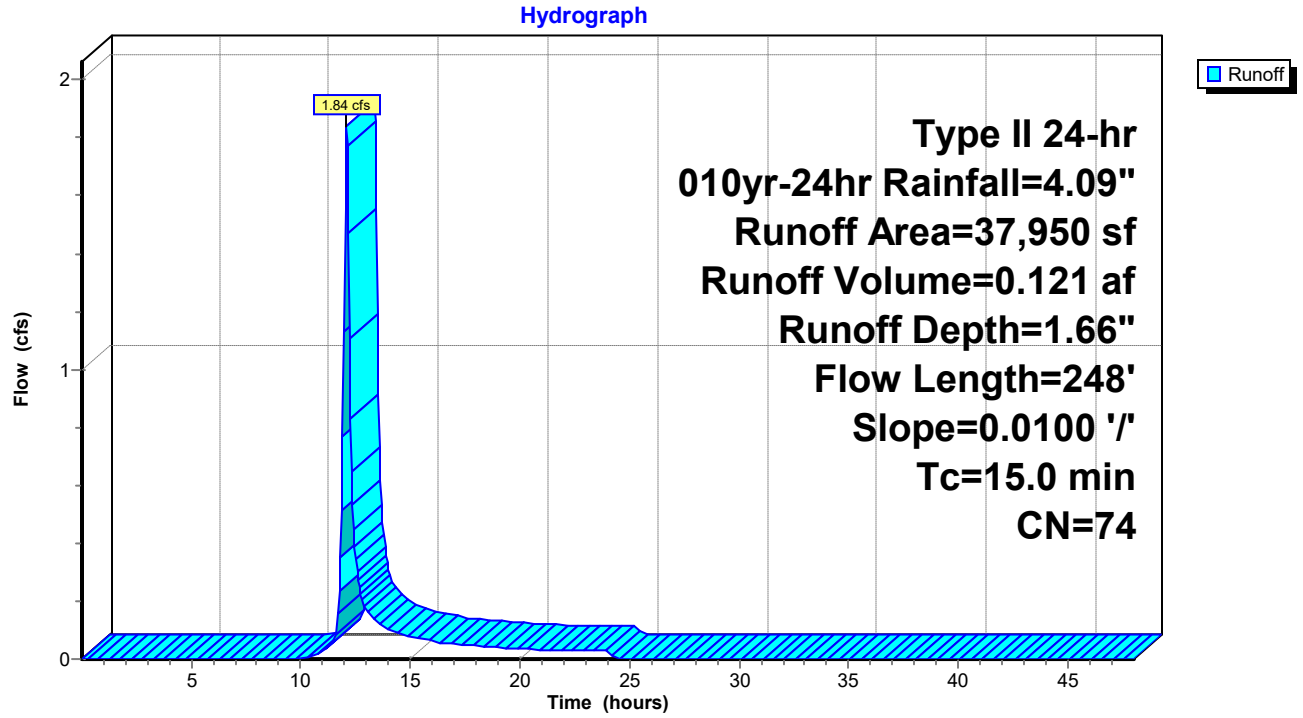
Runoff = 1.84 cfs @ 12.08 hrs, Volume= 0.121 af, Depth= 1.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (sf) | CN | Description |
|---|---|---|
| 37,950 | 74 | >75% Grass cover, Good, HSG C |
| 37,950 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 148 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 248 | Total | | | |

## Subcatchment 2s: EX2



## Summary for Subcatchment 3s: EX3

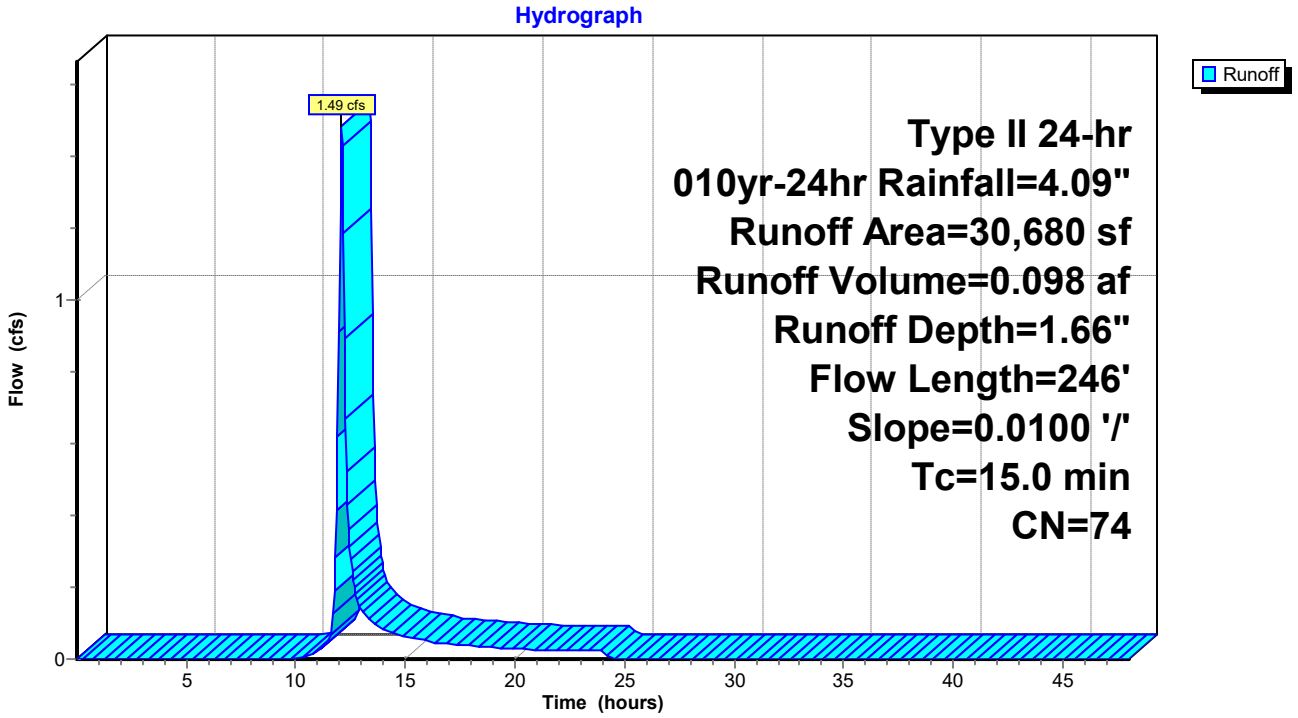
Runoff = 1.49 cfs @ 12.08 hrs, Volume= 0.098 af, Depth= 1.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (sf) | CN | Description |
|---|---|---|
| 30,680 | 74 | >75% Grass cover, Good, HSG C |
| 30,680 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 146 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 246 | Total | | | |

## Subcatchment 3s: EX3



## Summary for Subcatchment 4s: EX4

[49] Hint: Tc<2dt may require smaller dt

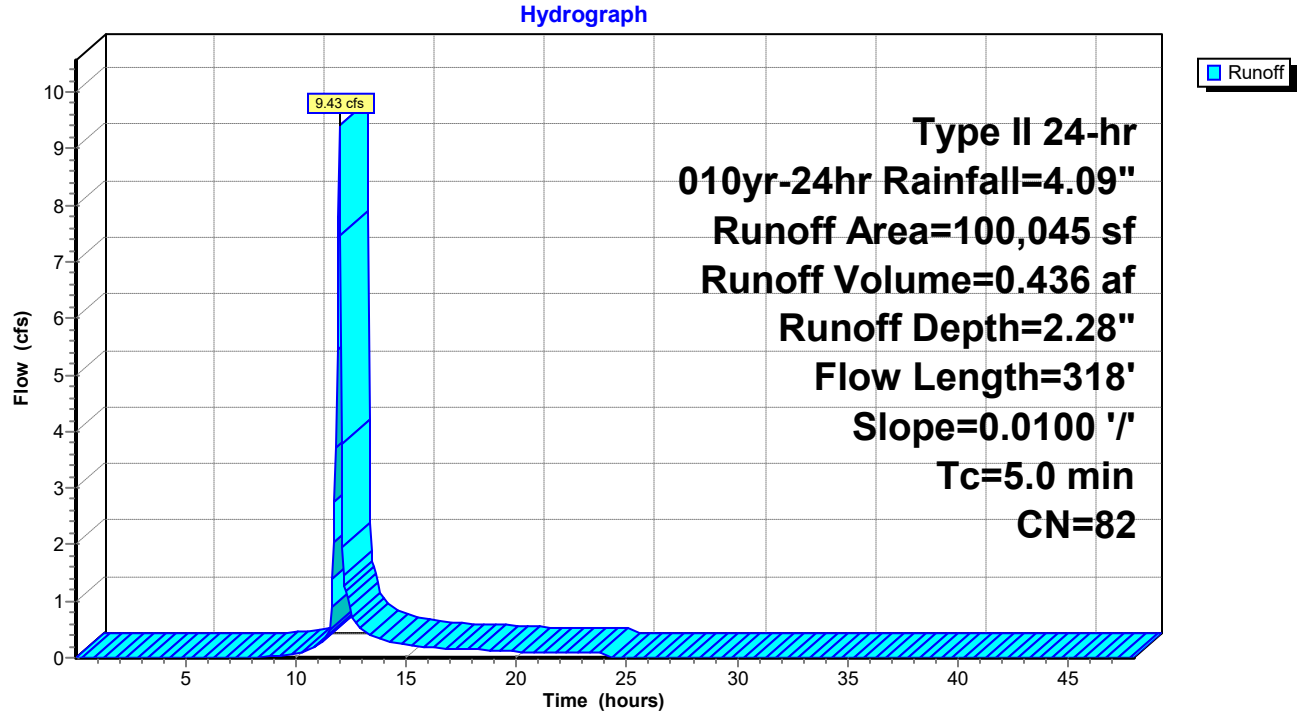
Runoff = 9.43 cfs @ 11.96 hrs, Volume= 0.436 af, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (sf) | CN | Description |
|---|---|---|
| 64,745 | 74 | >75% Grass cover, Good, HSG C |
| 27,940 | 98 | Paved parking, HSG C |
| 7,360 | 98 | Roofs, HSG C |
| 100,045 | 82 | Weighted Average |
| 64,745 | | 64.72% Pervious Area |
| 35,300 | | 35.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.7 | 100 | 0.0100 | 1.00 | | **Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.92" |
| 2.3 | 218 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 4.0 | 318 | Total, Increased to minimum Tc = 5.0 min | | | |

## Subcatchment 4s: EX4



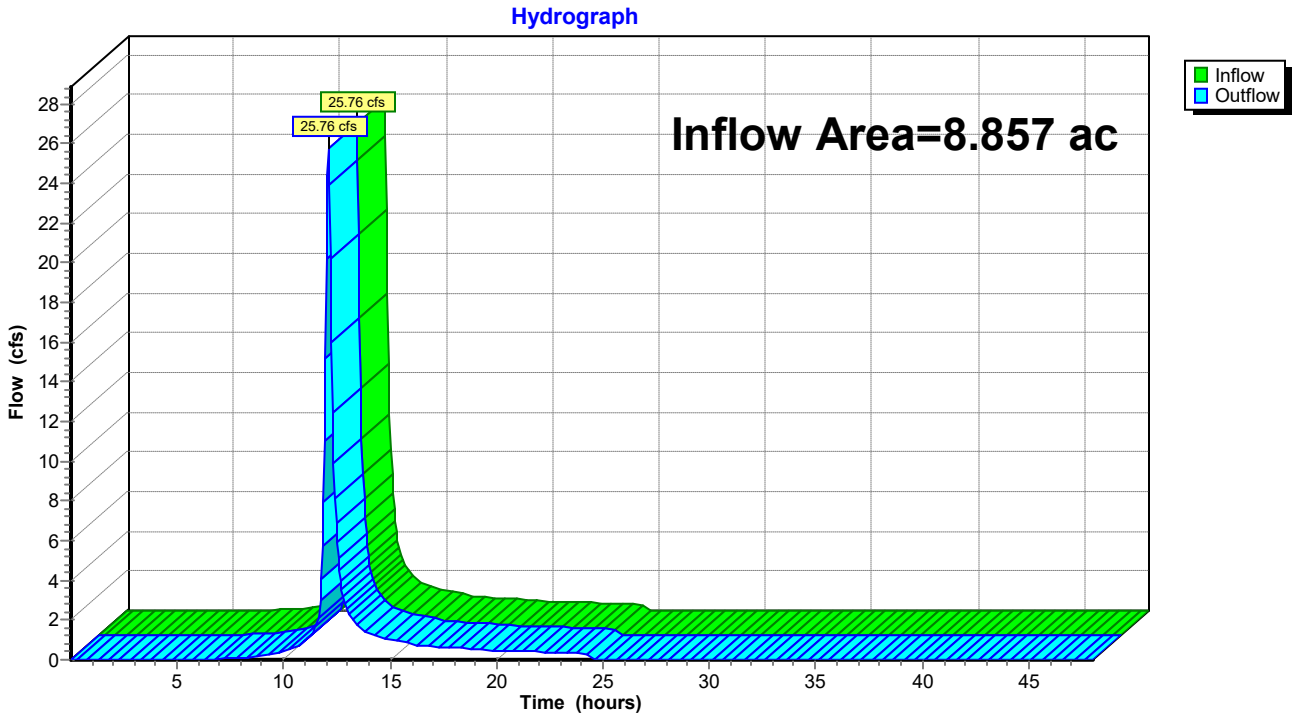
## Summary for Reach 1R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.857 ac, 46.23% Impervious, Inflow Depth = 2.53" for 010yr-24hr event
Inflow = 25.76 cfs @ 12.11 hrs, Volume= 1.870 af
Outflow = 25.76 cfs @ 12.11 hrs, Volume= 1.870 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 1R: US 31 DITCH



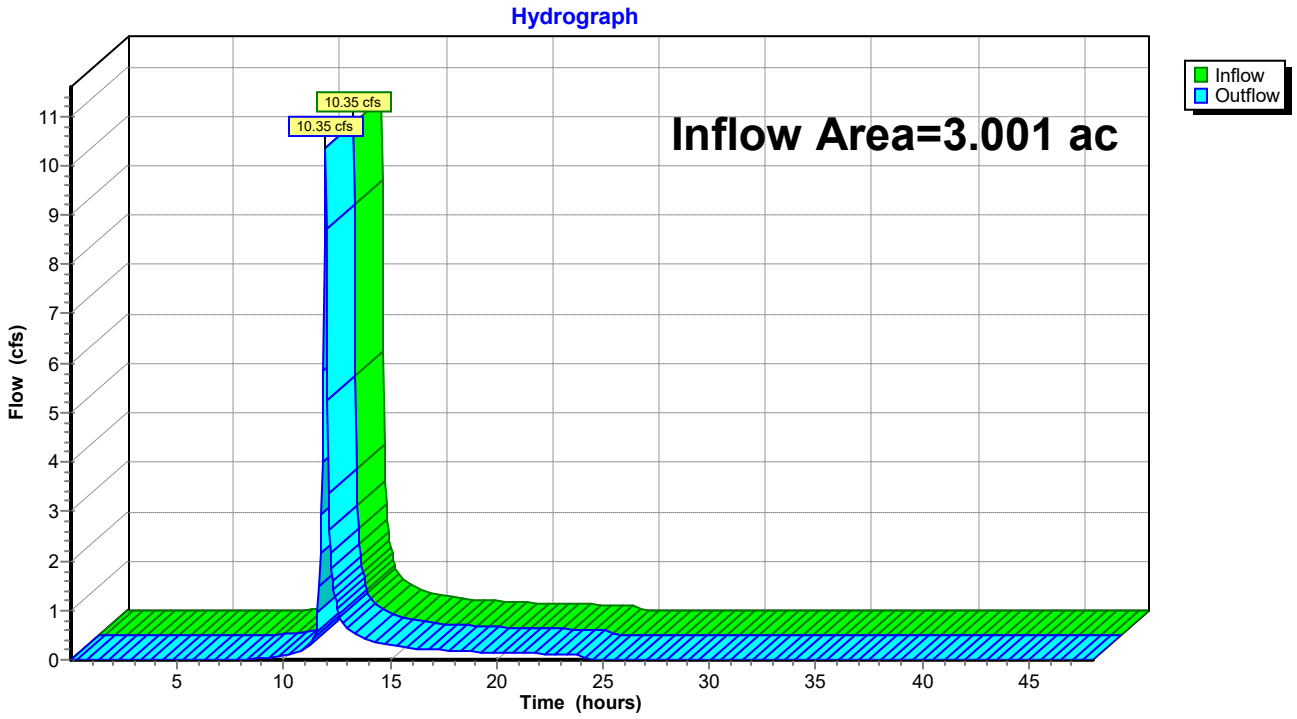
## Summary for Reach 2R: EX POND TO WEST

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.001 ac, 27.00% Impervious, Inflow Depth = 2.14" for 010yr-24hr event
Inflow = 10.35 cfs @ 11.96 hrs, Volume= 0.534 af
Outflow = 10.35 cfs @ 11.96 hrs, Volume= 0.534 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 2R: EX POND TO WEST



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1s: EX1** Runoff Area=347,870 sf 51.27% Impervious Runoff Depth=3.27"
Flow Length=600' Slope=0.0100 '/' Tc=18.7 min CN=86 Runoff=29.68 cfs 2.177 af

**Subcatchment 2s: EX2** Runoff Area=37,950 sf 0.00% Impervious Runoff Depth=2.20"
Flow Length=248' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=2.45 cfs 0.160 af

**Subcatchment 3s: EX3** Runoff Area=30,680 sf 0.00% Impervious Runoff Depth=2.20"
Flow Length=246' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=1.98 cfs 0.129 af

**Subcatchment 4s: EX4** Runoff Area=100,045 sf 35.28% Impervious Runoff Depth=2.89"
Flow Length=318' Slope=0.0100 '/' Tc=5.0 min CN=82 Runoff=11.86 cfs 0.553 af

**Reach 1R: US 31 DITCH** Inflow=32.04 cfs 2.337 af
Outflow=32.04 cfs 2.337 af

**Reach 2R: EX POND TO WEST** Inflow=13.11 cfs 0.683 af
Outflow=13.11 cfs 0.683 af

**Total Runoff Area = 11.858 ac Runoff Volume = 3.019 af Average Runoff Depth = 3.06"**
**58.64% Pervious = 6.954 ac 41.36% Impervious = 4.905 ac**

## Summary for Subcatchment 1s: EX1

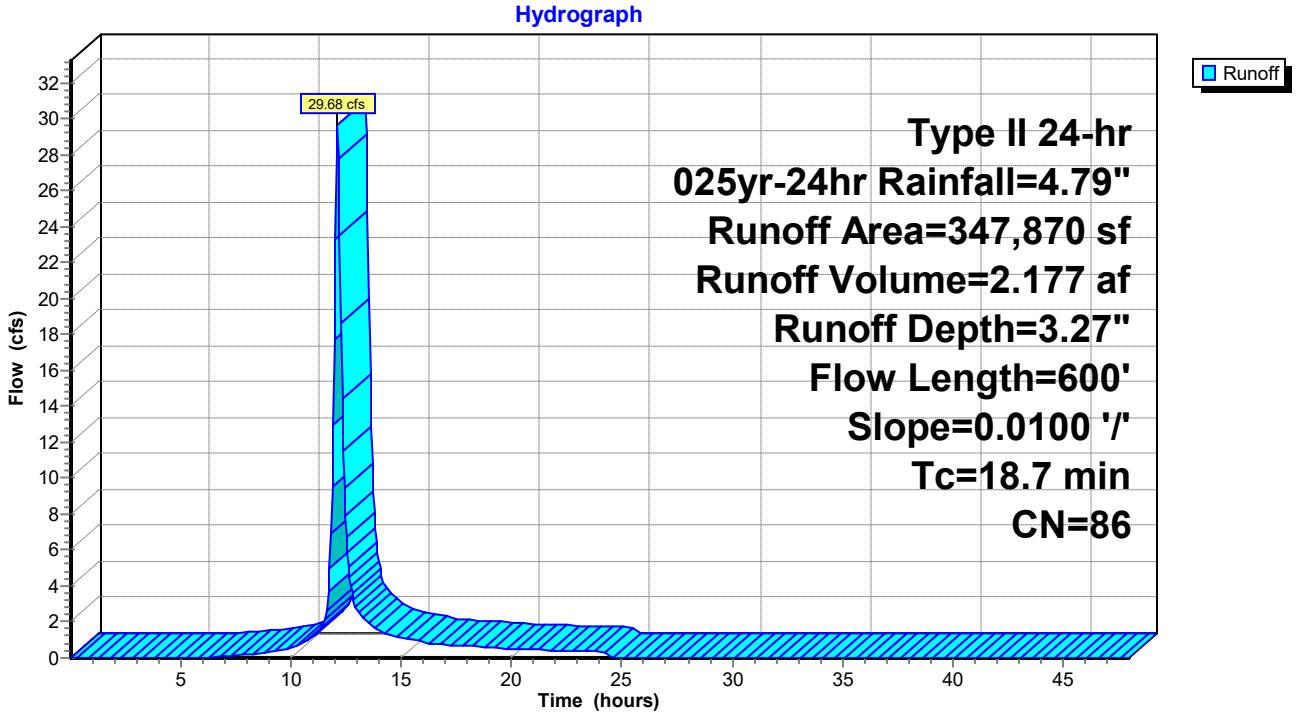
Runoff = 29.68 cfs @ 12.11 hrs, Volume= 2.177 af, Depth= 3.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (sf) | CN | Description |
|---|---|---|
| 169,520 | 74 | >75% Grass cover, Good, HSG C |
| 158,000 | 98 | Paved parking, HSG C |
| 20,350 | 98 | Roofs, HSG C |
| 347,870 | 86 | Weighted Average |
| 169,520 | | 48.73% Pervious Area |
| 178,350 | | 51.27% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow** n= 0.150 P2= 2.92" |
| 5.2 | 500 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 18.7 | 600 | Total | | | |

### Subcatchment 1s: EX1



## Summary for Subcatchment 2s: EX2

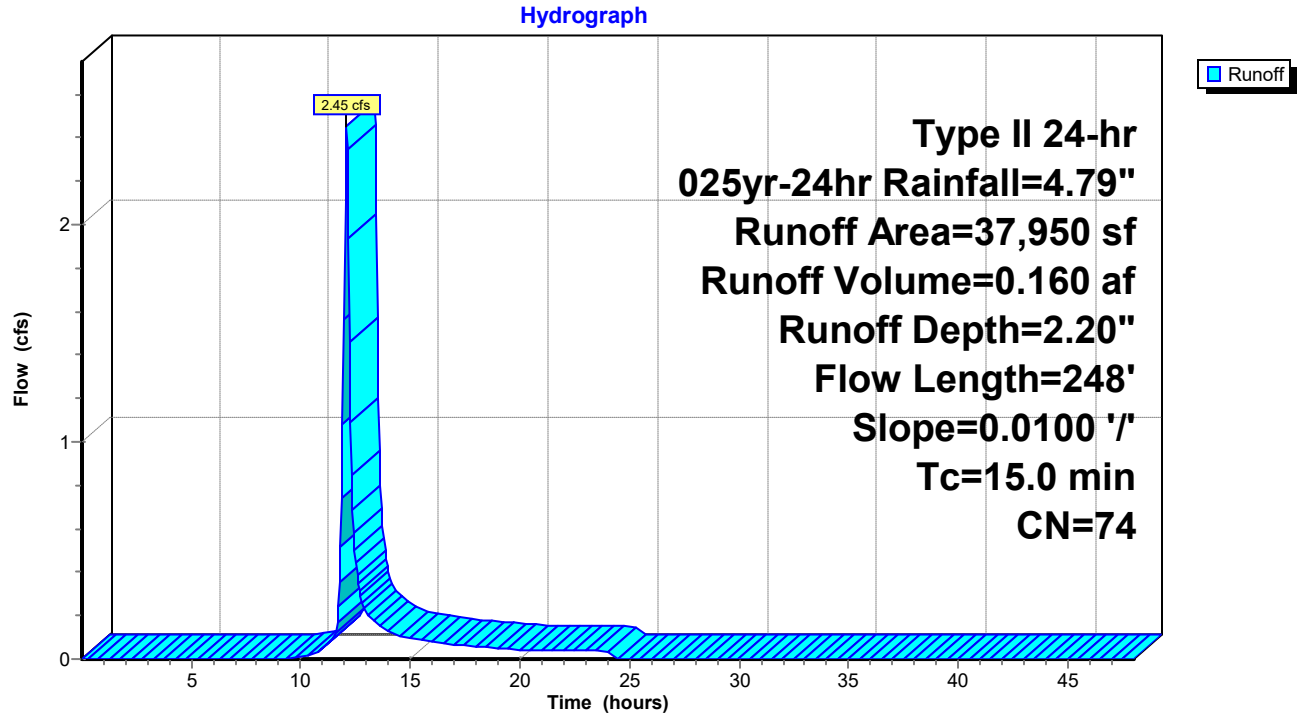
Runoff = 2.45 cfs @ 12.07 hrs, Volume= 0.160 af, Depth= 2.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (sf) | CN | Description |
|---|---|---|
| 37,950 | 74 | >75% Grass cover, Good, HSG C |
| 37,950 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 148 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 248 | Total | | | |

### Subcatchment 2s: EX2



## Summary for Subcatchment 3s: EX3

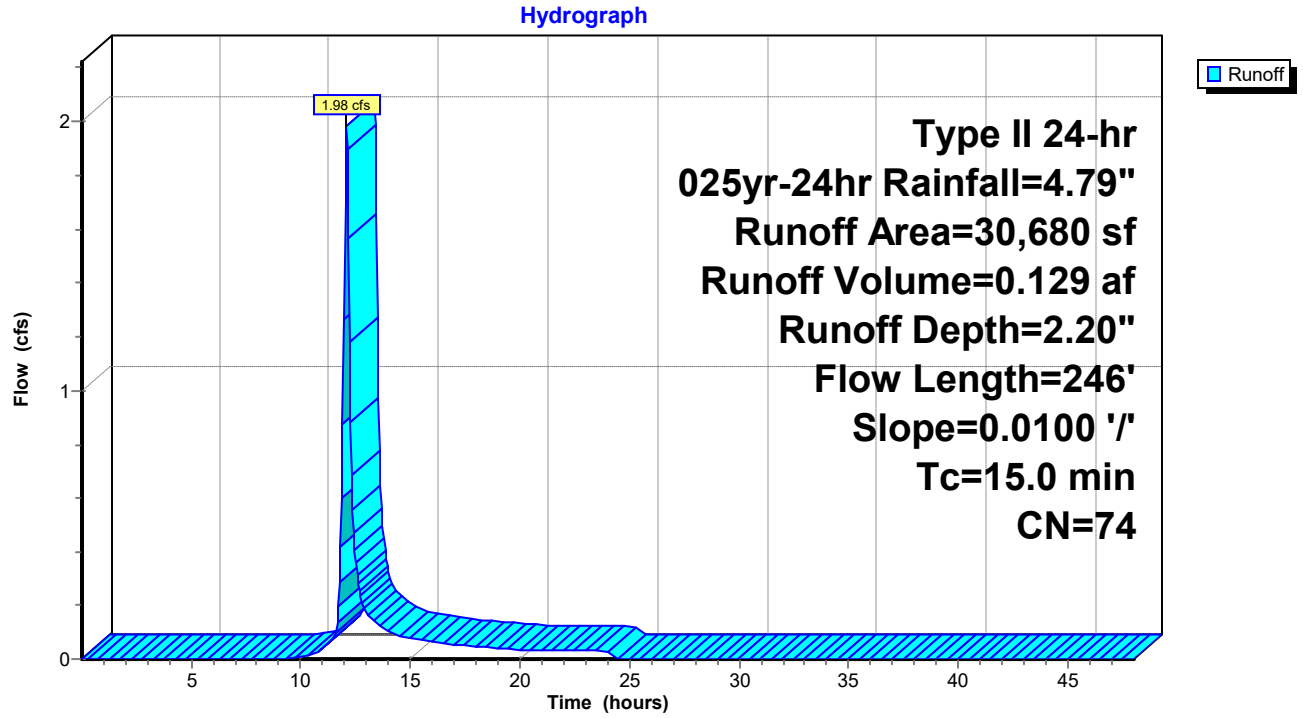
Runoff = 1.98 cfs @ 12.07 hrs, Volume= 0.129 af, Depth= 2.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (sf) | CN | Description |
|---|---|---|
| 30,680 | 74 | >75% Grass cover, Good, HSG C |
| 30,680 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 146 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 246 | Total | | | |

## Subcatchment 3s: EX3



## Summary for Subcatchment 4s: EX4

[49] Hint: Tc<2dt may require smaller dt

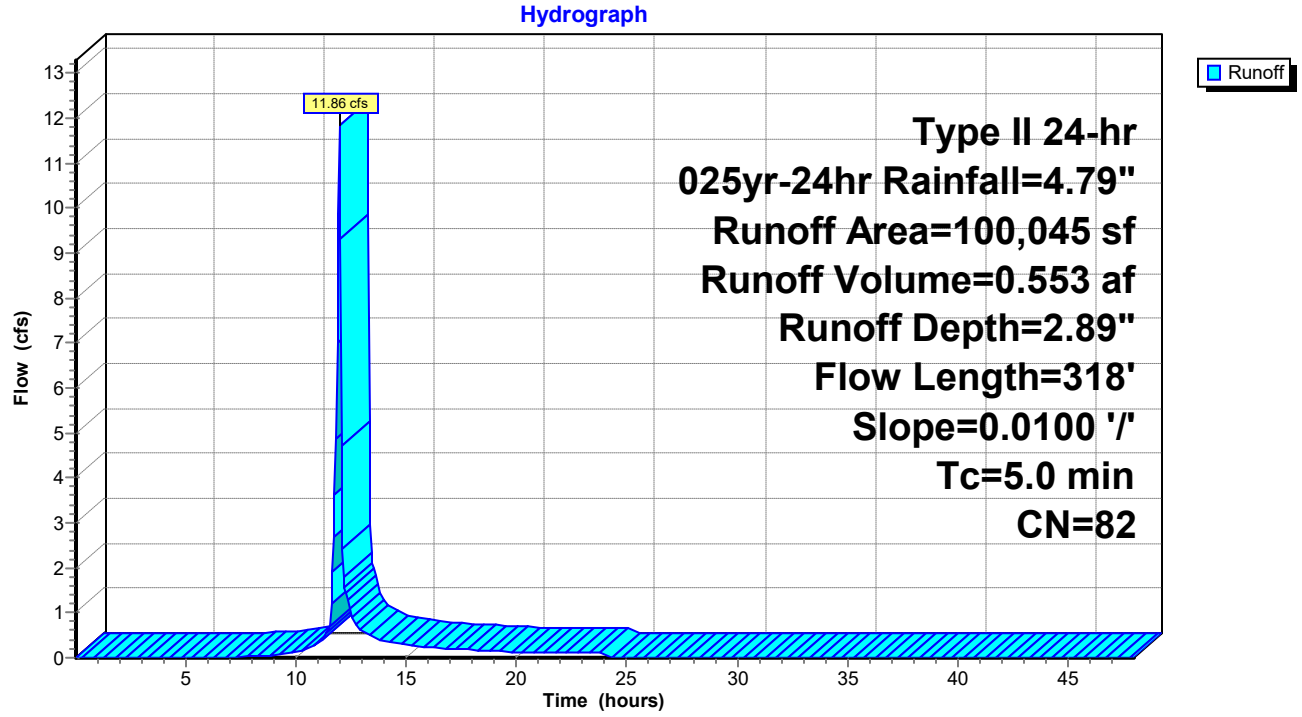
Runoff = 11.86 cfs @ 11.96 hrs, Volume= 0.553 af, Depth= 2.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (sf) | CN | Description |
|---|---|---|
| 64,745 | 74 | >75% Grass cover, Good, HSG C |
| 27,940 | 98 | Paved parking, HSG C |
| 7,360 | 98 | Roofs, HSG C |
| 100,045 | 82 | Weighted Average |
| 64,745 | | 64.72% Pervious Area |
| 35,300 | | 35.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.7 | 100 | 0.0100 | 1.00 | | **Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.92" |
| 2.3 | 218 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 4.0 | 318 | Total, Increased to minimum Tc = 5.0 min | | | |

### Subcatchment 4s: EX4



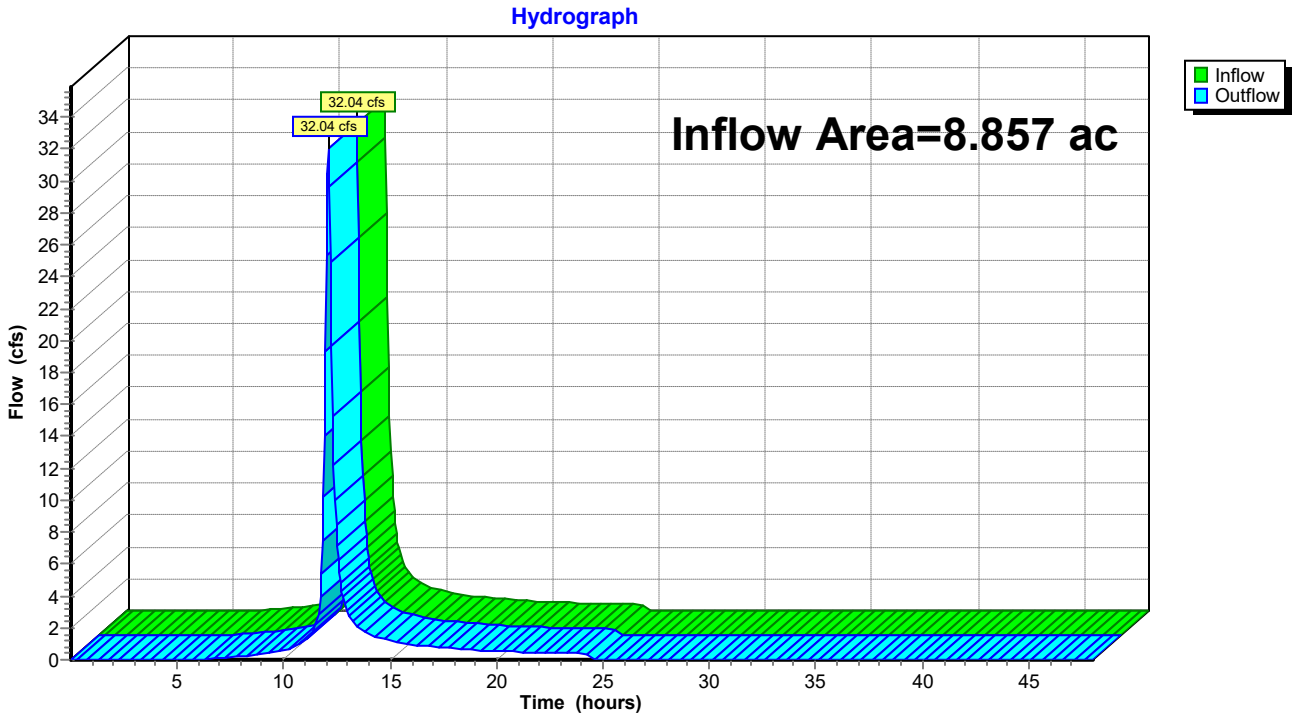
## Summary for Reach 1R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.857 ac, 46.23% Impervious, Inflow Depth = 3.17" for 025yr-24hr event
Inflow = 32.04 cfs @ 12.11 hrs, Volume= 2.337 af
Outflow = 32.04 cfs @ 12.11 hrs, Volume= 2.337 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 1R: US 31 DITCH



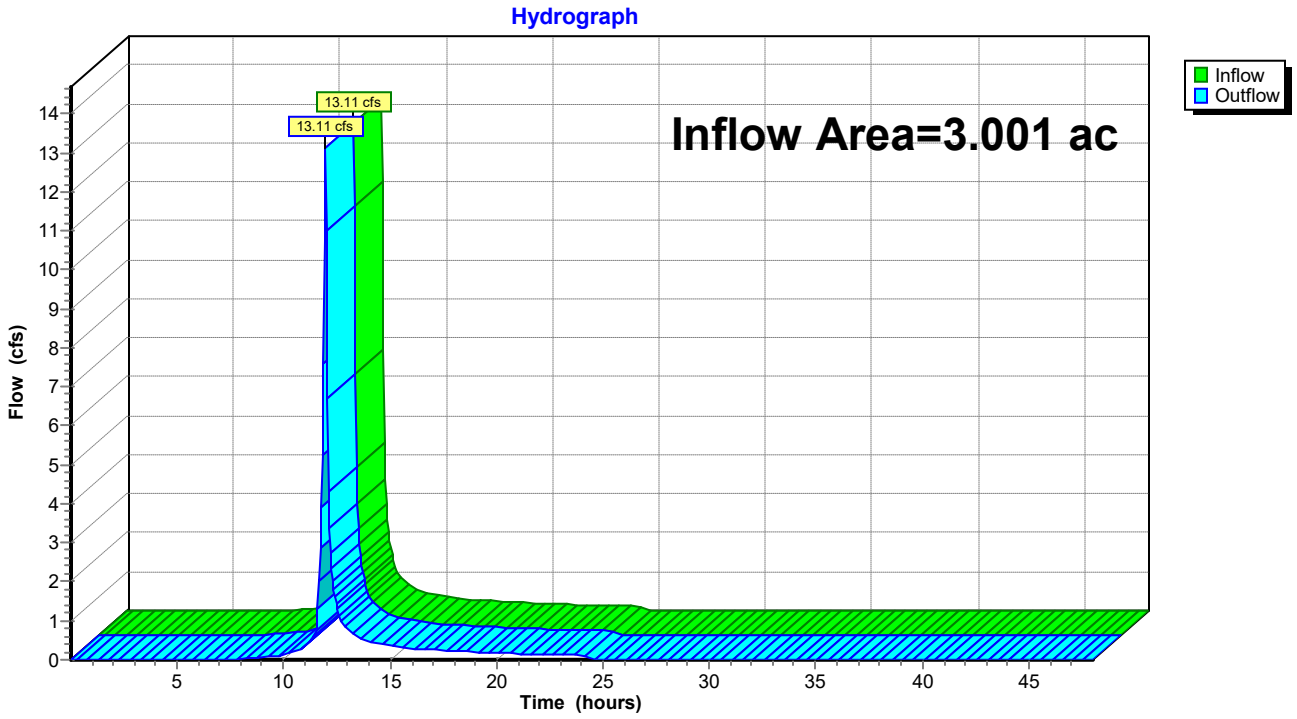
## Summary for Reach 2R: EX POND TO WEST

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.001 ac, 27.00% Impervious, Inflow Depth = 2.73" for 025yr-24hr event
Inflow = 13.11 cfs @ 11.96 hrs, Volume= 0.683 af
Outflow = 13.11 cfs @ 11.96 hrs, Volume= 0.683 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 2R: EX POND TO WEST



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1s: EX1** Runoff Area=347,870 sf 51.27% Impervious Runoff Depth=3.26"
Flow Length=600' Slope=0.0100 '/' Tc=18.7 min CN=86 Runoff=35.06 cfs 2.171 af

**Subcatchment 2s: EX2** Runoff Area=37,950 sf 0.00% Impervious Runoff Depth=2.19"
Flow Length=248' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=2.90 cfs 0.159 af

**Subcatchment 3s: EX3** Runoff Area=30,680 sf 0.00% Impervious Runoff Depth=2.19"
Flow Length=246' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=2.35 cfs 0.129 af

**Subcatchment 4s: EX4** Runoff Area=100,045 sf 35.28% Impervious Runoff Depth=2.88"
Flow Length=318' Slope=0.0100 '/' Tc=5.0 min CN=82 Runoff=14.12 cfs 0.552 af

**Reach 1R: US 31 DITCH** Inflow=37.85 cfs 2.330 af
Outflow=37.85 cfs 2.330 af

**Reach 2R: EX POND TO WEST** Inflow=15.55 cfs 0.680 af
Outflow=15.55 cfs 0.680 af

**Total Runoff Area = 11.858 ac Runoff Volume = 3.010 af Average Runoff Depth = 3.05"**
**58.64% Pervious = 6.954 ac 41.36% Impervious = 4.905 ac**

## Summary for Subcatchment 1s: EX1

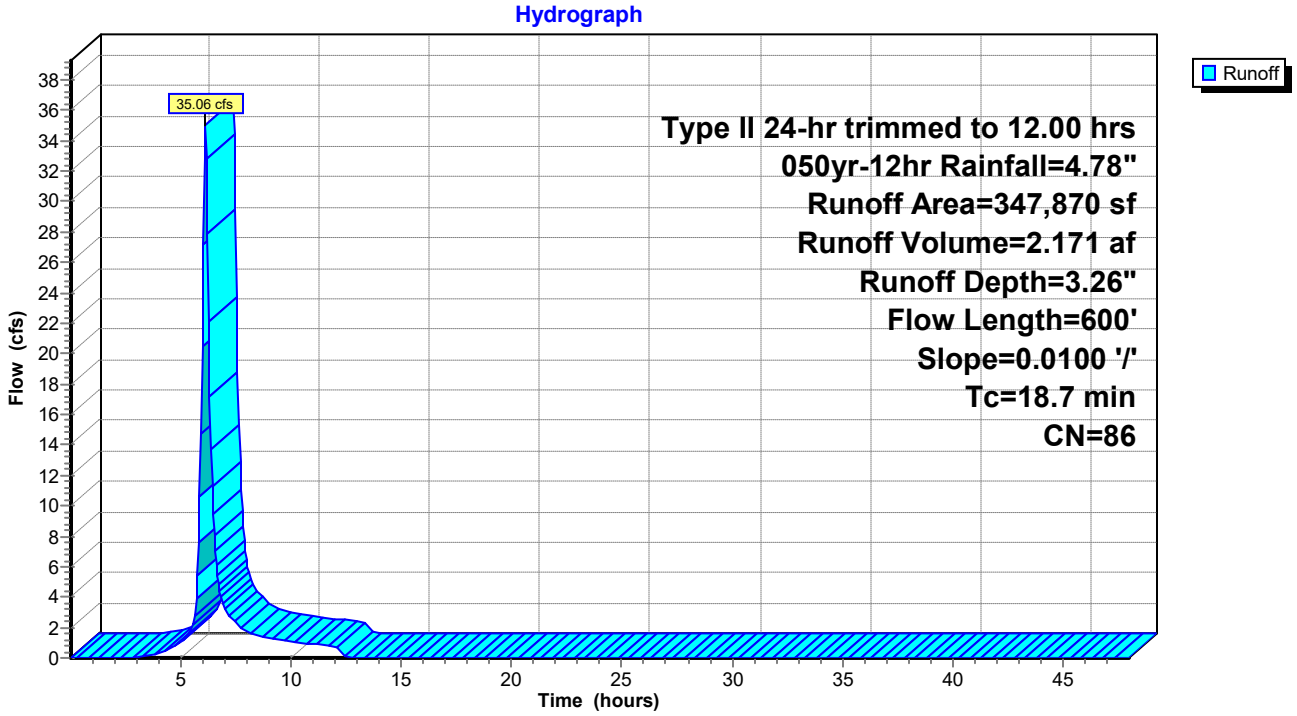
Runoff = 35.06 cfs @ 6.11 hrs, Volume= 2.171 af, Depth= 3.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (sf) | CN | Description |
|---|---|---|
| 169,520 | 74 | >75% Grass cover, Good, HSG C |
| 158,000 | 98 | Paved parking, HSG C |
| 20,350 | 98 | Roofs, HSG C |
| 347,870 | 86 | Weighted Average |
| 169,520 | | 48.73% Pervious Area |
| 178,350 | | 51.27% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow** n= 0.150 P2= 2.92" |
| 5.2 | 500 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 18.7 | 600 | Total | | | |

## Subcatchment 1s: EX1



## Summary for Subcatchment 2s: EX2

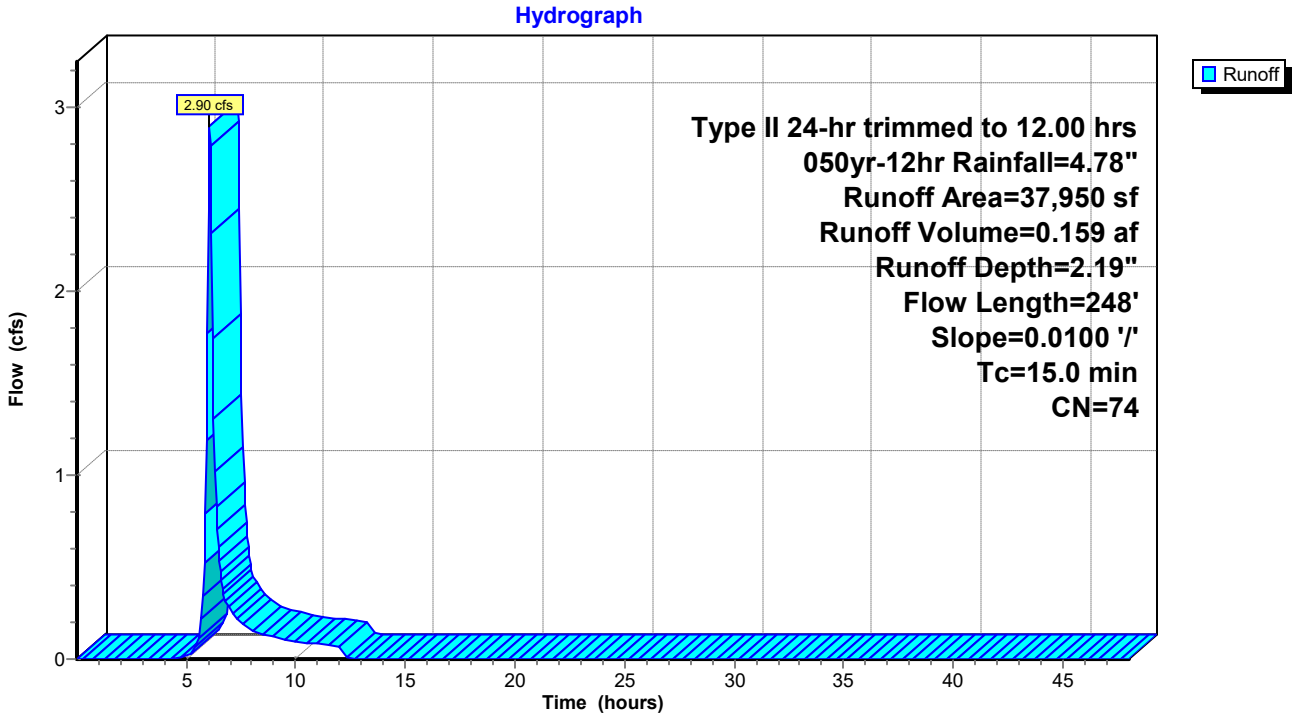
Runoff = 2.90 cfs @ 6.08 hrs, Volume= 0.159 af, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (sf) | CN | Description |
|---|---|---|
| 37,950 | 74 | >75% Grass cover, Good, HSG C |
| 37,950 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 148 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 248 | Total | | | |

## Subcatchment 2s: EX2



## Summary for Subcatchment 3s: EX3

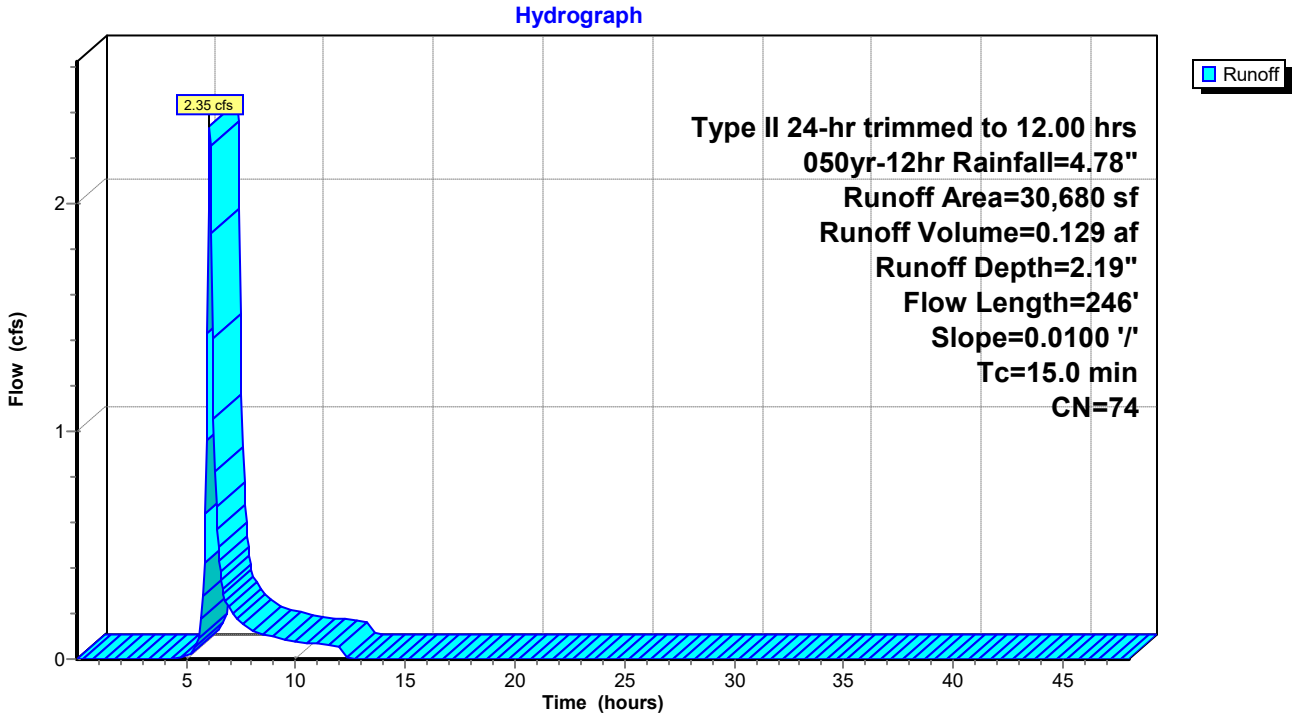
Runoff = 2.35 cfs @ 6.08 hrs, Volume= 0.129 af, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (sf) | CN | Description |
|---|---|---|
| 30,680 | 74 | >75% Grass cover, Good, HSG C |
| 30,680 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 146 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 246 | Total | | | |

## Subcatchment 3s: EX3



## Summary for Subcatchment 4s: EX4

[49] Hint: Tc<2dt may require smaller dt

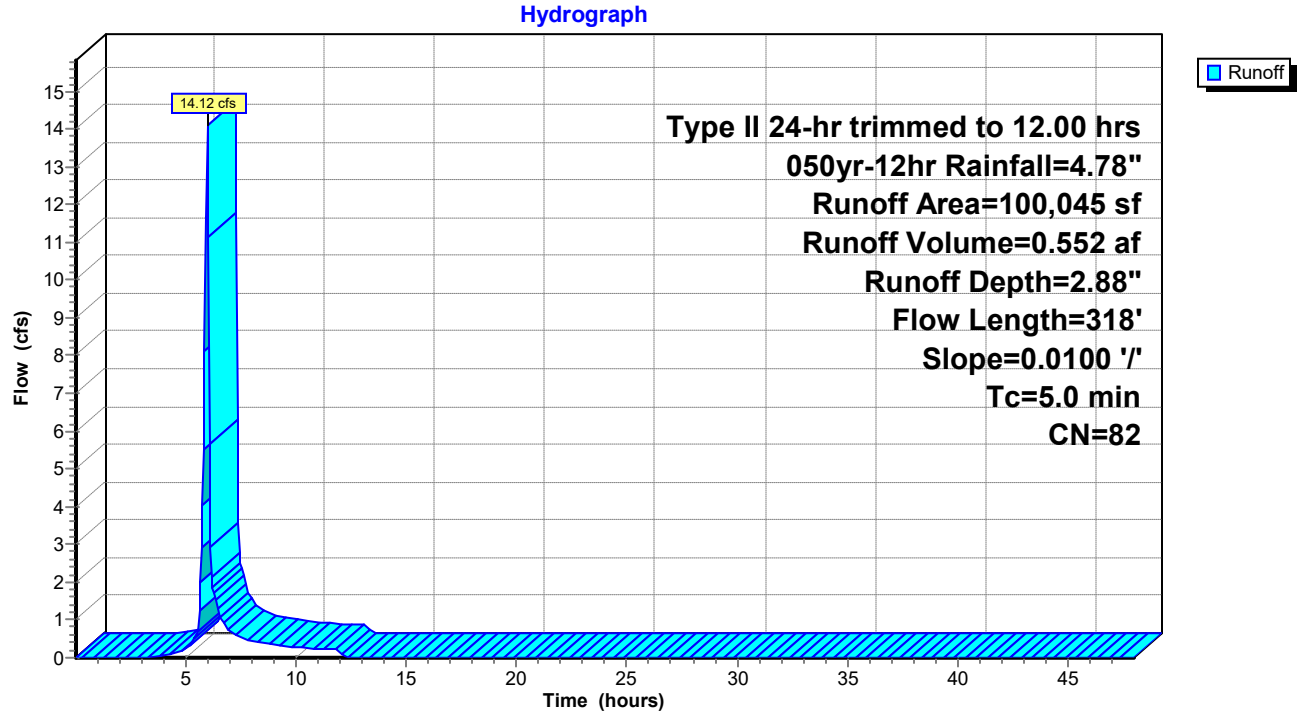
Runoff = 14.12 cfs @ 5.96 hrs, Volume= 0.552 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (sf) | CN | Description |
|---|---|---|
| 64,745 | 74 | >75% Grass cover, Good, HSG C |
| 27,940 | 98 | Paved parking, HSG C |
| 7,360 | 98 | Roofs, HSG C |
| 100,045 | 82 | Weighted Average |
| 64,745 | | 64.72% Pervious Area |
| 35,300 | | 35.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.7 | 100 | 0.0100 | 1.00 | | **Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.92" |
| 2.3 | 218 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 4.0 | 318 | Total, Increased to minimum Tc = 5.0 min | | | |

## Subcatchment 4s: EX4



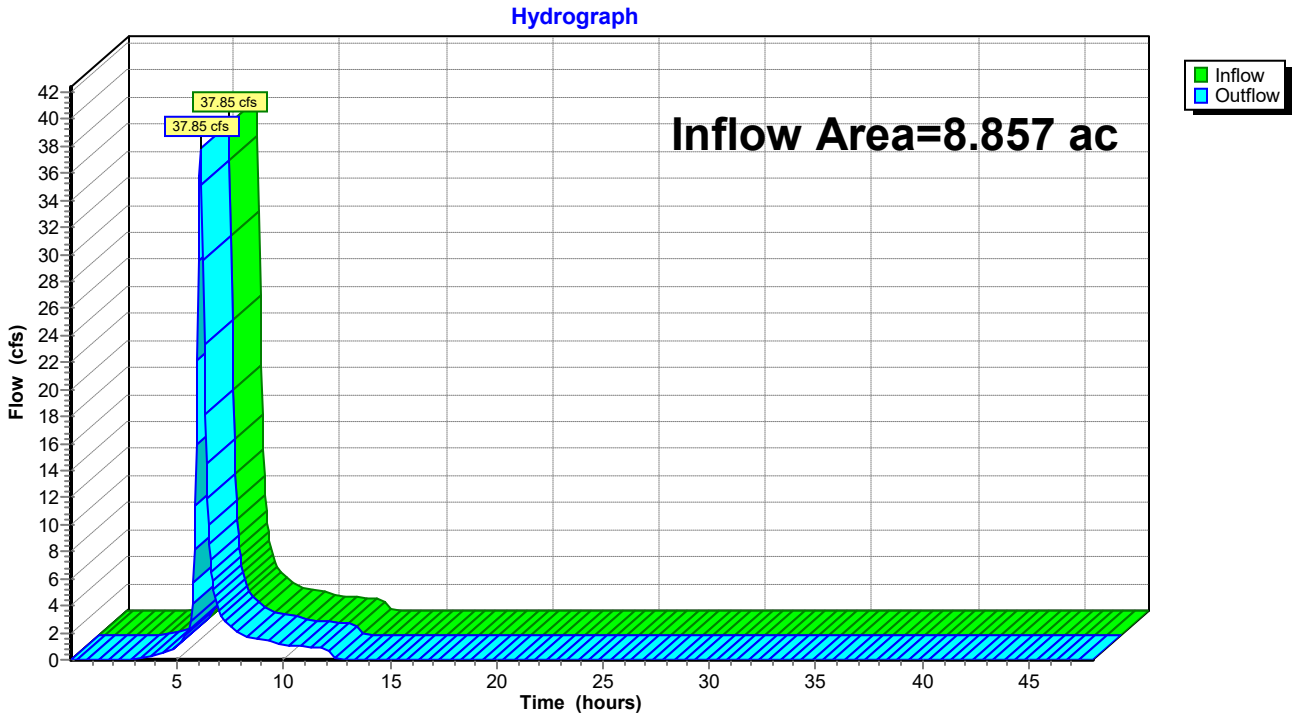
## Summary for Reach 1R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.857 ac, 46.23% Impervious, Inflow Depth = 3.16" for 050yr-12hr event
Inflow = 37.85 cfs @ 6.11 hrs, Volume= 2.330 af
Outflow = 37.85 cfs @ 6.11 hrs, Volume= 2.330 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 1R: US 31 DITCH



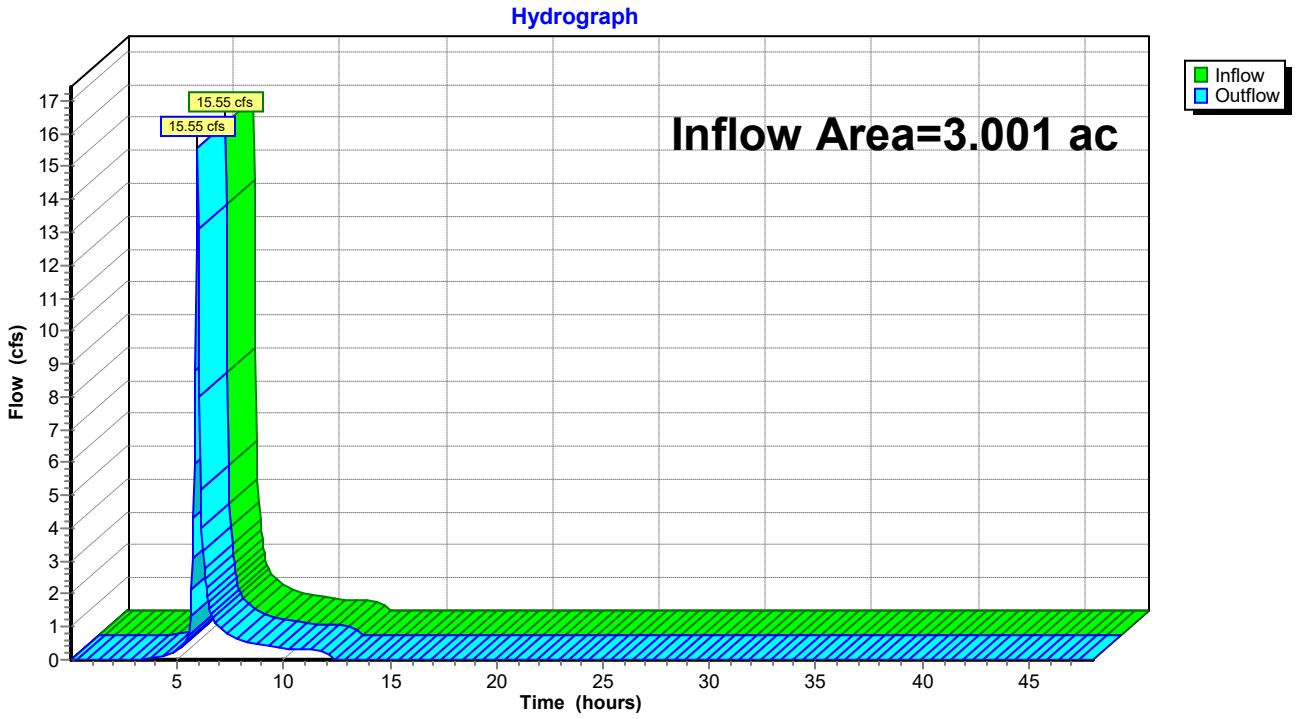
## Summary for Reach 2R: EX POND TO WEST

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.001 ac, 27.00% Impervious, Inflow Depth = 2.72" for 050yr-12hr event
Inflow = 15.55 cfs @ 5.96 hrs, Volume= 0.680 af
Outflow = 15.55 cfs @ 5.96 hrs, Volume= 0.680 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 2R: EX POND TO WEST



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1s: EX1** Runoff Area=347,870 sf 51.27% Impervious Runoff Depth=3.25"
Flow Length=600' Slope=0.0100 '/' Tc=18.7 min CN=86 Runoff=41.34 cfs 2.165 af

**Subcatchment 2s: EX2** Runoff Area=37,950 sf 0.00% Impervious Runoff Depth=2.18"
Flow Length=248' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=3.43 cfs 0.158 af

**Subcatchment 3s: EX3** Runoff Area=30,680 sf 0.00% Impervious Runoff Depth=2.18"
Flow Length=246' Slope=0.0100 '/' Tc=15.0 min CN=74 Runoff=2.77 cfs 0.128 af

**Subcatchment 4s: EX4** Runoff Area=100,045 sf 35.28% Impervious Runoff Depth=2.87"
Flow Length=318' Slope=0.0100 '/' Tc=5.0 min CN=82 Runoff=16.85 cfs 0.550 af

**Reach 1R: US 31 DITCH** Inflow=44.66 cfs 2.323 af
Outflow=44.66 cfs 2.323 af

**Reach 2R: EX POND TO WEST** Inflow=18.47 cfs 0.678 af
Outflow=18.47 cfs 0.678 af

**Total Runoff Area = 11.858 ac Runoff Volume = 3.001 af Average Runoff Depth = 3.04"**
**58.64% Pervious = 6.954 ac 41.36% Impervious = 4.905 ac**

## Summary for Subcatchment 1s: EX1

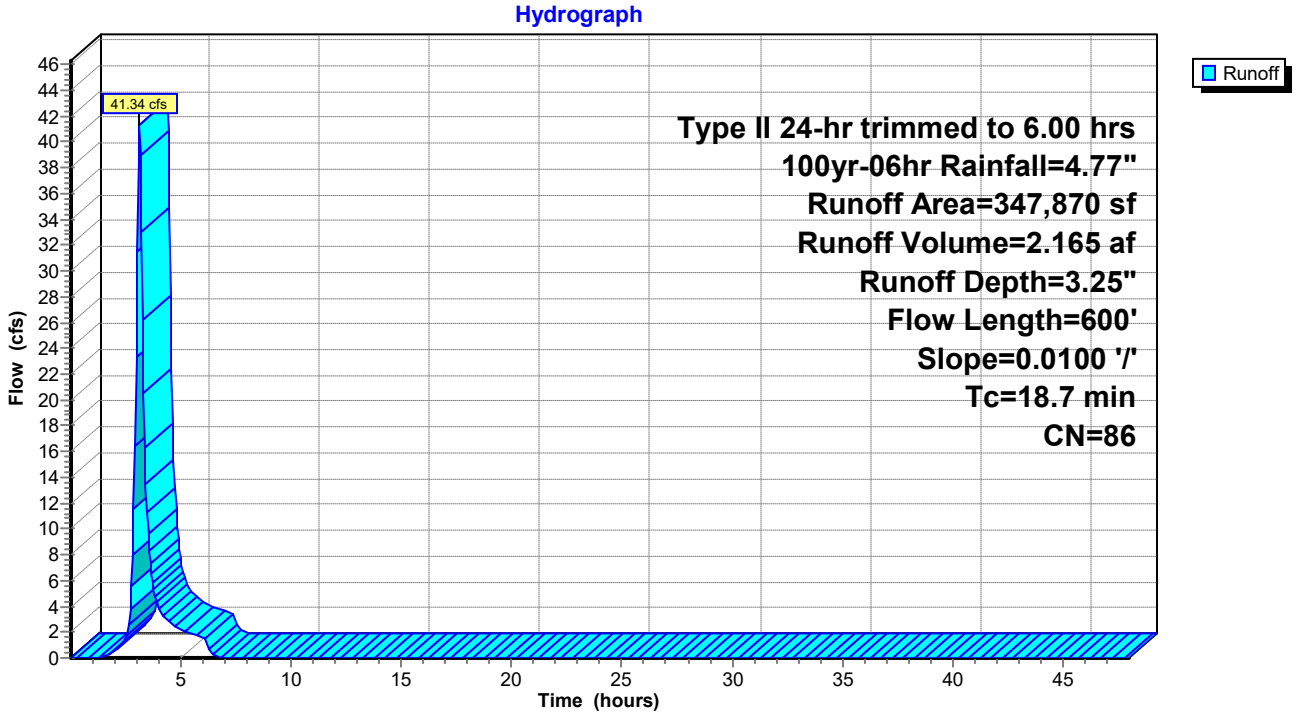
Runoff = 41.34 cfs @ 3.11 hrs, Volume= 2.165 af, Depth= 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 100yr-06hr Rainfall=4.77"

| Area (sf) | CN | Description |
|---|---|---|
| 169,520 | 74 | >75% Grass cover, Good, HSG C |
| 158,000 | 98 | Paved parking, HSG C |
| 20,350 | 98 | Roofs, HSG C |
| 347,870 | 86 | Weighted Average |
| 169,520 | | 48.73% Pervious Area |
| 178,350 | | 51.27% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow** n= 0.150 P2= 2.92" |
| 5.2 | 500 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 18.7 | 600 | Total | | | |

## Subcatchment 1s: EX1



## Summary for Subcatchment 2s: EX2

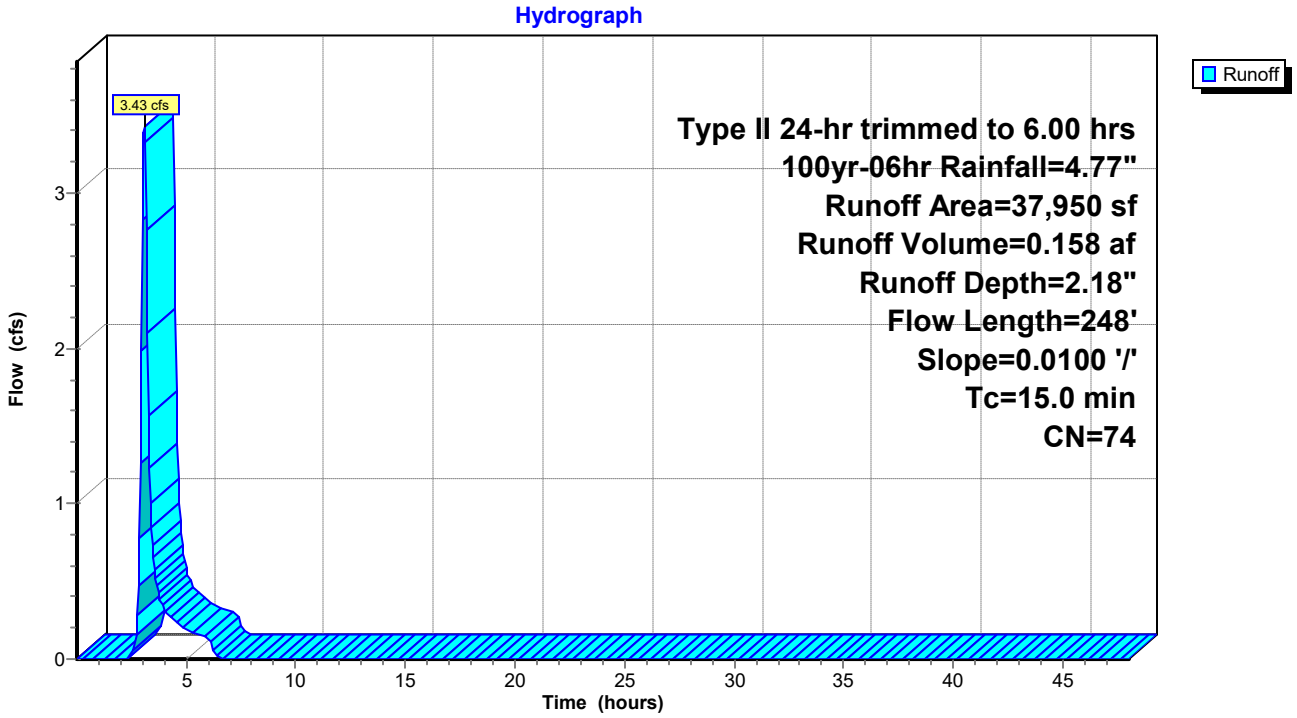
Runoff = 3.43 cfs @ 3.08 hrs, Volume= 0.158 af, Depth= 2.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 100yr-06hr Rainfall=4.77"

| Area (sf) | CN | Description |
|---|---|---|
| 37,950 | 74 | >75% Grass cover, Good, HSG C |
| 37,950 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 148 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 248 | Total | | | |

## Subcatchment 2s: EX2



## Summary for Subcatchment 3s: EX3

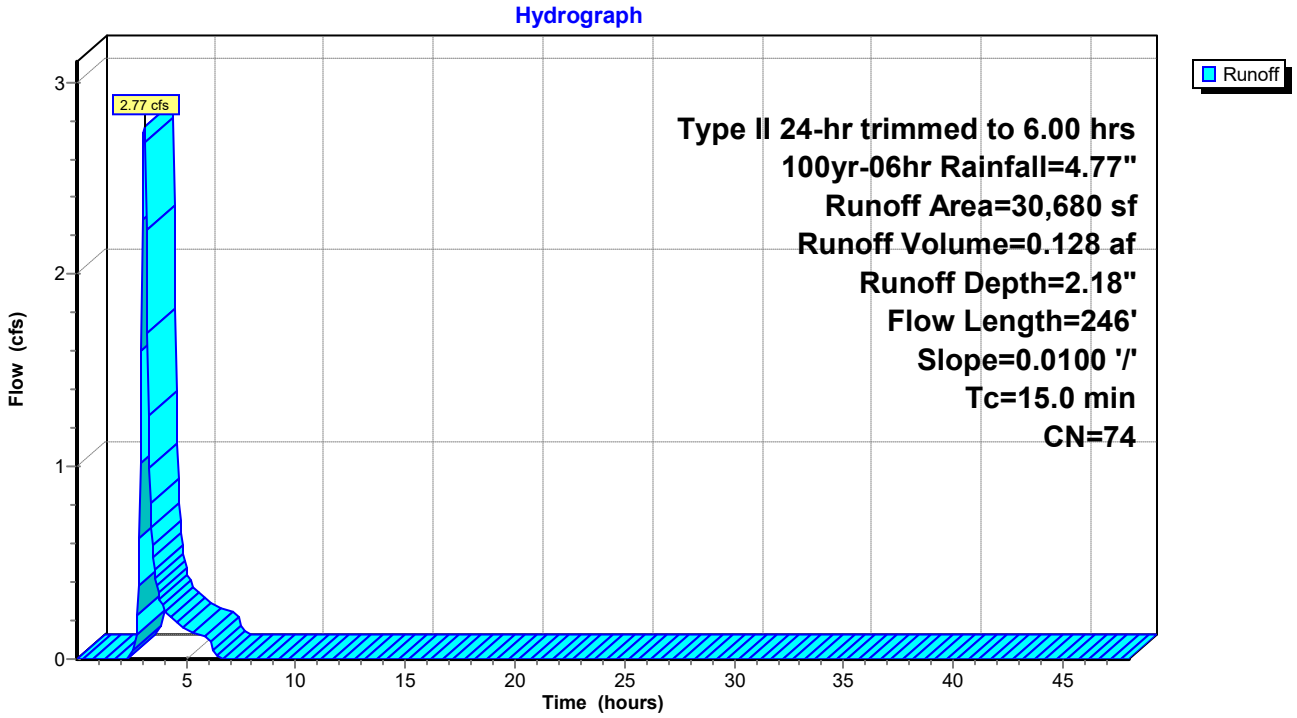
Runoff = 2.77 cfs @ 3.08 hrs, Volume= 0.128 af, Depth= 2.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 100yr-06hr Rainfall=4.77"

| Area (sf) | CN | Description |
|---|---|---|
| 30,680 | 74 | >75% Grass cover, Good, HSG C |
| 30,680 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 13.5 | 100 | 0.0100 | 0.12 | | **Sheet Flow, Sheet Flow**<br>Grass: Short n= 0.150 P2= 2.92" |
| 1.5 | 146 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc**<br>Unpaved Kv= 16.1 fps |
| 15.0 | 246 | Total | | | |

## Subcatchment 3s: EX3



## Summary for Subcatchment 4s: EX4

[49] Hint: Tc<2dt may require smaller dt

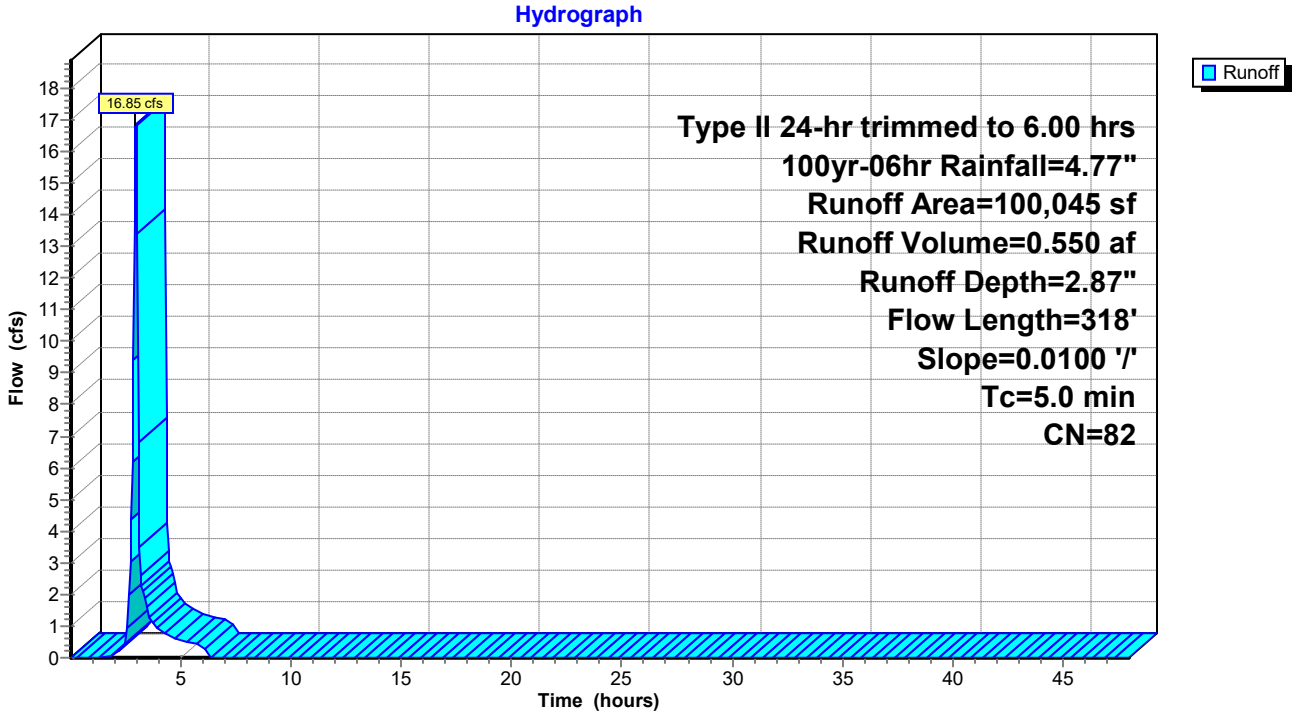
Runoff = 16.85 cfs @ 2.96 hrs, Volume= 0.550 af, Depth= 2.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 6.00 hrs 100yr-06hr Rainfall=4.77"

| Area (sf) | CN | Description |
|---|---|---|
| 64,745 | 74 | >75% Grass cover, Good, HSG C |
| 27,940 | 98 | Paved parking, HSG C |
| 7,360 | 98 | Roofs, HSG C |
| 100,045 | 82 | Weighted Average |
| 64,745 | | 64.72% Pervious Area |
| 35,300 | | 35.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.7 | 100 | 0.0100 | 1.00 | | **Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 2.92" |
| 2.3 | 218 | 0.0100 | 1.61 | | **Shallow Concentrated Flow, Shallow Conc** Unpaved Kv= 16.1 fps |
| 4.0 | 318 | Total, Increased to minimum Tc = 5.0 min | | | |

## Subcatchment 4s: EX4



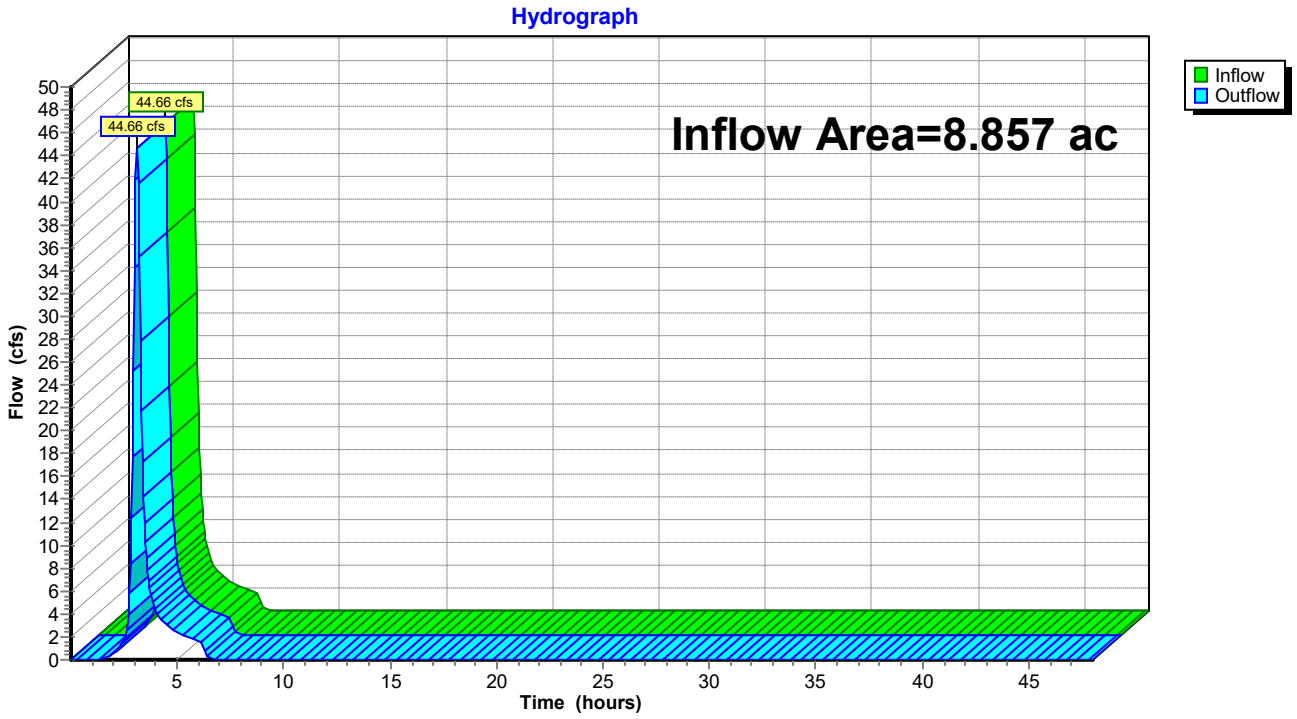
## Summary for Reach 1R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.857 ac, 46.23% Impervious, Inflow Depth = 3.15" for 100yr-06hr event
Inflow = 44.66 cfs @ 3.11 hrs, Volume= 2.323 af
Outflow = 44.66 cfs @ 3.11 hrs, Volume= 2.323 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 1R: US 31 DITCH



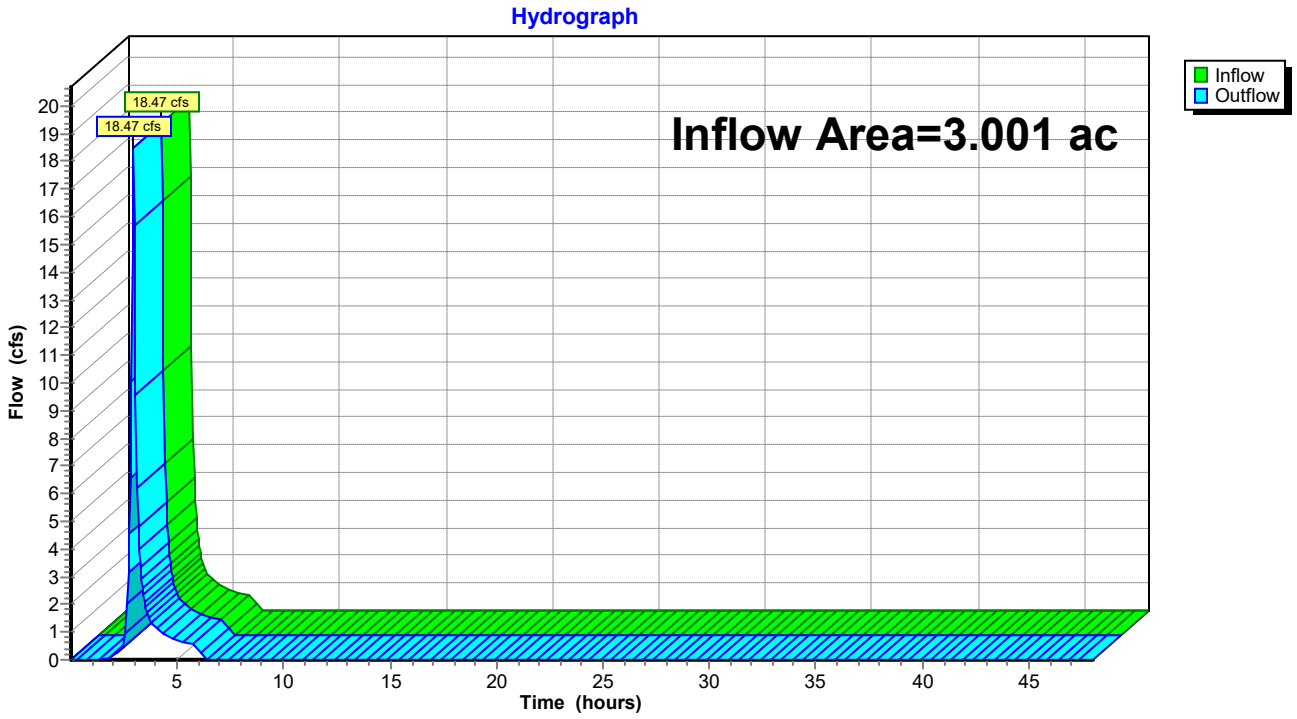
## Summary for Reach 2R: EX POND TO WEST

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.001 ac, 27.00% Impervious, Inflow Depth = 2.71" for 100yr-06hr event
Inflow = 18.47 cfs @ 2.96 hrs, Volume= 0.678 af
Outflow = 18.47 cfs @ 2.96 hrs, Volume= 0.678 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs

### Reach 2R: EX POND TO WEST



## Events for Subcatchment 1s: EX1

| Event | Rainfall (inches) | Runoff (cfs) | Volume (acre-feet) | Depth (inches) |
|---|---|---|---|---|
| 002yr-06hr | 2.50 | 15.93 | 0.828 | 1.24 |
| 010yr-24hr | 4.09 | 23.99 | 1.749 | 2.63 |
| 025yr-24hr | **4.79** | 29.68 | **2.177** | **3.27** |
| 050yr-12hr | 4.78 | 35.06 | 2.171 | 3.26 |
| 100yr-06hr | 4.77 | **41.34** | 2.165 | 3.25 |

## Events for Subcatchment 2s: EX2

| Event | Rainfall (inches) | Runoff (cfs) | Volume (acre-feet) | Depth (inches) |
|---|---|---|---|---|
| 002yr-06hr | 2.50 | 0.88 | 0.044 | 0.61 |
| 010yr-24hr | 4.09 | 1.84 | 0.121 | 1.66 |
| 025yr-24hr | **4.79** | 2.45 | **0.160** | **2.20** |
| 050yr-12hr | 4.78 | 2.90 | 0.159 | 2.19 |
| 100yr-06hr | 4.77 | **3.43** | 0.158 | 2.18 |

## Events for Subcatchment 3s: EX3

| Event | Rainfall (inches) | Runoff (cfs) | Volume (acre-feet) | Depth (inches) |
|---|---|---|---|---|
| 002yr-06hr | 2.50 | 0.71 | 0.036 | 0.61 |
| 010yr-24hr | 4.09 | 1.49 | 0.098 | 1.66 |
| 025yr-24hr | **4.79** | 1.98 | **0.129** | **2.20** |
| 050yr-12hr | 4.78 | 2.35 | 0.129 | 2.19 |
| 100yr-06hr | 4.77 | **2.77** | 0.128 | 2.18 |

## Events for Subcatchment 4s: EX4

| Event | Rainfall (inches) | Runoff (cfs) | Volume (acre-feet) | Depth (inches) |
|---|---|---|---|---|
| 002yr-06hr | 2.50 | 6.05 | 0.191 | 1.00 |
| 010yr-24hr | 4.09 | 9.43 | 0.436 | 2.28 |
| 025yr-24hr | **4.79** | 11.86 | **0.553** | **2.89** |
| 050yr-12hr | 4.78 | 14.12 | 0.552 | 2.88 |
| 100yr-06hr | 4.77 | **16.85** | 0.550 | 2.87 |

## Events for Reach 1R: US 31 DITCH

| Event | Inflow (cfs) | Outflow (cfs) | Elevation (feet) | Storage (cubic-feet) |
|---|---|---|---|---|
| 002yr-06hr | 16.80 | 16.80 | **0.00** | **0** |
| 010yr-24hr | 25.76 | 25.76 | 0.00 | 0 |
| 025yr-24hr | 32.04 | 32.04 | 0.00 | 0 |
| 050yr-12hr | 37.85 | 37.85 | 0.00 | 0 |
| 100yr-06hr | **44.66** | **44.66** | 0.00 | 0 |

## Events for Reach 2R: EX POND TO WEST

| Event | Inflow (cfs) | Outflow (cfs) | Elevation (feet) | Storage (cubic-feet) |
|---|---|---|---|---|
| 002yr-06hr | 6.36 | 6.36 | **0.00** | **0** |
| 010yr-24hr | 10.35 | 10.35 | 0.00 | 0 |
| 025yr-24hr | 13.11 | 13.11 | 0.00 | 0 |
| 050yr-12hr | 15.55 | 15.55 | 0.00 | 0 |
| 100yr-06hr | **18.47** | **18.47** | 0.00 | 0 |

# *APPENDIX E – PROPOSED DRAINAGE ANALYSIS*

SIMON RD
(PUBLIC ROW)

S07°04'30"E 16.50'

S82°55'30"W 302.50'(C)302.84'(P)

S82°55'30"E 466.72'

S55°28'26"E 55.44'

20' FRONT BSL (LOCAL)

10' LANDSCAPE & SIDEWALK EASEMENT

FRONT BSL (LOCAL)

20' DRAINAGE & UTILITY EASEMENT BK264 PG96
BK PG 851

LOT 1
0.921 AC.
40,137 SF

LOT 2
1.426 AC.
62,137 SF

LOT 3
1.220 AC.
53,158 SF

LOT 4
1.396 AC.
60,810 SF

LOT 5
5.35 AC
233,077 SF

COMMON AREA 'A'
1.540 AC.
67,068 SF

20' BUFFERYARD

35' SIDE BSL

50' FRONT BSL (ARTERIAL)

10' LANDSCAPE & SIDEWALK EASEMENT

N00°42'47"E 525.11'(C)486.20'(P)

S00°42'48"W 582.94'

S0° 42' 47"W 260.25'

40' REAR BSL

20' BUFFERYARD

S88°23'23"W 264.72'

N87°33'14"E 163.49'

N87°45'18"E 4.12'

S16°21'00"E 247.50'

20' BUFFERYARD

40' REAR BSL

US HWY 31 / N. MORTON ST.
(PUBLIC ROW)

MUSTANG CT

RBC

RB

601 602 603 604 610 612 613 620 621 622 623 624 625 626 627 631 651 652

N

0 80' 160'

SCALE: 1" = 80'

**Fritz Engineering**
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SHEET NAME / NO.

**PROPOSED STORM BASIN MAP**

# EXH-3

Fritz Engineering Services, LLC

# STORM SEWER DESIGN CALCULATIONS

## RATIONAL METHOD PEAK RUNOFF

***PROJECT NAME:*** ***BDH REALTY CAR WASH***
***FES PROJECT #:*** ***2006004***
***DATE:*** ***3/30/21***

DESIGN STORM: 10 Year

| STRUCTURE | | BASINS | | | | | | | COMPOSITE BASINS | | | | TRAVEL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UP | DOWN | BASIN # | c | A (acres) | c*A | Tc (min) | I (in/hr) | Q (cfs) | SUM (c*A) | Tc (min) | I (in/hr) | Q (cfs) | TIME (min) |
| 652 | 651 | 652 | 0.25 | 0.19 Ac. | 0.05 | 21 min. | 3.93 in/hr | 0.19 cfs | 0.05 | 21 min. | 3.93 in/hr | 0.19 cfs | 0.3 min. |
| 627 | 626 | 627 | 0.72 | 0.19 Ac. | 0.14 | 5 min. | 6.12 in/hr | 0.84 cfs | 0.14 | 5 min. | 6.12 in/hr | 0.84 cfs | 1.0 min. |
| 626 | 625 | 626 | 0.75 | 0.31 Ac. | 0.23 | 5 min. | 6.12 in/hr | 1.43 cfs | 0.37 | 6 min. | 5.92 in/hr | 2.19 cfs | 0.0 min. |
| 625 | 624 | 625 | 0.80 | 0.11 Ac. | 0.09 | 5 min. | 6.12 in/hr | 0.55 cfs | 0.46 | 6 min. | 5.92 in/hr | 2.72 cfs | 0.7 min. |
| 624 | 623 | 624 | 0.78 | 0.15 Ac. | 0.12 | 5 min. | 6.12 in/hr | 0.73 cfs | 0.58 | 7 min. | 5.73 in/hr | 3.32 cfs | 0.3 min. |
| 623 | 622 | 623 | 0.68 | 0.16 Ac. | 0.11 | 5 min. | 6.12 in/hr | 0.68 cfs | 0.69 | 8 min. | 5.55 in/hr | 3.83 cfs | 0.0 min. |
| 622 | 621 | 622 | 0.81 | 0.45 Ac. | 0.37 | 5 min. | 6.12 in/hr | 2.23 cfs | 1.06 | 8 min. | 5.55 in/hr | 5.86 cfs | 0.5 min. |
| 631 | 621 | 631 | 0.83 | 0.33 Ac. | 0.27 | 5 min. | 6.12 in/hr | 1.67 cfs | 0.27 | 5 min. | 6.12 in/hr | 1.67 cfs | 1.1 min. |
| 621 | 620 | 621 | 0.77 | 0.48 Ac. | 0.37 | 5 min. | 6.12 in/hr | 2.26 cfs | 1.70 | 9 min. | 5.38 in/hr | 9.14 cfs | 0.2 min. |
| 613 | 612 | 613 | 0.72 | 1.98 Ac. | 1.42 | 5 min. | 6.12 in/hr | 8.68 cfs | 1.42 | 5 min. | 6.12 in/hr | 8.68 cfs | 0.2 min. |
| 612 | 611 | 612 | 0.85 | 0.18 Ac. | 0.15 | 5 min. | 6.12 in/hr | 0.93 cfs | 1.57 | 6 min. | 5.92 in/hr | 9.29 cfs | 0.1 min. |
| 604 | 602 | 604 | 0.25 | 0.62 Ac. | 0.15 | 22 min. | 3.84 in/hr | 0.59 cfs | 0.15 | 23 min. | 3.76 in/hr | 0.58 cfs | 0.1 min. |
| 603 | 602 | 603 | 0.00 | 0.00 Ac. | 0.00 | 0 min. | 0.00 in/hr | 0.00 cfs | 0.00 | 0 min. | 0.00 in/hr | 0.00 cfs | #N/A |
| 602 | 601 | 602 | 0.00 | 0.00 Ac. | 0.00 | 0 min. | 0.00 in/hr | 0.00 cfs | 0.15 | #N/A | 0.00 in/hr | 0.00 cfs | #N/A |

Fritz Engineering Services, LLC

# STORM SEWER DESIGN CALCULATIONS

## PIPE SIZING CALCULATIONS

***PROJECT NAME:*** ***BDH REALTY CAR WASH***
***FES PROJECT #:*** ***2006004***
***DATE:*** ***3/30/2021***

DESIGN STORM: 10 Year

| STRUCTURE UP | STRUCTURE DOWN | DESIGN Q (cfs) | L (ft) | DIA. (in) | SLOPE % | MTRL | MANN. COEFF. n | CAP. Q (cfs) | FULL VEL. (ft/s) | ACTUAL DEPTH (in) | ACTUAL VEL. (ft/s) | RIM ELEV. UP | RIM ELEV. DOWN | INVERT ELEV. UP | INVERT ELEV. DOWN | COVER (ft) UP | COVER (ft) DOWN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 652 | 651 | 0.19 | 27 LF | 12 in. | 0.30% | RCP | 0.012 | 2.12 cfs | 2.5 ft/s | 2.4 in. | 1.5 ft/s | | | 756.00 | 755.92 | | |
| 627 | 626 | 0.84 | 133 LF | 12 in. | 0.30% | RCP | 0.012 | 2.12 cfs | 2.5 ft/s | 5.2 in. | 2.3 ft/s | 759.14 | 758.69 | 756.65 | 756.25 | 1.3 | 1.3 |
| 626 | 625 | 2.19 | 8 LF | 12 in. | 0.35% | RCP | 0.012 | 2.29 cfs | 2.7 ft/s | 9.4 in. | 3.1 ft/s | 758.69 | 758.50 | 756.20 | 756.17 | 1.3 | 1.2 |
| 625 | 624 | 2.72 | 120 LF | 15 in. | 0.25% | RCP | 0.012 | 3.51 cfs | 2.6 ft/s | 9.9 in. | 2.9 ft/s | 758.50 | 759.31 | 755.97 | 755.67 | 1.1 | 2.2 |
| 624 | 623 | 3.32 | 59 LF | 15 in. | 0.30% | RCP | 0.012 | 3.84 cfs | 2.9 ft/s | 10.7 in. | 3.3 ft/s | 759.31 | 758.91 | 755.62 | 755.45 | 2.3 | 2.0 |
| 623 | 622 | 3.83 | 8 LF | 15 in. | 0.35% | RCP | 0.012 | 4.15 cfs | 3.1 ft/s | 11.3 in. | 3.6 ft/s | 758.91 | 758.00 | 755.40 | 755.37 | 2.1 | 1.2 |
| 622 | 621 | 5.86 | 106 LF | 18 in. | 0.32% | RCP | 0.012 | 6.45 cfs | 3.4 ft/s | 13.3 in. | 3.8 ft/s | 758.00 | 760.29 | 755.17 | 754.83 | 1.1 | 3.8 |
| 631 | 621 | 1.67 | 183 LF | 12 in. | 0.30% | RCP | 0.012 | 2.12 cfs | 2.5 ft/s | 8.0 in. | 2.8 ft/s | 758.81 | 760.29 | 755.50 | 754.95 | 2.1 | 4.2 |
| 621 | 620 | 9.14 | 69 LF | 21 in. | 0.40% | RCP | 0.012 | 10.89 cfs | 4.2 ft/s | 14.7 in. | 4.7 ft/s | 760.29 | | 754.70 | 754.42 | 3.6 | |
| 613 | 612 | 8.68 | 47 LF | 21 in. | 0.50% | RCP | 0.012 | 12.17 cfs | 4.7 ft/s | 13.0 in. | 5.1 ft/s | 758.50 | 758.55 | 755.00 | 754.77 | 1.5 | 1.8 |
| 612 | 611 | 9.29 | 45 LF | 21 in. | 0.50% | RCP | 0.012 | 12.17 cfs | 4.7 ft/s | 13.7 in. | 5.2 ft/s | 758.55 | | 754.72 | 754.49 | 1.9 | |
| 604 | 602 | 0.58 | 18 LF | 12 in. | 0.54% | RCP | 0.012 | 2.84 cfs | 3.4 ft/s | 3.6 in. | 2.6 ft/s | | 759.16 | 754.40 | 754.30 | | 3.7 |
| 603 | 602 | 0.00 | 25 LF | 15 in. | 0.34% | RCP | 0.012 | 4.09 cfs | 3.1 ft/s | #N/A | #N/A | 757.50 | 759.16 | 754.40 | 754.32 | 1.7 | 3.4 |
| 602 | 601 | 0.00 | 391 LF | 15 in. | 0.30% | RCP | 0.012 | 3.84 cfs | 2.9 ft/s | #N/A | #N/A | 759.16 | | 754.27 | 753.09 | 3.5 | |

Fritz Engineering Services, LLC

# WEIGHTED RUNOFF COEFFICIENTS

***PROJECT NAME:*** ***BDH REALTY CAR WASH***
***FES PROJECT #:*** ***2006004***
***DATE:*** ***3/30/2021***

| STRUCTURE/BASIN I.D. | TOTAL DRAINAGE AREA | RUNOFF COEFFICIENTS CALCULATIONS | | | |
|---|---|---|---|---|---|
| | (Ac.) | % Grass 0.25 | % Gravel/Pvmt 0.85 | % Rooftop 0.90 | Weighted C |
| 627 | 0.19 Ac. | 22% | 78% | 0% | Weighted C= 0.72 |
| | 8,285 SF | 1,785 SF | 6,500 SF | SF | |
| 626 | 0.31 Ac. | 17% | 83% | 0% | Weighted C= 0.75 |
| | 13,630 SF | 2,280 SF | 11,350 SF | SF | |
| 625 | 0.11 Ac. | 8% | 92% | 0% | Weighted C= 0.80 |
| | 4,855 SF | 375 SF | 4,480 SF | SF | |
| 624 | 0.15 Ac. | 12% | 88% | 0% | Weighted C= 0.78 |
| | 6,657 SF | 807 SF | 5,850 SF | SF | |
| 623 | 0.16 Ac. | 28% | 72% | 0% | Weighted C= 0.68 |
| | 7,100 SF | 2,000 SF | 5,100 SF | SF | |
| 622 | 0.45 Ac. | 8% | 77% | 15% | Weighted C= 0.81 |
| | 19,586 SF | 1,586 SF | 15,000 SF | 3,000 SF | |

Fritz Engineering Services, LLC

# WEIGHTED RUNOFF COEFFICIENTS

***PROJECT NAME:*** ***BDH REALTY CAR WASH***
***FES PROJECT #:*** ***2006004***
***DATE:*** ***3/30/2021***

| STRUCTURE/BASIN I.D. | TOTAL DRAINAGE AREA | RUNOFF COEFFICIENTS CALCULATIONS | | | |
|---|---|---|---|---|---|
| | (Ac.) | % Grass 0.25 | % Gravel/Pvmt 0.85 | % Rooftop 0.90 | Weighted C |
| 621 | 0.48 Ac. | 14% | 71% | 14% | Weighted C= 0.77 |
| | 21,023 SF | 3,023 SF | 15,000 SF | 3,000 SF | |
| 652 | 0.19 Ac. | 100% | 0% | 0% | Weighted C= 0.25 |
| | 8,353 SF | 8,353 SF | SF | SF | |
| 613 | 1.98 Ac. | 23% | 64% | 13% | Weighted C= 0.72 |
| | 86,268 SF | 20,268 SF | 55,000 SF | 11,000 SF | |
| 612 | 0.18 Ac. | 0% | 100% | 0% | Weighted C= 0.85 |
| | 7,789 SF | SF | 7,789 SF | SF | |
| 604 | 0.62 Ac. | 100% | 0% | 0% | Weighted C= 0.25 |
| | 26,836 SF | 26,836 SF | SF | SF | |
| 603 | 0.00 Ac. | 0% | 0% | 0% | Weighted C= 0.00 |
| | SF | SF | SF | SF | |
| 602 | 0.00 Ac. | 0% | 0% | 0% | Weighted C= 0.00 |
| | SF | SF | SF | SF | |
| 631 | 0.33 Ac. | 7% | 57% | 36% | Weighted C= 0.83 |
| | 14,376 SF | 976 SF | 8,200 SF | 5,200 SF | |

Fritz Engineering Services, LLC

# WEIGHTED RUNOFF COEFFICIENTS

***PROJECT NAME:*** ***BDH REALTY CAR WASH***
***FES PROJECT #:*** ***2006004***
***DATE:*** ***3/30/2021***

| STRUCTURE/BASIN I.D. | TOTAL DRAINAGE AREA | RUNOFF COEFFICIENTS CALCULATIONS | | | |
|---|---|---|---|---|---|
| | (Ac.) | % Grass 0.25 | % Gravel/Pvmt 0.85 | % Rooftop 0.90 | Weighted C |
| Overall | 5.16 Ac. | 30% | 60% | 10% | Weighted C= 0.68 |
| | 224,758 SF | 68,289 SF | 134,269 SF | 22,200 SF | |

Fritz Engineering Services, LLC

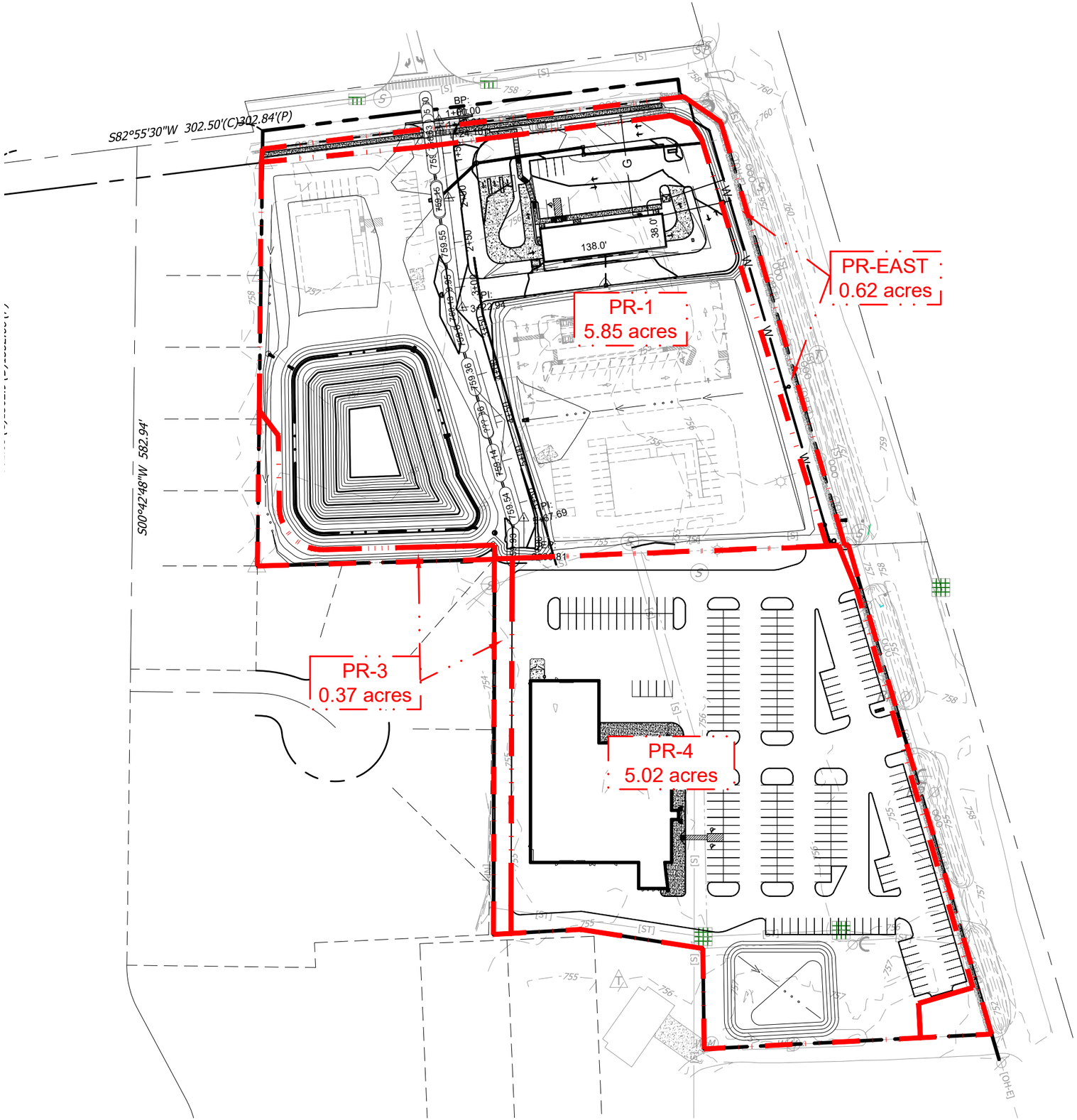
# AREA INLET CAPACITY CALCULATIONS

(Sag / Low Point)

***PROJECT NAME:*** ***BDH REALTY CAR WASH***
***FES PROJECT #:*** ***2006004***
***DATE:*** ***3/30/2021***

Enter Appropriate Information for Inlet Grate Capacity

| Grate # | Grate Type | Open Area, sf | Perimeter, ft. | Head, ft | Capacity, cfs | 50% Clogged Capacity, cfs | Capacity, cfs | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Weir | Transitional | Orifice |
| R-4342 | A,C | 2.0 | 6.0 | 0.50 | 5.79 | 2.89 | 6.81 | 5.79 | 7.00 |
| R-3286-8V | V | 0.7 | 4.4 | 0.50 | 2.55 | 1.28 | 2.55 | | 5.13 |
| R-3010 | A,C | 1.0 | 4.6 | 0.50 | 3.40 | 1.70 | 3.40 | | 5.37 |




0 80' 160'

SCALE: 1" = 80'

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SHEET NAME / NO.

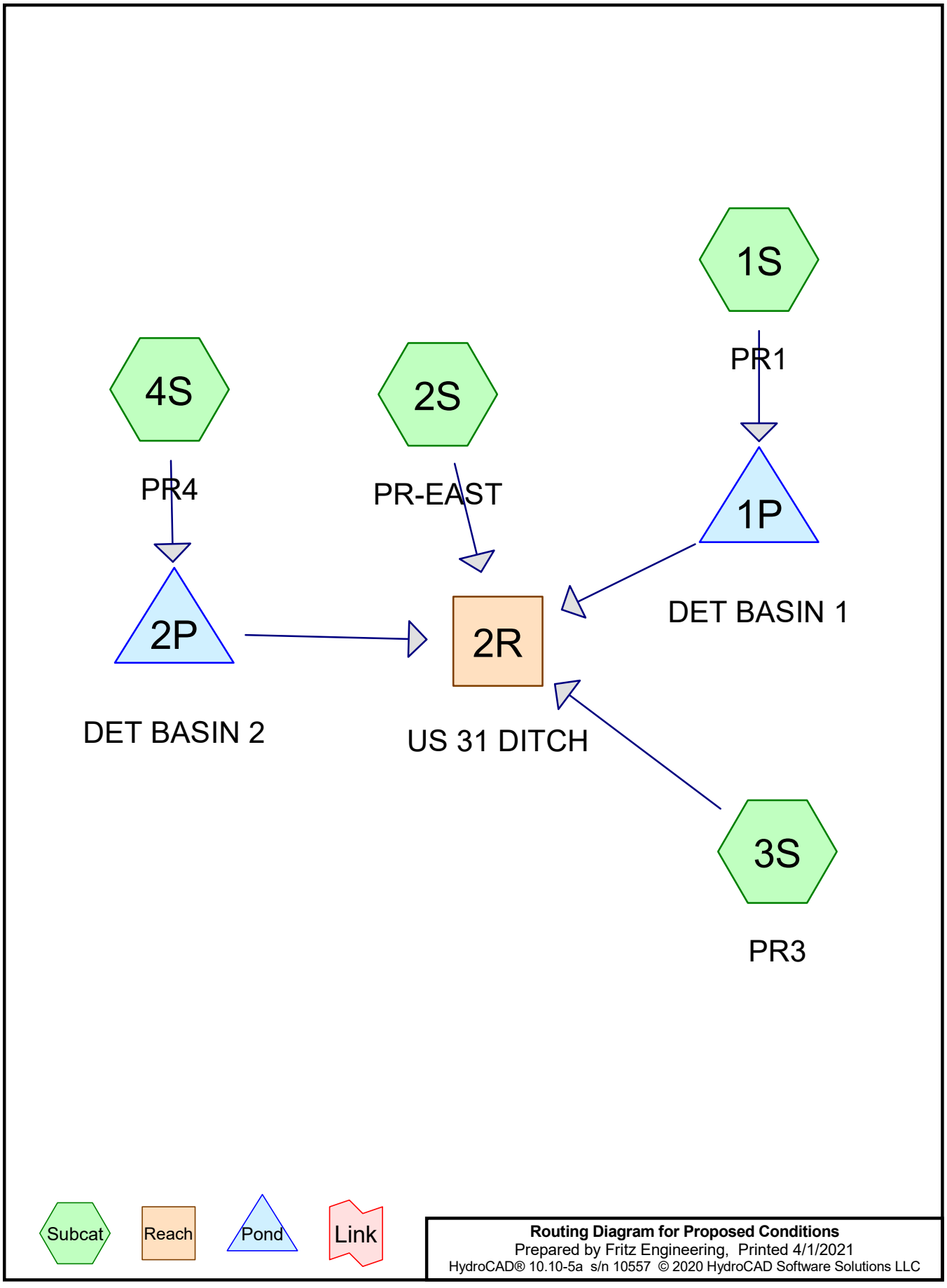
**PROPOSED DETENTION BASIN MAP**

# EXH-2

**Proposed Conditions** *Type II 24-hr 100yr-24hr Rainfall=5.91"*
Prepared by Fritz Engineering Printed 4/1/2021


## Events for Reach 2R: US 31 DITCH

| Event | Inflow (cfs) | Outflow (cfs) | Elevation (feet) | Storage (cubic-feet) |
|---|---|---|---|---|
| 002yr-01hr | 5.96 | 5.96 | **0.00** | **0** |
| 002yr-02hr | 6.85 | 6.85 | 0.00 | 0 |
| 002yr-03hr | 6.99 | 6.99 | 0.00 | 0 |
| 002yr-06hr | 9.83 | 9.83 | 0.00 | 0 |
| 002yr-12hr | 8.74 | 8.74 | 0.00 | 0 |
| 002yr-24hr | 9.62 | 9.62 | 0.00 | 0 |
| 010yr-01hr | 9.82 | 9.82 | 0.00 | 0 |
| 010yr-02hr | 11.19 | 11.19 | 0.00 | 0 |
| 010yr-03hr | 11.38 | 11.38 | 0.00 | 0 |
| 010yr-06hr | 12.80 | 12.80 | 0.00 | 0 |
| 010yr-12hr | 13.69 | 13.69 | 0.00 | 0 |
| 010yr-24hr | 14.28 | 14.28 | 0.00 | 0 |
| 025yr-01hr | 12.44 | 12.44 | 0.00 | 0 |
| 025yr-02hr | 14.03 | 14.03 | 0.00 | 0 |
| 025yr-03hr | 14.35 | 14.35 | 0.00 | 0 |
| 025yr-06hr | 16.20 | 16.20 | 0.00 | 0 |
| 025yr-12hr | 16.76 | 16.76 | 0.00 | 0 |
| 025yr-24hr | 17.01 | 17.01 | 0.00 | 0 |
| 050yr-01hr | 14.33 | 14.33 | 0.00 | 0 |
| 050yr-02hr | 16.46 | 16.46 | 0.00 | 0 |
| 050yr-03hr | 16.95 | 16.95 | 0.00 | 0 |
| 050yr-06hr | 18.75 | 18.75 | 0.00 | 0 |
| 050yr-12hr | 19.16 | 19.16 | 0.00 | 0 |
| 050yr-24hr | 19.00 | 19.00 | 0.00 | 0 |
| 100yr-01hr | 16.20 | 16.20 | 0.00 | 0 |
| 100yr-02hr | 18.85 | 18.85 | 0.00 | 0 |
| 100yr-03hr | 19.39 | 19.39 | 0.00 | 0 |
| 100yr-06hr | 21.38 | 21.38 | 0.00 | 0 |
| 100yr-12hr | **21.52** | **21.52** | 0.00 | 0 |
| 100yr-24hr | 20.97 | 20.97 | 0.00 | 0 |




**Routing Diagram for Proposed Conditions**
Prepared by Fritz Engineering, Printed 4/1/2021
HydroCAD® 10.10-5a s/n 10557 © 2020 HydroCAD Software Solutions LLC

## Project Notes

Rainfall events imported from "Existing Conditions.hcp"
Rainfall events imported from "Existing Conditions.hcp"

## Rainfall Events Listing (selected events)

| Event# | Event Name | Storm Type | Curve | Mode | Duration (hours) | B/B | Depth (inches) | AMC |
|---|---|---|---|---|---|---|---|---|
| 1 | 002yr-24hr | Type II 24-hr | | Default | 24.00 | 1 | 2.92 | 2 |
| 2 | 010yr-24hr | Type II 24-hr | | Default | 24.00 | 1 | 4.09 | 2 |
| 3 | 025yr-24hr | Type II 24-hr | | Default | 24.00 | 1 | 4.79 | 2 |
| 4 | 050yr-12hr | Type II 24-hr | | Trim | 12.00 | 1 | 4.78 | 2 |
| 5 | 100yr-12hr | Type II 24-hr | | Trim | 12.00 | 1 | 5.37 | 2 |

**Proposed Conditions**
Prepared by Fritz Engineering




## Area Listing (all nodes)

| Area (acres) | CN | Description (subcatchment-numbers) |
|---|---|---|
| 0.990 | 74 | >75% Grass cover, Good, HSG C (2S, 3S) |
| 4.670 | 94 | Urban commercial, 85% imp, HSG C (4S) |
| 5.350 | 95 | Urban commercial, 85% imp, HSG D (1S) |
| 0.850 | 98 | Water Surface, HSG C (1S, 4S) |
| **11.860** | **93** | **TOTAL AREA** |

## Soil Listing (all nodes)

| Area (acres) | Soil Group | Subcatchment Numbers |
|---|---|---|
| 0.000 | HSG A | |
| 0.000 | HSG B | |
| 6.510 | HSG C | 1S, 2S, 3S, 4S |
| 5.350 | HSG D | 1S |
| 0.000 | Other | |
| **11.860** | | **TOTAL AREA** |

## Ground Covers (all nodes)

| HSG-A (acres) | HSG-B (acres) | HSG-C (acres) | HSG-D (acres) | Other (acres) | Total (acres) | Ground Cover | Subcatchment Numbers |
|---|---|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.990 | 0.000 | 0.000 | 0.990 | >75% Grass cover, Good | 2S, 3S |
| 0.000 | 0.000 | 4.670 | 5.350 | 0.000 | 10.020 | Urban commercial, 85% imp | 1S, 4S |
| 0.000 | 0.000 | 0.850 | 0.000 | 0.000 | 0.850 | Water Surface | 1S, 4S |
| **0.000** | **0.000** | **6.510** | **5.350** | **0.000** | **11.860** | **TOTAL AREA** | |

## Pipe Listing (all nodes)

| Line# | Node Number | In-Invert (feet) | Out-Invert (feet) | Length (feet) | Slope (ft/ft) | n | Width (inches) | Diam/Height (inches) | Inside-Fill (inches) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1P | 754.40 | 753.07 | 444.0 | 0.0030 | 0.012 | 0.0 | 15.0 | 0.0 |
| 2 | 2P | 751.50 | 751.33 | 50.0 | 0.0034 | 0.013 | 0.0 | 18.0 | 0.0 |

Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: PR1** Runoff Area=5.850 ac 86.28% Impervious Runoff Depth=2.37"
Tc=10.0 min CN=95 Runoff=19.70 cfs 1.156 af

**Subcatchment 2S: PR-EAST** Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=0.86"
Tc=5.0 min CN=74 Runoff=0.95 cfs 0.044 af

**Subcatchment 3S: PR3** Runoff Area=0.370 ac 0.00% Impervious Runoff Depth=0.86"
Tc=5.0 min CN=74 Runoff=0.57 cfs 0.026 af

**Subcatchment 4S: PR4** Runoff Area=5.020 ac 86.05% Impervious Runoff Depth=2.27"
Tc=5.0 min CN=94 Runoff=19.27 cfs 0.951 af

**Reach 2R: US 31 DITCH** Inflow=9.62 cfs 2.105 af
Outflow=9.62 cfs 2.105 af

**Pond 1P: DET BASIN 1** Peak Elev=755.25' Storage=29,110 cf Inflow=19.70 cfs 1.156 af
15.0" Round Culvert n=0.012 L=444.0' S=0.0030 '/' Outflow=1.99 cfs 1.083 af

**Pond 2P: DET BASIN 2** Peak Elev=753.40' Storage=12,422 cf Inflow=19.27 cfs 0.951 af
18.0" Round Culvert n=0.013 L=50.0' S=0.0034 '/' Outflow=7.43 cfs 0.951 af

**Total Runoff Area = 11.860 ac Runoff Volume = 2.178 af Average Runoff Depth = 2.20"**
**21.02% Pervious = 2.493 ac 78.98% Impervious = 9.367 ac**

## Summary for Subcatchment 1S: PR1

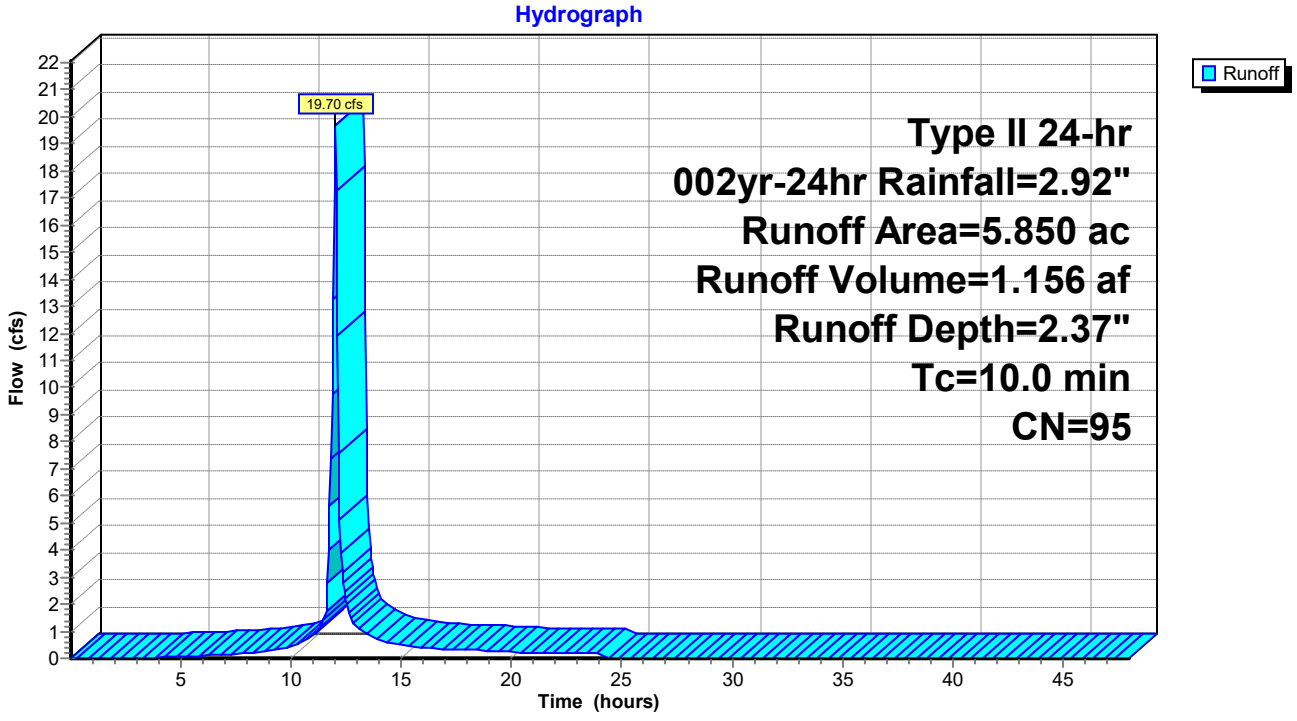
Runoff = 19.70 cfs @ 12.01 hrs, Volume= 1.156 af, Depth= 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 002yr-24hr Rainfall=2.92"

| Area (ac) | CN | Description |
|---|---|---|
| 5.350 | 95 | Urban commercial, 85% imp, HSG D |
| 0.500 | 98 | Water Surface, HSG C |
| 5.850 | 95 | Weighted Average |
| 0.802 | | 13.72% Pervious Area |
| 5.047 | | 86.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, Direct Entry** |

## Subcatchment 1S: PR1



## Summary for Subcatchment 2S: PR-EAST

[49] Hint: Tc<2dt may require smaller dt

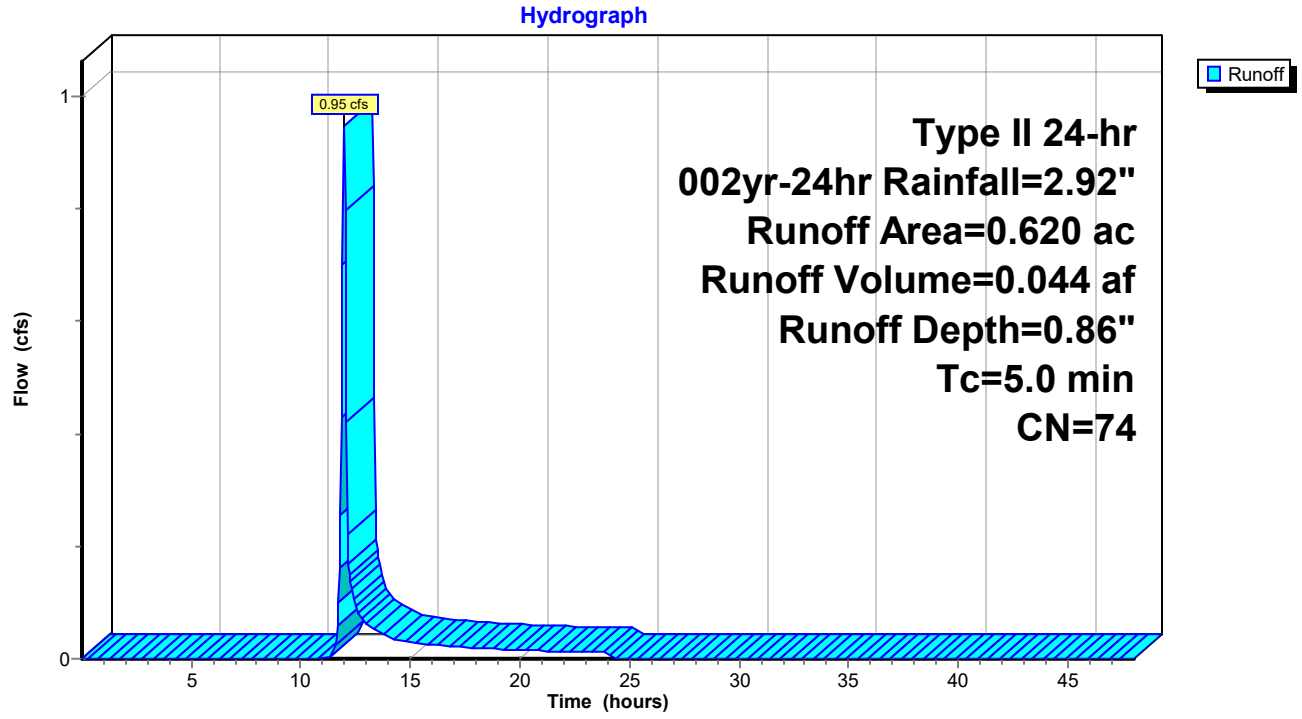
Runoff = 0.95 cfs @ 11.97 hrs, Volume= 0.044 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 002yr-24hr Rainfall=2.92"

| Area (ac) | CN | Description |
|---|---|---|
| 0.620 | 74 | >75% Grass cover, Good, HSG C |
| 0.620 | | 100.00% Pervious Area |

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

### Subcatchment 2S: PR-EAST



## Summary for Subcatchment 3S: PR3

[49] Hint: Tc<2dt may require smaller dt

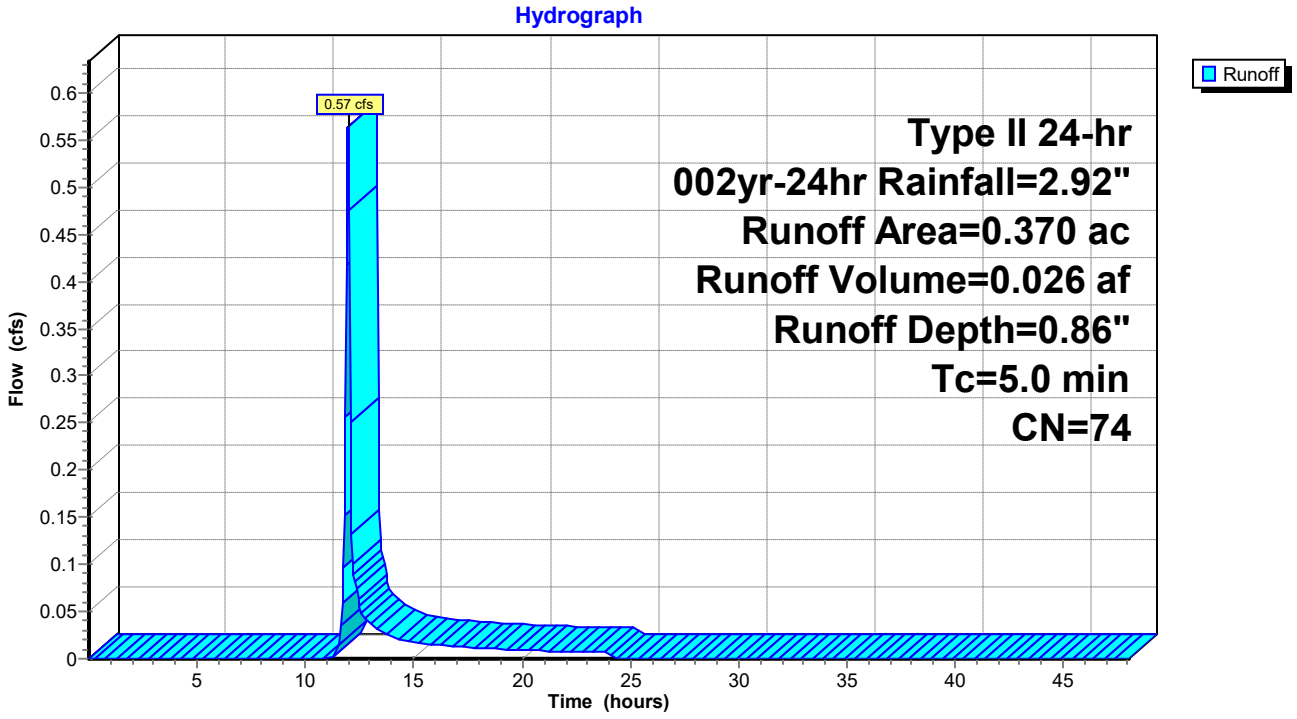
Runoff = 0.57 cfs @ 11.97 hrs, Volume= 0.026 af, Depth= 0.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 002yr-24hr Rainfall=2.92"

| Area (ac) | CN | Description |
|---|---|---|
| 0.370 | 74 | >75% Grass cover, Good, HSG C |
| 0.370 | | 100.00% Pervious Area |

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

## Subcatchment 3S: PR3



## Summary for Subcatchment 4S: PR4

[49] Hint: Tc<2dt may require smaller dt

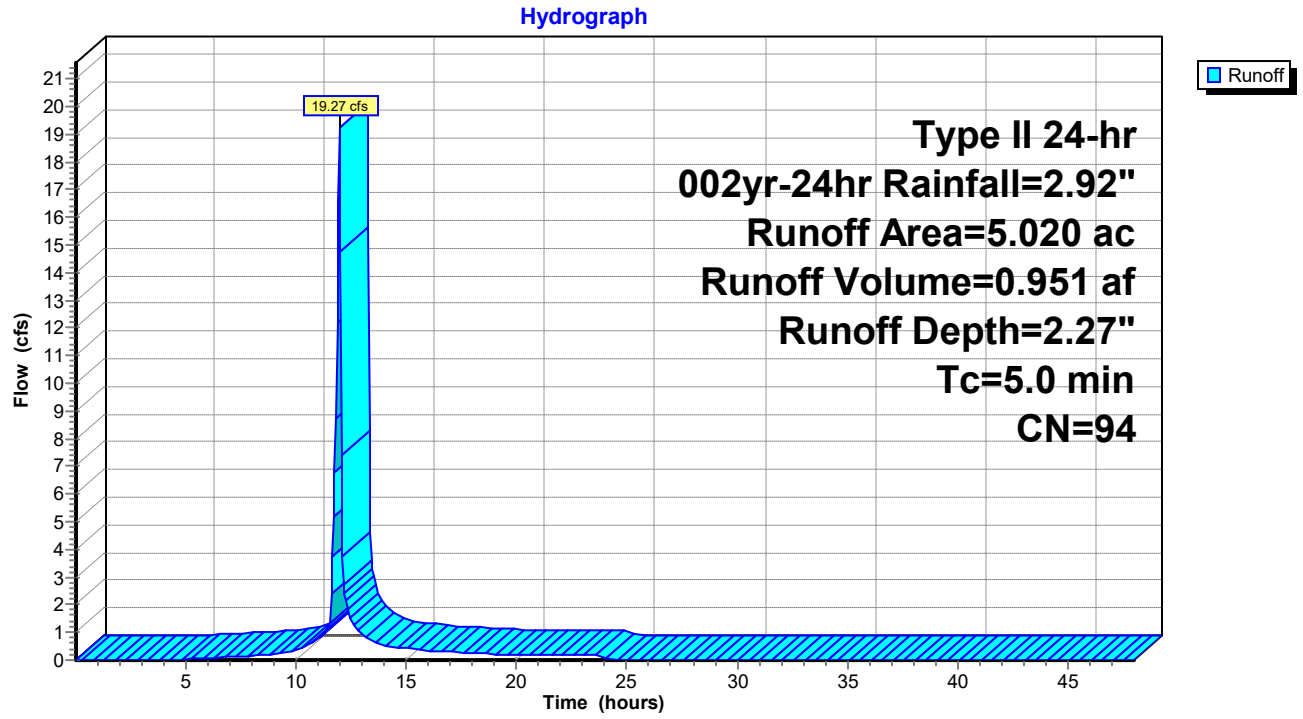
Runoff = 19.27 cfs @ 11.95 hrs, Volume= 0.951 af, Depth= 2.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 002yr-24hr Rainfall=2.92"

| Area (ac) | CN | Description |
|---|---|---|
| 0.350 | 98 | Water Surface, HSG C |
| 4.670 | 94 | Urban commercial, 85% imp, HSG C |
| 5.020 | 94 | Weighted Average |
| 0.700 | | 13.95% Pervious Area |
| 4.320 | | 86.05% Impervious Area |

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

### Subcatchment 4S: PR4



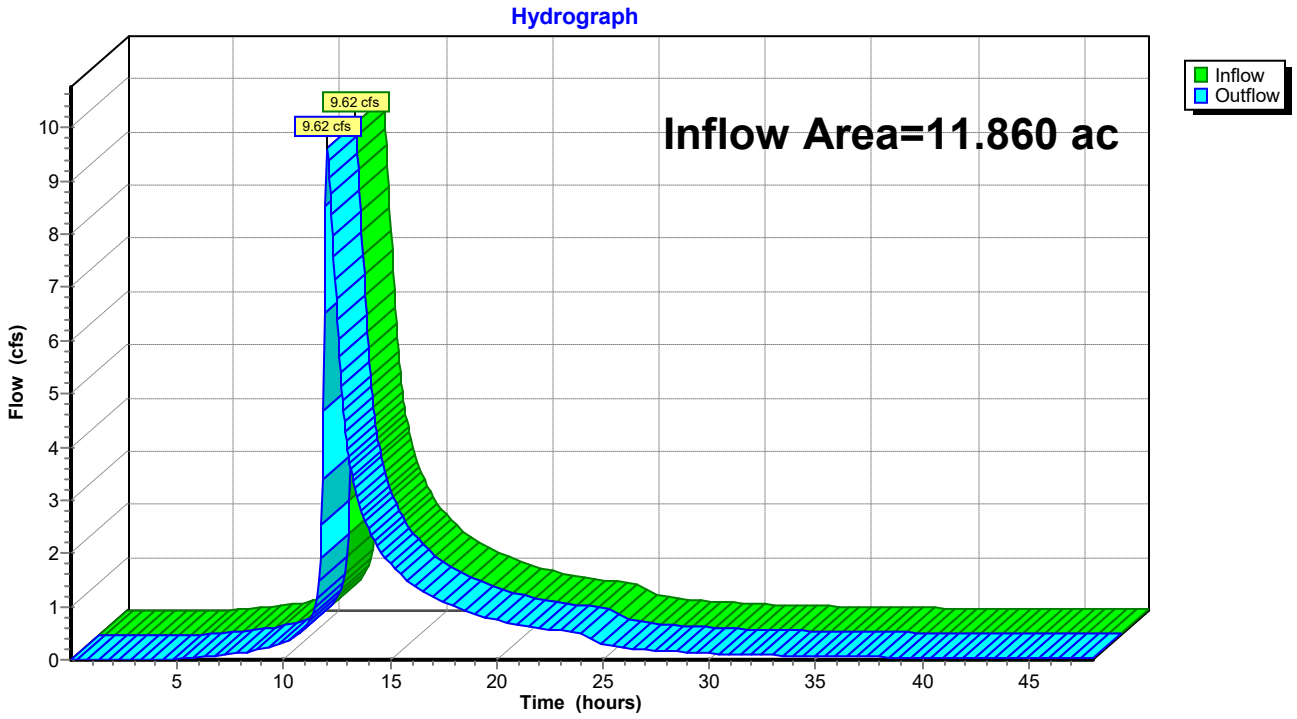
## Summary for Reach 2R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.860 ac, 78.98% Impervious, Inflow Depth > 2.13" for 002yr-24hr event
Inflow = 9.62 cfs @ 12.03 hrs, Volume= 2.105 af
Outflow = 9.62 cfs @ 12.03 hrs, Volume= 2.105 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2

### Reach 2R: US 31 DITCH



## Summary for Pond 1P: DET BASIN 1

Inflow Area = 5.850 ac, 86.28% Impervious, Inflow Depth = 2.37" for 002yr-24hr event
Inflow = 19.70 cfs @ 12.01 hrs, Volume= 1.156 af
Outflow = 1.99 cfs @ 12.51 hrs, Volume= 1.083 af, Atten= 90%, Lag= 30.1 min
Primary = 1.99 cfs @ 12.51 hrs, Volume= 1.083 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 755.25' @ 12.51 hrs Surf.Area= 35,239 sf Storage= 29,110 cf

Plug-Flow detention time= 360.3 min calculated for 1.083 af (94% of inflow)
Center-of-Mass det. time= 324.7 min ( 1,109.0 - 784.2 )

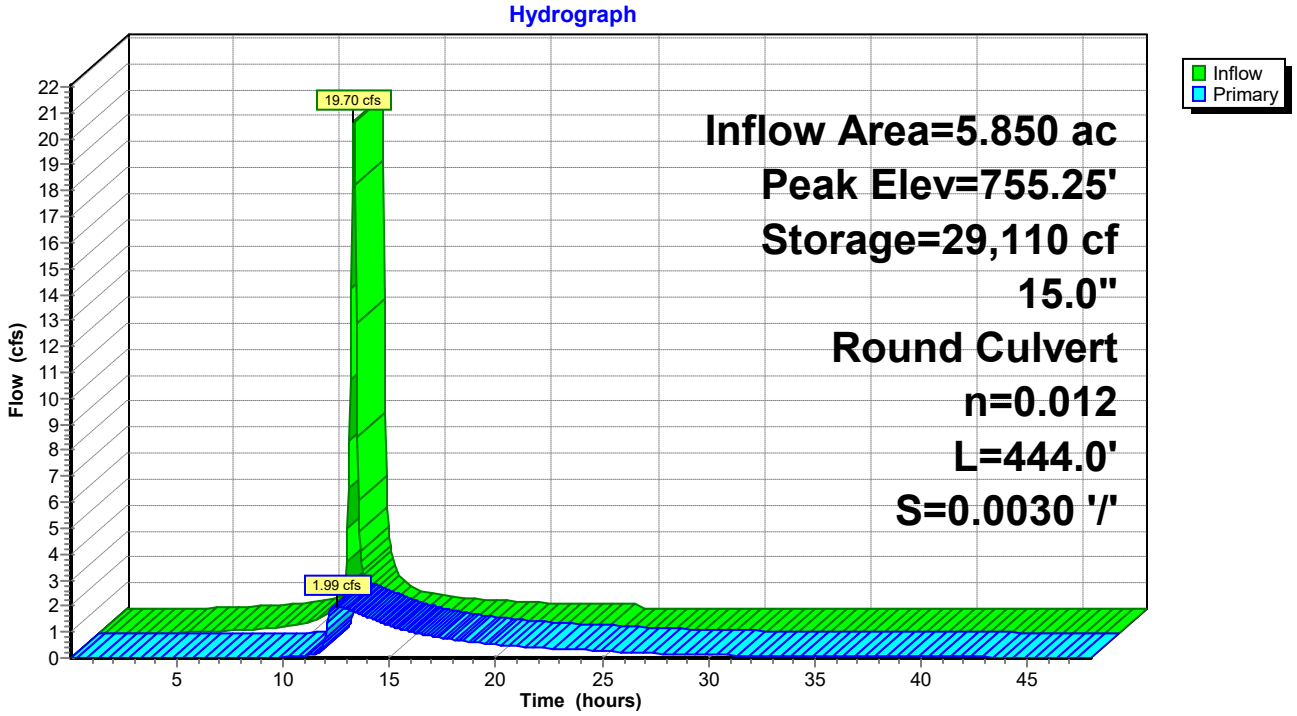
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 754.40' | 154,550 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 754.40 | 32,900 | 0 | 0 |
| 755.00 | 34,500 | 20,220 | 20,220 |
| 756.00 | 37,400 | 35,950 | 56,170 |
| 757.00 | 40,300 | 38,850 | 95,020 |
| 758.00 | 43,400 | 41,850 | 136,870 |
| 758.40 | 45,000 | 17,680 | 154,550 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 754.40' | **15.0" Round RCP_Round 15"**<br>L= 444.0' RCP, sq.cut end projecting, Ke= 0.500<br>Inlet / Outlet Invert= 754.40' / 753.07' S= 0.0030 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.23 sf |

**Primary OutFlow** Max=1.99 cfs @ 12.51 hrs HW=755.25' TW=0.00' (Dynamic Tailwater)
**1=RCP_Round 15"** (Barrel Controls 1.99 cfs @ 3.13 fps)

## Pond 1P: DET BASIN 1



## Summary for Pond 2P: DET BASIN 2

Inflow Area = 5.020 ac, 86.05% Impervious, Inflow Depth = 2.27" for 002yr-24hr event
Inflow = 19.27 cfs @ 11.95 hrs, Volume= 0.951 af
Outflow = 7.43 cfs @ 12.07 hrs, Volume= 0.951 af, Atten= 61%, Lag= 7.0 min
Primary = 7.43 cfs @ 12.07 hrs, Volume= 0.951 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 753.40' @ 12.07 hrs Surf.Area= 9,110 sf Storage= 12,422 cf

Plug-Flow detention time= 29.2 min calculated for 0.950 af (100% of inflow)
Center-of-Mass det. time= 29.3 min ( 815.3 - 786.0 )

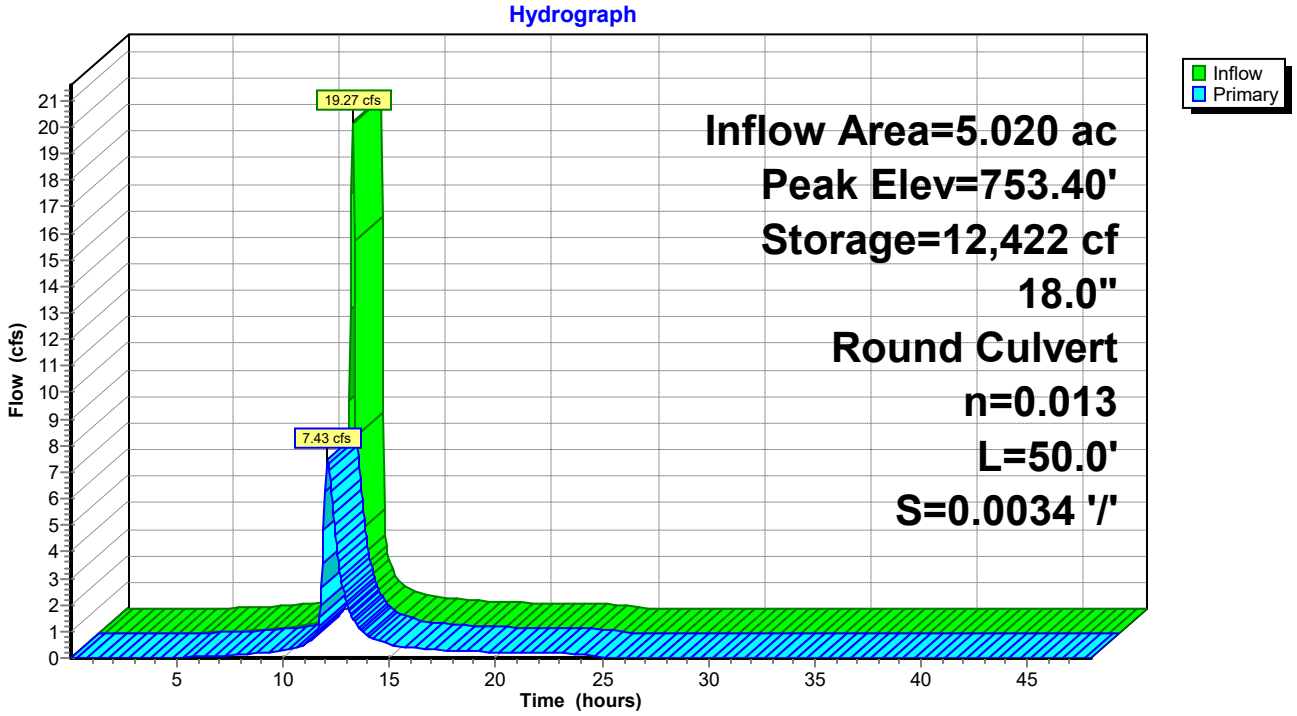
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 751.50' | 41,420 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 751.50 | 0 | 0 | 0 |
| 752.00 | 6,200 | 1,550 | 1,550 |
| 753.00 | 8,520 | 7,360 | 8,910 |
| 754.00 | 10,000 | 9,260 | 18,170 |
| 755.00 | 11,600 | 10,800 | 28,970 |
| 756.00 | 13,300 | 12,450 | 41,420 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 751.50' | **18.0" Round RCP_Round 18"**<br>L= 50.0' RCP, end-section conforming to fill, Ke= 0.500<br>Inlet / Outlet Invert= 751.50' / 751.33' S= 0.0034 '/' Cc= 0.900<br>n= 0.013 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=7.40 cfs @ 12.07 hrs HW=753.39' TW=0.00' (Dynamic Tailwater)
↑—**1=RCP_Round 18"** (Barrel Controls 7.40 cfs @ 4.28 fps)

## Pond 2P: DET BASIN 2



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: PR1** Runoff Area=5.850 ac 86.28% Impervious Runoff Depth=3.52"
Tc=10.0 min CN=95 Runoff=28.54 cfs 1.716 af

**Subcatchment 2S: PR-EAST** Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=1.66"
Tc=5.0 min CN=74 Runoff=1.88 cfs 0.086 af

**Subcatchment 3S: PR3** Runoff Area=0.370 ac 0.00% Impervious Runoff Depth=1.66"
Tc=5.0 min CN=74 Runoff=1.12 cfs 0.051 af

**Subcatchment 4S: PR4** Runoff Area=5.020 ac 86.05% Impervious Runoff Depth=3.41"
Tc=5.0 min CN=94 Runoff=28.15 cfs 1.428 af

**Reach 2R: US 31 DITCH** Inflow=14.28 cfs 3.205 af
Outflow=14.28 cfs 3.205 af

**Pond 1P: DET BASIN 1** Peak Elev=755.62' Storage=42,051 cf Inflow=28.54 cfs 1.716 af
15.0" Round Culvert n=0.012 L=444.0' S=0.0030 '/' Outflow=3.39 cfs 1.640 af

**Pond 2P: DET BASIN 2** Peak Elev=754.06' Storage=18,765 cf Inflow=28.15 cfs 1.428 af
18.0" Round Culvert n=0.013 L=50.0' S=0.0034 '/' Outflow=10.12 cfs 1.428 af

**Total Runoff Area = 11.860 ac Runoff Volume = 3.281 af Average Runoff Depth = 3.32"**
**21.02% Pervious = 2.493 ac 78.98% Impervious = 9.367 ac**

## Summary for Subcatchment 1S: PR1

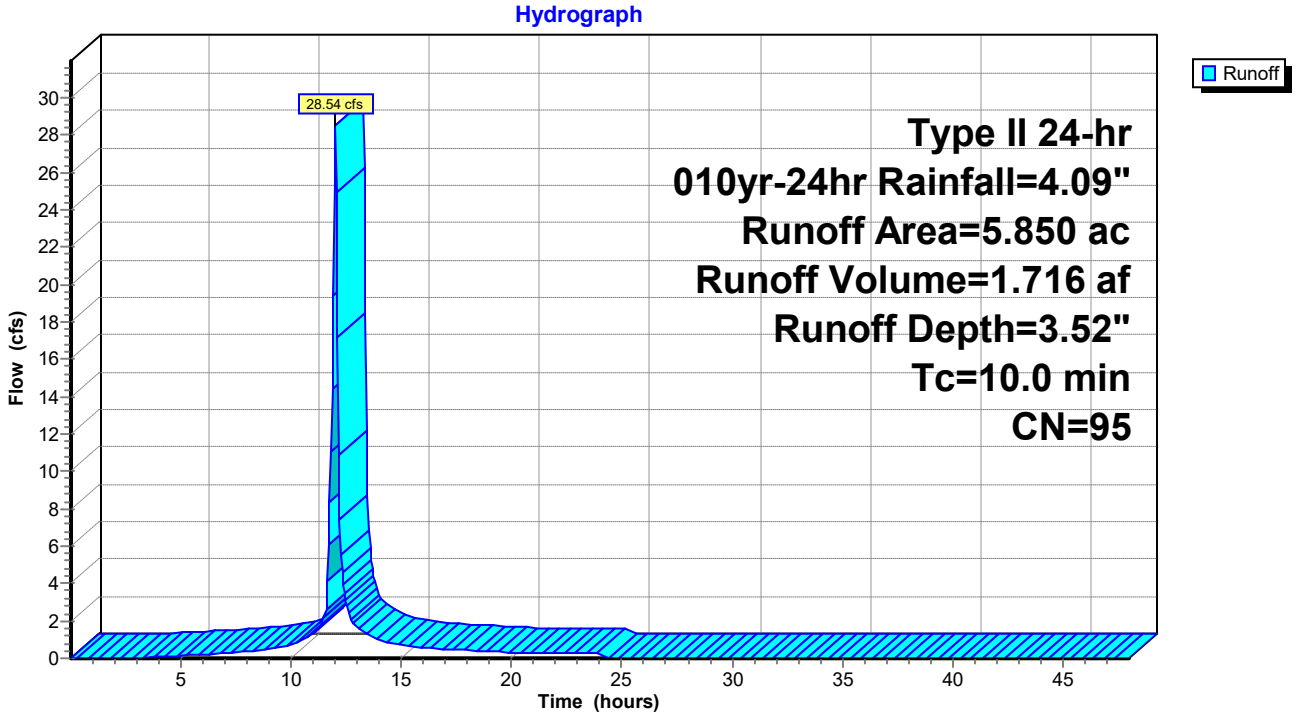
Runoff = 28.54 cfs @ 12.01 hrs, Volume= 1.716 af, Depth= 3.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (ac) | CN | Description |
|---|---|---|
| 5.350 | 95 | Urban commercial, 85% imp, HSG D |
| 0.500 | 98 | Water Surface, HSG C |
| 5.850 | 95 | Weighted Average |
| 0.802 | | 13.72% Pervious Area |
| 5.047 | | 86.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, Direct Entry** |

### Subcatchment 1S: PR1



## Summary for Subcatchment 2S: PR-EAST

[49] Hint: Tc<2dt may require smaller dt

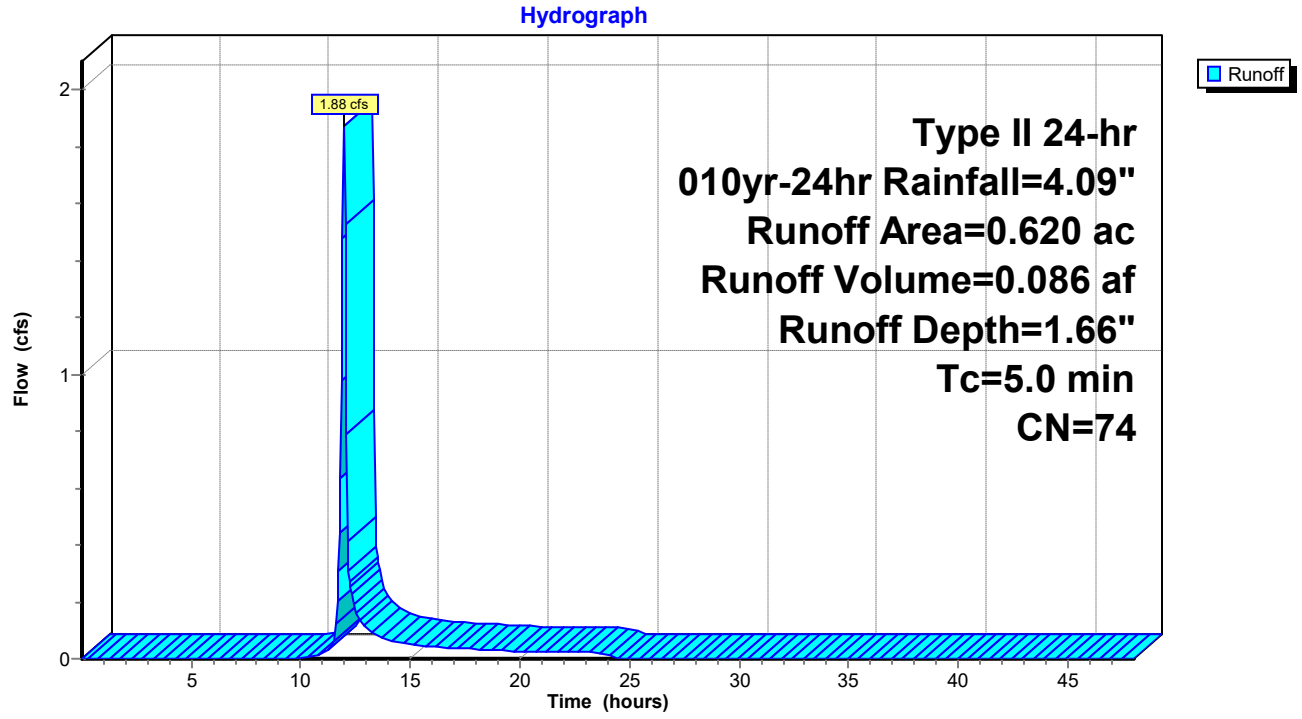
Runoff = 1.88 cfs @ 11.96 hrs, Volume= 0.086 af, Depth= 1.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (ac) | CN | Description |
|---|---|---|
| 0.620 | 74 | >75% Grass cover, Good, HSG C |
| 0.620 | | 100.00% Pervious Area |

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

### Subcatchment 2S: PR-EAST



## Summary for Subcatchment 3S: PR3

[49] Hint: Tc<2dt may require smaller dt

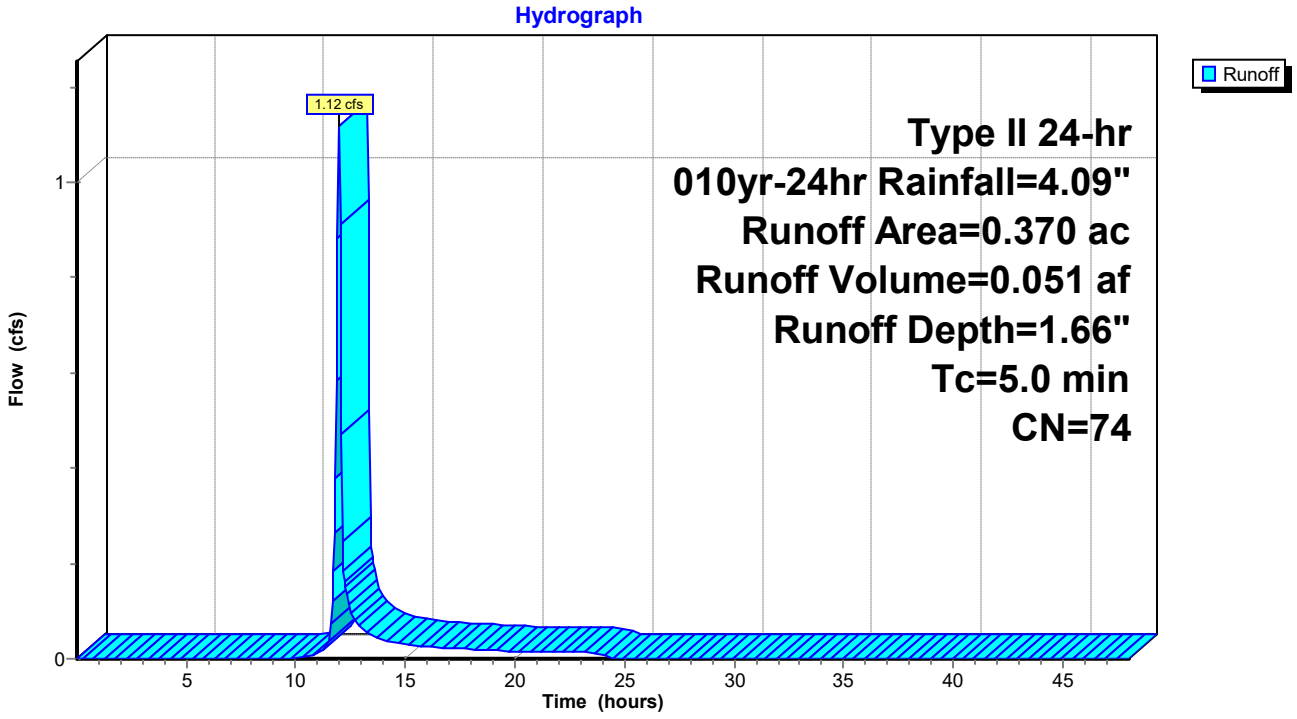
Runoff = 1.12 cfs @ 11.96 hrs, Volume= 0.051 af, Depth= 1.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (ac) | CN | Description |
|---|---|---|
| 0.370 | 74 | >75% Grass cover, Good, HSG C |
| 0.370 | | 100.00% Pervious Area |

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

### Subcatchment 3S: PR3



## Summary for Subcatchment 4S: PR4

[49] Hint: Tc<2dt may require smaller dt

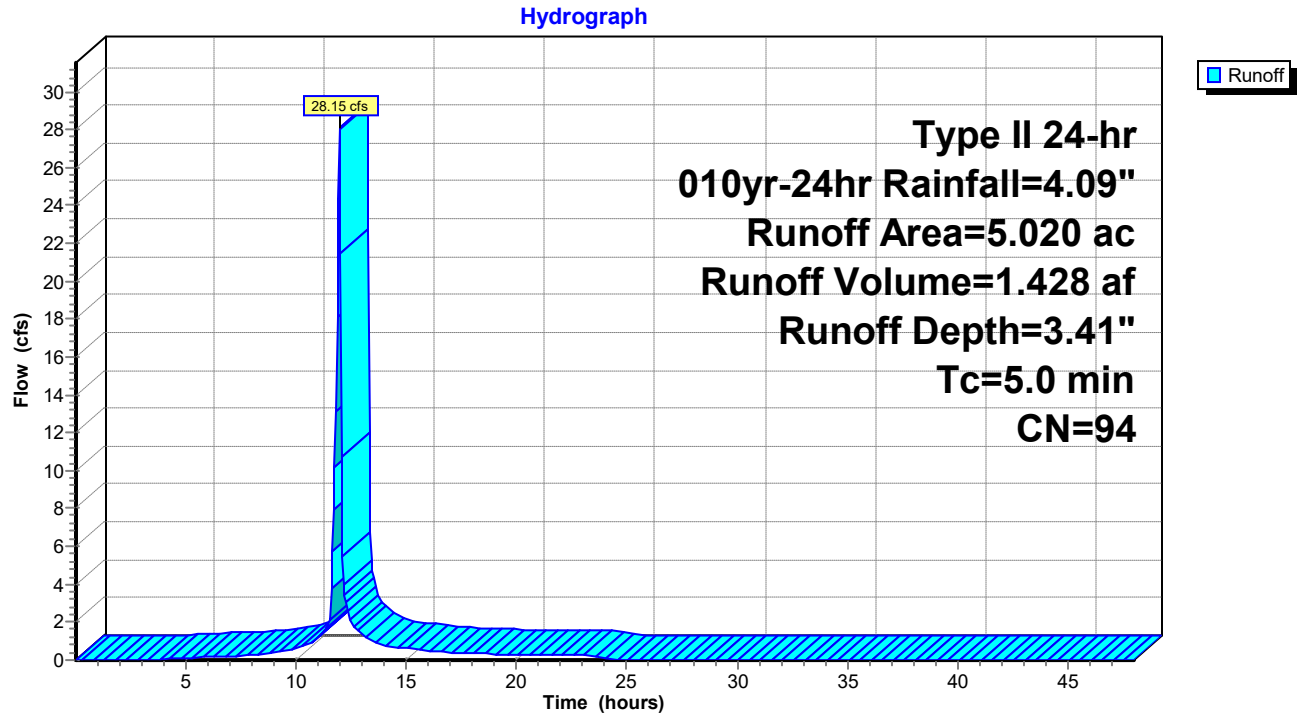
Runoff = 28.15 cfs @ 11.95 hrs, Volume= 1.428 af, Depth= 3.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 010yr-24hr Rainfall=4.09"

| Area (ac) | CN | Description |
|---|---|---|
| 0.350 | 98 | Water Surface, HSG C |
| 4.670 | 94 | Urban commercial, 85% imp, HSG C |
| 5.020 | 94 | Weighted Average |
| 0.700 | | 13.95% Pervious Area |
| 4.320 | | 86.05% Impervious Area |

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

### Subcatchment 4S: PR4



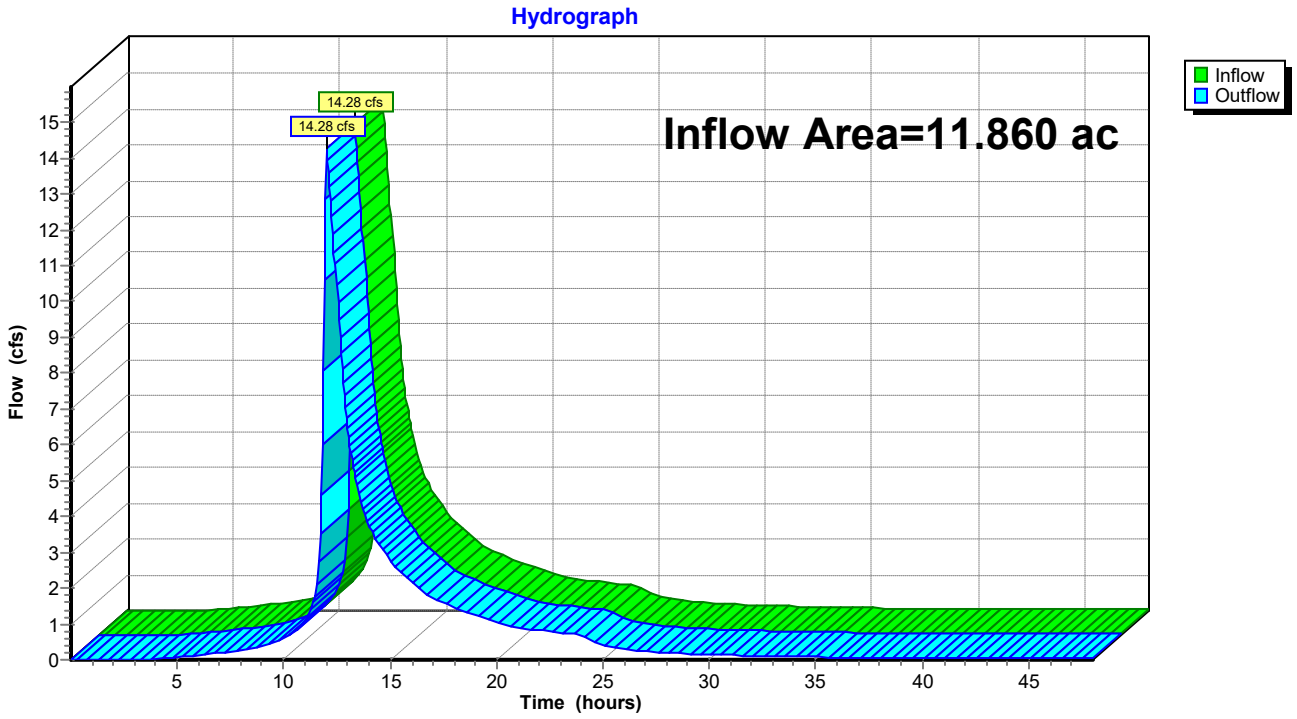
## Summary for Reach 2R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.860 ac, 78.98% Impervious, Inflow Depth > 3.24" for 010yr-24hr event
Inflow = 14.28 cfs @ 12.03 hrs, Volume= 3.205 af
Outflow = 14.28 cfs @ 12.03 hrs, Volume= 3.205 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2

### Reach 2R: US 31 DITCH



## Summary for Pond 1P: DET BASIN 1

Inflow Area = 5.850 ac, 86.28% Impervious, Inflow Depth = 3.52" for 010yr-24hr event
Inflow = 28.54 cfs @ 12.01 hrs, Volume= 1.716 af
Outflow = 3.39 cfs @ 12.43 hrs, Volume= 1.640 af, Atten= 88%, Lag= 25.0 min
Primary = 3.39 cfs @ 12.43 hrs, Volume= 1.640 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 755.62' @ 12.43 hrs Surf.Area= 36,289 sf Storage= 42,051 cf

Plug-Flow detention time= 307.2 min calculated for 1.639 af (96% of inflow)
Center-of-Mass det. time= 282.1 min ( 1,056.0 - 773.9 )

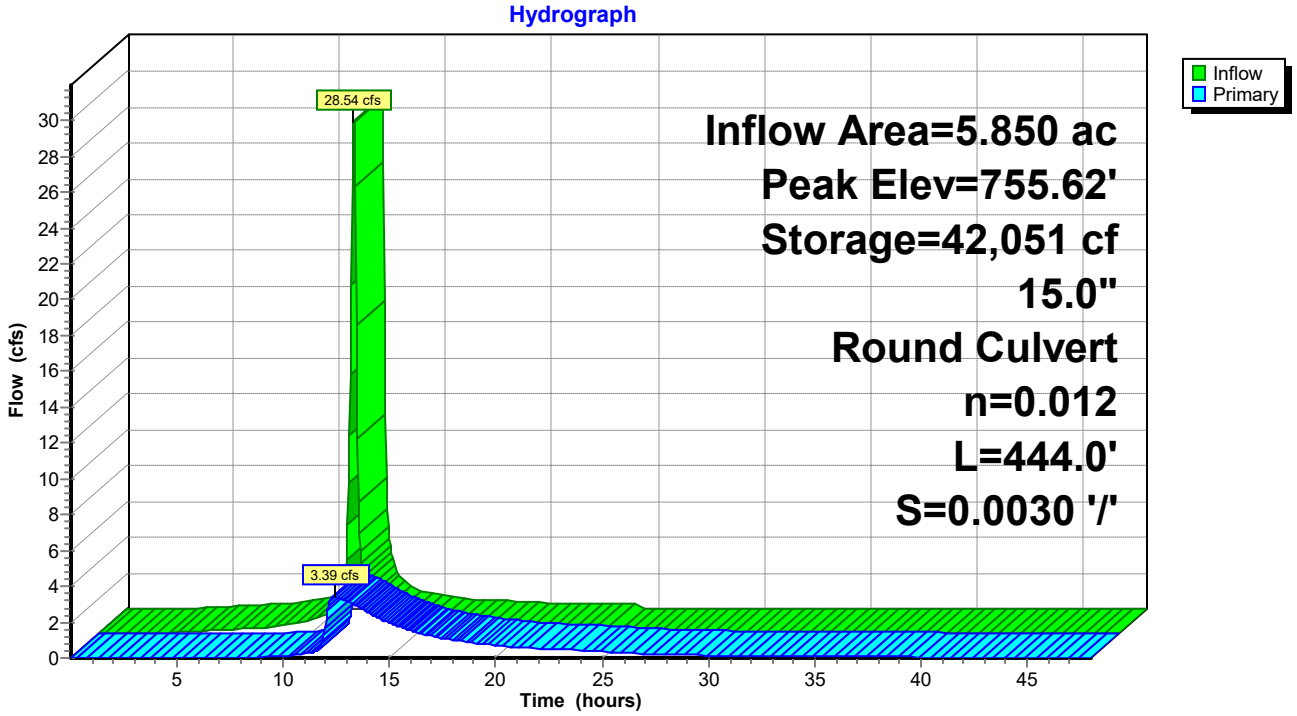
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 754.40' | 154,550 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 754.40 | 32,900 | 0 | 0 |
| 755.00 | 34,500 | 20,220 | 20,220 |
| 756.00 | 37,400 | 35,950 | 56,170 |
| 757.00 | 40,300 | 38,850 | 95,020 |
| 758.00 | 43,400 | 41,850 | 136,870 |
| 758.40 | 45,000 | 17,680 | 154,550 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 754.40' | **15.0" Round RCP_Round 15"**<br>L= 444.0' RCP, sq.cut end projecting, Ke= 0.500<br>Inlet / Outlet Invert= 754.40' / 753.07' S= 0.0030 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.23 sf |

**Primary OutFlow** Max=3.39 cfs @ 12.43 hrs HW=755.62' TW=0.00' (Dynamic Tailwater)
↑**1=RCP_Round 15"** (Barrel Controls 3.39 cfs @ 3.53 fps)

## Pond 1P: DET BASIN 1



## Summary for Pond 2P: DET BASIN 2

Inflow Area = 5.020 ac, 86.05% Impervious, Inflow Depth = 3.41" for 010yr-24hr event
Inflow = 28.15 cfs @ 11.95 hrs, Volume= 1.428 af
Outflow = 10.12 cfs @ 12.07 hrs, Volume= 1.428 af, Atten= 64%, Lag= 7.2 min
Primary = 10.12 cfs @ 12.07 hrs, Volume= 1.428 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 754.06' @ 12.07 hrs Surf.Area= 10,095 sf Storage= 18,765 cf

Plug-Flow detention time= 29.7 min calculated for 1.426 af (100% of inflow)
Center-of-Mass det. time= 29.7 min ( 804.8 - 775.0 )

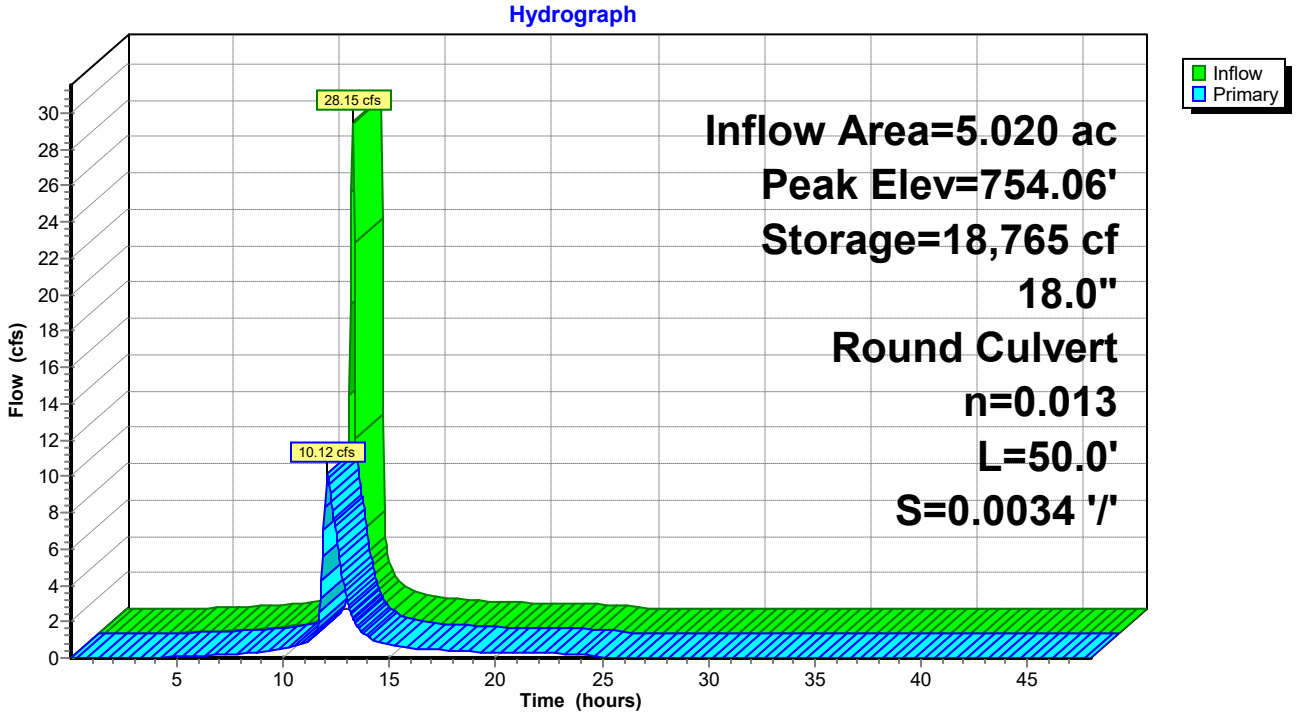
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 751.50' | 41,420 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 751.50 | 0 | 0 | 0 |
| 752.00 | 6,200 | 1,550 | 1,550 |
| 753.00 | 8,520 | 7,360 | 8,910 |
| 754.00 | 10,000 | 9,260 | 18,170 |
| 755.00 | 11,600 | 10,800 | 28,970 |
| 756.00 | 13,300 | 12,450 | 41,420 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 751.50' | **18.0" Round RCP_Round 18"**<br>L= 50.0' RCP, end-section conforming to fill, Ke= 0.500<br>Inlet / Outlet Invert= 751.50' / 751.33' S= 0.0034 '/' Cc= 0.900<br>n= 0.013 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=10.06 cfs @ 12.07 hrs HW=754.04' TW=0.00' (Dynamic Tailwater)
↑**1=RCP_Round 18"** (Barrel Controls 10.06 cfs @ 5.69 fps)

## Pond 2P: DET BASIN 2



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: PR1** Runoff Area=5.850 ac 86.28% Impervious Runoff Depth=4.21"
Tc=10.0 min CN=95 Runoff=33.79 cfs 2.053 af

**Subcatchment 2S: PR-EAST** Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=2.20"
Tc=5.0 min CN=74 Runoff=2.48 cfs 0.114 af

**Subcatchment 3S: PR3** Runoff Area=0.370 ac 0.00% Impervious Runoff Depth=2.20"
Tc=5.0 min CN=74 Runoff=1.48 cfs 0.068 af

**Subcatchment 4S: PR4** Runoff Area=5.020 ac 86.05% Impervious Runoff Depth=4.10"
Tc=5.0 min CN=94 Runoff=33.42 cfs 1.716 af

**Reach 2R: US 31 DITCH** Inflow=17.01 cfs 3.873 af
Outflow=17.01 cfs 3.873 af

**Pond 1P: DET BASIN 1** Peak Elev=755.83' Storage=49,781 cf Inflow=33.79 cfs 2.053 af
15.0" Round Culvert n=0.012 L=444.0' S=0.0030 '/' Outflow=4.04 cfs 1.976 af

**Pond 2P: DET BASIN 2** Peak Elev=754.43' Storage=22,643 cf Inflow=33.42 cfs 1.716 af
18.0" Round Culvert n=0.013 L=50.0' S=0.0034 '/' Outflow=11.55 cfs 1.716 af

**Total Runoff Area = 11.860 ac Runoff Volume = 3.950 af Average Runoff Depth = 4.00"**
**21.02% Pervious = 2.493 ac 78.98% Impervious = 9.367 ac**

## Summary for Subcatchment 1S: PR1

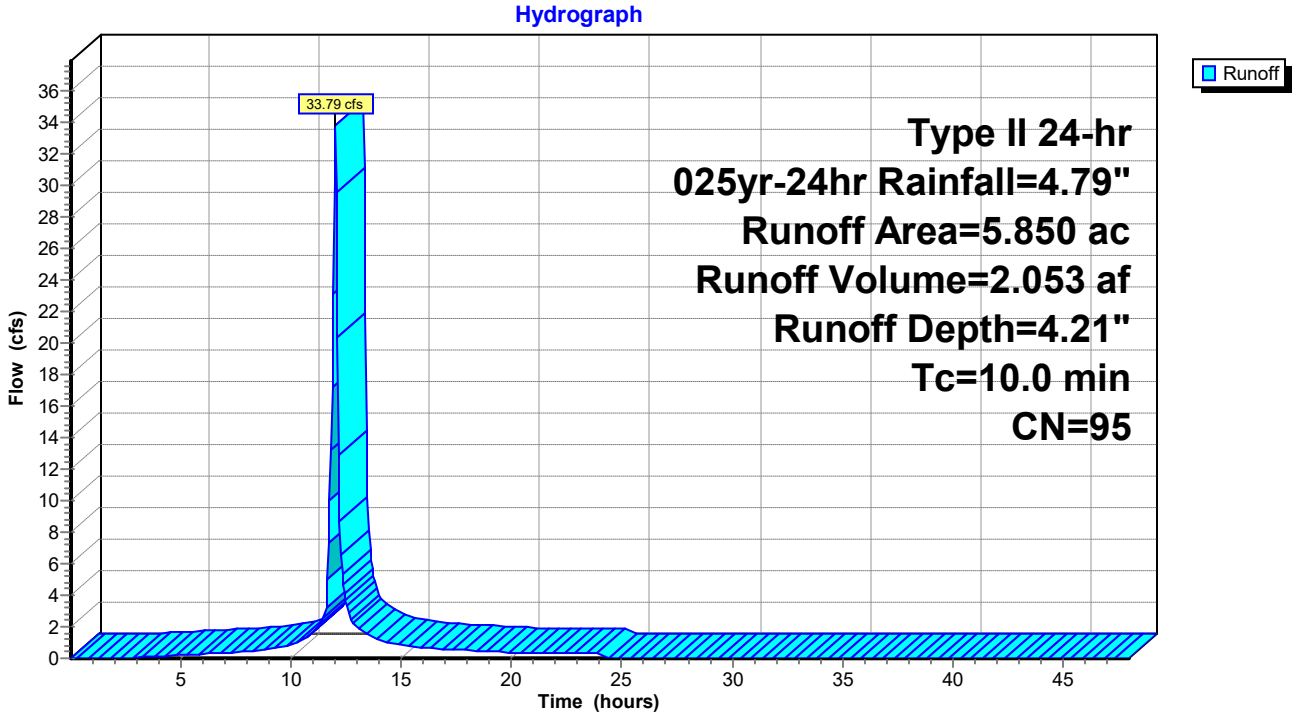
Runoff = 33.79 cfs @ 12.01 hrs, Volume= 2.053 af, Depth= 4.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (ac) | CN | Description |
|---|---|---|
| 5.350 | 95 | Urban commercial, 85% imp, HSG D |
| 0.500 | 98 | Water Surface, HSG C |
| 5.850 | 95 | Weighted Average |
| 0.802 | | 13.72% Pervious Area |
| 5.047 | | 86.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, Direct Entry** |

## Subcatchment 1S: PR1



## Summary for Subcatchment 2S: PR-EAST

[49] Hint: Tc<2dt may require smaller dt

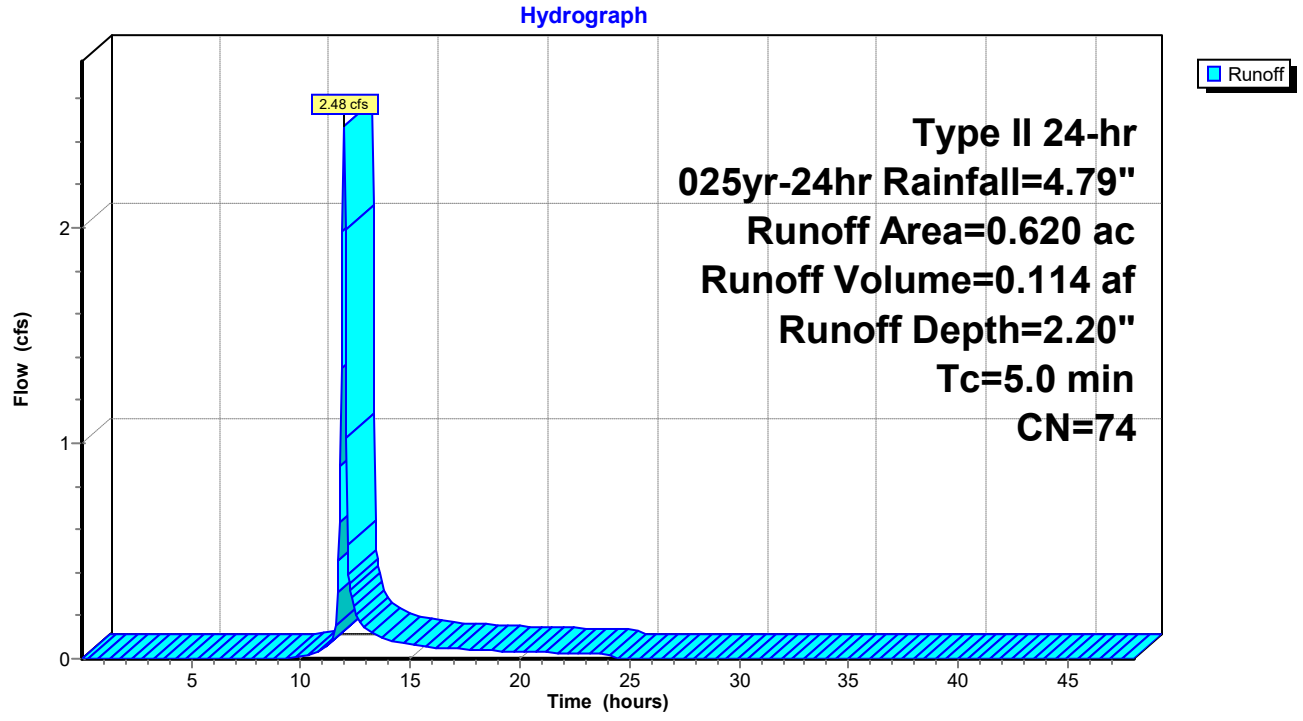
Runoff = 2.48 cfs @ 11.96 hrs, Volume= 0.114 af, Depth= 2.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (ac) | CN | Description |
|---|---|---|
| 0.620 | 74 | >75% Grass cover, Good, HSG C |
| 0.620 | | 100.00% Pervious Area |

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

### Subcatchment 2S: PR-EAST



## Summary for Subcatchment 3S: PR3

[49] Hint: Tc<2dt may require smaller dt

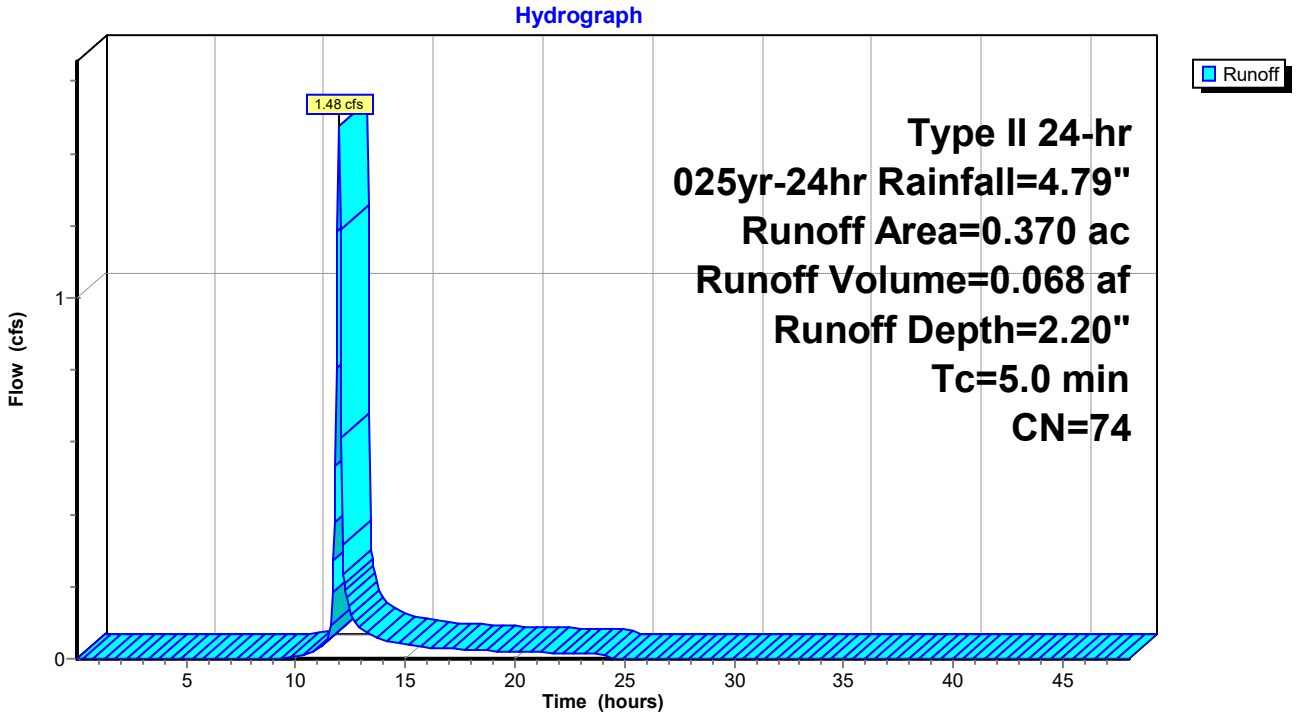
Runoff = 1.48 cfs @ 11.96 hrs, Volume= 0.068 af, Depth= 2.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (ac) | CN | Description |
|---|---|---|
| 0.370 | 74 | >75% Grass cover, Good, HSG C |
| 0.370 | | 100.00% Pervious Area |

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

### Subcatchment 3S: PR3



## Summary for Subcatchment 4S: PR4

[49] Hint: Tc<2dt may require smaller dt

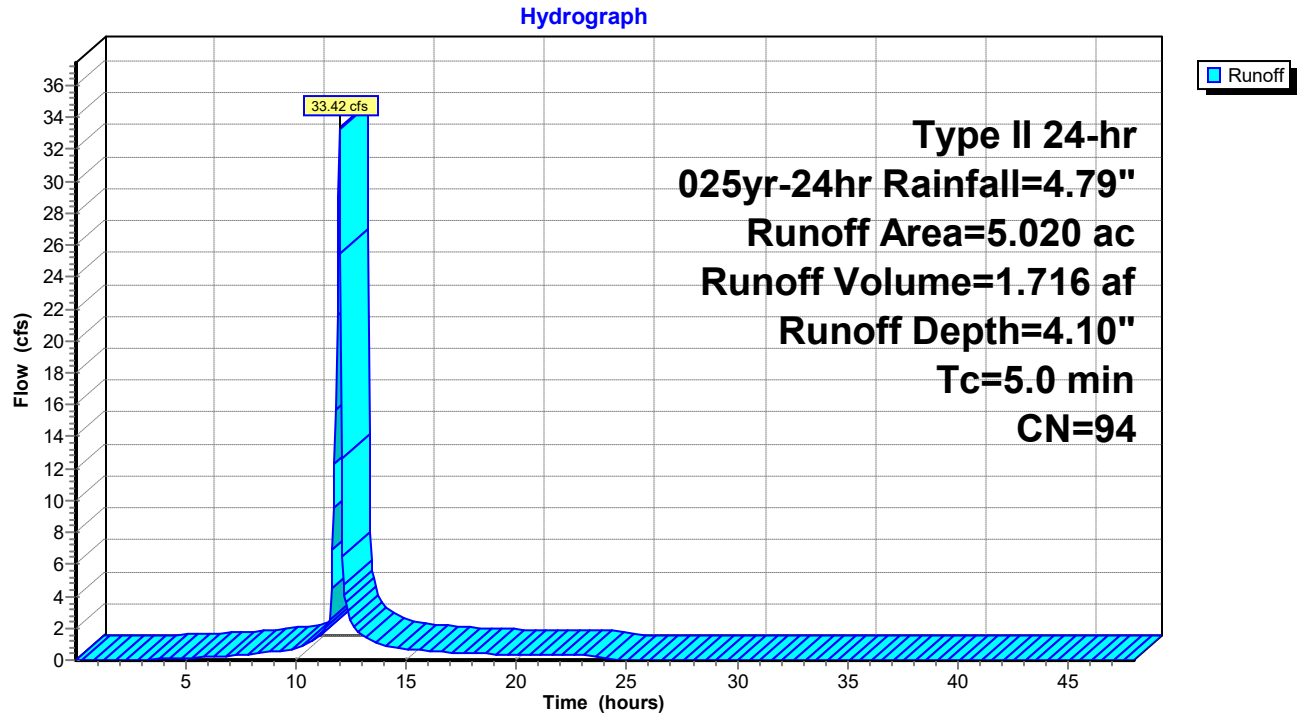
Runoff = 33.42 cfs @ 11.95 hrs, Volume= 1.716 af, Depth= 4.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr 025yr-24hr Rainfall=4.79"

| Area (ac) | CN | Description |
|---|---|---|
| 0.350 | 98 | Water Surface, HSG C |
| 4.670 | 94 | Urban commercial, 85% imp, HSG C |
| 5.020 | 94 | Weighted Average |
| 0.700 | | 13.95% Pervious Area |
| 4.320 | | 86.05% Impervious Area |

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

## Subcatchment 4S: PR4



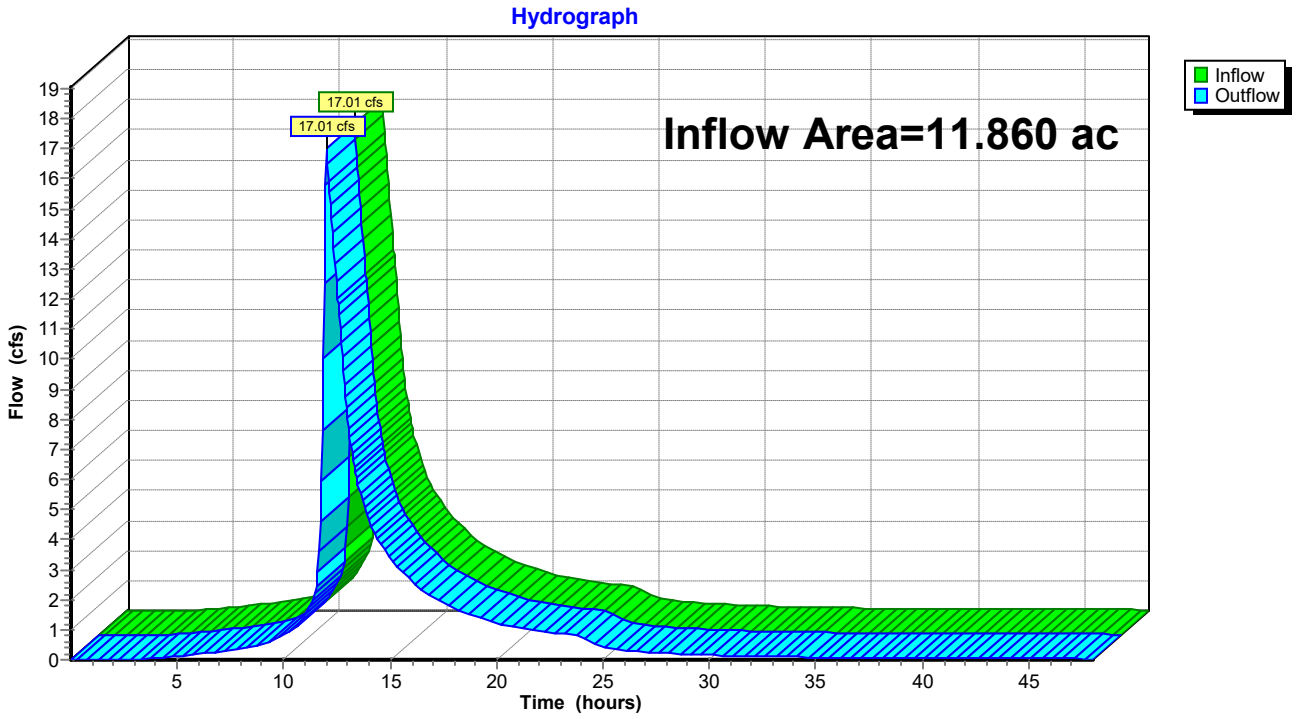
## Summary for Reach 2R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.860 ac, 78.98% Impervious, Inflow Depth > 3.92" for 025yr-24hr event
Inflow = 17.01 cfs @ 12.02 hrs, Volume= 3.873 af
Outflow = 17.01 cfs @ 12.02 hrs, Volume= 3.873 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2

### Reach 2R: US 31 DITCH



## Summary for Pond 1P: DET BASIN 1

Inflow Area = 5.850 ac, 86.28% Impervious, Inflow Depth = 4.21" for 025yr-24hr event
Inflow = 33.79 cfs @ 12.01 hrs, Volume= 2.053 af
Outflow = 4.04 cfs @ 12.42 hrs, Volume= 1.976 af, Atten= 88%, Lag= 24.8 min
Primary = 4.04 cfs @ 12.42 hrs, Volume= 1.976 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 755.83' @ 12.42 hrs Surf.Area= 36,901 sf Storage= 49,781 cf

Plug-Flow detention time= 289.3 min calculated for 1.974 af (96% of inflow)
Center-of-Mass det. time= 267.7 min ( 1,037.2 - 769.5 )

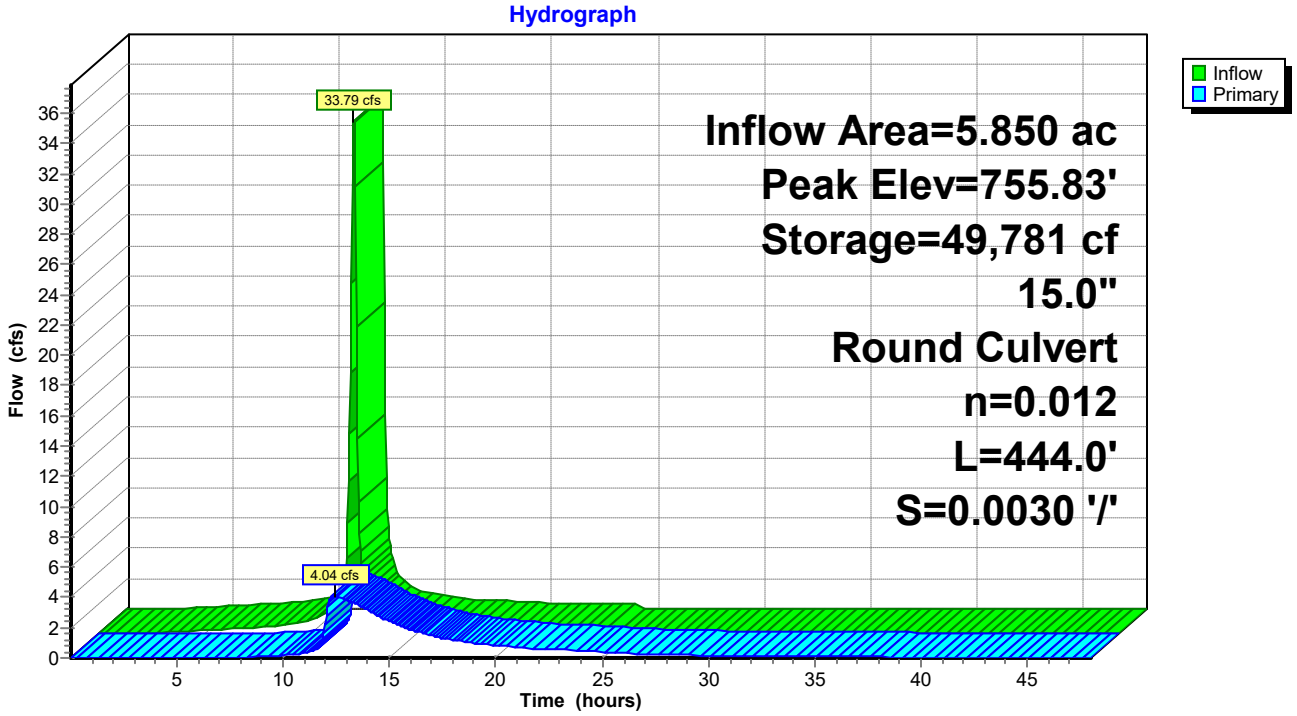
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 754.40' | 154,550 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 754.40 | 32,900 | 0 | 0 |
| 755.00 | 34,500 | 20,220 | 20,220 |
| 756.00 | 37,400 | 35,950 | 56,170 |
| 757.00 | 40,300 | 38,850 | 95,020 |
| 758.00 | 43,400 | 41,850 | 136,870 |
| 758.40 | 45,000 | 17,680 | 154,550 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 754.40' | **15.0" Round RCP_Round 15"**<br>L= 444.0' RCP, sq.cut end projecting, Ke= 0.500<br>Inlet / Outlet Invert= 754.40' / 753.07' S= 0.0030 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.23 sf |

**Primary OutFlow** Max=4.04 cfs @ 12.42 hrs HW=755.83' TW=0.00' (Dynamic Tailwater)
↑**1=RCP_Round 15"** (Barrel Controls 4.04 cfs @ 3.61 fps)

## Pond 1P: DET BASIN 1



## Summary for Pond 2P: DET BASIN 2

Inflow Area = 5.020 ac, 86.05% Impervious, Inflow Depth = 4.10" for 025yr-24hr event
Inflow = 33.42 cfs @ 11.95 hrs, Volume= 1.716 af
Outflow = 11.55 cfs @ 12.08 hrs, Volume= 1.716 af, Atten= 65%, Lag= 7.3 min
Primary = 11.55 cfs @ 12.08 hrs, Volume= 1.716 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 754.43' @ 12.08 hrs Surf.Area= 10,692 sf Storage= 22,643 cf

Plug-Flow detention time= 30.0 min calculated for 1.714 af (100% of inflow)
Center-of-Mass det. time= 30.1 min ( 800.4 - 770.3 )

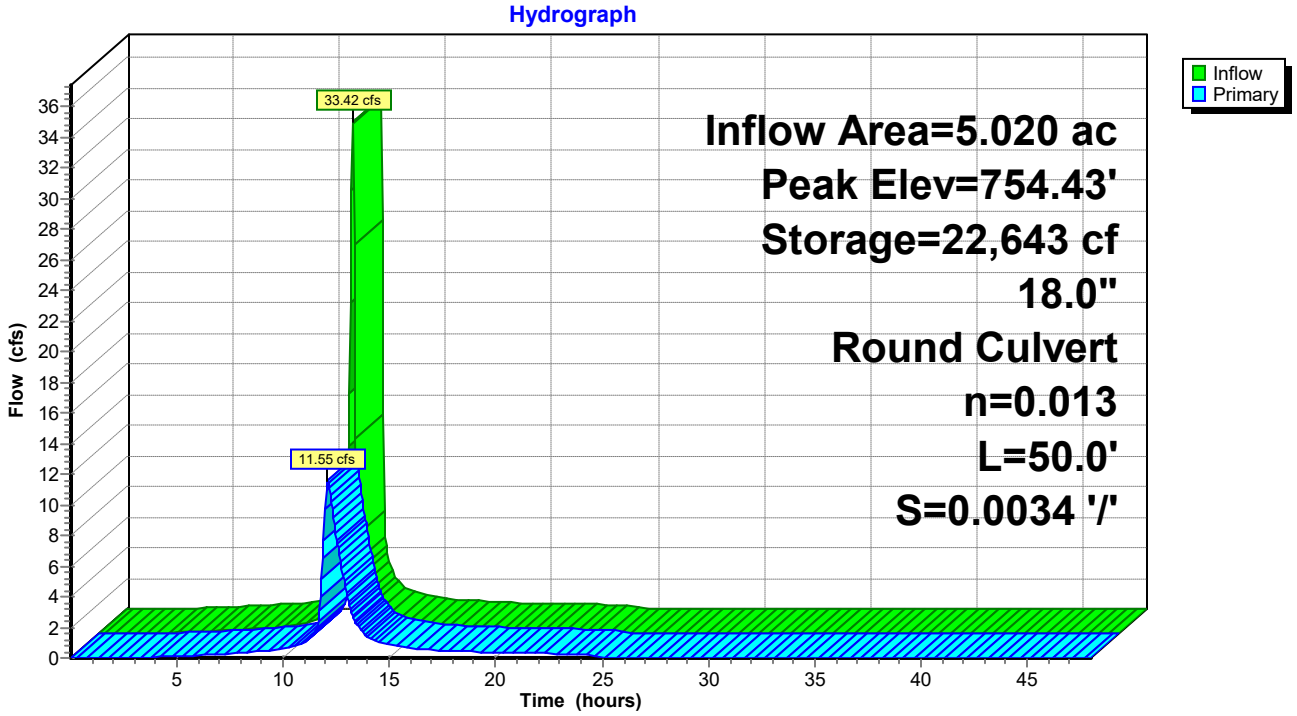
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 751.50' | 41,420 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 751.50 | 0 | 0 | 0 |
| 752.00 | 6,200 | 1,550 | 1,550 |
| 753.00 | 8,520 | 7,360 | 8,910 |
| 754.00 | 10,000 | 9,260 | 18,170 |
| 755.00 | 11,600 | 10,800 | 28,970 |
| 756.00 | 13,300 | 12,450 | 41,420 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 751.50' | **18.0" Round RCP_Round 18"**<br>L= 50.0' RCP, end-section conforming to fill, Ke= 0.500<br>Inlet / Outlet Invert= 751.50' / 751.33' S= 0.0034 '/' Cc= 0.900<br>n= 0.013 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=11.49 cfs @ 12.08 hrs HW=754.41' TW=0.00' (Dynamic Tailwater)
**1=RCP_Round 18"** (Barrel Controls 11.49 cfs @ 6.50 fps)

## Pond 2P: DET BASIN 2



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: PR1** Runoff Area=5.850 ac 86.28% Impervious Runoff Depth=4.20"
Tc=10.0 min CN=95 Runoff=40.08 cfs 2.048 af

**Subcatchment 2S: PR-EAST** Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=2.19"
Tc=5.0 min CN=74 Runoff=2.96 cfs 0.113 af

**Subcatchment 3S: PR3** Runoff Area=0.370 ac 0.00% Impervious Runoff Depth=2.19"
Tc=5.0 min CN=74 Runoff=1.77 cfs 0.068 af

**Subcatchment 4S: PR4** Runoff Area=5.020 ac 86.05% Impervious Runoff Depth=4.09"
Tc=5.0 min CN=94 Runoff=39.67 cfs 1.711 af

**Reach 2R: US 31 DITCH** Inflow=19.16 cfs 3.879 af
Outflow=19.16 cfs 3.879 af

**Pond 1P: DET BASIN 1** Peak Elev=755.97' Storage=55,017 cf Inflow=40.08 cfs 2.048 af
15.0" Round Culvert n=0.012 L=444.0' S=0.0030 '/' Outflow=4.26 cfs 1.987 af

**Pond 2P: DET BASIN 2** Peak Elev=754.83' Storage=27,025 cf Inflow=39.67 cfs 1.711 af
18.0" Round Culvert n=0.013 L=50.0' S=0.0034 '/' Outflow=12.91 cfs 1.711 af

**Total Runoff Area = 11.860 ac Runoff Volume = 3.940 af Average Runoff Depth = 3.99"**
**21.02% Pervious = 2.493 ac 78.98% Impervious = 9.367 ac**

## Summary for Subcatchment 1S: PR1

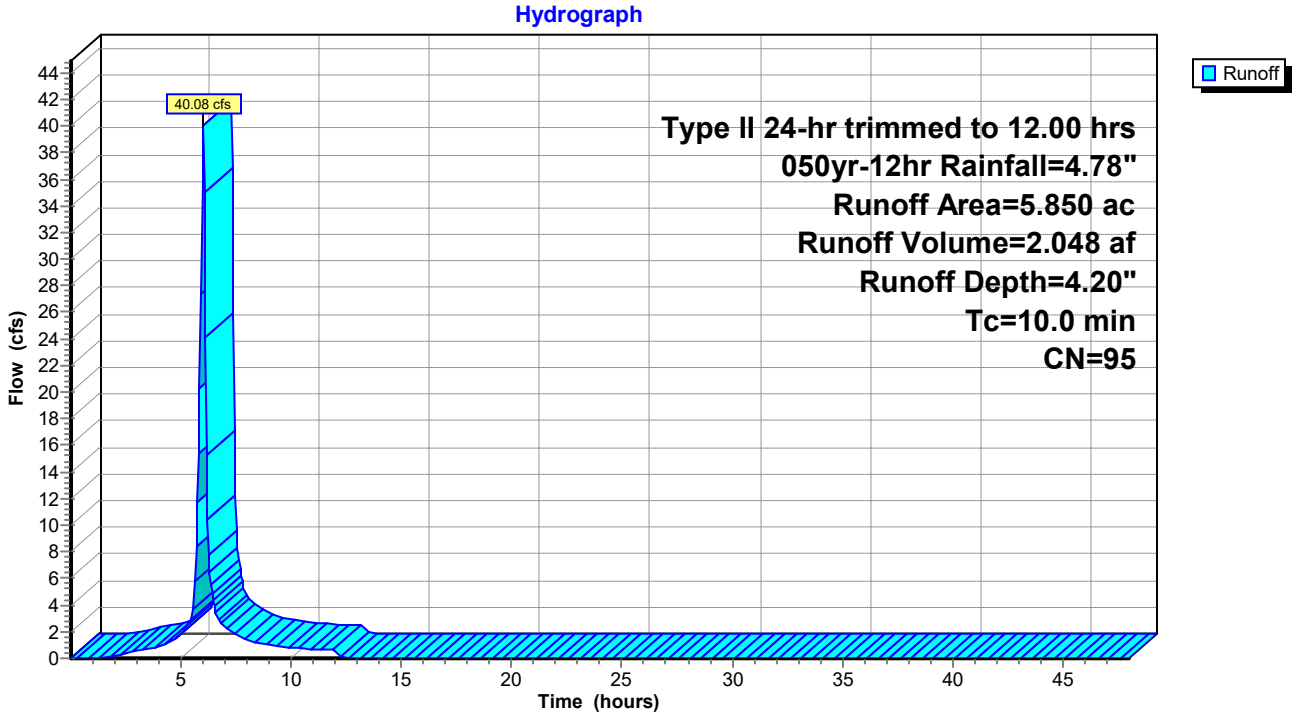
Runoff = 40.08 cfs @ 6.01 hrs, Volume= 2.048 af, Depth= 4.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (ac) | CN | Description |
|---|---|---|
| 5.350 | 95 | Urban commercial, 85% imp, HSG D |
| 0.500 | 98 | Water Surface, HSG C |
| 5.850 | 95 | Weighted Average |
| 0.802 | | 13.72% Pervious Area |
| 5.047 | | 86.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, Direct Entry** |

## Subcatchment 1S: PR1



## Summary for Subcatchment 2S: PR-EAST

[49] Hint: Tc<2dt may require smaller dt

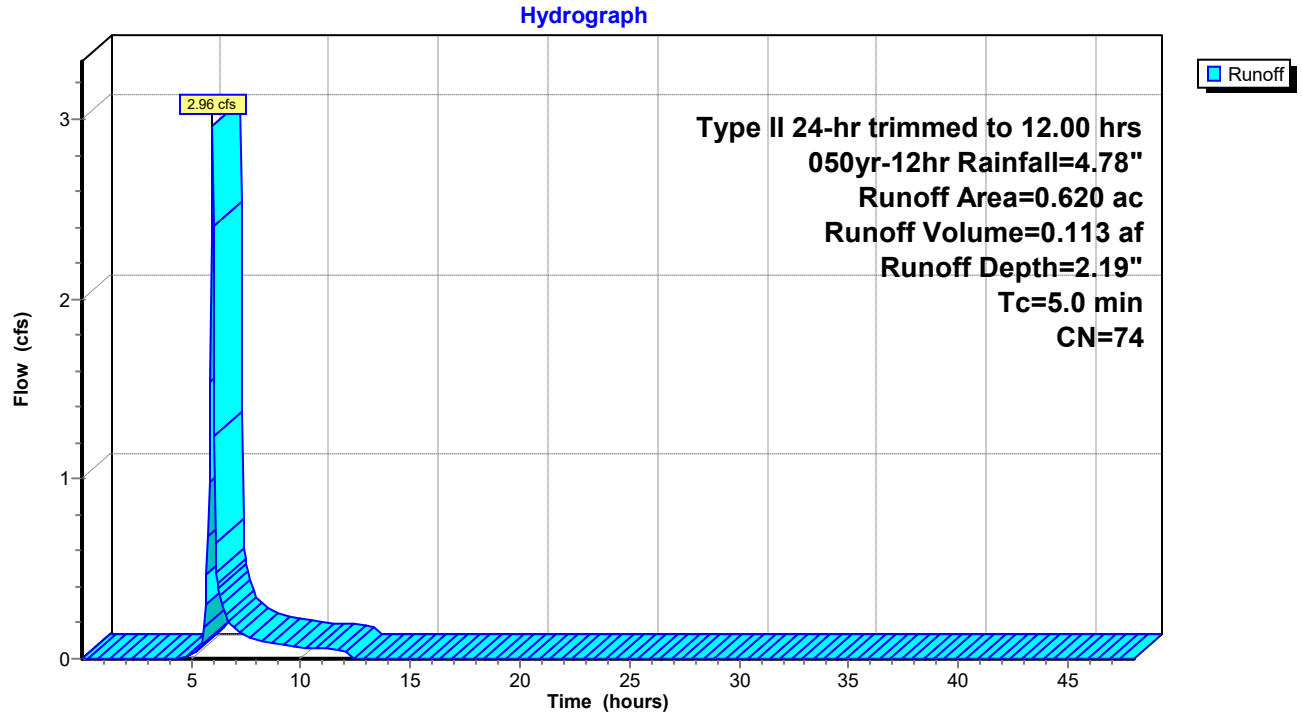
Runoff = 2.96 cfs @ 5.96 hrs, Volume= 0.113 af, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (ac) | CN | Description |
|---|---|---|
| 0.620 | 74 | >75% Grass cover, Good, HSG C |
| 0.620 | | 100.00% Pervious Area |

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

## Subcatchment 2S: PR-EAST



## Summary for Subcatchment 3S: PR3

[49] Hint: Tc<2dt may require smaller dt

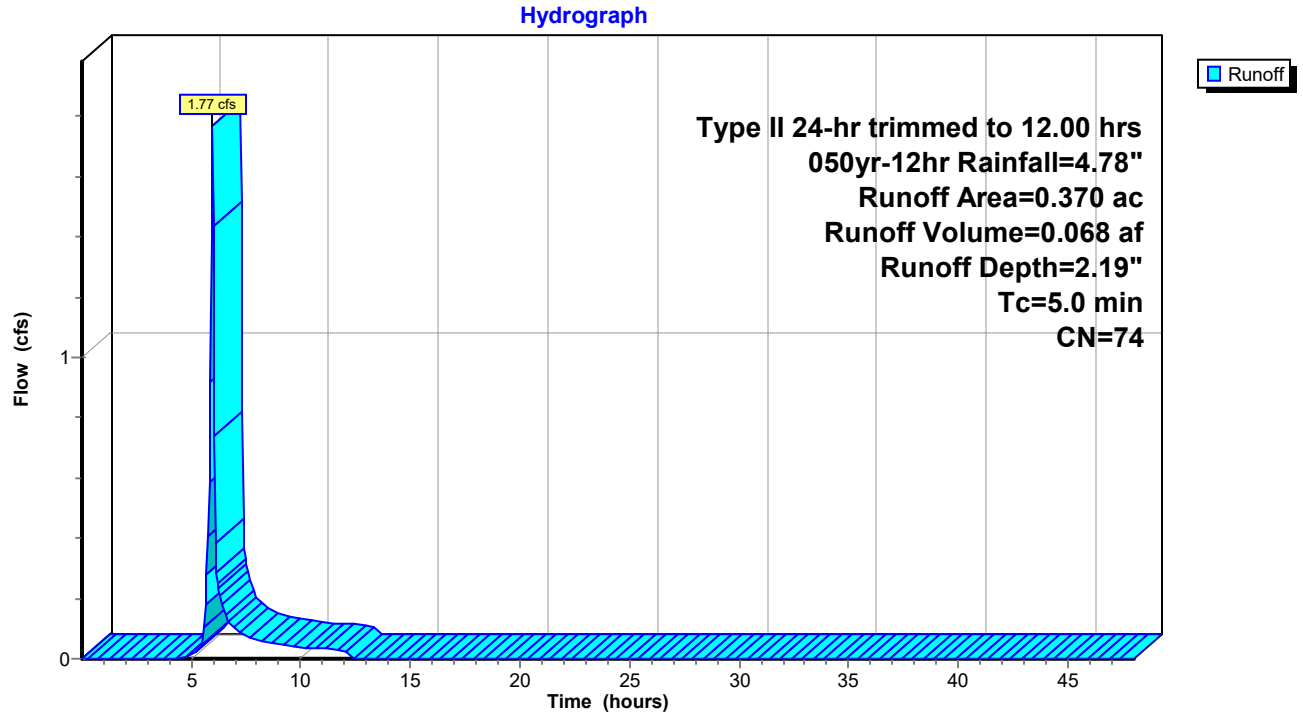
Runoff = 1.77 cfs @ 5.96 hrs, Volume= 0.068 af, Depth= 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (ac) | CN | Description |
|---|---|---|
| 0.370 | 74 | >75% Grass cover, Good, HSG C |
| 0.370 | | 100.00% Pervious Area |

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

## Subcatchment 3S: PR3



## Summary for Subcatchment 4S: PR4

[49] Hint: Tc<2dt may require smaller dt

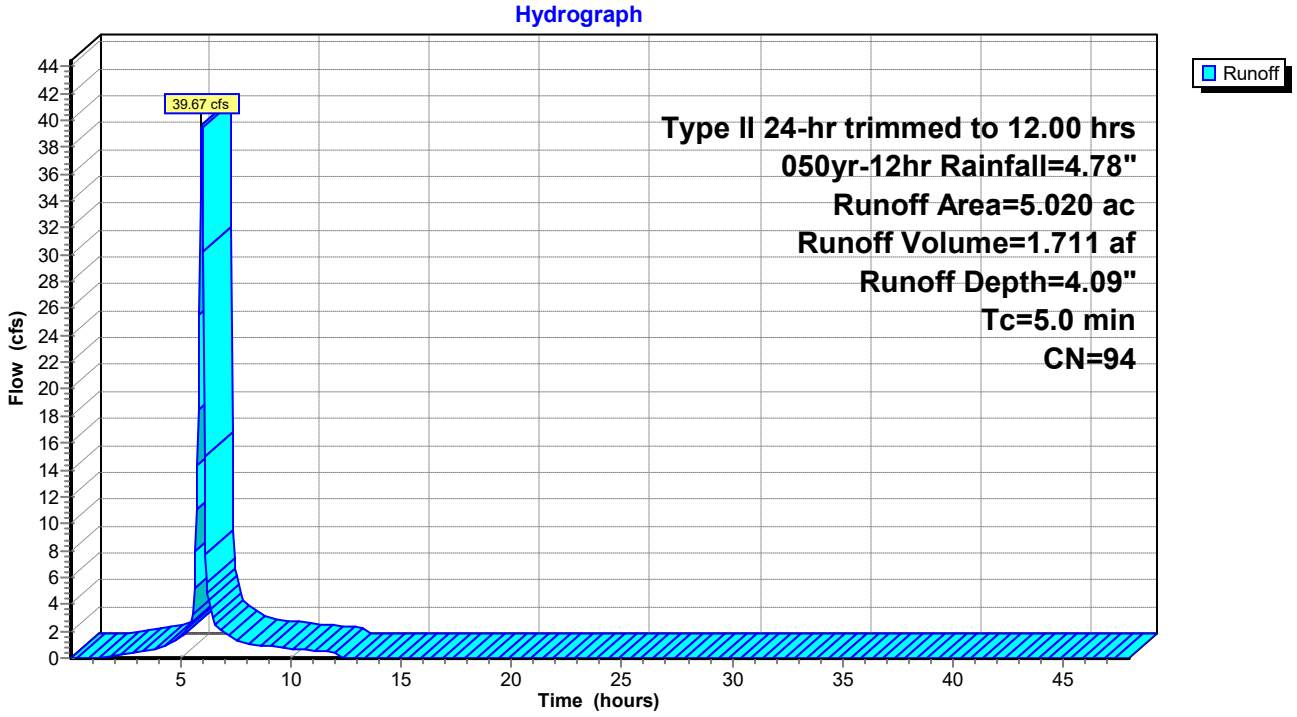
Runoff = 39.67 cfs @ 5.95 hrs, Volume= 1.711 af, Depth= 4.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 050yr-12hr Rainfall=4.78"

| Area (ac) | CN | Description |
|---|---|---|
| 0.350 | 98 | Water Surface, HSG C |
| 4.670 | 94 | Urban commercial, 85% imp, HSG C |
| 5.020 | 94 | Weighted Average |
| 0.700 | | 13.95% Pervious Area |
| 4.320 | | 86.05% Impervious Area |

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

## Subcatchment 4S: PR4



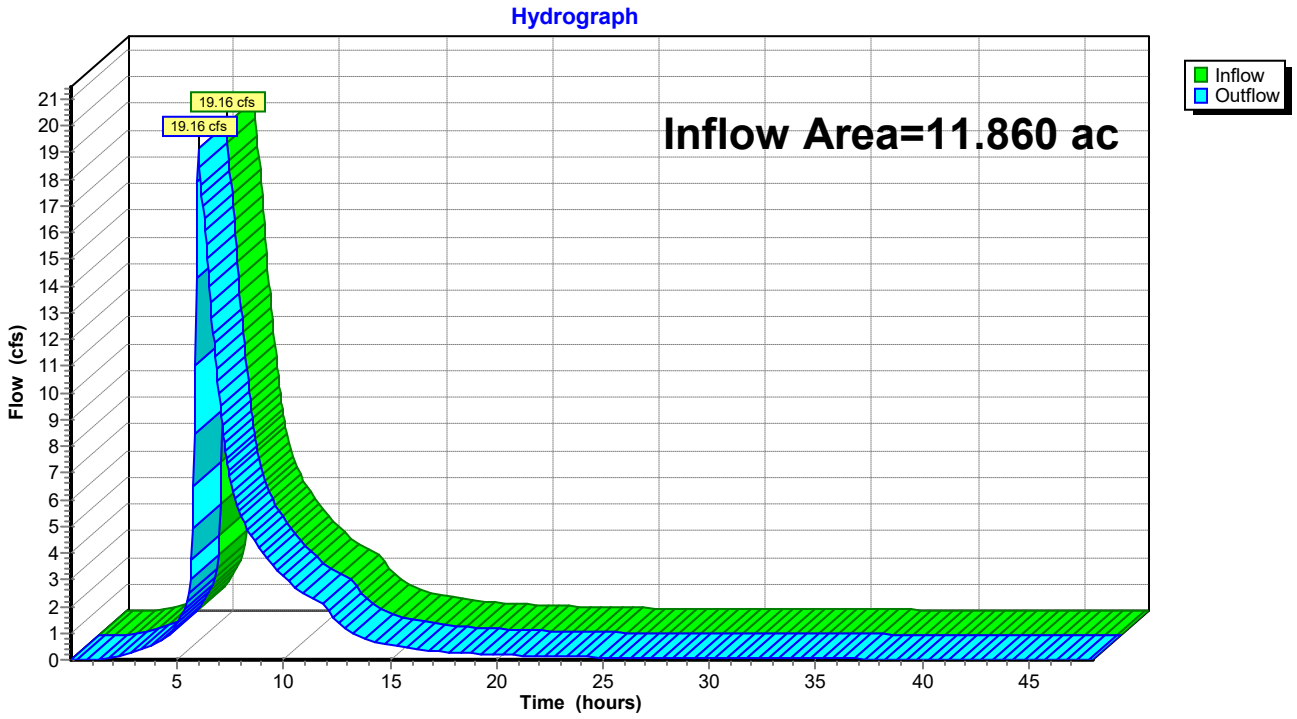
## Summary for Reach 2R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.860 ac, 78.98% Impervious, Inflow Depth > 3.93" for 050yr-12hr event
Inflow = 19.16 cfs @ 6.02 hrs, Volume= 3.879 af
Outflow = 19.16 cfs @ 6.02 hrs, Volume= 3.879 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2

### Reach 2R: US 31 DITCH



## Summary for Pond 1P: DET BASIN 1

Inflow Area = 5.850 ac, 86.28% Impervious, Inflow Depth = 4.20" for 050yr-12hr event
Inflow = 40.08 cfs @ 6.01 hrs, Volume= 2.048 af
Outflow = 4.26 cfs @ 6.48 hrs, Volume= 1.987 af, Atten= 89%, Lag= 28.1 min
Primary = 4.26 cfs @ 6.48 hrs, Volume= 1.987 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 755.97' @ 6.48 hrs Surf.Area= 37,310 sf Storage= 55,017 cf

Plug-Flow detention time= 268.9 min calculated for 1.985 af (97% of inflow)
Center-of-Mass det. time= 261.5 min ( 647.9 - 386.4 )

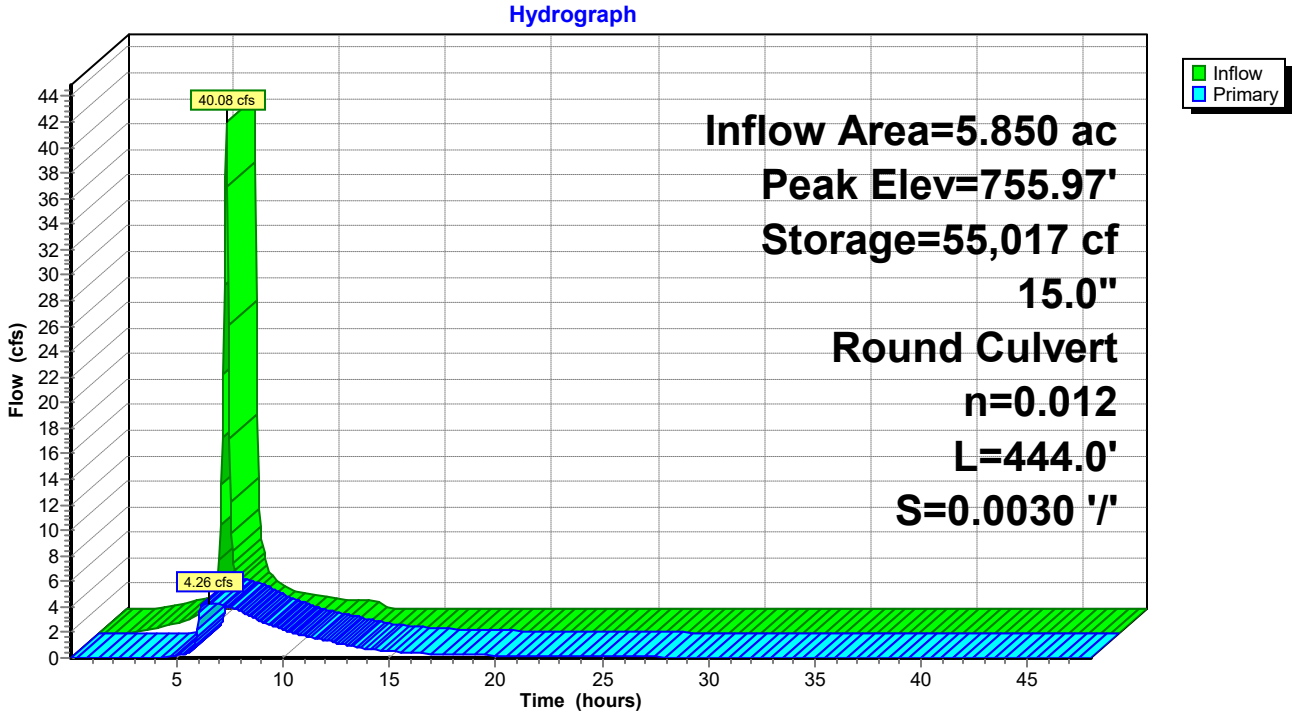
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 754.40' | 154,550 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 754.40 | 32,900 | 0 | 0 |
| 755.00 | 34,500 | 20,220 | 20,220 |
| 756.00 | 37,400 | 35,950 | 56,170 |
| 757.00 | 40,300 | 38,850 | 95,020 |
| 758.00 | 43,400 | 41,850 | 136,870 |
| 758.40 | 45,000 | 17,680 | 154,550 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 754.40' | **15.0" Round RCP_Round 15"**<br>L= 444.0' RCP, sq.cut end projecting, Ke= 0.500<br>Inlet / Outlet Invert= 754.40' / 753.07' S= 0.0030 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.23 sf |

**Primary OutFlow** Max=4.26 cfs @ 6.48 hrs HW=755.97' TW=0.00' (Dynamic Tailwater)
**1=RCP_Round 15"** (Barrel Controls 4.26 cfs @ 3.56 fps)

## Pond 1P: DET BASIN 1



## Summary for Pond 2P: DET BASIN 2

Inflow Area = 5.020 ac, 86.05% Impervious, Inflow Depth = 4.09" for 050yr-12hr event
Inflow = 39.67 cfs @ 5.95 hrs, Volume= 1.711 af
Outflow = 12.91 cfs @ 6.08 hrs, Volume= 1.711 af, Atten= 67%, Lag= 7.5 min
Primary = 12.91 cfs @ 6.08 hrs, Volume= 1.711 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 754.83' @ 6.08 hrs Surf.Area= 11,329 sf Storage= 27,025 cf

Plug-Flow detention time= 30.4 min calculated for 1.710 af (100% of inflow)
Center-of-Mass det. time= 30.5 min ( 415.0 - 384.5 )

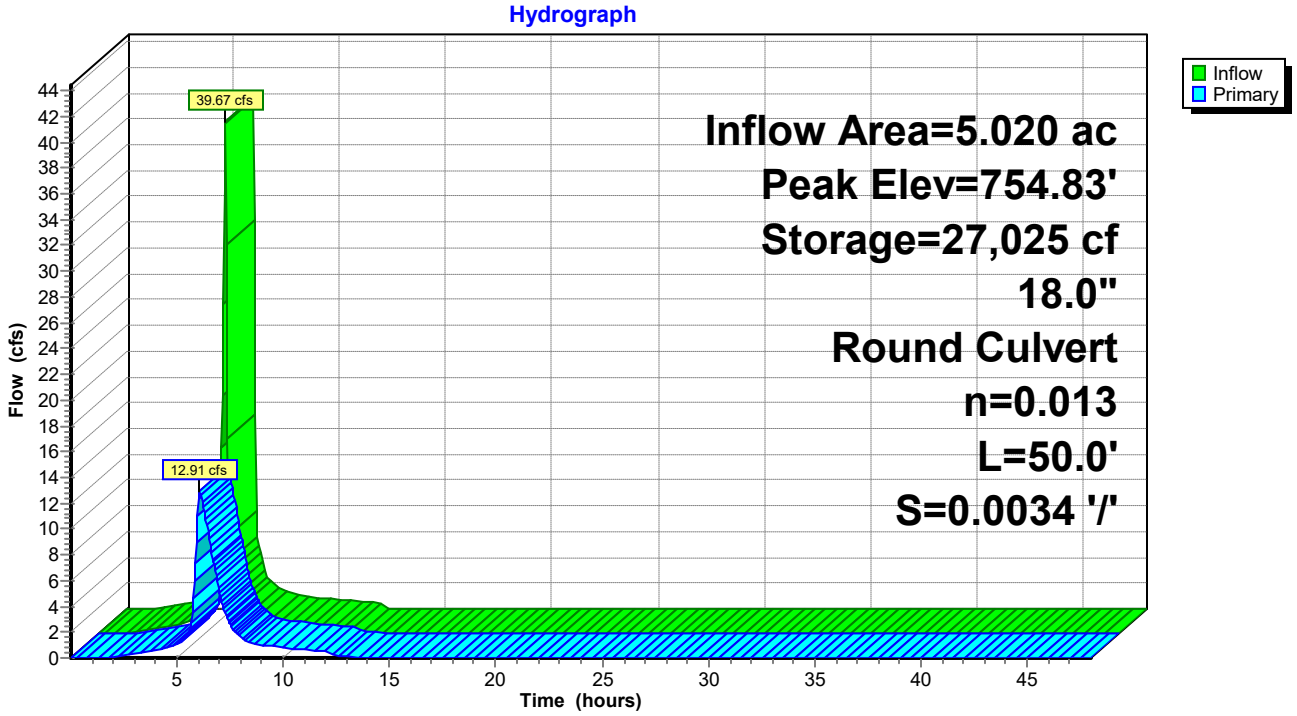
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 751.50' | 41,420 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 751.50 | 0 | 0 | 0 |
| 752.00 | 6,200 | 1,550 | 1,550 |
| 753.00 | 8,520 | 7,360 | 8,910 |
| 754.00 | 10,000 | 9,260 | 18,170 |
| 755.00 | 11,600 | 10,800 | 28,970 |
| 756.00 | 13,300 | 12,450 | 41,420 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 751.50' | **18.0" Round RCP_Round 18"**<br>L= 50.0' RCP, end-section conforming to fill, Ke= 0.500<br>Inlet / Outlet Invert= 751.50' / 751.33' S= 0.0034 '/' Cc= 0.900<br>n= 0.013 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=12.84 cfs @ 6.08 hrs HW=754.81' TW=0.00' (Dynamic Tailwater)
↑**1=RCP_Round 18"** (Barrel Controls 12.84 cfs @ 7.26 fps)

## Pond 2P: DET BASIN 2



Time span=0.01-48.00 hrs, dt=0.05 hrs, 961 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

**Subcatchment 1S: PR1** Runoff Area=5.850 ac 86.28% Impervious Runoff Depth=4.79"
Tc=10.0 min CN=95 Runoff=45.31 cfs 2.333 af

**Subcatchment 2S: PR-EAST** Runoff Area=0.620 ac 0.00% Impervious Runoff Depth=2.66"
Tc=5.0 min CN=74 Runoff=3.59 cfs 0.138 af

**Subcatchment 3S: PR3** Runoff Area=0.370 ac 0.00% Impervious Runoff Depth=2.66"
Tc=5.0 min CN=74 Runoff=2.14 cfs 0.082 af

**Subcatchment 4S: PR4** Runoff Area=5.020 ac 86.05% Impervious Runoff Depth=4.67"
Tc=5.0 min CN=94 Runoff=44.92 cfs 1.955 af

**Reach 2R: US 31 DITCH** Inflow=21.52 cfs 4.446 af
Outflow=21.52 cfs 4.446 af

**Pond 1P: DET BASIN 1** Peak Elev=756.19' Storage=63,396 cf Inflow=45.31 cfs 2.333 af
15.0" Round Culvert n=0.012 L=444.0' S=0.0030 '/' Outflow=4.27 cfs 2.272 af

**Pond 2P: DET BASIN 2** Peak Elev=755.18' Storage=31,126 cf Inflow=44.92 cfs 1.955 af
18.0" Round Culvert n=0.013 L=50.0' S=0.0034 '/' Outflow=14.00 cfs 1.955 af

**Total Runoff Area = 11.860 ac Runoff Volume = 4.508 af Average Runoff Depth = 4.56"**
**21.02% Pervious = 2.493 ac 78.98% Impervious = 9.367 ac**

## Summary for Subcatchment 1S: PR1

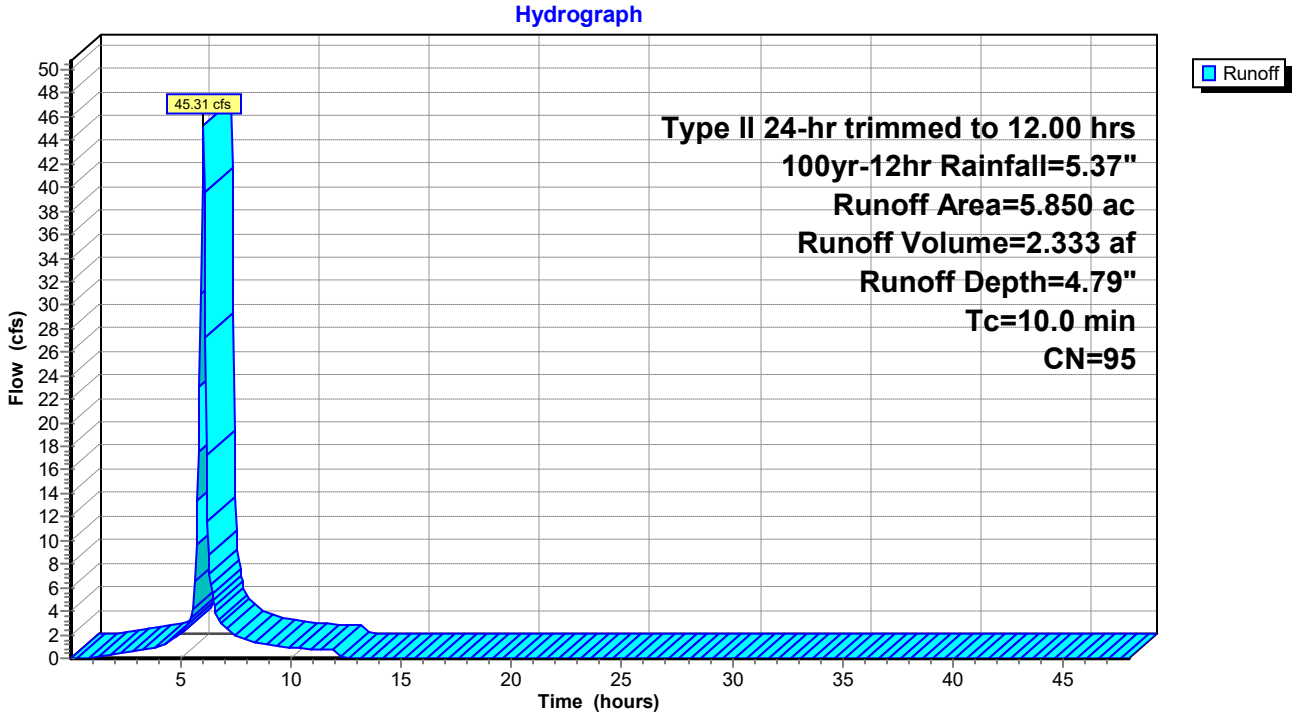
Runoff = 45.31 cfs @ 6.01 hrs, Volume= 2.333 af, Depth= 4.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 100yr-12hr Rainfall=5.37"

| Area (ac) | CN | Description |
|---|---|---|
| 5.350 | 95 | Urban commercial, 85% imp, HSG D |
| 0.500 | 98 | Water Surface, HSG C |
| 5.850 | 95 | Weighted Average |
| 0.802 | | 13.72% Pervious Area |
| 5.047 | | 86.28% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 10.0 | | | | | **Direct Entry, Direct Entry** |

## Subcatchment 1S: PR1



## Summary for Subcatchment 2S: PR-EAST

[49] Hint: Tc<2dt may require smaller dt

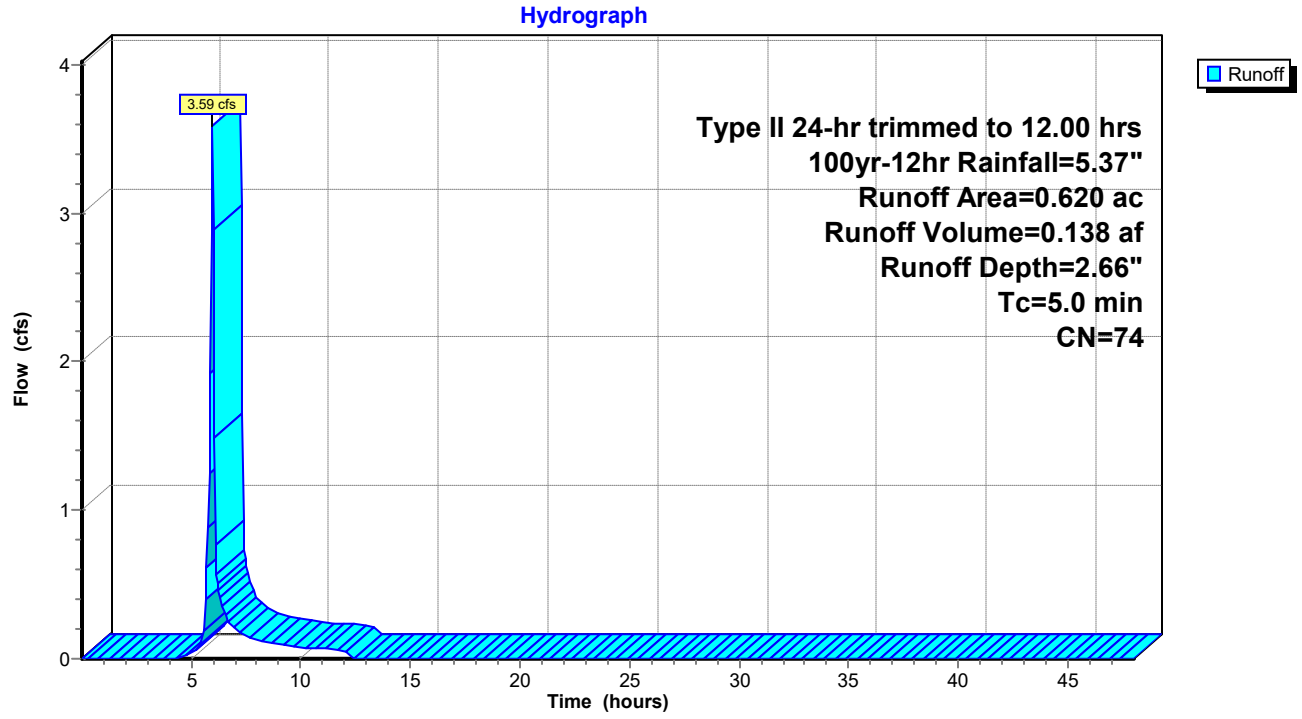
Runoff = 3.59 cfs @ 5.96 hrs, Volume= 0.138 af, Depth= 2.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 100yr-12hr Rainfall=5.37"

| Area (ac) | CN | Description |
|---|---|---|
| 0.620 | 74 | >75% Grass cover, Good, HSG C |
| 0.620 | | 100.00% Pervious Area |

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

## Subcatchment 2S: PR-EAST



## Summary for Subcatchment 3S: PR3

[49] Hint: Tc<2dt may require smaller dt

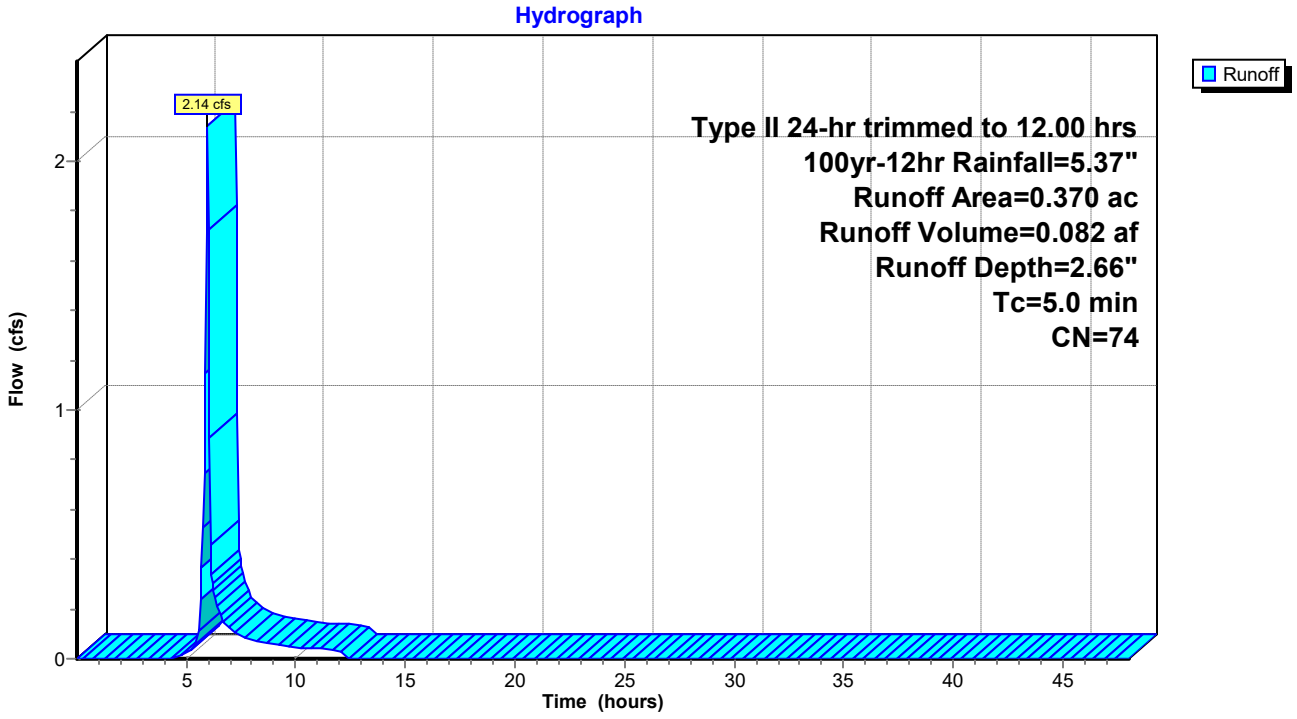
Runoff = 2.14 cfs @ 5.96 hrs, Volume= 0.082 af, Depth= 2.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 100yr-12hr Rainfall=5.37"

| Area (ac) | CN | Description |
|---|---|---|
| 0.370 | 74 | >75% Grass cover, Good, HSG C |
| 0.370 | | 100.00% Pervious Area |

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

## Subcatchment 3S: PR3



## Summary for Subcatchment 4S: PR4

[49] Hint: Tc<2dt may require smaller dt

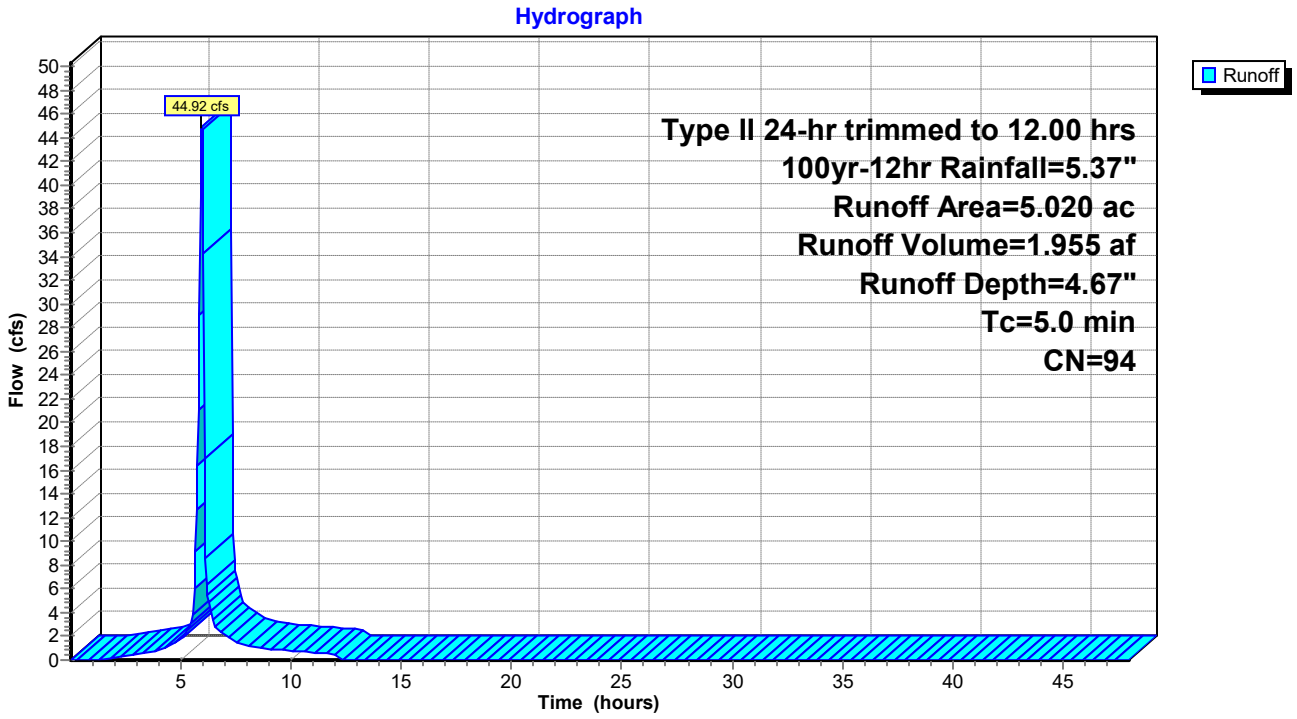
Runoff = 44.92 cfs @ 5.95 hrs, Volume= 1.955 af, Depth= 4.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs
Type II 24-hr trimmed to 12.00 hrs 100yr-12hr Rainfall=5.37"

| Area (ac) | CN | Description |
|---|---|---|
| 0.350 | 98 | Water Surface, HSG C |
| 4.670 | 94 | Urban commercial, 85% imp, HSG C |
| 5.020 | 94 | Weighted Average |
| 0.700 | | 13.95% Pervious Area |
| 4.320 | | 86.05% Impervious Area |

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

## Subcatchment 4S: PR4



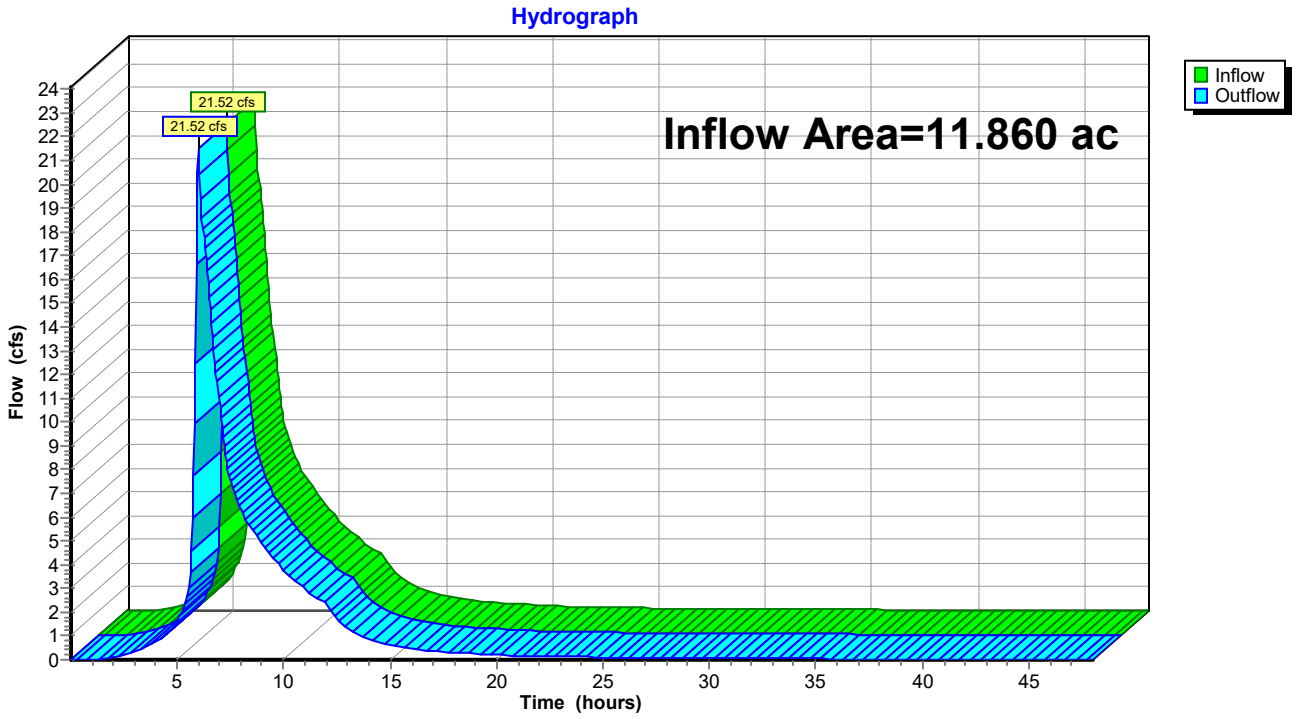
## Summary for Reach 2R: US 31 DITCH

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.860 ac, 78.98% Impervious, Inflow Depth > 4.50" for 100yr-12hr event
Inflow = 21.52 cfs @ 6.01 hrs, Volume= 4.446 af
Outflow = 21.52 cfs @ 6.01 hrs, Volume= 4.446 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2

### Reach 2R: US 31 DITCH



## Summary for Pond 1P: DET BASIN 1

Inflow Area = 5.850 ac, 86.28% Impervious, Inflow Depth = 4.79" for 100yr-12hr event
Inflow = 45.31 cfs @ 6.01 hrs, Volume= 2.333 af
Outflow = 4.27 cfs @ 7.78 hrs, Volume= 2.272 af, Atten= 91%, Lag= 106.6 min
Primary = 4.27 cfs @ 7.78 hrs, Volume= 2.272 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 756.19' @ 6.54 hrs Surf.Area= 37,956 sf Storage= 63,396 cf

Plug-Flow detention time= 267.9 min calculated for 2.269 af (97% of inflow)
Center-of-Mass det. time= 261.4 min ( 646.3 - 384.9 )

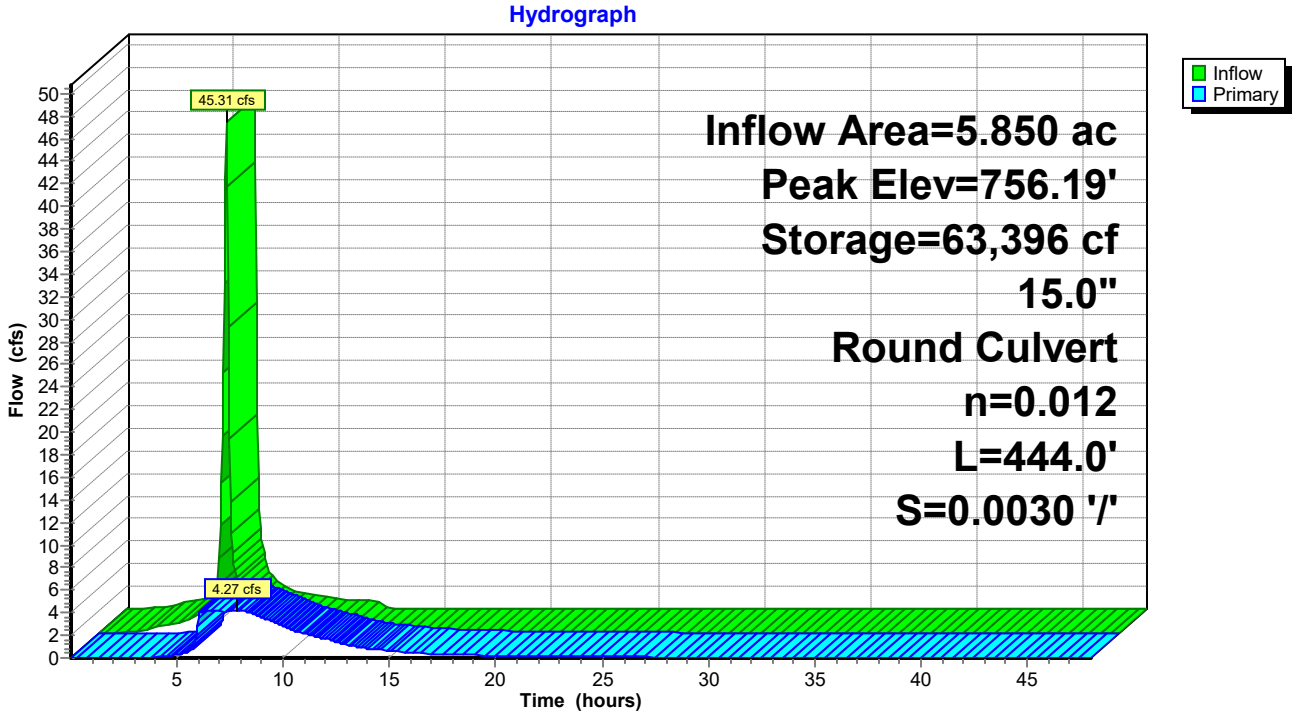
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 754.40' | 154,550 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 754.40 | 32,900 | 0 | 0 |
| 755.00 | 34,500 | 20,220 | 20,220 |
| 756.00 | 37,400 | 35,950 | 56,170 |
| 757.00 | 40,300 | 38,850 | 95,020 |
| 758.00 | 43,400 | 41,850 | 136,870 |
| 758.40 | 45,000 | 17,680 | 154,550 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 754.40' | **15.0" Round RCP_Round 15"**<br>L= 444.0' RCP, sq.cut end projecting, Ke= 0.500<br>Inlet / Outlet Invert= 754.40' / 753.07' S= 0.0030 '/' Cc= 0.900<br>n= 0.012, Flow Area= 1.23 sf |

**Primary OutFlow** Max=4.27 cfs @ 7.78 hrs HW=755.99' TW=0.00' (Dynamic Tailwater)
**1=RCP_Round 15"** (Barrel Controls 4.27 cfs @ 3.54 fps)

## Pond 1P: DET BASIN 1



## Summary for Pond 2P: DET BASIN 2

Inflow Area = 5.020 ac, 86.05% Impervious, Inflow Depth = 4.67" for 100yr-12hr event
Inflow = 44.92 cfs @ 5.95 hrs, Volume= 1.955 af
Outflow = 14.00 cfs @ 6.08 hrs, Volume= 1.955 af, Atten= 69%, Lag= 7.7 min
Primary = 14.00 cfs @ 6.08 hrs, Volume= 1.955 af

Routing by Dyn-Stor-Ind method, Time Span= 0.01-48.01 hrs, dt= 0.05 hrs / 2
Peak Elev= 755.18' @ 6.08 hrs Surf.Area= 11,912 sf Storage= 31,126 cf

Plug-Flow detention time= 31.0 min calculated for 1.953 af (100% of inflow)
Center-of-Mass det. time= 31.1 min ( 414.0 - 382.9 )

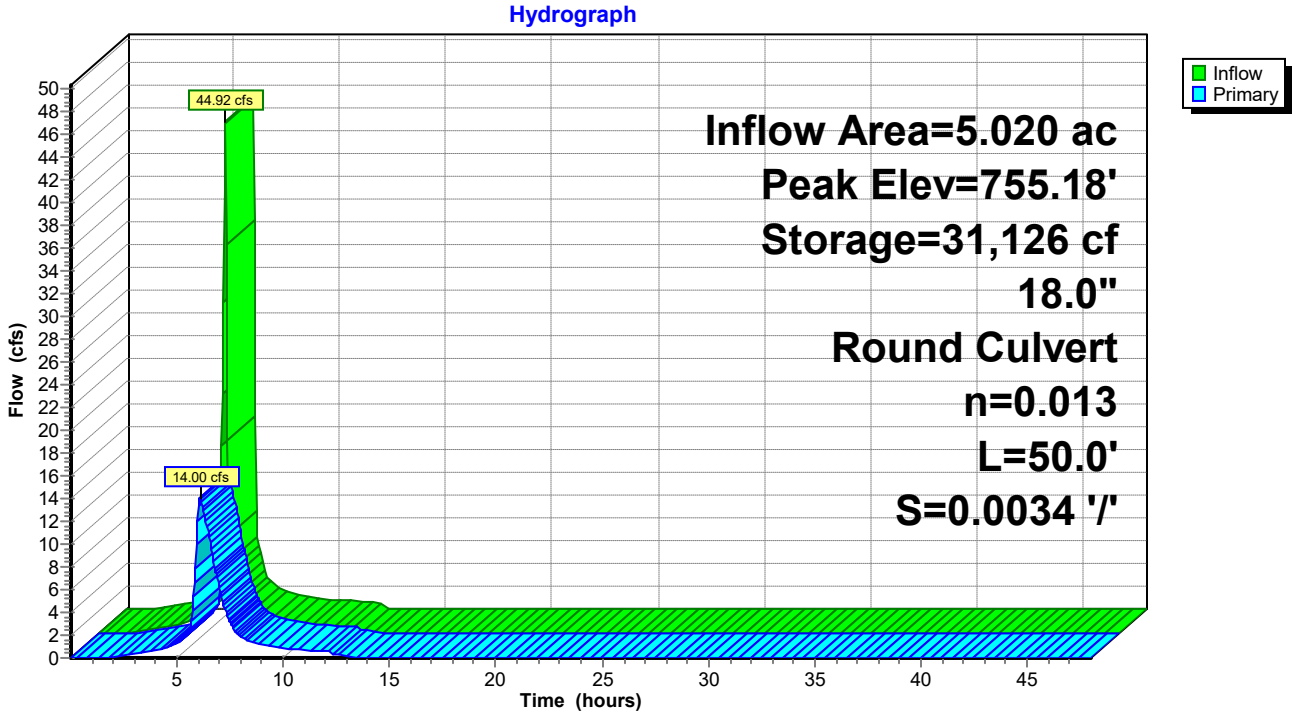
| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 751.50' | 41,420 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 751.50 | 0 | 0 | 0 |
| 752.00 | 6,200 | 1,550 | 1,550 |
| 753.00 | 8,520 | 7,360 | 8,910 |
| 754.00 | 10,000 | 9,260 | 18,170 |
| 755.00 | 11,600 | 10,800 | 28,970 |
| 756.00 | 13,300 | 12,450 | 41,420 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 751.50' | **18.0" Round RCP_Round 18"**<br>L= 50.0' RCP, end-section conforming to fill, Ke= 0.500<br>Inlet / Outlet Invert= 751.50' / 751.33' S= 0.0034 '/' Cc= 0.900<br>n= 0.013 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=13.93 cfs @ 6.08 hrs HW=755.16' TW=0.00' (Dynamic Tailwater)
↑**1=RCP_Round 18"** (Barrel Controls 13.93 cfs @ 7.88 fps)

## Pond 2P: DET BASIN 2



# *APPENDIX F – SUPPORT DOCUMENTATION*

**NOAA Atlas 14, Volume 2, Version 3**
**Location name: Franklin, Indiana, USA***
**Latitude: 39.4845°, Longitude: -86.058°**
**Elevation: 739.2 ft****
* source: ESRI Maps
** source: USGS

**POINT PRECIPITATION FREQUENCY ESTIMATES**

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 4.48 (3.98-5.06) | 5.33 (4.74-6.01) | 6.38 (5.66-7.20) | 7.21 (6.38-8.14) | 8.30 (7.30-9.37) | 9.16 (7.99-10.4) | 9.98 (8.63-11.3) | 10.9 (9.30-12.4) | 12.0 (10.1-13.8) | 12.9 (10.7-14.9) |
| 10-min | 3.47 (3.10-3.93) | 4.16 (3.70-4.69) | 4.96 (4.40-5.60) | 5.57 (4.93-6.28) | 6.35 (5.58-7.16) | 6.94 (6.05-7.85) | 7.52 (6.50-8.52) | 8.11 (6.94-9.23) | 8.84 (7.44-10.1) | 9.39 (7.79-10.8) |
| 15-min | 2.84 (2.53-3.21) | 3.39 (3.02-3.83) | 4.06 (3.61-4.58) | 4.57 (4.04-5.15) | 5.23 (4.60-5.90) | 5.73 (5.00-6.47) | 6.23 (5.38-7.06) | 6.72 (5.76-7.65) | 7.36 (6.19-8.43) | 7.82 (6.49-9.03) |
| 30-min | 1.88 (1.68-2.12) | 2.27 (2.02-2.56) | 2.78 (2.47-3.14) | 3.17 (2.81-3.57) | 3.69 (3.25-4.17) | 4.09 (3.57-4.63) | 4.50 (3.89-5.10) | 4.91 (4.20-5.58) | 5.45 (4.59-6.24) | 5.86 (4.86-6.77) |
| 60-min | 1.15 (1.02-1.30) | 1.39 (1.24-1.57) | 1.74 (1.55-1.97) | 2.02 (1.79-2.27) | 2.40 (2.11-2.70) | 2.70 (2.35-3.05) | 3.01 (2.60-3.41) | 3.33 (2.85-3.79) | 3.77 (3.17-4.32) | 4.12 (3.42-4.75) |
| 2-hr | 0.670 (0.598-0.760) | 0.812 (0.722-0.921) | 1.02 (0.907-1.16) | 1.19 (1.05-1.34) | 1.42 (1.25-1.61) | 1.62 (1.41-1.83) | 1.82 (1.57-2.06) | 2.04 (1.73-2.31) | 2.34 (1.95-2.67) | 2.59 (2.12-2.97) |
| 3-hr | 0.473 (0.423-0.538) | 0.573 (0.510-0.650) | 0.722 (0.642-0.820) | 0.843 (0.746-0.954) | 1.01 (0.888-1.15) | 1.16 (1.00-1.31) | 1.31 (1.12-1.49) | 1.47 (1.24-1.67) | 1.70 (1.40-1.95) | 1.89 (1.53-2.18) |
| 6-hr | 0.284 (0.252-0.325) | 0.343 (0.305-0.393) | 0.433 (0.384-0.494) | 0.507 (0.447-0.577) | 0.613 (0.534-0.696) | 0.702 (0.606-0.796) | 0.797 (0.679-0.905) | 0.899 (0.753-1.02) | 1.05 (0.857-1.20) | 1.17 (0.937-1.35) |
| 12-hr | 0.169 (0.151-0.191) | 0.203 (0.182-0.230) | 0.253 (0.226-0.286) | 0.293 (0.261-0.331) | 0.350 (0.308-0.393) | 0.397 (0.347-0.446) | 0.446 (0.385-0.501) | 0.498 (0.423-0.561) | 0.571 (0.476-0.648) | 0.630 (0.517-0.720) |
| 24-hr | 0.101 (0.094-0.111) | 0.122 (0.112-0.133) | 0.149 (0.137-0.163) | 0.171 (0.157-0.186) | 0.200 (0.183-0.218) | 0.223 (0.203-0.243) | 0.246 (0.223-0.269) | 0.270 (0.243-0.295) | 0.302 (0.270-0.331) | 0.328 (0.291-0.365) |
| 2-day | 0.059 (0.055-0.064) | 0.071 (0.066-0.077) | 0.087 (0.080-0.094) | 0.099 (0.091-0.107) | 0.115 (0.106-0.125) | 0.128 (0.117-0.139) | 0.141 (0.128-0.153) | 0.154 (0.139-0.168) | 0.172 (0.154-0.188) | 0.186 (0.165-0.203) |
| 3-day | 0.043 (0.040-0.046) | 0.051 (0.047-0.055) | 0.062 (0.057-0.066) | 0.070 (0.065-0.075) | 0.081 (0.075-0.087) | 0.090 (0.083-0.097) | 0.099 (0.091-0.107) | 0.108 (0.099-0.116) | 0.120 (0.109-0.130) | 0.130 (0.117-0.140) |
| 4-day | 0.034 (0.032-0.036) | 0.041 (0.038-0.043) | 0.049 (0.046-0.052) | 0.056 (0.052-0.059) | 0.064 (0.060-0.069) | 0.071 (0.066-0.076) | 0.078 (0.072-0.083) | 0.085 (0.079-0.091) | 0.094 (0.087-0.101) | 0.102 (0.093-0.109) |
| 7-day | 0.023 (0.022-0.025) | 0.027 (0.026-0.029) | 0.033 (0.031-0.035) | 0.037 (0.035-0.040) | 0.043 (0.040-0.046) | 0.048 (0.044-0.051) | 0.053 (0.049-0.056) | 0.057 (0.053-0.061) | 0.064 (0.058-0.068) | 0.069 (0.063-0.074) |
| 10-day | 0.018 (0.017-0.020) | 0.022 (0.021-0.023) | 0.026 (0.025-0.028) | 0.030 (0.028-0.032) | 0.034 (0.032-0.036) | 0.038 (0.035-0.040) | 0.041 (0.038-0.044) | 0.045 (0.042-0.048) | 0.050 (0.046-0.053) | 0.054 (0.049-0.058) |
| 20-day | 0.013 (0.012-0.013) | 0.015 (0.014-0.016) | 0.018 (0.017-0.019) | 0.020 (0.019-0.021) | 0.022 (0.021-0.024) | 0.025 (0.023-0.026) | 0.027 (0.025-0.028) | 0.029 (0.027-0.031) | 0.032 (0.029-0.033) | 0.034 (0.031-0.036) |
| 30-day | 0.010 (0.010-0.011) | 0.012 (0.012-0.013) | 0.014 (0.013-0.015) | 0.016 (0.015-0.017) | 0.018 (0.017-0.019) | 0.019 (0.018-0.020) | 0.021 (0.019-0.022) | 0.022 (0.021-0.024) | 0.024 (0.022-0.026) | 0.026 (0.024-0.027) |
| 45-day | 0.009 (0.008-0.009) | 0.010 (0.010-0.011) | 0.012 (0.011-0.013) | 0.013 (0.012-0.014) | 0.015 (0.014-0.015) | 0.016 (0.015-0.017) | 0.017 (0.016-0.018) | 0.018 (0.017-0.019) | 0.019 (0.018-0.020) | 0.020 (0.019-0.022) |
| 60-day | 0.008 (0.007-0.008) | 0.009 (0.009-0.010) | 0.011 (0.010-0.011) | 0.012 (0.011-0.012) | 0.013 (0.012-0.014) | 0.014 (0.013-0.015) | 0.015 (0.014-0.016) | 0.016 (0.015-0.017) | 0.017 (0.016-0.018) | 0.018 (0.017-0.019) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

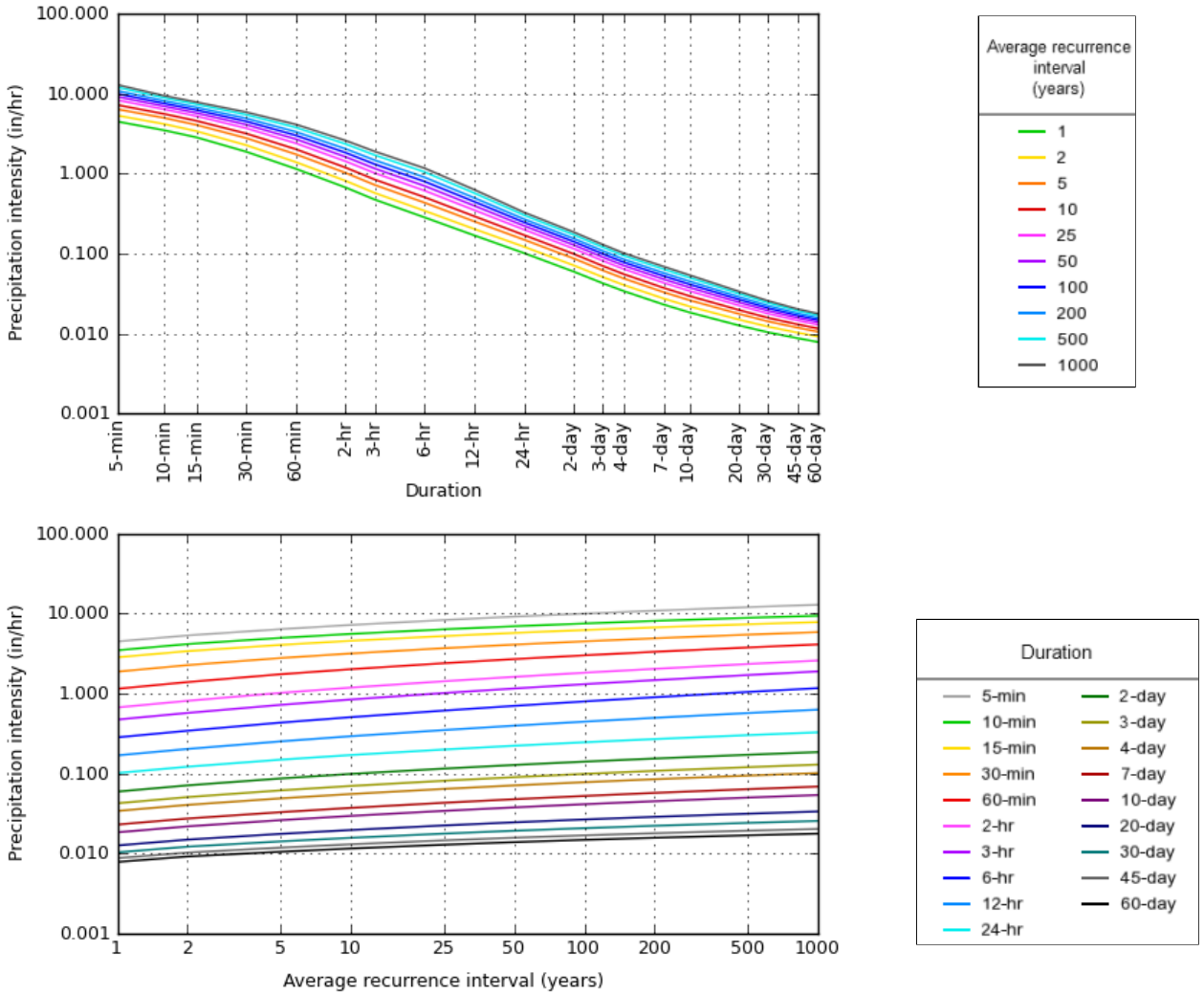
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

## PF graphical

PDS-based intensity-duration-frequency (IDF) curves
Latitude: 39.4845°, Longitude: -86.0580°



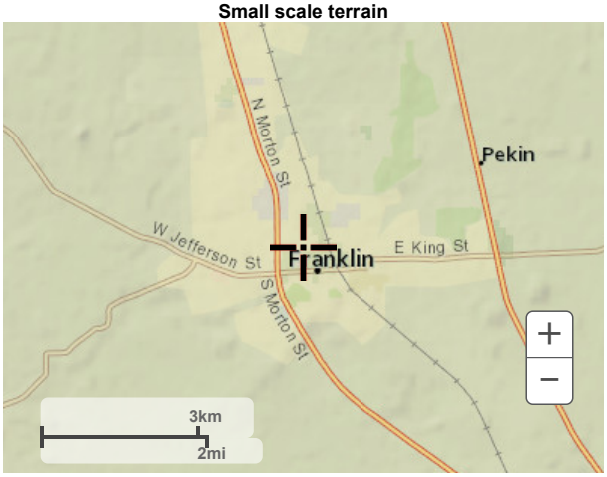

NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Sun Jan 31 16:50:36 2021

Back to Top

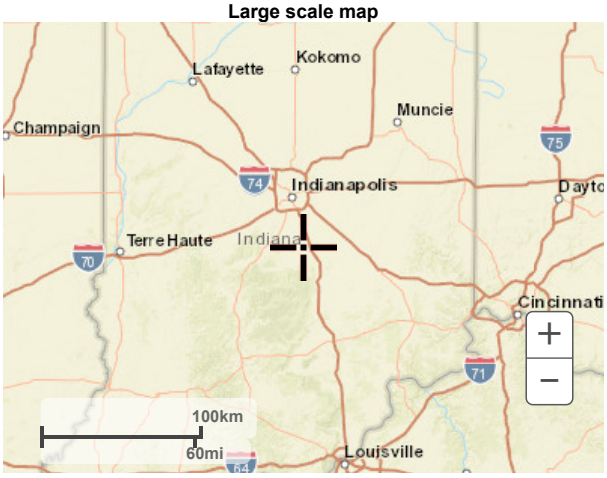
## Maps & aerials

**Small scale terrain**

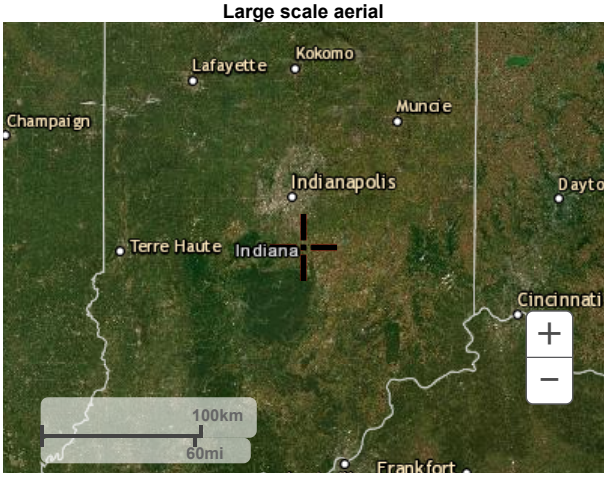



**Large scale terrain**


**Large scale map**




**Large scale aerial**




Back to Top

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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

**NOAA Atlas 14, Volume 2, Version 3**
**Location name: Franklin, Indiana, USA***
**Latitude: 39.4845°, Longitude: -86.058°**
**Elevation: 739.2 ft****
* source: ESRI Maps
** source: USGS

**POINT PRECIPITATION FREQUENCY ESTIMATES**

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.373 (0.332-0.422) | 0.444 (0.395-0.501) | 0.532 (0.472-0.600) | 0.601 (0.532-0.678) | 0.692 (0.608-0.781) | 0.763 (0.666-0.863) | 0.832 (0.719-0.943) | 0.905 (0.775-1.03) | 1.00 (0.844-1.15) | 1.08 (0.892-1.24) |
| 10-min | 0.579 (0.517-0.655) | 0.693 (0.617-0.782) | 0.827 (0.734-0.933) | 0.928 (0.822-1.05) | 1.06 (0.930-1.19) | 1.16 (1.01-1.31) | 1.25 (1.08-1.42) | 1.35 (1.16-1.54) | 1.47 (1.24-1.69) | 1.57 (1.30-1.81) |
| 15-min | 0.710 (0.633-0.803) | 0.848 (0.755-0.957) | 1.01 (0.902-1.15) | 1.14 (1.01-1.29) | 1.31 (1.15-1.48) | 1.43 (1.25-1.62) | 1.56 (1.35-1.76) | 1.68 (1.44-1.91) | 1.84 (1.55-2.11) | 1.96 (1.62-2.26) |
| 30-min | 0.939 (0.838-1.06) | 1.13 (1.01-1.28) | 1.39 (1.24-1.57) | 1.59 (1.40-1.79) | 1.85 (1.62-2.08) | 2.05 (1.79-2.31) | 2.25 (1.94-2.55) | 2.45 (2.10-2.79) | 2.73 (2.29-3.12) | 2.93 (2.43-3.39) |
| 60-min | 1.15 (1.02-1.30) | 1.39 (1.24-1.57) | 1.74 (1.55-1.97) | 2.02 (1.79-2.27) | 2.40 (2.11-2.70) | 2.70 (2.35-3.05) | 3.01 (2.60-3.41) | 3.33 (2.85-3.79) | 3.77 (3.17-4.32) | 4.12 (3.42-4.75) |
| 2-hr | 1.34 (1.20-1.52) | 1.62 (1.45-1.84) | 2.04 (1.81-2.31) | 2.38 (2.10-2.69) | 2.85 (2.50-3.22) | 3.23 (2.82-3.65) | 3.65 (3.13-4.12) | 4.08 (3.46-4.61) | 4.68 (3.90-5.34) | 5.17 (4.23-5.94) |
| 3-hr | 1.42 (1.27-1.62) | 1.72 (1.53-1.95) | 2.17 (1.93-2.46) | 2.53 (2.24-2.86) | 3.05 (2.67-3.44) | 3.48 (3.01-3.93) | 3.94 (3.37-4.46) | 4.42 (3.73-5.02) | 5.12 (4.22-5.86) | 5.68 (4.59-6.55) |
| 6-hr | 1.70 (1.51-1.95) | 2.05 (1.83-2.35) | 2.59 (2.30-2.96) | 3.04 (2.67-3.46) | 3.67 (3.20-4.17) | 4.20 (3.63-4.77) | 4.77 (4.06-5.42) | 5.38 (4.51-6.14) | 6.27 (5.13-7.17) | 7.00 (5.61-8.06) |
| 12-hr | 2.03 (1.82-2.30) | 2.45 (2.19-2.77) | 3.04 (2.72-3.44) | 3.53 (3.14-3.99) | 4.21 (3.72-4.74) | 4.78 (4.18-5.37) | 5.37 (4.64-6.04) | 5.99 (5.10-6.76) | 6.88 (5.73-7.81) | 7.59 (6.22-8.68) |
| 24-hr | 2.43 (2.25-2.66) | 2.92 (2.69-3.19) | 3.58 (3.30-3.90) | 4.09 (3.76-4.46) | 4.79 (4.38-5.22) | 5.34 (4.87-5.83) | 5.91 (5.35-6.45) | 6.48 (5.84-7.08) | 7.26 (6.48-7.95) | 7.86 (6.97-8.76) |
| 2-day | 2.86 (2.64-3.09) | 3.42 (3.16-3.70) | 4.17 (3.85-4.51) | 4.75 (4.37-5.15) | 5.53 (5.07-6.00) | 6.15 (5.61-6.67) | 6.77 (6.15-7.36) | 7.40 (6.69-8.06) | 8.25 (7.40-9.01) | 8.91 (7.93-9.77) |
| 3-day | 3.06 (2.85-3.29) | 3.66 (3.41-3.93) | 4.43 (4.12-4.77) | 5.04 (4.68-5.42) | 5.85 (5.41-6.29) | 6.49 (5.98-6.97) | 7.13 (6.55-7.67) | 7.78 (7.11-8.38) | 8.65 (7.86-9.34) | 9.32 (8.42-10.1) |
| 4-day | 3.27 (3.06-3.49) | 3.90 (3.65-4.16) | 4.70 (4.40-5.03) | 5.33 (4.98-5.69) | 6.17 (5.75-6.58) | 6.83 (6.35-7.27) | 7.49 (6.95-7.99) | 8.16 (7.54-8.70) | 9.06 (8.32-9.67) | 9.74 (8.91-10.4) |
| 7-day | 3.87 (3.62-4.15) | 4.61 (4.30-4.93) | 5.53 (5.16-5.92) | 6.26 (5.83-6.70) | 7.25 (6.74-7.75) | 8.03 (7.44-8.58) | 8.82 (8.16-9.43) | 9.63 (8.87-10.3) | 10.7 (9.83-11.5) | 11.6 (10.5-12.4) |
| 10-day | 4.42 (4.14-4.72) | 5.25 (4.92-5.61) | 6.28 (5.88-6.71) | 7.09 (6.64-7.57) | 8.20 (7.65-8.74) | 9.07 (8.44-9.66) | 9.94 (9.23-10.6) | 10.8 (10.0-11.5) | 12.0 (11.1-12.8) | 12.9 (11.9-13.8) |
| 20-day | 6.06 (5.71-6.45) | 7.17 (6.75-7.63) | 8.46 (7.96-9.00) | 9.46 (8.88-10.1) | 10.8 (10.1-11.5) | 11.8 (11.0-12.5) | 12.8 (12.0-13.6) | 13.8 (12.8-14.7) | 15.1 (14.0-16.1) | 16.1 (14.9-17.1) |
| 30-day | 7.47 (7.04-7.90) | 8.79 (8.29-9.31) | 10.2 (9.64-10.8) | 11.3 (10.7-12.0) | 12.8 (12.0-13.5) | 13.9 (13.0-14.7) | 15.0 (14.0-15.9) | 16.0 (15.0-17.0) | 17.4 (16.2-18.5) | 18.4 (17.1-19.6) |
| 45-day | 9.47 (8.92-10.0) | 11.1 (10.5-11.8) | 12.8 (12.1-13.6) | 14.1 (13.3-14.9) | 15.8 (14.8-16.7) | 17.0 (16.0-18.0) | 18.2 (17.1-19.3) | 19.4 (18.1-20.5) | 20.9 (19.4-22.1) | 21.9 (20.4-23.3) |
| 60-day | 11.3 (10.7-12.0) | 13.2 (12.5-14.0) | 15.2 (14.3-16.1) | 16.7 (15.7-17.7) | 18.6 (17.5-19.7) | 20.0 (18.8-21.2) | 21.4 (20.0-22.6) | 22.7 (21.2-24.1) | 24.4 (22.7-25.8) | 25.6 (23.8-27.2) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

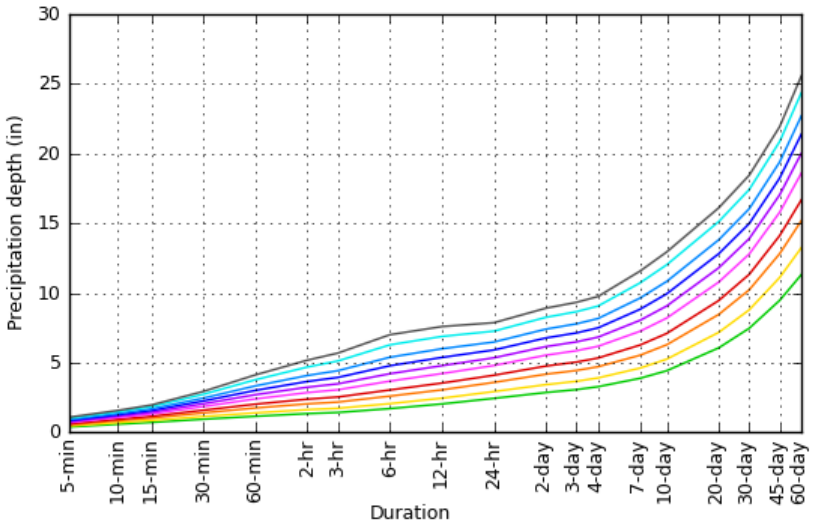
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

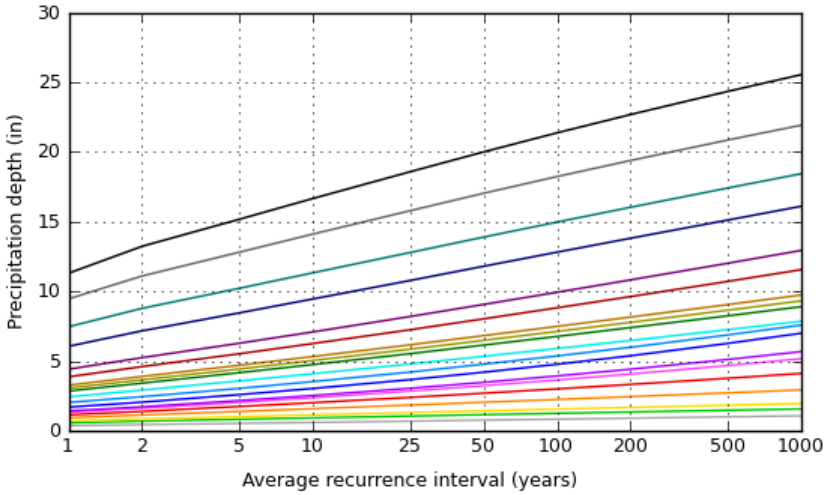
Please refer to NOAA Atlas 14 document for more information.

Back to Top

## PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 39.4845°, Longitude: -86.0580°




NOAA Atlas 14, Volume 2, Version 3

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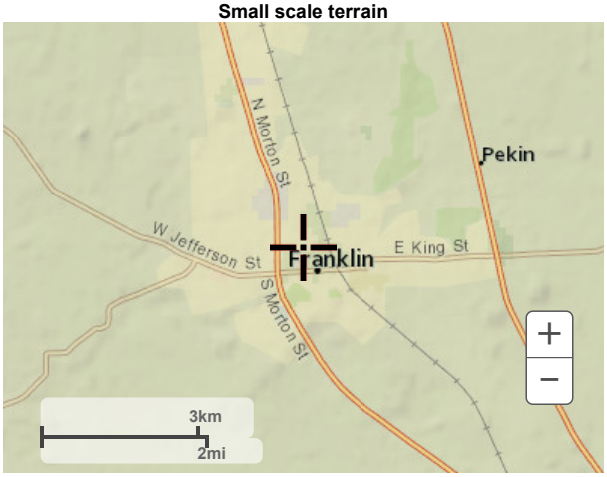
Back to Top

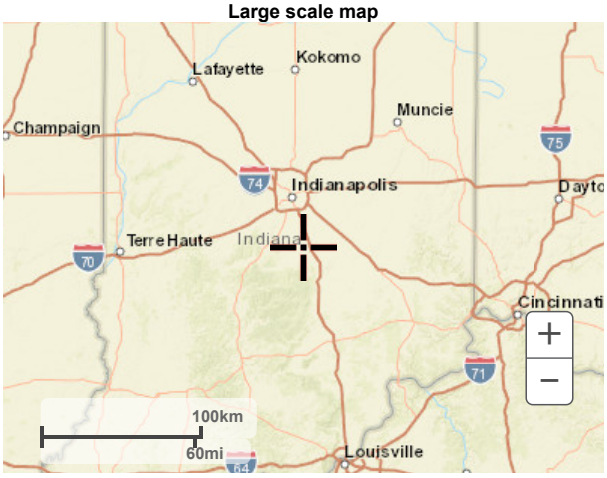
## Maps & aerials

**Small scale terrain**

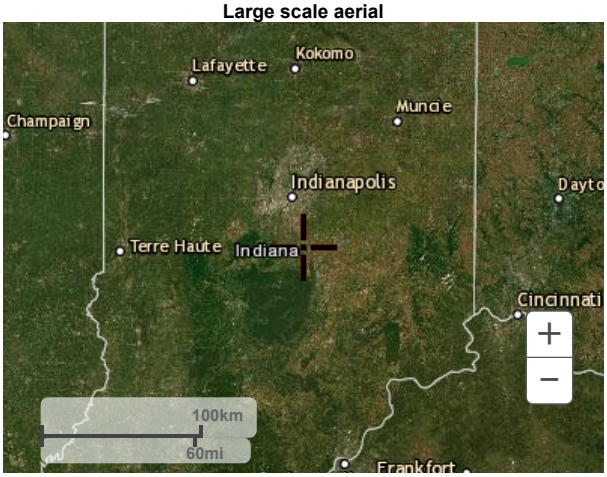



**Large scale terrain**


**Large scale map**




**Large scale aerial**




Back to Top

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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

storm-sewer system. The results from an electronic or manual method should be provided in an accepted tabular method as shown in Figure 203-4 I.

### 203-4.05(03) Hydraulic Grade Line Check

The final storm-sewer design should be checked to determine its adequacy by analysis using a 2% annual EP through the entire system of the hydraulic gradient. The gradient line should not exceed the elevation of an opening into the system. A tabular summary or plotted profile should be provided in the hydraulics-report submittal.

### 203-4.05(04) Plan and Profile

Road plans for a storm-drain project should be submitted so that the appropriate inlet and storm drain pipe locations can be identified. The plan view should be simplified to show the pipe type, slope, and size; structure identifier, road grade, and other information necessary to evaluate the storm-drain system. The plans structure numbers should match the computer and tabular results in the report submittal. All discrepancies should be addressed prior to report submittal.

### 203-4.05(05) Additional Information

Other information that the designer deems necessary toward validation of the design should be provided in the hydraulics report. Non-traditional methodology requires the approval of the Office of Hydraulics manager.

## 203-5.0 STORMWATER MANAGEMENT AND DETENTION

### 203-5.01 Introduction

The traditional design of a storm-drainage system has been to collect and convey storm runoff as rapidly as possible to a suitable location where it can be discharged. However, the impact of such a traditional storm-drainage design has not always been favorable. Rapidly conveying stormwater can cause environmental impacts to karst topography and wetlands downstream, overwhelm limited outlet capacities, and flood downstream properties, especially where the amount of impervious area is increased as part of a roadway project. To reduce these impacts, various forms of stormwater management have been developed, for an open-system or closed-system facility, as described below.

## 203-5.02 General Policy

### 203-5.02(01) Reasons for Storage

Controlling the quantity of stormwater release using a storage facility can provide the potential benefits as follows:

1. prevention or reduction of peak runoff rate increase;
2. mitigation of downstream drainage-capacity problems;
3. reduction or elimination of the need for downstream outfall improvements; and
4. protection of environmentally-sensitive areas, such as karst topography.

### 203-5.02(02) Downstream Conditions

Storage can be developed in a depressed area in a parking lot, road embankment, freeway interchange, or a small lake, pond, or depression. The utility of a storage facility depends on the amount of storage, its location within the system, and its operational characteristics. An analysis of such a storage facility should consist of comparing the design flow at a point or points downstream of the proposed storage site, with or without storage. Other flows in excess of the design flow that can be expected to pass through the storage facility may be required in the analysis, i.e., 1% annual EP flood. The design criteria for a storage facility should include the following:

1. release rate;
2. storage volume;
3. grading and depth requirements;
4. outlet works; and
5. location.

At a minimum, a storage facility should be designed to detain the 1% annual EP, post-development peak runoff rate, and release it at the 10% annual EP, pre-developed peak runoff rate. An emergency overflow capable of accommodating the 1% annual EP post-development discharge may be required.

### 203-5.02(03) Local Jurisdictional Requirements

A local jurisdiction can be more restrictive than INDOT drainage requirements. INDOT requirements need not be in accordance with local jurisdictional rules and regulations. However, the local design parameters should be followed as much as practical.

## 203-5.03 Design Considerations

A pump station may be required to outlet from an infiltration/detention facility. The use of a pump station to outlet a facility is not desirable. If a pump station is being considered, the Office of Hydraulics should be contacted for approval.

Dam safety should be considered for a berm or embankment created as part of a detention facility. An embankment should not be subject to IDNR regulation and inspection requirements. Per the Indiana Code, IDNR has jurisdiction over all structures, except where the embankment is lower than 20 ft, the contributing drainage area is less than 1 sq mi, or the storage volume behind the structure is less than 100 ac-ft. For more information, see *Indiana Code* 14-27-7.5: Regulation of Dams.

### 203-5.03(01) Detention Pond

A detention pond is designed to reduce the peak discharge and detain runoff only for a specific duration. A detention basin should have a positive outlet that empties all runoff between storms. The excavation of a detention pond can extend below the water table or outlet level where the bottom is sealed due to sedimentation. This is a detention pond or wet-bottom detention basin. The detention pond also has a positive outlet and releases all temporary storage.

A dry-bottom detention facility should be used. A detention basin will require additional right of way. The basin will require a certain amount of space, and it should be outside the clear-zone for safety purposes. The pond location and outlet should be considered, especially for flood routing. The overflow location should avoid impacting nearby property and the roadway.

### 203-5.03(02) Retention Pond

A retention pond retains runoff for an indefinite time and has no positive outlet. Runoff is removed only by means of infiltration through a permeable bottom or by means of evaporation. A retention pond or lake is an example of a retention facility. A retention pond is designed to drain into the groundwater table.

Soil characteristics are the primary concern in designing a retention pond. A geotechnical report should be obtained from the Office of Geotechnical Services, county surveyor's office, etc, to determine the infiltration capacity of the substratum.

A retention pond will require additional right of way. It should be located outside the clear-zone for safety purposes.

### 203-5.03(03) Roadside Ditch Detention

A roadside ditch detention system takes advantage of the additional capacity of the roadside and median ditches created by the clear-zone requirements. A roadside ditch detains runoff from the roadway and discharges it at a restricted rate to a positive outlet.

A roadside ditch is the least expensive open-detention system, since it does not require additional right of way or significant additional maintenance. Since the ditch is within the right of way, safety considerations and roadway serviceability should be evaluated.

### 203-5.03(04) Underground Storage

Underground detention is best suited to an urbanized area where right of way and available land are constrained. It is desirable for where an underground storage structure is to be located outside the pavement limits. Coordination with local utilities is required. Conflicts should be minimized. Clearances should be observed between stormwater and other systems such as drinking water and sanitary sewers. In considering underground detention, the native soil should be determined to ensure constructability. All inline detention should have a positive grade to minimize sedimentation. Access should be provided for cleaning of the underground facility. The grade should be set to avoid the need for a pump station if possible.

The types of underground detention include underground storage, inline detention, parallel storage systems, oversize storm-sewer system, and infiltration trench. Underground storage can be built as one single unit with one inlet and one outlet, under a large area such as a parking lot. It can also be built as a pipe network or conduit system with multiple inlets and only one outlet, under a large area such as a parking lot. Inline detention replaces part of a storm-sewer system with a larger structure near the outlet to detain water within the system. A parallel storage system runs parallel to the existing storm-sewer system to provide additional storage. An oversize storm-sewer system increases the pipe sizes as needed in parts of the storm sewer to add storage to the entire system. An infiltration trench functions like a roadway underdrain, but it can be used only in sandy soil, where the infiltration rate is high.

### 203-5.03(05) Outlet Conditions

An outlet work can take the form of combinations of a drop inlet, pipe, weir, or orifice. An outlet work selected for a storage facility includes a principal spillway or an emergency overflow. It should be able to accomplish the design functions of the facility.

A slotted-riser pipe should not be used due to clogging problems. A curb opening can be used for parking-lot storage. The principal spillway is intended to convey the design storm without allowing flow to enter an emergency outlet.

An emergency spillway is an outlet provided to allow excess water to exit the pond once the design storm is exceeded. Usually in the shape of a weir, the emergency outlet should be located so that the excess stormwater flows to an adequate outlet and does not damage nearby property. An emergency spillway should be included in a storage-facility design if possible. However, a viable emergency spillway location may not exist.

### 203-5.03(06) Maintenance

To ensure acceptable performance and function, a storage facility that requires extensive maintenance is discouraged. The maintenance problems that are typical of a detention facility are as follows:

1. weed growth;
2. grass and vegetation maintenance;
3. bank deterioration;
4. standing water or soggy surface;
5. mosquito control;
6. blockage of outlet structures;
7. litter accumulation; or
8. maintenance of fences and perimeter plantings.

The design should focus on the elimination or reduction of maintenance requirements by addressing the potential for problems as follows:

1. Both weed growth and grass maintenance can be addressed by constructing side slopes that can be maintained using available power-driven equipment, such as a tractor mower.
2. Bank deterioration can be controlled with protective lining or by limiting bank slopes.
3. Standing water or soggy surfaces can be eliminated by means of sloping the basin bottom toward the outlet, or by means of constructing a low-flow pilot channel across the basin bottom, from the inlet to the outlet.

4. Once the problems listed above are addressed, mosquito control will not be a major problem.
5. An outlet structure should be selected to minimize the possibility of blockage. A pipe of diameter of less than 6 in. tends to block easily and should be avoided.
6. The facility should be located for easy access where the maintenance associated with litter and damage to fences or perimeter plantings can be conducted regularly.

Routine maintenance activities include an annual inspection, preferably during wet weather, and mowing, as required.

### 203-5.03(07) Safety Issues

Ponding of water for a significant period of time, at a relatively shallow depth, can introduce an additional risk factor for property damage, personal injury, or loss of life. Safety considerations include reducing the chance of drowning by fencing the basin, reducing the maximum depth, or including ledges or mild slopes to prevent a person from falling in and to facilitate his or her escape from the basin. A storage facility in a location that is easily accessible to the public should be provided with fencing adequate to prevent entry onto the site by unauthorized persons. A storage facility located adjacent to a roadway should be provided with an adequate clear zone to minimize the accidental entry of an errant vehicle.

Protective treatment is required to prevent entry to a facility that poses a hazard to all persons. Fences and signs are required for a detention or retention pond with a locked gate to allow for maintenance access.

Where a storage facility is located near a roadway, the road should be provided with an adequate clear zone. The maximum operating-pool depth is limited to 5 ft unless otherwise approved by the Office of Hydraulics.

## 203-5.04 Design Procedure

A storage facility will require an inflow rate and an outflow rate to determine the necessary storage volume.

The amount of water flowing into the storage facility should be determined. This inflow rate is the post-developed 1% annual EP. However, an additional smaller inflow rate should be considered, if a stricter local ordinance is being followed. The outflow rate should then be determined. The outflow rate is the pre-developed 10% annual EP. However, additional smaller outflow rate should be considered, if a stricter local ordinance is being followed.

The required storage volume should be calculated, based on the inflow and outflow rates, and storm duration. If the watershed draining into a storage facility is greater than 2 ac, the design should be based on reservoir-routing methods which develop hydrographs for both inflow and outflow. WinTR-20 and HEC-HMS are available public-domain hydrographic programs. A basin regulating less than 2 ac can be analyzed using the Rational Method to create a triangular hydrograph.

### 203-5.04(01) Detention Pond

For a detention pond, a minimum freeboard of 1 ft above the 1% annual EP storm highwater elevation should be provided. Other considerations in setting the depth include flood-elevation requirements, public safety, land availability, land value, present and future land use, water-table fluctuations, soil characteristics, maintenance requirements, and required freeboard.

The primary outlet should be designed to drain the entire detention volume within 72 h. A restrictor plate should not be used. See the INDOT *Standard Drawings*.

An emergency overflow structure should also be added. The emergency overflow structure should be placed in a location that will accept the extra flow. This may or may not outlet to the design outfall. Usually, the emergency overflow structure takes the shape of a weir.

The area above the detention pond's normal high-water elevation should be sloped towards the pond. The bottom area of the pond should be graded toward the outlet to prevent standing water conditions. A low-flow or pilot channel constructed across the facility bottom from the inlet to the outlet should be used to convey low flow. See HEC-22, Chapter 8 for example problems and more information.

### 203-5.04(02) Retention Pond

The inflow rate is calculated using the Rational Method, regardless of the size of the drainage area. Since the pond is retaining all of the runoff from the 1% annual EP, the outflow rate is almost negligible, because infiltration and evaporation are the only available mechanisms for drainage. To determine the infiltration rate, soil borings should be obtained to ensure accurate calculations.

A retention pond also requires an emergency spillway. The emergency spillway should overflow to an acceptable outlet. The pond should be sized to allow for 1 ft of freeboard below the emergency spillway. If an acceptable emergency overflow outlet is not available, the pond should be sized for 1.5 times the total volume required, plus 1 ft of freeboard.

The construction of a storage facility can require excavation or placement of an earthen embankment to obtain sufficient storage volume. The embankment should be of less than 6.5 ft height. A vegetated embankment should not be steeper than 3H:1V. A riprap-protected embankment should not be steeper than 2H:1V. An excavated storage facility should not have an operating design-pool depth of greater than 5 ft unless approved by the Office of Hydraulics.

### 203-5.04(03) Roadside Ditch Detention

A detention pond detains water from the entire drainage area. A roadside ditch detains water only from additional pavement being added during construction. However, the methodology for determining that volume remains the same. To detain the water in a roadside ditch, a berm should be built upstream of the stream receiving the flow from the ditch. The outlet structure diameter should not be smaller than 6 in. to prevent clogging. The berm should be constructed with an overflow weir for a storm event that exceeds the design storm. For more information on emergency overflow design, see HEC-22, Chapter 8. The capacity of the outfall may not allow for a normal 1% annual EP inflow and 10% annual EP outflow situation. The release rate should be considered, since the roadside ditch can be outletting upstream of existing structures.

### 203-5.04(04) Oversized Storm Sewer and Inline Detention

An oversized storm sewer system upsizes the pipes near the outlet of the system to provide extra capacity. An oversized storm-sewer system uses larger round or deformed pipes to provide the extra capacity, while inline detention uses vaults or boxes to provide the extra capacity.

An oversized storm sewer or inline detention should be designed in accordance with Section 203-4.0 for inlet spacing, water-spread calculations, trunk-line placement, and outlet tailwater conditions. However, detention-routing calculations should be performed to ensure that a sufficient amount of water is being detained. Gravity flow should be maintained for the 10% annual EP. The 2% annual EP hydraulic-grade line should remain below the structure top casting elevation. If local detention requirements require the 1% annual EP to be detained, another hydraulic-grade-line check should be made, to ensure that the hydraulic-grade line remains below the structure top casting elevation at the 1% annual EP. Since the velocity through the oversized section is likely to be lower than the suggested minimum velocity, sedimentation is a potential problem. Manholes should be oversized and placed more frequently through the oversized section, to assist maintenance personnel in removing sediment from the storm-sewer system.

Since inline detention is usually present near the outlet of the storm-sewer system, an emergency overflow structure should be placed in the underground storage vault. This consists of a pipe

placed in the upper corner of the storage vault. A pipe of diameter of at least 6 in. should be used to prevent the emergency overflow structure from clogging.

### 203-5.04(05) Infiltration Trench

An infiltration trench is similar to a retention pond, except it is long and narrow and may work within the right-of-way. An infiltration trench is lined with geotextiles and backfilled with aggregate. The Rational Method should be used to calculate the inflow rate. The outflow rate will then be determined based on the infiltration capacity of the soil. Only highly pervious soils should be considered. The length of the system will depend on the volume required, given the inflow and outflow rates. Only the volume of the pipe should be considered for storage. The volume of the voids available in the backfilled trench should be ignored, to provide a factor of safety. Larger pipes should be used, to allow for maintenance. An infiltration trench should be constructed in accordance with Section 203-4.0. For additional information, see HEC-22, Chapter 8 or Chapter 10.

## 203-5.05 Pump Station

A pump station requires electricity as well as regular maintenance for proper function. It requires accessibility, monitoring, has limited capacity, and can be expensive. During a large storm event, it can be prone to flooding and failure. For these reasons, use of a pump station is discouraged by INDOT. However, because of topography or geometrics, it may become necessary. If so, the Office of Hydraulics should be contacted and the design guidelines for a pump station shown in HEC-24 should be followed.

## 203-5.06 Documentation

The information is required for a storage-facility submittal is as follows:

1. project background, including existing and proposed structure;
2. summary of hydraulics design and assumptions, including design criteria;
3. USGS topographic map, or county 2 ft contour lines, and aerial map of the project site to determine the drainage area for the storage design;
4. Hydrology, depending on methods used, IDNR discharge letter if required, coordinated discharges, FIS information, gaged sites or TR-55 and hydrograph methodologies. See Section 203-2.0;

5. computation of the inflow hydrograph;
6. computation of the outflow hydrograph or the restricted outflow according to the pertinent ordinance;
7. summary performance table for the storage system used to determine the maximum storage volume and the maximum water surface elevation, and to verify the release rate relative to the INDOT, city or town, or county regulation. See Figure 203-5A;
8. computation of the outflow-rating curve, or stage-storage-discharge relationship;
9. plan sheet showing the geometric shape of the detention including the maximum water surface elevation inside the pond, the freeboard, and the emergency spillway if applicable; and
10. an appendix including the calculation and computer-program input and output data used to determine the data shown on the summary-performance table.

## 203-6.0 CHANNEL OR DITCH

### 203-6.01 Introduction

An open channel is a natural or constructed conveyance for water in which the water surface is exposed to the atmosphere and the gravity-force component in the direction of motion is the driving force.

The types of open channels related to a transportation facility are stream channel, or artificial channel or ditch.

The principles of open-channel-flow hydraulics are applicable to each drainage facility including a culvert or a storm drain.

A stream channel has the properties as follows:

1. a natural channel with its size and shape determined by means of natural forces;
2. compound in cross section with a main channel for conveying low flow and a floodplain to transport flood flow, and
3. shaped geomorphologically due to the long-term history of sediment load and water discharge which it experiences.