

# TECHNICAL INFORMATION REPORT

FOR

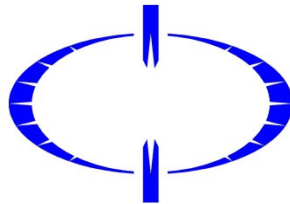
Direct Conveyors  
Office/Warehouse Facility

Linville Way  
Franklin, Indiana 46131

PREPARED BY

RICHARD R. HOOVER, P.E.  
HOOVER ENGINEERING, LLC

November 6, 2017  
Revised November 13, 2017



11/13/17

#### **LOCATION AND EXISTING DEVELOPMENT:**

The site is located on the north side of Commerce Drive where Commerce Drive turns south and is more specifically located at the northwest corner of Commerce Drive and a proposed street called Linville Way. The site is currently vacant and formerly a farm field, approximately 5.074 acres in size, and has a zoning designation of Light Industrial. The site is within an unshaded Zone X and drains general from northeast to southwest towards Commerce Drive. There are existing ditches and culverts along Commerce Drive, and a new pipe is proposed under Commerce Drive with the Linville Way construction.

#### **PROPOSED DEVELOPMENT:**

The proposed development entails the construction of a 29,700 square-foot Office/Warehouse facility that will house Direct Conveyors. The current proposed development will entail the construction of 67 parking spaces and 3 truck docks. In the future, an expansion may be necessary, so the calculations for detention take into account that expansion. Water quality will be provided in the proposed ponds.

The proposed runoff will sheet flow across the parking and dock areas to swales that will convey runoff to a wet detention facility on the west side of the site. Runoff from the proposed 100-Year storm event will be detained and released at the existing 10-Year event rate, and the proposed 10-Year event will be detained and released at the existing 2-Year event rate. Water Quality will be provided in the proposed pond which will detain at least 20% of the required WQU detention volume for 24 hours after the peak inflow.

#### **EXISTING DRAINAGE:**

The existing site is a part of an overall area that is currently being developed with uses in the City of Franklin's Light Industrial District. HydroCAD, an SCS based hydrological software program was utilized to model the existing and proposed conditions. All modeling for this development were based upon the 24-Hour storm events with a calculated time of concentration. The models were also created to be consistent with the Shell Building project calculations prepared by Veridus Group. That report is included in Appendix C. The output from the program is included in Appendix A, Existing Modeling. This appendix also contains the Times of Concentration spreadsheets as well as the CN calculations for the existing conditions. The results of the model were an allowable 2-Year release rate of 2.64 cfs and an allowable 10-Year release rate of 6.01 cfs.

#### **PROPOSED DRAINAGE:**

The proposed drainage will utilize sheet flow across the parking areas to inlets and swales where runoff will be directed into the pond. The roof area of the proposed and future buildings will discharge directly into the pond. The truck dock area will be a 4-foot depressed dock area and will gravity drain into a storm lift station that will discharge into the proposed storm sewer system. An area of off-site street right-of-way consisting of 0.50 acres will be included with the calculations for detention and water quality. As stated previously, the pond will detain the proposed 10-year and 100-year events and release those events at the existing 2-year and 10-year existing rates, respectively. Appendix B contains the information created for the modeling for the proposed conditions and the HydroCAD output. Two areas were created as a result of the design. Basin 1 contains the larger area with the development while Basin 2 consists of a 0.105-acre pervious area that will discharge directly offsite. It should be noted that the proposed time of concentration was based on the time of concentration determined by the storm sewer design calculation worksheet (enclosed).

### **Water Quality:**

Water Quality will be provided within the proposed detention facility. The proposed storm sewer system and swale along the north boundary line direct runoff from the entire site with the exception of 0.105 acres mentioned previously into the upper two-thirds of the pond. The structure designed to control the discharge from the pond consists of a 4' square inlet with an upper orifice and a lower orifice. The lower orifice is 4 inches in diameter and will help detain the required volume of runoff for 24 hours beyond the peak inflow rate. The required amount of volume was calculated by a 1.25" storm and a ½" direct runoff, resulting in 20% required volumes of 1,612 cft and 1,986 cft, respectively. The greater of the two is the required volume, and since the peak inflow of both the 10-Yr and 100-Yr storm events was at 11.99 hours, the remaining volume in the pond at 36 hours was found. The 10-Yr and 100-Yr storms will have remaining volumes of 2,744 cft and 3,049 cft, respectively. Appendix B also contains the modeling and calculations for the required volumes.

### **Storm Sewer Design:**

Appendix C contains the design worksheets for the storm sewer system. Included are the basin map, the design worksheet, and the inlet capacity worksheets.

### **Overflow Design:**

The overflow design was determined utilizing the combined 100-year peak flows from Lot 1, Block A1, Block A2, and the roadway area not included in the pond design (146.43 cfs) combined with the peak discharges from Lot 1 and the site. Appendix D contains the HydroCAD results for all but Lot 1 and the site. The Lot 1 peak discharge, 3.91 cfs, was determined from the Veridus Group drainage report, also contained in Appendix D. The peak discharge from onsite is 39.11 cfs with the overflow design requirement of 48.89 cfs (1.25 times the peak inflow). The combined discharge of 199.23 cfs will discharge over the overflow at a depth of 0.82' (752.58).

### **RESULTS AND COMPARISONS:**

The existing allowable rates are: 10-Yr = 2.07 cfs    100-Yr = 6.01 cfs

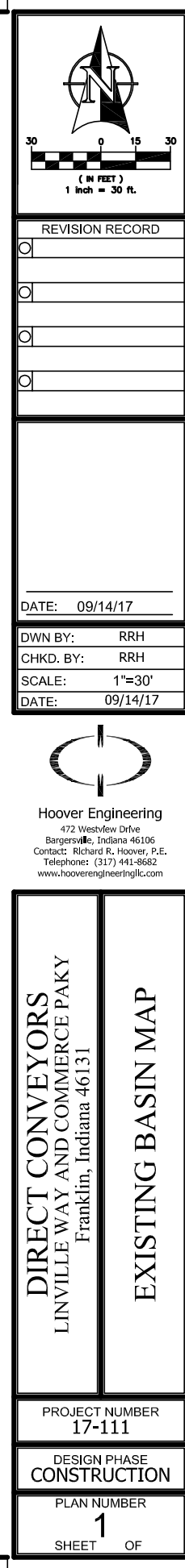
Results from the proposed HydroCAD runs are tabulated below.

Event	Basin 1	Basin 2	Total
10-YR, 24 HR	1.54 cfs	0.31 cfs	1.85 cfs
100-Yr, 24 HR	4.06 cfs	0.60 cfs	4.66 cfs

The results of the modeling show that the proposed release rates will be less than the allowable rates.

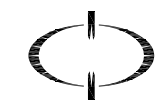
## **APPENDIX A**

**Existing Basin Map  
HydroCAD Modeling  
Time of Concentration Worksheet  
Curve Number (CN) Worksheet**



REVISION RECORD	
<input type="radio"/>	
<input type="radio"/>	
<input type="radio"/>	
<input type="radio"/>	

DATE:	09/14/17
DWN BY:	RRH
CHKD. BY:	RRH
SCALE:	1"=30'
DATE:	09/14/17



**Hoover Engineering**  
472 Westview Drive  
Bargersville, Indiana 46106  
Contact: Richard R. Hoover, P.E.  
Telephone: (317) 441-8682  
[www.hooverengineeringllc.com](http://www.hooverengineeringllc.com)

**DIRECT CONVEYORS**  
LINVILLE WAY AND COMMERCE PAKY  
Franklin, Indiana 46131

**EXISTING BASIN MAP**

PROJECT NUMBER  
17-111

DESIGN PHASE  
CONSTRUCTION

PLAN NUMBER  
1

SHEET OF

# 17111.Direct.Conveyors.Existing

Type II 24-hr 24HR10YR Rainfall=4.08"

Prepared by {enter your company name here}

Printed 11/7/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 1

## Summary for Subcatchment 1E: Existing Basin

Runoff = 6.01 cfs @ 12.35 hrs, Volume= 0.704 af, Depth= 1.52"

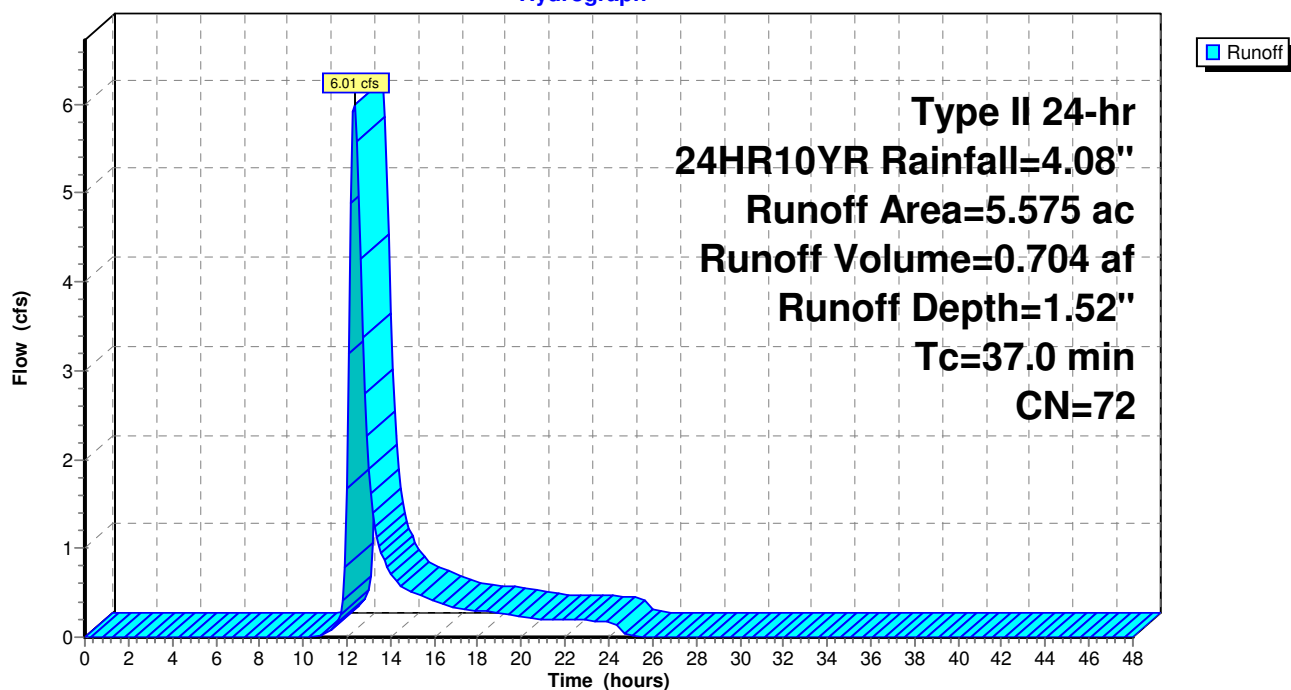
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.10 hrs  
Type II 24-hr 24HR10YR Rainfall=4.08"

Area (ac)	CN	Description
* 5.575	72	Existing Basin
5.575		100.00% Pervious Area

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

## Subcatchment 1E: Existing Basin

Hydrograph



# 17111.Direct.Conveyors.Existing

Type II 24-hr 24HR2YR Rainfall=2.64"

Prepared by {enter your company name here}

Printed 11/7/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 2

## Summary for Subcatchment 1E: Existing Basin

Runoff = 2.07 cfs @ 12.39 hrs, Volume= 0.280 af, Depth= 0.60"

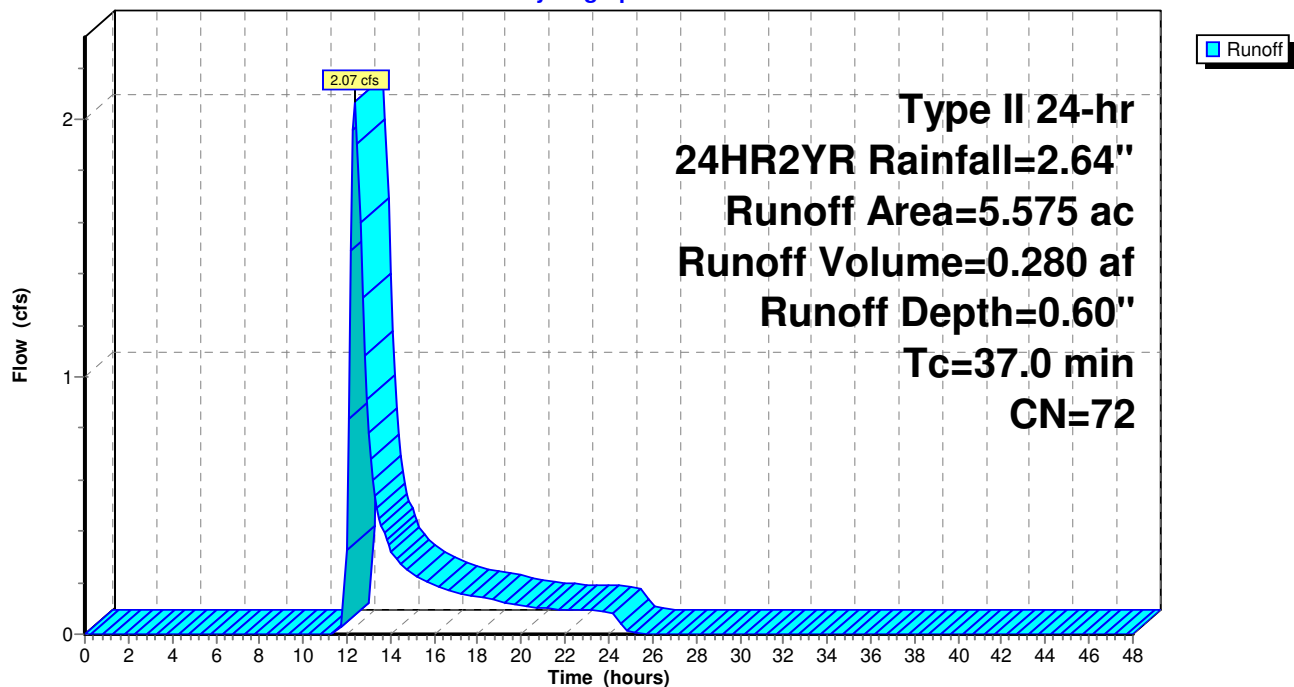
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.10 hrs  
Type II 24-hr 24HR2YR Rainfall=2.64"

Area (ac)	CN	Description
* 5.575	72	Existing Basin
5.575		100.00% Pervious Area

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

## Subcatchment 1E: Existing Basin

Hydrograph



## Time of Concentration/Travel Time Worksheet

Hoover Engineering Project No.  
Project  
Location  
Description

17-111  
Direct Conveyors  
Linville Way  
Existing Basin

By RRH  
Date 11/06/17

### FOR OVERALL SITE - LONGEST T<sub>c</sub>

#### SHEET FLOW (Applicable to T<sub>c</sub> only)

- |   | Segment ID                      |
|---|---------------------------------|
| 1. Surface description  | .....                           |
| 2. Manning's roughness coefficient, n   | .....                           |
| 3. Flow length, L (total L ≤ 100 ft)  | ..... ft                        |
| 4. two-year, 24-hour rainfall, P <sub>2</sub>   | ..... in                        |
| 5. Land slope, s  | ..... ft/ft                     |
| 6. T <sub>t</sub> = [0.007(nL) <sup>0.8</sup> ]/[P <sub>2</sub> <sup>0.5</sup> s <sup>0.4</sup> ] | Compute T <sub>t</sub> ..... hr |

1			Total
Field			
0.250			
95			
2.91			
0.0033			
0.507			0.507

n source:

P<sub>2</sub> source:

#### SHALLOW CONCENTRATED FLOW

- |   | Segment ID                      |
|---|---------------------------------|
| 7. Surface description (paved or unpaved) | .....                           |
| 8. Flow length, L                         | ..... ft                        |
| 9. Watercourse slope, s                   | ..... ft/ft                     |
| 10. Average velocity, v                   | ..... ft/s                      |
| 11. T <sub>t</sub> = (L/v)/3600           | Compute T <sub>t</sub> ..... hr |

2	3	3	Total
UNPAVED	UNPAVED	UNPAVED	
110.19	462.47	99.02	
0.0091	0.0062	0.0158	
1.94	1.60	2.56	
0.016	0.080	0.011	0.107

v = 20.3282(s)<sup>0.5</sup> for paved surfaces

v = 16.1345(s)<sup>0.5</sup> for unpaved surfaces

#### CHANNEL FLOW

- |  | Segment ID                      |
|--|---------------------------------|
| 12. Cross sectional flow area, a                   | ..... ft <sup>2</sup>           |
| 13. Wetted perimeter, P <sub>w</sub>               | ..... ft                        |
| 14. Hydraulic radius, r = a/P <sub>w</sub>         | Compute r ..... ft              |
| 15. Channel slope, s                               | ..... ft/ft                     |
| 16. Manning's roughness coefficient, n             | .....                           |
| 17. v = (1.49r <sup>2/3</sup> s <sup>1/2</sup> )/n | Compute v ..... ft/s            |
| 18. Flow length, L                                 | ..... ft                        |
| 19. T <sub>t</sub> = (L/v)/3600                    | Compute T <sub>t</sub> ..... hr |

			Total
			0.000

n source:

20. Total Time of Concentration/Travel Time ..... hours = **0.614**  
minutes = **36.827**  
**Use 37 Minutes**



## Composite Curve Number Computation Worksheet

Job No. 17-111  
 Project Direct Conveyors  
 Location Linville Way  
 Description Existing Basin  
 Total Area 5.575 Acres

By RRH  
 Date 11/06/17

Soil name and hydrologic group	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN			Area  ac/mi2/%	Product of CN x area
Br Group B	Rural, 0.974 Ac Field/Crops (CN=81)			61	0.9740	59.41
CrA Group C	Rural, 4.601 Ac Field/Crops (CN=88)			74	4.6010	340.47
Totals =					5.58	399.89

$$\text{CN (weighted)} = \text{total product/total area} = \frac{399.89}{5.58} = 71.73$$

Use CN = 72

Cover Description	Curve Numbers for Hydrologic Soil Groups			
Cover Type and Hydrologic Condition	A	B	C	D
Cultivated Land (Row Crops)	72	81	88	91
With conservation treatment	62	71	78	81
Without conservation treatment				
Pasture or Range Land	68	79	86	89
Poor condition	39	61	74	80
Good condition				
Meadow	30	58	71	78
Good condition				
Wood or Forest Land				
Thin stand, poor cover, no mulch	45	66	77	83
Good cover	25	55	70	77

**TABLE 205-03: Runoff Curve Numbers for Undeveloped Areas**  
(SOURCE: 210-VI-TR-55, Second Ed., June 1986)

Cover Description	Curve Numbers for Hydrologic Soil Groups			
Cover Type and Hydrologic Condition	A	B	C	D
Pasture, grassland or range with continuous forage for grazing.				
Poor	68	79	86	89
Fair	49	69	79	84
Good	39	61	74	80
Meadow with continuous grass, protected from grazing and generally mowed for hay.	30	58	71	78
Brush/brush-weed-grass mixture with brush being the major element.				
Poor	48	67	77	83
Fair	35	56	70	77
Good	30	48	65	73
Woods and grass combination (orchard or tree farm).				
Poor	57	73	82	86
Fair	43	65	76	82
Good	32	58	72	79
Woods				
Poor	45	66	77	83
Fair	36	60	73	79
Good	30	55	70	77
Farmsteads	59	74	82	86

**TABLE 205-04: Runoff Curve Numbers for Agricultural Lands**  
(SOURCE: 210-VI-TR-55, Second Ed., June 1986)

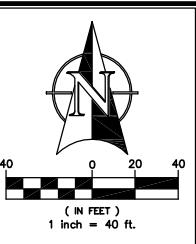
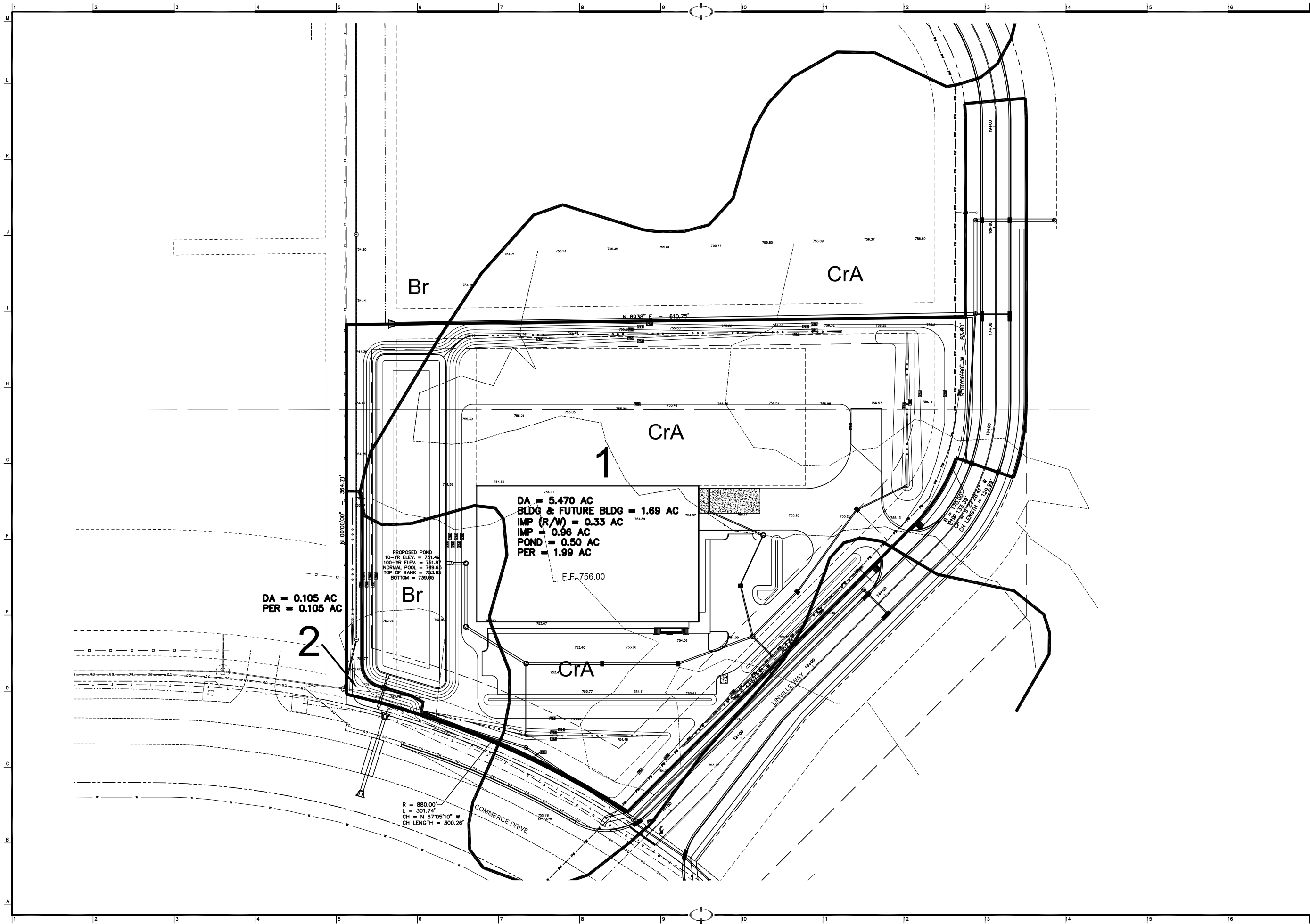
Hours	Minutes	Return Period - Rainfall Intensity (in/hr)					
		2	5	10	25	50	100
0.08	5	4.75	6.14	6.99	8.08	8.83	9.69
0.17	10	3.63	4.75	5.48	6.40	7.07	7.77
0.25	15	2.97	3.92	4.55	5.34	5.94	6.53
0.5	30	1.98	2.64	3.09	3.65	4.10	4.50
1	60	1.25	1.67	1.96	2.31	2.62	2.88
2	120	0.76	1.02	1.20	1.40	1.59	1.75
3	180	0.56	0.75	0.88	1.03	1.17	1.29
6	360	0.33	0.44	0.52	0.60	0.68	0.75
12	720	0.20	0.26	0.30	0.35	0.39	0.43
24	1440	0.11	0.15	0.17	0.20	0.22	0.25

Hours	Minutes	Return Period - Rainfall Depth (in)					
		2	5	10	25	50	100
0.08	5	0.40	0.51	0.58	0.67	0.74	0.81
0.17	10	0.61	0.79	0.91	1.07	1.18	1.30
0.25	15	0.74	0.98	1.14	1.34	1.49	1.63
0.5	30	0.99	1.32	1.55	1.83	2.05	2.25
1	60	1.25	1.67	1.96	2.31	2.62	2.88
2	120	1.52	2.04	2.40	2.80	3.18	3.50
3	180	1.68	2.25	2.64	3.09	3.51	3.87
6	360	1.98	2.64	3.12	3.60	4.08	4.50
12	720	2.40	3.12	3.60	4.20	4.68	5.16
24	1440	2.64	3.60	4.08	4.80	5.28	6.00

**TABLE 202-02: IDF and IDD Tables for Indianapolis, IN**

## **APPENDIX B**

**Proposed Basin Map  
HydroCAD Modeling  
Curve Number (CN) Worksheets  
Orifice Flow Worksheets  
Stage/Storage Worksheet**



REVISION RECORD	

*Richard R. Hoover*  
DATE: 11/06/17

DWN BY:	RRH
CHKD. BY:	RRH
SCALE:	1"=40'
DATE:	09/14/17

Hoover Engineering  
472 Westview Drive  
Bargersville, Indiana 46106  
Contact: Richard R. Hoover, P.E.  
Telephone: (317) 441-8682  
www.hooverengineeringllc.com

DIRECT CONVEYORS  
LINVILLE WAY AND COMMERCE PAKY  
Franklin, Indiana 46131

PROPOSED BASIN MAP

PROJECT NUMBER	17-111
DESIGN PHASE	CONSTRUCTION
PLAN NUMBER	C3.0
SHEET	OF

**17-111.Proposed.Basin.1.1**

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/8/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 1

**Summary for Pond 1POND: (new Pond)**

Inflow Area = 5.470 ac, 0.00% Impervious, Inflow Depth = 4.74" for 24HR100YR event  
 Inflow = 39.11 cfs @ 11.99 hrs, Volume= 2.159 af  
 Outflow = 4.06 cfs @ 12.44 hrs, Volume= 2.083 af, Atten= 90%, Lag= 27.0 min  
 Primary = 4.06 cfs @ 12.44 hrs, Volume= 2.083 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 751.76' @ 12.44 hrs Surf.Area= 0.000 ac Storage= 1.207 af

Plug-Flow detention time= 347.6 min calculated for 2.083 af (97% of inflow)  
 Center-of-Mass det. time= 326.5 min ( 1,113.6 - 787.1 )

Volume	Invert	Avail.Storage	Storage Description
#1	749.65'	2.879 af	<b>Custom Stage Data</b> Listed below

Elevation (feet)	Cum.Store (acre-feet)
749.65	0.000
750.00	0.179
751.00	0.732
752.00	1.357
753.00	2.068
754.00	2.879

Device	Routing	Invert	Outlet Devices
#1	Primary	749.65'	<b>Special &amp; User-Defined</b>
			Elev. (feet) 749.65 750.00 751.00 752.00 753.00 754.00
			Disch. (cfs) 0.000 0.130 1.300 4.930 6.820 8.280

**Primary OutFlow** Max=4.06 cfs @ 12.44 hrs HW=751.76' (Free Discharge)

↑ **1=Special & User-Defined** (Custom Controls 4.06 cfs)

# 17-111.Proposed.Basin.1.1

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

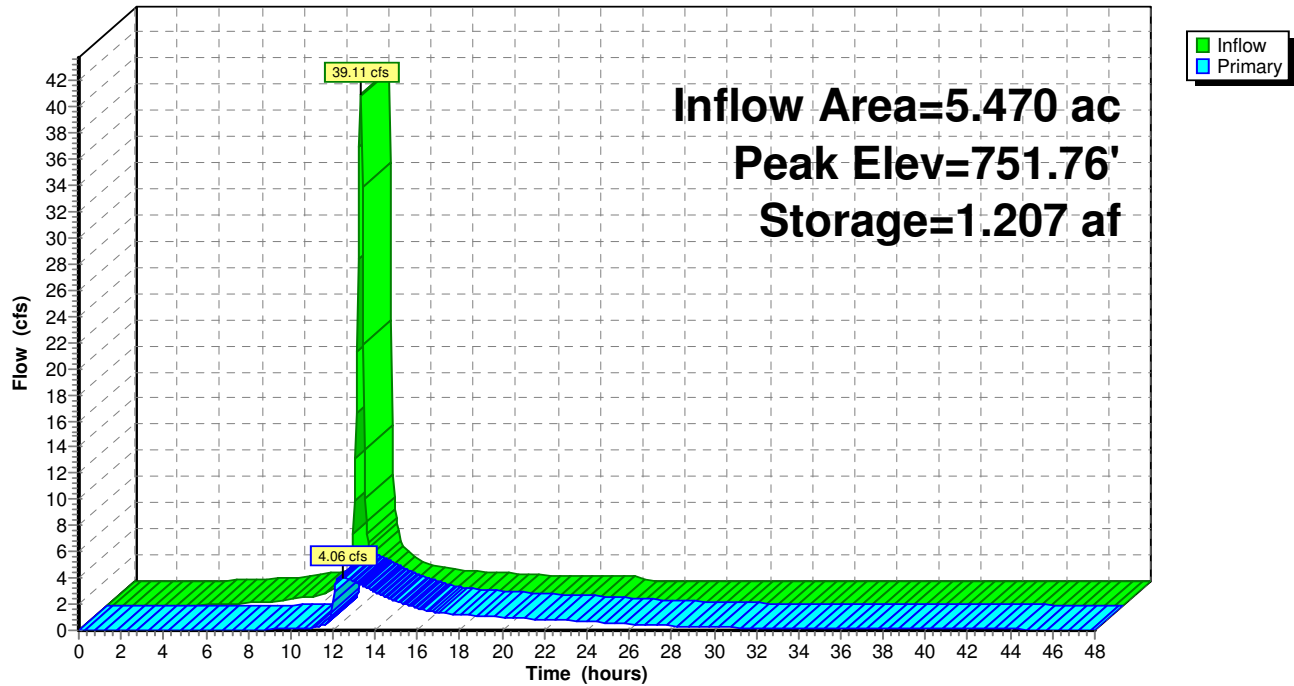
Type II 24-hr 24HR100YR Rainfall=6.00"

Printed 11/8/2017

Page 2

## Pond 1POND: (new Pond)

Hydrograph



**17-111.Proposed.Basin.1.1**

Type II 24-hr 24HR10YR Rainfall=4.08"

Prepared by {enter your company name here}

Printed 11/8/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 3

**Summary for Pond 1POND: (new Pond)**

Inflow Area = 5.470 ac, 0.00% Impervious, Inflow Depth = 2.90" for 24HR10YR event  
 Inflow = 24.64 cfs @ 11.99 hrs, Volume= 1.321 af  
 Outflow = 1.54 cfs @ 12.85 hrs, Volume= 1.254 af, Atten= 94%, Lag= 51.4 min  
 Primary = 1.54 cfs @ 12.85 hrs, Volume= 1.254 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
 Peak Elev= 751.07' @ 12.85 hrs Surf.Area= 0.000 ac Storage= 0.774 af

Plug-Flow detention time= 434.0 min calculated for 1.253 af (95% of inflow)  
 Center-of-Mass det. time= 406.0 min ( 1,206.8 - 800.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	749.65'	2.879 af	<b>Custom Stage Data</b> Listed below

Elevation (feet)	Cum.Store (acre-feet)
749.65	0.000
750.00	0.179
751.00	0.732
752.00	1.357
753.00	2.068
754.00	2.879

Device	Routing	Invert	Outlet Devices
#1	Primary	749.65'	<b>Special &amp; User-Defined</b>
			Elev. (feet) 749.65 750.00 751.00 752.00 753.00 754.00
			Disch. (cfs) 0.000 0.130 1.300 4.930 6.820 8.280

**Primary OutFlow** Max=1.54 cfs @ 12.85 hrs HW=751.07' (Free Discharge)

↑ **1=Special & User-Defined** (Custom Controls 1.54 cfs)



# 17-111.Proposed.Basin.1.1

Type II 24-hr 24HR10YR Rainfall=4.08"

Prepared by {enter your company name here}

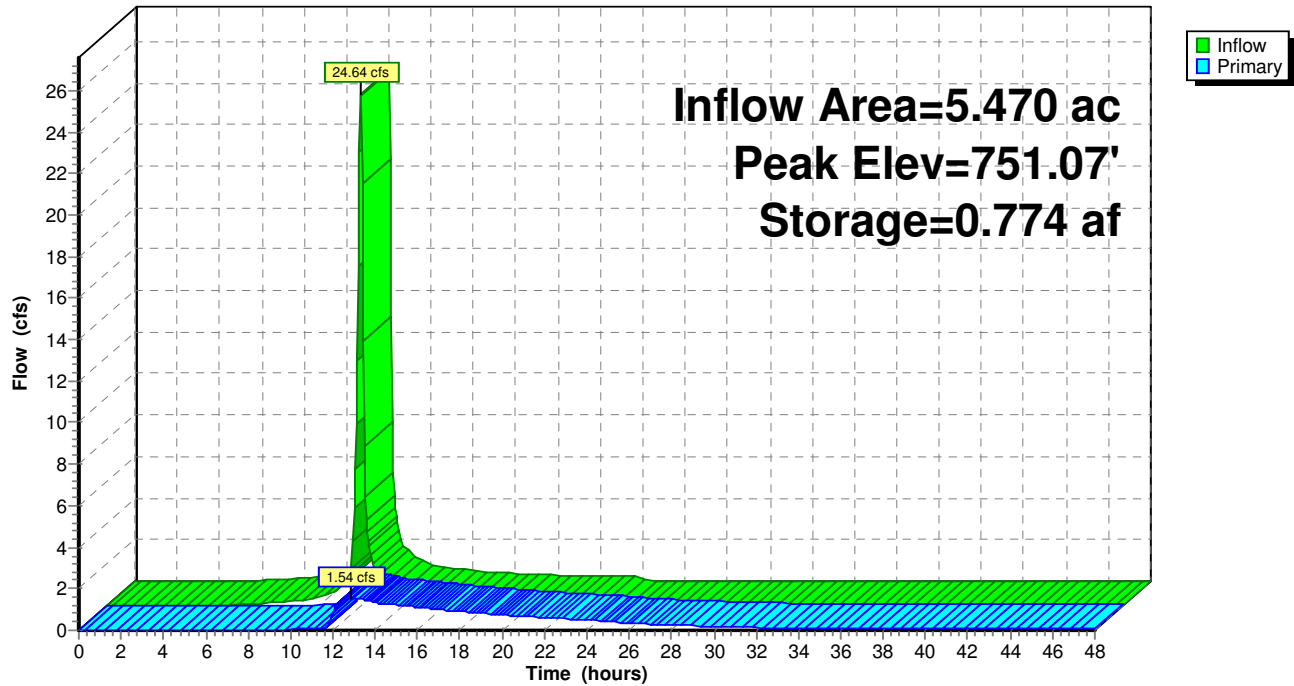
Printed 11/8/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 4

## Pond 1POND: (new Pond)

Hydrograph



## 17-111.Proposed.Basin.2

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/7/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 1

### Summary for Subcatchment P2: Basin 2

[49] Hint:  $T_c < 2dt$  may require smaller  $dt$

Runoff = 0.60 cfs @ 11.96 hrs, Volume= 0.028 af, Depth= 3.18"

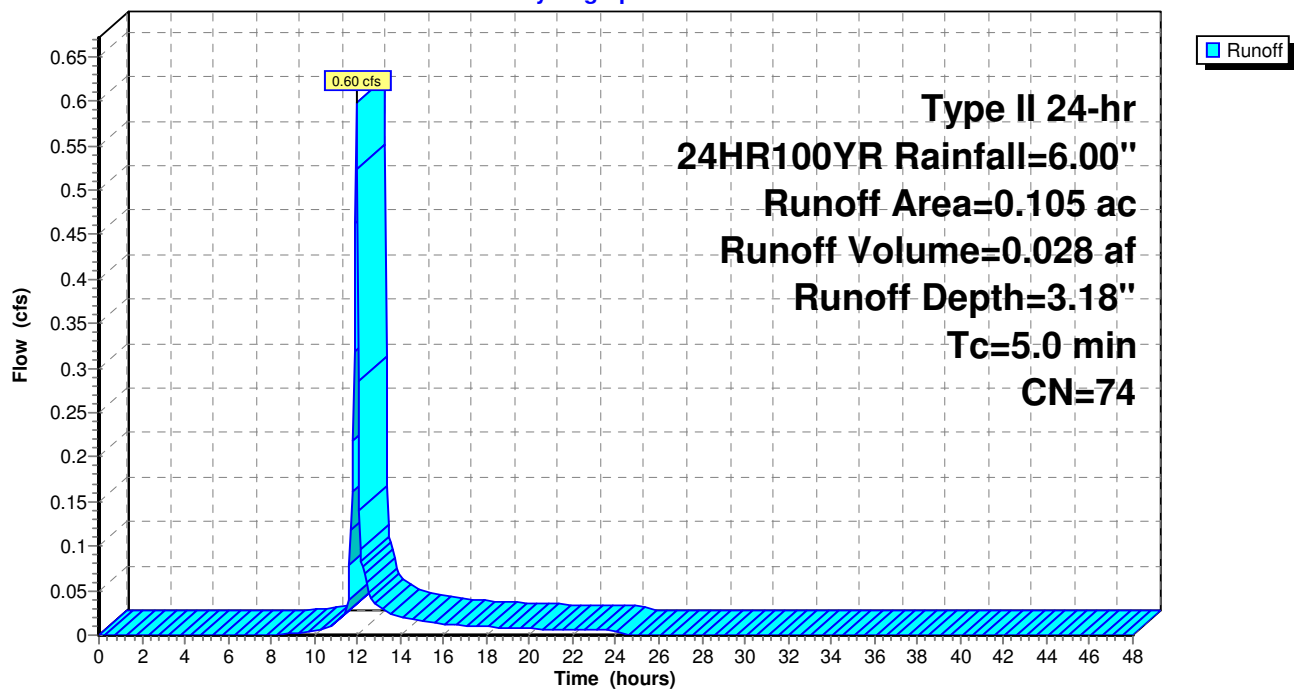
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs,  $dt=0.05$  hrs  
Type II 24-hr 24HR100YR Rainfall=6.00"

Area (ac)	CN	Description
* 0.105	74	
0.105		100.00% Pervious Area

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

### Subcatchment P2: Basin 2

Hydrograph



**17-111.Proposed.Basin.2**

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/7/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 2

**Hydrograph for Subcatchment P2: Basin 2**

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	6.00	3.18	0.00
0.50	0.03	0.00	0.00	26.50	6.00	3.18	0.00
1.00	0.06	0.00	0.00	27.00	6.00	3.18	0.00
1.50	0.10	0.00	0.00	27.50	6.00	3.18	0.00
2.00	0.13	0.00	0.00	28.00	6.00	3.18	0.00
2.50	0.17	0.00	0.00	28.50	6.00	3.18	0.00
3.00	0.21	0.00	0.00	29.00	6.00	3.18	0.00
3.50	0.25	0.00	0.00	29.50	6.00	3.18	0.00
4.00	0.29	0.00	0.00	30.00	6.00	3.18	0.00
4.50	0.33	0.00	0.00	30.50	6.00	3.18	0.00
5.00	0.38	0.00	0.00	31.00	6.00	3.18	0.00
5.50	0.43	0.00	0.00	31.50	6.00	3.18	0.00
6.00	0.48	0.00	0.00	32.00	6.00	3.18	0.00
6.50	0.54	0.00	0.00	32.50	6.00	3.18	0.00
7.00	0.59	0.00	0.00	33.00	6.00	3.18	0.00
7.50	0.66	0.00	0.00	33.50	6.00	3.18	0.00
8.00	0.72	0.00	0.00	34.00	6.00	3.18	0.00
8.50	0.79	0.00	0.00	34.50	6.00	3.18	0.00
9.00	0.88	0.01	0.00	35.00	6.00	3.18	0.00
9.50	0.98	0.02	0.00	35.50	6.00	3.18	0.00
10.00	1.09	0.04	0.00	36.00	6.00	3.18	0.00
10.50	1.22	0.07	0.01	36.50	6.00	3.18	0.00
11.00	1.41	0.12	0.01	37.00	6.00	3.18	0.00
11.50	1.70	0.22	<b>0.03</b>	37.50	6.00	3.18	0.00
12.00	3.98	1.58	<b>0.52</b>	38.00	6.00	3.18	0.00
12.50	4.41	1.90	0.05	38.50	6.00	3.18	0.00
13.00	4.63	2.07	0.03	39.00	6.00	3.18	0.00
13.50	4.79	2.20	0.02	39.50	6.00	3.18	0.00
14.00	4.92	2.30	0.02	40.00	6.00	3.18	0.00
14.50	5.03	2.38	0.02	40.50	6.00	3.18	0.00
15.00	5.12	2.46	0.02	41.00	6.00	3.18	0.00
15.50	5.21	2.53	0.01	41.50	6.00	3.18	0.00
16.00	5.28	2.59	0.01	42.00	6.00	3.18	0.00
16.50	5.35	2.64	0.01	42.50	6.00	3.18	0.00
17.00	5.41	2.70	0.01	43.00	6.00	3.18	0.00
17.50	5.47	2.74	0.01	43.50	6.00	3.18	0.00
18.00	5.53	2.79	0.01	44.00	6.00	3.18	0.00
18.50	5.58	2.83	0.01	44.50	6.00	3.18	0.00
19.00	5.63	2.87	0.01	45.00	6.00	3.18	0.00
19.50	5.67	2.91	0.01	45.50	6.00	3.18	0.00
20.00	5.71	2.94	0.01	46.00	6.00	3.18	0.00
20.50	5.75	2.98	0.01	46.50	6.00	3.18	0.00
21.00	5.79	3.01	0.01	47.00	6.00	3.18	0.00
21.50	5.83	3.04	0.01	47.50	6.00	3.18	0.00
22.00	5.86	3.07	0.01	48.00	6.00	3.18	0.00
22.50	5.90	3.10	0.01				
23.00	5.93	3.13	0.01				
23.50	5.97	3.16	0.01				
24.00	<b>6.00</b>	<b>3.18</b>	0.01				
24.50	6.00	3.18	0.00				
25.00	6.00	3.18	0.00				
25.50	6.00	3.18	0.00				

## 17-111.Proposed.Basin.2

Type II 24-hr 24HR10YR Rainfall=4.08"

Prepared by {enter your company name here}

Printed 11/7/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 3

### Summary for Subcatchment P2: Basin 2

[49] Hint:  $T_c < 2dt$  may require smaller  $dt$

Runoff = 0.31 cfs @ 11.96 hrs, Volume= 0.014 af, Depth= 1.66"

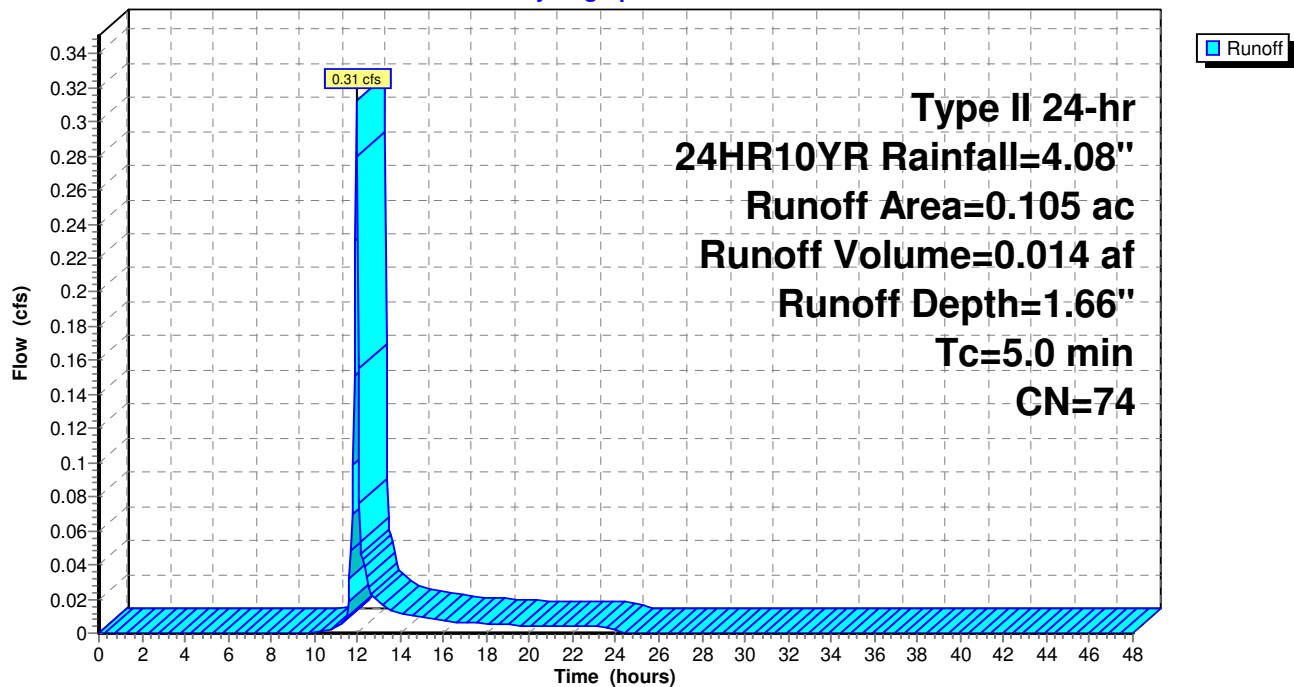
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs,  $dt=0.05$  hrs  
Type II 24-hr 24HR10YR Rainfall=4.08"

Area (ac)	CN	Description
* 0.105	74	
0.105		100.00% Pervious Area

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

### Subcatchment P2: Basin 2

Hydrograph



**17-111.Proposed.Basin.2**

Type II 24-hr 24HR10YR Rainfall=4.08"

Prepared by {enter your company name here}

Printed 11/7/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 4

**Hydrograph for Subcatchment P2: Basin 2**

Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)	Time (hours)	Precip. (inches)	Excess (inches)	Runoff (cfs)
0.00	0.00	0.00	0.00	26.00	4.08	1.66	0.00
0.50	0.02	0.00	0.00	26.50	4.08	1.66	0.00
1.00	0.04	0.00	0.00	27.00	4.08	1.66	0.00
1.50	0.07	0.00	0.00	27.50	4.08	1.66	0.00
2.00	0.09	0.00	0.00	28.00	4.08	1.66	0.00
2.50	0.11	0.00	0.00	28.50	4.08	1.66	0.00
3.00	0.14	0.00	0.00	29.00	4.08	1.66	0.00
3.50	0.17	0.00	0.00	29.50	4.08	1.66	0.00
4.00	0.20	0.00	0.00	30.00	4.08	1.66	0.00
4.50	0.23	0.00	0.00	30.50	4.08	1.66	0.00
5.00	0.26	0.00	0.00	31.00	4.08	1.66	0.00
5.50	0.29	0.00	0.00	31.50	4.08	1.66	0.00
6.00	0.33	0.00	0.00	32.00	4.08	1.66	0.00
6.50	0.36	0.00	0.00	32.50	4.08	1.66	0.00
7.00	0.40	0.00	0.00	33.00	4.08	1.66	0.00
7.50	0.45	0.00	0.00	33.50	4.08	1.66	0.00
8.00	0.49	0.00	0.00	34.00	4.08	1.66	0.00
8.50	0.54	0.00	0.00	34.50	4.08	1.66	0.00
9.00	0.60	0.00	0.00	35.00	4.08	1.66	0.00
9.50	0.67	0.00	0.00	35.50	4.08	1.66	0.00
10.00	0.74	0.00	0.00	36.00	4.08	1.66	0.00
10.50	0.83	0.00	0.00	36.50	4.08	1.66	0.00
11.00	0.96	0.02	0.00	37.00	4.08	1.66	0.00
11.50	1.15	0.05	<b>0.01</b>	37.50	4.08	1.66	0.00
12.00	2.71	0.73	<b>0.28</b>	38.00	4.08	1.66	0.00
12.50	3.00	0.91	0.03	38.50	4.08	1.66	0.00
13.00	3.15	1.00	0.02	39.00	4.08	1.66	0.00
13.50	3.26	1.08	0.01	39.50	4.08	1.66	0.00
14.00	3.35	1.13	0.01	40.00	4.08	1.66	0.00
14.50	3.42	1.18	0.01	40.50	4.08	1.66	0.00
15.00	3.48	1.23	0.01	41.00	4.08	1.66	0.00
15.50	3.54	1.27	0.01	41.50	4.08	1.66	0.00
16.00	3.59	1.30	0.01	42.00	4.08	1.66	0.00
16.50	3.64	1.33	0.01	42.50	4.08	1.66	0.00
17.00	3.68	1.37	0.01	43.00	4.08	1.66	0.00
17.50	3.72	1.39	0.01	43.50	4.08	1.66	0.00
18.00	3.76	1.42	0.01	44.00	4.08	1.66	0.00
18.50	3.79	1.45	0.01	44.50	4.08	1.66	0.00
19.00	3.83	1.47	0.00	45.00	4.08	1.66	0.00
19.50	3.86	1.49	0.00	45.50	4.08	1.66	0.00
20.00	3.88	1.51	0.00	46.00	4.08	1.66	0.00
20.50	3.91	1.53	0.00	46.50	4.08	1.66	0.00
21.00	3.94	1.55	0.00	47.00	4.08	1.66	0.00
21.50	3.96	1.57	0.00	47.50	4.08	1.66	0.00
22.00	3.99	1.59	0.00	48.00	4.08	1.66	0.00
22.50	4.01	1.60	0.00				
23.00	4.03	1.62	0.00				
23.50	4.06	1.64	0.00				
24.00	<b>4.08</b>	<b>1.66</b>	0.00				
24.50	4.08	1.66	0.00				
25.00	4.08	1.66	0.00				
25.50	4.08	1.66	0.00				

## Composite Curve Number Computation Worksheet

Job No. 17-111  
 Project Direct Conveyors  
 Location Linville Way  
 Description Proposed Basin 1  
 Total Area 5.470 Acres

By RRH  
 Date 11/06/17

Soil name and hydrologic group	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN			Area ac/mi2/%	Product of CN x area
CrA Group C	Urban, 2.98 Impervious (CN=98)			98	2.9800	292.04
CrA Group C	Urban, 0.50 Pond (CN=100)			100	0.5000	50.00
CrA Group C	Urban, 1.99 Pervious (CN=74)			74	1.9900	147.26
Totals =					5.47	489.30

$$\text{CN (weighted)} = \text{total product/total area} = \frac{489.30}{5.47} = 89.45$$

Use CN = 89

## Composite Curve Number Computation Worksheet

Job No. 17-111  
 Project Direct Conveyors  
 Location Linville Way  
 Description Proposed Basin 2  
 Total Area 0.105 Acres

By RRH  
 Date 11/06/17

Soil name and hydrologic group	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN			Area  ac/mi2/%	Product of CN x area
CrA Group C	Urban, 0.105 Pervious (CN=74)			74	0.1050	7.77
Totals =					0.11	7.77

$$\text{CN (weighted)} = \text{total product/total area} = \frac{7.77}{0.11} = 74.00$$

Use CN = 74

## Orifice Flow Computations

Hoover Engineering Project No. 17-111

Project Name Direct Conveyors

Location Linville Way

Description Orifice Control Structure - WQU

By RRH

Date 11/06/17

$C_d = 0.70$   
 $D = 0.25$  ft  
 $A = 0.05$  ft<sup>2</sup>  
 Invert Elevation = 749.65 ft  
 Orifice Center = 749.78 ft  
                             32.2

Elevation (ft)	h (ft)	Q (cfs)
749.65	-0.13	#NUM!
750.00	0.23	0.13
751.00	1.23	0.31
752.00	2.23	0.41
753.00	3.23	0.50
754.00	4.23	0.57
	-749.78	#NUM!
	-749.78	#NUM!
	-749.78	#NUM!
	-749.78	#NUM!
	-749.78	#NUM!
	-749.78	#NUM!
	-749.78	#NUM!

$C_d$  = Coefficient of orifice flow

D = Orifice diameter (ft)

A = Flow area (ft<sup>2</sup>)

h = Head (ft)

Q = Flow rate (cfs)

g = 32.2 ft/s<sup>2</sup>

$$A = \pi(D/2)^2$$

$$\text{Orifice Center} = \text{Invert Elevation} + (D/2)$$

$$h = \text{Elevation} - \text{Orifice Center}$$

$$Q = C_d A (2gh)^{0.5}$$

$C_d$  source:



## Orifice Flow Computations

Hoover Engineering Project No. 17-111

Project Name Direct Conveyors

Location Linville Way

Description Orifice Control Structure - Detention

By RRH  
Date 11/06/17

$C_d = 0.70$   
 $D = 1.00$  ft  
 $A = 0.79$  ft<sup>2</sup>  
 Invert Elevation = 750.45 ft  
 Orifice Center = 750.95 ft  
                             32.2

Elevation	h	Q
(ft)	(ft)	(cfs)
750.40	-0.55	#NUM!
751.00	0.05	0.99
752.00	1.05	4.52
753.00	2.05	6.32
754.00	3.05	7.71
	-750.95	#NUM!
	-750.95	#NUM!
	-750.95	#NUM!
	-750.95	#NUM!
	-750.95	#NUM!
	-750.95	#NUM!
	-750.95	#NUM!
	-750.95	#NUM!

$C_d$  = Coefficient of orifice flow

D = Orifice diameter (ft)

A = Flow area (ft<sup>2</sup>)

h = Head (ft)

Q = Flow rate (cfs)

g = 32.2 ft/s<sup>2</sup>

$$A = \pi(D/2)^2$$

$$\text{Orifice Center} = \text{Invert Elevation} + (D/2)$$

$$h = \text{Elevation} - \text{Orifice Center}$$

$$Q = C_d A (2gh)^{0.5}$$

$C_d$  source:

## Stage-Storage Computations

Hoover Engineering Project Number 17-112  
 Project Name Direct Conveyors  
 Location Linville Way  
 Description Detention Facility

By RRH  
 Date 11/06/17

$V_i$  = Incremental volume (acre-ft) Normal Pool = 749.65  
 $h$  = Elevation difference (ft) Top of Bank = 754.00  
 $A$  = Surface area (acres)

$h = \text{Elevation}_2 - \text{Elevation}_1$

Average Area =  $(A_1 + A_2 + (A_1 A_2)^{0.5})/3$

Conic Volume:  $V_i = h[(A_1 + A_2 + (A_1 A_2)^{0.5})/3]$

Elevation	Area	Average Area	h	$V_i$	Total Volume
(ft)	(acres)	(acres)	(ft)	(acre-ft)	(acre-ft)
749.65	0.5006				0.0000
		0.51	0.35	0.18	
750.00	0.5210				0.1788
		0.55	1.00	0.55	
751.00	0.5857				0.7318
		0.62	1.00	0.62	
752.00	0.6648				1.3566
		0.71	1.00	0.71	
753.00	0.7584				2.0677
		0.81	1.00	0.81	
754.00	0.8656				2.8791
		0.29	-754.00	-217.55	
					-214.6750
		0.00	0.00	0.00	
					-214.68
		0.00	0.00	0.00	
					-214.68
		0.00	0.00	0.00	
					-214.68
		0.00	0.00	0.00	
					-214.68

Cover Description	Curve Numbers for Hydrologic Soil Groups				
Cover Type and Hydrologic Condition	Average Percent <sup>2</sup> Impervious Area	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)		68	79	86	89
Poor condition (grass cover < 50%)		49	69	79	84
Fair condition (grass cover 50% to 75%)		39	61	74	80
Good condition (grass cover > 75%)					
Impervious Areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and Roads:					
Paved; curbs and storm drains (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Urban Districts:					
Commercial and Business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential Districts by Average Lot Size:					
0.125 acre or less (townhouses)	65	77	85	90	92
0.25 acre	38	61	75	83	87
0.33 acre	30	57	72	81	86
0.50 acre	25	54	70	80	85
1.00 acre	20	51	68	79	84
2.00 acre	12	46	65	77	82
Developing Urban Areas					
Newly graded areas (pervious area only, no vegetation)		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in <i>Table 205-04</i> ).					

<sup>1</sup> Average runoff condition, and  $I_a = 0.2S$

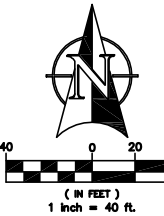
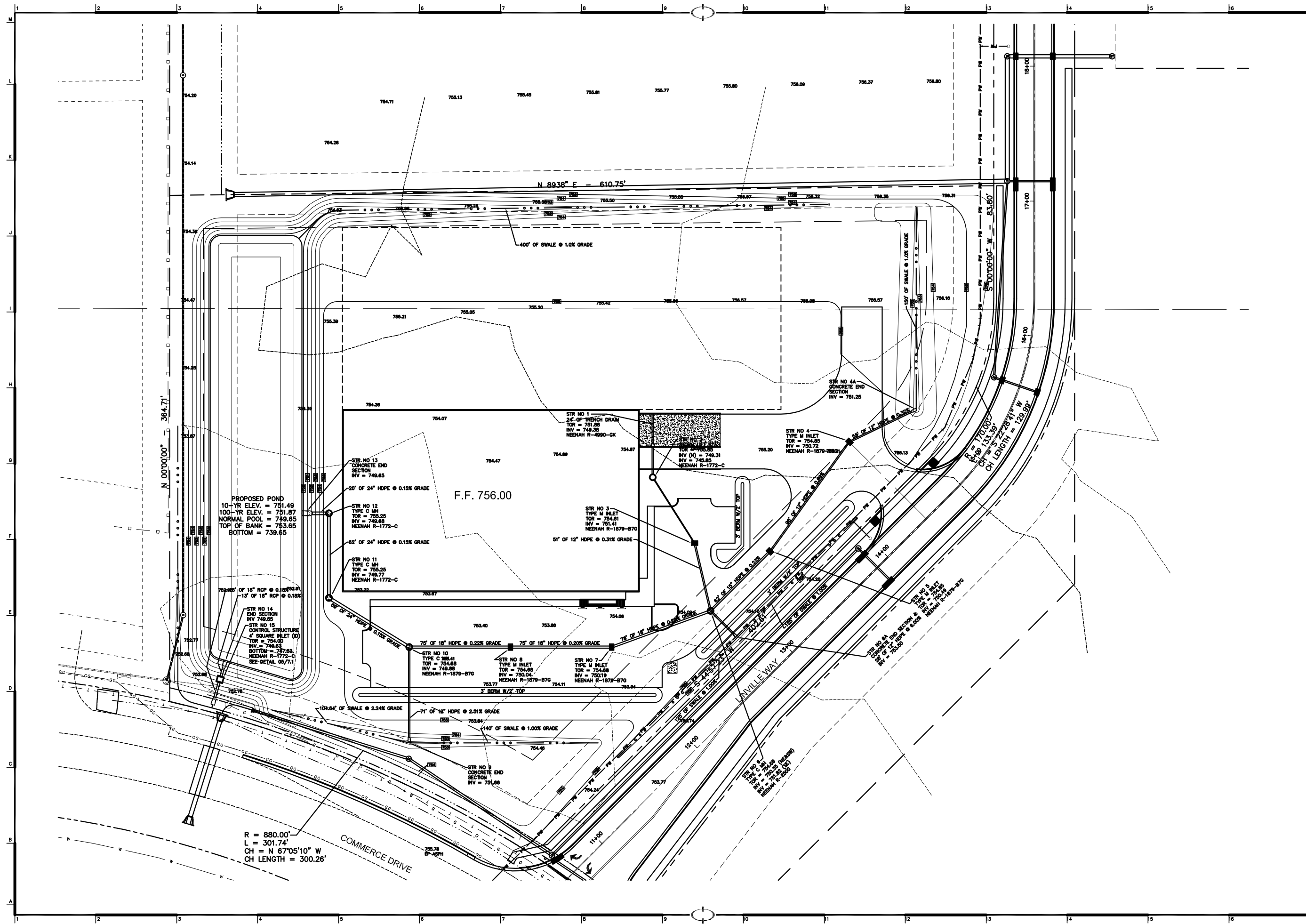
<sup>2</sup> The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: Impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. If the impervious area is not connected, the NRCS method has an adjustment to reduce the effect.

<sup>3</sup> CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

**TABLE 205-02: Runoff Curve Numbers for Urban Areas**  
(SOURCE: 210-VI-TR-55, Second Ed., June 1986)

## **APPENDIX C**

**Proposed Basin Map  
Storm sewer Design Worksheet  
Inlet Capacity Worksheet**



REVISION RECORD




*Richard R. Hoover*

DATE: 11/06/17

DWN BY: RRH

CHKD. BY: RRH

SCALE: 1"=40'

DATE: 09/14/17



Hoover Engineering  
472 Westview Drive  
Bargersville, Indiana 46106  
Contact: Richard R. Hoover, P.E.  
Telephone: (317) 441-8682  
www.hooverengineeringllc.com

DIRECT CONVEYORS  
LINVILLE WAY AND COMMERCE PAKY  
Franklin, Indiana 46131

STORM SEWER DESIGN MAP

PROJECT NUMBER  
17-111

DESIGN PHASE  
CONSTRUCTION

PLAN NUMBER  
**C3.0**  
SHEET OF

Storm Drain Flow Tabulation Form

Hoover Engineering Project No.17-111  
ProjectDirect Conveyors  
LocationLinville Way  
Description

ByRRH  
Date11/06/17  
Checked  
Date

Design Storm Frequency =10-yr  
Manning's n =0.013

STRUCTURE		LENGTH	DRAINAGE AREA "A"		RUNOFF COEFFICIENT "C"	"A" x "C"		FLOW TIME		RAINFALL INTENSITY	TOTAL RUNOFF	PIPE DIAMETER	SLOPE OF SEWER	FULL CAPACITY	VELOCITY		RIM ELEVATION		INVERT ELEVATION		COVER		STRUCTURE INVERT DROP
			Increment	Total				To Upper End	In Section						Flowing Full	Design Flow	U/S Structure	D/S Structure	U/S Structure	D/S Structure	U/S Structure	D/S Structure	
U/S	D/S	(ft)	(acres)	(acres)		Increment	Total	(min)	(min)	(in/hr)	(cfs)	(ft)	%	(cfs)	(ft/s)	(ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
1	2	24	0.10	0.10	0.90	0.09	0.09	5.00	0.16	6.99	0.63	1.00	0.31	1.99	2.53		751.88	755.45	749.28	749.21	1.43	5.07	
2	3	NA	Storm Lift Station														755.45	754.61	749.21	751.41	6.16	3.11	
3	6	51	0.16	0.26	0.68	0.11	0.20	5.16	0.34	6.88	1.37	1.00	0.31	1.99	2.53		754.61	754.68	751.41	751.25	2.03	2.26	
4A	4	55	0.59	0.59	0.49	0.29	0.29	5.00	0.36	6.99	2.02	1.00	0.32	2.02	2.57		NA	754.85	751.25	751.08	#VALUE!	2.61	
4	5	98	0.12	0.71	0.90	0.11	0.40	5.36	0.46	6.88	2.73	1.00	0.60	2.77	3.52		754.85	754.85	751.08	750.49	2.61	3.19	
5	6	62	0.09	0.80	0.57	0.05	0.45	5.82	0.41	6.68	3.00	1.25	0.23	3.11	2.53		754.85	754.68	750.49	750.35	2.92	2.90	
6A	6	28	0.09	0.09	0.30	0.03	0.03	5.00	0.04	6.99	0.19	1.00	6.00	8.75	11.14		NA	754.68	753.50	751.82	#VALUE!	1.69	
6	7	78	0.06	0.99	0.81	0.05	0.57	6.23	0.49	6.56	3.71	1.50	0.20	4.71	2.67		754.68	754.68	750.35	750.19	2.62	2.78	
7	8	75	0.13	1.12	0.81	0.11	0.67	6.72	0.47	6.52	4.37	1.50	0.20	4.71	2.67		754.68	754.68	750.19	750.04	2.78	2.93	
8	10	75	0.13	1.25	0.81	0.11	0.78	7.18	0.45	6.27	4.87	1.50	0.22	4.94	2.80		754.68	754.68	750.04	749.88	2.93	3.10	
9	10	71	0.40	0.40	0.30	0.12	0.12	5.00	0.16	6.99	0.84	1.00	2.51	5.66	7.21		NA	754.68	751.66	749.88	#VALUE!	3.64	
10	11	69	0.13	1.78	0.80	0.10	1.00	7.63	0.41	6.14	6.14	2.00	0.15	8.79	2.80		754.68	755.25	749.88	749.77	2.55	3.23	
11	12	62	0.00	1.78	0.00	0.00	1.00	8.04	0.37	6.01	6.01	2.00	0.15	8.79	2.80		755.25	755.25	749.77	749.68	3.23	3.32	
12	13	20	0.00	1.78	0.00	0.00	1.00	8.41	0.12	5.90	5.90	2.00	0.15	8.79	2.80		755.25	NA	749.68	749.65	3.32	#VALUE!	

## Inlet Capacity Computations

Hoover Engineering Project No.	17-111	By RRH
Project	Direct Conveyors	Date 11/6/2017
Location	Linville Way	Checked
Description	50% blocked	Date
5 cfs Design Discharge Exceeds All Actual Discharges		

Inlet Type: Neenah R-1879-B7G		$h_o = 0.48$ ft
$A = 3.00$	$A = 1.50$ ft <sup>2</sup>	
$P = 10.6$	$P = 5.30$ ft	$h_w = 0.43$ ft
	$Q = 5.00$ cfs	
Design Frequency:	10-Year	
	$C_d = 0.60$	$h = 0.48$ ft
	$C_w = 3.30$	$h = 5.75$ in

$A$  = Free open area of grate (ft<sup>2</sup>)  
 $P$  = Perimeter of grate (ft)  
 $Q$  = Flow rate (cfs)  
 $C_d$  = Coefficient of flow for orifice  
 $C_w$  = Coefficient of flow for weir  
 $h_o$  = Head (flow depth at grate) for orifice flow (ft)  
 $h_w$  = Head (flow depth at grate) for weir flow (ft)  
 $h$  = Head (flow depth at grate) (ft or in)  
 $g = 32.2$  ft/s<sup>2</sup>

$$Q = C_d A (2gh_o)^{1/2}$$

$$h_o = [Q / (C_d A)]^2 / 2g$$

$$Q = C_w P h_w^{3/2}$$

$$h_w = [Q / (C_w P)]^{2/3}$$

For  $Q$ ,  $h_o$  and  $h_w$  are computed.  $h$  = the greater of  $h_o$  and  $h_w$ .

$C_d$  source:

$C_w$  source:

## Inlet Capacity Computations

Hoover Engineering Project No.	17-111	By RRH
Project	Direct Conveyors	Date 11/6/2017
Location	Linville Way	Checked
Description	50% blocked	Date
All Discharges to Inlets Are Less Than 1.0 cfs		

Inlet Type: Neenah R-2500		$h_o = 0.21$ ft
$A = 0.90$	$A = 0.45$ ft <sup>2</sup>	
$P = 6.2$	$P = 3.10$ ft	$h_w = 0.21$ ft
	$Q = 1.00$ cfs	
Design Frequency: 10-Year		
	$C_d = 0.60$	$h = 0.21$ ft
	$C_w = 3.30$	$h = 2.56$ in

$A$  = Free open area of grate (ft<sup>2</sup>)  
 $P$  = Perimeter of grate (ft)  
 $Q$  = Flow rate (cfs)  
 $C_d$  = Coefficient of flow for orifice  
 $C_w$  = Coefficient of flow for weir  
 $h_o$  = Head (flow depth at grate) for orifice flow (ft)  
 $h_w$  = Head (flow depth at grate) for weir flow (ft)  
 $h$  = Head (flow depth at grate) (ft or in)  
 $g = 32.2$  ft/s<sup>2</sup>

$$Q = C_d A (2gh_o)^{1/2}$$

$$h_o = [Q / (C_d A)]^2 / 2g$$

$$Q = C_w P h_w^{3/2}$$

$$h_w = [Q / (C_w P)]^{2/3}$$

For  $Q$ ,  $h_o$  and  $h_w$  are computed.  $h$  = the greater of  $h_o$  and  $h_w$ .

$C_d$  source:

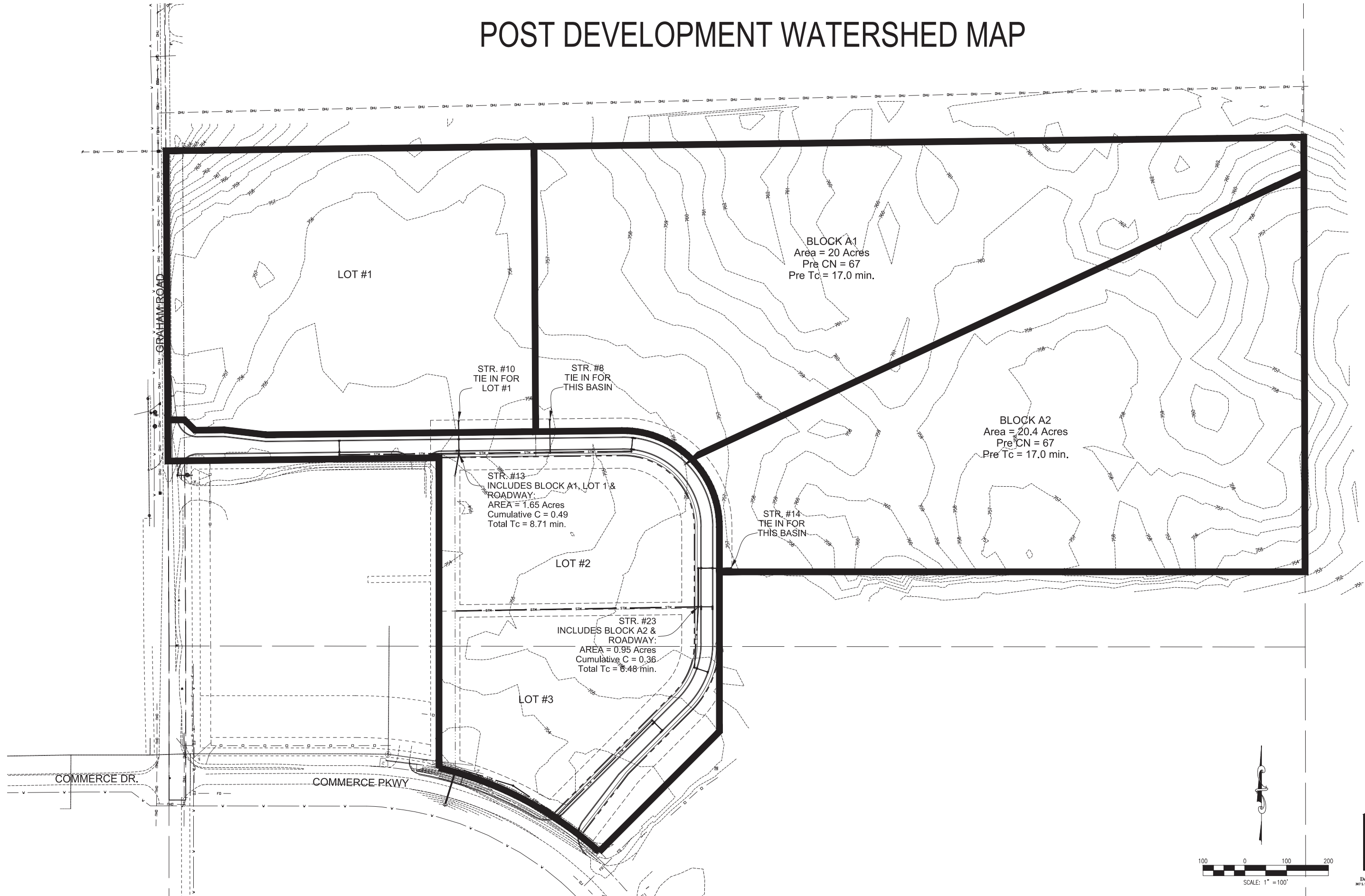
$C_w$  source:

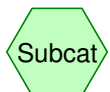
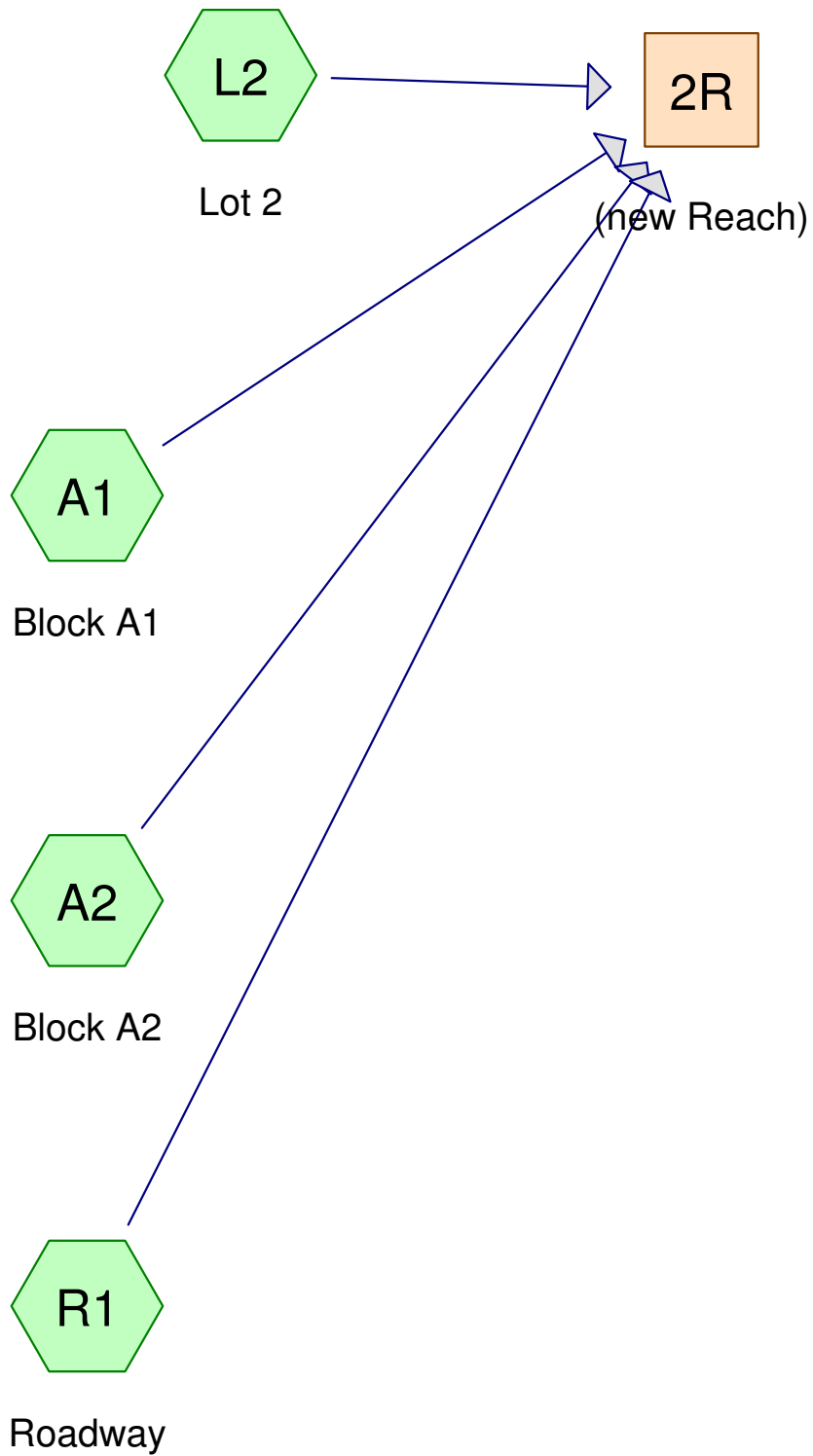


## **APPENDIX D**

**Post Development Watershed Map (by Crossroad Engineers)  
HydroCAD Modeling for Overflow Discharges  
Stormwater Drainage Technical Report  
By Veridus Group  
Trapezoidal Channel Worksheet**

# POST DEVELOPMENT WATERSHED MAP

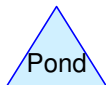




Subcat



Reach



Pond



Link

**Routing Diagram for 17-111.Combined 1**

Prepared by {enter your company name here}, Printed 11/14/2017  
HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

## 17-111.Combined 1

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 2

### Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
45.400	67	(A1, A2, L2)
1.650	90	(R1)
<b>47.050</b>	<b>68</b>	<b>TOTAL AREA</b>

## 17-111.Combined 1

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 3

### Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
47.050	Other	A1, A2, L2, R1
<b>47.050</b>		<b>TOTAL AREA</b>

**17-111.Combined 1**

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 4

**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	0.000	0.000	47.050	47.050		A1, A2, L2, R1
<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>47.050</b>	<b>47.050</b>	<b>TOTAL AREA</b>	

**17-111.Combined 1***Type II 24-hr 24HR100YR Rainfall=6.00"*

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 5

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

**Subcatchment A1: Block A1**

Runoff Area=20.000 ac 0.00% Impervious Runoff Depth=2.53"  
Tc=17.0 min CN=67 Runoff=60.48 cfs 4.217 af

**Subcatchment A2: Block A2**

Runoff Area=20.400 ac 0.00% Impervious Runoff Depth=2.53"  
Tc=17.0 min CN=67 Runoff=61.69 cfs 4.301 af

**Subcatchment L2: Lot 2**

Runoff Area=5.000 ac 0.00% Impervious Runoff Depth=2.53"  
Tc=17.0 min CN=67 Runoff=15.12 cfs 1.054 af

**Subcatchment R1: Roadway**

Runoff Area=1.650 ac 0.00% Impervious Runoff Depth=4.85"  
Tc=17.0 min CN=90 Runoff=9.20 cfs 0.666 af

**Reach 2R: (new Reach)**

Inflow=146.43 cfs 10.238 af  
Outflow=146.43 cfs 10.238 af

**Total Runoff Area = 47.050 ac Runoff Volume = 10.238 af Average Runoff Depth = 2.61"**  
**100.00% Pervious = 47.050 ac 0.00% Impervious = 0.000 ac**

**17-111.Combined 1**

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 6

**Summary for Subcatchment A1: Block A1**

Runoff = 60.48 cfs @ 12.10 hrs, Volume= 4.217 af, Depth= 2.53"

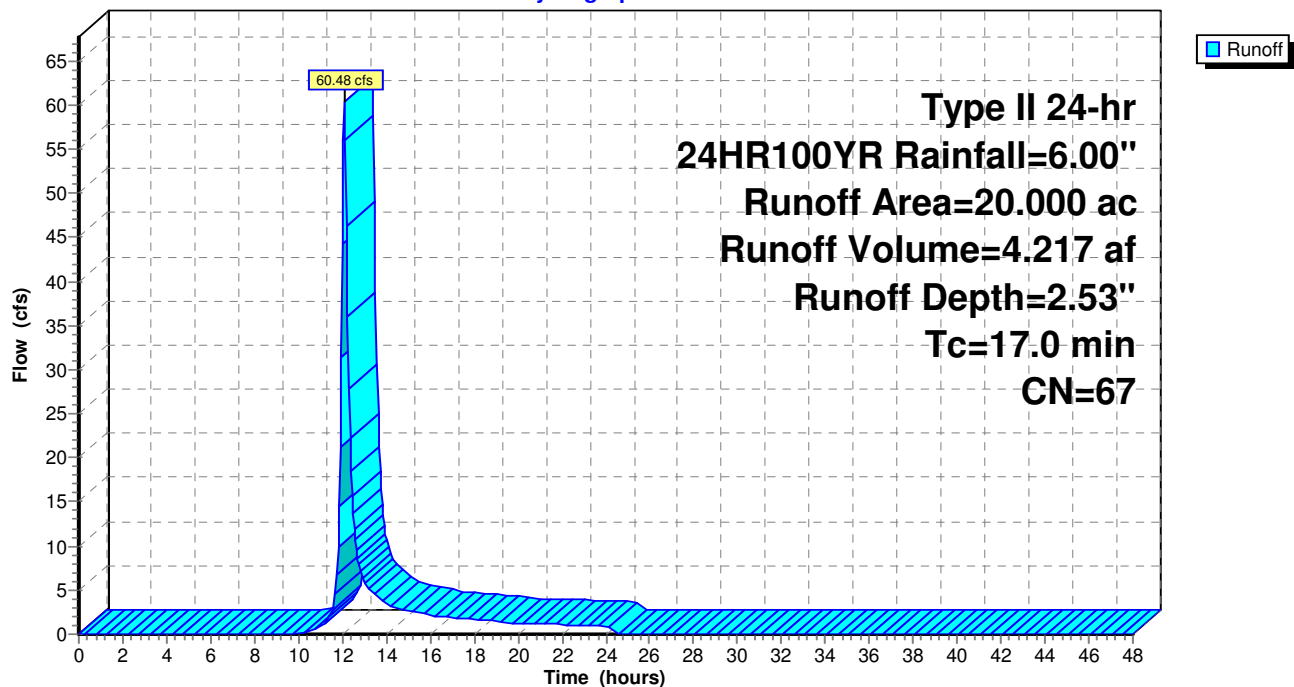
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 24HR100YR Rainfall=6.00"

Area (ac)	CN	Description
* 20.000	67	
20.000		100.00% Pervious Area

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

**Subcatchment A1: Block A1**

Hydrograph





**17-111.Combined 1**

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 7

**Summary for Subcatchment A2: Block A2**

Runoff = 61.69 cfs @ 12.10 hrs, Volume= 4.301 af, Depth= 2.53"

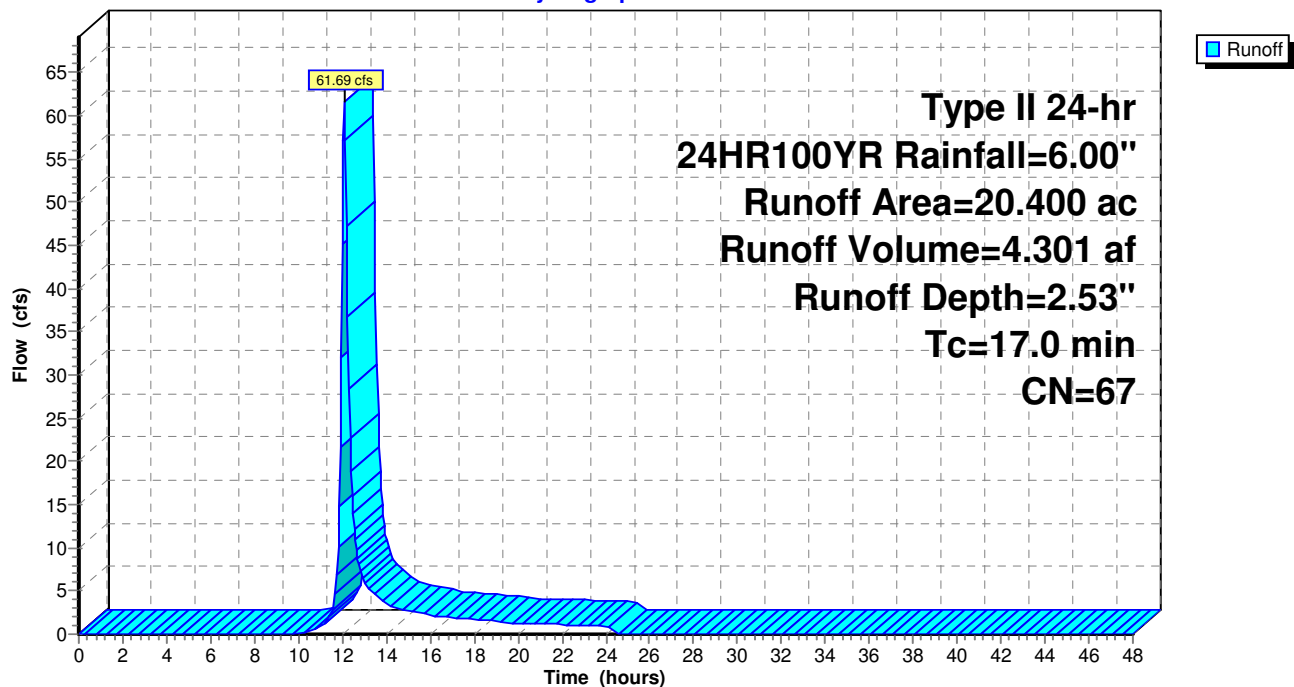
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 24HR100YR Rainfall=6.00"

Area (ac)	CN	Description
* 20.400	67	
20.400		100.00% Pervious Area

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

**Subcatchment A2: Block A2**

Hydrograph



**17-111.Combined 1**

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 8

**Summary for Subcatchment L2: Lot 2**

Runoff = 15.12 cfs @ 12.10 hrs, Volume= 1.054 af, Depth= 2.53"

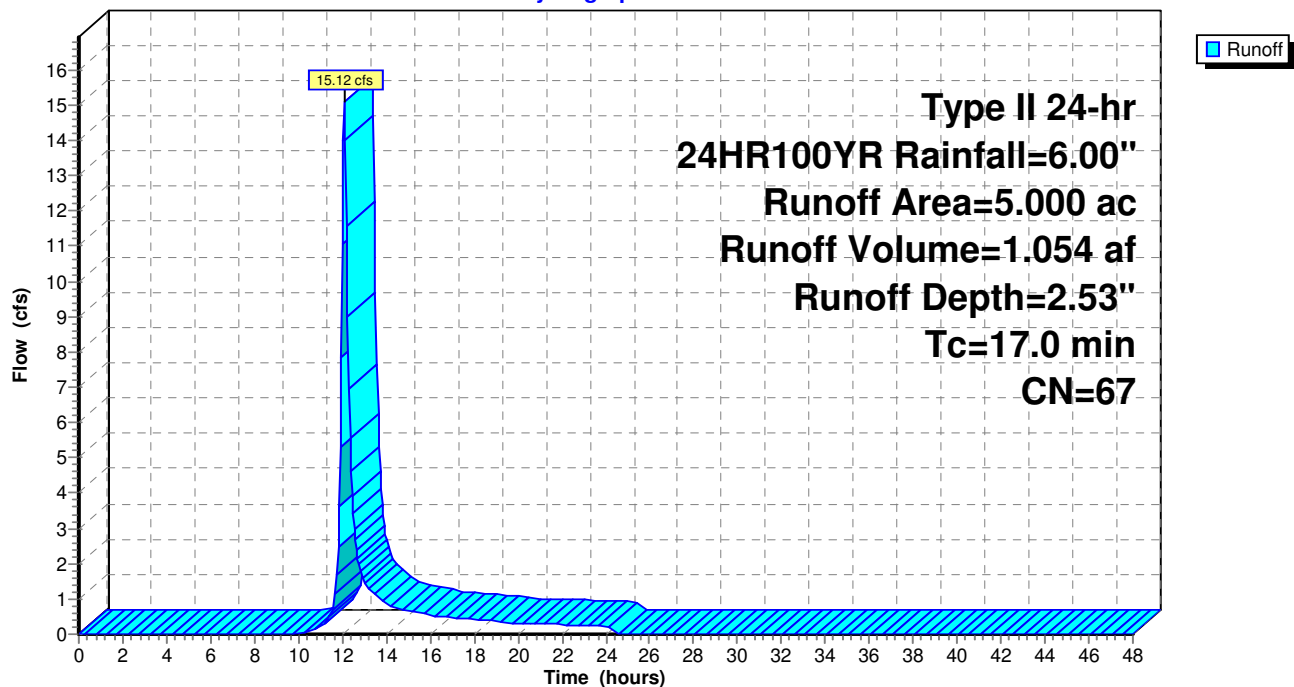
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 24HR100YR Rainfall=6.00"

Area (ac)	CN	Description
* 5.000	67	
5.000		100.00% Pervious Area

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

**Subcatchment L2: Lot 2**

Hydrograph



**17-111.Combined 1**

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 9

**Summary for Subcatchment R1: Roadway**

Runoff = 9.20 cfs @ 12.09 hrs, Volume= 0.666 af, Depth= 4.85"

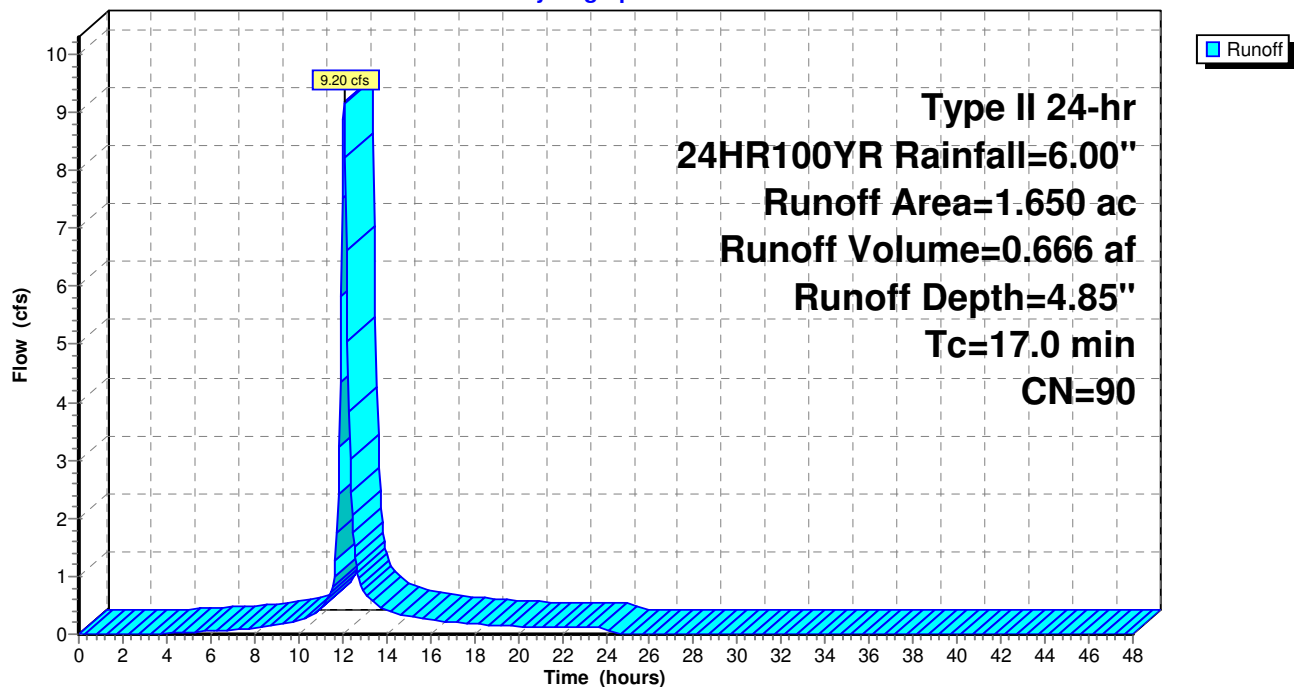
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 24HR100YR Rainfall=6.00"

Area (ac)	CN	Description
* 1.650	90	
1.650		100.00% Pervious Area

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

**Subcatchment R1: Roadway**

Hydrograph



## 17-111.Combined 1

Type II 24-hr 24HR100YR Rainfall=6.00"

Prepared by {enter your company name here}

Printed 11/14/2017

HydroCAD® 10.00-20 s/n 10057 © 2017 HydroCAD Software Solutions LLC

Page 10

### Summary for Reach 2R: (new Reach)

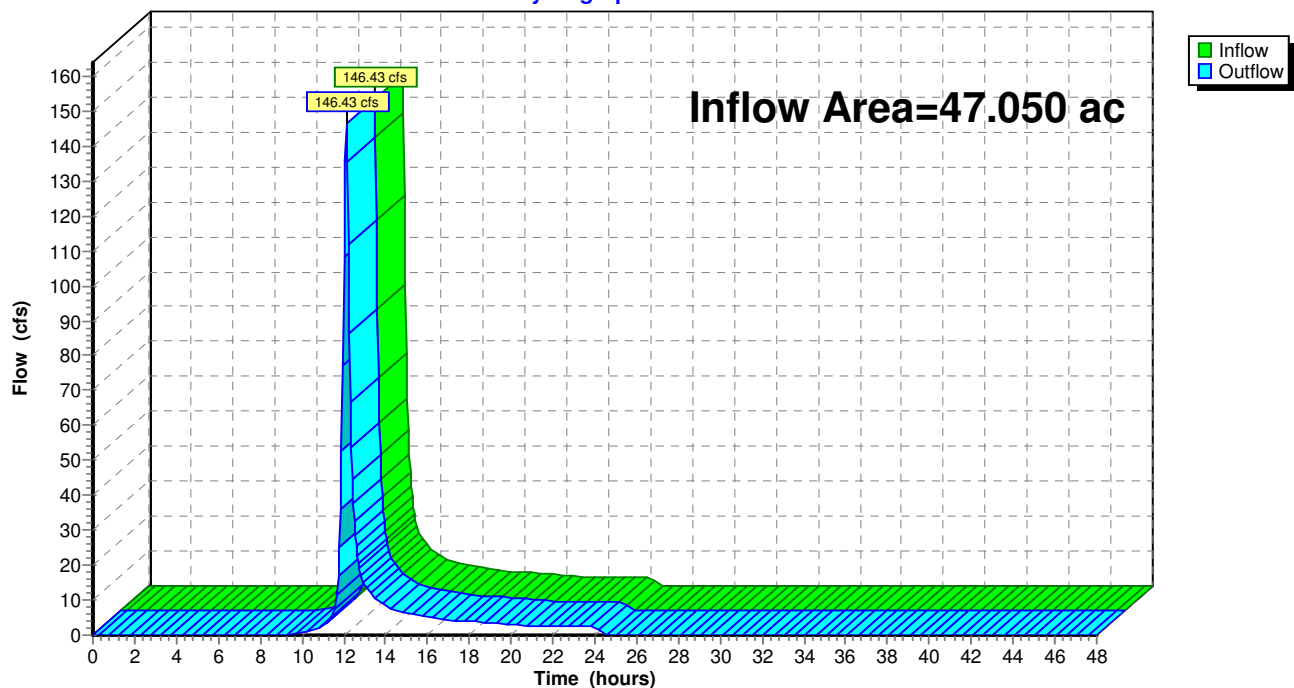
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 47.050 ac, 0.00% Impervious, Inflow Depth = 2.61" for 24HR100YR event  
Inflow = 146.43 cfs @ 12.10 hrs, Volume= 10.238 af  
Outflow = 146.43 cfs @ 12.10 hrs, Volume= 10.238 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

### Reach 2R: (new Reach)

Hydrograph





# STORMWATER DRAINAGE TECHNICAL REPORT

For

Franklin Shell Building  
40 Linville Way  
Franklin, IN

By

Kristopher Holeyfield, PE

Veridus Group, Inc.  
6280 N. Shadeland Avenue, Suite A  
Indianapolis, IN 46220

September 18, 2017 – Revision 01

Original: July 13, 2017





## Table of Contents

Project Narrative.....	3
Existing Conditions.....	5
Proposed Conditions.....	5
Storm Sewers .....	5
Drainage Overflow Design .....	5
Stormwater Quantity .....	5
Stormwater Quality.....	6
Conclusion.....	6
Appendix A: FEMA floodplain map .....	7
Appendix B: NRCS Soil Map and Soil Information.....	8
Appendix E: Detention Calculations (HydroCAD Report).....	9



## Project Narrative

The project site is located on an approximately 13.2-acre parcel located at the northeast corner of Musicland Dr. and Graham Rd., Franklin, Indiana. The proposed project will be the first phase of an overall industrial development that is planned for this property. Phase I includes the construction of an approximately 50,400 square foot spec industrial building. The proposed truck docks with face south towards Musicland Dr. and proposed employee parking is also located on the south side of the building.

The project site is zoned IL, Industrial Light, by the City of Franklin. The proposed use is in compliance with the zoning. Figure 1 below is a location map and Figure 2 is a zoomed in aerial photograph showing the existing conditions of the site.



*Figure 1: Location Map*





*Figure 2: Existing Conditions*





## Existing Conditions

The property is currently vacant farmland. There is no floodplain on the property. Existing soils on the property are a mixture of Brookstone Silty Clay Loam (Br) and Crosby Silt Loam (CrA). Each of these soils are classified under the hydrologic soil group B and C respectively. Refer to the Appendix for FEMA floodplain information, soil map, and soil information.

## Proposed Conditions

The runoff rate for the development was determined using the HydroCAD computer software modeling hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies. Curve numbers for pre-development conditions were determined using the hydrologic soil group B. Curve numbers for post-development conditions were determined using the hydrologic soil group D. The 24-hour NRCS Type 2 Rainfall Distribution was utilized for runoff calculations. Rainfall data was pulled from NOAA to determine the rainfall depths. Please refer to the appendix for the NOAA rainfall information.

### Storm Sewers

A majority of the current site surface flows into the stormwater detention basin or vegetative swales. The underground storm sewers provided convey roof drainage and detention outfall flows. These systems were designed to handle the peak runoff from a 24-hour, 10-year frequency storm. Reinforced concrete pipe (RCP) and High-Density Polyethylene (HDPE) are proposed on site and maintain 2.0-ft of cover.

### Drainage Overflow Design

The stormwater detention basin will overflow into the outlet structure and southeast towards the proposed road. This path will be updated once the road design is complete and the vertical curves and sags are identified.

### Stormwater Quantity

The stormwater detention pond is designed to take 9.35-acres of the 13.2-acre site in a fully developed condition. Using a hydrologic soil group B and under the pasture properties, the CN for the pre-developed property is 61. Based on a hydrologic soil group D, pervious, and impervious areas, the weighted CN for the fully developed property is 93. The building, pavement, future pavement, and future building were considered impervious and have a CN of 98. The remaining pervious area had a CN value of 80. Refer to the hydrocad report in the appendix for a breakdown of these areas.



Given this information, the total watershed for the proposed ponds is 9.35-acres. The pond is designed to release the post 10-yr event at the pre 2-yr rates and the post 100-yr event at the pre 10-yr rates. The allowable and proposed discharges are as follows:

	<b>Allowable Discharge</b>	<b>Proposed Discharge</b>	<b>Water Surface Elevation</b>	<b>Storage (cu. Ft.)</b>
<b>10-year</b>	3.36-cfs	2.37-cfs	755.46	69,438
<b>100-year</b>	12.44-cfs	3.91-cfs	756.12	105,149
<b>Normal Pool</b>			754.00	

Two 8" storm pipes will control the release of the 10-yr and 100-yr storm events. Refer to the construction details and hydrocad report for additional weir information.

**Bypass:** Since a portion of the site does not drain directly to the pond, it has been oversized to account for the bypass. 3.85-acres bypass the site in the future condition. The bypass is designed to the current phased condition since it is the most stringent phase. When the complete project is built out, a majority of the bypass watershed will be picked up with roof drainage and piped to the proposed pond. The proposed pond is designed to account for this flow.

Since the pond is discharging at the 100-yr condition 3.91-cfs, a total peak flow of 8.53-cfs is allowed from the bypass watershed. Using an 12" pipe to control the peak flow into the Linville Way stormwater system, the 100-yr release peak flow for the bypass area is 5.93-cfs, less than what is allowed. Please refer to the hydrocad report and drainage area exhibit for details.

### Stormwater Quality

The wet detention pond provides the stormwater quality measures.

## Conclusion

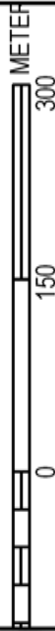
The design and analysis methods used in this study conform to the requirements of The City of Franklin Indiana Subdivision Control Ordinance and commonly accepted civil engineering practices. As proven, the allowable discharge rates have been satisfied. Therefore, no adverse effects are anticipated for adjacent or downstream land use.



## Appendix A: FEMA floodplain map



MAP SCALE 1" = 500'



NFIP

PANEL 0143D

**NATIONAL FLOOD INSURANCE PROGRAM**

**FIRM**  
FLOOD INSURANCE RATE MAP  
JOHNSON COUNTY,  
INDIANA  
AND INCORPORATED AREAS

**PANEL 143 OF 352**  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FRANKLIN, CITY OF	180114	0143	D
JOHNSON COUNTY	180111	0143	D

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.



**MAP NUMBER**  
18081C0143D  
**EFFECTIVE DATE**  
AUGUST 2, 2007

**Federal Emergency Management Agency**

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)



## Appendix B: NRCS Soil Map and Soil Information



Soil Map—Johnson County, Indiana



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 24, Sep 15, 2016

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

Date(s) aerial images were photographed: Sep 17, 2011—Mar 10, 2012

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

Johnson County, Indiana (IN081)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Br	Brookston silty clay loam, 0 to 2 percent slopes	24.1	60.6%
CrA	Crosby silt loam, fine-loamy subsoil, 0 to 2 percent slopes	14.4	36.3%
FxC2	Fox complex, 6 to 12 percent slopes, eroded	1.0	2.6%
MnC2	Miami silt loam, 6 to 12 percent slopes, eroded	0.2	0.5%
<b>Totals for Area of Interest</b>		<b>39.7</b>	<b>100.0%</b>



## Johnson County, Indiana

### Br—Brookston silty clay loam, 0 to 2 percent slopes

#### Map Unit Setting

*National map unit symbol:* 2t98n

*Elevation:* 600 to 1,260 feet

*Mean annual precipitation:* 37 to 46 inches

*Mean annual air temperature:* 48 to 55 degrees F

*Frost-free period:* 145 to 180 days

*Farmland classification:* Prime farmland if drained

#### Map Unit Composition

*Brookston and similar soils:* 95 percent

*Minor components:* 5 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Brookston

##### Setting

*Landform:* Depressions, till plains

*Landform position (two-dimensional):* Toeslope

*Landform position (three-dimensional):* Dip

*Down-slope shape:* Concave, linear

*Across-slope shape:* Concave

*Parent material:* Loess over loamy till

##### Typical profile

*Ap - 0 to 16 inches:* silty clay loam

*Btg1 - 16 to 32 inches:* silty clay loam

*Btg2 - 32 to 44 inches:* loam

*C - 44 to 60 inches:* loam

##### Properties and qualities

*Slope:* 0 to 2 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Poorly drained

*Runoff class:* Negligible

*Capacity of the most limiting layer to transmit water (Ksat):*

Moderately high (0.20 to 0.60 in/hr)

*Depth to water table:* About 0 to 12 inches

*Frequency of flooding:* None

*Frequency of ponding:* Frequent

*Calcium carbonate, maximum in profile:* 40 percent

*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

*Available water storage in profile:* Moderate (about 8.9 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 2w

*Hydrologic Soil Group:* B/D  
*Hydric soil rating:* Yes

#### **Minor Components**

##### **Crosby**

*Percent of map unit:* 5 percent  
*Landform:* Till plains  
*Landform position (two-dimensional):* Footslope, summit  
*Landform position (three-dimensional):* Talf  
*Down-slope shape:* Concave  
*Across-slope shape:* Linear  
*Hydric soil rating:* No

## **Data Source Information**

Soil Survey Area: Johnson County, Indiana  
Survey Area Data: Version 24, Sep 15, 2016

## Johnson County, Indiana

### CrA—Crosby silt loam, fine-loamy subsoil, 0 to 2 percent slopes

#### Map Unit Setting

*National map unit symbol:* 2thy4

*Elevation:* 600 to 1,000 feet

*Mean annual precipitation:* 36 to 44 inches

*Mean annual air temperature:* 49 to 54 degrees F

*Frost-free period:* 145 to 180 days

*Farmland classification:* Prime farmland if drained

#### Map Unit Composition

*Crosby and similar soils:* 93 percent

*Minor components:* 7 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Crosby

##### Setting

*Landform:* Ground moraines, recessional moraines, water-lain moraines

*Landform position (two-dimensional):* Summit, backslope, footslope

*Landform position (three-dimensional):* Interfluve, rise

*Down-slope shape:* Convex, linear

*Across-slope shape:* Linear, convex

*Parent material:* Silty material or loess over loamy till

##### Typical profile

*Ap - 0 to 10 inches:* silt loam

*Btg - 10 to 17 inches:* silty clay loam

*2Bt - 17 to 29 inches:* clay loam

*2BCt - 29 to 36 inches:* loam

*2Cd - 36 to 79 inches:* loam

##### Properties and qualities

*Slope:* 0 to 2 percent

*Depth to restrictive feature:* 24 to 40 inches to densic material

*Natural drainage class:* Somewhat poorly drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Low to moderately high (0.01 to 0.20 in/hr)

*Depth to water table:* About 6 to 24 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum in profile:* 55 percent

*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

*Available water storage in profile:* Moderate (about 6.5 inches)

### **Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 2w

*Hydrologic Soil Group:* C/D

*Hydric soil rating:* No

### **Minor Components**

#### **Williamstown, eroded**

*Percent of map unit:* 5 percent

*Landform:* Ground moraines, recessional moraines, water-lain moraines

*Landform position (two-dimensional):* Summit, shoulder, backslope

*Landform position (three-dimensional):* Crest, head slope, nose slope, side slope, rise

*Down-slope shape:* Convex, linear

*Across-slope shape:* Linear, convex

*Hydric soil rating:* No

#### **Treaty, drained**

*Percent of map unit:* 2 percent

*Landform:* Depressions, swales, water-lain moraines

*Landform position (two-dimensional):* Toeslope, footslope

*Landform position (three-dimensional):* Base slope, dip

*Down-slope shape:* Linear

*Across-slope shape:* Concave

*Hydric soil rating:* Yes

## **Data Source Information**

Soil Survey Area: Johnson County, Indiana

Survey Area Data: Version 24, Sep 15, 2016



## Appendix E: Detention Calculations (HydroCAD Report)



NOAA Atlas 14, Volume 2, Version 3  
 Location name: Franklin, Indiana, USA\*  
 Latitude: 39.5107°, Longitude: -86.0542°  
 Elevation: 755.79 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 & aeriels](#)

## PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) <sup>1</sup>										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.373 (0.333-0.422)	0.444 (0.396-0.501)	0.532 (0.472-0.601)	0.601 (0.532-0.678)	0.692 (0.608-0.781)	0.763 (0.666-0.863)	0.832 (0.719-0.944)	0.905 (0.775-1.03)	1.00 (0.844-1.15)	1.07 (0.891-1.24)
10-min	0.580 (0.517-0.655)	0.693 (0.618-0.783)	0.827 (0.734-0.933)	0.928 (0.822-1.05)	1.06 (0.930-1.20)	1.16 (1.01-1.31)	1.25 (1.08-1.42)	1.35 (1.16-1.54)	1.47 (1.24-1.69)	1.56 (1.30-1.81)
15-min	0.711 (0.634-0.803)	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 (1.35-1.77)	1.68 (1.44-1.91)	1.84 (1.55-2.11)	1.96 (1.62-2.26)
30-min	0.940 (0.839-1.06)	1.13 (1.01-1.28)	1.39 (1.24-1.57)	1.59 (1.40-1.79)	1.85 (1.62-2.09)	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 (2.43-3.38)
60-min	1.15 (1.02-1.30)	1.39 (1.24-1.57)	1.74 (1.55-1.97)	2.02 (1.79-2.28)	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 (1.82-2.31)	2.38 (2.10-2.69)	2.85 (2.50-3.21)	3.23 (2.81-3.65)	3.64 (3.13-4.11)	4.07 (3.45-4.61)	4.68 (3.89-5.33)	5.17 (4.22-5.93)
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)	3.47 (3.01-3.92)	3.93 (3.36-4.45)	4.41 (3.72-5.01)	5.11 (4.21-5.84)	5.67 (4.58-6.53)
6-hr	1.70 (1.51-1.94)	2.05 (1.82-2.35)	2.59 (2.29-2.95)	3.03 (2.67-3.45)	3.66 (3.19-4.16)	4.19 (3.62-4.75)	4.76 (4.05-5.40)	5.37 (4.50-6.11)	6.25 (5.11-7.14)	6.97 (5.59-8.02)
12-hr	2.03 (1.82-2.30)	2.44 (2.19-2.76)	3.04 (2.72-3.43)	3.52 (3.14-3.98)	4.20 (3.71-4.72)	4.77 (4.17-5.35)	5.36 (4.63-6.02)	5.98 (5.09-6.74)	6.85 (5.72-7.78)	7.56 (6.20-8.63)
24-hr	2.43 (2.24-2.65)	2.91 (2.68-3.18)	3.57 (3.28-3.89)	4.08 (3.75-4.44)	4.77 (4.36-5.20)	5.32 (4.85-5.80)	5.88 (5.33-6.41)	6.44 (5.81-7.04)	7.21 (6.44-7.90)	7.80 (6.93-8.72)
2-day	2.85 (2.63-3.08)	3.41 (3.15-3.69)	4.15 (3.83-4.50)	4.73 (4.36-5.12)	5.51 (5.05-5.97)	6.12 (5.59-6.64)	6.74 (6.12-7.32)	7.36 (6.66-8.02)	8.20 (7.36-8.95)	8.85 (7.88-9.70)
3-day	3.05 (2.84-3.28)	3.64 (3.39-3.92)	4.42 (4.11-4.75)	5.02 (4.66-5.39)	5.82 (5.39-6.26)	6.45 (5.95-6.94)	7.09 (6.51-7.63)	7.73 (7.07-8.33)	8.59 (7.81-9.27)	9.25 (8.36-10.0)
4-day	3.26 (3.05-3.48)	3.88 (3.64-4.15)	4.68 (4.38-5.00)	5.30 (4.96-5.66)	6.14 (5.72-6.55)	6.79 (6.32-7.23)	7.44 (6.91-7.94)	8.11 (7.49-8.64)	8.99 (8.26-9.59)	9.66 (8.84-10.3)
7-day	3.86 (3.60-4.14)	4.59 (4.28-4.92)	5.50 (5.13-5.90)	6.23 (5.80-6.67)	7.22 (6.70-7.72)	7.99 (7.40-8.54)	8.78 (8.11-9.39)	9.58 (8.82-10.2)	10.7 (9.77-11.4)	11.5 (10.5-12.3)
10-day	4.40 (4.12-4.71)	5.23 (4.90-5.59)	6.25 (5.86-6.68)	7.06 (6.61-7.54)	8.16 (7.61-8.70)	9.02 (8.40-9.62)	9.89 (9.19-10.5)	10.8 (9.97-11.5)	12.0 (11.0-12.8)	12.9 (11.8-13.8)
20-day	6.04 (5.69-6.42)	7.14 (6.72-7.60)	8.42 (7.92-8.96)	9.42 (8.84-10.0)	10.7 (10.1-11.4)	11.8 (11.0-12.5)	12.8 (11.9-13.5)	13.8 (12.8-14.6)	15.1 (13.9-16.0)	16.0 (14.8-17.1)
30-day	7.43 (7.01-7.87)	8.75 (8.25-9.27)	10.2 (9.59-10.8)	11.3 (10.6-12.0)	12.7 (12.0-13.5)	13.8 (13.0-14.6)	14.9 (13.9-15.8)	16.0 (14.9-16.9)	17.3 (16.1-18.4)	18.3 (17.0-19.5)
45-day	9.43 (8.88-9.98)	11.1 (10.4-11.7)	12.8 (12.0-13.5)	14.1 (13.2-14.9)	15.7 (14.8-16.6)	17.0 (15.9-18.0)	18.2 (17.0-19.2)	19.3 (18.0-20.5)	20.8 (19.3-22.0)	21.8 (20.2-23.2)
60-day	11.3 (10.6-11.9)	13.2 (12.4-14.0)	15.1 (14.2-16.0)	16.6 (15.6-17.6)	18.5 (17.4-19.6)	19.9 (18.7-21.1)	21.3 (19.9-22.6)	22.6 (21.1-24.0)	24.3 (22.6-25.7)	25.5 (23.7-27.1)

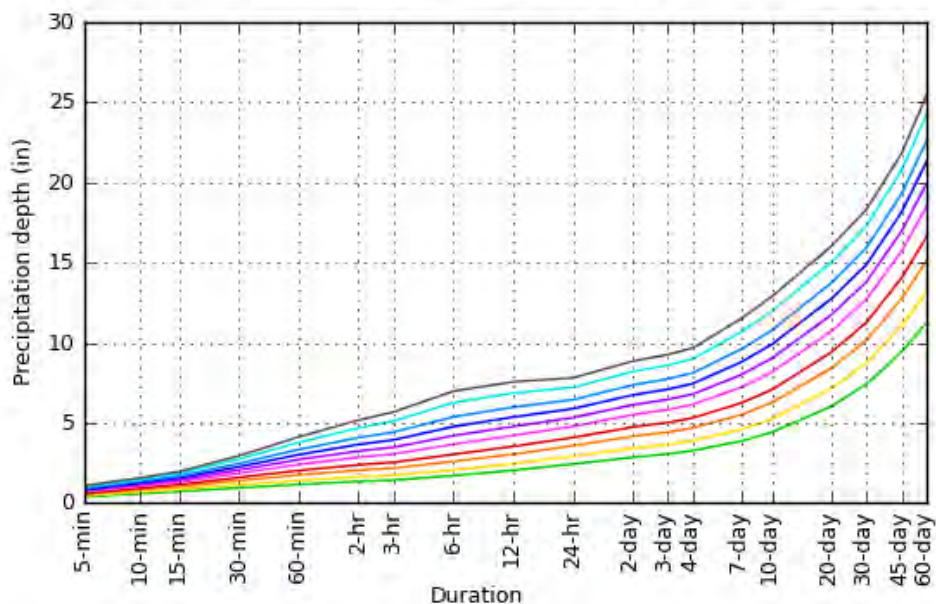
<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration 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](#)

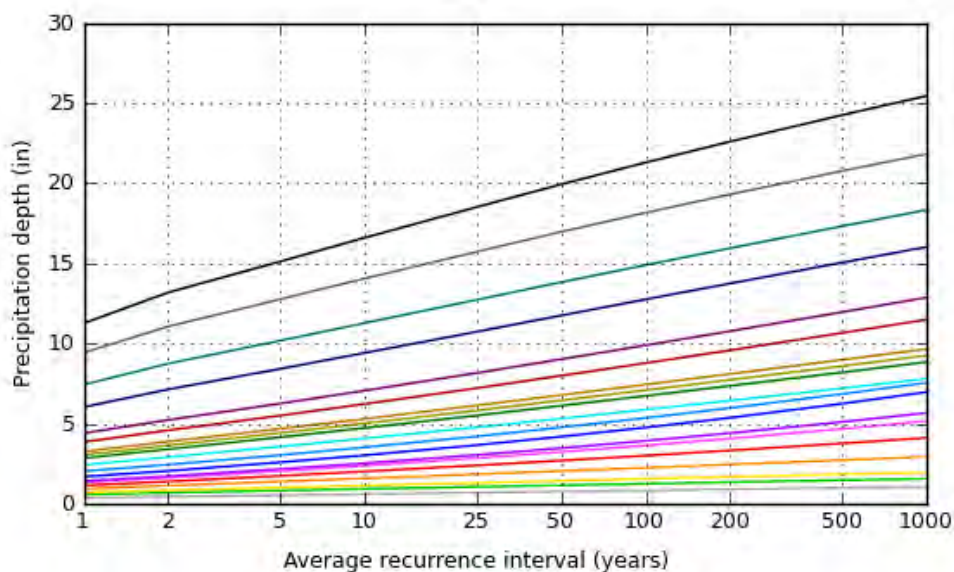
## PF graphical

## PDS-based depth-duration-frequency (DDF) curves

Latitude: 39.5107°, Longitude: -86.0542°



Average recurrence interval (years)
1
2
5
10
25
50
100
200
500
1000



Duration	
5-min	2-day
10-min	3-day
15-min	4-day
30-min	7-day
60-min	10-day
2-hr	20-day
3-hr	30-day
6-hr	45-day
12-hr	60-day
24-hr	

NOAA Atlas 14, Volume 2, Version 3

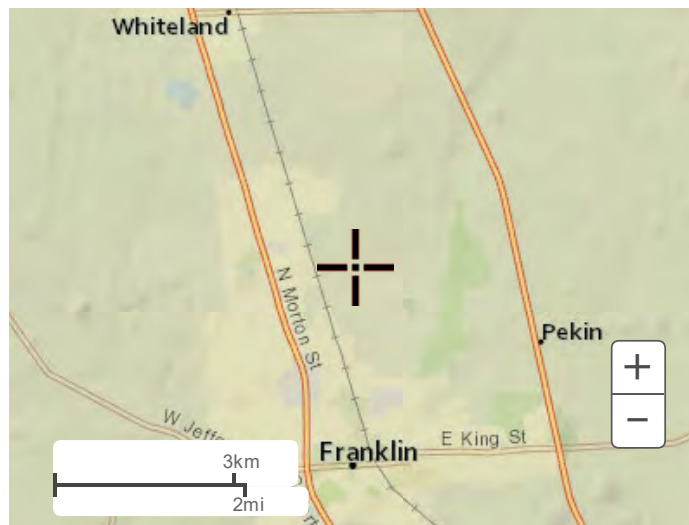
Created (GMT): Wed Jul 5 20:29:42 2017

[Back to Top](#)

## Maps &amp; aeriels

Small scale terrain





Large scale terrain



Large scale map



Large scale aerial





[Back to Top](#)

---

[US Department of Commerce](#)  
[National Oceanic and Atmospheric Administration](#)  
[National Weather Service](#)  
[National Water Center](#)  
1325 East West Highway  
Silver Spring, MD 20910  
Questions?: [HDSC.Questions@noaa.gov](mailto:HDSC.Questions@noaa.gov)

[Disclaimer](#)

## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Predevelopment Basin

Type II 24-hr 2 yr Rainfall=2.91"

Printed 7/13/2017

Page 1

### Summary for Subcatchment EX: Existing

Runoff = 3.36 cfs @ 12.12 hrs, Volume= 0.363 af, Depth= 0.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 2 yr Rainfall=2.91"

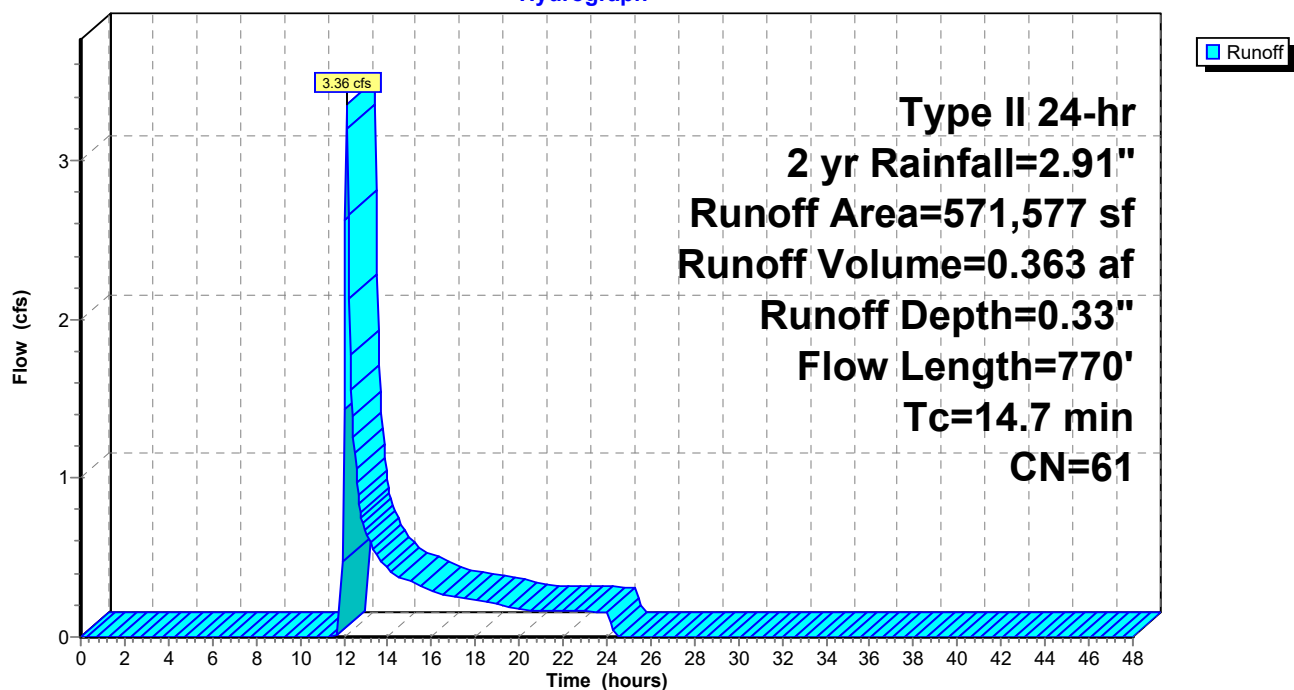
Area (sf)	CN	Description
571,577	61	Pasture/grassland/range, Good, HSG B
571,577		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	20	0.0500	0.19		Sheet Flow, Range n= 0.130 P2= 2.91"
12.9	750	0.0036	0.97		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
14.7	770	Total			

### Subcatchment EX: Existing

Hydrograph



## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Predevelopment Basin

Type II 24-hr 10 yr Rainfall=4.08"

Printed 7/13/2017

Page 2

### Summary for Subcatchment EX: Existing

Runoff = 12.44 cfs @ 12.09 hrs, Volume= 0.933 af, Depth= 0.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 10 yr Rainfall=4.08"

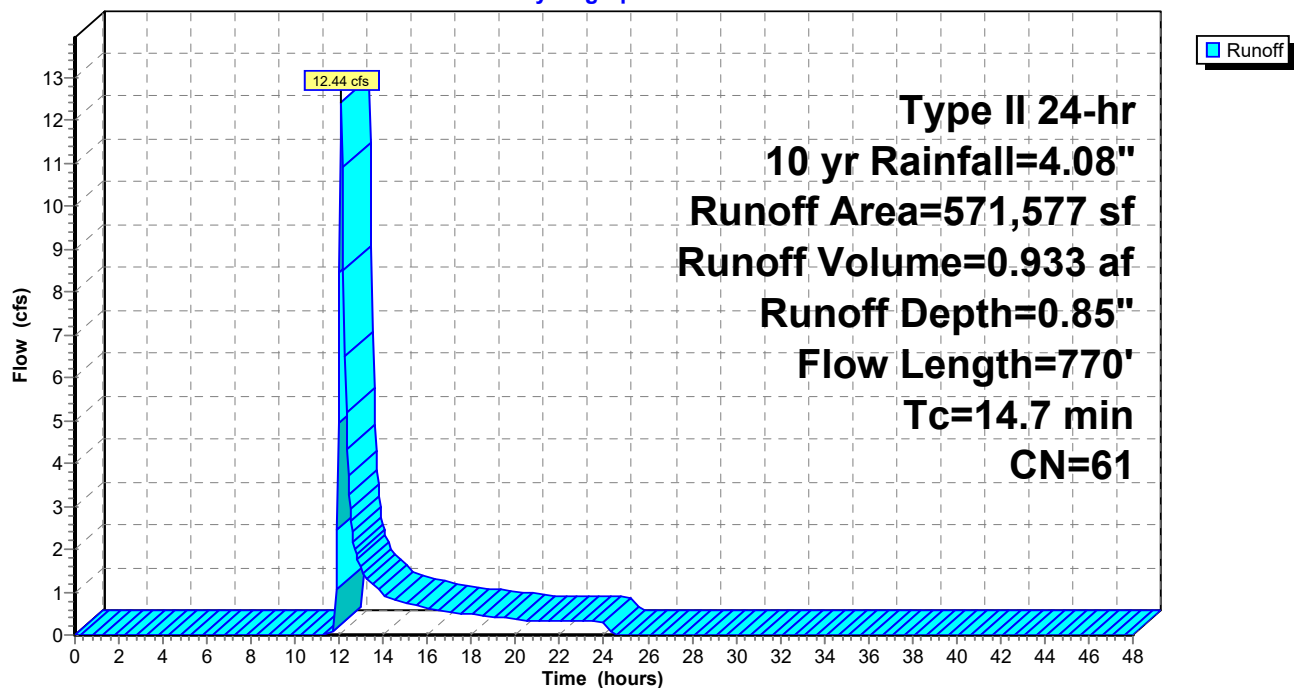
Area (sf)	CN	Description
571,577	61	Pasture/grassland/range, Good, HSG B
571,577		100.00% Pervious Area

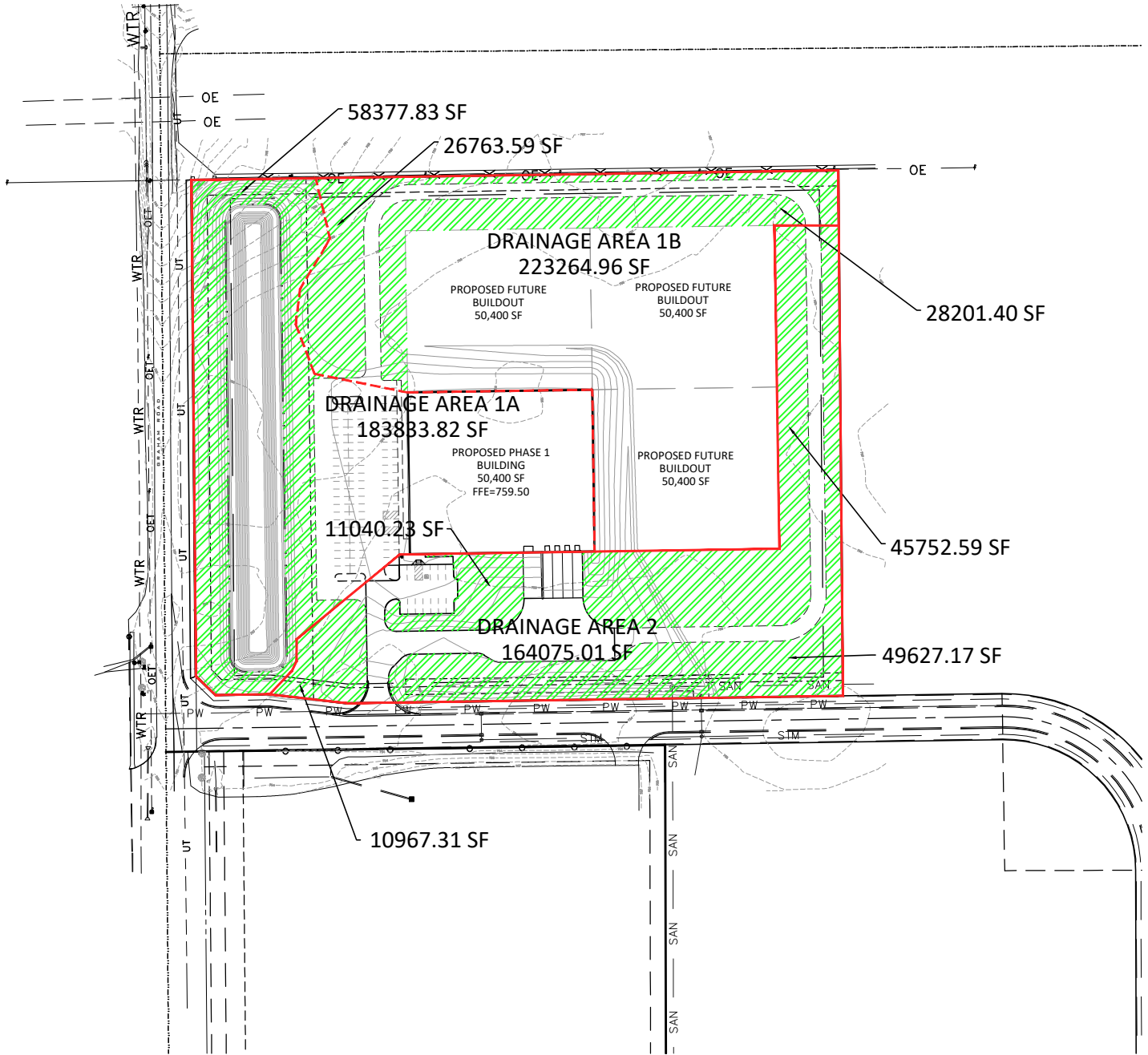
  

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.8	20	0.0500	0.19		Sheet Flow, Range n= 0.130 P2= 2.91"
12.9	750	0.0036	0.97		Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
14.7	770	Total			

### Subcatchment EX: Existing

Hydrograph





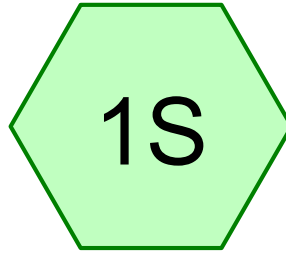
**VERIDUS**  
ENGINEERING

6280 N. Shadeland Avenue, Suite A  
Indianapolis, IN 46220  
Phone: (317) 598-6647 | [www.theveridusgroup.com](http://www.theveridusgroup.com)

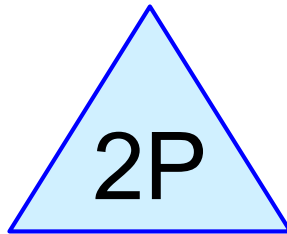
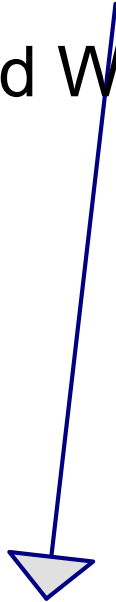


NORTH

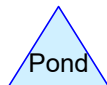
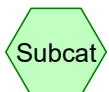
**PROPOSED DRAINAGE AREAS**  
Scale: 1" = 200'



Pond Watershed



Pond



**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

Printed 9/18/2017

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Page 2

**Area Listing (selected nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
2.602	80	>75% Grass cover, Good, HSG D (1S)
6.744	98	Paved parking, HSG D (1S)
<b>9.346</b>	<b>93</b>	<b>TOTAL AREA</b>

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

Printed 9/18/2017

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Page 3

**Soil Listing (selected nodes)**

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
9.346	HSG D	1S
0.000	Other	
<b>9.346</b>		<b>TOTAL AREA</b>

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

Printed 9/18/2017

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Page 4

**Ground Covers (selected 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	0.000	2.602	0.000	2.602	>75% Grass cover, Good	1S
0.000	0.000	0.000	6.744	0.000	6.744	Paved parking	1S
<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>9.346</b>	<b>0.000</b>	<b>9.346</b>	<b>TOTAL AREA</b>	



## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Pond  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 5

### Summary for Subcatchment 1S: Pond Watershed

Runoff = 43.71 cfs @ 12.01 hrs, Volume= 2.568 af, Depth= 3.30"

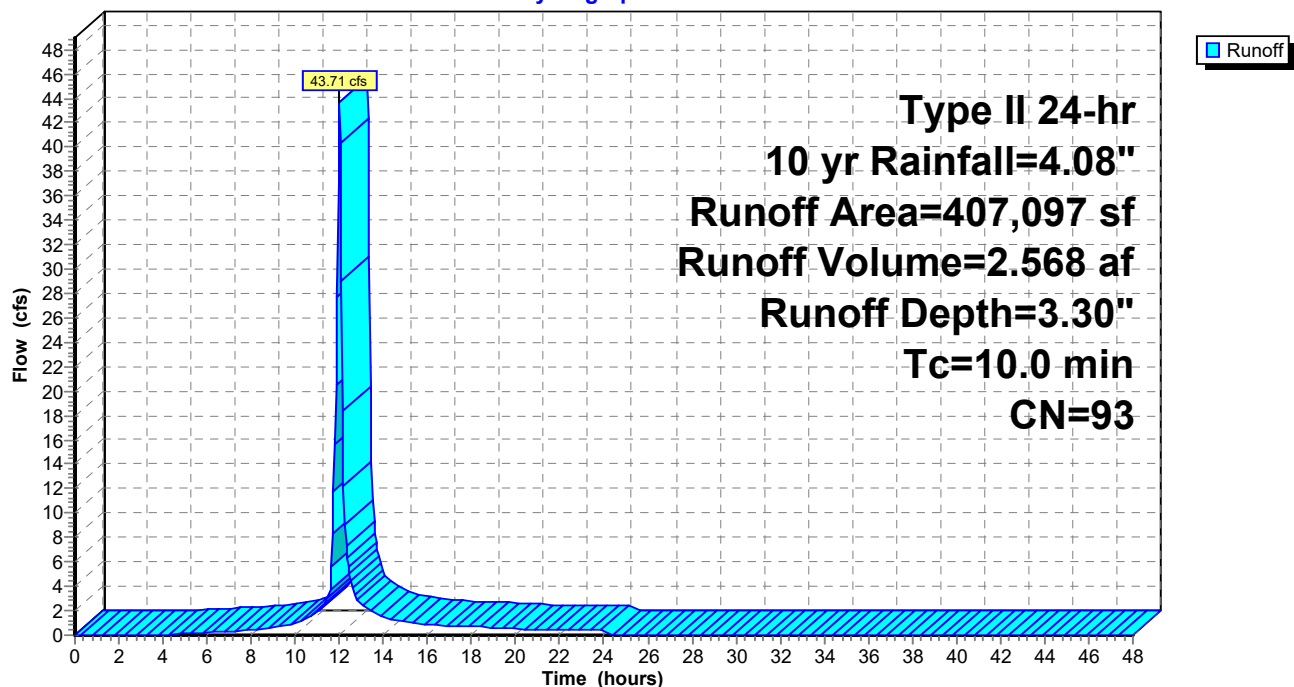
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 10 yr Rainfall=4.08"

Area (sf)	CN	Description
293,756	98	Paved parking, HSG D
113,341	80	>75% Grass cover, Good, HSG D
407,097	93	Weighted Average
113,341		27.84% Pervious Area
293,756		72.16% Impervious Area

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

### Subcatchment 1S: Pond Watershed

Hydrograph



## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Pond  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 6

### Summary for Pond 2P: Pond

Inflow Area = 9.346 ac, 72.16% Impervious, Inflow Depth = 3.30" for 10 yr event  
Inflow = 43.71 cfs @ 12.01 hrs, Volume= 2.568 af  
Outflow = 2.37 cfs @ 13.10 hrs, Volume= 2.427 af, Atten= 95%, Lag= 65.4 min  
Primary = 2.37 cfs @ 13.10 hrs, Volume= 2.427 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Peak Elev= 755.46' @ 13.10 hrs Surf.Area= 51,683 sf Storage= 69,438 cf

Plug-Flow detention time= 495.8 min calculated for 2.424 af (94% of inflow)  
Center-of-Mass det. time= 465.2 min ( 1,250.2 - 785.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	754.00'	186,531 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
754.00	43,711	0	0
757.50	62,878	186,531	186,531

Device	Routing	Invert	Outlet Devices
#1	Primary	753.96'	<b>18.0" Vert. Orifice/Grate</b> C= 0.600
#2	Device 1	754.00'	<b>8.0" Vert. Orifice/Grate</b> X 2 rows with 12.0" cc spacing C= 0.600
#3	Device 1	755.90'	<b>8.0" Vert. Orifice/Grate</b> C= 0.600

**Primary OutFlow** Max=2.37 cfs @ 13.10 hrs HW=755.46' (Free Discharge)

1=Orifice/Grate (Passes 2.37 cfs of 7.36 cfs potential flow)

2=Orifice/Grate (Orifice Controls 2.37 cfs @ 3.92 fps)

3=Orifice/Grate ( Controls 0.00 cfs)

# Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

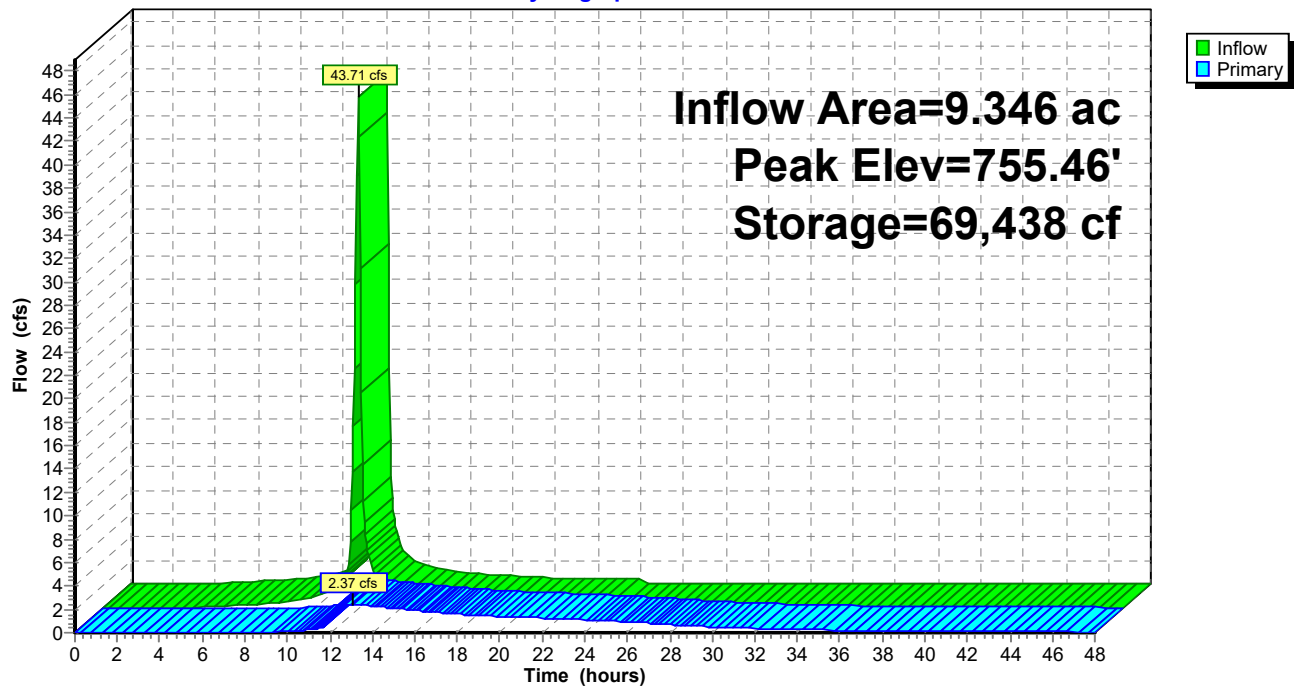
Post Development Pond  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 7

## Pond 2P: Pond

Hydrograph



**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Pond  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 8

**Stage-Discharge for Pond 2P: Pond**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
754.00	0.00	755.02	1.39	756.04	3.68	757.06	6.51
754.02	0.00	755.04	1.42	756.06	3.73	757.08	6.55
754.04	0.01	755.06	1.45	756.08	3.78	757.10	6.59
754.06	0.01	755.08	1.48	756.10	3.84	757.12	6.63
754.08	0.02	755.10	1.51	756.12	3.90	757.14	6.68
754.10	0.04	755.12	1.54	756.14	3.96	757.16	6.72
754.12	0.05	755.14	1.58	756.16	4.02	757.18	6.76
754.14	0.07	755.16	1.62	756.18	4.08	757.20	6.79
754.16	0.09	755.18	1.66	756.20	4.15	757.22	6.83
754.18	0.11	755.20	1.70	756.22	4.21	757.24	6.87
754.20	0.13	755.22	1.74	756.24	4.28	757.26	6.91
754.22	0.16	755.24	1.79	756.26	4.34	757.28	6.95
754.24	0.19	755.26	1.84	756.28	4.41	757.30	6.99
754.26	0.22	755.28	1.89	756.30	4.48	757.32	7.03
754.28	0.25	755.30	1.94	756.32	4.55	757.34	7.06
754.30	0.28	755.32	1.99	756.34	4.62	757.36	7.10
754.32	0.32	755.34	2.04	756.36	4.69	757.38	7.14
754.34	0.36	755.36	2.10	756.38	4.76	757.40	7.17
754.36	0.39	755.38	2.15	756.40	4.83	757.42	7.21
754.38	0.43	755.40	2.21	756.42	4.90	757.44	7.25
754.40	0.47	755.42	2.26	756.44	4.97	757.46	7.28
754.42	0.51	755.44	2.32	756.46	5.03	757.48	7.32
754.44	0.55	755.46	2.38	756.48	5.10	757.50	<b>7.36</b>
754.46	0.59	755.48	2.43	756.50	5.16		
754.48	0.63	755.50	2.49	756.52	5.22		
754.50	0.68	755.52	2.55	756.54	5.28		
754.52	0.72	755.54	2.60	756.56	5.33		
754.54	0.76	755.56	2.66	756.58	5.39		
754.56	0.80	755.58	2.71	756.60	5.44		
754.58	0.84	755.60	2.76	756.62	5.49		
754.60	0.87	755.62	2.81	756.64	5.55		
754.62	0.91	755.64	2.86	756.66	5.60		
754.64	0.94	755.66	2.90	756.68	5.65		
754.66	0.96	755.68	2.94	756.70	5.70		
754.68	0.99	755.70	2.98	756.72	5.75		
754.70	1.02	755.72	3.02	756.74	5.80		
754.72	1.05	755.74	3.07	756.76	5.85		
754.74	1.07	755.76	3.11	756.78	5.89		
754.76	1.10	755.78	3.14	756.80	5.94		
754.78	1.12	755.80	3.18	756.82	5.99		
754.80	1.15	755.82	3.22	756.84	6.03		
754.82	1.17	755.84	3.26	756.86	6.08		
754.84	1.20	755.86	3.30	756.88	6.12		
754.86	1.22	755.88	3.33	756.90	6.17		
754.88	1.24	755.90	3.37	756.92	6.21		
754.90	1.27	755.92	3.41	756.94	6.26		
754.92	1.29	755.94	3.45	756.96	6.30		
754.94	1.31	755.96	3.49	756.98	6.34		
754.96	1.33	755.98	3.53	757.00	6.39		
754.98	1.35	756.00	3.58	757.02	6.43		
755.00	1.37	756.02	3.63	757.04	6.47		

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Pond  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 9

**Stage-Area-Storage for Pond 2P: Pond**

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
754.00	43,711	0	756.55	57,676	129,268
754.05	43,985	2,192	756.60	57,949	132,158
754.10	44,259	4,398	756.65	58,223	135,063
754.15	44,532	6,618	756.70	58,497	137,981
754.20	44,806	8,852	756.75	58,771	140,912
754.25	45,080	11,099	756.80	59,045	143,858
754.30	45,354	13,360	756.85	59,318	146,817
754.35	45,628	15,634	756.90	59,592	149,790
754.40	45,902	17,923	756.95	59,866	152,776
754.45	46,175	20,224	757.00	60,140	155,776
754.50	46,449	22,540	757.05	60,414	158,790
754.55	46,723	24,869	757.10	60,687	161,818
754.60	46,997	27,212	757.15	60,961	164,859
754.65	47,271	29,569	757.20	61,235	167,914
754.70	47,544	31,939	757.25	61,509	170,982
754.75	47,818	34,323	757.30	61,783	174,065
754.80	48,092	36,721	757.35	62,057	177,161
754.85	48,366	39,133	757.40	62,330	180,270
754.90	48,640	41,558	757.45	62,604	183,394
754.95	48,913	43,997	757.50	<b>62,878</b>	<b>186,531</b>
755.00	49,187	46,449			
755.05	49,461	48,915			
755.10	49,735	51,395			
755.15	50,009	53,889			
755.20	50,283	56,396			
755.25	50,556	58,917			
755.30	50,830	61,452			
755.35	51,104	64,000			
755.40	51,378	66,562			
755.45	51,652	69,138			
755.50	51,925	71,727			
755.55	52,199	74,330			
755.60	52,473	76,947			
755.65	52,747	79,578			
755.70	53,021	82,222			
755.75	53,295	84,880			
755.80	53,568	87,551			
755.85	53,842	90,237			
755.90	54,116	92,936			
755.95	54,390	95,648			
756.00	54,664	98,375			
756.05	54,937	101,115			
756.10	55,211	103,868			
756.15	55,485	106,636			
756.20	55,759	109,417			
756.25	56,033	112,212			
756.30	56,306	115,020			
756.35	56,580	117,842			
756.40	56,854	120,678			
756.45	57,128	123,528			
756.50	57,402	126,391			

## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Pond  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 10

### Summary for Subcatchment 1S: Pond Watershed

Runoff = 65.39 cfs @ 12.01 hrs, Volume= 3.944 af, Depth= 5.06"

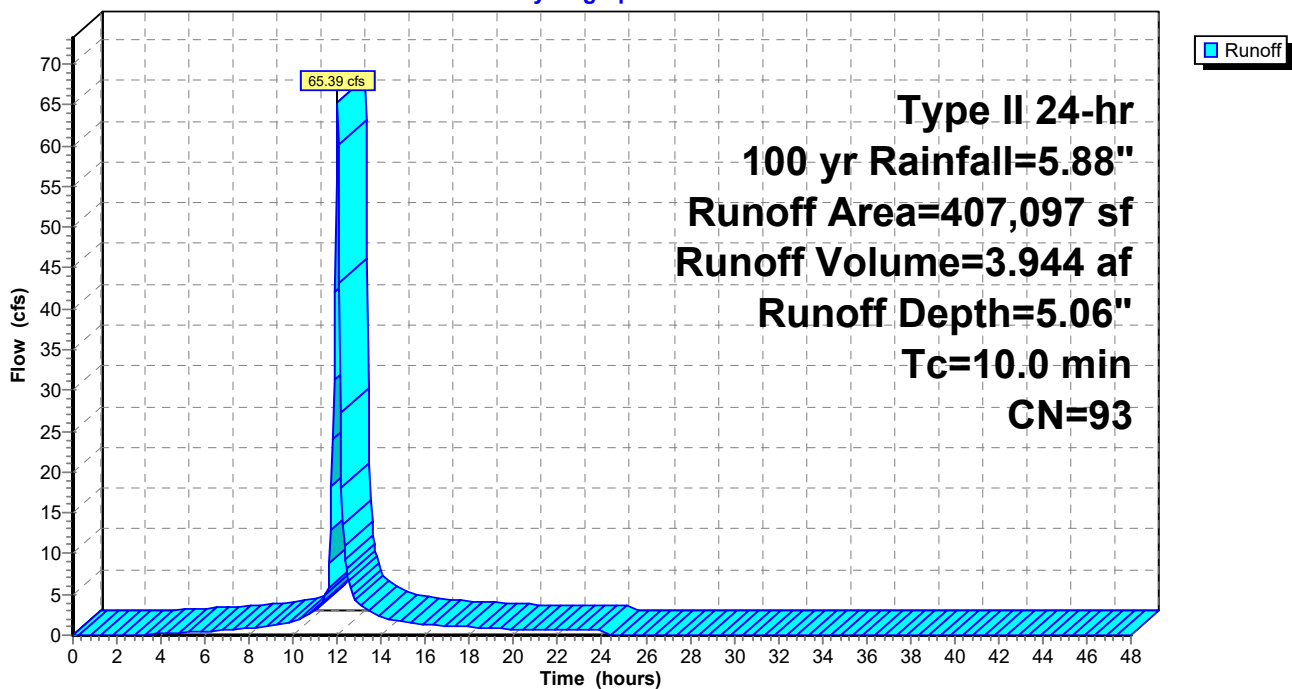
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 100 yr Rainfall=5.88"

Area (sf)	CN	Description
293,756	98	Paved parking, HSG D
113,341	80	>75% Grass cover, Good, HSG D
407,097	93	Weighted Average
113,341		27.84% Pervious Area
293,756		72.16% Impervious Area

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

### Subcatchment 1S: Pond Watershed

Hydrograph



## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Pond  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 11

### Summary for Pond 2P: Pond

Inflow Area = 9.346 ac, 72.16% Impervious, Inflow Depth = 5.06" for 100 yr event  
Inflow = 65.39 cfs @ 12.01 hrs, Volume= 3.944 af  
Outflow = 3.91 cfs @ 12.94 hrs, Volume= 3.784 af, Atten= 94%, Lag= 56.0 min  
Primary = 3.91 cfs @ 12.94 hrs, Volume= 3.784 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Peak Elev= 756.12' @ 12.94 hrs Surf.Area= 55,338 sf Storage= 105,148 cf

Plug-Flow detention time= 464.5 min calculated for 3.780 af (96% of inflow)  
Center-of-Mass det. time= 441.1 min ( 1,214.8 - 773.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	754.00'	186,531 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
754.00	43,711	0	0
757.50	62,878	186,531	186,531

Device	Routing	Invert	Outlet Devices
#1	Primary	753.96'	<b>18.0" Vert. Orifice/Grate</b> C= 0.600
#2	Device 1	754.00'	<b>8.0" Vert. Orifice/Grate</b> X 2 rows with 12.0" cc spacing C= 0.600
#3	Device 1	755.90'	<b>8.0" Vert. Orifice/Grate</b> C= 0.600

**Primary OutFlow** Max=3.91 cfs @ 12.94 hrs HW=756.12' (Free Discharge)

1=Orifice/Grate (Passes 3.91 cfs of 10.11 cfs potential flow)

2=Orifice/Grate (Orifice Controls 3.74 cfs @ 5.36 fps)

3=Orifice/Grate (Orifice Controls 0.16 cfs @ 1.61 fps)

# Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

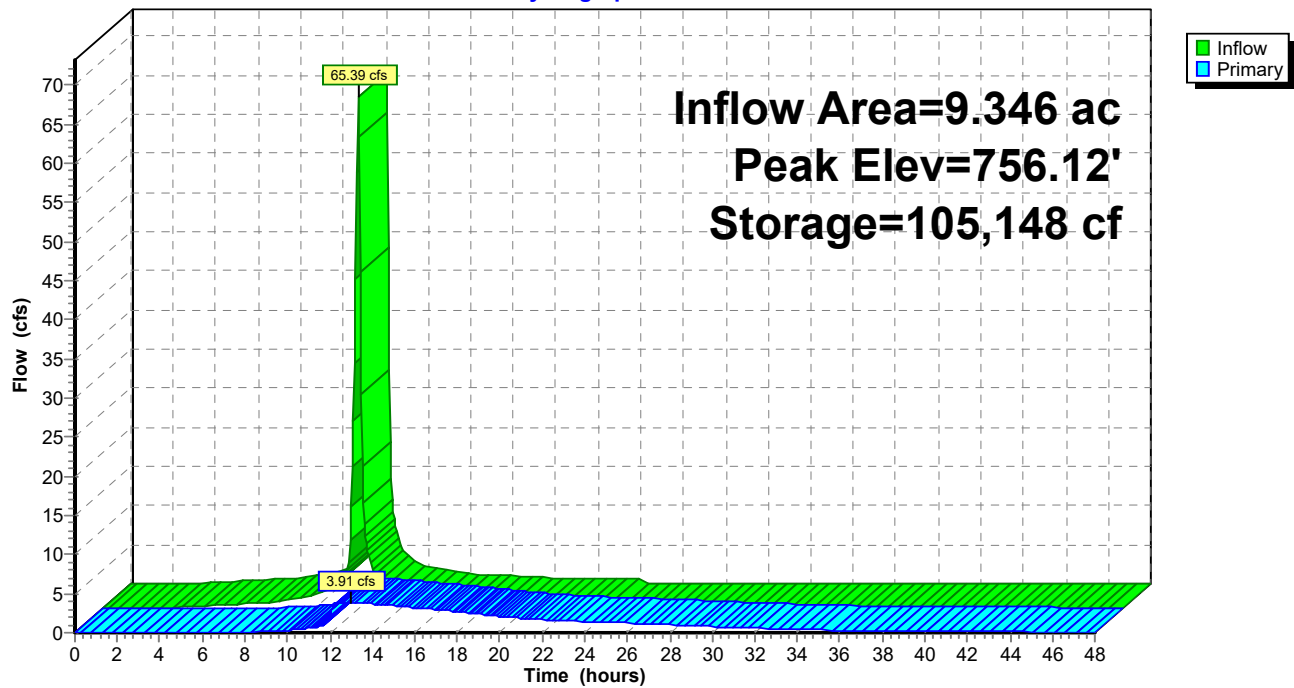
Post Development Pond  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 12

## Pond 2P: Pond

### Hydrograph





**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Pond  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 13

**Stage-Discharge for Pond 2P: Pond**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
754.00	0.00	755.02	1.39	756.04	3.68	757.06	6.51
754.02	0.00	755.04	1.42	756.06	3.73	757.08	6.55
754.04	0.01	755.06	1.45	756.08	3.78	757.10	6.59
754.06	0.01	755.08	1.48	756.10	3.84	757.12	6.63
754.08	0.02	755.10	1.51	756.12	3.90	757.14	6.68
754.10	0.04	755.12	1.54	756.14	3.96	757.16	6.72
754.12	0.05	755.14	1.58	756.16	4.02	757.18	6.76
754.14	0.07	755.16	1.62	756.18	4.08	757.20	6.79
754.16	0.09	755.18	1.66	756.20	4.15	757.22	6.83
754.18	0.11	755.20	1.70	756.22	4.21	757.24	6.87
754.20	0.13	755.22	1.74	756.24	4.28	757.26	6.91
754.22	0.16	755.24	1.79	756.26	4.34	757.28	6.95
754.24	0.19	755.26	1.84	756.28	4.41	757.30	6.99
754.26	0.22	755.28	1.89	756.30	4.48	757.32	7.03
754.28	0.25	755.30	1.94	756.32	4.55	757.34	7.06
754.30	0.28	755.32	1.99	756.34	4.62	757.36	7.10
754.32	0.32	755.34	2.04	756.36	4.69	757.38	7.14
754.34	0.36	755.36	2.10	756.38	4.76	757.40	7.17
754.36	0.39	755.38	2.15	756.40	4.83	757.42	7.21
754.38	0.43	755.40	2.21	756.42	4.90	757.44	7.25
754.40	0.47	755.42	2.26	756.44	4.97	757.46	7.28
754.42	0.51	755.44	2.32	756.46	5.03	757.48	7.32
754.44	0.55	755.46	2.38	756.48	5.10	757.50	<b>7.36</b>
754.46	0.59	755.48	2.43	756.50	5.16		
754.48	0.63	755.50	2.49	756.52	5.22		
754.50	0.68	755.52	2.55	756.54	5.28		
754.52	0.72	755.54	2.60	756.56	5.33		
754.54	0.76	755.56	2.66	756.58	5.39		
754.56	0.80	755.58	2.71	756.60	5.44		
754.58	0.84	755.60	2.76	756.62	5.49		
754.60	0.87	755.62	2.81	756.64	5.55		
754.62	0.91	755.64	2.86	756.66	5.60		
754.64	0.94	755.66	2.90	756.68	5.65		
754.66	0.96	755.68	2.94	756.70	5.70		
754.68	0.99	755.70	2.98	756.72	5.75		
754.70	1.02	755.72	3.02	756.74	5.80		
754.72	1.05	755.74	3.07	756.76	5.85		
754.74	1.07	755.76	3.11	756.78	5.89		
754.76	1.10	755.78	3.14	756.80	5.94		
754.78	1.12	755.80	3.18	756.82	5.99		
754.80	1.15	755.82	3.22	756.84	6.03		
754.82	1.17	755.84	3.26	756.86	6.08		
754.84	1.20	755.86	3.30	756.88	6.12		
754.86	1.22	755.88	3.33	756.90	6.17		
754.88	1.24	755.90	3.37	756.92	6.21		
754.90	1.27	755.92	3.41	756.94	6.26		
754.92	1.29	755.94	3.45	756.96	6.30		
754.94	1.31	755.96	3.49	756.98	6.34		
754.96	1.33	755.98	3.53	757.00	6.39		
754.98	1.35	756.00	3.58	757.02	6.43		
755.00	1.37	756.02	3.63	757.04	6.47		

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

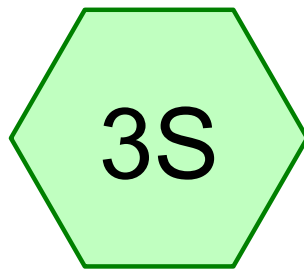
Post Development Pond  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

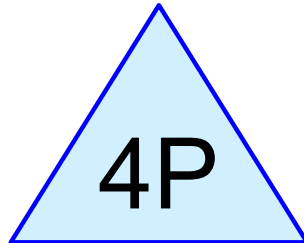
Page 14

**Stage-Area-Storage for Pond 2P: Pond**

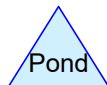
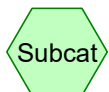
Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
754.00	43,711	0	756.55	57,676	129,268
754.05	43,985	2,192	756.60	57,949	132,158
754.10	44,259	4,398	756.65	58,223	135,063
754.15	44,532	6,618	756.70	58,497	137,981
754.20	44,806	8,852	756.75	58,771	140,912
754.25	45,080	11,099	756.80	59,045	143,858
754.30	45,354	13,360	756.85	59,318	146,817
754.35	45,628	15,634	756.90	59,592	149,790
754.40	45,902	17,923	756.95	59,866	152,776
754.45	46,175	20,224	757.00	60,140	155,776
754.50	46,449	22,540	757.05	60,414	158,790
754.55	46,723	24,869	757.10	60,687	161,818
754.60	46,997	27,212	757.15	60,961	164,859
754.65	47,271	29,569	757.20	61,235	167,914
754.70	47,544	31,939	757.25	61,509	170,982
754.75	47,818	34,323	757.30	61,783	174,065
754.80	48,092	36,721	757.35	62,057	177,161
754.85	48,366	39,133	757.40	62,330	180,270
754.90	48,640	41,558	757.45	62,604	183,394
754.95	48,913	43,997	757.50	<b>62,878</b>	<b>186,531</b>
755.00	49,187	46,449			
755.05	49,461	48,915			
755.10	49,735	51,395			
755.15	50,009	53,889			
755.20	50,283	56,396			
755.25	50,556	58,917			
755.30	50,830	61,452			
755.35	51,104	64,000			
755.40	51,378	66,562			
755.45	51,652	69,138			
755.50	51,925	71,727			
755.55	52,199	74,330			
755.60	52,473	76,947			
755.65	52,747	79,578			
755.70	53,021	82,222			
755.75	53,295	84,880			
755.80	53,568	87,551			
755.85	53,842	90,237			
755.90	54,116	92,936			
755.95	54,390	95,648			
756.00	54,664	98,375			
756.05	54,937	101,115			
756.10	55,211	103,868			
756.15	55,485	106,636			
756.20	55,759	109,417			
756.25	56,033	112,212			
756.30	56,306	115,020			
756.35	56,580	117,842			
756.40	56,854	120,678			
756.45	57,128	123,528			
756.50	57,402	126,391			



Bypass Watershed



Drainage Swales



**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

Printed 9/18/2017

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Page 2

**Area Listing (selected nodes)**

Area (acres)	CN	Description (subcatchment-numbers)
5.125	61	DRAINAGE AREA 1B: PERVIOUS (3S)
1.072	98	DRAINAGE AREA 2: IMPERVIOUS (3S)
2.695	80	DRAINAGE AREA 2: PERVIOUS (3S)
<b>8.892</b>	<b>71</b>	<b>TOTAL AREA</b>

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

Printed 9/18/2017

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Page 3

**Soil Listing (selected nodes)**

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
8.892	Other	3S
<b>8.892</b>		<b>TOTAL AREA</b>

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

Printed 9/18/2017

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Page 4

**Ground Covers (selected nodes)**

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchm Numbers
0.000	0.000	0.000	0.000	5.125	5.125	DRAINAGE AREA 1B: PERVIOUS	
0.000	0.000	0.000	0.000	1.072	1.072	DRAINAGE AREA 2: IMPERVIOUS	
0.000	0.000	0.000	0.000	2.695	2.695	DRAINAGE AREA 2: PERVIOUS	
<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>8.892</b>	<b>8.892</b>	<b>TOTAL AREA</b>	

## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 5

### Summary for Subcatchment 3S: Bypass Watershed

Runoff = 19.21 cfs @ 12.02 hrs, Volume= 1.074 af, Depth= 1.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 10 yr Rainfall=4.08"

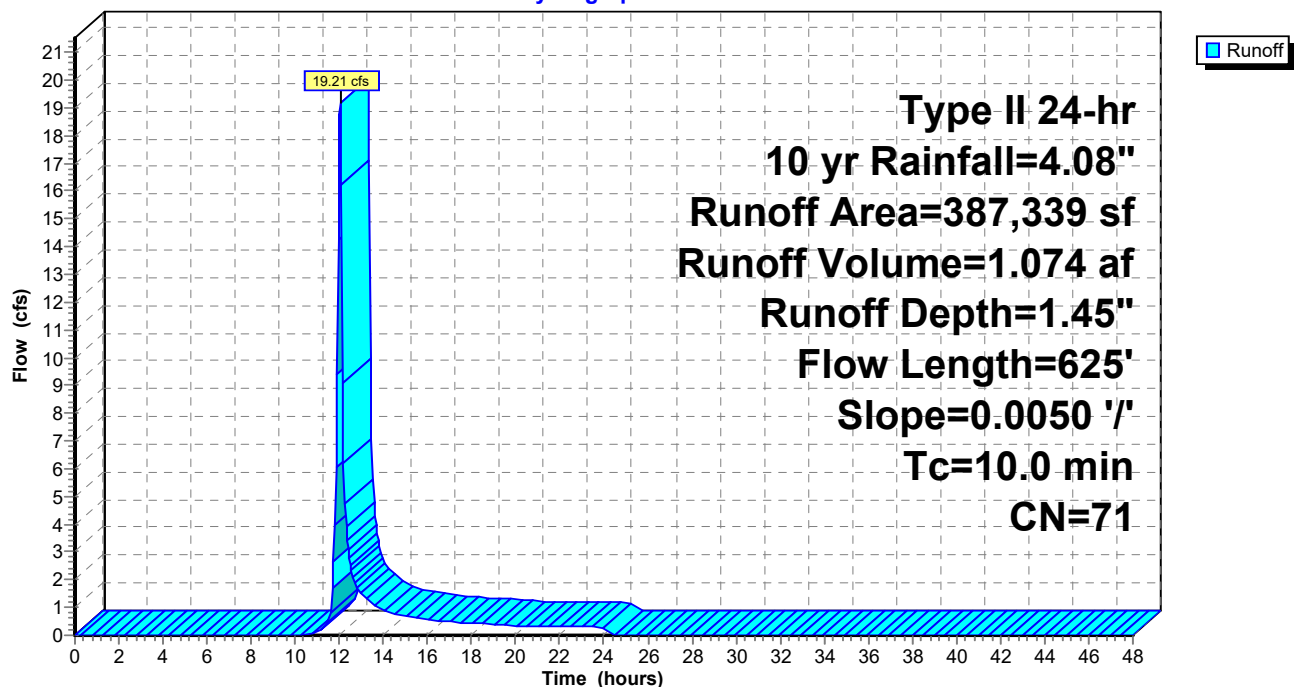
	Area (sf)	CN	Description
*	117,386	80	DRAINAGE AREA 2: PERVIOUS
*	46,689	98	DRAINAGE AREA 2: IMPERVIOUS
*	223,264	61	DRAINAGE AREA 1B: PERVIOUS
	387,339	71	Weighted Average
	340,650		87.95% Pervious Area
	46,689		12.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	625	0.0050	3.78	25.35	<b>Channel Flow,</b> Area= 6.7 sf Perim= 9.5' r= 0.71' n= 0.022 Earth, clean & straight

2.8 625 Total, Increased to minimum Tc = 10.0 min

### Subcatchment 3S: Bypass Watershed

Hydrograph



## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 6

### Summary for Pond 4P: Drainage Swales

Inflow Area = 8.892 ac, 12.05% Impervious, Inflow Depth = 1.45" for 10 yr event  
Inflow = 19.21 cfs @ 12.02 hrs, Volume= 1.074 af  
Outflow = 4.89 cfs @ 12.25 hrs, Volume= 1.074 af, Atten= 75%, Lag= 13.6 min  
Primary = 4.89 cfs @ 12.25 hrs, Volume= 1.074 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Peak Elev= 753.38' @ 12.25 hrs Surf.Area= 17,043 sf Storage= 12,237 cf

Plug-Flow detention time= 16.8 min calculated for 1.073 af (100% of inflow)  
Center-of-Mass det. time= 16.7 min ( 873.5 - 856.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	751.20'	68,534 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
751.20	0	0.0	0	0	0
752.00	2,261	560.0	603	603	24,957
753.00	11,539	1,262.0	6,303	6,906	126,744
754.00	28,569	1,733.0	19,421	26,327	239,009
755.00	57,516	2,166.0	42,207	68,534	373,371

Device	Routing	Invert	Outlet Devices
#1	Primary	751.20'	<b>18.0" Vert. Orifice/Grate</b> C= 0.600
#2	Device 1	751.20'	<b>12.0" Vert. Orifice/Grate</b> C= 0.600

**Primary OutFlow** Max=4.89 cfs @ 12.25 hrs HW=753.38' (Free Discharge)

↑ **1=Orifice/Grate** (Passes 4.89 cfs of 10.16 cfs potential flow)

↑ **2=Orifice/Grate** (Orifice Controls 4.89 cfs @ 6.23 fps)



# Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

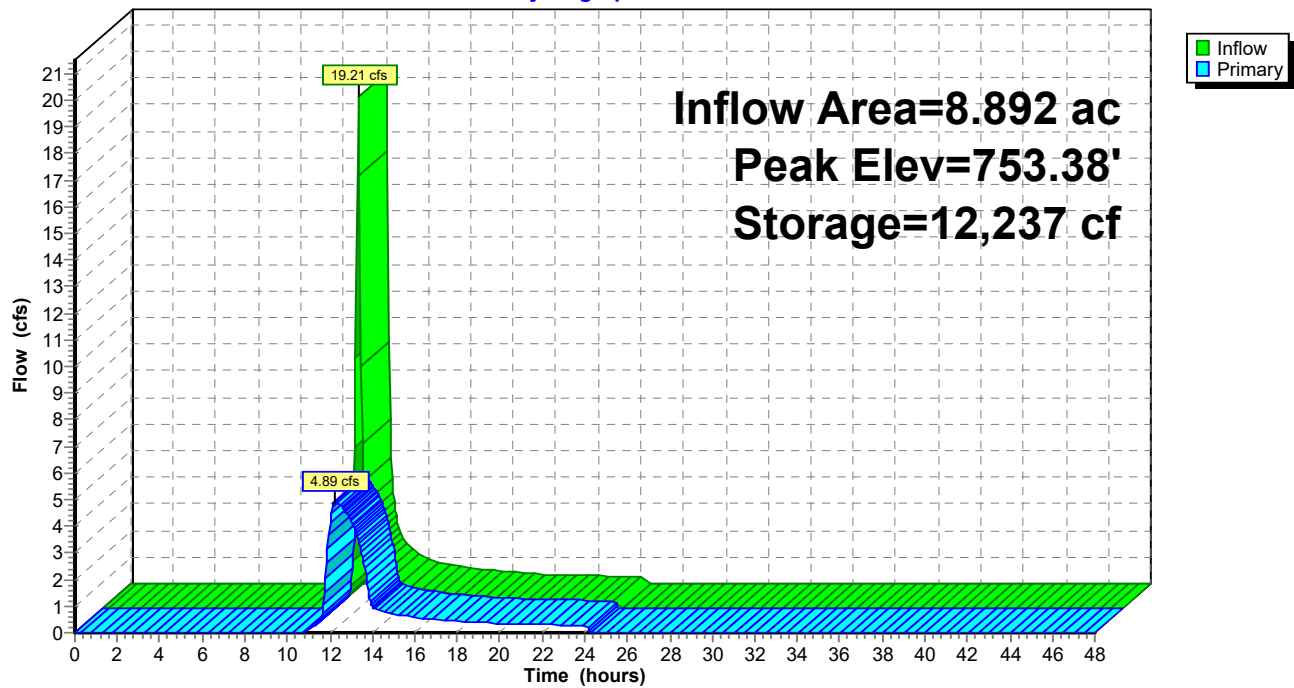
Post Development Bypass  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 7

## Pond 4P: Drainage Swales

Hydrograph



**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 8

**Stage-Discharge for Pond 4P: Drainage Swales**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
751.20	0.00	752.22	2.73	753.24	4.69	754.26	6.05
751.22	0.00	752.24	2.78	753.26	4.72	754.28	6.07
751.24	0.01	752.26	2.83	753.28	4.75	754.30	6.10
751.26	0.02	752.28	2.88	753.30	4.78	754.32	6.12
751.28	0.03	752.30	2.93	753.32	4.81	754.34	6.14
751.30	0.04	752.32	2.98	753.34	4.84	754.36	6.17
751.32	0.06	752.34	3.03	753.36	4.87	754.38	6.19
751.34	0.09	752.36	3.07	753.38	4.90	754.40	6.21
751.36	0.11	752.38	3.12	753.40	4.93	754.42	6.24
751.38	0.14	752.40	3.16	753.42	4.96	754.44	6.26
751.40	0.17	752.42	3.21	753.44	4.99	754.46	6.28
751.42	0.20	752.44	3.25	753.46	5.02	754.48	6.31
751.44	0.24	752.46	3.30	753.48	5.05	754.50	6.33
751.46	0.28	752.48	3.34	753.50	5.07	754.52	6.35
751.48	0.32	752.50	3.38	753.52	5.10	754.54	6.37
751.50	0.37	752.52	3.42	753.54	5.13	754.56	6.40
751.52	0.42	752.54	3.47	753.56	5.16	754.58	6.42
751.54	0.47	752.56	3.51	753.58	5.19	754.60	6.44
751.56	0.52	752.58	3.55	753.60	5.21	754.62	6.46
751.58	0.57	752.60	3.59	753.62	5.24	754.64	6.48
751.60	0.63	752.62	3.63	753.64	5.27	754.66	6.51
751.62	0.69	752.64	3.67	753.66	5.29	754.68	6.53
751.64	0.75	752.66	3.71	753.68	5.32	754.70	6.55
751.66	0.81	752.68	3.74	753.70	5.35	754.72	6.57
751.68	0.88	752.70	3.78	753.72	5.37	754.74	6.59
751.70	0.95	752.72	3.82	753.74	5.40	754.76	6.62
751.72	1.01	752.74	3.86	753.76	5.43	754.78	6.64
751.74	1.08	752.76	3.89	753.78	5.45	754.80	6.66
751.76	1.15	752.78	3.93	753.80	5.48	754.82	6.68
751.78	1.22	752.80	3.97	753.82	5.51	754.84	6.70
751.80	1.30	752.82	4.00	753.84	5.53	754.86	6.72
751.82	1.37	752.84	4.04	753.86	5.56	754.88	6.74
751.84	1.45	752.86	4.07	753.88	5.58	754.90	6.76
751.86	1.52	752.88	4.11	753.90	5.61	754.92	6.79
751.88	1.60	752.90	4.14	753.92	5.63	754.94	6.81
751.90	1.67	752.92	4.18	753.94	5.66	754.96	6.83
751.92	1.75	752.94	4.21	753.96	5.69	754.98	6.85
751.94	1.83	752.96	4.24	753.98	5.71	755.00	<b>6.87</b>
751.96	1.90	752.98	4.28	754.00	5.74		
751.98	1.98	753.00	4.31	754.02	5.76		
752.00	2.05	753.02	4.34	754.04	5.78		
752.02	2.13	753.04	4.38	754.06	5.81		
752.04	2.20	753.06	4.41	754.08	5.83		
752.06	2.27	753.08	4.44	754.10	5.86		
752.08	2.34	753.10	4.47	754.12	5.88		
752.10	2.40	753.12	4.51	754.14	5.91		
752.12	2.47	753.14	4.54	754.16	5.93		
752.14	2.53	753.16	4.57	754.18	5.96		
752.16	2.58	753.18	4.60	754.20	5.98		
752.18	2.63	753.20	4.63	754.22	6.00		
752.20	2.67	753.22	4.66	754.24	6.03		

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 10 yr Rainfall=4.08"

Printed 9/18/2017

Page 9

**Stage-Area-Storage for Pond 4P: Drainage Swales**

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
751.20	0	0	753.75	23,600	19,816
751.25	9	0	753.80	24,556	21,020
751.30	35	1	753.85	25,531	22,272
751.35	79	4	753.90	26,524	23,573
751.40	141	9	753.95	27,537	24,924
751.45	221	18	754.00	28,569	26,327
751.50	318	32	754.05	29,778	27,786
751.55	433	50	754.10	31,013	29,305
751.60	565	75	754.15	32,272	30,887
751.65	715	107	754.20	33,556	32,533
751.70	883	147	754.25	34,866	34,243
751.75	1,069	196	754.30	36,200	36,020
751.80	1,272	254	754.35	37,560	37,864
751.85	1,493	323	754.40	38,945	39,776
751.90	1,731	404	754.45	40,354	41,759
751.95	1,987	497	754.50	41,789	43,812
752.00	2,261	603	754.55	43,249	45,938
752.05	2,555	723	754.60	44,734	48,138
752.10	2,866	859	754.65	46,244	50,412
752.15	3,196	1,010	754.70	47,779	52,762
752.20	3,543	1,179	754.75	49,339	55,190
752.25	3,908	1,365	754.80	50,925	57,697
752.30	4,292	1,570	754.85	52,535	60,283
752.35	4,693	1,794	754.90	54,170	62,951
752.40	5,112	2,039	754.95	55,831	65,700
752.45	5,549	2,306	755.00	<b>57,516</b>	<b>68,534</b>
752.50	6,004	2,594			
752.55	6,477	2,906			
752.60	6,968	3,242			
752.65	7,476	3,603			
752.70	8,003	3,990			
752.75	8,547	4,404			
752.80	9,110	4,845			
752.85	9,690	5,315			
752.90	10,289	5,815			
752.95	10,905	6,345			
753.00	11,539	6,906			
753.05	12,210	7,499			
753.10	12,900	8,127			
753.15	13,610	8,790			
753.20	14,338	9,488			
753.25	15,085	10,224			
753.30	15,851	10,997			
753.35	16,636	11,809			
753.40	17,440	12,661			
753.45	18,263	13,553			
753.50	19,105	14,488			
753.55	19,966	15,464			
753.60	20,846	16,484			
753.65	21,745	17,549			
753.70	22,663	18,659			

## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 10

### Summary for Subcatchment 3S: Bypass Watershed

Runoff = 37.76 cfs @ 12.02 hrs, Volume= 2.077 af, Depth= 2.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Type II 24-hr 100 yr Rainfall=5.88"

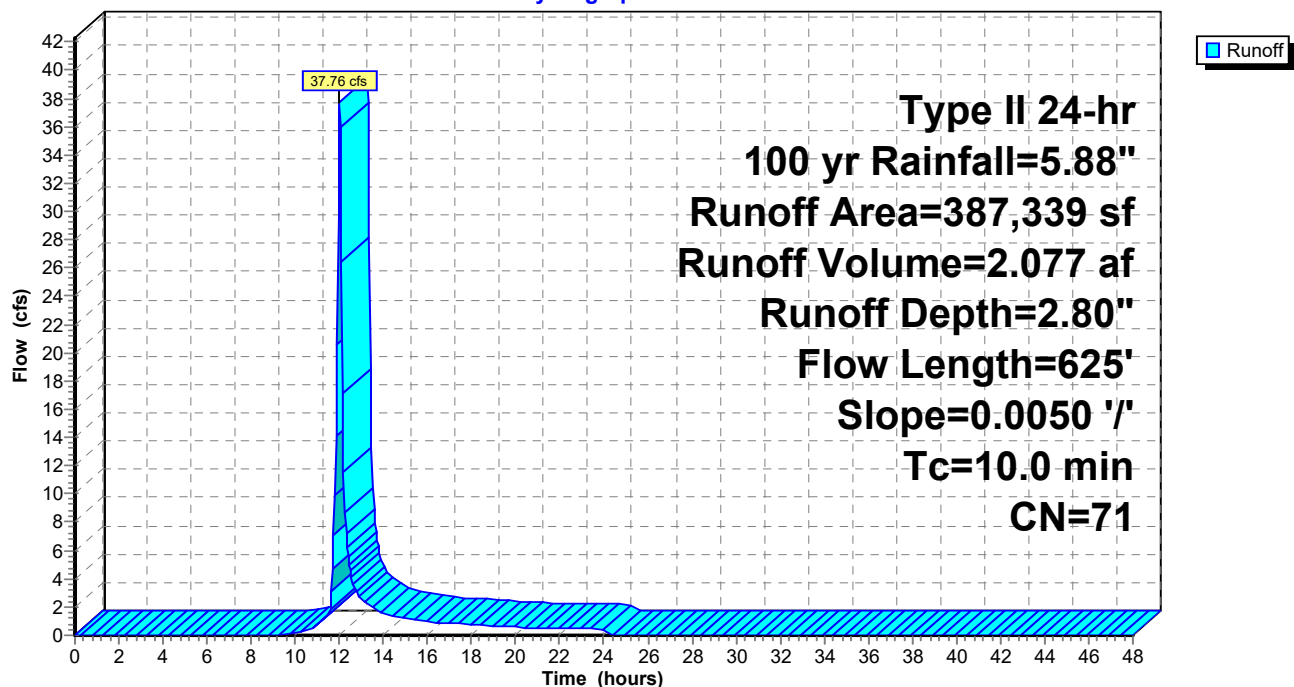
	Area (sf)	CN	Description
*	117,386	80	DRAINAGE AREA 2: PERVIOUS
*	46,689	98	DRAINAGE AREA 2: IMPERVIOUS
*	223,264	61	DRAINAGE AREA 1B: PERVIOUS
	387,339	71	Weighted Average
	340,650		87.95% Pervious Area
	46,689		12.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	625	0.0050	3.78	25.35	<b>Channel Flow,</b> Area= 6.7 sf Perim= 9.5' r= 0.71' n= 0.022 Earth, clean & straight

2.8 625 Total, Increased to minimum Tc = 10.0 min

### Subcatchment 3S: Bypass Watershed

Hydrograph



## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 11

### Summary for Pond 4P: Drainage Swales

Inflow Area = 8.892 ac, 12.05% Impervious, Inflow Depth = 2.80" for 100 yr event  
Inflow = 37.76 cfs @ 12.02 hrs, Volume= 2.077 af  
Outflow = 5.93 cfs @ 12.37 hrs, Volume= 2.077 af, Atten= 84%, Lag= 21.3 min  
Primary = 5.93 cfs @ 12.37 hrs, Volume= 2.077 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs  
Peak Elev= 754.16' @ 12.37 hrs Surf.Area= 32,460 sf Storage= 31,126 cf

Plug-Flow detention time= 39.9 min calculated for 2.074 af (100% of inflow)  
Center-of-Mass det. time= 39.8 min ( 877.2 - 837.4 )

Volume	Invert	Avail.Storage	Storage Description
#1	751.20'	68,534 cf	<b>Custom Stage Data (Irregular)</b> Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
751.20	0	0.0	0	0	0
752.00	2,261	560.0	603	603	24,957
753.00	11,539	1,262.0	6,303	6,906	126,744
754.00	28,569	1,733.0	19,421	26,327	239,009
755.00	57,516	2,166.0	42,207	68,534	373,371

Device	Routing	Invert	Outlet Devices
#1	Primary	751.20'	<b>18.0" Vert. Orifice/Grate</b> C= 0.600
#2	Device 1	751.20'	<b>12.0" Vert. Orifice/Grate</b> C= 0.600

**Primary OutFlow** Max=5.93 cfs @ 12.37 hrs HW=754.16' (Free Discharge)

↑ **1=Orifice/Grate** (Passes 5.93 cfs of 12.64 cfs potential flow)

↑ **2=Orifice/Grate** (Orifice Controls 5.93 cfs @ 7.55 fps)

## Franklin Spec\_Drainage

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

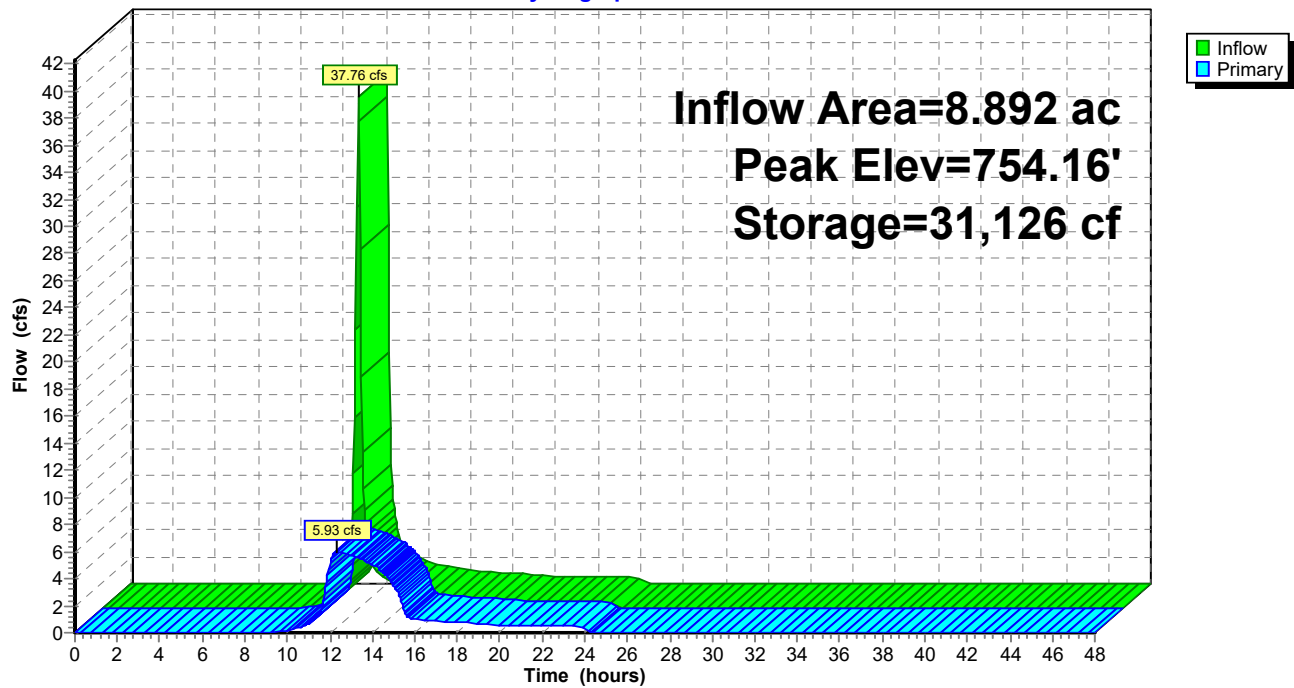
Post Development Bypass  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 12

### Pond 4P: Drainage Swales

Hydrograph



**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 13

**Stage-Discharge for Pond 4P: Drainage Swales**

Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)	Elevation (feet)	Primary (cfs)
751.20	0.00	752.22	2.73	753.24	4.69	754.26	6.05
751.22	0.00	752.24	2.78	753.26	4.72	754.28	6.07
751.24	0.01	752.26	2.83	753.28	4.75	754.30	6.10
751.26	0.02	752.28	2.88	753.30	4.78	754.32	6.12
751.28	0.03	752.30	2.93	753.32	4.81	754.34	6.14
751.30	0.04	752.32	2.98	753.34	4.84	754.36	6.17
751.32	0.06	752.34	3.03	753.36	4.87	754.38	6.19
751.34	0.09	752.36	3.07	753.38	4.90	754.40	6.21
751.36	0.11	752.38	3.12	753.40	4.93	754.42	6.24
751.38	0.14	752.40	3.16	753.42	4.96	754.44	6.26
751.40	0.17	752.42	3.21	753.44	4.99	754.46	6.28
751.42	0.20	752.44	3.25	753.46	5.02	754.48	6.31
751.44	0.24	752.46	3.30	753.48	5.05	754.50	6.33
751.46	0.28	752.48	3.34	753.50	5.07	754.52	6.35
751.48	0.32	752.50	3.38	753.52	5.10	754.54	6.37
751.50	0.37	752.52	3.42	753.54	5.13	754.56	6.40
751.52	0.42	752.54	3.47	753.56	5.16	754.58	6.42
751.54	0.47	752.56	3.51	753.58	5.19	754.60	6.44
751.56	0.52	752.58	3.55	753.60	5.21	754.62	6.46
751.58	0.57	752.60	3.59	753.62	5.24	754.64	6.48
751.60	0.63	752.62	3.63	753.64	5.27	754.66	6.51
751.62	0.69	752.64	3.67	753.66	5.29	754.68	6.53
751.64	0.75	752.66	3.71	753.68	5.32	754.70	6.55
751.66	0.81	752.68	3.74	753.70	5.35	754.72	6.57
751.68	0.88	752.70	3.78	753.72	5.37	754.74	6.59
751.70	0.95	752.72	3.82	753.74	5.40	754.76	6.62
751.72	1.01	752.74	3.86	753.76	5.43	754.78	6.64
751.74	1.08	752.76	3.89	753.78	5.45	754.80	6.66
751.76	1.15	752.78	3.93	753.80	5.48	754.82	6.68
751.78	1.22	752.80	3.97	753.82	5.51	754.84	6.70
751.80	1.30	752.82	4.00	753.84	5.53	754.86	6.72
751.82	1.37	752.84	4.04	753.86	5.56	754.88	6.74
751.84	1.45	752.86	4.07	753.88	5.58	754.90	6.76
751.86	1.52	752.88	4.11	753.90	5.61	754.92	6.79
751.88	1.60	752.90	4.14	753.92	5.63	754.94	6.81
751.90	1.67	752.92	4.18	753.94	5.66	754.96	6.83
751.92	1.75	752.94	4.21	753.96	5.69	754.98	6.85
751.94	1.83	752.96	4.24	753.98	5.71	755.00	<b>6.87</b>
751.96	1.90	752.98	4.28	754.00	5.74		
751.98	1.98	753.00	4.31	754.02	5.76		
752.00	2.05	753.02	4.34	754.04	5.78		
752.02	2.13	753.04	4.38	754.06	5.81		
752.04	2.20	753.06	4.41	754.08	5.83		
752.06	2.27	753.08	4.44	754.10	5.86		
752.08	2.34	753.10	4.47	754.12	5.88		
752.10	2.40	753.12	4.51	754.14	5.91		
752.12	2.47	753.14	4.54	754.16	5.93		
752.14	2.53	753.16	4.57	754.18	5.96		
752.16	2.58	753.18	4.60	754.20	5.98		
752.18	2.63	753.20	4.63	754.22	6.00		
752.20	2.67	753.22	4.66	754.24	6.03		

**Franklin Spec\_Drainage**

Prepared by Hewlett-Packard Company

HydroCAD® 10.00-19 s/n 08421 © 2016 HydroCAD Software Solutions LLC

Post Development Bypass  
Type II 24-hr 100 yr Rainfall=5.88"

Printed 9/18/2017

Page 14

**Stage-Area-Storage for Pond 4P: Drainage Swales**

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
751.20	0	0	753.75	23,600	19,816
751.25	9	0	753.80	24,556	21,020
751.30	35	1	753.85	25,531	22,272
751.35	79	4	753.90	26,524	23,573
751.40	141	9	753.95	27,537	24,924
751.45	221	18	754.00	28,569	26,327
751.50	318	32	754.05	29,778	27,786
751.55	433	50	754.10	31,013	29,305
751.60	565	75	754.15	32,272	30,887
751.65	715	107	754.20	33,556	32,533
751.70	883	147	754.25	34,866	34,243
751.75	1,069	196	754.30	36,200	36,020
751.80	1,272	254	754.35	37,560	37,864
751.85	1,493	323	754.40	38,945	39,776
751.90	1,731	404	754.45	40,354	41,759
751.95	1,987	497	754.50	41,789	43,812
752.00	2,261	603	754.55	43,249	45,938
752.05	2,555	723	754.60	44,734	48,138
752.10	2,866	859	754.65	46,244	50,412
752.15	3,196	1,010	754.70	47,779	52,762
752.20	3,543	1,179	754.75	49,339	55,190
752.25	3,908	1,365	754.80	50,925	57,697
752.30	4,292	1,570	754.85	52,535	60,283
752.35	4,693	1,794	754.90	54,170	62,951
752.40	5,112	2,039	754.95	55,831	65,700
752.45	5,549	2,306	755.00	<b>57,516</b>	<b>68,534</b>
752.50	6,004	2,594			
752.55	6,477	2,906			
752.60	6,968	3,242			
752.65	7,476	3,603			
752.70	8,003	3,990			
752.75	8,547	4,404			
752.80	9,110	4,845			
752.85	9,690	5,315			
752.90	10,289	5,815			
752.95	10,905	6,345			
753.00	11,539	6,906			
753.05	12,210	7,499			
753.10	12,900	8,127			
753.15	13,610	8,790			
753.20	14,338	9,488			
753.25	15,085	10,224			
753.30	15,851	10,997			
753.35	16,636	11,809			
753.40	17,440	12,661			
753.45	18,263	13,553			
753.50	19,105	14,488			
753.55	19,966	15,464			
753.60	20,846	16,484			
753.65	21,745	17,549			
753.70	22,663	18,659			



## Trapezoidal Channel Flow Computations

Hoover Engineering Project No. 17-111  
 Project Direct Conveyors  
 Location Linville Way  
 Description Overflow Channel

By RRH  
 Date 11/13/17  
 Checked  
 Date

n = 0.035  
 B = 51.00 ft  
 z<sub>L</sub> = 2.00 ft:1 ft rise  
 z<sub>R</sub> = 2.00 ft:1 ft rise  
 S = 0.0164 ft/ft

Input Depth of Flow		
d =	0.352	ft
A =	18.20	sf
P <sub>w</sub> =	52.57	ft
R <sub>h</sub> =	0.35	ft
Q =	48.92	cfs
v =	2.69	ft/s

Input Flow Rate		
Q =	199.23	cfs
d =	0.82	ft
A =	42.89	sf
P <sub>w</sub> =	54.64	ft
R <sub>h</sub> =	0.78	ft
v =	4.64	ft/s

n = Manning's roughness coefficient  
 B = Bottom width of channel (ft)  
 z<sub>L</sub> = Slope of left bank (ft:1 ft rise)  
 z<sub>R</sub> = Slope of right bank (ft:1 ft rise)  
 S = Channel slope (ft/ft)  
 d = Flow depth (ft)  
 A = Cross sectional flow area (ft<sup>2</sup>)  
 P<sub>w</sub> = Wetted perimeter (ft)  
 R<sub>h</sub> = Hydraulic radius (ft)  
 Q = Flow rate (cfs)  
 v = Flow velocity (ft/s)  
 T = Top width of flow (ft)

$$Q = (1.49/n)(A)(R_h)^{2/3}(S)^{1/2}$$

$$T = B + (z_L d) + (z_R d)$$

$$A = (d)[(B + T)/2]$$

$$P_w = B + [d^2 + (z_L d)^2]^{1/2} + [d^2 + (z_R d)^2]^{1/2}$$

$$R_h = A/P_w$$

$$v = Q/A$$

n source: