ARBORWALK WESTERN DRAINAGE AREA - MACRO DRAINAGE STUDY

Prepared for:

Scenic Development LLC

6731 W 121st Street, Suite 100

Overland Park, KS 66209

August 2022

Revision January 2023

Olsson Project No. A21-04054

olsson®

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

APPENDICES

1. GENERAL INFORMATION

This Marco Drainage study is to evaluate the western drainage area of the Arborwalk Development. This study is specifically prepared to review the future 15.84-acre mixed-use area within the Arborwalk development, referred to as “Arborwalk West” from this point on. We will analyze only the west portion of the Arborwalk development in the watershed that drains to an existing culvert crossing Highway 150, just west of Arborridge Drive. This area has been partially developed; however, comprehensive stormwater management detail records were not locatable. Since Arborwalk West is at the bottom of the watershed, this study will analyze the total drainage area from predevelopment to ideal build out to better understand stormwater management needs. The development contains commercial, open space, residential, public right-of-way and utility main extensions required to serve the development. Most of Arborwalk drains south under Highway 150 to an unnamed tributary that drains to Raintree Lake. An undeveloped area northwest of Arborwalk drains northwest through a storm drainage system to Mouse Creek. The northwest area draining to Mouse Creek has not been analyzed for this study.

1.1 Project Location

Arborwalk West is in the City of Lee’s Summit, Missouri. The area to be developed is bounded by SW Pryor Road to the west and Highway 150 to the south. Residential areas bound the area to the north and east.

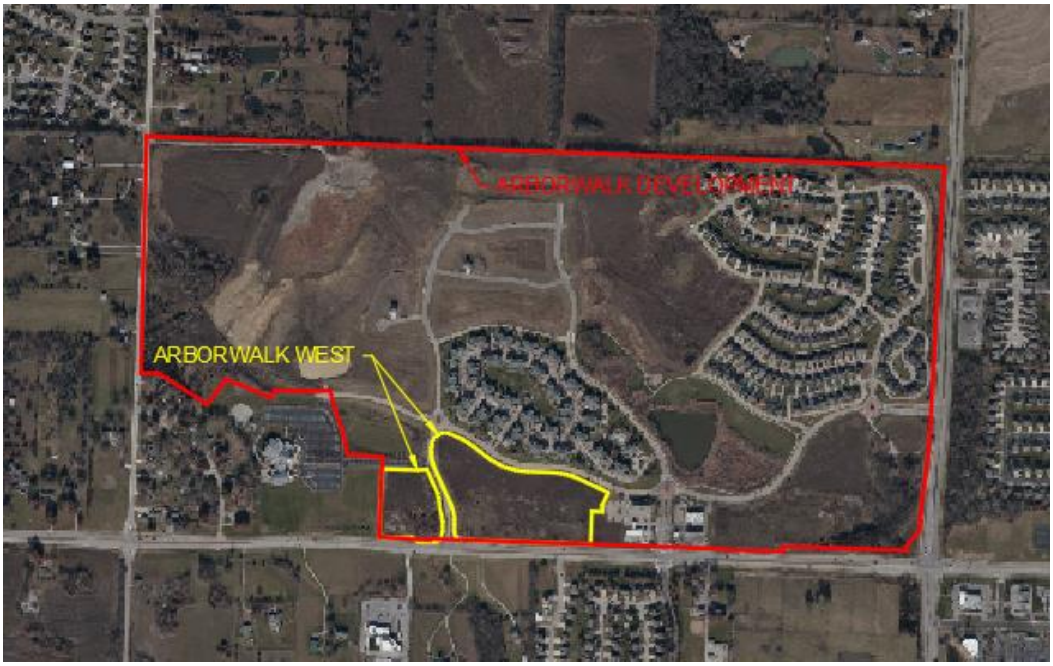


Figure 1. Arborwalk West Location Map

1.2 Federal Emergency Management Agency Floodplain Classification

Arborwalk West lies entirely within areas determined to be outside the 0.2% annual chance floodplain (unshaded Zone X) as depicted on the FEMA Flood Insurance Rate Map (FIRM) Community Panel No 29095C0531G (City of Lee's Summit, Missouri), revised January 20, 2017. A copy of the FEMA FIRM panel is included in Appendix E.

1.3 Soil Classifications

A geotechnical investigation has not been completed for this site. Soil Maps published in the NRCS Web Soils Survey for Jackson County, Missouri categorize soils in the watershed as:

Table 1. Soil Classifications

Symbol	Name	Slopes	Hydrologic Soil Group
10000	Arisburg silt loam	1-5%	C
10082	Arisburg-Urban land complex	1-5%	C
10116	Sampsel silty clay loam	2-5%	C/D
10117	Sampsel silty clay loam	5-9%	C/D
10122	Sharpsburg silt loam	5-9%	C
10128	Sharpsburg-Urban land complex	2-5%	D
10181	Udarents-Urban land-Sampsel complex	5-9%	C

NRCS Runoff Curve Numbers (CN's) in this study have been assigned to tributary areas onsite, based upon these Hydrologic Soil Groups and associated existing and proposed land use. Land uses were determined using zoning maps, aerial photos, and site visits. A copy of the NRCS printout is included in Appendix D.

1.4 Existing Stormwater Studies and Systems

An existing stormwater study for this area is believed to have been created. However, the existing stormwater study has not been located and therefore is being recreated with this study.

Design updates to Missouri State Highway 150 from Horridge Road to Market Street in Lee's Summit was commissioned by the Missouri Department of Transportation resulting in construction documents titled "Missouri Highways and Transportation Commission Plans for Proposed State Highway", June 10, 2009 by GBA Architects, job number J4U1130D. Highway updates include design information of a 6' x 4' reinforced concrete box (R.C.B.) culvert that drains stormwater from Arborwalk West.

2. METHODOLOGY

The storm drainage study will be analyzed in accordance with the February 16, 2011 edition of the Kansas City Metropolitan Chapter, American Public Works Association, (KCAPWA) Construction and Material Specifications, Section 5601.5.A.4, as currently adopted by the City of Kansas City, Missouri:

"New development or redevelopment as defined in Section 5601.2 shall incorporate stormwater management measures to control runoff from the site. Allowable runoff from a site may be limited by the need to minimize downstream flood damage, prevent erosion, and/or minimize impacts to the ecology and water quality of the downstream drainage system."

"…peak runoff control is provided for the 2%, 10%, and 100% chance storms and volumetric and/or extended detention control of the 90% mean annual event storm for broad protection of the receiving system."

The Existing Conditions hydrology will be evaluated in Section 3, and Future Conditions hydrology will be computed in Section 4. The Future Conditions discharge data for each stage of development will be compared to the Existing Conditions results; variations in quantity and rate of stormwater discharge between these models will represent the hydrologic impact generated by future development. The overall stormwater management plan will be designed utilizing this information. Section 3 assumes agricultural land use before development in 2004 within the tributary watershed, and pre-development conditions within the project boundary. Section 4 assumes future land use before development in 2004 within the tributary sub-watersheds, and fully developed conditions within the project area boundary.

Runoff rates and detention hydraulics were analyzed using Autodesk Storm and Sanitary Analysis 2022 (SSA). SSA utilizes the following approved methods to model Existing and Future Conditions for stormwater runoff.

- NRCS TR-55 Unit Hydrograph Method
- 2-,10-, and 100-year Return Frequency, 24-hr. Storm Precipitation Depths (TP-40)
- ARC Type II Soil Moisture Conditions
- 24-Hour NRCS Type II Rainfall Distribution
- Runoff Curve Numbers per NRCS TR-55 (Tables 2-2a - 2-2c) and KCAPWA Section 5602.3
- NRCS TR-55 Methods for determination of Time of Concentration and Travel Time.
  NOTE: SSA models use "Time of Concentration" rather than "Lag Time" for computing subarea hydrology.

Stormwater runoff models were created for the 2%, 10%, and 100% design storm events. The precipitation depths used in the analyses have been interpolated from the "Technical Paper No.40

Rainfall Frequency Atlas of the United States" (TP-40) isopluvial maps (May 1961). The following table summarizes the rainfall depths used in this analysis:

Table 2. Precipitation Depths.

Return Period	24-Hour Precipitation Depth (in.)
1-Year (100% Storm)	3.5
10-Year (10% Storm)	5.3
100-Year (1% Storm)	7.7

3. EXISTING CONDITIONS

To quantify the effects of development of this project, the following area and point of interest has been used for Existing and Future Conditions analyses. See Exhibit "EX-300" in Appendix A, Existing Conditions Drainage Area Map.

Outfall 1

Project area tributary to Outfall 1 slopes from north to south to an existing R.C.B. under Highway 150, then flows south offsite to an unnamed tributary to Lake Winnebago. Water travels over the undeveloped site to Outfall 1 via sheet flow and shallow concentrated flow. Outfall 1 is the end of the R.C.B. as it flows to the tributary.

The design of the existing R.C.B. has been reviewed and found to be undersized. The drainage area for the R.C.B. from the existing plans in Appendix F shows 87 acres, while this study has determined an existing drainage area of 112 acres. The existing conditions analysis will not consider the design from the Highway 150 plan set.

Runoff Curve Numbers have been developed for the outfall area, based upon the past land use obtained from aerial photography of year 2003, before development of this area began. The site at that time was agriculture. Existing site model input data is summarized in Table 3, below. Refer to the Existing Conditions Drainage Area Map (EX-300) located in Appendix A for Runoff Curve Number (CN) values and model calculations located in Appendix C with Time of Concentration (Tc) calculations.

Table 3-1. Existing Site Data

Subbasin	Drainage Area (ac.)	CN	Tc (min)	Q_2	Q_{10}	Q_{100}
Subarea 1	112.03	82.00	25.54	193.20	362.61	595.19

These routings, drainage area, and CN and Tc values for the corresponding areas were used as input to the Existing Conditions model to evaluate the existing stormwater hydrology for the project. The resulting peak flows of the hydrologic routing are provided in Table 3-2, below. Hydrographs can be found in Appendix B and model output data can be found in its entirety in Appendix C.

Table 3-2. Existing Peak Discharge Rates

Outfall	Q_2 (cfs)	T_{P-1}	Q_{10} (cfs)	T_{P-10}	Q_{100} (cfs)	T_{P-100}
Outfall 1	192.80	12.15	362.34	12.15	517.78	12.03

The design flow capacity of Outfall 1 is 438.12 cfs. Outfall 1 can handle the 2-year and 10-year storms, but not the 100-year storm. Additionally, the 50-year existing storm event is 517.44 cfs through the pipe under pressure which overflows and will not completely be contained within the pipe. It is noted that the 50-year and 100-year flows through Outfall 1 are similar. This is due to the R.C.B. under pressure flow in both storm events. The R.C.B. was to be designed for the 50-year storm event, but the model shows that the R.C.B. is undersized.

4. FUTURE CONDITIONS ANALYSIS

Future development contains commercial, open space, residential, public right-of-way and utility main extensions required to serve each development. The sections below will provide updated model calculation results for Future Conditions.

4.1 Future Conditions Site Hydrology

The subarea in the existing model has been divided into subbasins due to the tributary shifts caused by site grading and sewer construction, as shown in Exhibit “EX-301” in Appendix A, Future Conditions Drainage Area Map. Table 4-1, below, provides a summary of the future site tributary areas. Refer to the Future Conditions Drainage Area Map (EX-301) located in Appendix A for Runoff CN values and model calculations located in Appendix C with Time of Concentration (Tc) calculations.

Subareas 1, 2, 3, and 4 are tributary to the single Outfall 1 as in existing conditions south of the site. Subarea 1 will flow to a proposed basin and be released from there through a storm system. Subareas 2, 3, and 4 will be routed through a storm system to Outfall 1. At the time of future development, further calculations will determine if additional stormwater measures need to be taken to control a possible increase in flows due to development.

As of the writing of this study, a dry detention basin is in operation for stormwater from Subarea 1 called Basin 1. Basin 1 collects stormwater from Subarea 1 and releases stormwater from an outlet structure to a storm system. Not all information for the outlet structure could be determined. The outlet structure must be revised to make the outlet structure useable. The additional measures are noted in the detail below.

Subarea 1 – Basin 1:

- Top of Dam: 1012.00
- Bottom Elevation: 1004.00
- Outlet Structure
    - 6’ x 8’ Outlet Structure, Top Elevation of 1009.49
    - Top Grate: 3’ x 6’ standard grate, 1009.49
    - Top Opening, 1 – Side: 14” V x 96” H, Bottom Elevation = 1007.99
    - Low Opening (to be added), 1 – Side: 30” V x 96” H, Bottom Elevation = 1004.00

Outfall 1:

- 6’ x 4’ R.C.B.
- 132’ length, 2.00% Slope
    - Inlet Elevation: 991.73
    - Outlet Elevation: 989.00

Table 4-1. Future Site Data

Subarea	Drainage Area (ac.)	CN	Tc (min)	Q_2	T_{P-2} (hr)	Q_{10}	T_{P-10} (hr)	Q_{100}	T_{P-100} (hr)
Subarea 1	84.25	88.31	18.99	216.18	12.08	368.00	12.08	568.94	12.08
Subarea 2	5.65	88.24	16.52	15.33	12.07	26.07	12.08	40.33	12.08
Subarea 3	4.31	90.55	5.00	16.68	11.93	27.43	11.93	41.57	11.93
Subarea 4	8.69	89.28	5.00	32.31	11.93	54.05	11.93	82.72	11.93

Table 4-2. Future Conditions Detention Basin Data

	Peak Q In (cfs)	T_P In (hr.)	Peak Q Out (cfs)	T_P Out (hr.)	Max V_R (ac-ft)	Peak W.S.E. (ft)
Basin 1						
2-Year	215.64	12.08	84.98	12.50	4.11	1007.46
10-Year	366.28	12.17	105.56	12.50	8.53	1009.18
100-Year	566.28	12.17	129.09	12.50	14.96	1011.40

Although the future conditions increase the peak flows due to curve number for each subarea, Basin 1 decreases the Peak Out flows decreasing the amount of flow towards Outfall 1. The peak W.S.E. for a 100-year storm event is 0.60’ from the existing basin dam.

From development within the subbasin areas and corresponding reactions from the stormwater detention basin, Table 4-3 below shows the updated runoff results to the outfalls for the watershed.

Table 4-3. Future Conditions Peak Discharge Rates

Outfall	Q_2 (cfs)	T_{P-2} (hr)	Q_{10} (cfs)	T_{P-10} (hr)	Q_{100} (cfs)	T_{P-100} (hr)
Outfall 1	116.55	12.05	171.10	12.03	236.05	11.95

Comparing the future flowrates for the outfall shown above with the outfall within the Existing Conditions results, it is shown that the flowrate is reduced from existing conditions. Cumulative runoff volume curves that depict the future effects of the stormwater management facilities and compare existing and proposed conditions hydrographs at the outfall locations are provided in Appendix B of this report. Refer to the tables below, and the Volume Comparison hydrographs provided in Appendix B for graphical representation of the existing and proposed conditions stormwater hydrology in comparison to the existing conditions peak flowrates.

5. RESULTS

As shown in the discussion and tables in the previous sections, the existing R.C.B. is undersized for existing conditions. Future development includes a detention basin for the residential development to the north that decreases the amount of flow to the R.C.B. The storm system and detention basin reduce the flow to the R.C.B. that the R.C.B. will be no longer undersized. Table 5-1, below, summarizes future conditions results and compares them with existing conditions.

Table 5-1. Future Conditions Outfall Discharge Comparison

Outfall		Q_2 (cfs)	Q_{10} (cfs)	Q_{100} (cfs)
1	Existing	192.80	362.34	517.78
	Future	116.55	171.10	236.05
	Difference	-76.25	-191.24	-281.73

6. CONCLUSION

This Macro Stormwater Drainage Study has been prepared for the future development to establish a comprehensive stormwater management plan for the western area of the Arborwalk Development. The stormwater management plan has been designed to achieve compliance with current design criteria in effect for the City of Lee's Summit, Missouri.

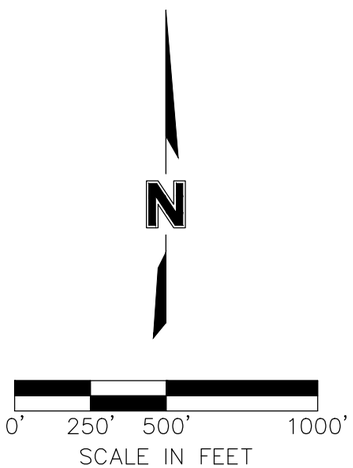
This study demonstrated the overall compliance with LS Section 5600.

APPENDIX A
Exhibits

LAND COVER LEGEND			
	TREATMENT	AREA (AC.)	CN SOIL C
	UNDEVELOPED CONTOURED CROPS	112.03	82

BOUNDARY LEGEND

TRIBUTARY DRAINAGE BOUNDARY



olsson
Olsson - Civil Engineering
Missouri Certificate of Authority #001592
1301 Burlington Street
North Kansas City, MO 64116
TEL 816.361.1177
www.olsson.com

REV. NO.	DATE	REVISIONS DESCRIPTION
		REVISIONS

EXISTING CONDITIONS DRAINAGE AREA MAP

ARBORWALK WEST

LEE'S SUMMIT, MISSOURI

2022

drawn by: MO
checked by: SS
approved by: JS
project no.:
drawing no.: B21-04054

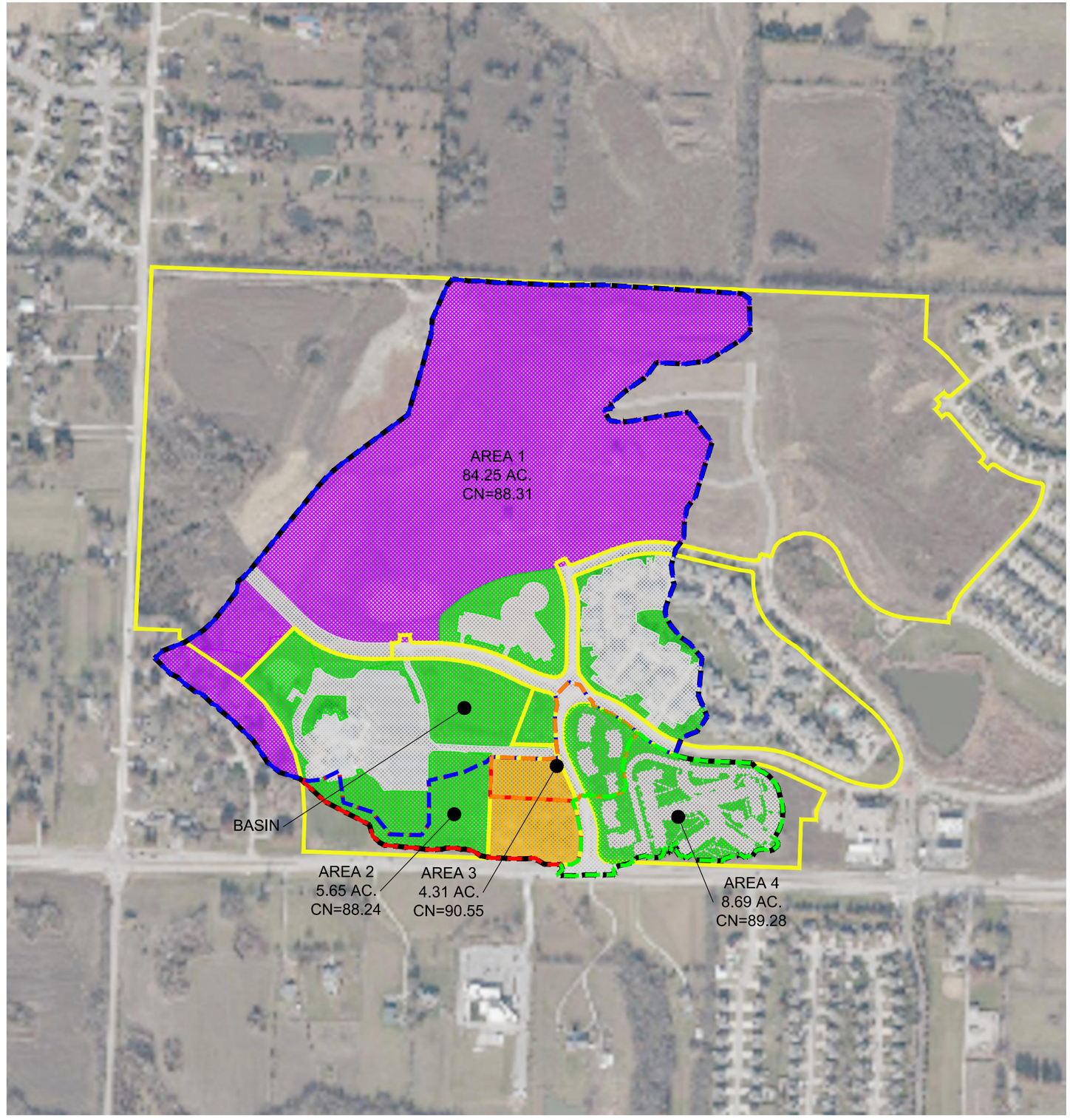
SHEET EX-300

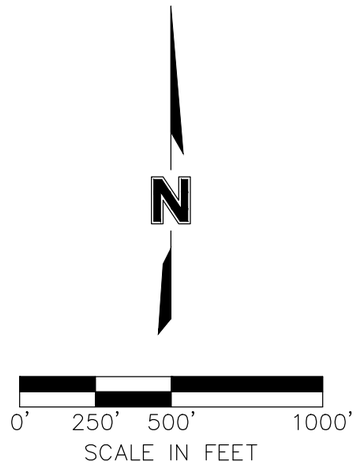
DWG: F:\2021\04001-04500\021-04054-B\40-Design\Reports\dNCV\Stormwater_Report_B2104054\Rev_0\Stormwater Report Exhibits\EX-300_Existing_Conditions.dwg USER: ssoylor
DATE: Aug 18, 2022 12:37pm XREFS: C_XBASE_02102689 C_PBNDY_02102689 C_FBASE_02102689

LAND COVER LEGEND			
	TREATMENT	AREA (AC.)	CN
	COMMERCIAL	8.04	95
	IMPERVIOUS	25.36	98
	OPEN SPACE	21.73	80
	RESIDENTIAL	47.77	87

LEGEND

- DRAINAGE AREA 1
- DRAINAGE AREA 2
- DRAINAGE AREA 3
- DRAINAGE AREA 4
- TRIBUTARY DRAINAGE BOUNDARY
- PROPERTY BOUNDARY





olsson

Olsson - Civil Engineering
Missouri Certificate of Authority #001592
1301 Burlington Street
North Kansas City, MO 64116
TEL 816.361.1177
www.olsson.com

REVISIONS

REV. NO.	DATE	REVISIONS DESCRIPTION

FUTURE CONDITIONS DRAINAGE AREA MAP

ARBORWALK WEST

LEE'S SUMMIT, MISSOURI

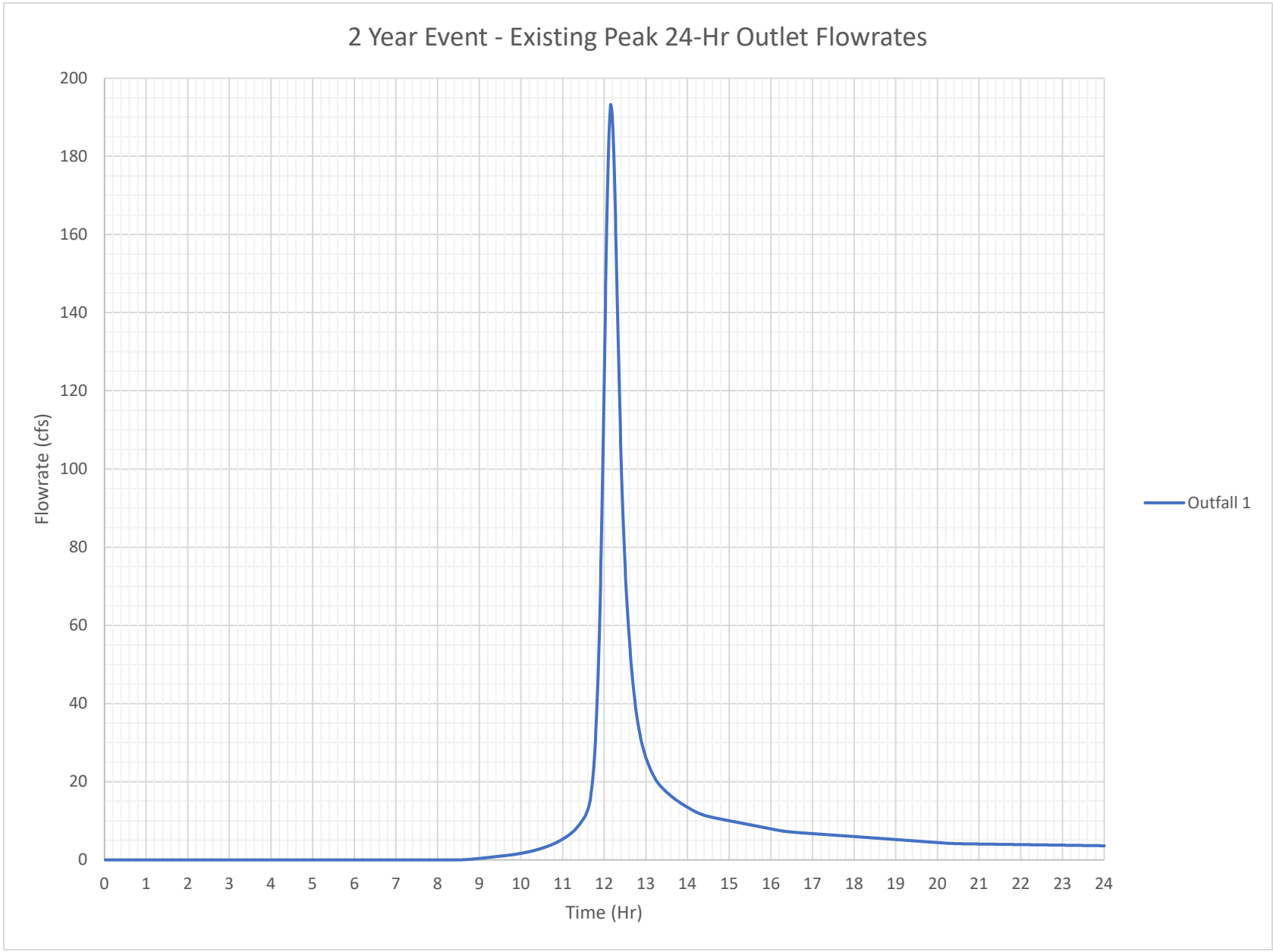
2022

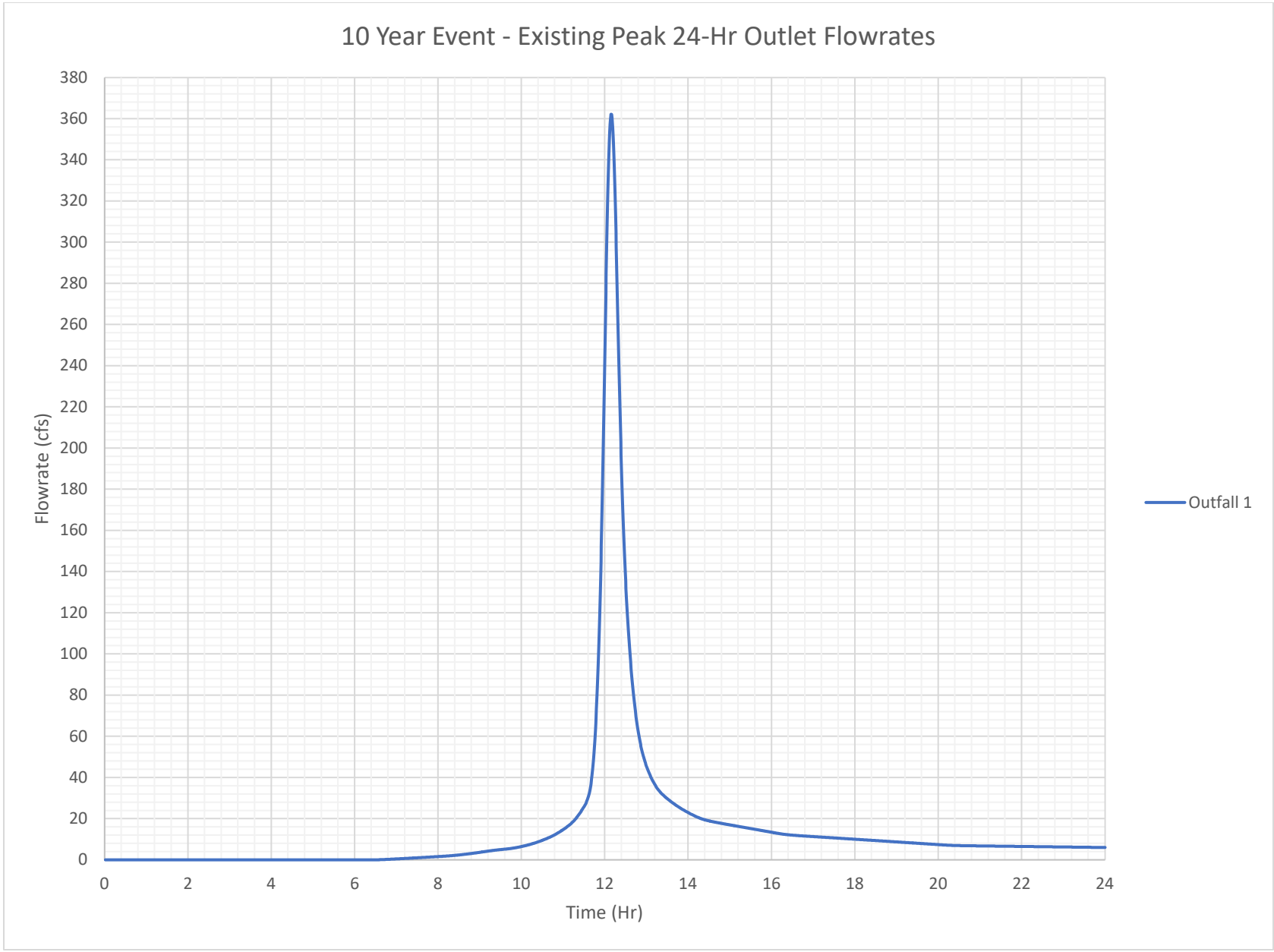
drawn by: MO
checked by: SS
approved by: JS
project no.:
drawing no.: 021-02689

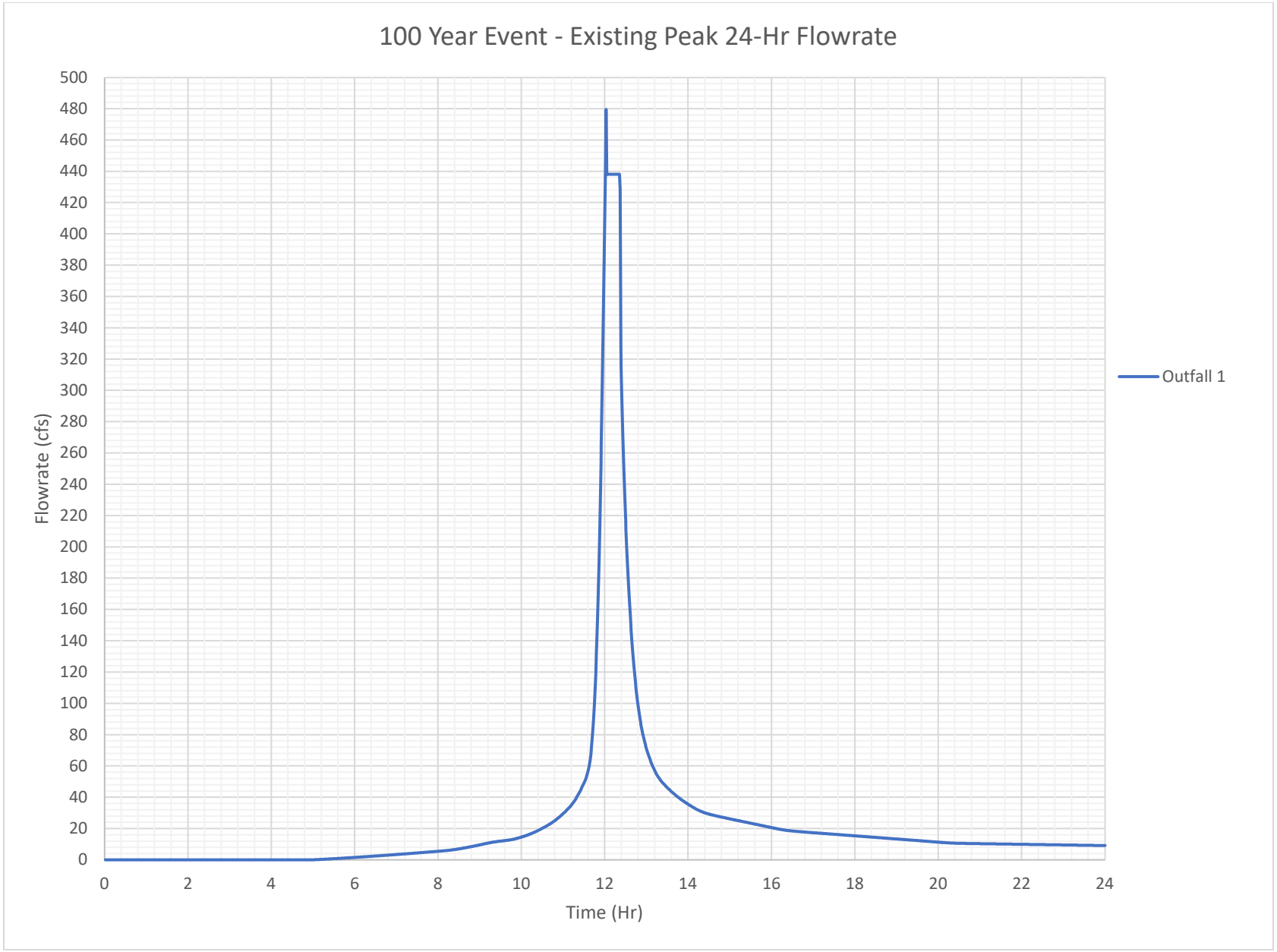
SHEET
EX-301

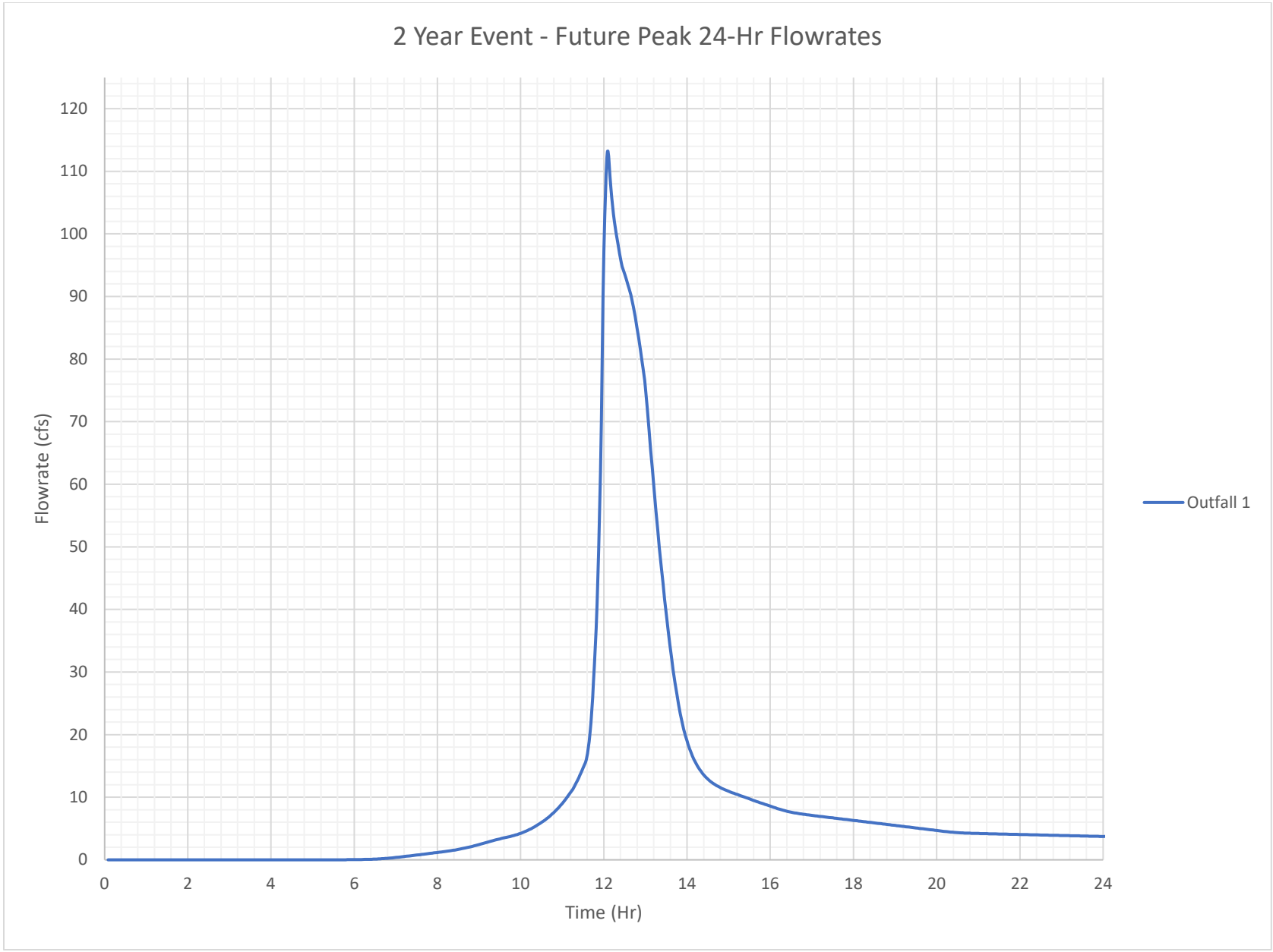
DWG: F:\2021\04001-04500\021-04054-B\40-Design\Reports\GNCV\Stormwater_Report_B2104054\Rev_0\Stormwater Report Exhibits\EX-301_Future_Conditions.dwg USER: ssaylor
DATE: Aug 24, 2022 1:43pm XREFS: C_XBASE_02102689 C_PBNDY_02102689 C_FBASE_02102689

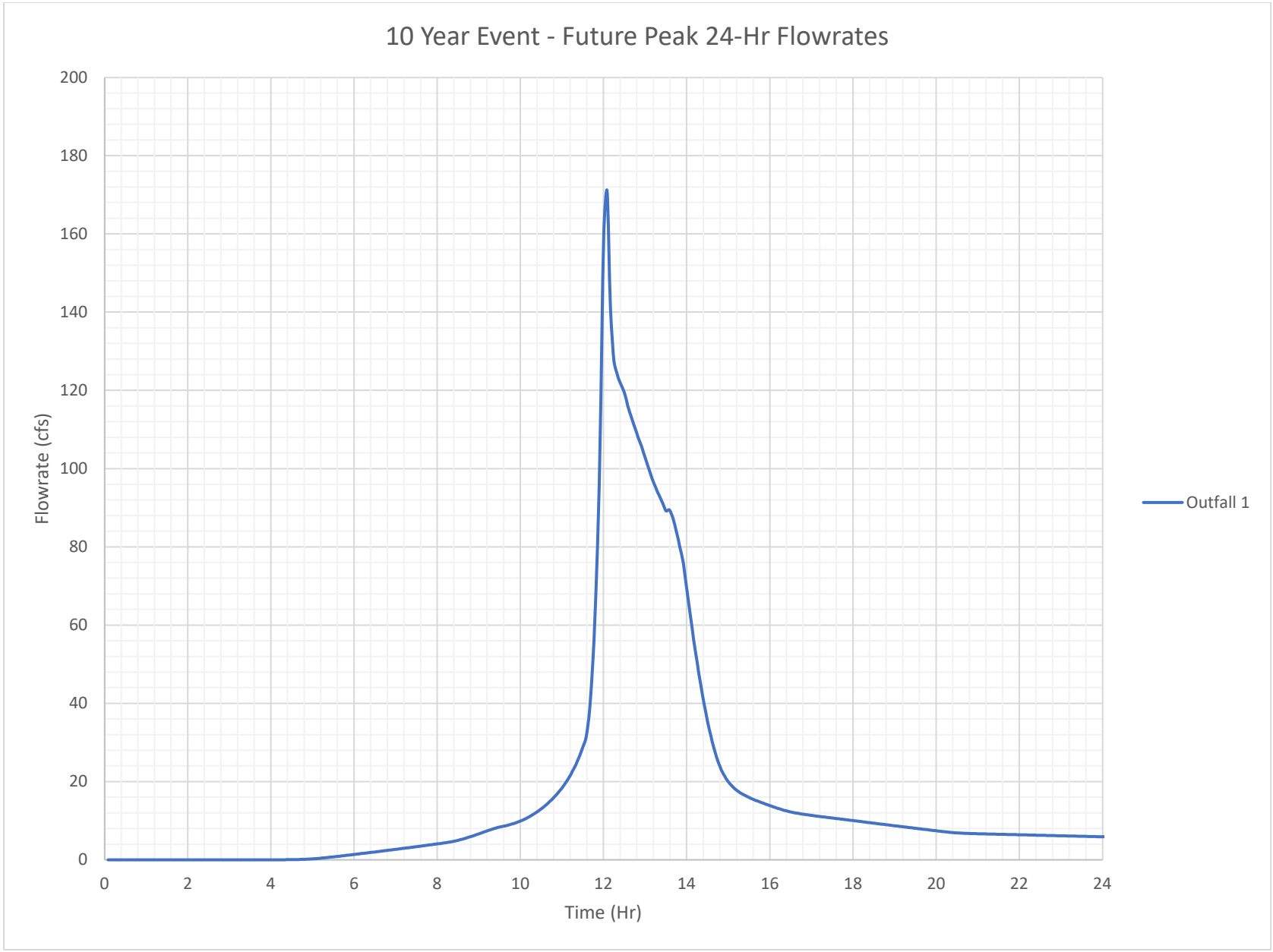
APPENDIX B
Hydrographs

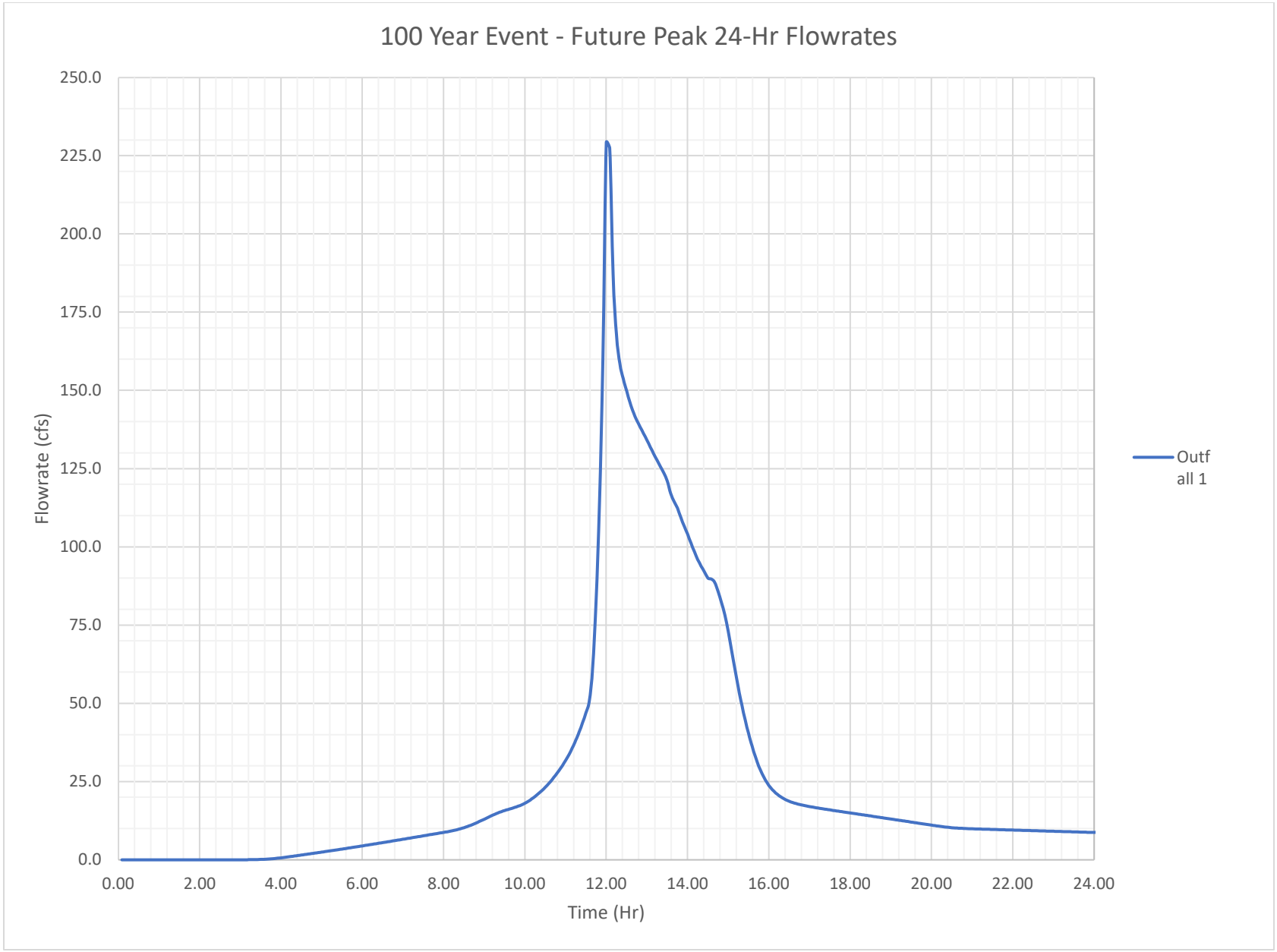

2 Year Event - Existing Peak 24-Hr Outlet Flowrates
Flowrate (cfs)
200
180
160
140
120
100
80
60
40
20
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Time (Hr)
Outfall 1

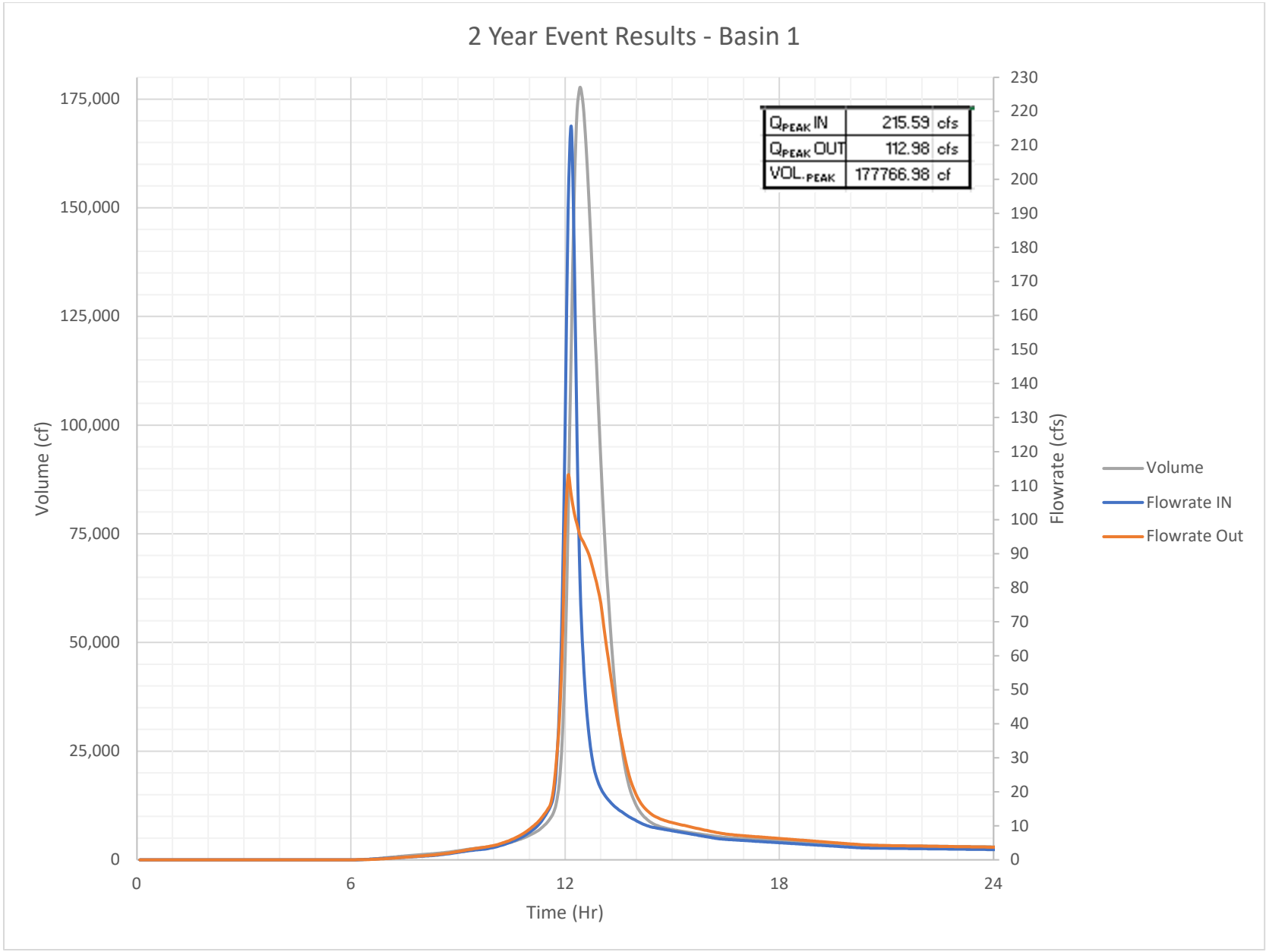

10 Year Event - Existing Peak 24-Hr Outlet Flowrates
Flowrate (cfs)
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Time (Hr)
Outfall 1

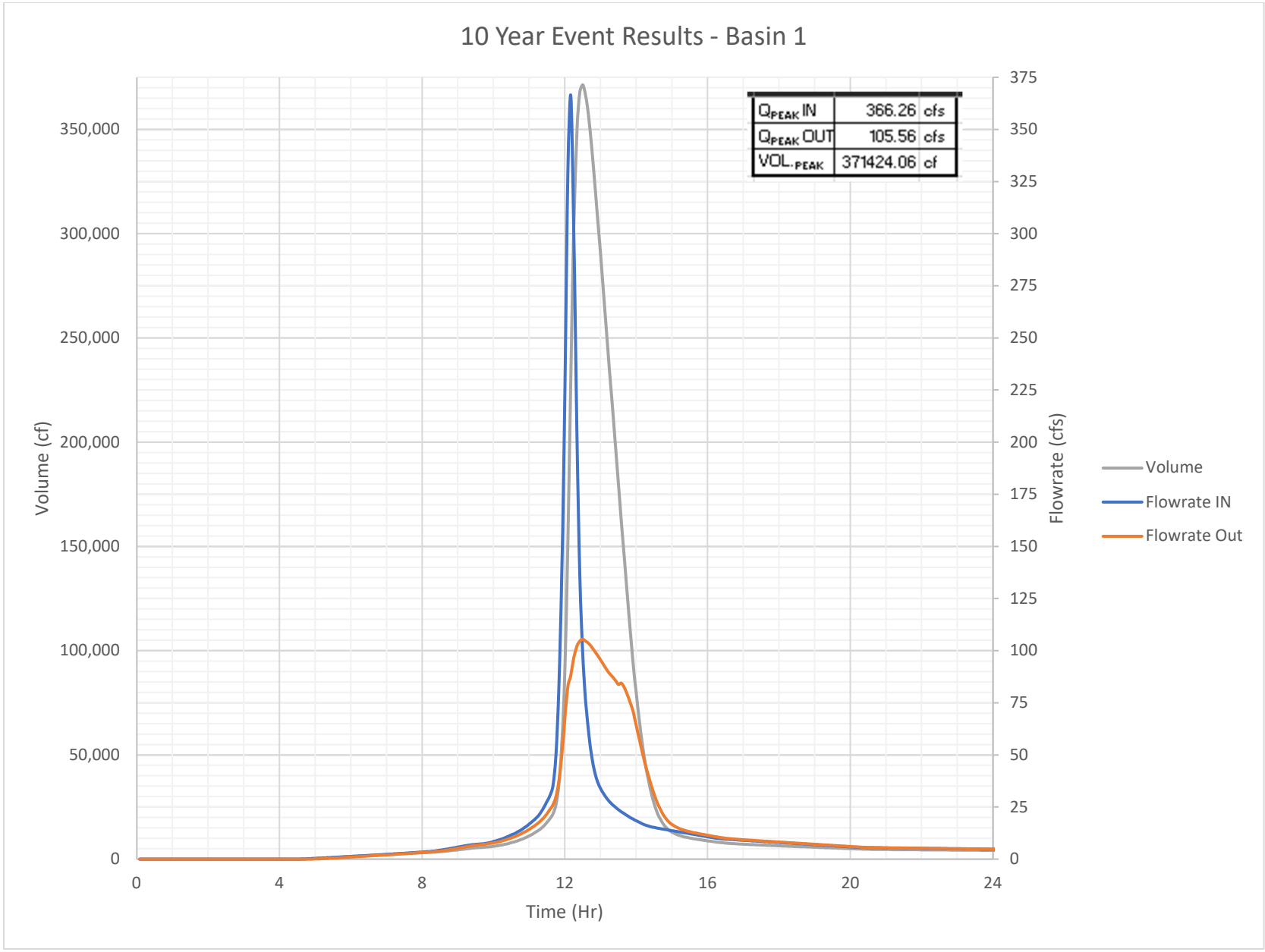

100 Year Event - Existing Peak 24-Hr Flowrate
Flowrate (cfs)
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Time (Hr)
Outfall 1

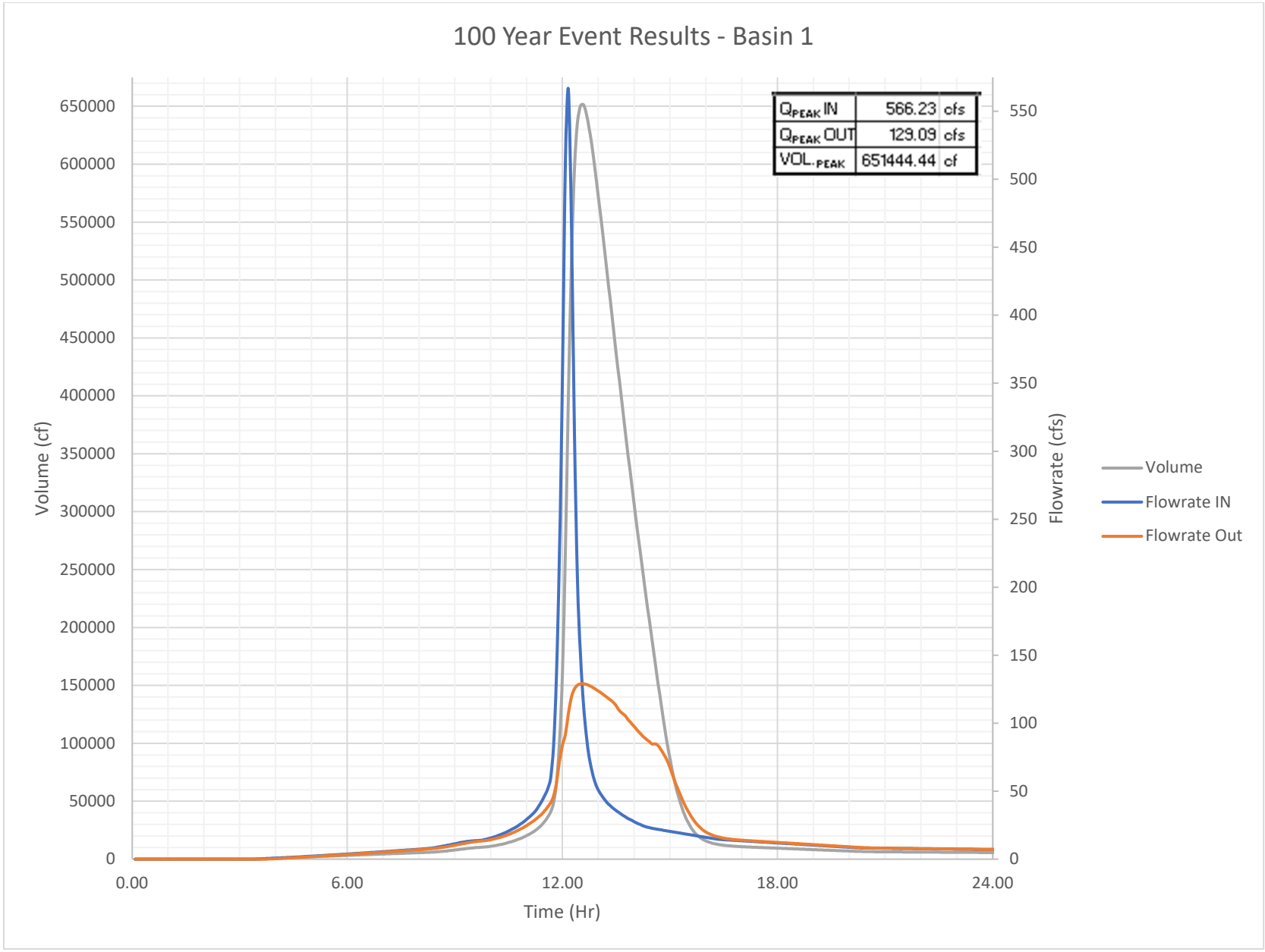

2 Year Event - Future Peak 24-Hr Flowrates
Flowrate (cfs)
120
110
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Time (Hr)
Outfall 1


10 Year Event - Future Peak 24-Hr Flowrates
Flowrate (cfs)
200
180
160
140
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
22
24
Time (Hr)
Outfall 1


100 Year Event - Future Peak 24-Hr Flowrates
250.0
225.0
200.0
175.0
150.0
125.0
100.0
75.0
50.0
25.0
0.0
Flowrate (cfs)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
18.00
20.00
22.00
24.00
Time (Hr)
Outf
all 1


2 Year Event Results - Basin 1
Q_{PEAK} IN 215.59 cfs
Q_{PEAK} OUT 112.98 cfs
$VOL._{PEAK}$ 177766.98 cf
Volume (cf)
Flowrate (cfs)
Time (Hr)
0
25,000
50,000
75,000
100,000
125,000
150,000
175,000
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
0
6
12
18
24
Volume
Flowrate IN
Flowrate Out

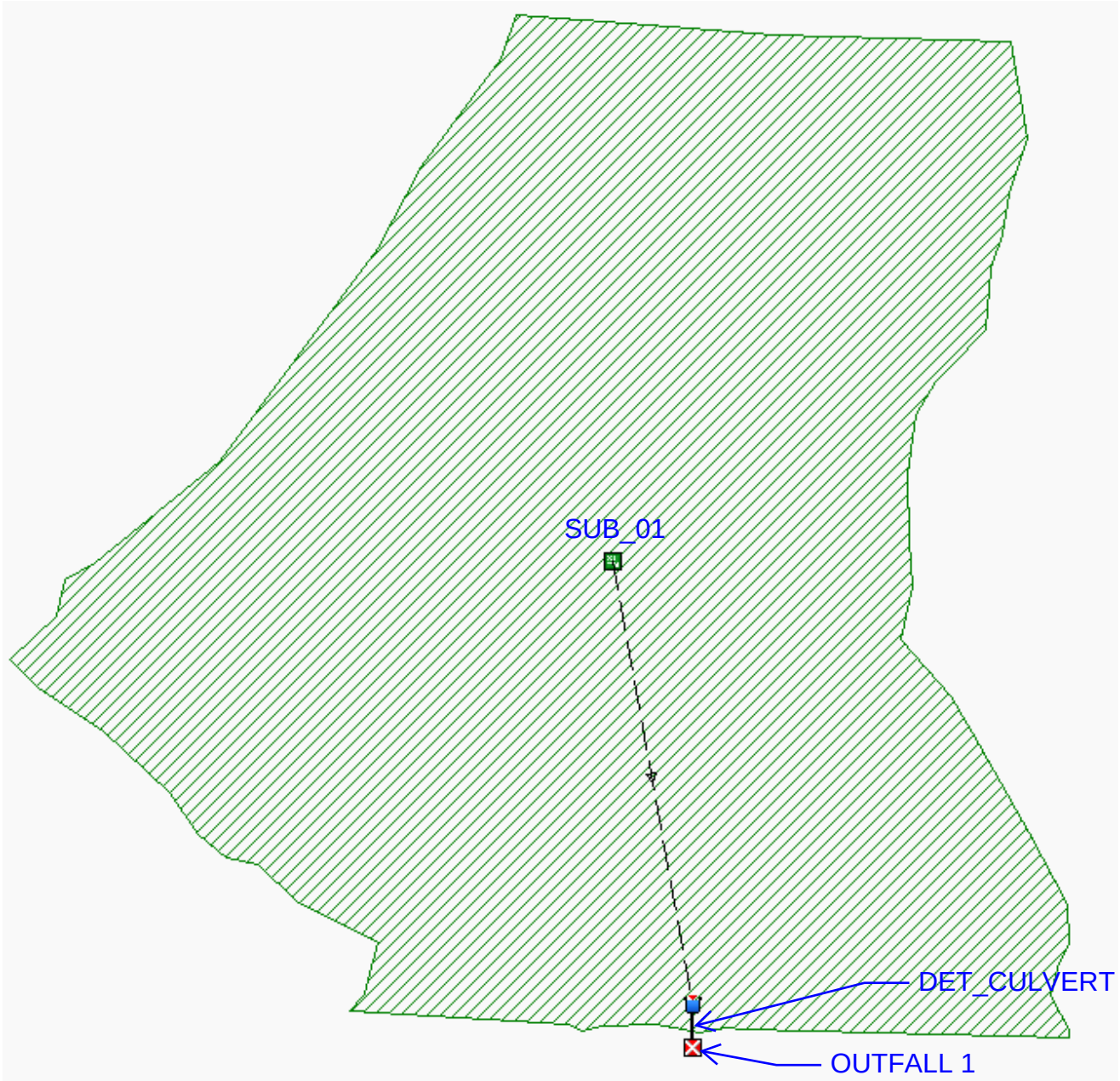

10 Year Event Results - Basin 1
Q_{PEAK} IN 366.26 cfs
Q_{PEAK} OUT 105.56 cfs
$VOL._{PEAK}$ 371424.06 cf
Volume (cf)
Flowrate (cfs)
Time (Hr)
0
50,000
100,000
150,000
200,000
250,000
300,000
350,000
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
0
4
8
12
16
20
24
Volume
Flowrate IN
Flowrate Out


100 Year Event Results - Basin 1
Q_{PEAK} IN 566.23 cfs
Q_{PEAK} OUT 129.09 cfs
$VOL._{PEAK}$ 651444.44 cf
Volume (cf)
650000
600000
550000
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
Flowrate (cfs)
550
500
450
400
350
300
250
200
150
100
50
0
0.00
6.00
12.00
18.00
24.00
Time (Hr)
Volume
Flowrate IN
Flowrate Out

APPENDIX C
Model Results

Existing Conditions Results

EXISTING MODEL



Project Description

File Name	Existing.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:01:00	days hh:mm:ss
Routing Time Step	1	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	1
Nodes	2
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	1
Channels	0
Pipes	1
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	002-Year	Cumulative	inches	Missouri	Jackson	2.00	3.50	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-01	112.03	484.00	82.00	3.50	1.78	199.75	193.21	0 00:25:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	989.00					193.17	990.83					
2	Det_Culvert	Storage Node	991.64	998.00	991.72		0.00	193.20	993.47				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Culvert	Pipe	Det_Culvert	Out-01	132.00	991.64	989.00	2.0000	48.000	0.0130	193.17	438.12	0.44	17.60	1.83	0.46	0.00	Calculated

Subbasin Hydrology

Subbasin : Sub-01

Input Data

Area (ac)	112.03
Peak Rate Factor	484
Weighted Curve Number	82
Rain Gage ID	Rain Gage

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Row crops, contoured, Good	112.03	C	82
Composite Area & Weighted CN	112.03		82

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.3	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.24	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.75	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	300	0	0
Slope (%) :	6.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	4.11	0	0
Computed Flow Time (min) :	1.22	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	2892	0	0
Channel Slope (%) :	1.92	0	0
Cross Section Area (ft²) :	55	0	0
Wetted Perimeter (ft) :	29	0	0
Velocity (ft/sec) :	10.54	0	0
Computed Flow Time (min) :	4.57	0	0

Total TOC (min) 25.54

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	1.78
Peak Runoff (cfs)	193.21
Weighted Curve Number	82
Time of Concentration (days hh:mm:ss)	0 00:25:32

Storage Nodes

Storage Node : Det_Culvert

Input Data

Invert Elevation (ft)	991.64
Max (Rim) Elevation (ft)	998
Max (Rim) Offset (ft)	6.36
Initial Water Elevation (ft)	991.72
Initial Water Depth (ft)	0.08
Ponded Area (ft²)	0
Evaporation Loss	0

Project Description

File Name	Existing.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:01:00	days hh:mm:ss
Routing Time Step	1	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	1
Nodes	2
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	1
Channels	0
Pipes	1
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	010-Year	Cumulative	inches	Missouri	Jackson	10.00	5.30	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-01	112.03	484.00	82.00	5.30	3.35	375.19	362.61	0 00:25:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	989.00					362.34	991.89					
2	Det_Culvert	Storage Node	991.64	998.00	991.72		0.00	362.39	994.53				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Culvert	Pipe	Det_Culvert	Out-01	132.00	991.64	989.00	2.0000	48.000	0.0130	362.34	438.12	0.83	20.91	2.89	0.72	0.00	Calculated

Subbasin Hydrology

Subbasin : Sub-01

Input Data

Area (ac)	112.03
Peak Rate Factor	484
Weighted Curve Number	82
Rain Gage ID	Rain Gage

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Row crops, contoured, Good	112.03	C	82
Composite Area & Weighted CN	112.03		82

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.3	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.24	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.75	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	300	0	0
Slope (%) :	6.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	4.11	0	0
Computed Flow Time (min) :	1.22	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	2892	0	0
Channel Slope (%) :	1.92	0	0
Cross Section Area (ft²) :	55	0	0
Wetted Perimeter (ft) :	29	0	0
Velocity (ft/sec) :	10.54	0	0
Computed Flow Time (min) :	4.57	0	0

Total TOC (min) 25.54

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	3.35
Peak Runoff (cfs)	362.61
Weighted Curve Number	82
Time of Concentration (days hh:mm:ss)	0 00:25:32

Storage Nodes

Storage Node : Det_Culvert

Input Data

Invert Elevation (ft)	991.64
Max (Rim) Elevation (ft)	998
Max (Rim) Offset (ft)	6.36
Initial Water Elevation (ft)	991.72
Initial Water Depth (ft)	0.08
Ponded Area (ft²)	0
Evaporation Loss	0

Project Description

File Name	Existing.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:01:00	days hh:mm:ss
Routing Time Step	1	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	1
Nodes	2
Junctions	0
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	1
Channels	0
Pipes	1
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100-Year	Cumulative	inches	Missouri	Jackson	100.00	7.70	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-01	112.03	484.00	82.00	7.70	5.58	624.57	595.19	0 00:25:32

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Out-01	Outfall	989.00					517.78	992.79					
2	Det_Culvert	Storage Node	991.64	998.00	991.72		0.00	595.17	998.00				25.21	14.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Culvert	Pipe	Det_Culvert	Out-01	132.00	991.64	989.00	2.0000	48.000	0.0130	517.78	438.12	1.18	24.38	3.78	0.96	0.00	> CAPACITY

Subbasin Hydrology

Subbasin : Sub-01

Input Data

Area (ac)	112.03
Peak Rate Factor	484
Weighted Curve Number	82
Rain Gage ID	Rain Gage

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Row crops, contoured, Good	112.03	C	82
Composite Area & Weighted CN	112.03		82

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.3	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	1.24	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	19.75	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	300	0	0
Slope (%) :	6.5	0	0
Surface Type :	Unpaved	Unpaved	Unpaved
Velocity (ft/sec) :	4.11	0	0
Computed Flow Time (min) :	1.22	0	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.03	0	0
Flow Length (ft) :	2892	0	0
Channel Slope (%) :	1.92	0	0
Cross Section Area (ft²) :	55	0	0
Wetted Perimeter (ft) :	29	0	0
Velocity (ft/sec) :	10.54	0	0
Computed Flow Time (min) :	4.57	0	0

Total TOC (min) 25.54

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	5.58
Peak Runoff (cfs)	595.19
Weighted Curve Number	82
Time of Concentration (days hh:mm:ss)	0 00:25:32

Storage Nodes

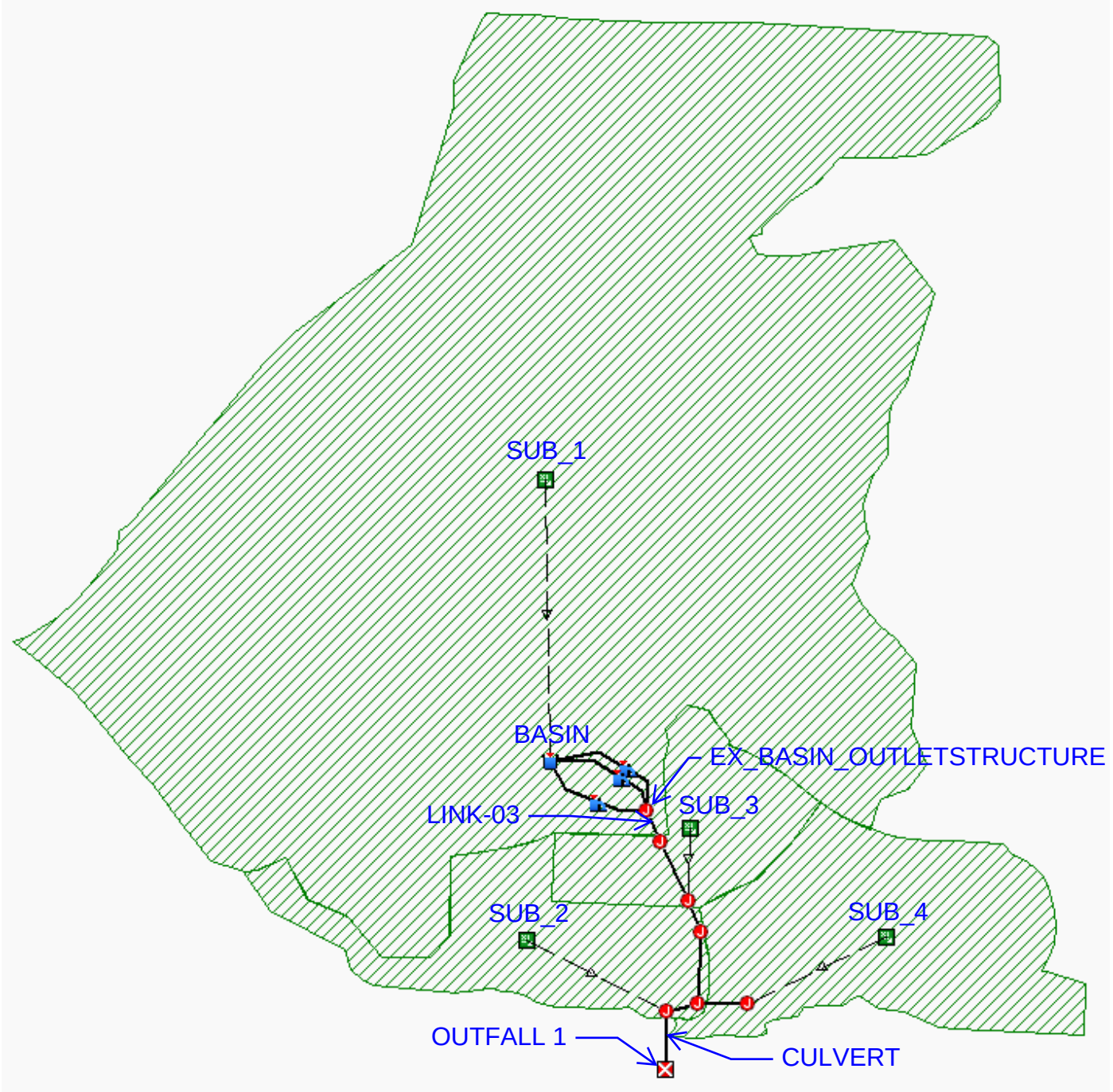
Storage Node : Det_Culvert

Input Data

Invert Elevation (ft)	991.64
Max (Rim) Elevation (ft)	998
Max (Rim) Offset (ft)	6.36
Initial Water Elevation (ft)	991.72
Initial Water Depth (ft)	0.08
Ponded Area (ft²)	0
Evaporation Loss	0

Future Conditions Results

FUTURE MODEL



Project Description

File Name ..... Future.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... SCS TR-55
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Hydrodynamic
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ... NO

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:01:00 days hh:mm:ss
Routing Time Step ..... 5 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	9
Junctions	7
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	10
Channels	0
Pipes	7
Pumps	0
Orifices	3
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	002-Year	Cumulative	inches	Missouri	Jackson	2.00	3.50	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub_1	84.25	484.00	88.31	3.50	2.30	193.44	216.18	0 00:18:59
2	Sub_2	5.65	484.00	88.24	3.50	2.29	12.94	15.33	0 00:16:31
3	Sub_3	4.31	484.00	90.55	3.50	2.50	10.77	16.68	0 00:05:00
4	Sub_4	8.69	484.00	89.28	3.50	2.38	20.69	32.31	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)
1	Box_Culvert	Junction	991.64	998.00	0.00	6.00	0.00	116.58	995.16	0.00	2.84	0 00:00	0.00
2	Culvert_2	Junction	995.22	999.00	0.00	3.78	0.00	32.25	996.11	0.00	3.11	0 00:00	0.00
3	EX_Basin_OutletStructure	Junction	1003.28	1012.00	0.00	6.00	0.00	85.37	1006.75	0.00	5.25	0 00:00	0.00
4	Proposed_1	Junction	991.99	999.00	0.00	6.00	0.00	101.76	995.87	0.00	3.13	0 00:00	0.00
5	Proposed_2	Junction	995.52	1001.52	0.00	6.00	0.00	87.13	997.76	0.00	3.76	0 00:00	0.00
6	Proposed_3	Junction	997.36	1003.36	0.00	6.00	0.00	87.13	999.82	0.00	3.54	0 00:00	0.00
7	Proposed_4	Junction	1000.50	1006.50	0.00	6.00	0.00	84.99	1002.78	0.00	3.72	0 00:00	0.00
8	Out-01	Outfall	989.00					116.55	990.27				
9	Basin	Storage Node	1004.00	1012.00	1004.00		136880.00	215.64	1007.46				0.00

Total Time Flooded (min)
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Culvert	Pipe	Box_Culvert	Out-01	132.00	991.73	989.00	2.0700	48.000	0.0130	116.55	445.52	0.26	8.25	2.35	0.59	0.00	Calculated
2	Link-03	Pipe	EX_Basin_OutletStructure	Proposed_4	83.44	1003.28	1001.00	2.7300	42.000	0.0220	84.99	98.27	0.86	9.97	2.99	0.85	0.00	Calculated
3	Link-04	Pipe	Proposed_1	Box_Culvert	80.58	991.99	991.73	0.3200	72.000	0.0130	101.49	240.57	0.42	5.84	3.66	0.61	0.00	Calculated
4	Link-05	Pipe	Proposed_2	Proposed_1	188.26	995.52	992.49	1.6100	60.000	0.0120	87.12	357.95	0.24	8.48	2.70	0.54	0.00	Calculated
5	Link-06	Pipe	Proposed_3	Proposed_2	81.53	997.36	996.02	1.6400	60.000	0.0120	87.13	361.72	0.24	11.24	2.10	0.42	0.00	Calculated
6	Link-07	Pipe	Proposed_4	Proposed_3	161.10	1000.50	997.86	1.6400	54.000	0.0120	85.00	272.71	0.31	11.59	2.12	0.47	0.00	Calculated
7	Link-08	Pipe	Culvert_2	Proposed_1	71.61	992.74	992.49	0.3500	48.000	0.0120	32.31	303.84	0.11	5.38	2.07	0.52	0.00	Calculated
8	EX_Basin_LowOpening	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		30.000		85.37							
9	EX_Basin_TopGrate	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		120.000		0.00							
10	EX_Basin_TopOpening	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		14.000		0.00							

Subbasin Hydrology

Subbasin : Sub_1

Input Data

Area (ac) 84.25
Peak Rate Factor 484
Weighted Curve Number 88.31
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	51.79	D	87
Paved roads with curbs & sewers	4.39	D	98
> 75% grass cover, Good	13.7	D	80
Paved parking & roofs	14.37	D	98
Composite Area & Weighted CN	84.25		88.31

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

User-Defined TOC override (minutes): 18.99

Subbasin Runoff Results

Total Rainfall (in) 3.5

Total Runoff (in) 2.3
Peak Runoff (cfs) 216.18
Weighted Curve Number 88.31
Time of Concentration (days hh:mm:ss) 0 00:18:59

Subbasin : Sub_2

Input Data

Area (ac)	5.65
Peak Rate Factor	484
Weighted Curve Number	88.24
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	3.06	D	80
Paved parking & roofs	2.55	D	98
Urban commercial, 85% imp	0.05	D	95
Composite Area & Weighted CN	5.66		88.24

Time of Concentration

User-Defined TOC override (minutes): 16.52

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	2.29
Peak Runoff (cfs)	15.33
Weighted Curve Number	88.24
Time of Concentration (days hh:mm:ss)	0 00:16:31

Subbasin : Sub_3

Input Data

Area (ac)	4.31
Peak Rate Factor	484
Weighted Curve Number	90.55
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	1.42	D	95
Paved parking & roofs	1.34	D	98
> 75% grass cover, Good	1.55	D	80
Composite Area & Weighted CN	4.31		90.55

Time of Concentration

User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	2.5
Peak Runoff (cfs)	16.68
Weighted Curve Number	90.55
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub_4

Input Data

Area (ac)	8.69
Peak Rate Factor	484
Weighted Curve Number	89.28
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	0.01	D	95
Paved roads with curbs & sewers	4.47	D	98
> 75% grass cover, Good	4.21	D	80
Composite Area & Weighted CN	8.69		89.28

Time of Concentration

User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	2.38
Peak Runoff (cfs)	32.31
Weighted Curve Number	89.28
Time of Concentration (days hh:mm:ss)	0 00:05:00

Storage Nodes

Storage Node : Basin

Input Data

Invert Elevation (ft)	1004
Max (Rim) Elevation (ft)	1012
Max (Rim) Offset (ft)	8
Initial Water Elevation (ft)	1004
Initial Water Depth (ft)	0
Ponded Area (ft²)	136880
Evaporation Loss	0

Project Description

File Name	Future.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:01:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	9
Junctions	7
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	10
Channels	0
Pipes	7
Pumps	0
Orifices	3
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	010-Year	Cumulative	inches	Missouri	Jackson	10.00	5.30	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub_1	84.25	484.00	88.31	5.30	3.99	335.92	368.00	0 00:18:59
2	Sub_2	5.65	484.00	88.24	5.30	3.98	22.49	26.07	0 00:16:31
3	Sub_3	4.31	484.00	90.55	5.30	4.23	18.20	27.43	0 00:05:00
4	Sub_4	8.69	484.00	89.28	5.30	4.09	35.52	54.05	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)
1	Box_Culvert	Junction	991.64	998.00	0.00	6.00	0.00	171.22	996.28	0.00	1.72	0 00:00	0.00
2	Culvert_2	Junction	995.22	999.00	0.00	3.78	0.00	53.99	997.17	0.00	2.05	0 00:00	0.00
3	EX_Basin_OutletStructure	Junction	1003.28	1012.00	0.00	6.00	0.00	110.28	1008.68	0.00	3.32	0 00:00	0.00
4	Proposed_1	Junction	991.99	999.00	0.00	6.00	0.00	150.22	997.08	0.00	1.92	0 00:00	0.00
5	Proposed_2	Junction	995.52	1001.52	0.00	6.00	0.00	108.45	998.10	0.00	3.42	0 00:00	0.00
6	Proposed_3	Junction	997.36	1003.36	0.00	6.00	0.00	108.45	1000.20	0.00	3.16	0 00:00	0.00
7	Proposed_4	Junction	1000.50	1006.50	0.00	6.00	0.00	105.68	1003.16	0.00	3.34	0 00:00	0.00
8	Out-01	Outfall	989.00					171.17	990.66				
9	Basin	Storage Node	1004.00	1012.00	1004.00		136880.00	367.05	1009.19				0.00

Total Time Flooded (min)
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Culvert	Pipe	Box_Culvert	Out-01	132.00	991.73	989.00	2.0700	48.000	0.0130	171.17	445.52	0.38	10.08	2.83	0.71	0.00	Calculated
2	Link-03	Pipe	EX_Basin_OutletStructure	Proposed_4	83.44	1003.28	1001.00	2.7300	42.000	0.0220	105.68	98.27	1.08	11.22	3.31	0.95	0.00	> CAPACITY
3	Link-04	Pipe	Proposed_1	Box_Culvert	80.58	991.99	991.73	0.3200	72.000	0.0130	149.72	240.57	0.62	6.19	4.80	0.80	0.00	Calculated
4	Link-05	Pipe	Proposed_2	Proposed_1	188.26	995.52	992.49	1.6100	60.000	0.0120	108.49	357.95	0.30	8.59	3.49	0.70	0.00	Calculated
5	Link-06	Pipe	Proposed_3	Proposed_2	81.53	997.36	996.02	1.6400	60.000	0.0120	108.45	361.72	0.30	11.71	2.46	0.49	0.00	Calculated
6	Link-07	Pipe	Proposed_4	Proposed_3	161.10	1000.50	997.86	1.6400	54.000	0.0120	105.68	272.71	0.39	11.68	2.50	0.56	0.00	Calculated
7	Link-08	Pipe	Culvert_2	Proposed_1	71.61	992.74	992.49	0.3500	48.000	0.0120	53.66	303.84	0.18	5.49	2.97	0.74	0.00	Calculated
8	EX_Basin_LowOpening	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		30.000		91.22							
9	EX_Basin_TopGrate	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		120.000		0.00							
10	EX_Basin_TopOpening	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		14.000		35.09							

Subbasin Hydrology

Subbasin : Sub_1

Input Data

Area (ac) 84.25
Peak Rate Factor 484
Weighted Curve Number 88.31
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	51.79	D	87
Paved roads with curbs & sewers	4.39	D	98
> 75% grass cover, Good	13.7	D	80
Paved parking & roofs	14.37	D	98
Composite Area & Weighted CN	84.25		88.31

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft^2)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

User-Defined TOC override (minutes): 18.99

Subbasin Runoff Results

Total Rainfall (in) 5.3

Total Runoff (in) 3.99
Peak Runoff (cfs) 368
Weighted Curve Number 88.31
Time of Concentration (days hh:mm:ss) 0 00:18:59

Subbasin : Sub_2

Input Data

Area (ac)	5.65
Peak Rate Factor	484
Weighted Curve Number	88.24
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	3.06	D	80
Paved parking & roofs	2.55	D	98
Urban commercial, 85% imp	0.05	D	95
Composite Area & Weighted CN	5.66		88.24

Time of Concentration

User-Defined TOC override (minutes): 16.52

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	3.98
Peak Runoff (cfs)	26.07
Weighted Curve Number	88.24
Time of Concentration (days hh:mm:ss)	0 00:16:31

Subbasin : Sub_3

Input Data

Area (ac)	4.31
Peak Rate Factor	484
Weighted Curve Number	90.55
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	1.42	D	95
Paved parking & roofs	1.34	D	98
> 75% grass cover, Good	1.55	D	80
Composite Area & Weighted CN	4.31		90.55

Time of Concentration

User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	4.23
Peak Runoff (cfs)	27.43
Weighted Curve Number	90.55
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub_4

Input Data

Area (ac)	8.69
Peak Rate Factor	484
Weighted Curve Number	89.28
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	0.01	D	95
Paved roads with curbs & sewers	4.47	D	98
> 75% grass cover, Good	4.21	D	80
Composite Area & Weighted CN	8.69		89.28

Time of Concentration

User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	4.09
Peak Runoff (cfs)	54.05
Weighted Curve Number	89.28
Time of Concentration (days hh:mm:ss)	0 00:05:00

Storage Nodes

Storage Node : Basin

Input Data

Invert Elevation (ft)	1004
Max (Rim) Elevation (ft)	1012
Max (Rim) Offset (ft)	8
Initial Water Elevation (ft)	1004
Initial Water Depth (ft)	0
Ponded Area (ft²)	136880
Evaporation Loss	0

Project Description

File Name	Future.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	SCS TR-55
Time of Concentration (TOC) Method	SCS TR-55
Link Routing Method	Hydrodynamic
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:01:00	days hh:mm:ss
Routing Time Step	5	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins	4
Nodes	9
Junctions	7
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links	10
Channels	0
Pipes	7
Pumps	0
Orifices	3
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100-Year	Cumulative	inches	Missouri	Jackson	100.00	7.70	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub_1	84.25	484.00	88.31	7.70	6.31	531.80	568.94	0 00:18:59
2	Sub_2	5.65	484.00	88.24	7.70	6.30	35.61	40.33	0 00:16:31
3	Sub_3	4.31	484.00	90.55	7.70	6.58	28.33	41.57	0 00:05:00
4	Sub_4	8.69	484.00	89.28	7.70	6.43	55.82	82.72	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)
1	Box_Culvert	Junction	991.64	998.00	0.00	6.00	0.00	236.44	997.30	0.00	0.70	0 00:00	0.00
2	Culvert_2	Junction	995.22	999.00	0.00	3.78	0.00	82.69	999.21	0.00	0.01	0 00:00	0.00
3	EX_Basin_OutletStructure	Junction	1003.28	1012.00	0.00	6.00	0.00	129.39	1010.98	0.00	1.02	0 00:00	0.00
4	Proposed_1	Junction	991.99	999.00	0.00	6.00	0.00	206.32	998.37	0.00	0.63	0 00:00	0.00
5	Proposed_2	Junction	995.52	1001.52	0.00	6.00	0.00	133.07	999.18	0.00	2.34	0 00:00	0.00
6	Proposed_3	Junction	997.36	1003.36	0.00	6.00	0.00	133.07	1000.73	0.00	2.63	0 00:00	0.00
7	Proposed_4	Junction	1000.50	1006.50	0.00	6.00	0.00	129.22	1003.60	0.00	2.90	0 00:00	0.00
8	Out-01	Outfall	989.00					236.34	991.09				
9	Basin	Storage Node	1004.00	1012.00	1004.00		136880.00	568.83	1011.41				0.00

Total Time Flooded (min)
0.00
0.00
0.00
0.00
0.00
0.00
0.00
0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Culvert	Pipe	Box_Culvert	Out-01	132.00	991.73	989.00	2.0700	48.000	0.0130	236.34	445.52	0.53	12.94	3.04	0.76	0.00	Calculated
2	Link-03	Pipe	EX_Basin_OutletStructure	Proposed_4	83.44	1003.28	1001.00	2.7300	42.000	0.0220	129.22	98.27	1.31	13.55	3.40	0.97	0.00	> CAPACITY
3	Link-04	Pipe	Proposed_1	Box_Culvert	80.58	991.99	991.73	0.3200	72.000	0.0130	206.28	240.57	0.86	7.38	5.79	0.96	0.00	Calculated
4	Link-05	Pipe	Proposed_2	Proposed_1	188.26	995.52	992.49	1.6100	60.000	0.0120	133.06	357.95	0.37	8.86	4.33	0.87	0.00	Calculated
5	Link-06	Pipe	Proposed_3	Proposed_2	81.53	997.36	996.02	1.6400	60.000	0.0120	133.07	361.72	0.37	11.72	3.26	0.65	0.00	Calculated
6	Link-07	Pipe	Proposed_4	Proposed_3	161.10	1000.50	997.86	1.6400	54.000	0.0120	129.22	272.71	0.47	11.79	2.94	0.65	0.00	Calculated
7	Link-08	Pipe	Culvert_2	Proposed_1	71.61	992.74	992.49	0.3500	48.000	0.0120	82.54	303.84	0.27	6.57	3.99	1.00	0.00	Calculated
8	EX_Basin_LowOpening	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		30.000		92.08							
9	EX_Basin_TopGrate	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		120.000		38.40							
10	EX_Basin_TopOpening	Orifice	Basin	EX_Basin_OutletStructure		1004.00	1003.28		14.000		36.78							

Subbasin Hydrology

Subbasin : Sub_1

Input Data

Area (ac) 84.25
Peak Rate Factor 484
Weighted Curve Number 88.31
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
1/4 acre lots, 38% impervious	51.79	D	87
Paved roads with curbs & sewers	4.39	D	98
> 75% grass cover, Good	13.7	D	80
Paved parking & roofs	14.37	D	98
Composite Area & Weighted CN	84.25		88.31

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

Tc = (0.007 * ((n * Lf)^0.8)) / ((P^0.5) * (Sf^0.4))

Where :

Tc = Time of Concentration (hr)
n = Manning's roughness
Lf = Flow Length (ft)
P = 2 yr, 24 hr Rainfall (inches)
Sf = Slope (ft/ft)

Shallow Concentrated Flow Equation :

V = 16.1345 * (Sf^0.5) (unpaved surface)
V = 20.3282 * (Sf^0.5) (paved surface)
V = 15.0 * (Sf^0.5) (grassed waterway surface)
V = 10.0 * (Sf^0.5) (nearly bare & untilled surface)
V = 9.0 * (Sf^0.5) (cultivated straight rows surface)
V = 7.0 * (Sf^0.5) (short grass pasture surface)
V = 5.0 * (Sf^0.5) (woodland surface)
V = 2.5 * (Sf^0.5) (forest w/heavy litter surface)
Tc = (Lf / V) / (3600 sec/hr)

Where:

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

User-Defined TOC override (minutes): 18.99

Subbasin Runoff Results

Total Rainfall (in) 7.7

Total Runoff (in) 6.31
Peak Runoff (cfs) 568.94
Weighted Curve Number 88.31
Time of Concentration (days hh:mm:ss) 0 00:18:59

Subbasin : Sub_2

Input Data

Area (ac)	5.65
Peak Rate Factor	484
Weighted Curve Number	88.24
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	3.06	D	80
Paved parking & roofs	2.55	D	98
Urban commercial, 85% imp	0.05	D	95
Composite Area & Weighted CN	5.66		88.24

Time of Concentration

User-Defined TOC override (minutes): 16.52

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	6.3
Peak Runoff (cfs)	40.33
Weighted Curve Number	88.24
Time of Concentration (days hh:mm:ss)	0 00:16:31

Subbasin : Sub_3

Input Data

Area (ac)	4.31
Peak Rate Factor	484
Weighted Curve Number	90.55
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	1.42	D	95
Paved parking & roofs	1.34	D	98
> 75% grass cover, Good	1.55	D	80
Composite Area & Weighted CN	4.31		90.55

Time of Concentration

User-Defined TOC override (minutes): 5

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	6.58
Peak Runoff (cfs)	41.57
Weighted Curve Number	90.55
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub_4

Input Data

Area (ac)	8.69
Peak Rate Factor	484
Weighted Curve Number	89.28
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	0.01	D	95
Paved roads with curbs & sewers	4.47	D	98
> 75% grass cover, Good	4.21	D	80
Composite Area & Weighted CN	8.69		89.28

Time of Concentration

User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	6.43
Peak Runoff (cfs)	82.72
Weighted Curve Number	89.28
Time of Concentration (days hh:mm:ss)	0 00:05:00

Storage Nodes

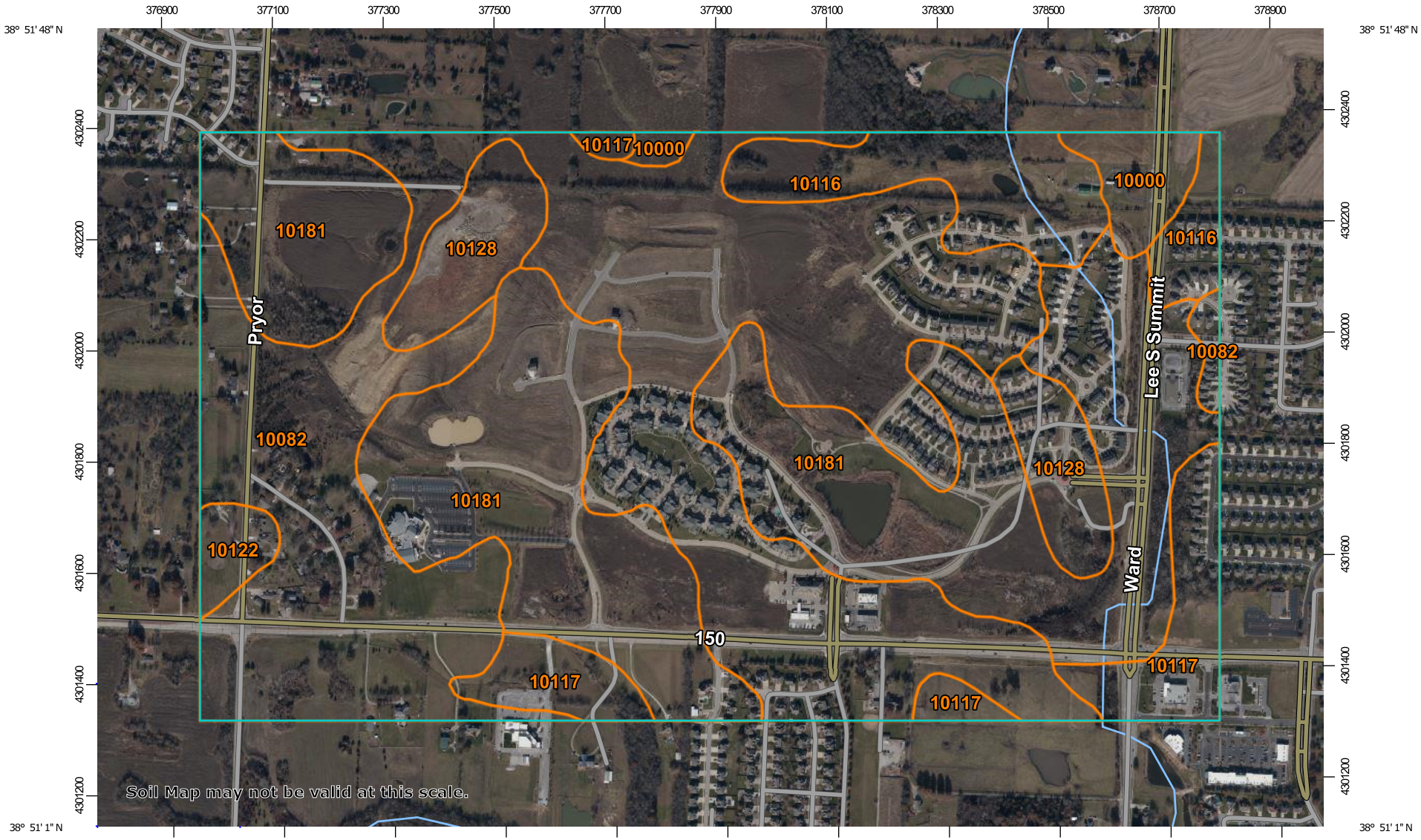
Storage Node : Basin

Input Data

Invert Elevation (ft)	1004
Max (Rim) Elevation (ft)	1012
Max (Rim) Offset (ft)	8
Initial Water Elevation (ft)	1004
Initial Water Depth (ft)	0
Ponded Area (ft²)	136880
Evaporation Loss	0

APPENDIX D
Soil

Soil Map—Jackson County, Missouri



Map Scale: 1:10,100 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 100 200 400 600

Feet
0 450 900 1800 2700

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

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

Special Point Features

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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: Jackson County, Missouri
Survey Area Data: Version 23, Sep 1, 2021

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

Date(s) aerial images were photographed: Sep 6, 2019—Nov 16, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10000	Arisburg silt loam, 1 to 5 percent slopes	9.8	2.0%
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	212.7	44.0%
10116	Sampsel silty clay loam, 2 to 5 percent slopes	30.7	6.3%
10117	Sampsel silty clay loam, 5 to 9 percent slopes	27.5	5.7%
10122	Sharpsburg silt loam, 5 to 9 percent slopes, eroded	5.1	1.1%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	25.6	5.3%
10181	Udarents-Urban land-Sampsel complex, 5 to 9 percent slopes	171.8	35.6%
Totals for Area of Interest		**483.2**	**100.0%**

APPENDIX E

Federal Emergency Management Agency Flood Map

National Flood Hazard Layer FIRMette

FEMA

94°25'4"W 38°51'41"N

94°24'26"W 38°51'13"N

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

1:6,000

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

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/27/2022 at 10:41 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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