Stormwater Drainage Technical Report

Primary Plat
I-65 South Commerce Park

August 11, 2022

Prepared by:
Studio A of Indianapolis, Inc.
9511 East 96th Street
Indianapolis, IN 46256

Site Development
Landscape Architecture
Environmental Documents

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FIGURES

1.0. PROJECT SUMMARY

Purpose:	Master Drainage Report – Primary PLAT
Project Name:	I-65 South Commerce Park
Location:	East and adjacent Jim Black Road / North and adjacent SR-44
Regulatory Jurisdiction:	City of Franklin
Water Quality Treatment:	Wet Pond BMPs
Receiving Body:	Amity Ditch

2.0. INTRODUCTION

Studio A of Indianapolis, Inc. has completed a Primary PLAT to establish 9 lots across approximately 543 acres for the development of general warehouse use with associated parking, drives, and stormwater management.

Amity Ditch runs through the site for approximately 7,800 feet providing a convenient outlet for the various wet ponds which will serve the 9 lots. A substantial hurdle associated with the site is the presence of large areas of regulatory floodplain in the southeastern portion of the site. Prior to the development of these portions of the site, a letter of map revision will be obtained from the FEMA upon concurrence of the IDNR of proposed changes to Amity Ditch. Details of the proposed widening of the Ditch were performed by Christopher B. Burke Engineering and are included as Appendix ‘C’.

The purpose of this reporting is to demonstrate that the development plan for the SITE is in compliance with the General Drainage Standards for the City of Franklin. The aerial photograph shown on Figure 1 illustrates the SITE location of all 543 acres, along with the Ditch location, and provides land use and context for the development.

Existing conditions are discussed in Section 3.0, while a discussion of the proposed conditions and stormwater design are discussed in Section 4.0.

3.0. EXISTING CONDITIONS

The existing site covers 543 acres as depicted on Figure 1. As shown on the Figure, the site consists nearly exclusively of row crops. The west and east sides of the site drain overland via natural topography towards Amity Ditch. The Owen Tile Legal Drain also helps the southwestern areas of the site drain to the Ditch. Also identified on Figure 1 is an approximately 44 acre offsite watershed at the headwaters of Amity Ditch which drain onto the northwest corner of the site by culvert beneath Jim Black Road.

As provided on Figure 2, FEMA identifies substantial portions of the Amity Ditch overbank to be considered Zone 'A' floodplain. Additionally, any activity in the lower 1,900 feet of the Ditch is regulated by the IDNR.

As provided on Figure 3, the USDA identifies a typical anticipated mix of Brookston, Crosby, and Miami silt loams. These soils behave as poorly drained 'C' and 'D' type soils in an undrained condition, but demonstrate higher initial abstractions once established in a drained condition.

Hydrograph methods based upon TR-20 have been used to develop peak discharges from the site. The HydroCAD has been loaded with storm depths and distributions as prescribed by the City of Franklin Stormwater Management Ordinance. Details of the hydrologic input and output can be viewed in Appendix 'B'. A summary of peak rates is provided in Table 1, below:

Table 1: Existing Peak Flow Matrix

EX	Runoff (cfs)
2YR1HR	**241.20**
2YR2HR	197.19
2YR30MIN	196.19
10YR1HR	**515.87**
10YR2HR	435.93
10YR30MIN	463.36
100YR1HR	**916.83**
100YR2HR	786.36
100YR30MIN	850.53

4.0. PROPOSED SYSTEM DESIGN

Storm Routing and Detention

Figure 4 provides the overall conceptual layout of the warehouse buildings, parking, and detention ponds across the 9 platted lots. The flow arrows indicate that via interconnected wet ponds, each developed area will be routed generally by storm sewer to its respective wet pond in route to discharge into the Amity Ditch.

First, in order to determine adequate pond storage regarding a conceptual layout, it is necessary to prescribe a maximum allowable imperviousness of each lot. For the I-65 South Commerce Park, the **maximum allowable imperviousness shall be 85%**. For runoff curve numbers, a CN of 94 will be used in hydrologic computations.
Second, the available area for detention must be aggregated. For modeling purposes, this is partitioned into two main areas; lots westerly of Amity Ditch, and those easterly of Amity Ditch.

The Lots 1,2,3,4, and 5, totaling 270.8 acres (less dedicated right-of-way) will be served by 5 wet ponds totaling 14.1 acres at normal pool, with a top of bank footprint totaling 39.6 acres. Due to the requirement of substantial overbank fill in the lower reaches of Amity Ditch, more wet pond area will be created in the easterly Lots 6,7,8, and 9. Specifically, this 254.8 acre section (less dedicated right-of-way) will be served by a total of 32.2 acres at normal pool, with a top of bank footprint totaling 57.4 acres.

As detailed in Appendix ‘B’, attenuating runoff to those allowed by Standard results in an average staging depth of only 3.5 feet for the westerly ponds and 2.6 feet for the easterly ponds during the most demanding 100 year event. Actual results may very as the detailed outlets and designs are finished, but the goal of this master drainage report is to demonstrate adequate storage available. Proposed pond dynamics for this sample run executed with the HydroCAD model are summarized in Table 2, below:

Table 2: Proposed Detention Capability

	Allowable Release Rate (cfs)	Modeled Release Rate (cfs)	Average West Pond Stage (ft)	Average East Pond Stage (ft)
10 YR	241.20	48.29	2.6	1.8
100 YR	515.87	65.68	3.5	2.6

As seen above, constricting the release rate far below that allowed requires only moderate pond staging. Therefore, the platted layout and pond distribution is adequate for stormwater detention requirements.

Existing FEMA SFHA

The substantial Flood Hazard Area identified by FEMA must be addressed prior to a feasible development of Lots 5,6 and 8. As viewable in Appendix 'C', it is proposed to transform the Amity Ditch cross-section into a wider two-stage ditch cross-section. Preliminary modeling indicates that the improved cross-section will allow the infill of existing overbank areas and result in a reduction in regulatory 100 year flood elevations. The construction of the two-stage ditch will also generate much needed fill to achieve a developable pad elevation on the noted lots.

Offsite Flow

As shown on Figure 1, approximately 44 acres are discharged onto the site from the west under Jim Black Road. This flow will not be routed through the site detention system. Rather, the proposed Amity Ditch will be formerly extended west so that the offsite flow can bypass the development and discharge directly to the proposed two-stage ditch. This ditch extension is proposed with the development of Lots 1 and 2; forecast to be the first developed Lots.

Water Quality

As noted in the Introduction, water quality treatment for the site will be accomplished through the use of wet detention pond BMPs. Given the magnitude of wet pond area proposed, and the fill necessary for site development, the aggregate pond volume beneath normal pool is expected to far exceed that necessary per Standard.

The other primary requirement for the water quality volume is that it be discharged in an extended fashion. Given the limited staging values computed above, this requirement is expected to be attainable without compromising required storage volume.

AMITY DITCH OPEN DRAIN

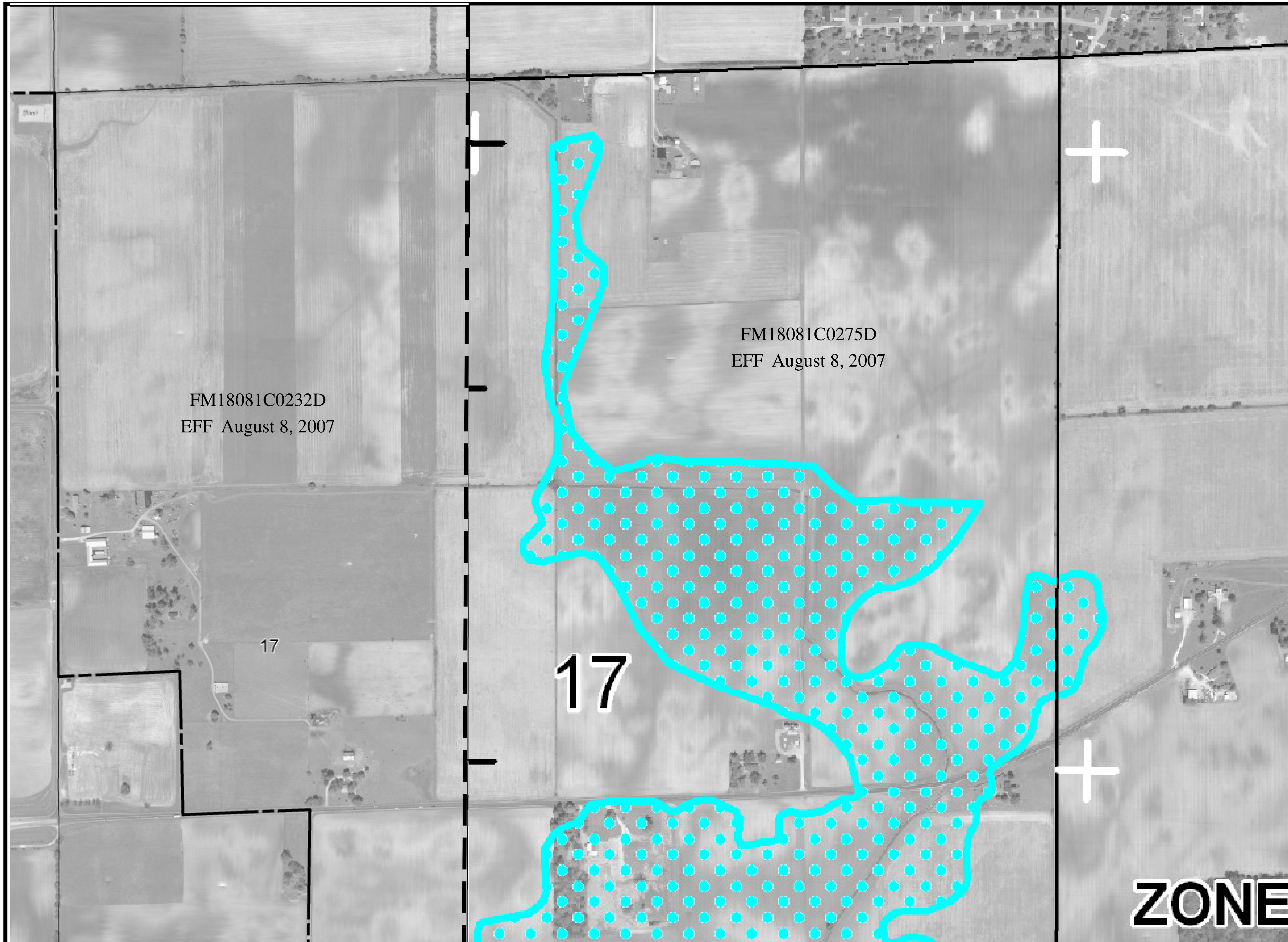
OWEN TILE LEGAL DRAIN

Prepared by:
Studio A of Indianapolis, Inc.

OVERALL SITE LOCATION

I-65 South Commerce Park
Aerial Mapping and Property Boundary
JOHNSON COUNTY, INDIANA

Figure 1



Prepared by:
Studio A of Indianapolis, Inc.

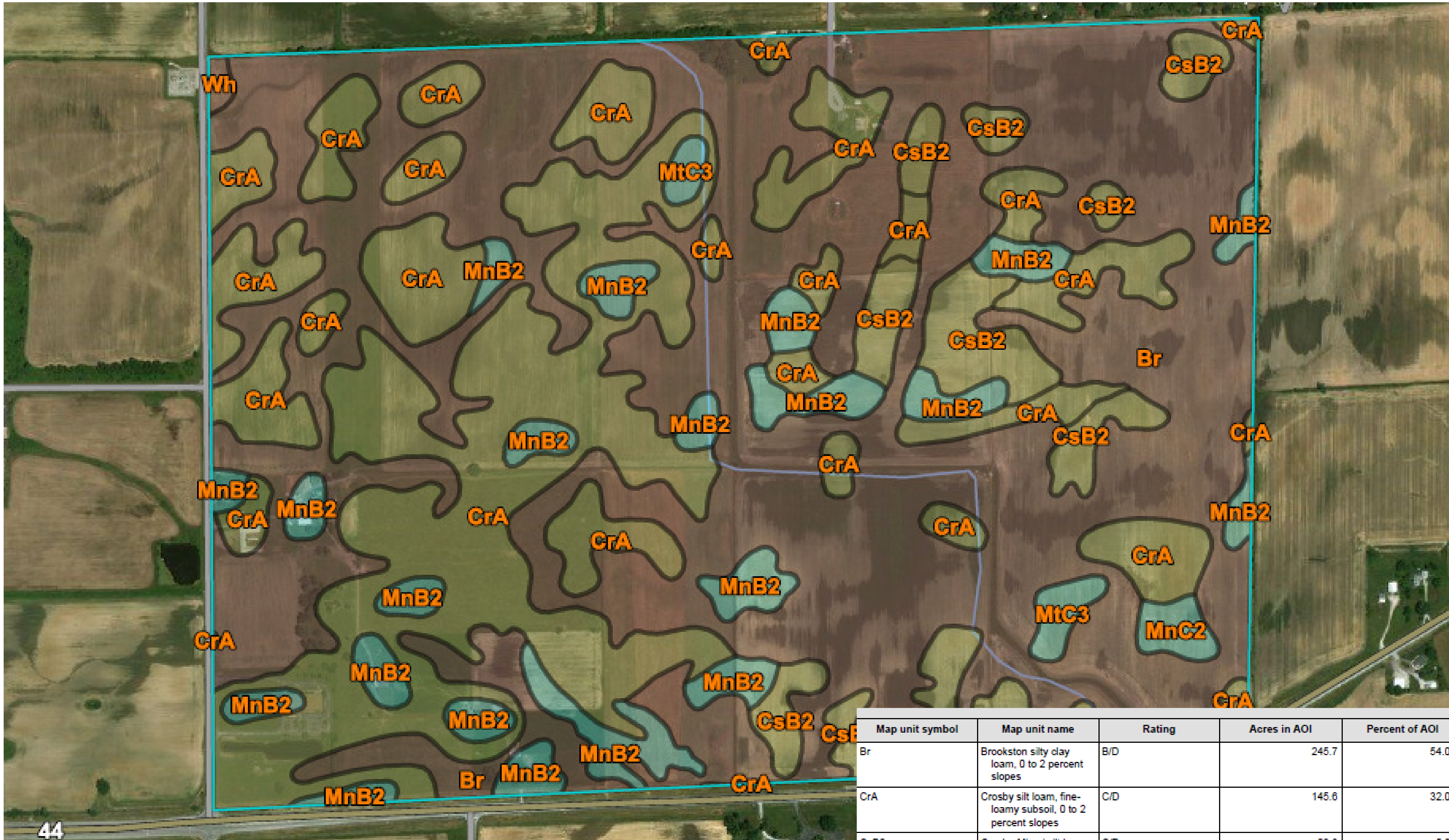
FEMA FIRM

I-65 South Commerce Park

NRCS SOIL MAPPING

JOHNSON COUNTY, INDIANA

Figure 2



Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D

N

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Br	Brookston silty clay loam, 0 to 2 percent slopes	B/D	245.7	54.0%
CrA	Crosby silt loam, fine-loamy subsoil, 0 to 2 percent slopes	C/D	145.6	32.0%
CsB2	Crosby-Miami silt loams, 2 to 4 percent slopes, eroded	C/D	23.6	5.2%
MnB2	Miami silt loam, 2 to 6 percent slopes, eroded	C	33.9	7.5%
MnC2	Miami silt loam, 6 to 12 percent slopes, eroded	C	2.3	0.5%
MtC3	Miami clay loam, 6 to 12 percent slopes, severely eroded	C	3.4	0.7%
Wh	Whitaker silt loam, 0 to 2 percent slopes	B/D	0.7	0.2%
Totals for Area of Interest			455.1	100.0%

Prepared by:
Studio A of Indianapolis, Inc.

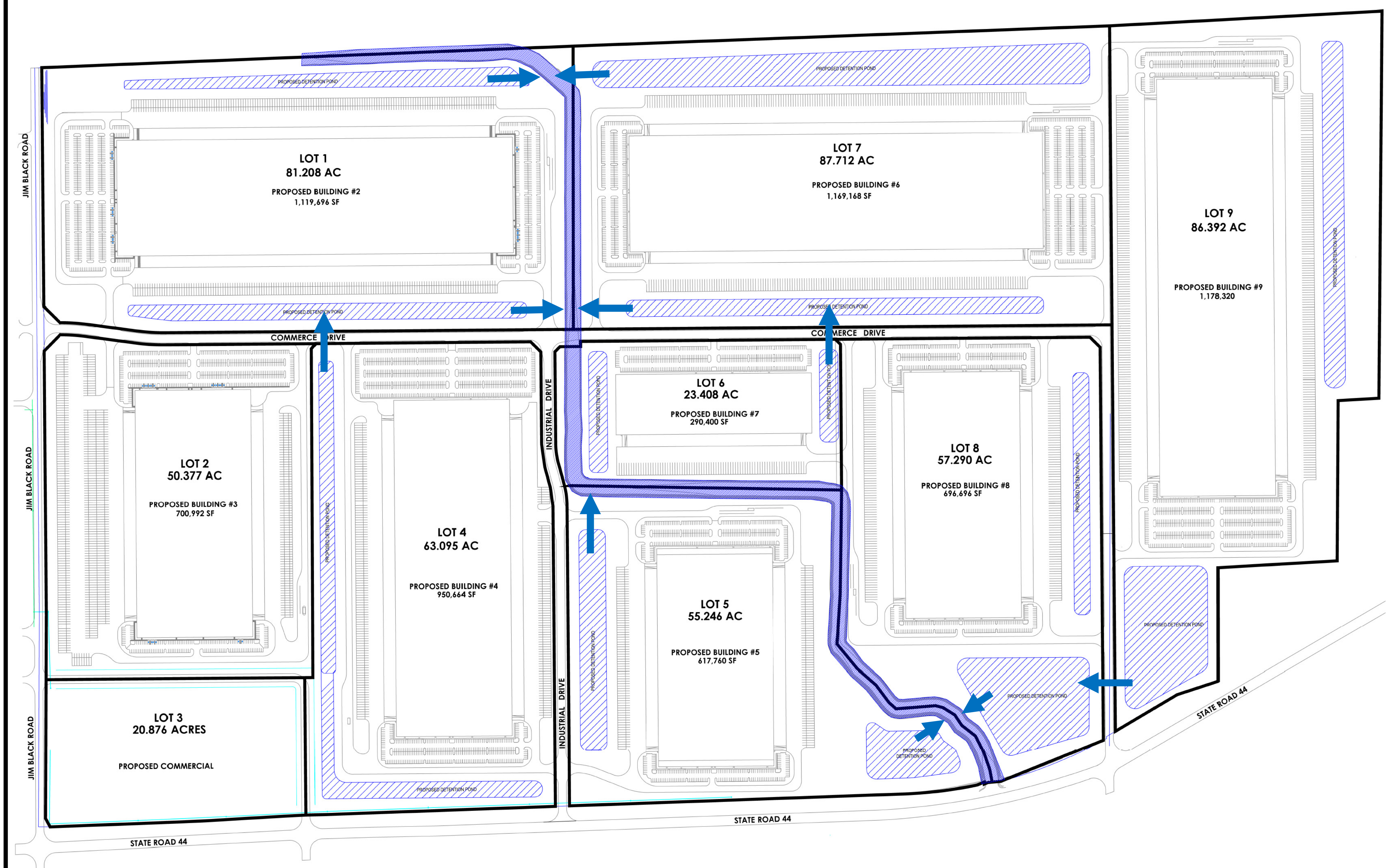
USDA Soil Mapping

I-65 South Commerce Park

NRCS SOIL MAPPING

JOHNSON COUNTY, INDIANA

Figure 3



Prepared by:
Studio A of Indianapolis, Inc.

Proposed Delineation and Routing

I-65 South Commerce Park

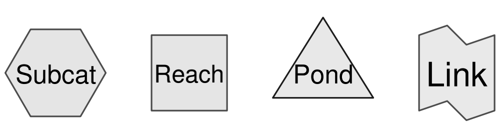
JOHNSON COUNTY, INDIANA

Figure 4

Appendix A

Existing Condition Peak Runoff Analysis

I-65 Commerce Park PLAT Lots 1-9



Routing Diagram for I-65 Master Draiange
Prepared by Studio A, Printed 7/3/2022

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
47.223	85	Row crops, straight row, Good, HSG C (71S)
495.567	89	Row crops, straight row, Good, HSG D (71S)

Summary for Subcatchment 71S: DA EX

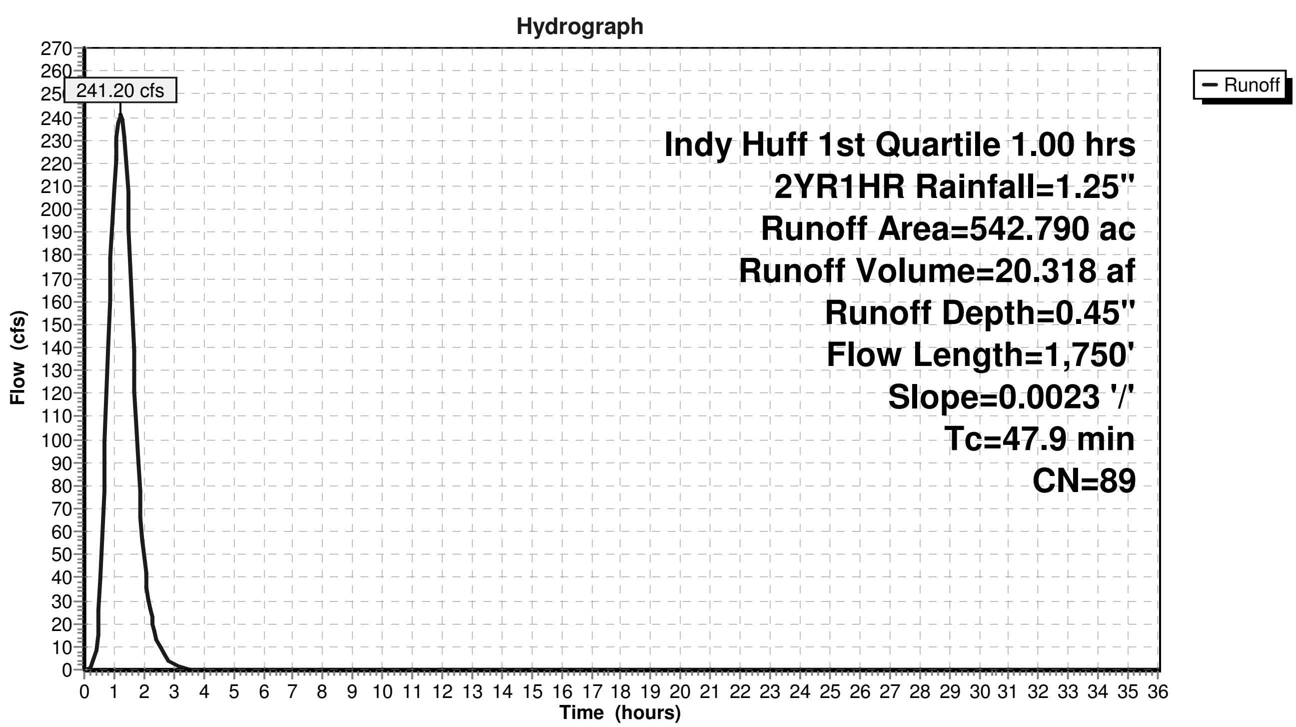
Runoff = 241.20 cfs @ 1.23 hrs, Volume= 20.318 af, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 1.00 hrs 2YR1HR Rainfall=1.25"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component**
					Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow**
					Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

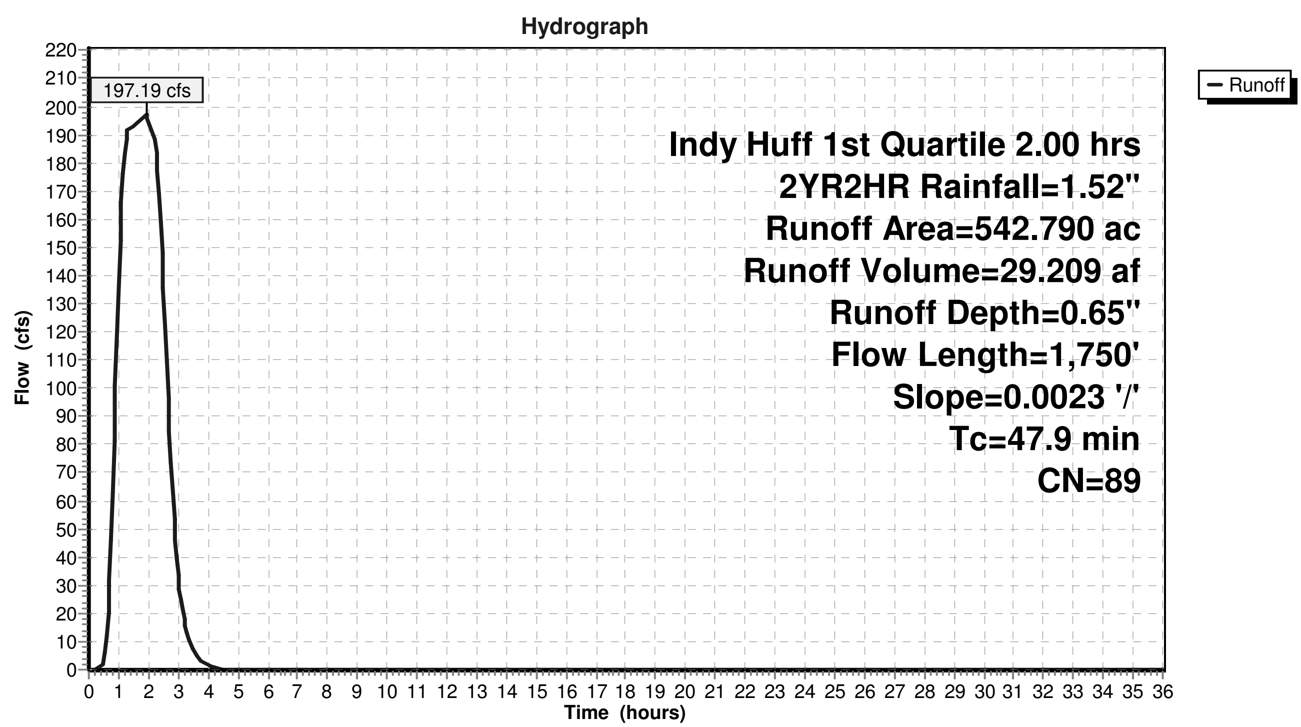
Runoff = 197.19 cfs @ 1.93 hrs, Volume= 29.209 af, Depth= 0.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 2.00 hrs 2YR2HR Rainfall=1.52"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component** Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

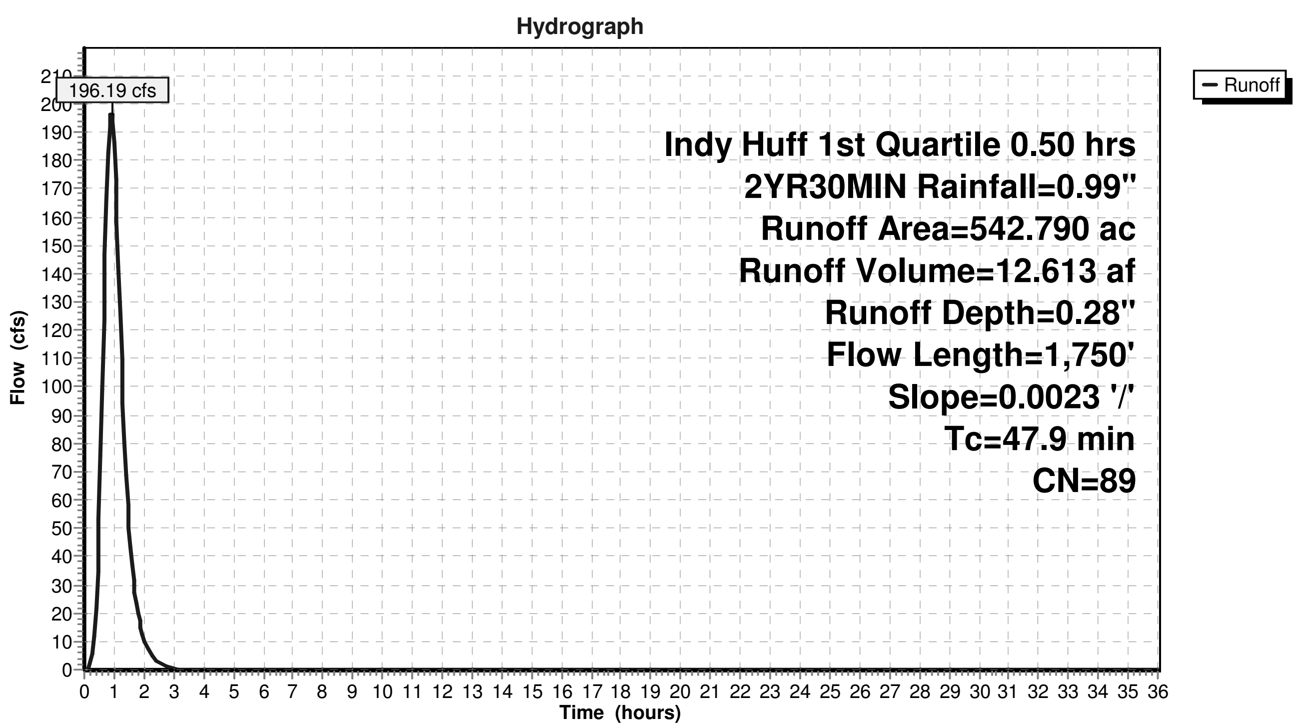
Runoff = 196.19 cfs @ 0.91 hrs, Volume= 12.613 af, Depth= 0.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 0.50 hrs 2YR30MIN Rainfall=0.99"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component** Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

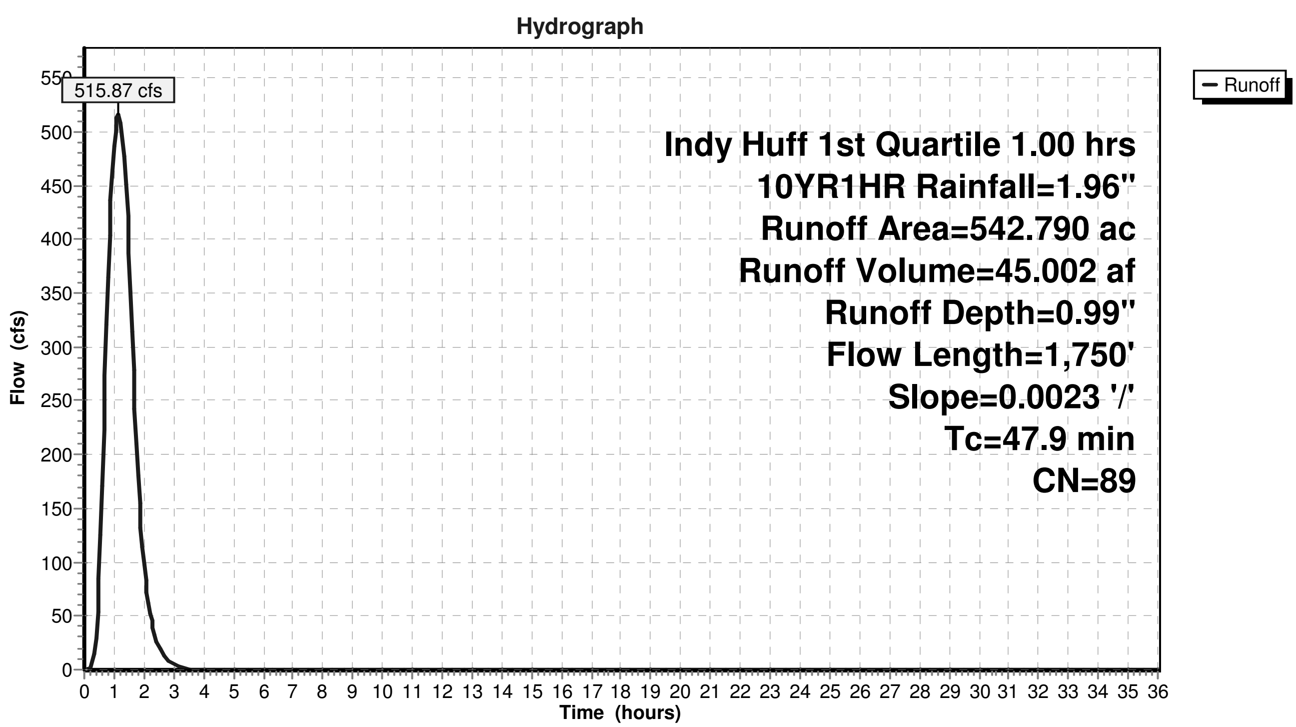
Runoff = 515.87 cfs @ 1.16 hrs, Volume= 45.002 af, Depth= 0.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 1.00 hrs 10YR1HR Rainfall=1.96"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component**
					Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow**
					Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

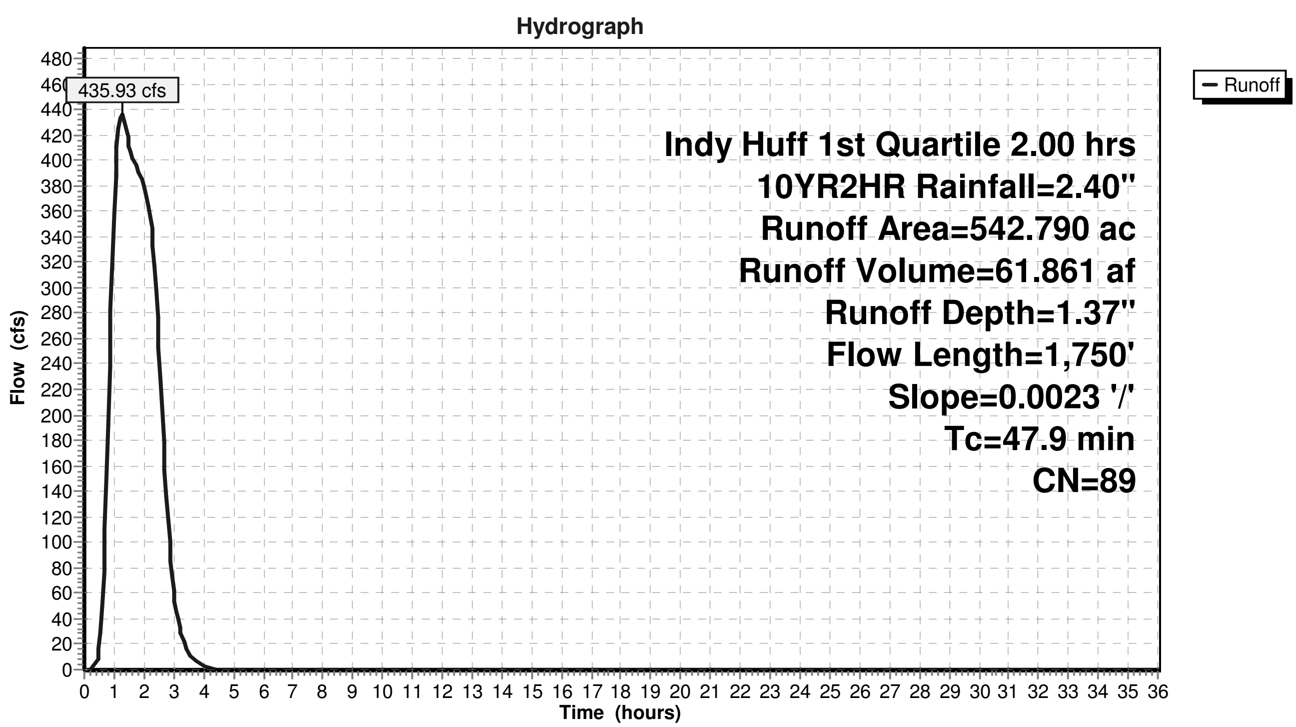
Runoff = 435.93 cfs @ 1.25 hrs, Volume= 61.861 af, Depth= 1.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 2.00 hrs 10YR2HR Rainfall=2.40"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component**
					Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow**
					Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

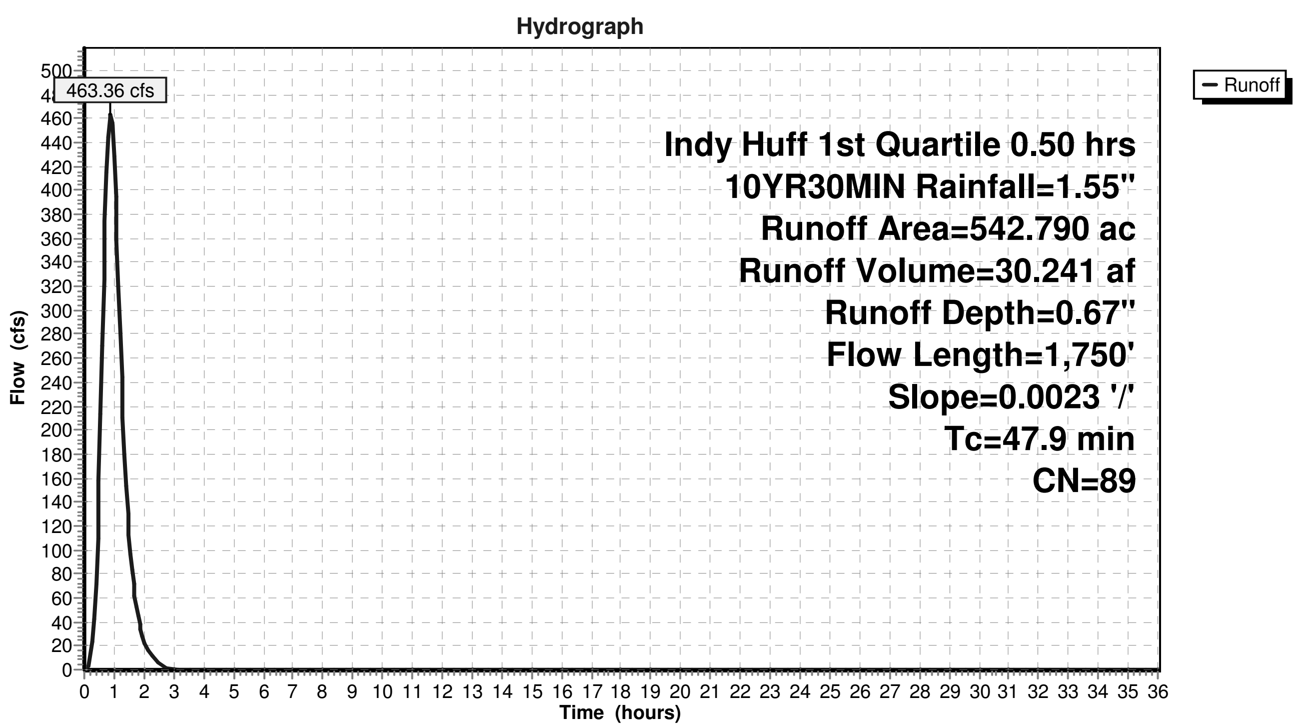
Runoff = 463.36 cfs @ 0.88 hrs, Volume= 30.241 af, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 0.50 hrs 10YR30MIN Rainfall=1.55"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component**
					Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow**
					Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

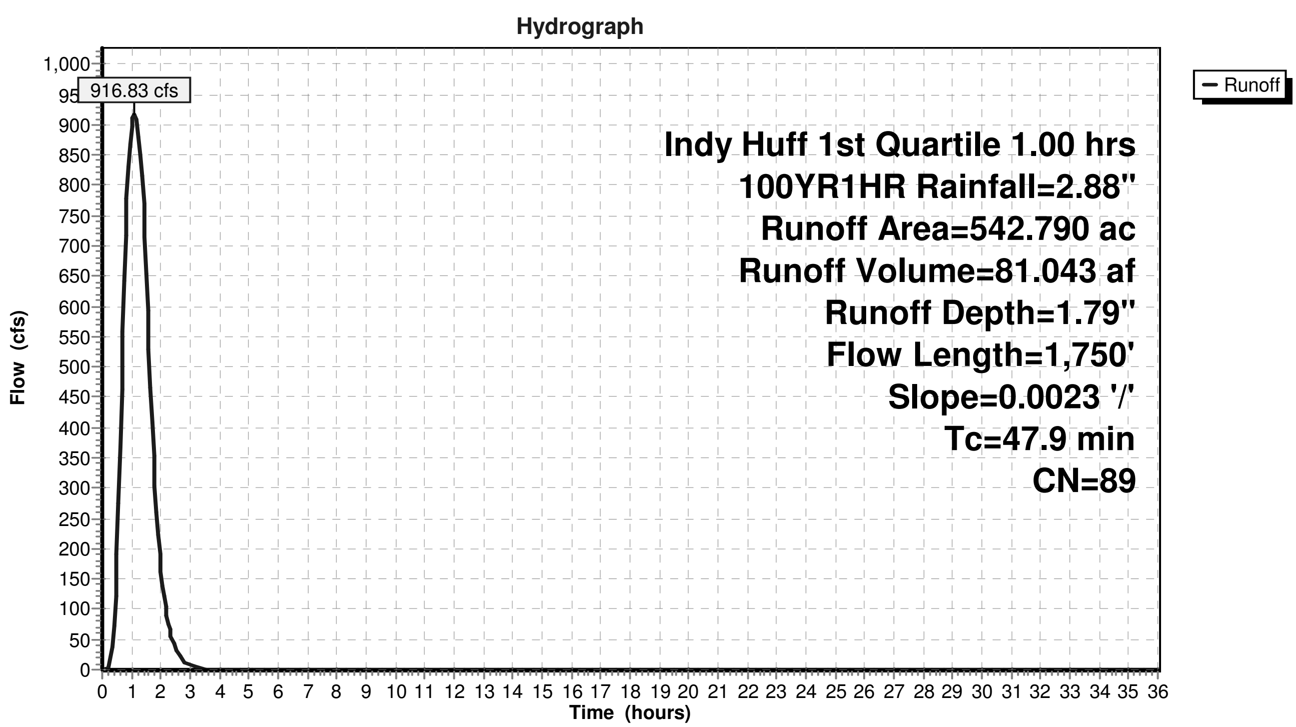
Runoff = 916.83 cfs @ 1.10 hrs, Volume= 81.043 af, Depth= 1.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 1.00 hrs 100YR1HR Rainfall=2.88"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component**
					Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow**
					Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

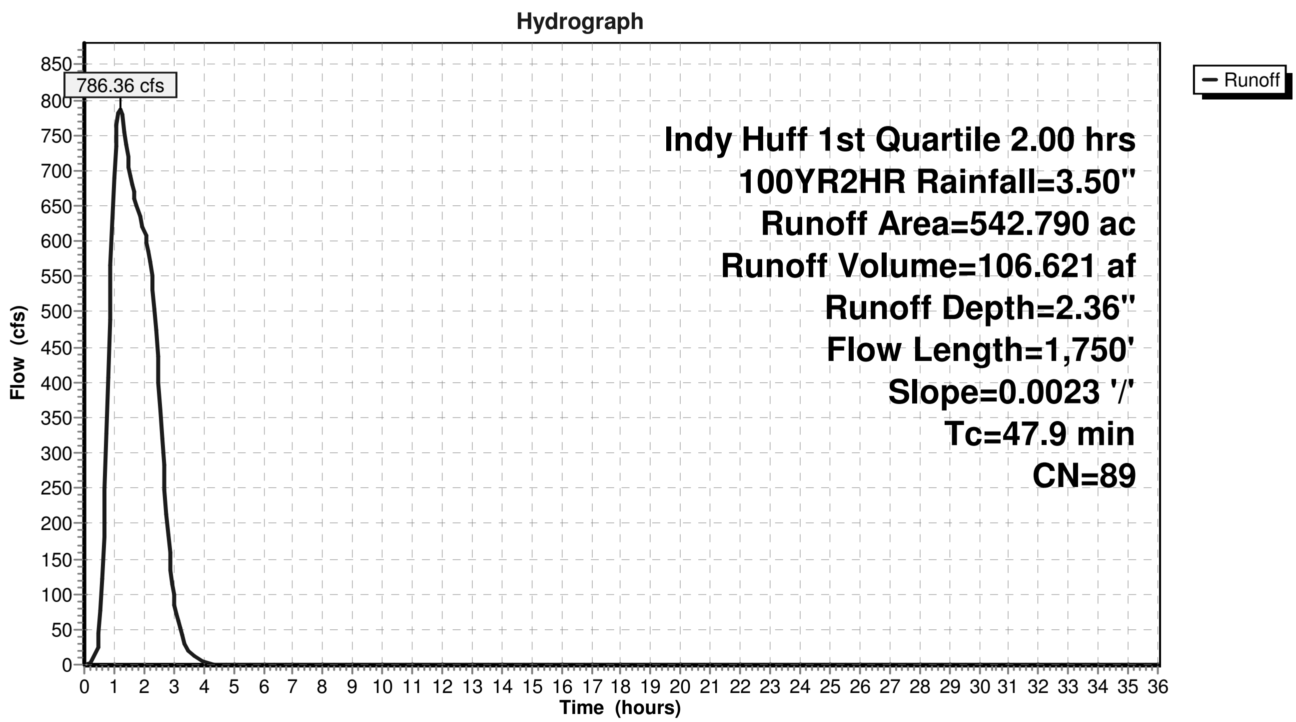
Runoff = 786.36 cfs @ 1.20 hrs, Volume= 106.621 af, Depth= 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 2.00 hrs 100YR2HR Rainfall=3.50"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component** Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow** Unpaved Kv= 16.1 fps
47.9	1,750	Total			

Subcatchment 71S: DA EX



Summary for Subcatchment 71S: DA EX

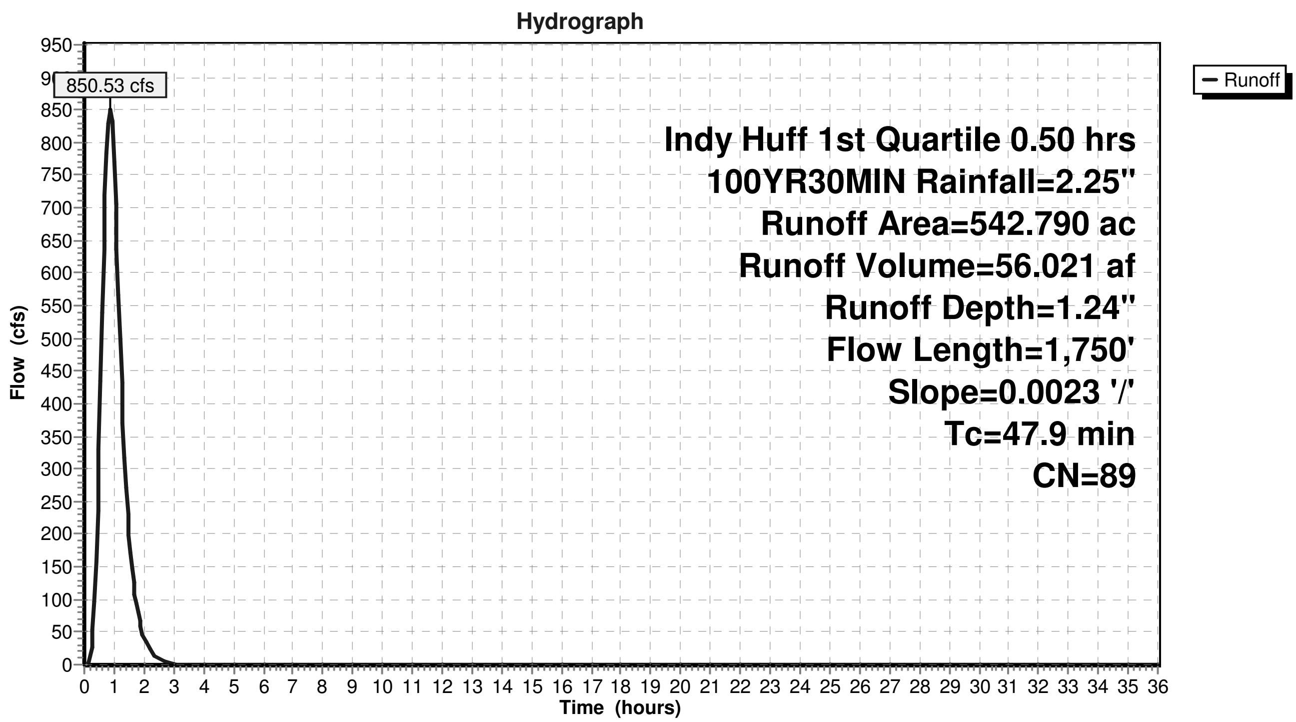
Runoff = 850.53 cfs @ 0.87 hrs, Volume= 56.021 af, Depth= 1.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 1st Quartile 0.50 hrs 100YR30MIN Rainfall=2.25"

Area (ac)	CN	Description
47.223	85	Row crops, straight row, Good, HSG C
495.567	89	Row crops, straight row, Good, HSG D
542.790	89	Weighted Average
542.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0023	0.14		**Sheet Flow, Sheet Component**
					Cultivated: Residue<=20% n= 0.060 P2= 2.64"
35.6	1,650	0.0023	0.77		**Shallow Concentrated Flow, Shallow**
					Unpaved Kv= 16.1 fps
47.9	1,750	Total			

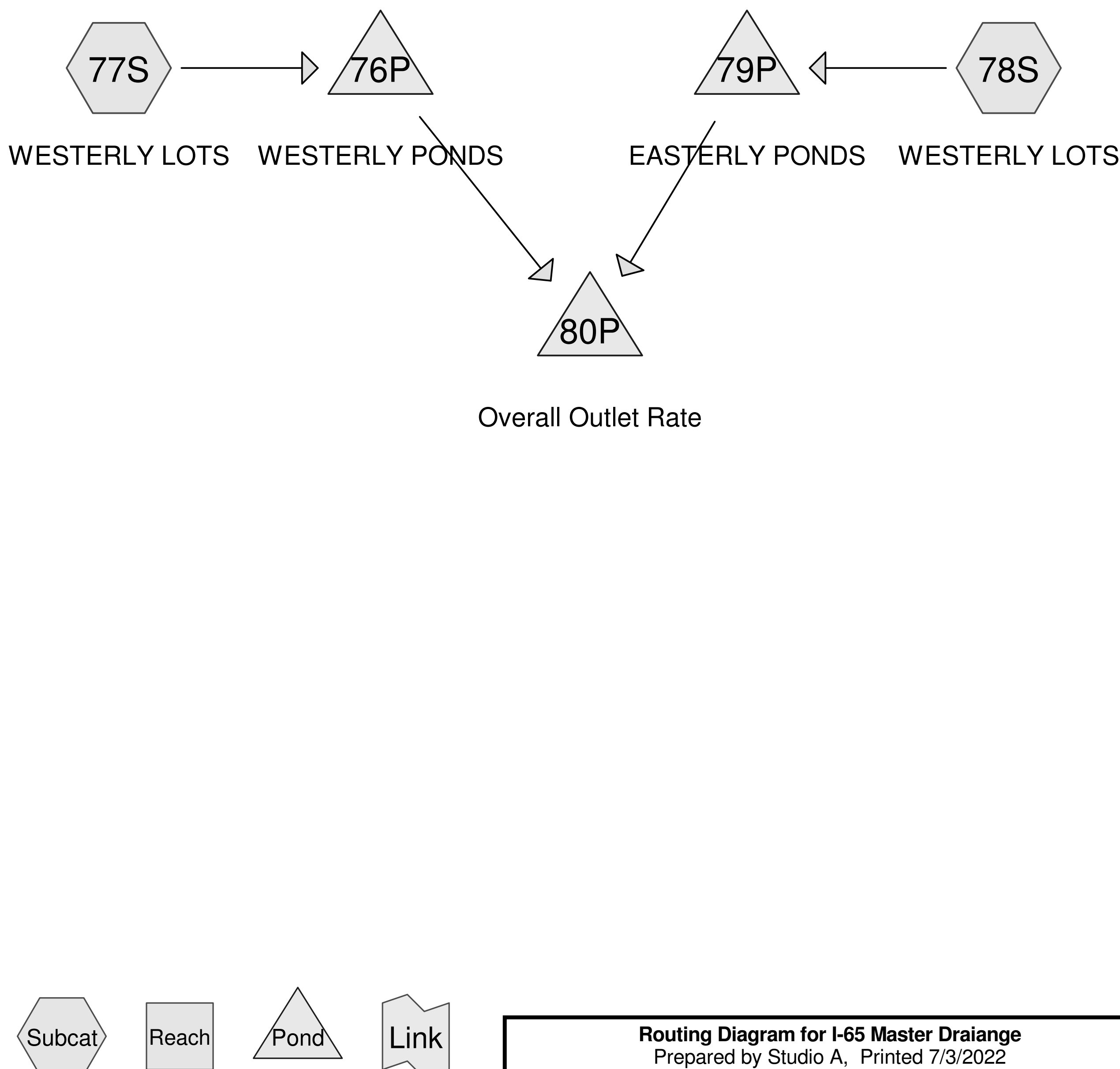
Subcatchment 71S: DA EX



Appendix B

Proposed Condition Aggregate Staging and Release Rate

I-65 Commerce Park PLAT Lots 1-9



Routing Diagram for I-65 Master Draiange
Prepared by Studio A, Printed 7/3/2022
HydroCAD® 10.00-22 s/n 10388 © 2018 HydroCAD Software Solutions LLC

Summary for Subcatchment 77S: WESTERLY LOTS

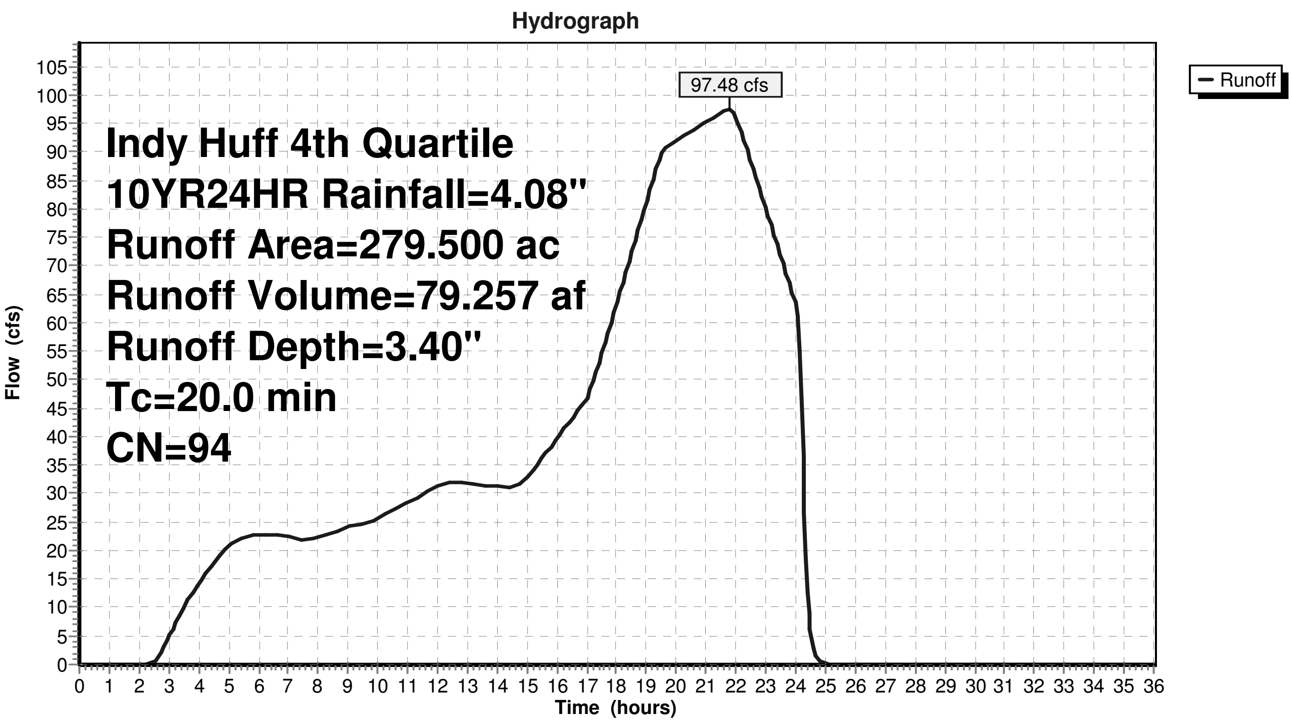
Runoff = 97.48 cfs @ 21.77 hrs, Volume= 79.257 af, Depth= 3.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 4th Quartile 10YR24HR Rainfall=4.08"

	Area (ac)	CN	Description
*	81.208	94	LOT1
*	50.377	94	LOT2
*	20.876	94	LOT3
*	63.095	94	LOT4
*	55.246	94	LOT5
*	8.698	94	ROW
	279.500	94	Weighted Average
	279.500		100.00% Pervious Area

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

Subcatchment 77S: WESTERLY LOTS



Summary for Subcatchment 78S: WESTERLY LOTS

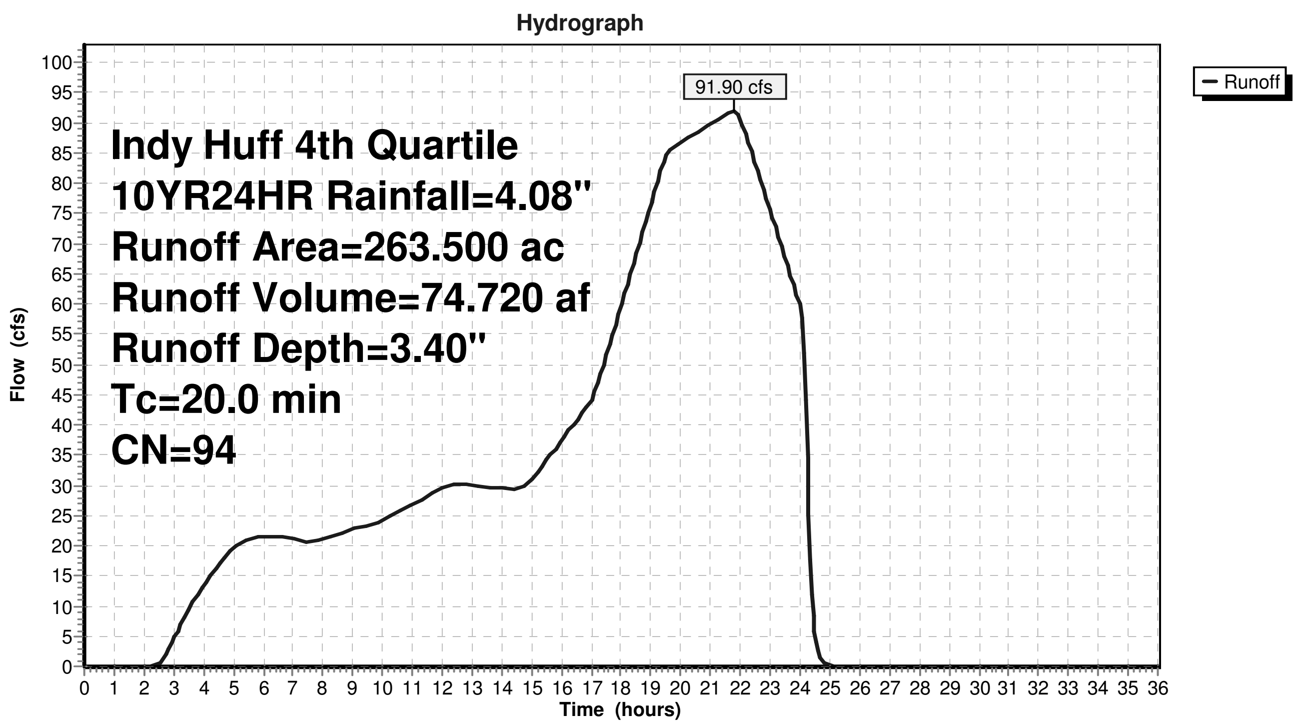
Runoff = 91.90 cfs @ 21.77 hrs, Volume= 74.720 af, Depth= 3.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 4th Quartile 10YR24HR Rainfall=4.08"

	Area (ac)	CN	Description
*	23.408	94	LOT6
*	87.712	94	LOT7
*	57.290	94	LOT8
*	86.392	94	LOT9
*	8.698	94	ROW
	263.500	94	Weighted Average
	263.500		100.00% Pervious Area

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

Subcatchment 78S: WESTERLY LOTS



Summary for Pond 76P: WESTERLY PONDS

Inflow Area = 279.500 ac, 0.00% Impervious, Inflow Depth = 3.40" for 10YR24HR event
Inflow = 97.48 cfs @ 21.77 hrs, Volume= 79.257 af
Outflow = 41.50 cfs @ 24.23 hrs, Volume= 54.779 af, Atten= 57%, Lag= 147.3 min
Primary = 41.50 cfs @ 24.23 hrs, Volume= 54.779 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 718.57' @ 24.23 hrs Surf.Area= 27.187 ac Storage= 53.042 af

Plug-Flow detention time= 594.2 min calculated for 54.703 af (69% of inflow)
Center-of-Mass det. time= 449.9 min (1,470.0 - 1,020.1)

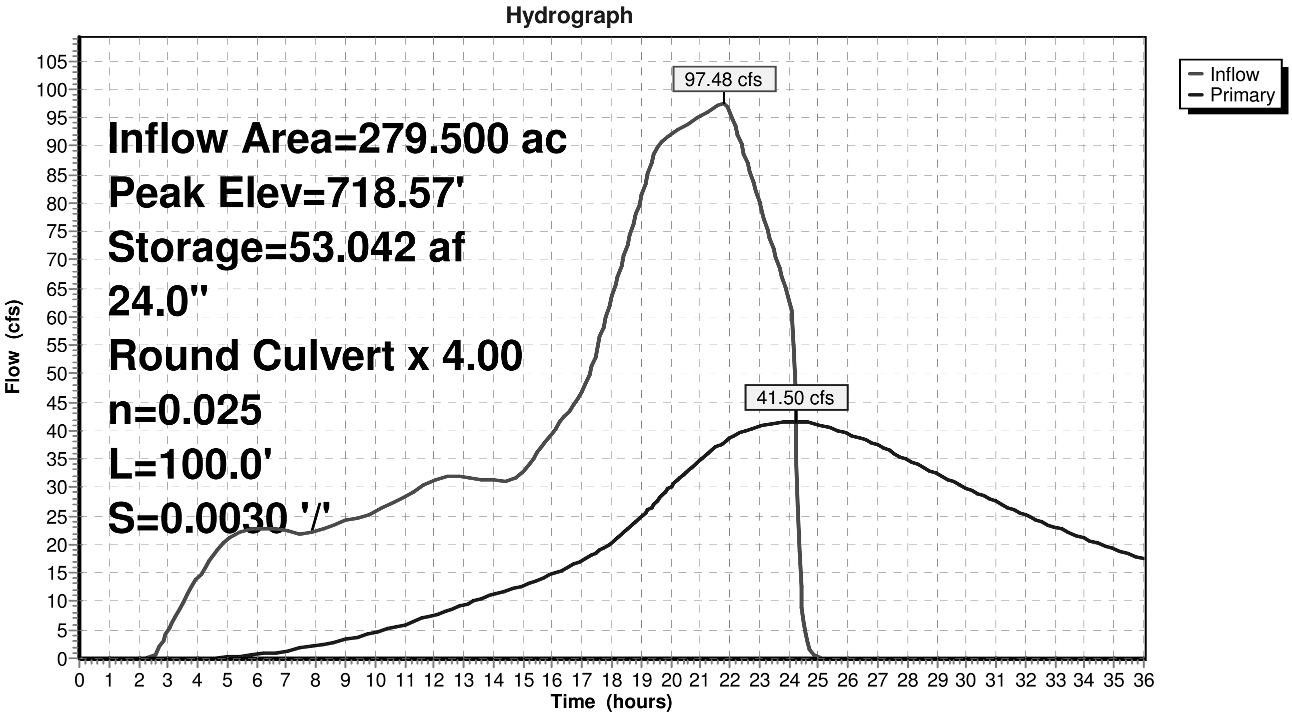
Volume	Invert	Avail.Storage	Storage Description
#1	716.00'	134.137 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
716.00	14.081	0.000	0.000
721.00	39.574	134.137	134.137

Device	Routing	Invert	Outlet Devices
#1	Primary	716.00'	**24.0" Round Culvert X 4.00** L= 100.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 716.00' / 715.70' S= 0.0030 '/' Cc= 0.900 n= 0.025, Flow Area= 3.14 sf

Primary OutFlow Max=41.50 cfs @ 24.23 hrs HW=718.57' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 41.50 cfs @ 3.34 fps)

Pond 76P: WESTERLY PONDS



Summary for Pond 79P: EASTERLY PONDS

Inflow Area = 263.500 ac, 0.00% Impervious, Inflow Depth = 3.40" for 10YR24HR event
Inflow = 91.90 cfs @ 21.77 hrs, Volume= 74.720 af
Outflow = 6.81 cfs @ 24.48 hrs, Volume= 8.923 af, Atten= 93%, Lag= 162.6 min
Primary = 6.81 cfs @ 24.48 hrs, Volume= 8.923 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 717.79' @ 24.48 hrs Surf.Area= 43.855 ac Storage= 71.812 af

Plug-Flow detention time= 1,252.5 min calculated for 8.911 af (12% of inflow)
Center-of-Mass det. time= 606.3 min (1,626.4 - 1,020.1)

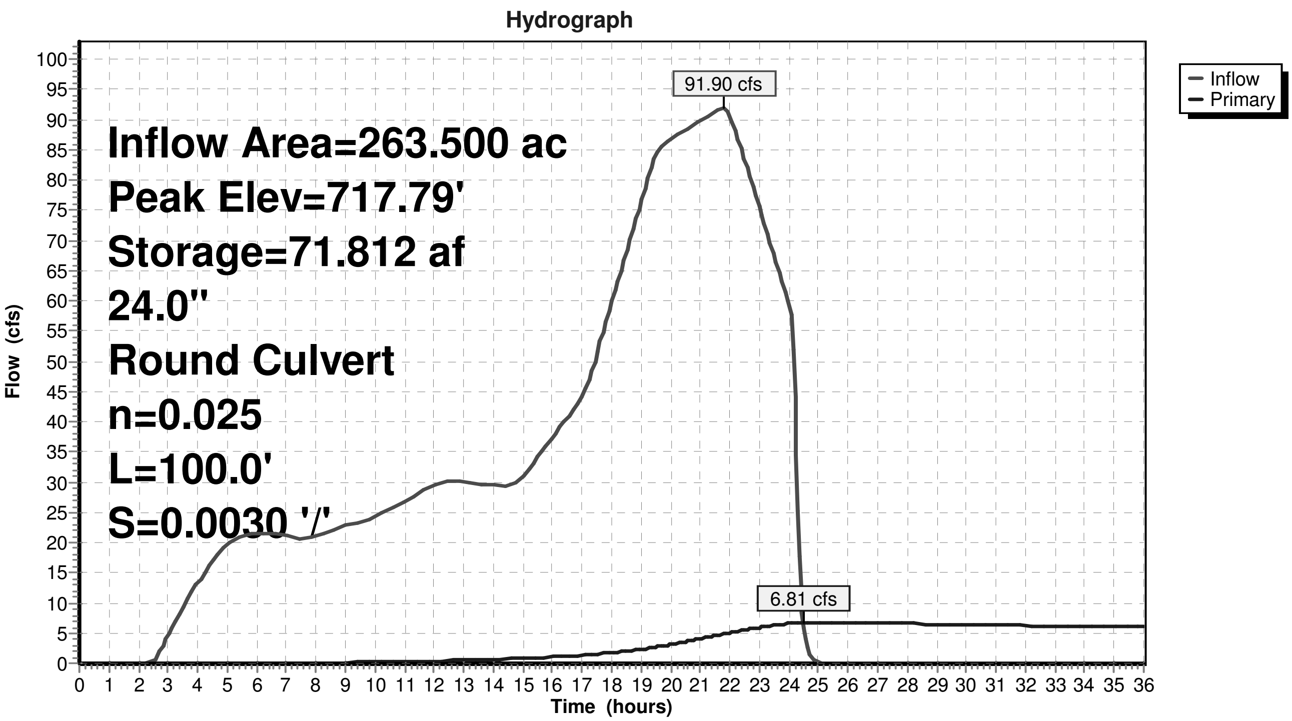
Volume	Invert	Avail.Storage	Storage Description
#1	716.00'	234.245 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
716.00	36.267	0.000	0.000
721.00	57.431	234.245	234.245

Device	Routing	Invert	Outlet Devices
#1	Primary	716.00'	**24.0" Round Culvert** L= 100.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 716.00' / 715.70' S= 0.0030 '/' Cc= 0.900 n= 0.025, Flow Area= 3.14 sf

Primary OutFlow Max=6.81 cfs @ 24.48 hrs HW=717.79' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 6.81 cfs @ 3.03 fps)

Pond 79P: EASTERLY PONDS

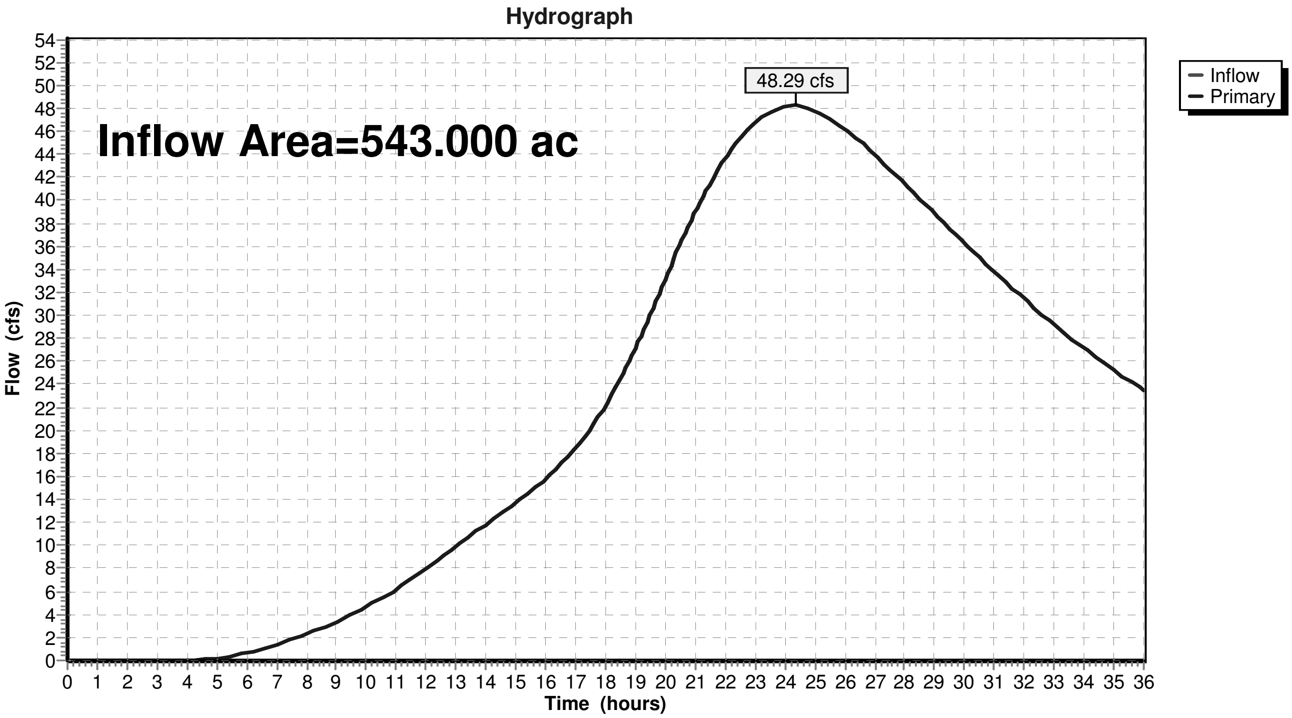


Summary for Pond 80P: Overall Outlet Rate

Inflow Area = 543.000 ac, 0.00% Impervious, Inflow Depth > 1.41" for 10YR24HR event
Inflow = 48.29 cfs @ 24.34 hrs, Volume= 63.702 af
Primary = 48.29 cfs @ 24.34 hrs, Volume= 63.702 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 80P: Overall Outlet Rate



Summary for Subcatchment 77S: WESTERLY LOTS

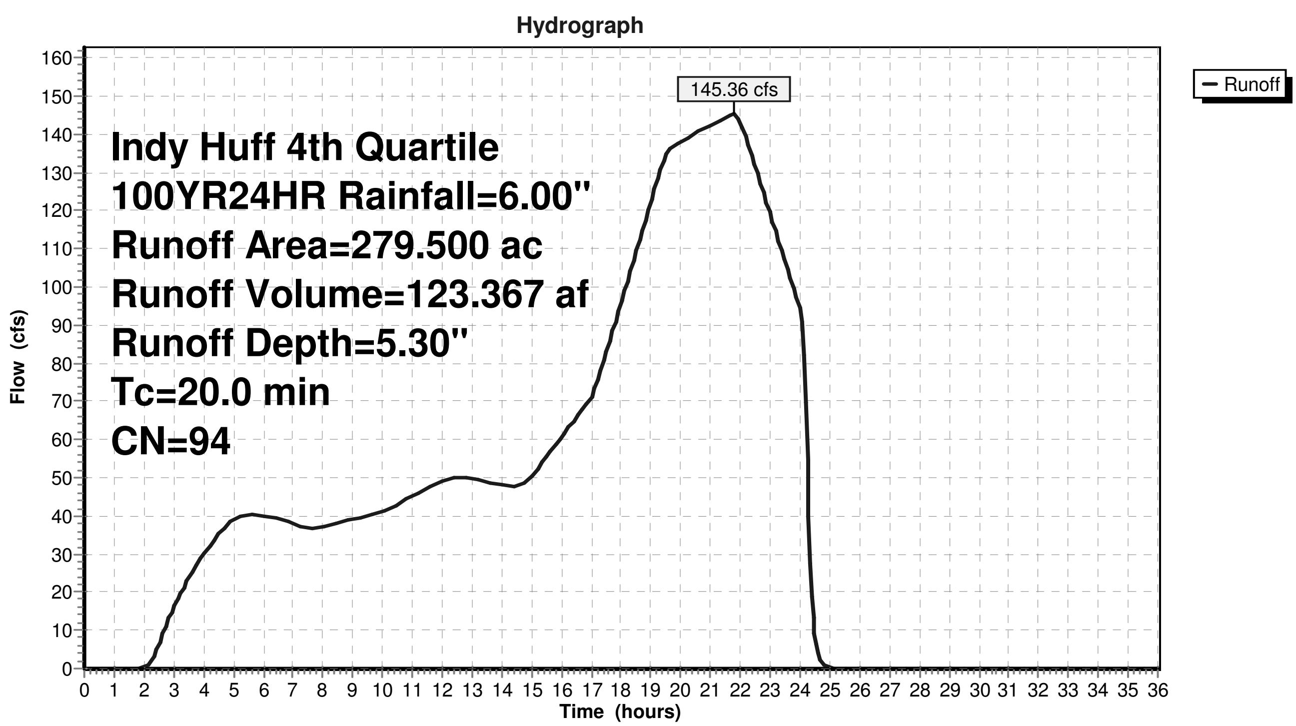
Runoff = 145.36 cfs @ 21.76 hrs, Volume= 123.367 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 4th Quartile 100YR24HR Rainfall=6.00"

	Area (ac)	CN	Description
*	81.208	94	LOT1
*	50.377	94	LOT2
*	20.876	94	LOT3
*	63.095	94	LOT4
*	55.246	94	LOT5
*	8.698	94	ROW
	279.500	94	Weighted Average
	279.500		100.00% Pervious Area

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

Subcatchment 77S: WESTERLY LOTS



Summary for Subcatchment 78S: WESTERLY LOTS

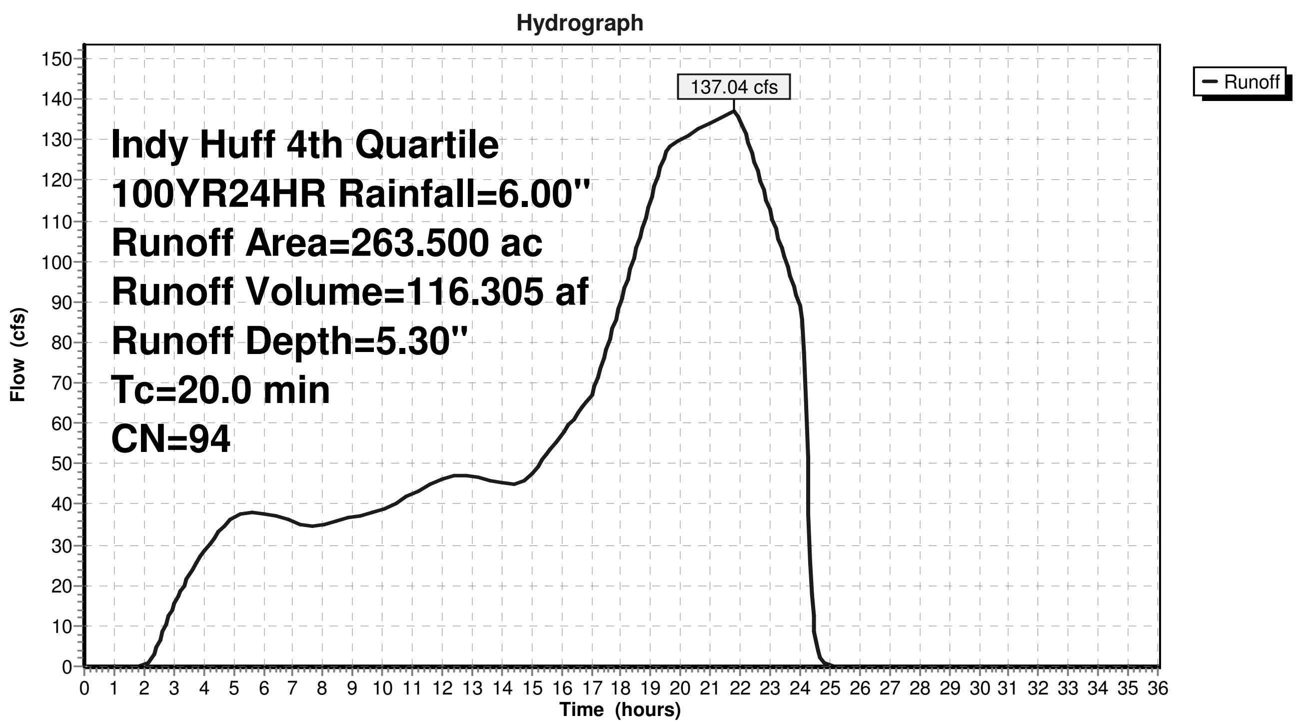
Runoff = 137.04 cfs @ 21.76 hrs, Volume= 116.305 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Indy Huff 4th Quartile 100YR24HR Rainfall=6.00"

	Area (ac)	CN	Description
*	23.408	94	LOT6
*	87.712	94	LOT7
*	57.290	94	LOT8
*	86.392	94	LOT9
*	8.698	94	ROW
	263.500	94	Weighted Average
	263.500		100.00% Pervious Area

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

Subcatchment 78S: WESTERLY LOTS



Summary for Pond 76P: WESTERLY PONDS

Inflow Area = 279.500 ac, 0.00% Impervious, Inflow Depth = 5.30" for 100YR24HR event
Inflow = 145.36 cfs @ 21.76 hrs, Volume= 123.367 af
Outflow = 55.36 cfs @ 24.25 hrs, Volume= 83.757 af, Atten= 62%, Lag= 148.9 min
Primary = 55.36 cfs @ 24.25 hrs, Volume= 83.757 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 719.54' @ 24.25 hrs Surf.Area= 32.134 ac Storage= 81.817 af

Plug-Flow detention time= 605.1 min calculated for 83.641 af (68% of inflow)
Center-of-Mass det. time= 445.5 min (1,442.4 - 996.9)

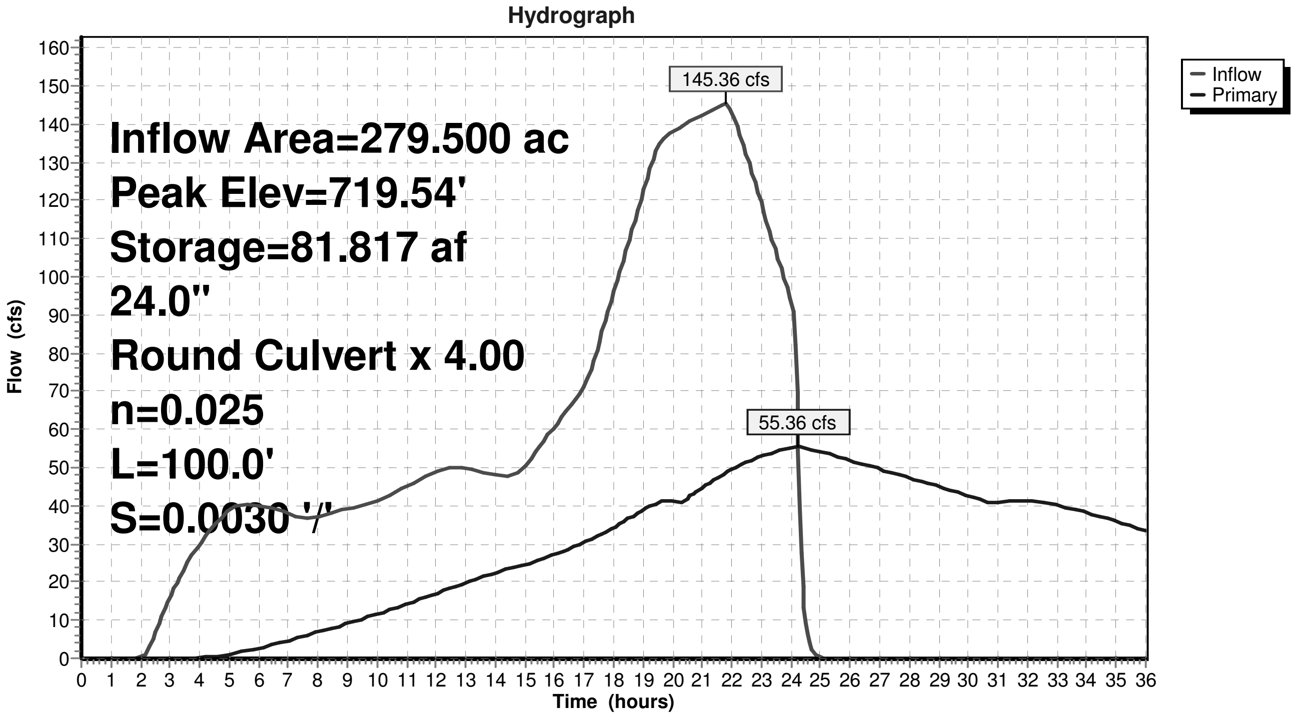
Volume	Invert	Avail.Storage	Storage Description
#1	716.00'	134.137 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
716.00	14.081	0.000	0.000
721.00	39.574	134.137	134.137

Device	Routing	Invert	Outlet Devices
#1	Primary	716.00'	**24.0" Round Culvert X 4.00** L= 100.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 716.00' / 715.70' S= 0.0030 '/' Cc= 0.900 n= 0.025, Flow Area= 3.14 sf

Primary OutFlow Max=55.35 cfs @ 24.25 hrs HW=719.54' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 55.35 cfs @ 4.40 fps)

Pond 76P: WESTERLY PONDS



Summary for Pond 79P: EASTERLY PONDS

Inflow Area = 263.500 ac, 0.00% Impervious, Inflow Depth = 5.30" for 100YR24HR event
Inflow = 137.04 cfs @ 21.76 hrs, Volume= 116.305 af
Outflow = 10.38 cfs @ 27.57 hrs, Volume= 15.581 af, Atten= 92%, Lag= 348.4 min
Primary = 10.38 cfs @ 27.57 hrs, Volume= 15.581 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
Peak Elev= 718.64' @ 24.48 hrs Surf.Area= 47.437 ac Storage= 110.442 af

Plug-Flow detention time= 1,234.5 min calculated for 15.560 af (13% of inflow)
Center-of-Mass det. time= 587.7 min (1,584.6 - 996.9)

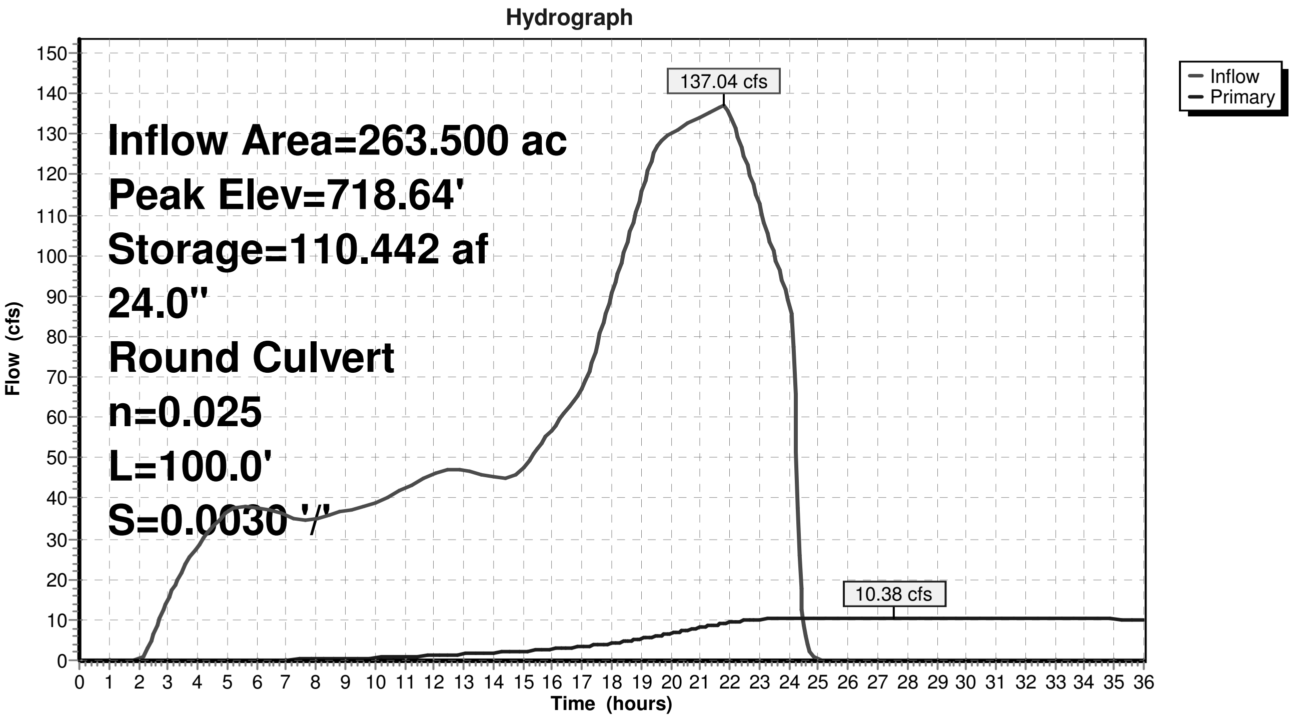
Volume	Invert	Avail.Storage	Storage Description
#1	716.00'	234.245 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
716.00	36.267	0.000	0.000
721.00	57.431	234.245	234.245

Device	Routing	Invert	Outlet Devices
#1	Primary	716.00'	**24.0" Round Culvert** L= 100.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 716.00' / 715.70' S= 0.0030 '/' Cc= 0.900 n= 0.025, Flow Area= 3.14 sf

Primary OutFlow Max=10.38 cfs @ 27.57 hrs HW=718.59' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 10.38 cfs @ 3.33 fps)

Pond 79P: EASTERLY PONDS

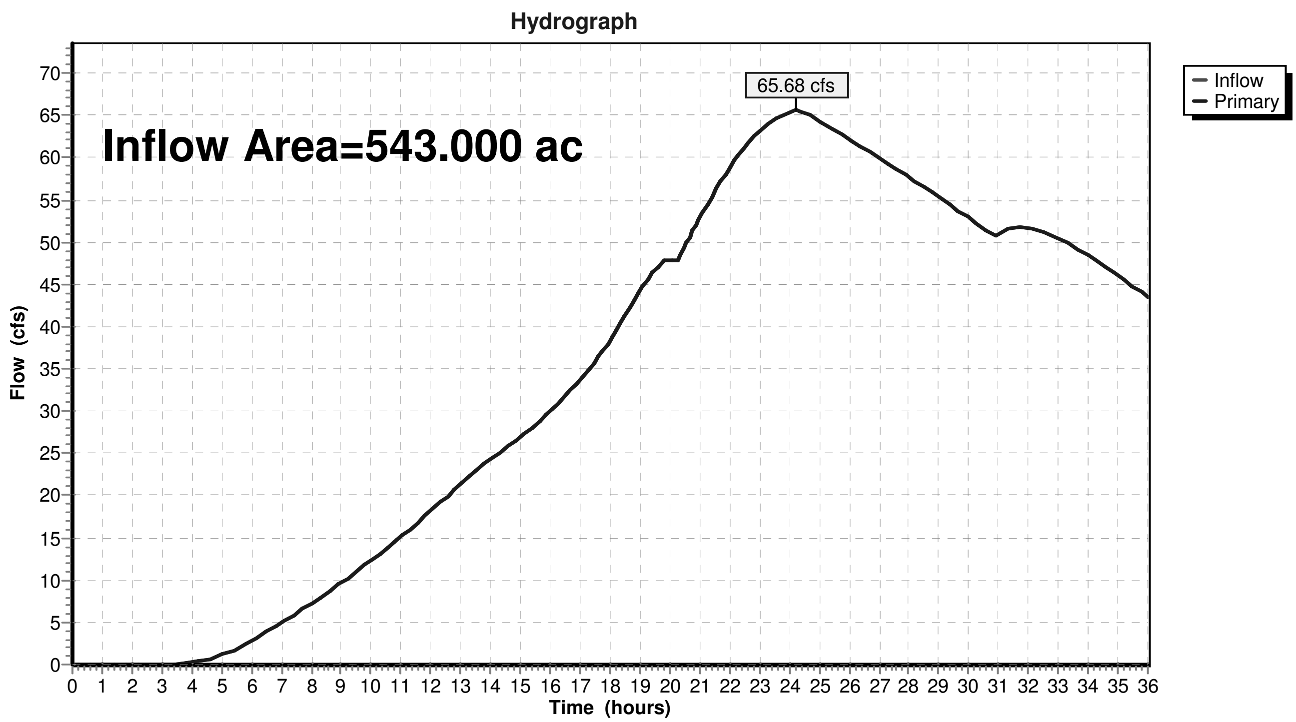


Summary for Pond 80P: Overall Outlet Rate

Inflow Area = 543.000 ac, 0.00% Impervious, Inflow Depth > 2.20" for 100YR24HR event
Inflow = 65.68 cfs @ 24.23 hrs, Volume= 99.338 af
Primary = 65.68 cfs @ 24.23 hrs, Volume= 99.338 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Pond 80P: Overall Outlet Rate



Appendix C

CBBEL Proposed Amity Ditch Study

I-65 Commerce Park PLAT Lots 1-9

To:	Max Mouser, Studio A of Indianapolis
From:	Ian Hahus, E.I.
Subject:	Amity Ditch
Date:	March 26, 2021
Project Name:	Amity Ditch Floodplain Reduction Feasibility Study
Project No.:	19.R200396.00000
CC:	Jenny Leshney, P.E., Matt Mead, P.E.

INTRODUCTION

This memorandum presents the findings of the Christopher B. Burke Engineering, LLC (Burke) floodplain analysis and feasibility study for modifications to Amity Ditch related to a proposed commerce park north of State Road 44 near Franklin, Indiana. A project location map is provided as **Exhibit 1**.

The purpose of this study was to perform hydrologic and hydraulic analyses to determine whether the current flow values used in the IDNR approximate model are reasonable, and if flow reduction or channel modifications to Amity Ditch could potentially reduce the floodplain and floodway within the footprint of the proposed development.

The proposed I-65 South Commerce Park lies adjacent to Amity Ditch, a tributary of Young's Creek. The ditch currently has a mapped Federal Emergency Management Agency (FEMA) Zone A floodplain that overlaps a portion of the eastern half of the proposed Commerce Park. The Indiana Department of Natural Resources (IDNR) also maintains a database of floodplains that have not yet been incorporated into the FEMA flood maps. This "Best Available" database shows the proposed park to be within the revised floodplain/floodway at throughout the southern portion of the site. Since the stream drainage area at the outlet of the subdivision is greater than one square mile, the stream falls under IDNR jurisdiction. Therefore, proposed development in the stream's approximate mapped floodway and existing Zone A floodplain would require an IDNR Construction in a Floodway Permit prior to building.

Burke performed the following tasks as part of this analysis:

- Reviewed the approximate model from IDNR as well as modeling, site survey, and conceptual site layout provided by the Client
- Performed a hydrologic analysis to produce revised flow values for the hydraulic model of Amity Ditch
- Updated the existing IDNR approximate model with the new flow values and additional survey and structure data near the site
- Analyzed potential ditch modifications and crossing structures to reduce the extent of the 1-Percent Annual Chance floodplain and associated floodway

HYDROLOGIC AND HYDRAULIC ANALYSIS

Burke developed hydrologic and hydraulic models using standard software from the U.S. Army Corps of Engineers Hydrologic Engineering Center (HEC).

The hydrologic model was used to determine the flow values along Amity Ditch corresponding to the 100-year (1% Annual Exceedance Probability) storm. The model was completed using the HEC Hydrologic Modeling System (HEC-HMS, version 4.2.1) and included the entire drainage area of Amity Ditch to the confluence with Young's Creek. A summary of the hydrologic parameters for the drainage area are listed in **Table 1** and a basin map and computation sheets are provided in **Appendix 1**.

Table 1 – Summary of Hydrologic Parameters

Subbasin	Area (ac)	Curve Number	Time of Concentration (hr)	Storage Coefficient (hr)
1	285	82	1.87	3.47
2	585	84	2.53	4.70
3	672	75	3.29	6.11
4	1068	81	2.99	5.55
5	1092	69	2.69	5.00
6	1012	76	4.65	8.64

The hydraulic model was used to calculate water surface elevations corresponding to the 100-year event in the existing and proposed conditions at the site. The model was completed using the HEC River Analysis System (HEC-RAS, version 4.1.0) and included information from the 2017 Johnson County Digital Elevation Model (DEM) as well as site survey data collected by others. The following is a summary of data and methodologies utilized for the hydrologic and hydraulic analysis:

- Topographic data: 2017 IndianaMap Digital Elevation Model (from LiDAR)
  - Supplemented with site survey by Coor Consulting and Land Services Corporation in June 2020 and February 2021
- Soils data: NRCS Soil Survey for Johnson County, Indiana
- Rainfall data: NOAA Atlas 14
- Rainfall distribution: NOAA 10% All Cases Distribution
- Land use: 2016 National Land Cover Database, updated based on 2016 aerial photography
- Time of concentration: NRCS Technical Release 55 (TR-55)
- Runoff: SCS Curve Number
- Transform: Clark R Method

The current IDNR approximate model ends approximately 1,900 ft upstream of SR 44, just downstream of an existing farm crossing. To complete the hydraulic analysis for the existing condition, the IDNR model was extended approximately 4,750 ft to the upstream end of the existing channel and hydraulic structure data were added for the SR 44 bridge and the culvert at the farm crossing. Channel bed elevations near and upstream of SR 44 were updated based on site survey data.

To complete the hydraulic analysis of the proposed condition, several 2-stage ditch designs were tested to reduce the 100-yr floodplain extents and elevations throughout the proposed project site. All configurations assumed that the bottom two feet of the channel would remain undisturbed. It was assumed that this would restrict modifications to taking place above the ordinary high water mark (OHWM) and perhaps eliminate the need for a Section 404 permit from the U.S. Army Corps of Engineers (USACE). The proposed 2-stage "shelves" extended out in both directions from the channel and kept a 0.01 ft/ft slope towards the channel to maintain positive drainage. The shelves were tied into existing grade using a 3:1 horizontal:vertical slope. Several sizes of prefabricated conspan structures were tested at the three proposed crossing sites to determine the required flow area.

In addition to channel and structure sizing, the proposed condition model also includes modifications to the overbank terrain to represent fill for the proposed development. The starting locations for the overbank fill were incrementally moved towards the channel to approximate the potential fill/development limits that would maximize developable area without causing an increase in the 100-yr elevations relative to the existing condition model. These approximate limits are overlain on an aerial image of the site in **Exhibit 2**.

The final proposed design consisted of a 60-ft total shelf width for the entire reach of Amity Ditch upstream of SR 44 and three identical 36-ft span x 8-ft rise conspan arch culverts at the three proposed crossing locations. Model results for the existing and proposed scenarios are provided in **Appendix 2** and summarized below in **Table 2.** A map showing the extents of the effective and proposed floodplains is included in **Exhibit 3.**

Table 2: Modeling Summary for Existing Conditions

Model Cross Section	Description	100-yr WSE, IDNR Model (ft[1])	100-yr WSE, Existing Condition (ft[1])	100-yr WSE, Proposed Condition (ft[1])
27672	Upstream of SR 44	718.51	718.08	718.15
29402	Limit of IDNR model[2]	719.37	719.34	718.71
29590	Upstream of farm crossing	-	719.34	718.80
30952	Upstream of proposed crossings	-	719.67	719.51
32337	Near existing home (5599 E 100 N)	-	720.93	720.37
34146	Upstream limit of existing ditch	-	721.89	720.96

Notes:

1. All elevations reference the NAVD88 vertical datum.
2. Effective IDNR model ends at location of approximately 1 mi^2 drainage area

CONCLUSIONS

The proposed alterations to the geometry of Amity Ditch reduce the 100-yr flood elevations relative to the existing condition model developed for this study. Reductions are generally on the order of 0.5 ft and range from 0.04 ft near the upstream-most proposed crossing to more than 0.9 ft at the upstream end of the model.

A Construction in a Floodway permit application will need to be filed with IDNR prior to completing any channel or site modifications that will include placing fill within the regulatory floodway. Because the Effective floodplain is mapped as "Zone A" on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM), this area is considered floodway for regulatory purposes. For the application, completed grading plans will be required for each structure being permitted in addition to the corresponding hydraulic modeling. Construction in a Floodway permits are active for up to two years. After the first year, an extension request would need to be filed with IDNR requesting an additional year to complete the work. Extensions beyond the two year limit are currently not permitted.

Because the proposed site conditions do not result in an increase of the 100-yr flood elevation, a Conditional Letter of Map Revision (CLOMR) may not be necessary from FEMA prior to construction. However, local authorities may request or require a CLOMR be obtained to assure the viability of the project. Early coordination with City of Franklin and Johnson County Drainage Board staff should occur prior to plan development to determine the preferred process.

A Letter of Map Revision (LOMR) will need to be filed after construction to remove any structures from the regulatory floodplain. Final grading and as-built construction documents would be required to update the modeling to complete the application.

Based on the proposed site layout provided by the Client, it may be possible to complete construction of proposed building #3, and potentially building #2, without obtaining an IDNR Construction in a Floodway permit if the final building footprints are outside of the regulatory floodplain extents. Indiana Department of Environmental Management 401 and Rule 5 as well as the US Army Corp of Engineers (USACE) 404 permits may still be required for the development.

Early coordination with local development and drainage authorities for Franklin and Johnson County is strongly recommended. It is possible that the Johnson County drainage board will require permits for modifications to Amity Ditch (a regulated drain) independent of those required by IDNR or USACE. As mentioned above, the City of Franklin may request that a CLOMR be filed before construction even if not legally required by FEMA.

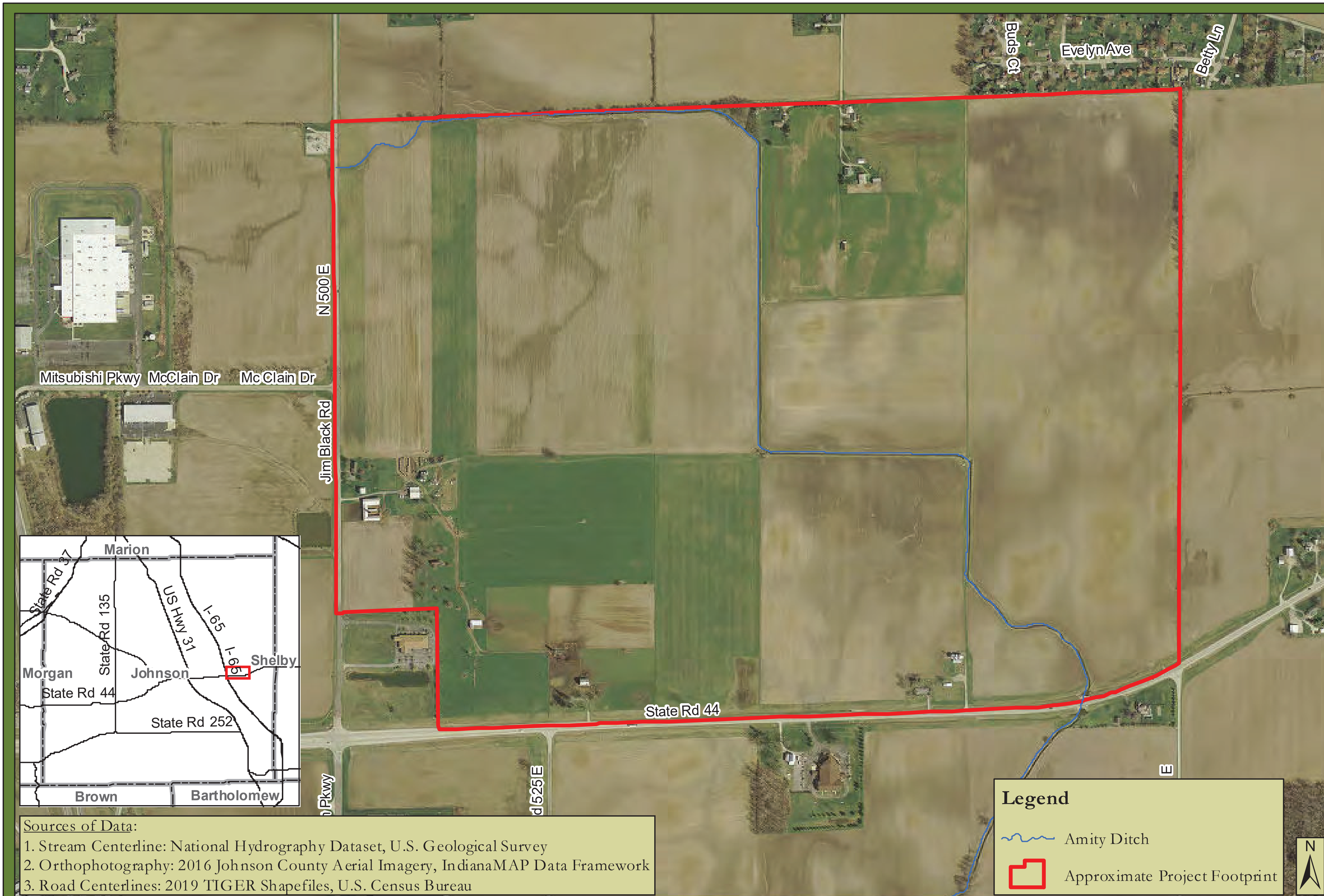
EXHIBITS

Exhibit 1 – Project Location Map
Exhibit 2 – Approximate Developable Area
Exhibit 3 – Effective and Proposed Floodplain Extents

APPENDICES

Appendix 1 – Hydrologic Analysis Data
Appendix 2 – Hydraulic Model Results

EXHIBITS



Sources of Data:
1. Stream Centerline: National Hydrography Dataset, U.S. Geological Survey
2. Orthophotography: 2016 Johnson County Aerial Imagery, IndianaMAP Data Framework
3. Road Centerlines: 2019 TIGER Shapefiles, U.S. Census Bureau

CB BB BURKE
Christopher B. Burke Engineering, LLC
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115 West Washington Street
Indianapolis, Indiana 46204
(t) 317.266.8000 www.cbbel-in.com

PROJECT: Amity Ditch Floodplain Reduction Feasibility Study

PROJECT NO. 20-0396

APPROX. SCALE 1"=800'

DATE: 03/2021

TITLE: Project Location Map

EXHIBIT 1

Sources of Data:
1. Stream Centerline: National Hydrography Dataset, U.S. Geological Survey
2. Orthophotography: 2016 Johnson County Aerial Imagery, IndianaMAP Data Framework
3. Road Centerlines: 2019 TIGER Shapefiles, U.S. Census Bureau

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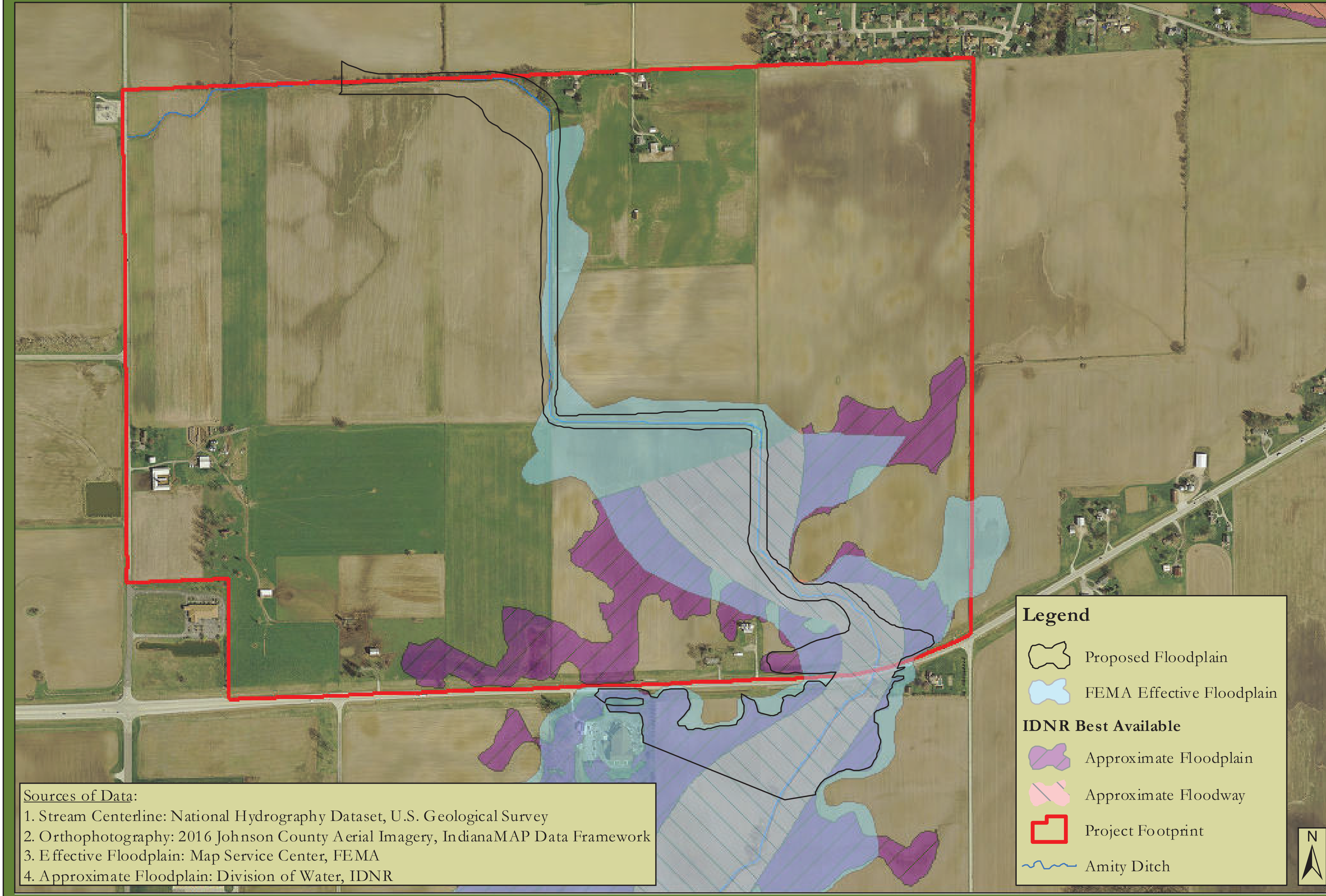
PROJECT:	**Amity Ditch Floodplain Reduction Feasibility Study**
PROJECT NO.	**20-0396**
APPROX. SCALE	**1"=700'**
DATE:	**03/2021**
TITLE:	**Approximate Developable Area**
EXHIBIT	**2**



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PROJECT: **Amity Ditch Floodplain Reduction Feasibility Study**

PROJECT NO. **20-0396**

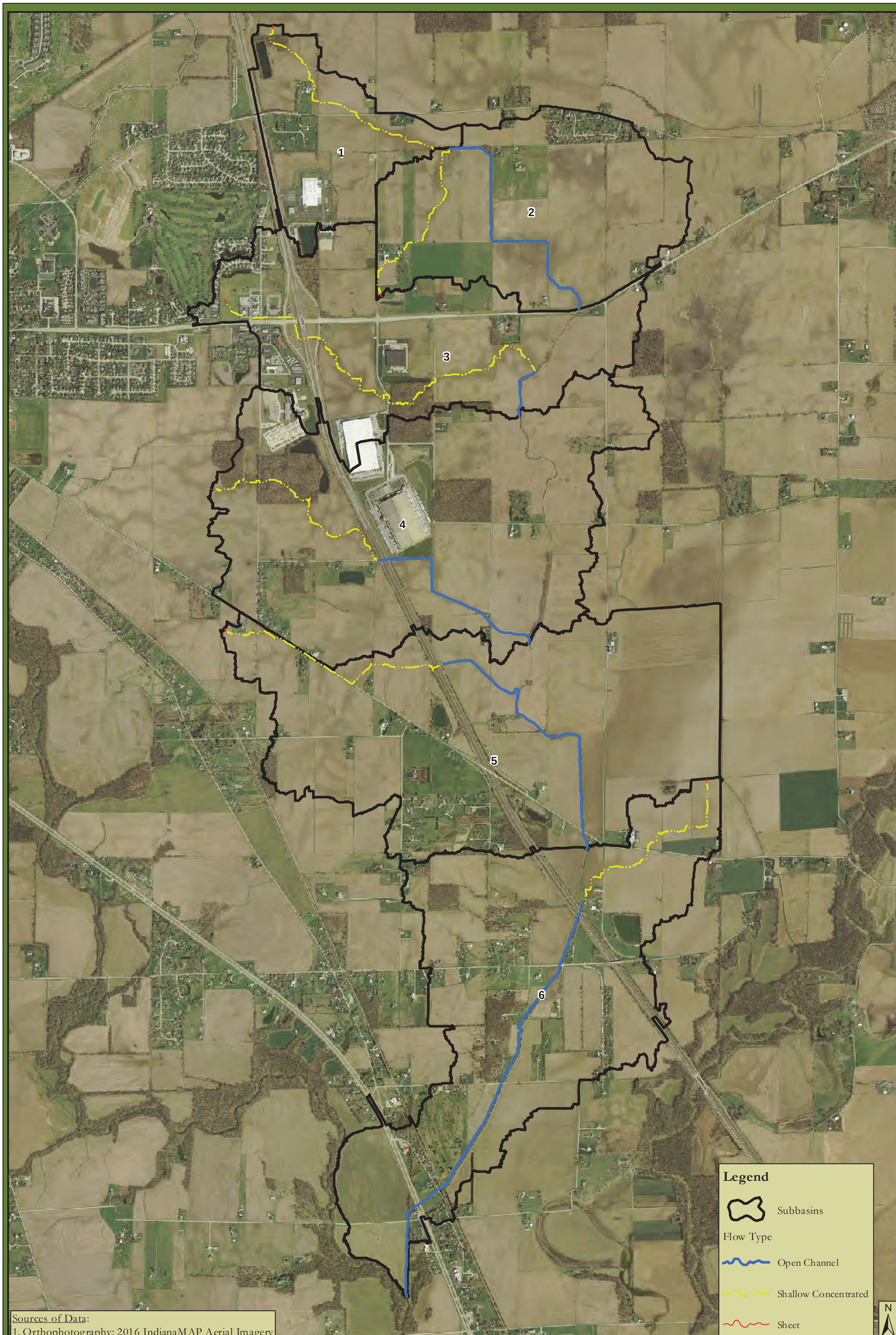
APPROX. SCALE 1"=800'

DATE: 03/2021

TITLE: **Effective and Proposed Floodplain Extents**

EXHIBIT 3

APPENDIX 1: HYDROLOGIC ANALYSIS DATA



Sources of Data:
1. Orthophotography: 2016 IndianaMAP Aerial Imagery

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(t) 317.266.8000 www.cbbel-in.com

PROJECT: Amity Ditch Floodplain Reduction Feasibility Analysis	PROJECT NO. 20-0396	APPROX. SCALE 1" = 2,000'
		DATE: 03/2021
TITLE: Subbasin Boundaries and Time of Concentration Flowpaths		APPENDIX 1

Christopher B. Burke Engineering, LLC
115 W. Washington St., Suite 1368 S
Indianapolis, IN 46204
(317) 266-8000

Project No.: 20-0396.00000
Project Name: Amity Ditch Floodplain Reduction Feasibility Study
Calcs. By: IKH Date: 2/17/21
Check By: MWM Date: 2/18/21

Time of Concentration

Basin: 1

SHEET FLOW

Tt(hr) = (0.007(n L)^0.8)/(P2^0.5 s^0.4)

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	P2 (in)	n	Tt (hr)
100	736.2	735.6	0.006	2.91	0.06	0.13

TOTAL T_t (hr) 0.13

Surface Description	n-value
Smooth surfaces	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover<20%	0.06
Residue cover>20%	0.17
Average	0.15
Grass:	
Short grass	0.15
Lawn grasses	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:	
Light underbrush	0.4
Dense underbrush	0.8

SHALLOW CONCENTRATED FLOW

Tt(hr) = L/(3600 V)

V(paved) = 20.3282 S^0.5
V(unpaved) = 16.1345 S^0.5

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	Pave(y/n)			Coef.	Velocity	Tt (hr)
5477.8	735.6	719.5	0.0029	N	y =	20.33	16.135	0.87	1.74
					n =	16.13			

TOTAL T_t (hr) 1.74

OPEN CHANNEL/PIPE FLOW
(assuming a velocity)

Tt(hr) = L/(3600 V)

Length (ft)	Velocity (ft/s)	Tt (hr)

TOTAL T_t (hr) 0.00

(w/o assuming a velocity)

Tt(hr) = L/(3600 V)

V(ft/s) = (1.49 R^2/3 S^1/2)/n

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	n-value	Open Channel Bottom (ft)	Open Channel SS (ft)	Pipe DIA (ft)	Depth (ft)	Area	R	Velocity	Tt (hr)

TOTAL T_t (hr) 0.00

Total T_c = 1.87 hours = 112 minutes T_{lag} = 1.12 hours = 67.4 minutes

Adjusted Indiana-Specific T_c = 3.12 hours = 187 minutes (If applicable)

Christopher B. Burke Engineering, LLC
115 W. Washington St., Suite 1368 S
Indianapolis, IN 46204
(317) 266-8000

Project No.: 20-0396.00000
Project Name: Amity Ditch Floodplain Reduction Feasibility Study
Calcs. By: IKH Date: 2/17/21
Check By: MWM Date: 2/18/21

Time of Concentration

Basin: 2

SHEET FLOW

Tt(hr) = (0.007(n L)^0.8)/(P2^0.5 s^0.4)

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	P2 (in)	n	Tt (hr)
100	732.9	731.9	0.01	2.91	0.24	0.33

Surface Description	n-value
Smooth surfaces	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover<20%	0.06
Residue cover>20%	0.17
Average	0.15
Grass:	
Short grass	0.15
Lawn grasses	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:	
Light underbrush	0.4
Dense underbrush	0.8

TOTAL T_t (hr) 0.33

SHALLOW CONCENTRATED FLOW

Tt(hr) = L/(3600 V)

V(paved) = 20.3282 S^0.5
V(unpaved) = 16.1345 S^0.5

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	Pave(y/n)			Coef.	Velocity	Tt (hr)
4628.7	731.9	720.7	0.0024	N	y =	20.33	16.135	0.79	1.62
					n =	16.13			

TOTAL T_t (hr) 1.62

OPEN CHANNEL/PIPE FLOW

(assuming a velocity)

Tt(hr) = L/(3600 V)

Length (ft)	Velocity (ft/s)	Tt (hr)
6234.6	3	0.58

TOTAL T_t (hr) 0.58

(w/o assuming a velocity)

Tt(hr) = L/(3600 V)

V(ft/s) = (1.49 R^2/3 S^1/2)/n

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	n-value	Open Channel Bottom (ft)	Open Channel SS (ft)	Pipe DIA (ft)	Depth (ft)	Area	R	Velocity	Tt (hr)

TOTAL T_t (hr) 0.00

Total T_c = 2.53 hours = 152 minutes **T_{lag} = 1.52 hours = 90.9 minutes**

Adjusted Indiana-Specific T_c = 4.21 hours = 253 minutes (If applicable)

Christopher B. Burke Engineering, LLC
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(317) 266-8000

Project No.: 20-0396.00000
Project Name: Amity Ditch Floodplain Reduction Feasibility Study
Calcs. By: IKH Date: 2/17/21
Check By: MWM Date: 2/18/21

Time of Concentration

Basin: 3

SHEET FLOW

Tt(hr) = (0.007(n L)^0.8)/(P2^0.5 s^0.4)

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	P2 (in)	n
100	752.3	751.1	0.012	2.91	0.15

Surface Description	n-value
Smooth surfaces	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover<20%	0.06
Residue cover>20%	0.17
Average	0.15
Grass:	
Short grass	0.15
Lawn grasses	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:	
Light underbrush	0.4
Dense underbrush	0.8

Tt (hr): 0.21

TOTAL T_t (hr): 0.21

SHALLOW CONCENTRATED FLOW

Tt(hr) = L/(3600 V)

V(paved) = 20.3282 S^0.5
V(unpaved) = 16.1345 S^0.5

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	Pave(y/n)			Coef.	Velocity
10362	751.1	713.5	0.0036	N	y =	20.33	16.135	0.97
					n =	16.13		

Tt (hr): 2.96

TOTAL T_t (hr): 2.96

OPEN CHANNEL/PIPE FLOW

(assuming a velocity)

Tt(hr) = L/(3600 V)

Length (ft)	Velocity (ft/s)
1261.7	3

Tt (hr): 0.12

TOTAL T_t (hr): 0.12

(w/o assuming a velocity)

Tt(hr) = L/(3600 V)

V(ft/s) = (1.49 R^2/3 S^1/2)/n

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	n-value	Open Channel Bottom (ft)	Open Channel SS (ft)	Pipe DIA (ft)	Depth (ft)	Area	R	Velocity	Tt (hr)

TOTAL T_t (hr): 0.00

Total T_c = 3.29 hours = 197 minutes

T_{lag} = 1.97 hours = 118 minutes

Adjusted Indiana-Specific T_c = 5.48 hours = 329 minutes (If applicable)

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Calcs. By: IKH Date: 2/17/21
Check By: MWM Date: 2/18/21

Time of Concentration

Basin: 4

SHEET FLOW

Tt(hr) = (0.007(n L)^0.8)/(P2^0.5 s^0.4)

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	P2 (in)	n
100	730.9	730.6	0.003	2.91	0.15

Surface Description	n-value
Smooth surfaces	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover<20%	0.06
Residue cover>20%	0.17
Average	0.15
Grass:	
Short grass	0.15
Lawn grasses	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:	
Light underbrush	0.4
Dense underbrush	0.8

Tt (hr): 0.37

TOTAL T_t (hr): 0.37

SHALLOW CONCENTRATED FLOW

Tt(hr) = L/(3600 V)

V(paved) = 20.3282 S^0.5
V(unpaved) = 16.1345 S^0.5

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	Pave(y/n)			Coef.	Velocity
5513.9	730.6	720.2	0.0019	N	y =	20.33	16.135	0.70
					n =	16.13		

Tt (hr): 2.19

TOTAL T_t (hr): 2.19

OPEN CHANNEL/PIPE FLOW

(assuming a velocity)

Tt(hr) = L/(3600 V)

Length (ft)	Velocity (ft/s)
4714.1	3

Tt (hr): 0.44

TOTAL T_t (hr): 0.44

(w/o assuming a velocity)

Tt(hr) = L/(3600 V)

V(ft/s) = (1.49 R^2/3 S^1/2)/n

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	n-value	Open Channel Bottom (ft)	Open Channel SS (ft)	Pipe DIA (ft)	Depth (ft)	Area	R	Velocity	Tt (hr)

TOTAL T_t (hr): 0.00

Total T_c = 2.99 hours = 179 minutes T_{lag} = 1.79 hours = 108 minutes

Adjusted Indiana-Specific T_c = 4.98 hours = 299 minutes (If applicable)

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Project No.:	20-0396.00000		
Project Name:	Amity Ditch Floodplain Reduction Feasibility Study		
Calcs. By:	IKH	Date:	2/17/21
Check By:	MWM	Date:	2/18/21

Time of Concentration

Basin: 5

SHEET FLOW

Tt(hr) = (0.007(n L)^0.8)/(P2^0.5 s^0.4)

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	P2 (in)	n	Tt (hr)
99.996	731.4	731	0.004	2.91	0.15	0.33

TOTAL T_t (hr) 0.33

Surface Description	n-value
Smooth surfaces	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover<20%	0.06
Residue cover>20%	0.17
Average	0.15
Grass:	
Short grass	0.15
Lawn grasses	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:	
Light underbrush	0.4
Dense underbrush	0.8

SHALLOW CONCENTRATED FLOW

Tt(hr) = L/(3600 V)

V(paved) = 20.3282 S^0.5
V(unpaved) = 16.1345 S^0.5

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	Pave(y/n)			Coef.	Velocity	Tt (hr)
5821.9	731	711.1	0.0034	N	y =	20.33	16.135	0.94	1.71
					n =	16.13			

TOTAL T_t (hr) 1.71

OPEN CHANNEL/PIPE FLOW

(assuming a velocity)

Tt(hr) = L/(3600 V)

Length (ft)	Velocity (ft/s)	Tt (hr)
6984	3	0.65

TOTAL T_t (hr) 0.65

(w/o assuming a velocity)

Tt(hr) = L/(3600 V)

V(ft/s) = (1.49 R^2/3 S^1/2)/n

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	n-value	Open Channel Bottom (ft)	Open Channel SS (ft)	Pipe DIA (ft)	Depth (ft)	Area	R	Velocity	Tt (hr)

TOTAL T_t (hr) 0.00

Total T_c = 2.69 hours = 161 minutes **T_{lag} = 1.61 hours = 96.7 minutes**

Adjusted Indiana-Specific T_c = 4.48 hours = 269 minutes (If applicable)

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Project No.: 20-0396.00000
Project Name: Amity Ditch Floodplain Reduction Feasibility Study
Calcs. By: IKH Date: 2/17/21
Check By: MWM Date: 2/18/21

Time of Concentration

Basin: 6

SHEET FLOW

Tt(hr) = (0.007(n L)^0.8)/(P2^0.5 s^0.4)

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	P2 (in)	n	Tt (hr)
100	700.4	699.2	0.012	2.91	0.15	0.21

TOTAL T_t (hr): 0.21

Surface Description	n-value
Smooth surfaces	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover<20%	0.06
Residue cover>20%	0.17
Average	0.15
Grass:	
Short grass	0.15
Lawn grasses	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:	
Light underbrush	0.4
Dense underbrush	0.8

SHALLOW CONCENTRATED FLOW

Tt(hr) = L/(3600 V)

V(paved) = 20.3282 S^0.5
V(unpaved) = 16.1345 S^0.5

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	Pave(y/n)			Coef.	Velocity	Tt (hr)
5389.9	699.2	695.3	0.0007	N	y =	20.33	16.135	0.43	3.45
					n =	16.13			

TOTAL T_t (hr): 3.45

OPEN CHANNEL/PIPE FLOW

(assuming a velocity)

Tt(hr) = L/(3600 V)

Length (ft)	Velocity (ft/s)	Tt (hr)
10703	3	0.99

TOTAL T_t (hr): 0.99

(w/o assuming a velocity)

Tt(hr) = L/(3600 V)

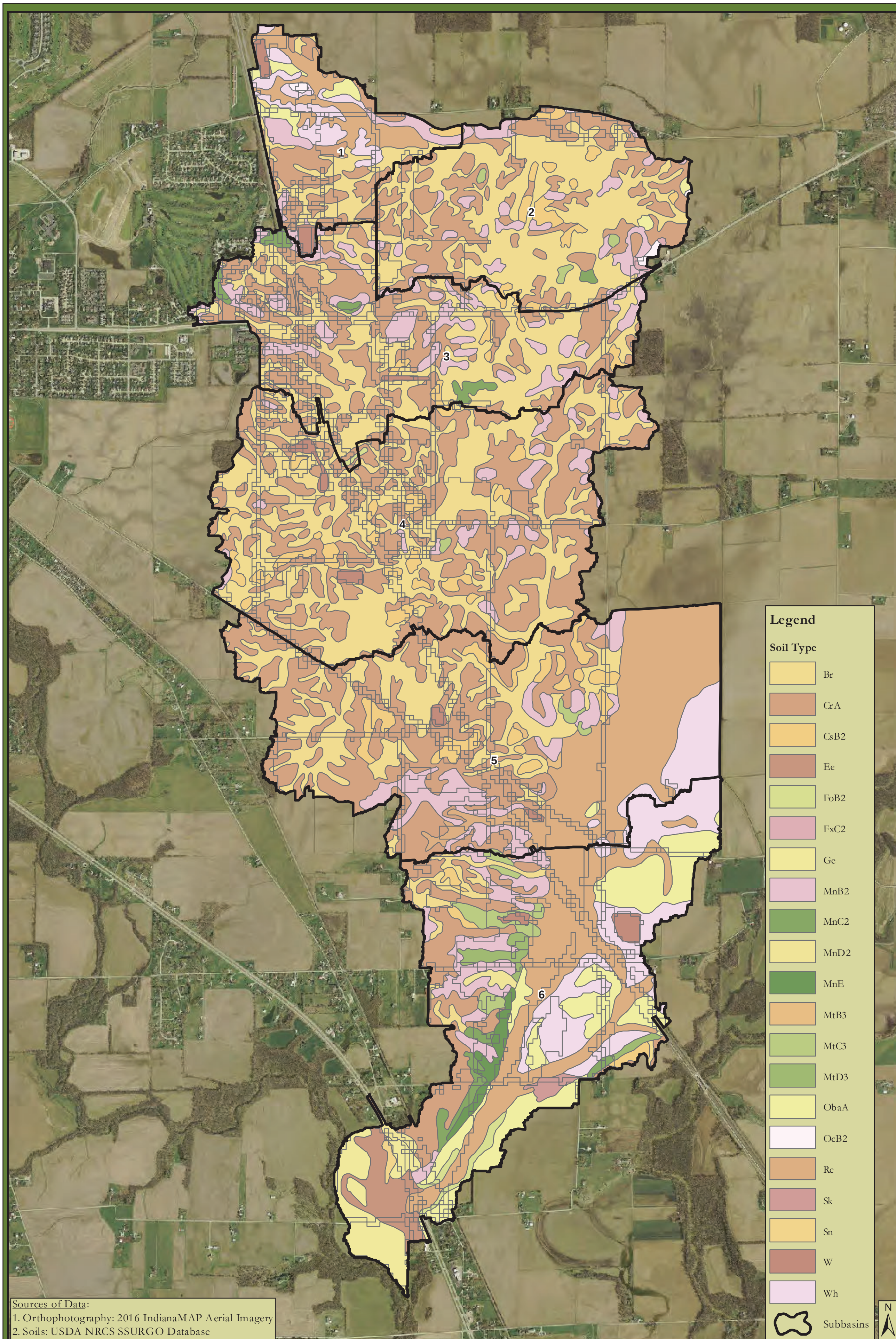
V(ft/s) = (1.49 R^2/3 S^1/2)/n

Length (ft)	U/S Elev (ft)	D/S Elev (ft)	Slope	n-value	Open Channel Bottom (ft)	Open Channel SS (ft)	Pipe DIA (ft)	Depth (ft)	Area	R	Velocity	Tt (hr)

TOTAL T_t (hr): 0.00

Total T_c = 4.65 hours = 279 minutes **T_{lag} = 2.79 hours = 167 minutes**

Adjusted Indiana-Specific T_c = 7.75 hours = 465 minutes (If applicable)



CBB BURKE
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PROJECT: Amity Ditch Floodplain Reduction Feasibility Analysis

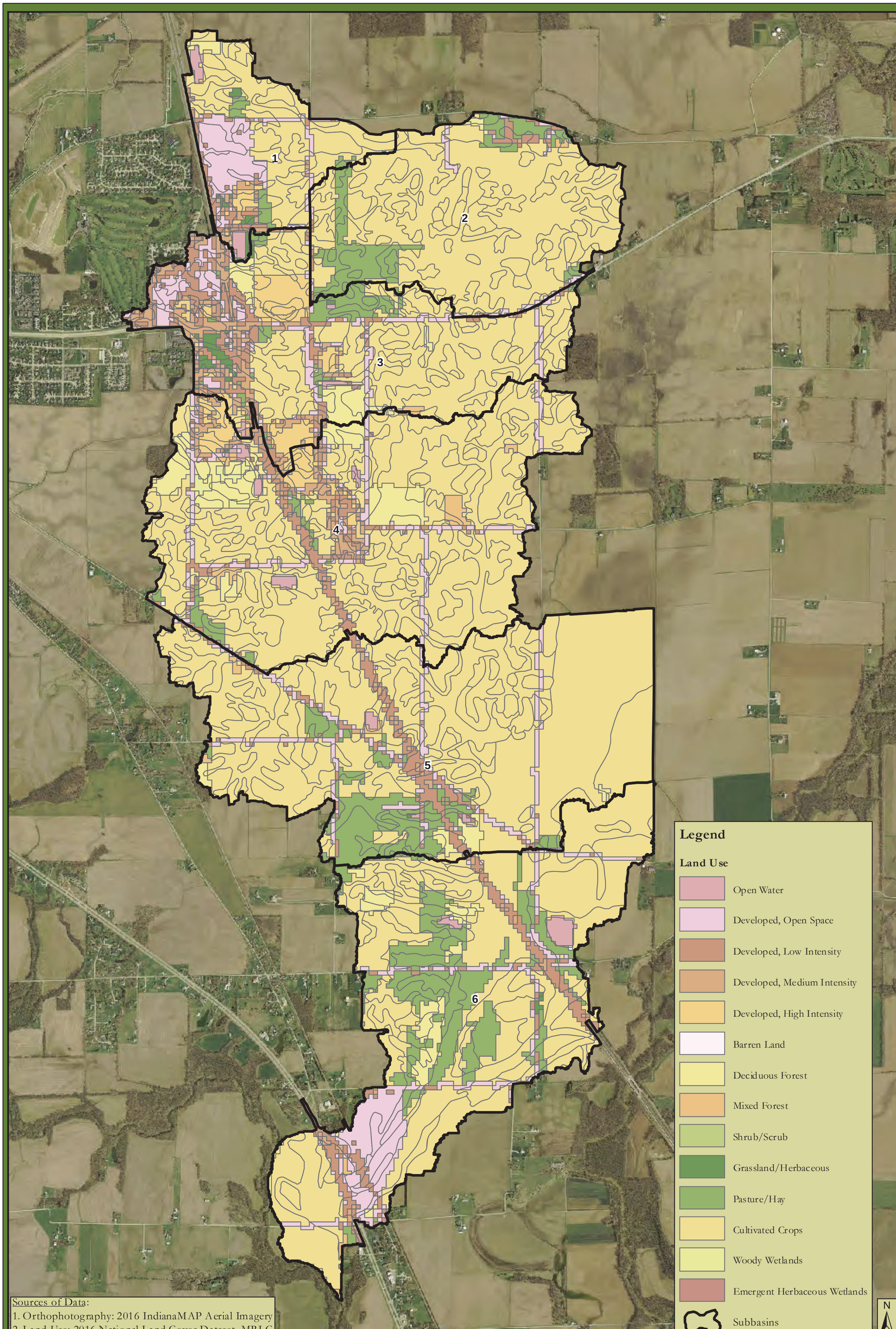
PROJECT NO. 20-0396

APPROX. SCALE 1" = 2,000'

DATE: 03/2021

TITLE: Soil Types

APPENDIX 1



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PROJECT:	Amity Ditch Floodplain Reduction Feasibility Analysis	PROJECT NO. 20-0396	APPROX. SCALE 1" = 2,000'
			DATE: 03/2021
TITLE:	Land Use		APPENDIX 1

Composite Curve Number Calculation Worksheet

Burke Project No.	20-0396.00000	Calcs. By	IKH	Date	2/17/2021
Burke Project Name	Amity Ditch Floodplain Reduction Feasibility Study	Check By	MWM	Date	2/18/2021
Basin Name	**1**				

Soil Name and Hydrologic Group	% Area for Each Soil Type	Cover Description	CN	% Land Use Area per Soil Type	% Total Area	CN X % Total Area
A		Open Water	100			
		Developed, Open Space	51			
		Developed, Low Intensity	61			
		Developed, Medium Intensity	75			
		Developed, High Intensity	89			
		Barren Land (Rock / Sand / Clay)	77			
		Deciduous Forest	25			
		Evergreen Forest	25			
		Mixed Forest	25			
		Shrub / Scrub	39			
		Grasslands / Herbaceous	30			
		Pasture / Hay	39			
		Cultivated Crops	64			
		Small Grains	39			
		Urban/Recreational Grasses	39			
		Woody Wetlands	30			
		Emergent Herbaceous Wetlands	49			
			Total =			
B	6.9	Open Water	100	1	0.0	3.6
		Developed, Open Space	68	22	1.6	105.7
		Developed, Low Intensity	75	11	0.8	57.0
		Developed, Medium Intensity	84	1	0.1	4.4
		Developed, High Intensity	92			
		Barren Land (Rock / Sand / Clay)	86			
		Deciduous Forest	55			
		Evergreen Forest	55			
		Mixed Forest	55			
		Shrub / Scrub	61	0	0.0	1.8
		Grasslands / Herbaceous	58	5	0.4	21.7
		Pasture / Hay	61	1	0.1	3.8
		Cultivated Crops	75	59	4.1	305.9
		Small Grains	61			
		Urban/Recreational Grasses	61			
		Woody Wetlands	55			
		Emergent Herbaceous Wetlands	69			
			Total =	100		
C	9.3	Open Water	100	1	0.1	6.9
		Developed, Open Space	79	41	3.8	302.7
		Developed, Low Intensity	83	8	0.8	64.8
		Developed, Medium Intensity	89	6	0.5	47.2
		Developed, High Intensity	94	1	0.1	7.9
		Barren Land (Rock / Sand / Clay)	91			
		Deciduous Forest	70	1	0.1	4.8
		Evergreen Forest	70			
		Mixed Forest	70			
		Shrub / Scrub	74			
		Grasslands / Herbaceous	71	3	0.3	19.2
		Pasture / Hay	74	1	0.1	4.1
		Cultivated Crops	82	39	3.6	296.9
		Small Grains	74			
		Urban/Recreational Grasses	74			
		Woody Wetlands	70			
		Emergent Herbaceous Wetlands	79			
			Total =	100		
D	80.0	Open Water	100	0	0.2	16.4
		Developed, Open Space	84	18	14.6	1225.6
		Developed, Low Intensity	87	6	4.9	423.5
		Developed, Medium Intensity	91	3	2.5	223.0
		Developed, High Intensity	95	3	2.2	213.5
		Barren Land (Rock / Sand / Clay)	94			
		Deciduous Forest	77	1	1.2	91.6
		Evergreen Forest	77			
		Mixed Forest	77	0	0.0	2.1
		Shrub / Scrub	80			
		Grasslands / Herbaceous	78	1	0.7	56.2
		Pasture / Hay	80	5	3.9	309.8
		Cultivated Crops	85	62	49.9	4241.6
		Small Grains	80			
		Urban/Recreational Grasses	80			
		Woody Wetlands	77			
		Emergent Herbaceous Wetlands	84			
			Total =	100		
Water	3.7081684	Open Water	100		3.7	370.8
Totals	100				100	8432.7
					CN =	84.3
					Use CN	**84**

Composite Curve Number Calculation Worksheet

Burke Project No.	20-0396.00000	Calcs. By	IKH	Date	2/17/2021
Burke Project Name	Amity Ditch Floodplain Reduction Feasibility Study	Check By	MWM	Date	2/18/2021
Basin Name	**2**				

Soil Name and Hydrologic Group	% Area for Each Soil Type	Cover Description	CN	% Land Use Area per Soil Type	% Total Area	CN X % Total Area
A		Open Water	100			
		Developed, Open Space	51			
		Developed, Low Intensity	61			
		Developed, Medium Intensity	75			
		Developed, High Intensity	89			
		Barren Land (Rock / Sand / Clay)	77			
		Deciduous Forest	25			
		Evergreen Forest	25			
		Mixed Forest	25			
		Shrub / Scrub	39			
		Grasslands / Herbaceous	30			
		Pasture / Hay	39			
		Cultivated Crops	64			
		Small Grains	39			
		Urban/Recreational Grasses	39			
		Woody Wetlands	30			
		Emergent Herbaceous Wetlands	49			
			Total =			
B	1.6	Open Water	100			
		Developed, Open Space	68	6	0.1	6.0
		Developed, Low Intensity	75	1	0.0	1.3
		Developed, Medium Intensity	84			
		Developed, High Intensity	92			
		Barren Land (Rock / Sand / Clay)	86			
		Deciduous Forest	55			
		Evergreen Forest	55			
		Mixed Forest	55			
		Shrub / Scrub	61			
		Grasslands / Herbaceous	58			
		Pasture / Hay	61	17	0.3	16.6
		Cultivated Crops	75	76	1.2	90.7
		Small Grains	61			
		Urban/Recreational Grasses	61			
		Woody Wetlands	55			
		Emergent Herbaceous Wetlands	69			
			Total =	100		
C	9.3	Open Water	100			
		Developed, Open Space	79	4	0.4	27.7
		Developed, Low Intensity	83	1	0.0	4.0
		Developed, Medium Intensity	89			
		Developed, High Intensity	94			
		Barren Land (Rock / Sand / Clay)	91			
		Deciduous Forest	70			
		Evergreen Forest	70			
		Mixed Forest	70	0	0.0	1.2
		Shrub / Scrub	74			
		Grasslands / Herbaceous	71			
		Pasture / Hay	74	9	0.9	64.1
		Cultivated Crops	82	86	8.0	659.3
		Small Grains	74			
		Urban/Recreational Grasses	74			
		Woody Wetlands	70			
		Emergent Herbaceous Wetlands	79			
			Total =	100		
D	89.1	Open Water	100			
		Developed, Open Space	84	2	1.7	145.1
		Developed, Low Intensity	87	2	1.7	146.0
		Developed, Medium Intensity	91	0	0.1	7.0
		Developed, High Intensity	95			
		Barren Land (Rock / Sand / Clay)	94			
		Deciduous Forest	77	0	0.3	25.1
		Evergreen Forest	77			
		Mixed Forest	77	0	0.2	13.4
		Shrub / Scrub	80			
		Grasslands / Herbaceous	78			
		Pasture / Hay	80	13	11.2	896.5
		Cultivated Crops	85	83	73.9	6281.8
		Small Grains	80			
		Urban/Recreational Grasses	80			
		Woody Wetlands	77			
		Emergent Herbaceous Wetlands	84			
			Total =	100		
Water		Open Water	100			
Totals	100				100	8385.7
					CN =	83.9
					Use CN	**84**

Composite Curve Number Calculation Worksheet

Burke Project No.	20-0396.00000	Calcs. By	IKH	Date	2/17/2021
Burke Project Name	Amity Ditch Floodplain Reduction Feasibility Study	Check By	MWM	Date	2/18/2021
Basin Name	3				

Soil Name and Hydrologic Group	% Area for Each Soil Type	Cover Description	CN	% Land Use Area per Soil Type	% Total Area	CN X % Total Area
A		Open Water	100			
		Developed, Open Space	51			
		Developed, Low Intensity	61			
		Developed, Medium Intensity	75			
		Developed, High Intensity	89			
		Barren Land (Rock / Sand / Clay)	77			
		Deciduous Forest	25			
		Evergreen Forest	25			
		Mixed Forest	25			
		Shrub / Scrub	39			
		Grasslands / Herbaceous	30			
		Pasture / Hay	39			
		Cultivated Crops	64			
		Small Grains	39			
		Urban/Recreational Grasses	39			
		Woody Wetlands	30			
		Emergent Herbaceous Wetlands	49			
			Total =			
B	0.1	Open Water	100			
		Developed, Open Space	68	2	0.0	0.1
		Developed, Low Intensity	75	1	0.0	0.1
		Developed, Medium Intensity	84	46	0.1	5.0
		Developed, High Intensity	92	52	0.1	6.2
		Barren Land (Rock / Sand / Clay)	86			
		Deciduous Forest	55			
		Evergreen Forest	55			
		Mixed Forest	55			
		Shrub / Scrub	61			
		Grasslands / Herbaceous	58			
		Pasture / Hay	61			
		Cultivated Crops	75			
		Small Grains	61			
		Urban/Recreational Grasses	61			
		Woody Wetlands	55			
		Emergent Herbaceous Wetlands	69			
			Total =	100		
C	17.3	Open Water	100	0	0.0	0.7
		Developed, Open Space	79	11	1.8	144.3
		Developed, Low Intensity	83	13	2.3	188.1
		Developed, Medium Intensity	89	8	1.5	129.4
		Developed, High Intensity	94	2	0.3	27.6
		Barren Land (Rock / Sand / Clay)	91			
		Deciduous Forest	70	1	0.2	13.4
		Evergreen Forest	70			
		Mixed Forest	70	0	0.0	0.4
		Shrub / Scrub	74			
		Grasslands / Herbaceous	71	2	0.4	28.6
		Pasture / Hay	74	7	1.2	89.1
		Cultivated Crops	82	56	9.6	790.9
		Small Grains	74			
		Urban/Recreational Grasses	74			
		Woody Wetlands	70			
		Emergent Herbaceous Wetlands	79			
			Total =	100		
D	82.2	Open Water	100	0	0.3	26.2
		Developed, Open Space	84	9	7.4	619.0
		Developed, Low Intensity	87	11	8.8	765.1
		Developed, Medium Intensity	91	8	6.9	627.7
		Developed, High Intensity	95	10	8.3	786.4
		Barren Land (Rock / Sand / Clay)	94			
		Deciduous Forest	77	5	4.4	336.2
		Evergreen Forest	77			
		Mixed Forest	77	0	0.3	20.4
		Shrub / Scrub	80			
		Grasslands / Herbaceous	78	1	1.1	88.0
		Pasture / Hay	80	5	4.2	334.6
		Cultivated Crops	85	49	40.6	3448.6
		Small Grains	80			
		Urban/Recreational Grasses	80			
		Woody Wetlands	77			
		Emergent Herbaceous Wetlands	84	0	0.1	6.1
			Total =	100		
Water	0.3878082	Open Water	100		0.4	38.8
Totals	100				100	8520.9
					CN =	85.2
					Use CN	**85**

Composite Curve Number Calculation Worksheet

Burke Project No.	20-0396.00000	Calcs. By	IKH	Date	2/17/2021
Burke Project Name	Amity Ditch Floodplain Reduction Feasibility Study	Check By	MWM	Date	2/18/2021
Basin Name	4				

Soil Name and Hydrologic Group	% Area for Each Soil Type	Cover Description	CN	% Land Use Area per Soil Type	% Total Area	CN X % Total Area
A		Open Water	100			
		Developed, Open Space	51			
		Developed, Low Intensity	61			
		Developed, Medium Intensity	75			
		Developed, High Intensity	89			
		Barren Land (Rock / Sand / Clay)	77			
		Deciduous Forest	25			
		Evergreen Forest	25			
		Mixed Forest	25			
		Shrub / Scrub	39			
		Grasslands / Herbaceous	30			
		Pasture / Hay	39			
		Cultivated Crops	64			
		Small Grains	39			
		Urban/Recreational Grasses	39			
		Woody Wetlands	30			
		Emergent Herbaceous Wetlands	49			
			Total =			
B	0.1	Open Water	100			
		Developed, Open Space	68			
		Developed, Low Intensity	75	3	0.0	0.2
		Developed, Medium Intensity	84	23	0.0	1.5
		Developed, High Intensity	92	75	0.1	5.3
		Barren Land (Rock / Sand / Clay)	86			
		Deciduous Forest	55			
		Evergreen Forest	55			
		Mixed Forest	55			
		Shrub / Scrub	61			
		Grasslands / Herbaceous	58			
		Pasture / Hay	61			
		Cultivated Crops	75			
		Small Grains	61			
		Urban/Recreational Grasses	61			
		Woody Wetlands	55			
		Emergent Herbaceous Wetlands	69			
			Total =	100		
C	4.4	Open Water	100			
		Developed, Open Space	79	6	0.3	20.5
		Developed, Low Intensity	83	1	0.0	2.0
		Developed, Medium Intensity	89	3	0.1	12.2
		Developed, High Intensity	94	2	0.1	6.2
		Barren Land (Rock / Sand / Clay)	91			
		Deciduous Forest	70	0	0.0	1.1
		Evergreen Forest	70			
		Mixed Forest	70	0	0.0	0.2
		Shrub / Scrub	74			
		Grasslands / Herbaceous	71			
		Pasture / Hay	74	1	0.0	2.1
		Cultivated Crops	82	88	3.9	317.2
		Small Grains	74			
		Urban/Recreational Grasses	74			
		Woody Wetlands	70			
		Emergent Herbaceous Wetlands	79			
			Total =	100		
D	94.5	Open Water	100	0	0.3	25.7
		Developed, Open Space	84	5	4.5	378.7
		Developed, Low Intensity	87	5	4.7	408.1
		Developed, Medium Intensity	91	3	3.1	282.0
		Developed, High Intensity	95	3	3.0	288.2
		Barren Land (Rock / Sand / Clay)	94	0	0.0	2.0
		Deciduous Forest	77	9	8.1	625.0
		Evergreen Forest	77			
		Mixed Forest	77	1	1.3	99.0
		Shrub / Scrub	80			
		Grasslands / Herbaceous	78	0	0.0	0.7
		Pasture / Hay	80	2	1.6	126.9
		Cultivated Crops	85	71	67.2	5707.8
		Small Grains	80			
		Urban/Recreational Grasses	80			
		Woody Wetlands	77	1	0.8	59.3
		Emergent Herbaceous Wetlands	84			
			Total =	100		
Water	0.9926042	Open Water	100		1.0	99.3
Totals	100				100	8471.1
					CN =	84.7
					Use CN	**85**

Composite Curve Number Calculation Worksheet

Burke Project No.	20-0396.00000	Calcs. By	IKH	Date	2/17/2021
Burke Project Name	Amity Ditch Floodplain Reduction Feasibility Study	Check By	MWM	Date	2/18/2021
Basin Name	**5**				

Soil Name and Hydrologic Group	% Area for Each Soil Type	Cover Description	CN	% Land Use Area per Soil Type	% Total Area	CN X % Total Area
A		Open Water	100			
		Developed, Open Space	51			
		Developed, Low Intensity	61			
		Developed, Medium Intensity	75			
		Developed, High Intensity	89			
		Barren Land (Rock / Sand / Clay)	77			
		Deciduous Forest	25			
		Evergreen Forest	25			
		Mixed Forest	25			
		Shrub / Scrub	39			
		Grasslands / Herbaceous	30			
		Pasture / Hay	39			
		Cultivated Crops	64			
		Small Grains	39			
		Urban/Recreational Grasses	39			
		Woody Wetlands	30			
		Emergent Herbaceous Wetlands	49			
			Total =			
B	0.2	Open Water	100			
		Developed, Open Space	68	16	0.0	1.7
		Developed, Low Intensity	75			
		Developed, Medium Intensity	84			
		Developed, High Intensity	92			
		Barren Land (Rock / Sand / Clay)	86			
		Deciduous Forest	55			
		Evergreen Forest	55			
		Mixed Forest	55			
		Shrub / Scrub	61			
		Grasslands / Herbaceous	58			
		Pasture / Hay	61			
		Cultivated Crops	75	84	0.1	10.0
		Small Grains	61			
		Urban/Recreational Grasses	61			
		Woody Wetlands	55			
		Emergent Herbaceous Wetlands	69			
			Total =	100		
C	9.4	Open Water	100	0	0.0	3.8
		Developed, Open Space	79	5	0.5	36.4
		Developed, Low Intensity	83	3	0.3	24.2
		Developed, Medium Intensity	89	0	0.0	0.0
		Developed, High Intensity	94			
		Barren Land (Rock / Sand / Clay)	91			
		Deciduous Forest	70	3	0.3	20.8
		Evergreen Forest	70			
		Mixed Forest	70			
		Shrub / Scrub	74			
		Grasslands / Herbaceous	71	0	0.0	1.2
		Pasture / Hay	74	28	2.7	198.5
		Cultivated Crops	82	60	5.6	461.9
		Small Grains	74			
		Urban/Recreational Grasses	74			
		Woody Wetlands	70			
		Emergent Herbaceous Wetlands	79			
			Total =	100		
D	89.9	Open Water	100	0	0.0	1.8
		Developed, Open Space	84	4	4.0	334.9
		Developed, Low Intensity	87	5	4.2	362.2
		Developed, Medium Intensity	91	0	0.4	40.5
		Developed, High Intensity	95			
		Barren Land (Rock / Sand / Clay)	94			
		Deciduous Forest	77	1	1.2	88.6
		Evergreen Forest	77			
		Mixed Forest	77	0	0.3	24.1
		Shrub / Scrub	80			
		Grasslands / Herbaceous	78	0	0.0	0.2
		Pasture / Hay	80	7	6.5	518.0
		Cultivated Crops	85	82	73.4	6236.9
		Small Grains	80			
		Urban/Recreational Grasses	80			
		Woody Wetlands	77			
		Emergent Herbaceous Wetlands	84	0	0.0	1.5
			Total =	100		
Water	0.4736239	Open Water	100		0.5	47.4
Totals	100				100	8414.6
					CN =	84.1
					Use CN	**84**

Composite Curve Number Calculation Worksheet

Burke Project No.	20-0396.00000	Calcs. By	IKH	Date	2/17/2021
Burke Project Name	Amity Ditch Floodplain Reduction Feasibility Study	Check By	MWM	Date	2/18/2021
Basin Name	**6**				

Soil Name and Hydrologic Group	% Area for Each Soil Type	Cover Description	CN	% Land Use Area per Soil Type	% Total Area	CN X % Total Area
A		Open Water	100			
		Developed, Open Space	51			
		Developed, Low Intensity	61			
		Developed, Medium Intensity	75			
		Developed, High Intensity	89			
		Barren Land (Rock / Sand / Clay)	77			
		Deciduous Forest	25			
		Evergreen Forest	25			
		Mixed Forest	25			
		Shrub / Scrub	39			
		Grasslands / Herbaceous	30			
		Pasture / Hay	39			
		Cultivated Crops	64			
		Small Grains	39			
		Urban/Recreational Grasses	39			
		Woody Wetlands	30			
		Emergent Herbaceous Wetlands	49			
			Total =			
B	24.5	Open Water	100			
		Developed, Open Space	68	10	2.6	173.5
		Developed, Low Intensity	75	6	1.5	114.2
		Developed, Medium Intensity	84	1	0.2	14.6
		Developed, High Intensity	92	0	0.0	1.5
		Barren Land (Rock / Sand / Clay)	86			
		Deciduous Forest	55	2	0.4	20.4
		Evergreen Forest	55			
		Mixed Forest	55	1	0.2	8.6
		Shrub / Scrub	61			
		Grasslands / Herbaceous	58	0	0.1	6.6
		Pasture / Hay	61	6	1.5	90.9
		Cultivated Crops	75	74	18.1	1360.1
		Small Grains	61			
		Urban/Recreational Grasses	61			
		Woody Wetlands	55	0	0.0	0.0
		Emergent Herbaceous Wetlands	69			
			Total =	100		
C	16.5	Open Water	100	0	0.0	4.9
		Developed, Open Space	79	11	1.8	145.1
		Developed, Low Intensity	83	4	0.7	54.6
		Developed, Medium Intensity	89	1	0.2	14.7
		Developed, High Intensity	94			
		Barren Land (Rock / Sand / Clay)	91	0	0.0	0.5
		Deciduous Forest	70	13	2.2	153.3
		Evergreen Forest	70			
		Mixed Forest	70	0	0.0	0.3
		Shrub / Scrub	74			
		Grasslands / Herbaceous	71			
		Pasture / Hay	74	39	6.5	480.7
		Cultivated Crops	82	31	5.1	415.1
		Small Grains	74			
		Urban/Recreational Grasses	74			
		Woody Wetlands	70			
		Emergent Herbaceous Wetlands	79			
			Total =	100		
D	57.8	Open Water	100	0	0.1	6.5
		Developed, Open Space	84	10	5.7	476.1
		Developed, Low Intensity	87	6	3.3	290.2
		Developed, Medium Intensity	91	1	0.4	36.4
		Developed, High Intensity	95	0	0.0	0.4
		Barren Land (Rock / Sand / Clay)	94	0	0.0	1.2
		Deciduous Forest	77	3	1.5	116.1
		Evergreen Forest	77			
		Mixed Forest	77	0	0.1	9.4
		Shrub / Scrub	80			
		Grasslands / Herbaceous	78	0	0.0	1.5
		Pasture / Hay	80	15	8.6	690.9
		Cultivated Crops	85	66	38.1	3236.4
		Small Grains	80			
		Urban/Recreational Grasses	80			
		Woody Wetlands	77			
		Emergent Herbaceous Wetlands	84			
			Total =	100		
Water	1.1592546	Open Water	100		1.2	115.9
Totals	100				100	8040.5
					CN =	80.4
					Use CN	**80**

APPENDIX 2: HYDRAULIC MODEL RESULTS

HEC-RAS Plan: Existing   River: AmityDitch   Reach: Study776   Profile: 1%

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Study776	34146	1%	157.00	717.22	721.89		721.91	0.000462	1.35	272.46	325.64	0.17
Study776	33518	1%	157.00	716.33	721.34	719.46	721.42	0.001481	2.56	107.09	162.81	0.31
Study776	33069	1%	157.00	715.76	721.18	718.69	721.19	0.000232	1.16	329.92	385.48	0.13
Study776	32337	1%	410.00	715.31	720.93	719.96	720.95	0.000377	1.49	742.73	606.62	0.16
Study776	31600	1%	410.00	714.81	720.67	719.27	720.68	0.000334	1.52	621.37	477.69	0.15
Study776	31086	1%	410.00	714.41	720.02		720.27	0.003179	4.82	184.65	187.62	0.46
Study776	30952	1%	410.00	714.30	719.67		719.83	0.002938	4.05	245.66	321.04	0.45
Study776	30843	1%	410.00	714.20	719.48		719.58	0.001712	3.08	305.15	354.86	0.35
Study776	30630	1%	410.00	714.08	719.44		719.45	0.000220	1.12	895.18	613.52	0.12
Study776	30527	1%	410.00	714.02	719.42		719.43	0.000185	1.06	984.30	688.28	0.11
Study776	30318	1%	410.00	713.80	719.39		719.39	0.000168	0.90	1083.28	804.32	0.10
Study776	29940	1%	410.00	713.62	719.35		719.36	0.000052	0.59	1767.60	1070.89	0.06
Study776	29793	1%	410.00	713.61	719.35		719.35	0.000042	0.52	1984.87	1206.66	0.05
Study776	29695	1%	410.00	713.60	719.34		719.35	0.000035	0.47	2165.34	1293.99	0.05
Study776	29590	1%	410.00	713.59	719.34	717.43	719.34	0.000030	0.46	2260.12	1354.37	0.05
Study776	29561 Farm Crossing		Culvert									
Study776	29508	1%	410.00	713.58	719.34		719.34	0.000029	0.40	2410.01	1497.53	0.04
Study776	29402	1%	410.00	713.31	719.34		719.34	0.000026	0.43	2482.87	1466.90	0.04
Study776	29104	1%	410.00	713.13	719.33		719.33	0.000036	0.52	2160.15	1326.79	0.05
Study776	28820	1%	410.00	712.96	719.27	717.22	719.30	0.000517	1.98	471.06	1229.15	0.20
Study776	28514	1%	410.00	712.65	718.92	718.09	719.03	0.001632	3.30	241.26	254.97	0.34
Study776	28217	1%	410.00	712.37	718.58		718.62	0.001006	2.49	434.80	468.91	0.26
Study776	27896	1%	410.00	712.06	718.30	716.80	718.36	0.000743	2.43	467.47	695.42	0.24
Study776	27672	1%	410.00	711.74	718.08	715.85	718.16	0.000950	2.71	230.02	930.36	0.27
Study776	27559 SR 44		Culvert									
Study776	27414	1%	410.00	711.72	717.93	716.09	718.12	0.002010	3.61	136.90	551.56	0.38
Study776	27140	1%	410.00	711.80	717.83	716.74	717.84	0.000334	1.53	783.32	680.89	0.15
Study776	26840	1%	410.00	711.82	717.78		717.79	0.000112	0.97	1124.17	682.88	0.09
Study776	26542	1%	466.00	712.06	717.77	715.77	717.77	0.000027	0.48	2414.32	1151.88	0.05

HEC-RAS Plan: Proposed River: AmityDitch Reach: Study776 Profile: 1%

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Study776	34146	1%	157.00	717.22	720.96	719.81	720.99	0.000675	1.41	111.12	189.90	0.20
Study776	33518	1%	157.00	716.33	720.74	718.92	720.75	0.000233	0.99	158.57	100.18	0.12
Study776	33069	1%	157.00	715.76	720.67	718.32	720.68	0.000119	0.80	197.17	313.98	0.09
Study776	32337	1%	410.00	715.31	720.37	718.45	720.42	0.000642	1.93	234.41	101.60	0.20
Study776	31600	1%	410.00	714.81	719.90	717.97	719.96	0.000623	1.91	242.55	105.19	0.20
Study776	31086	1%	410.00	714.41	719.59	717.51	719.64	0.000594	1.87	227.39	91.64	0.19
Study776	30952	1%	410.00	714.30	719.51	717.39	719.57	0.000568	1.87	220.38	77.47	0.19
Study776	30896 Prop. Crossing 1		Culvert									
Study776	30843	1%	410.00	714.20	719.44	717.24	719.50	0.000510	1.90	215.93	77.63	0.19
Study776	30630	1%	410.00	714.08	719.34	717.18	719.39	0.000502	1.80	245.73	90.13	0.18
Study776	30576 Prop. Crossing 2		Culvert									
Study776	30527	1%	410.00	714.02	719.27	717.11	719.32	0.000546	1.91	214.94	91.12	0.19
Study776	30318	1%	410.00	713.80	719.16	716.92	719.21	0.000496	1.77	241.42	96.08	0.18
Study776	29940	1%	410.00	713.62	718.99	716.70	719.04	0.000427	1.69	278.12	122.36	0.17
Study776	29793	1%	410.00	713.61	718.92	716.72	718.97	0.000489	1.77	251.47	126.60	0.18
Study776	29742 Prop. Crossing 3		Culvert									
Study776	29695	1%	410.00	713.60	718.85	716.68	718.91	0.000541	1.93	212.87	132.50	0.19
Study776	29590	1%	410.00	713.59	718.80	716.61	718.85	0.000493	1.80	248.01	147.15	0.18
Study776	29508	1%	410.00	713.58	718.76		718.81	0.000541	1.82	248.76	121.77	0.19
Study776	29402	1%	410.00	713.31	718.71		718.75	0.000429	1.71	260.12	103.26	0.17
Study776	29104	1%	410.00	713.13	718.58		718.62	0.000435	1.71	257.63	101.03	0.17
Study776	28820	1%	410.00	712.96	718.47	716.03	718.51	0.000384	1.64	274.30	115.19	0.16
Study776	28514	1%	410.00	712.65	718.36	715.81	718.39	0.000361	1.57	293.35	134.36	0.15
Study776	28217	1%	410.00	712.37	718.26		718.29	0.000318	1.51	276.67	105.30	0.14
Study776	27896	1%	410.00	712.06	718.18	715.19	718.21	0.000214	1.31	385.38	184.98	0.12
Study776	27672	1%	410.00	711.74	718.15	714.79	718.16	0.000140	1.15	413.25	1035.97	0.10
Study776	27559 SR 44		Culvert									
Study776	27414	1%	410.00	711.72	717.93	716.09	718.12	0.002010	3.61	136.90	551.56	0.38
Study776	27140	1%	410.00	711.80	717.83	716.74	717.84	0.000334	1.53	783.32	680.89	0.15
Study776	26840	1%	410.00	711.82	717.78		717.79	0.000112	0.97	1124.17	682.88	0.09
Study776	26542	1%	466.00	712.06	717.77	715.77	717.77	0.000027	0.48	2414.32	1151.88	0.05