

DRAINAGE STUDY

for

North Lawrence Riverfront

Preliminary Plat

Lawrence, Kansas

October 2018

LPE Project No. 20182022

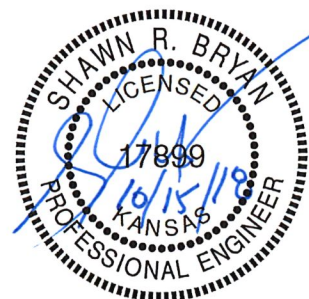
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GENERAL

North Lawrence Riverfront property is located entirely in Lawrence, Kansas. The property is bounded by Pacific Union railroad track to the North and East, N 2nd Street to the East, and Kansas River Levee to the South and West. The current zoning for the 16.11 acres property is intended to be Mixed Use (MU) including multi-dwelling, and commercial uses while current land uses include Industrial (IG), Commercial (CS) uses along with Open spaces (OS). According to the North Lawrence Watershed Drainage Study (2005), the property lies within the SYSTEM 3 tributary area. This system has a gravity flow outlet through the Kansas River levee for approximately a 20-acre area. The outlet pipe is a 48" RCP pipe located on the west side of the property which discharges to the Kansas river via a sluice gate constructed in the Kansas River Levee in the upstream of the Bowersock Dam protecting the site from high water level in the Kansas River during its flood time (mean annual WSE=814.0).

FLOODPLAIN INFORMATION

Most of the site lies within areas with reduced flood risk due to river levee (Zone X) as depicted on the FEMA Flood Insurance Rate Map (FIRM) Community Panel No. 200090 0176 E (City of Lawrence), Revised: September 2, 2015. According to this Panel, the east of the levee, Kansas River, is located within regulatory floodway with Base Flood Elevation (BFE) equal to 827.7 from sea level. Also, small portion of the site located in the west of N. 2nd street between Locust Street and Pacific Union railroad tracks and east of N Massachusetts Street, is identified as special flood hazard area (ZONE AH) with BFE equal to 820.0 subjected to inundation by the 1% annual chance, according to the FEMA FIRM Panel. A copy of the FEMA FIRM is included in Appendix D.

EXISTING CONDITIONS

The existing site consists of mostly open spaces, bounded by the public and private roadways and properties. Miscellaneous brush and trees are present along the East and the North East property. The site runoff is split between two discharge points. A majority of the onsite and offsite runoff for approximately 19 acres is conveyed via swales and pipes in a flat and interrupted drainage network located in the Perry, N 1st, and Maple street in the north of the site and N Massachusetts street in the south of the site, discharging into the 48" RCP pipe storm sewer crossing Kansas River Levee. No formal storm water management system currently exists on this part of the site, and the runoff is discharged directly to the Kansas river via various conveyance systems described above.

An approximate 1 acre of the site, as a small portion, located in the West of the N 2nd street and East of N Massachusetts street discharges to the West of N 2nd street right-of-way. This portion includes properties located in 311 N 2nd Street (known as The Last Carnival), 317 N 2nd street (known as Gaslight Gardens), 401 N 2nd street (known as Johnny 's Tavern), along with 415 N 2nd street. As described above, this portion is confined in the 100-year floodplain (FEMA Zone AH), discharges via sheet flow and shallow concentrated flow to the N 2nd street and Locust street right-of-way. The only existing drainage storm inlet in this part of the site is located in the East of the N Massachusetts street right-of-way collects low flows from this part and then connected to a storm junction box in the Locust street which ultimately discharges to a 36" CMP pipe located in the west side of N 2nd street. The storm runoff of this part of the site ultimately discharges into Kansas River at the downstream of Bowersock Dam.

The site soil is highly permeable and includes Eudora-Urban land complex, rarely flooded (7119). The Eudora-Urban land complex is classified as the hydrologic group B soil which was used for this drainage study. Refer to Figure 1 for soil maps from the USDA Websoil Survey website.

PROPOSED IMPROVEMENTS

The proposed improvements for the property was planned onto three phases. The initial development includes proposed improvements for Phase I and Phase II while future improvements on the site, named Phase III are expected on the north side of the site. Phase I and Phase II include constructing several multi-story residential-commercial buildings, impervious parking lots, site access pavements and green

spaces while Phase III includes building a multi-story hotel. Refer to table 1A and Exhibit 1. The proposed improvement divides the site into three drainage basins including East, Main, and West Basin. The East Basin is located within the FEMA floodplain Zone AH while the Main basin drains to the Kansas River via the existing 48" RCP mentioned above. A detention facility has been only sized for Main basin to accommodate and retain a typical SCS 24 hours-100 year stormwater runoff when Kansas River is under flooding, and gravity discharges to the river is not possible. The detention pond is connected to the 48" RCP existing pipe via two 36" RCP pipes which function as equalizer and conveyance pipes. West Basin directly drains to the Kansas river via rooftops drains and existing Levee trail above the top of the levee. Also, refer to Tables 1 through 3 on Page 3-5 for summaries of CN calculations, time of concentration calculations, and hydrologic modeling results for post condition for associated subbasins. Refer to Exhibit 2 for information on drainage areas and detention pond layout.

ANALYSIS

Times of concentration was calculated based on the Lawrence Stormwater Management Criteria (Feb 1996) using overland flow, shallow concentrated flow, and channel/system flow. The CN for each drainage area is based on a weighted average of pervious and impervious areas for hydrologic group B soils. All storm routing calculations were performed using Autodesk Storm and Sanitary Analysis ® software. Peak flows for 100-year storm events were modeled using SCS Type II 24-hr hyetograph storm based on 2014 rainfall intensities for Douglas County supplied by the Kansas Department of Transportation.

CONCLUSION

This study indicates that the proposed detention option in the Main Basin provide adequate detention for protecting the site from flooding due to increased runoff and blockage of gravity flow of its outlet resulting from Kansas River flooding period.

TABLE 1A - PHASES SUMMARY

	Building	Description	PLANNED USES
PHASE I	I	Existing JOHNNY'S 401 N 2ND STREET	RESTAURANT/BAR
	II	GASLIGHT 317 N 2ND STREET	BAR
	III	THIRD EYE SUSAN 311 N 2ND STREET	RETAIL/OFFICE
	IV	MULTI-USE COMMERCIAL BUILDING NO MORE THAN 6 STORIES PLUS I BASEMENT LEVEL	BASEMENT:PARKING 1ST FLOOR 1ST FLOOR:PARKING/RETAIL/OFFICE 2ND-6TH FLOOR: MULTI-FAMILY RESIDENTIAL
PHASE II	V	6 STORIES (INCLUDES 1 LEVEL OF PARKING)	PARKING, EATING, DRINKING, OFFICE & MULTI-FAMILY
	VI	9 STORIES (INCLUDES 2 LEVELS OF PARKING)	PARKING, EATING, DRINKING, OFFICE & MULTI-FAMILY
	VII	9 STORIES (INCLUDES 2 LEVELS OF PARKING)	PARKING, EATING, DRINKING, OFFICE & MULTI-FAMILY
PHASE III ^[1]	VIII	HOTEL UP TO 7 OCCUPIED STORIES	HOTEL

[1] THIS DRAINAGE STUDY ASSUMED THAT PHASE III WILL BE DEVELOPED IN FUTURE
THIS DRAINAGE STUDY SHALL BE REVISED FOR PHASE III DEVELOPMENT

TABLE 1B - BASINS CURVE NUMBER CALCULATIONS SUMMARY

BASIN	SUB BASIN	SCS CURVE NUMBER		AREA	COMP. CN
		73	98		
EAST BASIN					
	ONSITE				
	A1-1	0.23 ac	0.35 ac	0.58 ac	88.1
	A1-2	0.19 ac	0.32 ac	0.51 ac	88.7
	TOTAL			1.09 ac	88.4
MAIN BASIN					
	ONSITE				
	A1-3	0.19 ac	1.24 ac	1.43 ac	94.7
	A2-1	1.37 ac	3.12 ac	4.49 ac	90.4
	A3 ^[2]	6.19 ac	1.02 ac	7.21 ac	76.5
	OFFSITE				
	B3 ^[2]	3.00 ac	0.00 ac	3.00 ac	73.0
	TOTAL			16.13 ac	81.3
WEST BASIN					
	ONSITE				
	A2-2 ^[2]	0.10 ac	1.79 ac	1.89 ac	96.7
	OFFSITE				
	B2 ^[2]	0.09 ac	1.63 ac	1.72 ac	96.7
	TOTAL			3.61 ac	96.7
Grand Total				20.83 ac	84.37
ONSITE				16.11 ac	
OFFSITE				4.72 ac	

[2] For Hydrological Calculation a basin area equal to the total area of Onsite and Offsite Basins were used

TABLE 2 - TIMES OF CONCENTRATION SUMMARY												
	SUB BASIN	OVERLAND FLOW			SHALLOW CONCENTRATED FLOW			CHANNEL/SYSTEM FLOW			TIME OF CONC.	
		C	D	S	T(OLF)	D	S	T(SCF)	D	S		V
EAST BASIN												
	A1-1	0.7	134 ft	4.3%	5.1 min							5.1 min
	A1-2	0.7	74 ft	1.0%	6.2 min							6.2 min
MAIN BASIN												
	A1-3	0.8	72 ft	1.0%	4.6 min							8.5 min
	A2-1	0.9	50 ft	1.0%	2.5 min	Paved	233 ft	4.0%	0.9 min			5.8 min
	A3 & B3 [2]	0.3	75 ft	8.0%	6.2 min	Unpaved	400 ft	1.0%	4.1 min			11.6 min
WEST BASIN												
	A2-2 & B2 [2]	0.9	80 ft	1.0%	3.2 min	Paved	25 ft	1.0%	0.2 min			5.0 min

[2] For Hydrological Calculation a basin area equal to the total area of Onsite and Offsite Basins were used

TABLE 3 - SUMMARY OF HYDROLOGIC MODELING AND DISCHARGE

	Hydrograph	100-YR
EAST BASIN		
A1-1	A1-1	5.8 cfs
A1-2	A1-2	5.0 cfs
MAIN BASIN		
A1-3	A1-3	13.8 cfs
A2-1	A2-1	45.1 cfs
A3 & B3	A3 & B3	71.0 cfs
TOTAL DISCHARGE	OUT2-1	36.3 cfs
WEST BASIN		
A2-2 & B2	A2-2 & B2	38.6 cfs

Hydrologic Soil Group—Douglas County, Kansas
(North Lawrence)

FIGURE 1



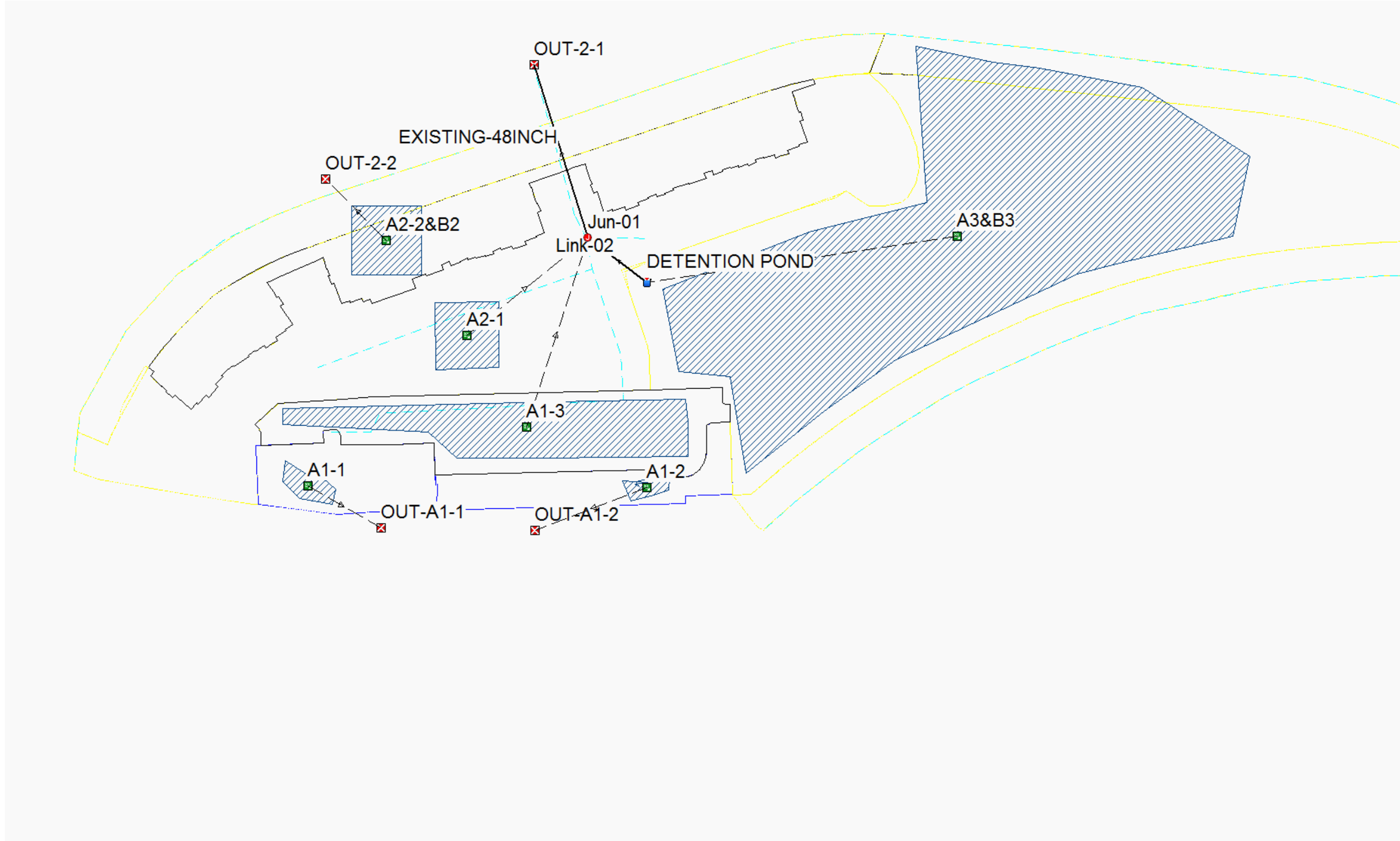
Map Scale: 1:3,970 if printed on A portrait (8.5" x 11") sheet.



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



MODEL LAYOUT



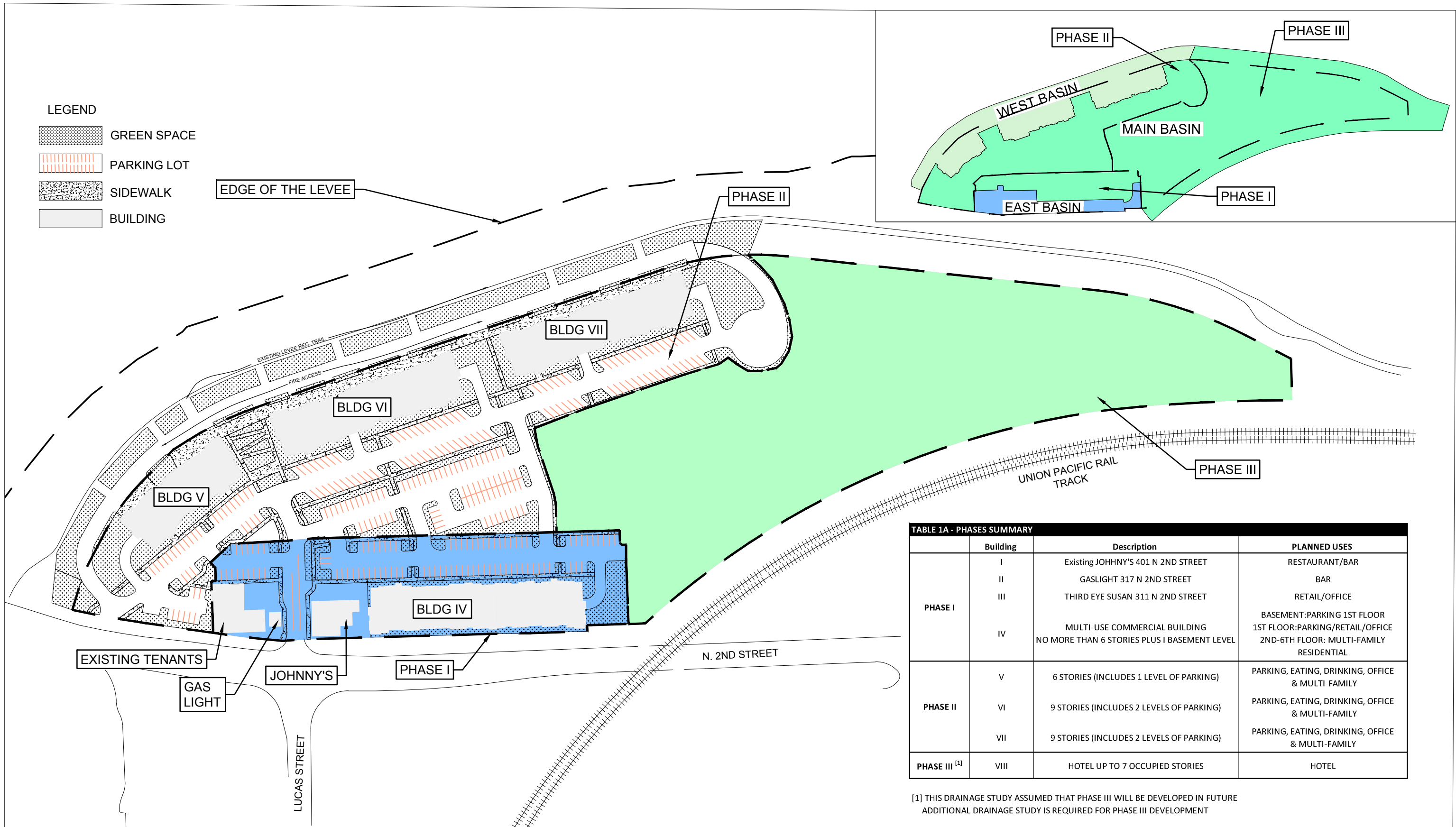


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PHASE II	V	6 STORIES (INCLUDES 1 LEVEL OF PARKING)	PARKING, EATING, DRINKING, OFFICE & MULTI-FAMILY
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	VII	9 STORIES (INCLUDES 2 LEVELS OF PARKING)	PARKING, EATING, DRINKING, OFFICE & MULTI-FAMILY
PHASE III ^[1]	VIII	HOTEL UP TO 7 OCCUPIED STORIES	HOTEL

[1] THIS DRAINAGE STUDY ASSUMED THAT PHASE III WILL BE DEVELOPED IN FUTURE
ADDITIONAL DRAINAGE STUDY IS REQUIRED FOR PHASE III DEVELOPMENT

SCALE: 1" = 150'



**NORTH LAWRENCE RIVERFRONT
LAND USES AND PHASING
EXHIBIT 1
OCTOBER, 2018**



KANSAS RIVER

AVERAGE ANNUAL ESTIMATED RIVER WSE. ~ 814

GRAVITY FLOW OUTLET THROUGH LEVEE

EXISTING 48" RCP PIPE
224 L.F
APP. UP FL. ELE. 816.00
APP. DS FL. ELE= 814.00

EXISTING SLUICE GATE

DETENTION POND
BOTTOM ELEVATION 817.00
BERM ELEVATION 822.0
WSE 100-YEAR
FREE FLOW 818.6
CLOSED LEVEE GATE 821.5

TOP OF THE BERM
FOR FULL DEVELOPMENT
(PHASE I-III)

AREA A2-2
AREA= 1.89 AC
TC= 5 MIN.
CN= 96.7

AREA B2
AREA= 1.72 AC
TC= 5 MIN.
CN= 96.7

AREA A2-1
AREA= 4.49 AC
TC= 5.8 MIN.
CN= 90.4

AREA B3
AREA= 3.00 AC
TC= 5 MIN.
CN= 73

AREA A3 & B3
AREA= 10.21 AC
TC= 11.6 MIN.
CN= 75.5

AREA A1-1
AREA= 0.58 AC
TC= 5.1 MIN.
CN= 88.1

AREA A1-2
AREA= 0.51 AC
TC= 6.2 MIN.
CN= 88.7

FEMA ZONE AH
BFE=820.0

AREA A1-3
AREA= 1.43 AC
TC= 8.5 MIN.
CN= 94.4

EXISTING STORM PIPE

2x120.0 L.F 24" RCP
@0.50%

EXISTING LEVEE REG. TRAIL

N 1ST ST.

UNION PACIFIC RAILROAD

N 2ND ST.

N 2ND ST.

LOCUST ST.

N 2ND ST.

LOW POINT ELEVATION= 822.0

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

N 2ND ST.

SCALE: 1" = 150'



NORTH LAWRENCE RIVERFRONT DRAINAGE AREA MAP, POST CONDITION EXHIBIT 2 OCTOBER, 2018



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APPENDIX A

DETENTION POND SIZING

Summary of Design Data

Proposed Condition:

Assumed case:

Sluice gate on West of the site is closed.

Detention pond should have enough volume for 100-year, 24-hour precipitation

1. Complete Development of Phase I, II

Detainable Drainage Area = 16.13 Acres (CN=82)

Including Following Basins

Onsite A1-3 (1.43 ac. CN=94.7)

Onsite A2-1 (4.49 ac. CN=90.4)

Onsite A3 (7.21 ac. CN=76.5)

Offsite B3 (3.00 ac. CN=73)

Runoff Volume from 100-Year, 24-Hour Storm Event (SCS-TR-55)

Soil types (NRCS): Eudora-Urban land. Soils is in hydrologic group 'B'

Weight SCS curve number (CN) = 82

100-year, 24-hour precipitation (P) = 8.16 inches

$S=(1000/CN)-10=2.19$ Inch

$Q=(P-0.2S)^2/(P+0.8S)= 6.01$ Inch

Converted to volume (V) of rainfall: 6.01 Inches x 1/12 x 16.13= 8.07 Acre-feet

Required Detention Volume: 8.10 Acre-feet

2. Complete Development of Phase I, II, and III

Detainable Drainage Area = 16.13 Acres (CN=88)

Including Following Basins

Onsite A1-3 (1.43 ac. CN=94.7)

Onsite A2-1 (4.49 ac. CN=90.4)

Onsite A3 (7.21 ac. CN=95)

Offsite B3 (3.00 ac. CN=73)

Weight SCS curve number (CN) = 90

100-year, 24-hour precipitation (P) = 8.16 inches

$S=(1000/CN)-10=1.11$ Inch

$Q=(P-0.2S)^2/(P+0.8S)= 6.96$ Inch

Converted to volume (V) of rainfall: 6.96 Inches x 1/12 x 16.18= 9.35 Acre-feet

DETENTION POND STORAGE CURVE (DEPTH VS AREA)

1. Complete Development of Phase I, II

ELEVATION	DEPTH (ft)	AREA (ft ²)	VOLUME (ft ³)	VOLUME (ac-ft)
817	0	66526	0	0
818	1	70333	68429.50	1.57
819	2	74197	140694.50	3.23
820	3	78117	216851.50	4.98
821	4	82093	296956.50	6.82
822	5	86126	381066.00	8.75

2. Complete Development of Phase I, II, III

ELEVATION	DEPTH (ft)	AREA (ft ²)	VOLUME (ft ³)	VOLUME (ac-ft)
817	0	69000	0	0
818	1	73334	71167.00	1.63
819	2	77940	146804.00	3.37
820	3	82835	227191.50	5.22
821	4	88039	312628.50	7.18
822	5	93568	403432.00	9.26

APPENDIX B
100-YEAR STORM EVENT
POST CONDITION
INITIAL DEVELOPMENT (PHASE I & II)

Project Description

File Name 20182022-Drainage_ PH I & PH II.SPF

Project Options

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

Analysis Options

Start Analysis On Oct 05, 2018 00:00:00
 End Analysis On Oct 07, 2018 00:00:00
 Start Reporting On Oct 05, 2018 00:00:00
 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 00:10:00 days hh:mm:ss
 Routing Time Step 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	6
Nodes.....	6
<i>Junctions</i>	1
<i>Outfalls</i>	4
<i>Flow Diversions</i>	0
<i>Inlets</i>	0
<i>Storage Nodes</i>	1
Links.....	2
<i>Channels</i>	0
<i>Pipes</i>	2
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	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
1		Time Series	TS-100	Year Intensity	inches	Kansas	Douglas	100	8.16	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area	Weighted Curve Number	Average Slope (%)	Flow Length (ft)	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1-1	0.58	88.10	0.5000	500.00	8.16	6.74	3.91	5.82	0 00:05:06
2	A1-2	0.51	88.70	0.5000	500.00	8.16	6.81	3.47	5.00	0 00:06:12
3	A1-3	1.43	94.70	0.5000	500.00	8.16	7.53	10.76	13.76	0 00:08:30
4	A2-1	4.49	90.40	0.5000	500.00	8.16	7.01	31.48	45.13	0 00:05:48
5	A2-2&B2	3.61	96.70	0.5000	500.00	8.16	7.76	28.03	38.60	0 00:05:00
6	A3&B3	10.21	75.50	0.5000	500.00	8.16	5.25	53.55	71.01	0 00:11:36

Node Summary

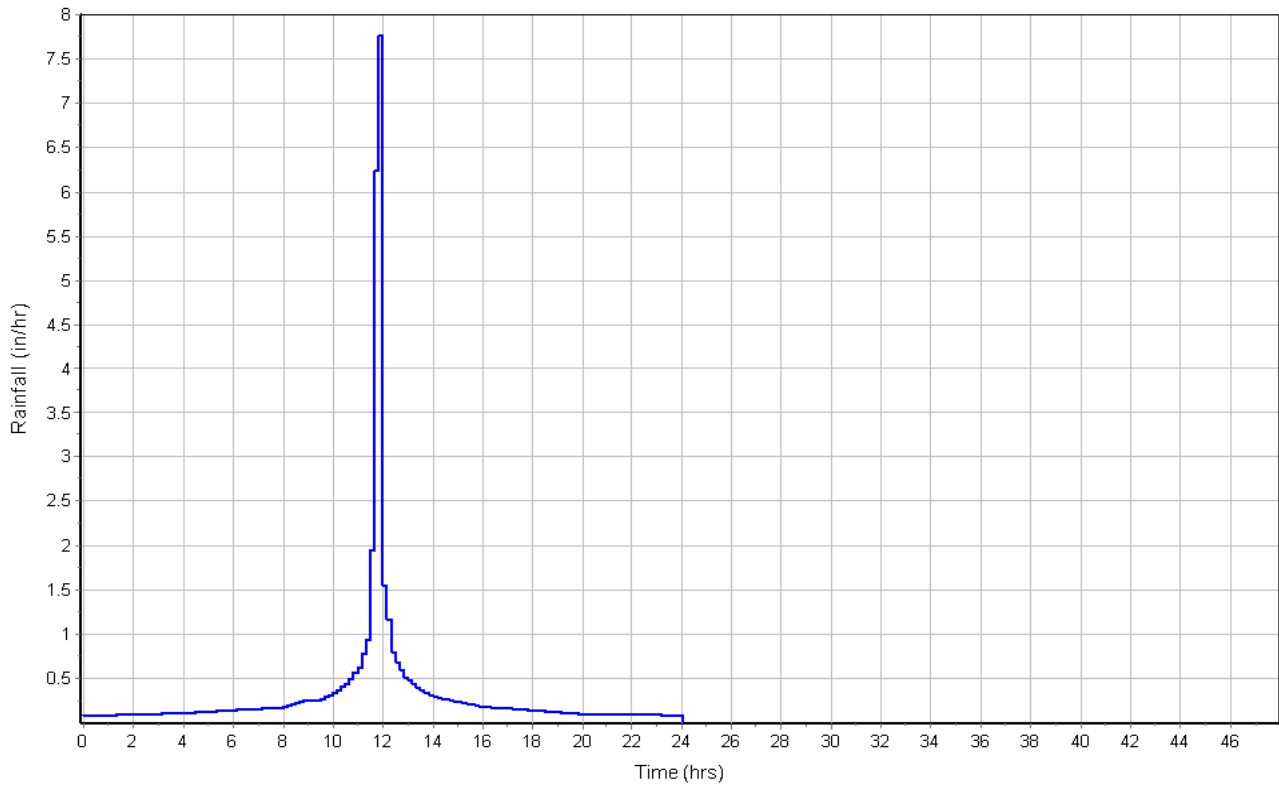
SN Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft ²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1 Jun-01	Junction	816.00	822.00	0.00	822.00	10.00	49.45	821.52	0.00	0.48	0 00:00	0.00	0.00
2 OUT-2-1	Outfall	813.00					0.00	827.70					
3 OUT-2-2	Outfall	0.00					29.68	0.00					
4 OUT-A1-1	Outfall	0.00					4.56	0.00					
5 OUT-A1-2	Outfall	0.00					4.19	0.00					
6 DETENTION POND	Storage Node	817.00	822.00	817.00		81364.00	120.00	821.52				0.00	0.00

Link Summary

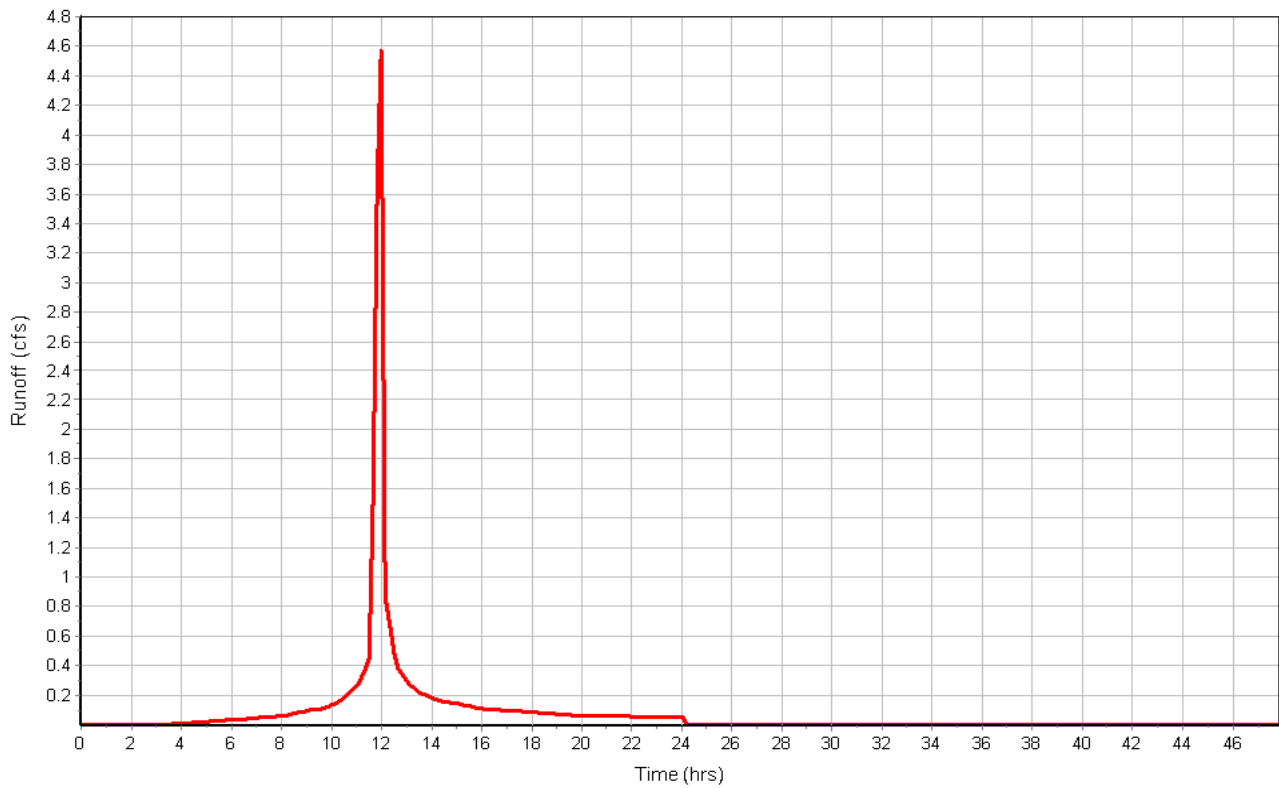
SN Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Reported Surcharged (min)	Reported Condition
1	EXISTING-48INCH Pipe	Jun-01	OUT-2-1	225.00	816.00	813.70	1.0200	48.000	0.0130	0.00	145.23	0.00	0.00	4.00	1.00	2142.00	SURCHARGED
2	Link-02	Pipe	DETENTION POND Jun-01	120.00	816.60	816.00	0.5000	24.000	0.0130	49.44	41.30	1.20	7.87	2.00	1.00	2151.00	SURCHARGED

Subbasin : A1-1

Rainfall Intensity Graph

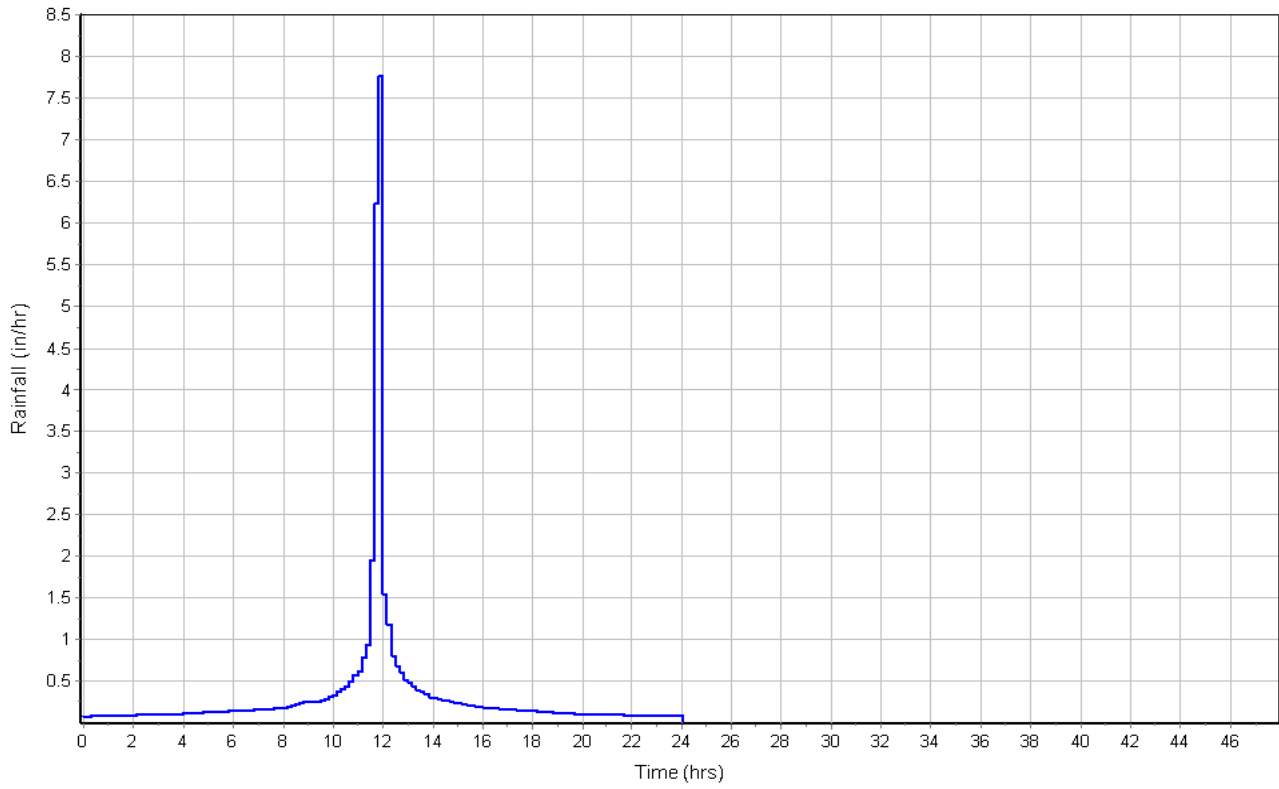


Runoff Hydrograph

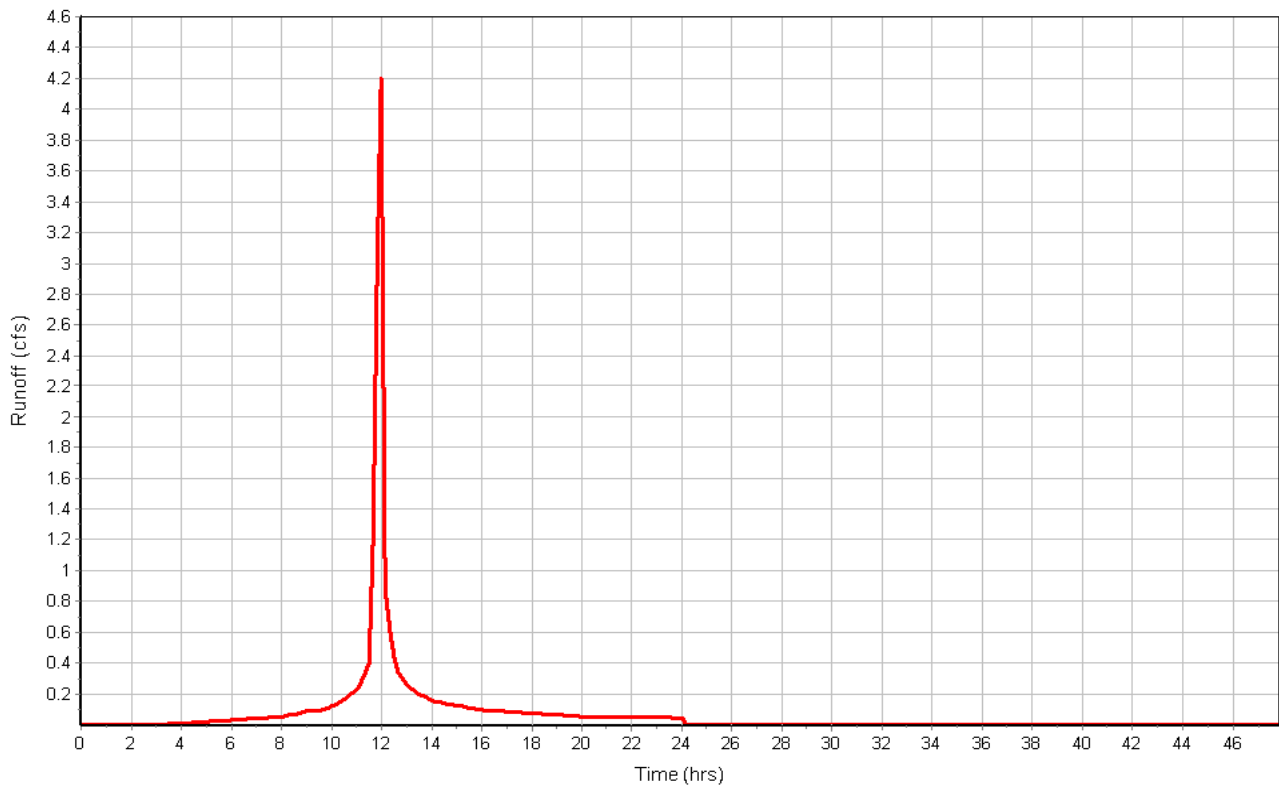


Subbasin : A1-2

Rainfall Intensity Graph

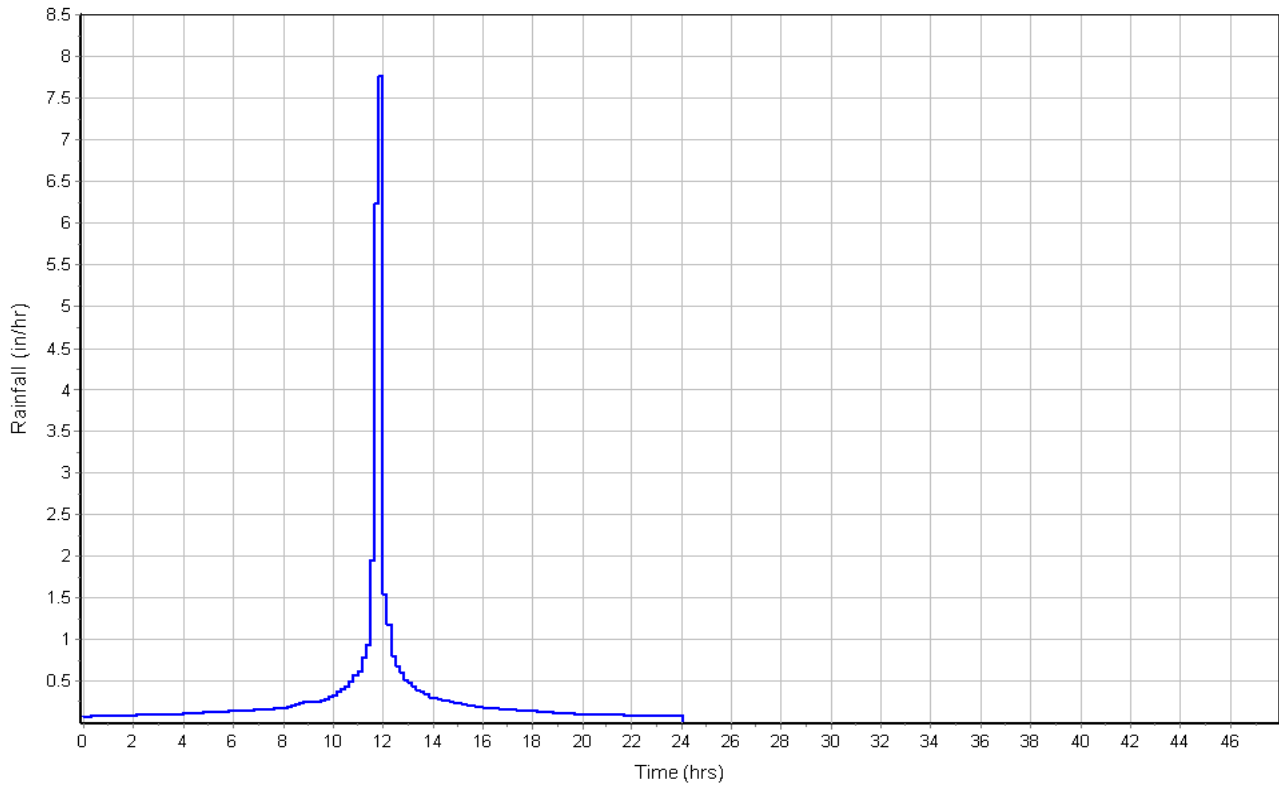


Runoff Hydrograph

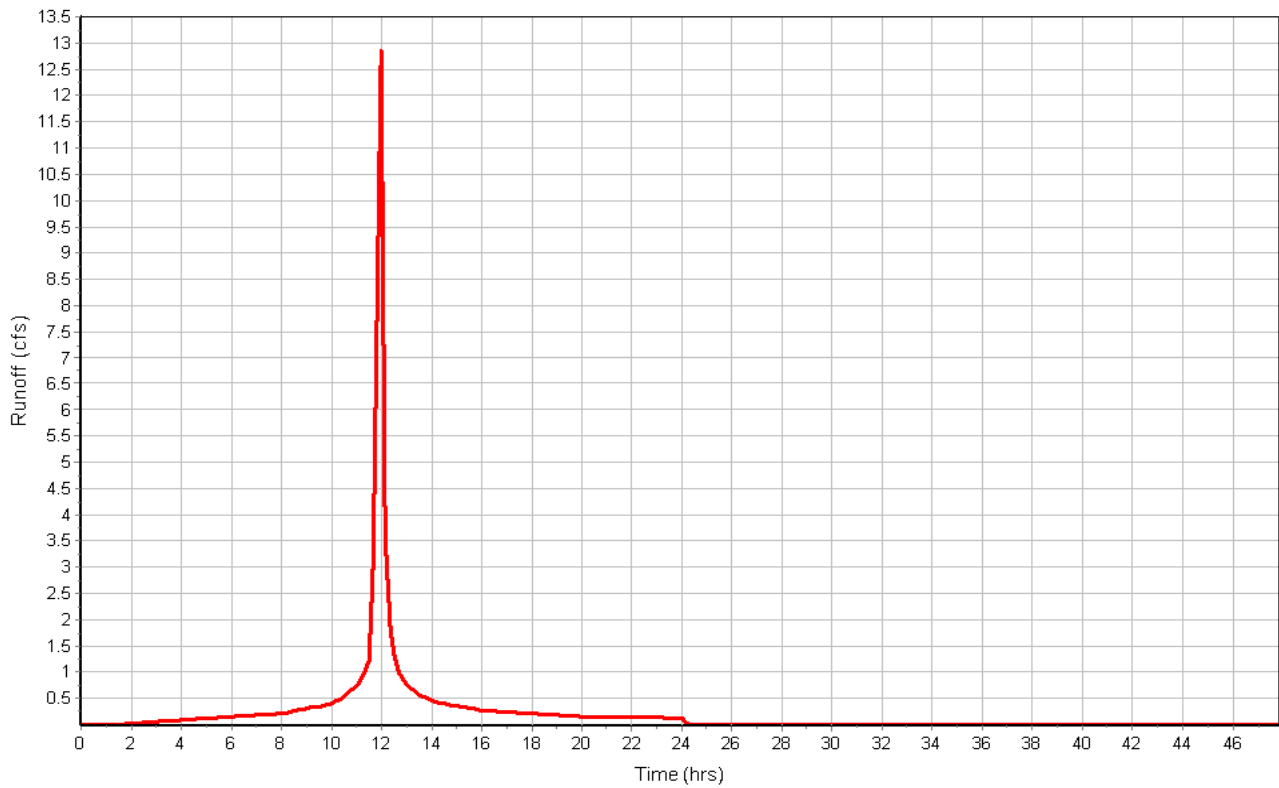


Subbasin : A1-3

Rainfall Intensity Graph

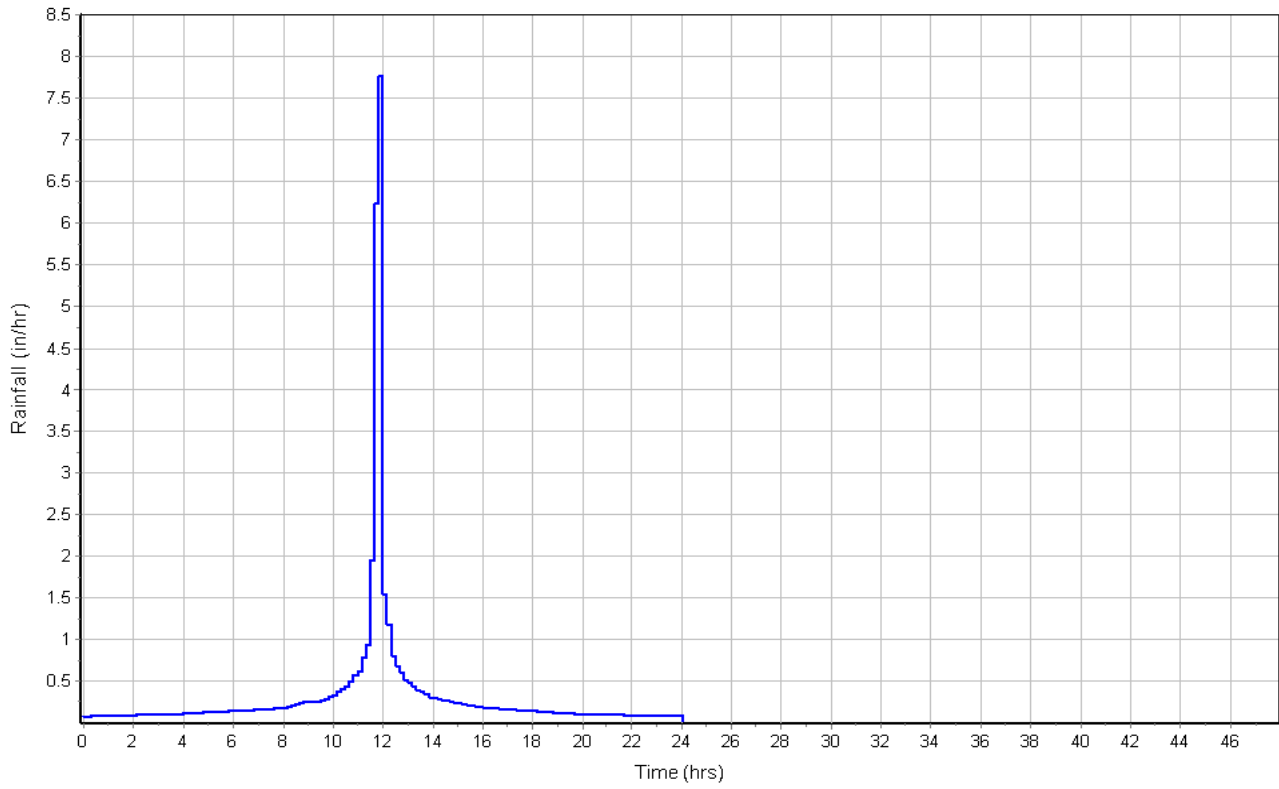


Runoff Hydrograph

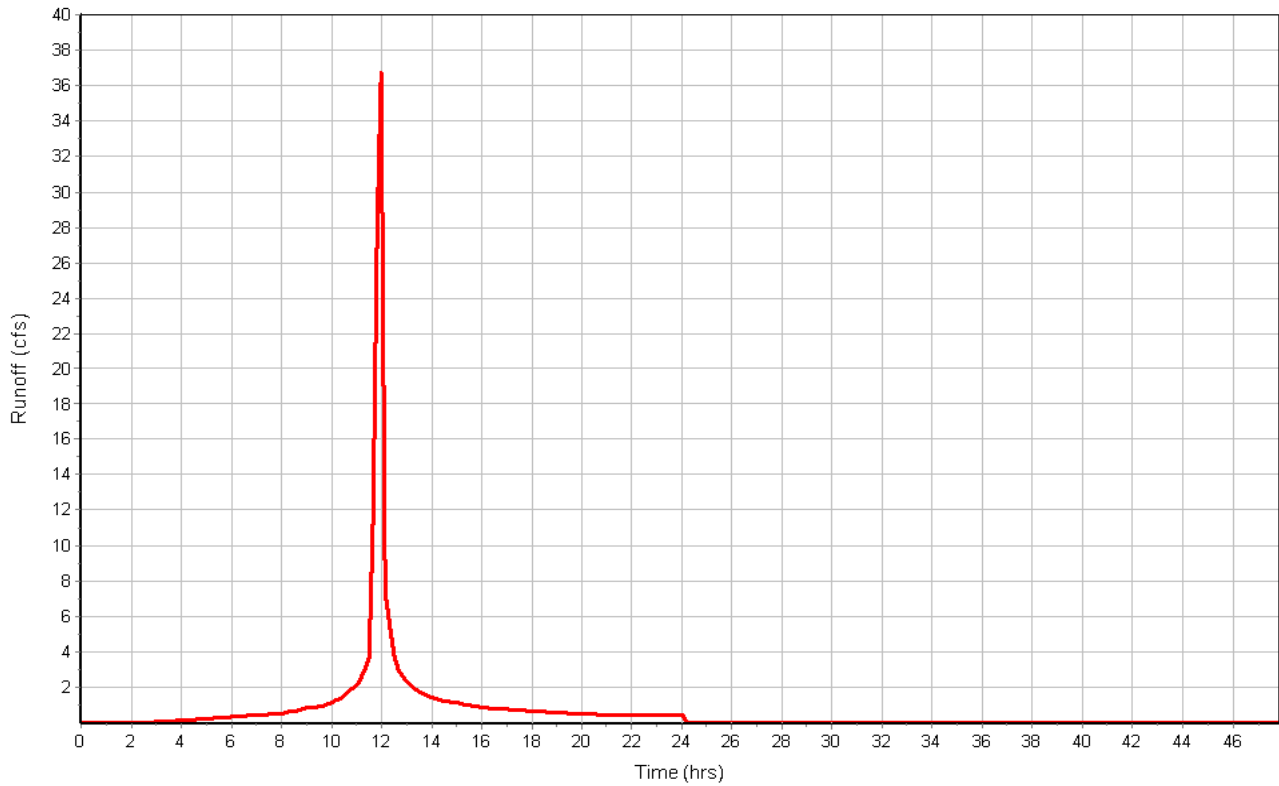


Subbasin : A2-1

Rainfall Intensity Graph

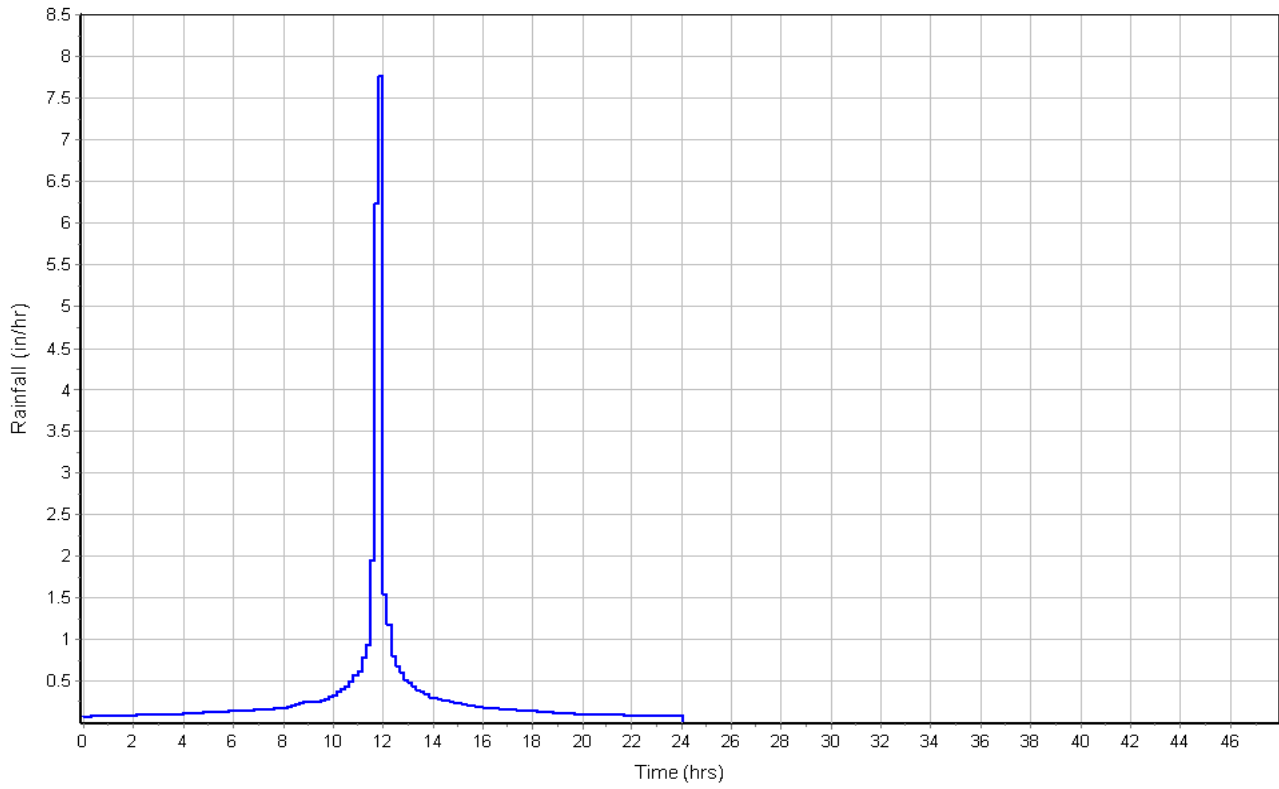


Runoff Hydrograph

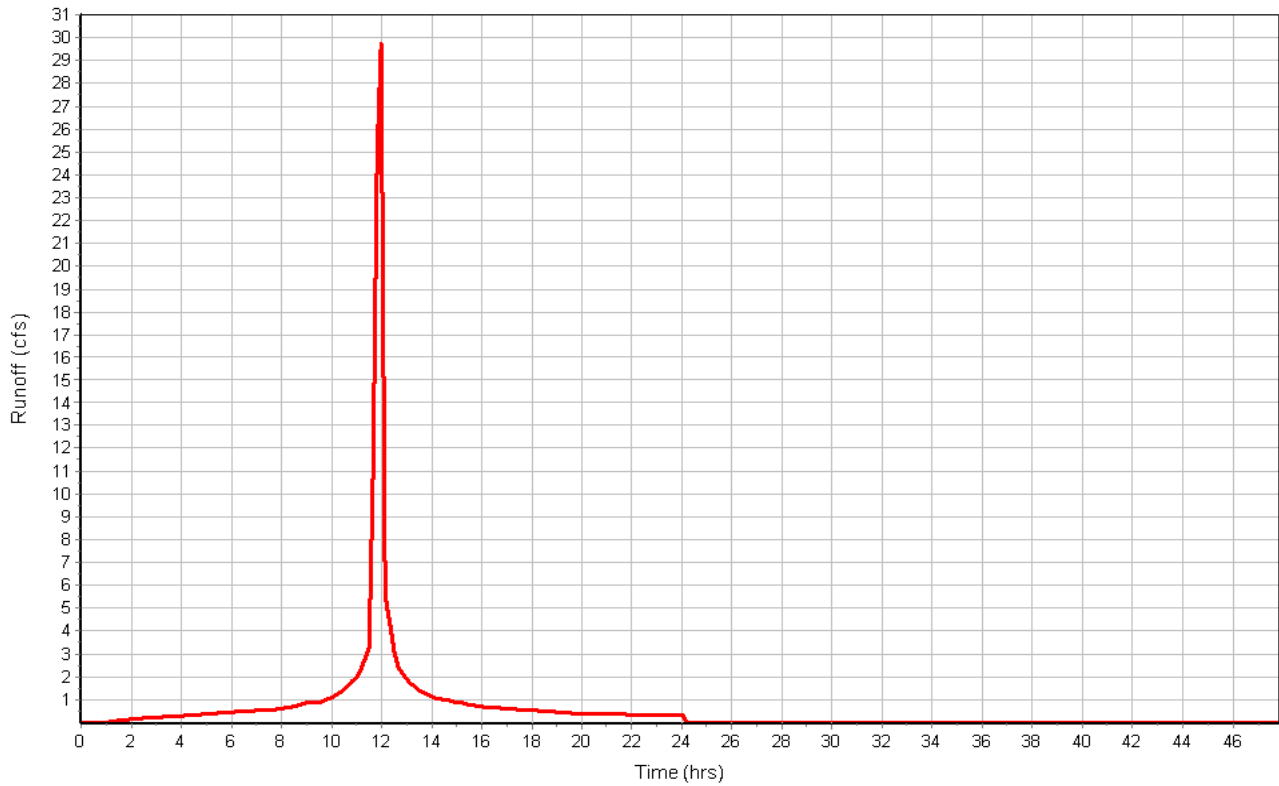


Subbasin : A2-2&B2

Rainfall Intensity Graph

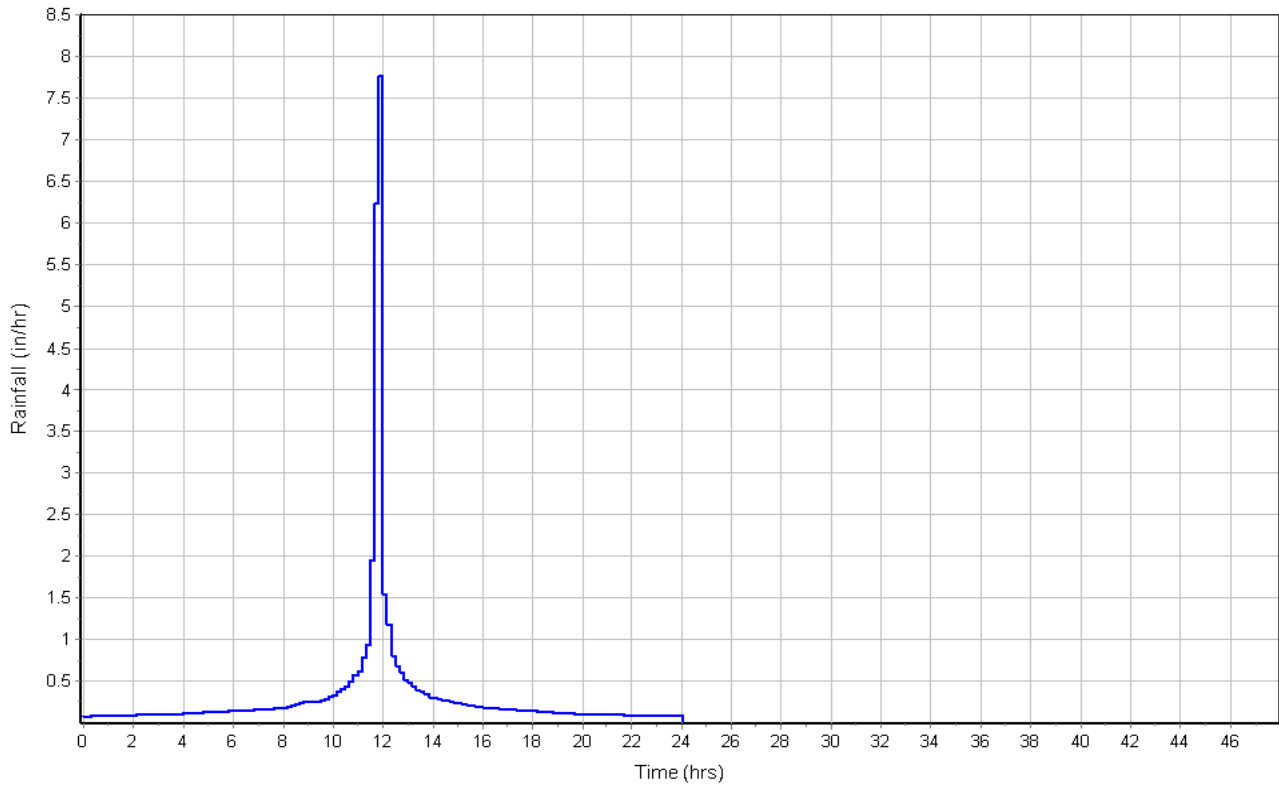


Runoff Hydrograph

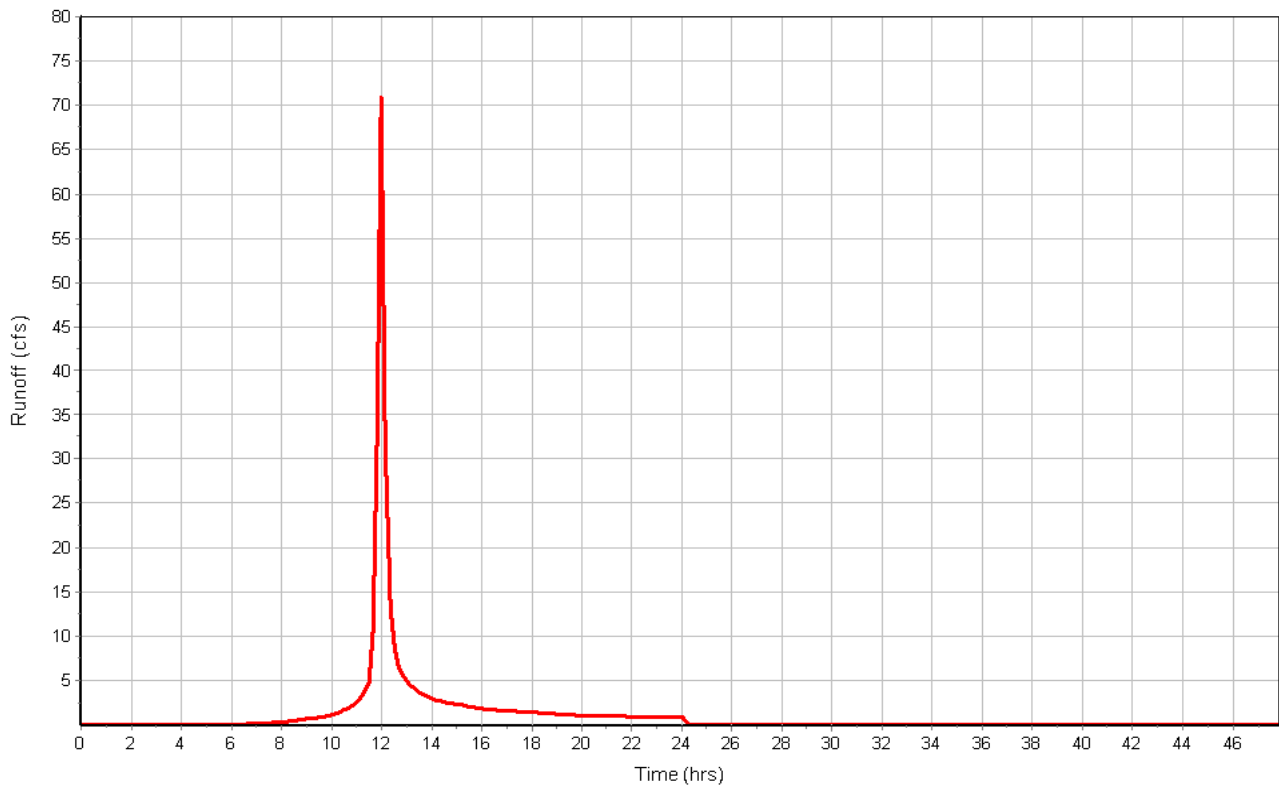


Subbasin : A3&B3

Rainfall Intensity Graph



Runoff Hydrograph



Junction Results

SN Element ID	Peak Inflow	Peak Lateral Inflow	Max HGL Elevation Attained	Max HGL Depth Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Max HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-in)	(min)
1 Jun-01	49.45	49.45	821.52	5.52	0.00	0.48	820.17	4.17	1 08:25	0 00:00	0.00	0.00

Pipe Results

SN Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1 EXISTING-48INCH	0.00	0 00:00	145.23	0.00	0.00		4.00	1.00	2142.00		SURCHARGED
2 Link-02	49.44	0 12:09	41.30	1.20	7.87	0.25	2.00	1.00	2151.00		SURCHARGED

Storage Nodes

Storage Node : DETENTION POND

Input Data

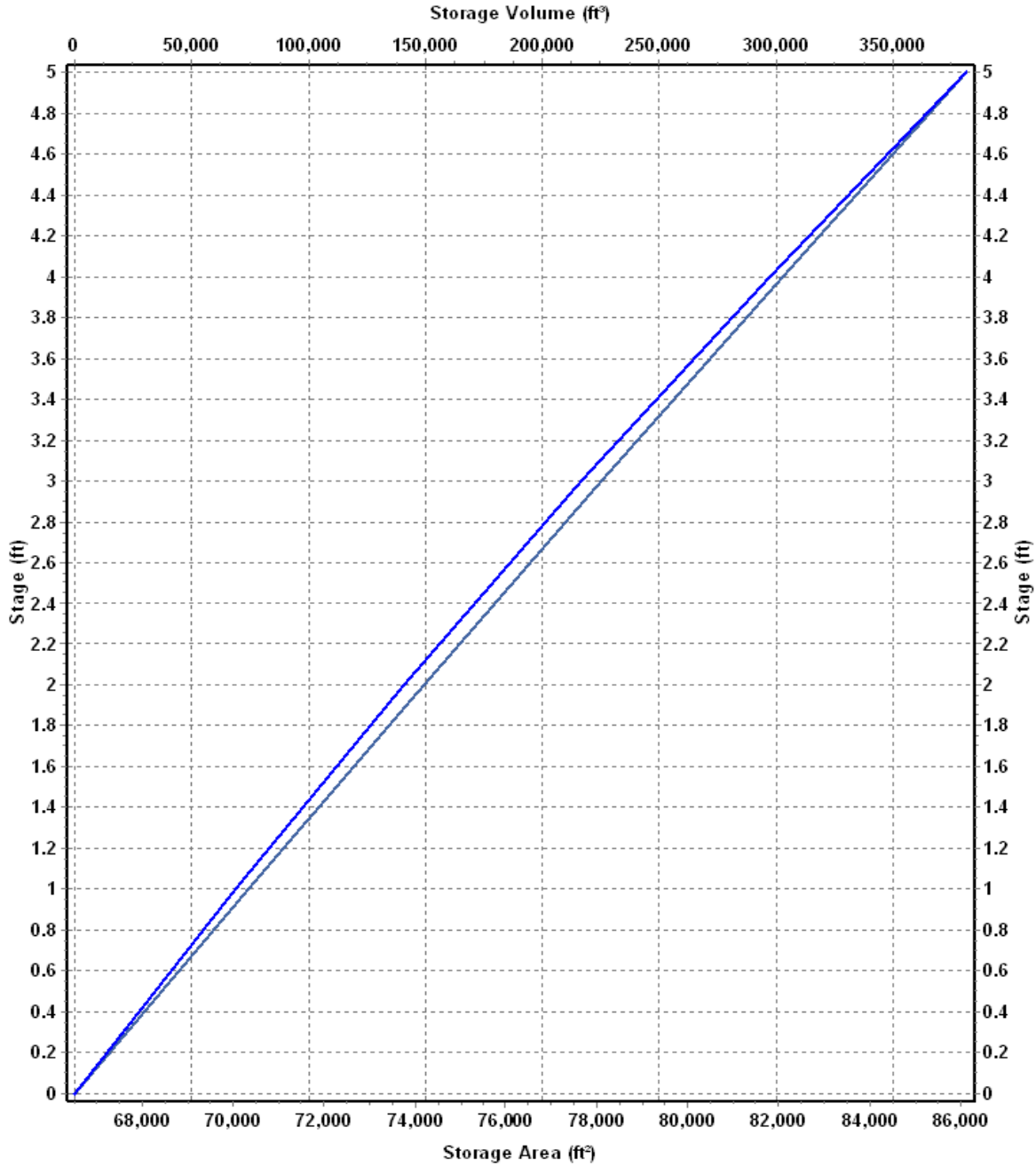
Invert Elevation (ft) 817.00
Max (Rim) Elevation (ft) 822.00
Max (Rim) Offset (ft) 5.00
Initial Water Elevation (ft) 817.00
Initial Water Depth (ft) 0.00
Ponded Area (ft²) 81364.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : DETENTION POND

Stage	Storage Area	Storage Volume
(ft)	(ft ²)	(ft ³)
0	66526	0.000
1	70333	68429.50
2	74197	140694.50
3	78117	216851.50
4	82093	296956.50
5	86126	381066.00

Storage Area Volume Curves



— Storage Area — Storage Volume

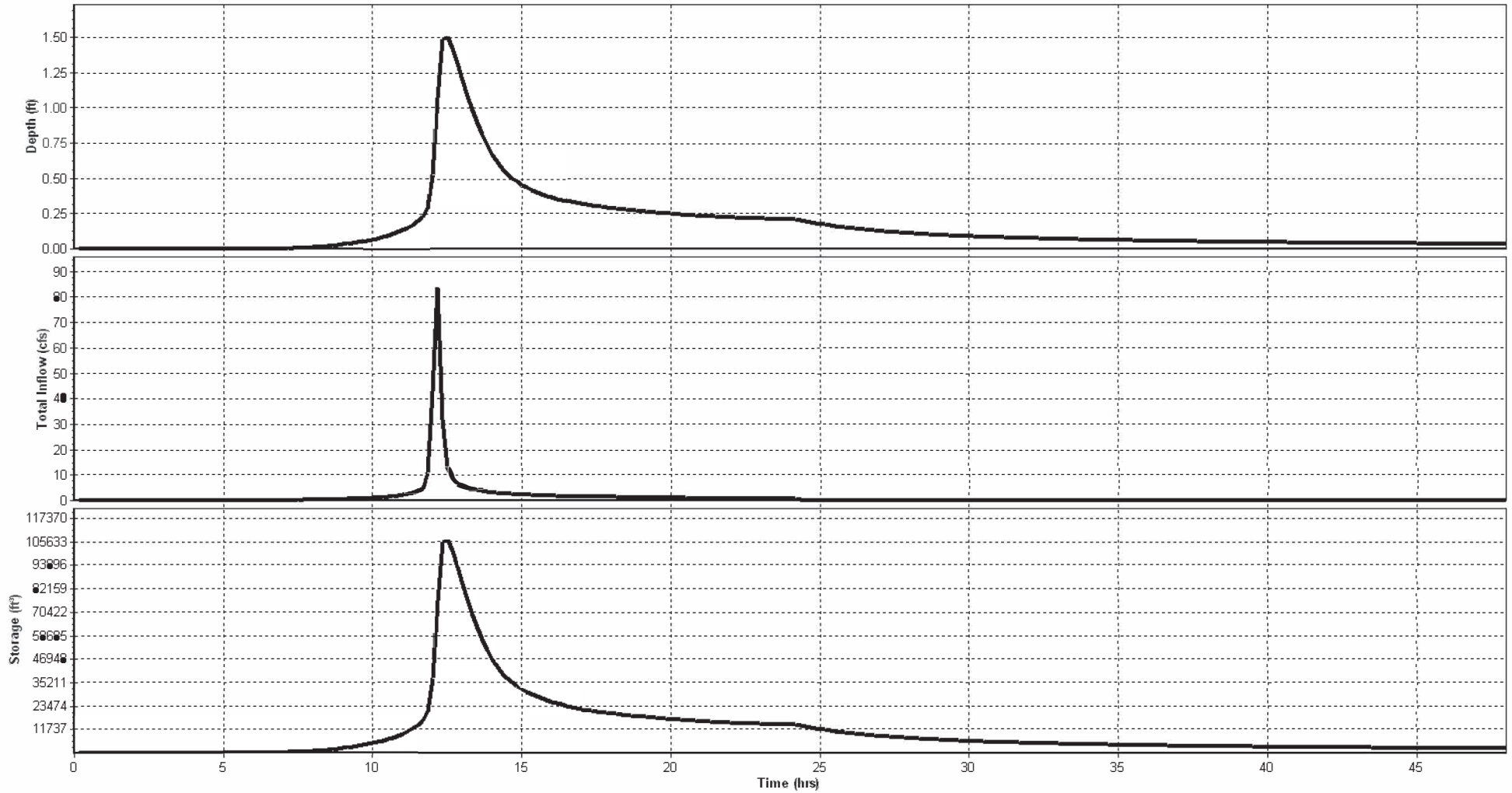
Storage Node : DETENTION POND (continued)

Output Summary Results

Peak Inflow (cfs)	120.00
Peak Lateral Inflow (cfs)	70.56
Peak Outflow (cfs)	0.00
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	821.52
Max HGL Depth Attained (ft)	4.52
Average HGL Elevation Attained (ft)	820.15
Average HGL Depth Attained (ft)	3.15
Time of Max HGL Occurrence (days hh:mm)	1 07:11
Total Exfiltration Volume (1000-ft ³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

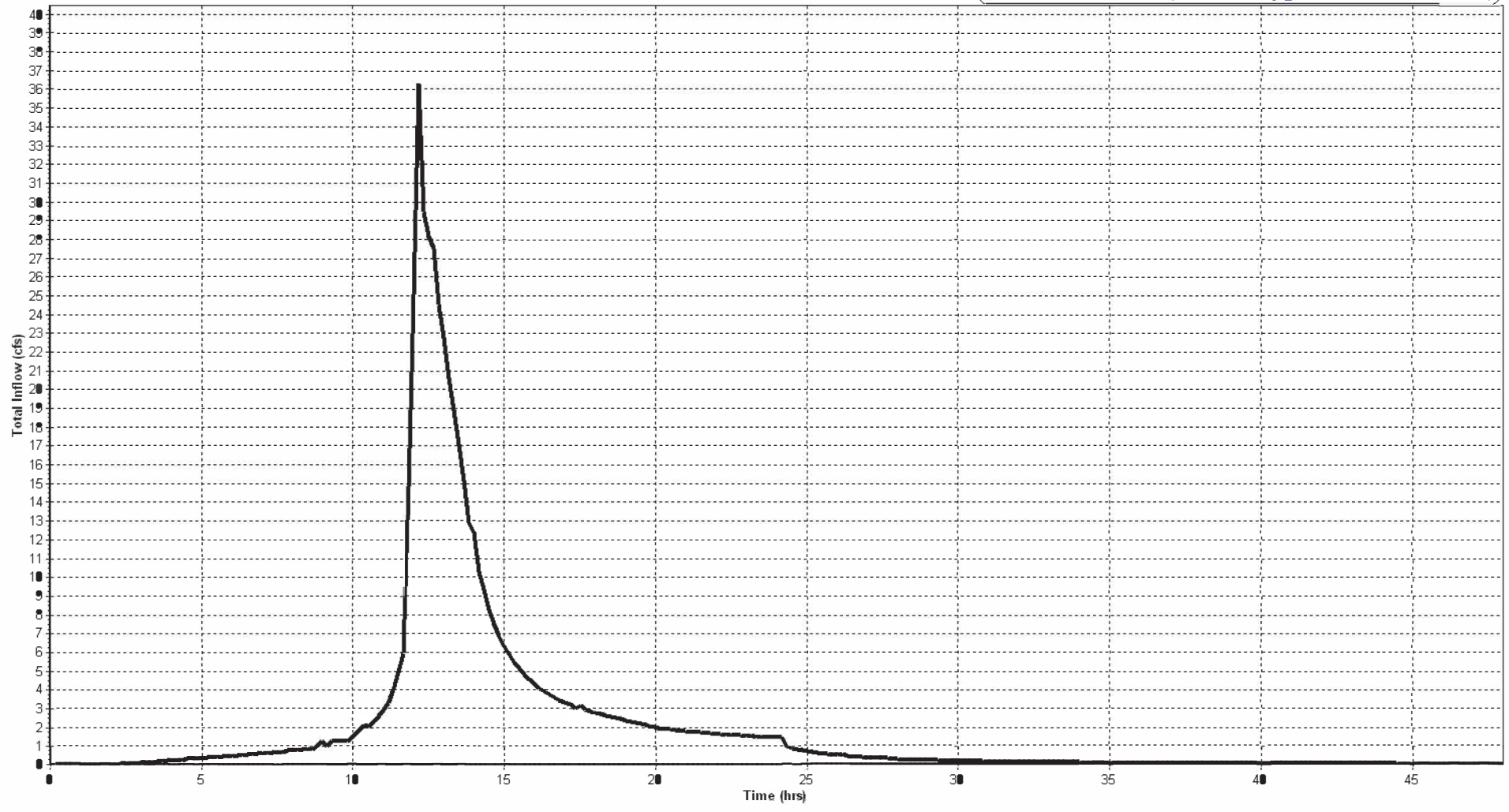
DETENTION POND - SLUICE GATE : OPEN

- Depth: Node - DETENTION POND (2018-2022-Drainage_PH I & PH II 2018-10-15 09:37:18)
- Storage: System (2018-2022-Drainage_PH I & PH II 2018-10-15 09:37:18)
- Total Inflow: Node - DETENTION POND (2018-2022-Drainage_PH I & PH II 2018-10-15 09:37:18)



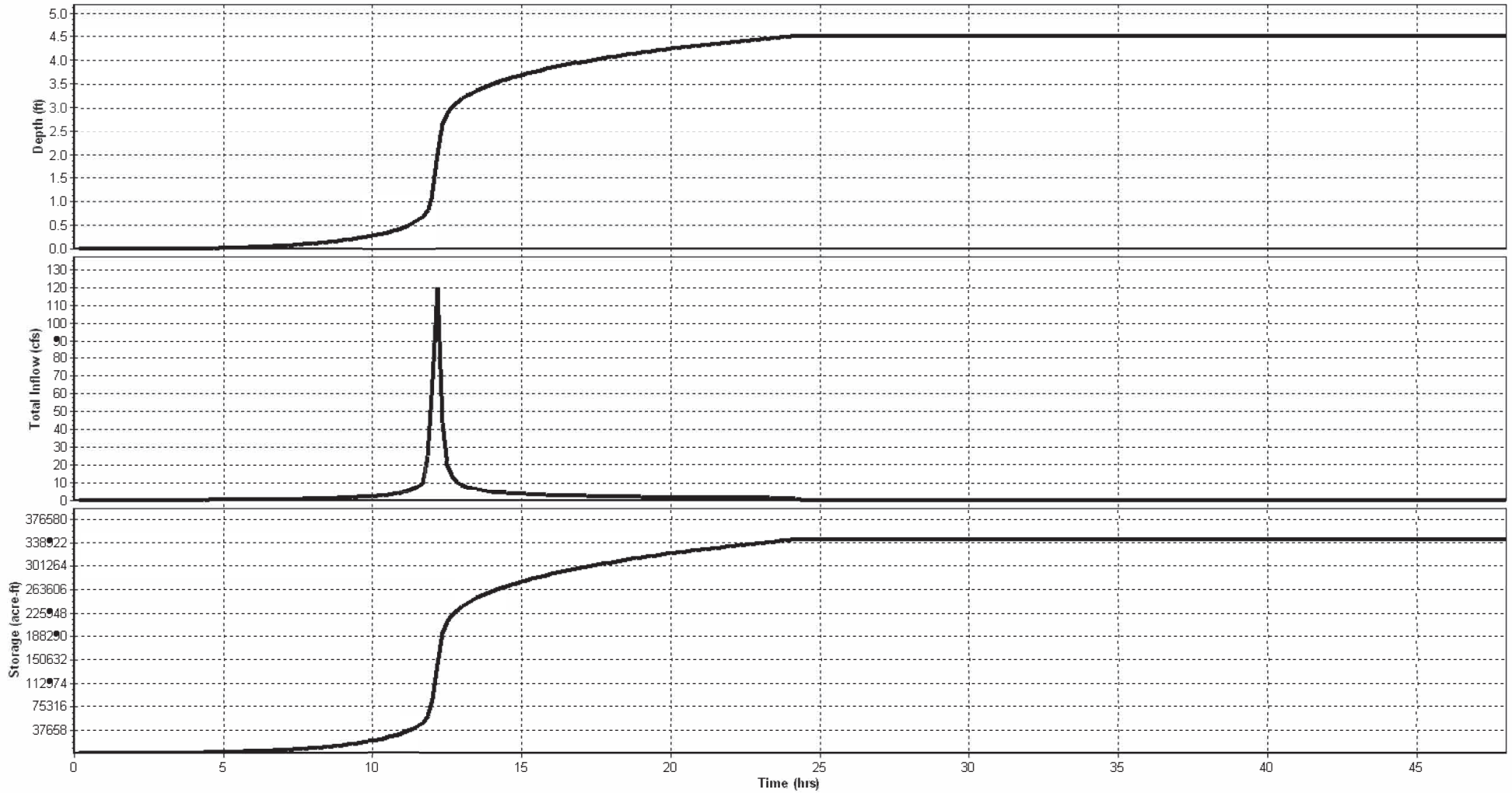
OUT-2-1 - SLUICE GATE: OPEN

Total Inflow: Node - ●UT-2-1 (2018-10-22-Drainage_PH I & PH II 2018-10-15 09:56:26)



DETENTION POND - SLUICE GATE : CLOSED

- Total Inflow: Node - DETENTION POND (20182022-Drainage_ PH I & PH II 2018-10-15 09:48:46)
- Depth: Node - DETENTION POND (20182022-Drainage_ PH I & PH II 2018-10-15 09:48:46)
- Storage: System (20182022-Drainage_ PH I & PH II 2018-10-15 09:48:46)



APPENDIX C
100-YEAR STORM EVENT
POST CONDITION
FULL DEVELOPMENT (PHASE I,II,III)

Project Description

File Name 20182022-Drainage_ PH I&II& III.SPF

Project Options

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

Analysis Options

Start Analysis On Oct 05, 2018 00:00:00
 End Analysis On Oct 07, 2018 00:00:00
 Start Reporting On Oct 05, 2018 00:00:00
 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 00:10:00 days hh:mm:ss
 Routing Time Step 30 seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins.....	6
Nodes.....	6
<i>Junctions</i>	1
<i>Outfalls</i>	4
<i>Flow Diversions</i>	0
<i>Inlets</i>	0
<i>Storage Nodes</i>	1
Links.....	2
<i>Channels</i>	0
<i>Pipes</i>	2
<i>Pumps</i>	0
<i>Orifices</i>	0
<i>Weirs</i>	0
<i>Outlets</i>	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
1		Time Series	TS-100	Year Intensity	inches	Kansas	Douglas	100	8.16	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area	Weighted Curve Number	Average Slope (%)	Flow Length (ft)	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	A1-1	0.58	88.10	0.5000	500.00	8.16	6.74	3.91	5.82	0 00:05:06
2	A1-2	0.51	88.70	0.5000	500.00	8.16	6.81	3.47	5.00	0 00:06:12
3	A1-3	1.43	94.80	0.5000	500.00	8.16	7.54	10.78	13.77	0 00:08:30
4	A2-1	4.49	90.40	0.5000	500.00	8.16	7.01	31.48	45.13	0 00:05:48
5	A2-2&B2	3.61	96.70	0.5000	500.00	8.16	7.76	28.03	38.60	0 00:05:00
6	A3&B3	10.21	88.00	0.5000	500.00	8.16	6.73	68.66	94.18	0 00:08:00

Node Summary

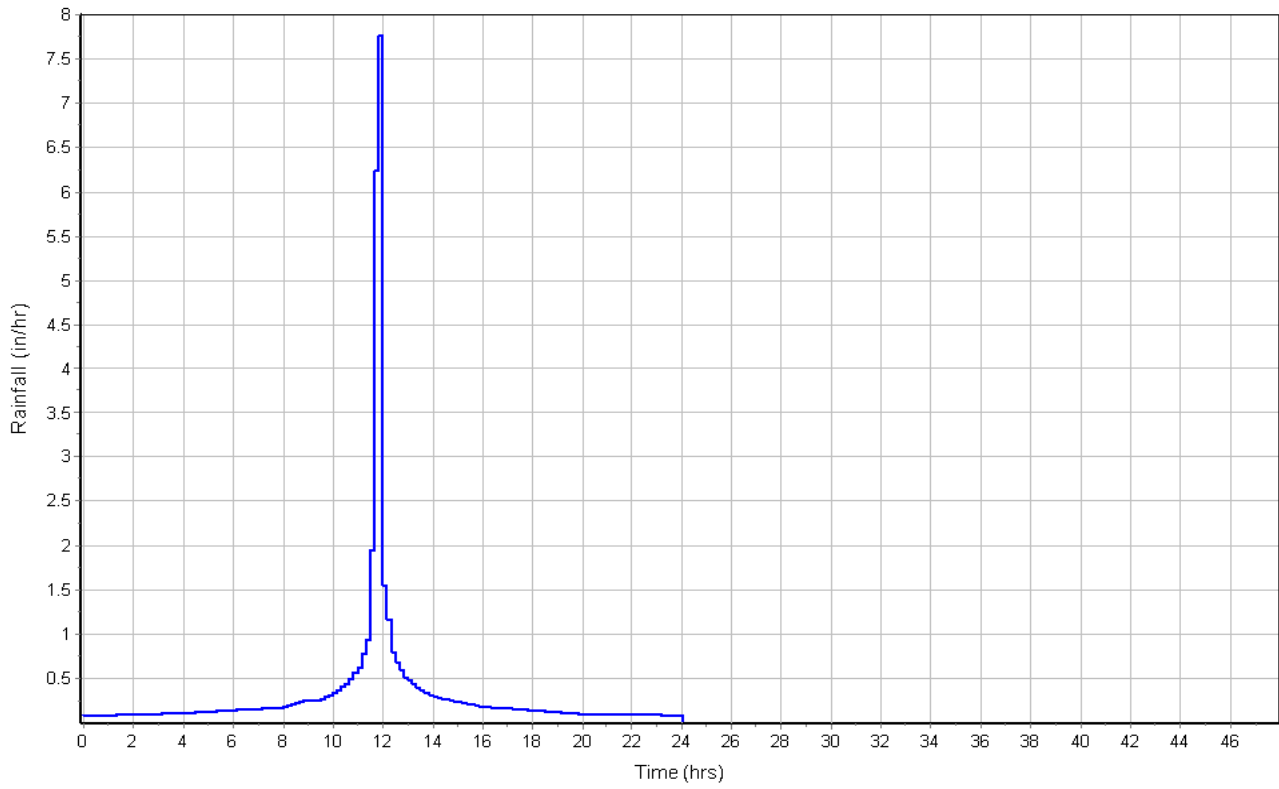
SN Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft ²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1 Jun-01	Junction	816.00	822.00	0.00	822.00	20.00	49.12	821.89	0.00	0.11	0 00:00	0.00	0.00
2 Out-2-1	Outfall	813.00					0.00	827.70					
3 Out-2-2	Outfall	0.00					29.56	0.00					
4 Out-A1-1	Outfall	0.00					4.54	0.00					
5 Out-A1-2	Outfall	0.00					4.16	0.00					
6 DETENTION POND	Storage Node	817.00	822.00	817.00		93568.00	134.08	821.88				0.00	0.00

Link Summary

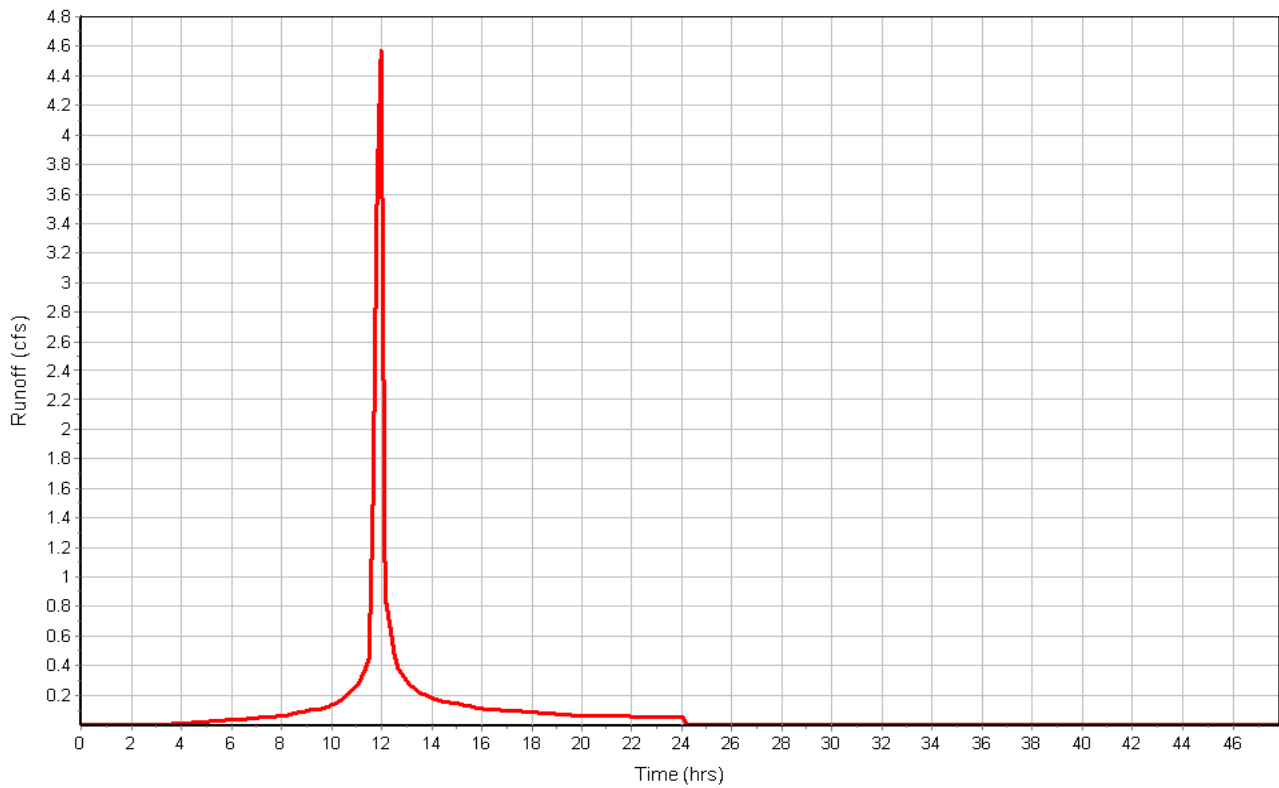
SN Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/Total Depth Ratio	Total Time Reported (min)	Surcharged Condition
1	EXISTIN-48INCH Pipe	Jun-01	Out-2-1	225.00	816.00	813.70	1.0200	48.000	0.0130	0.00	145.23	0.00	0.00	4.00	1.00	2160.00	SURCHARGED
2	Link-02 Pipe	DETENTION POND	Jun-01	120.00	816.60	816.00	0.5000	24.000	0.0130	48.69	41.30	1.18	7.75	2.00	1.00	2156.00	SURCHARGED

Subbasin : A1-1

Rainfall Intensity Graph

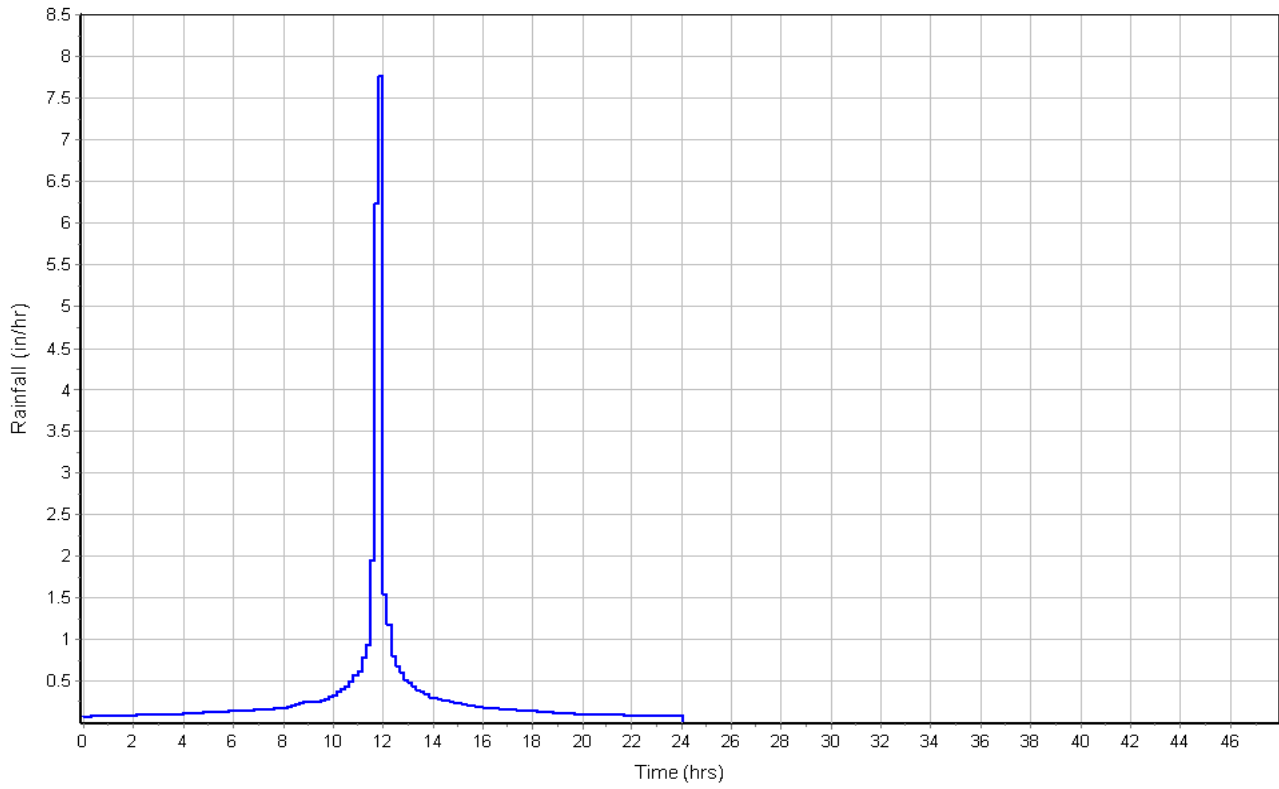


Runoff Hydrograph

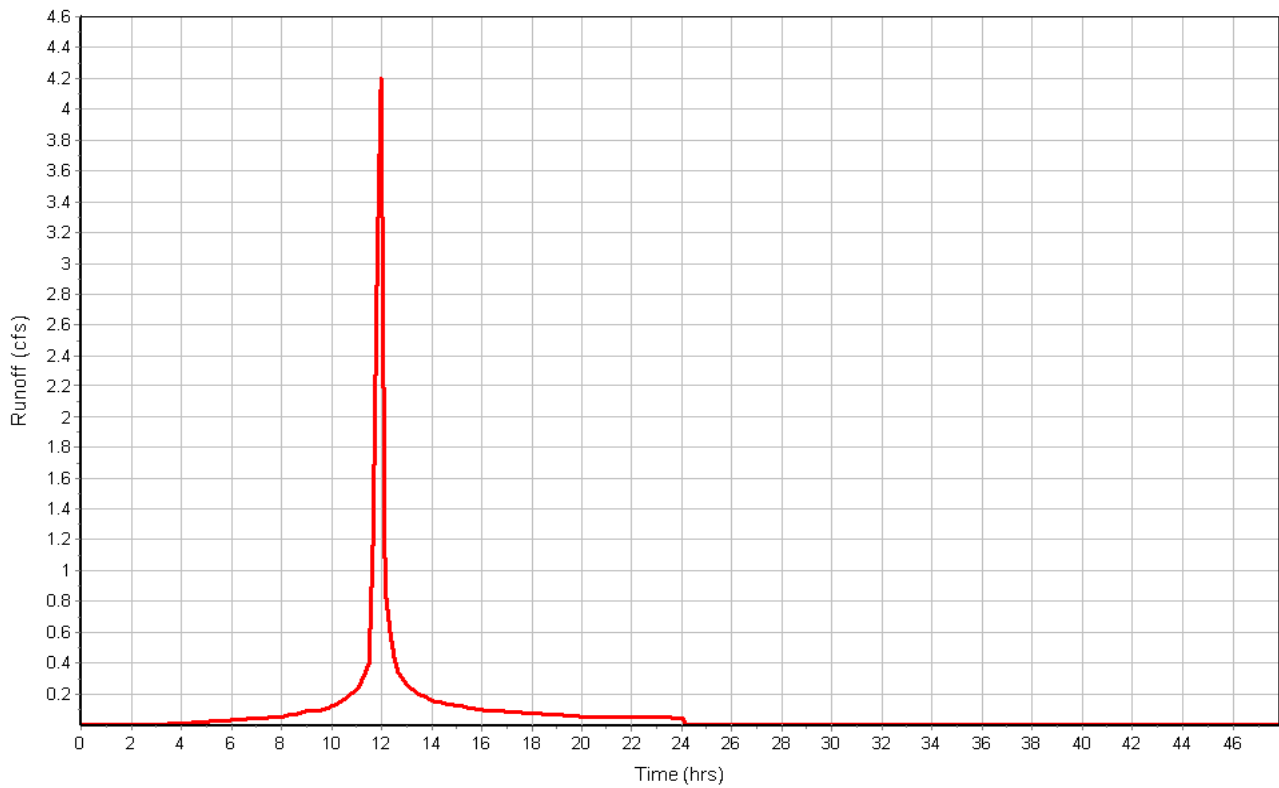


Subbasin : A1-2

Rainfall Intensity Graph

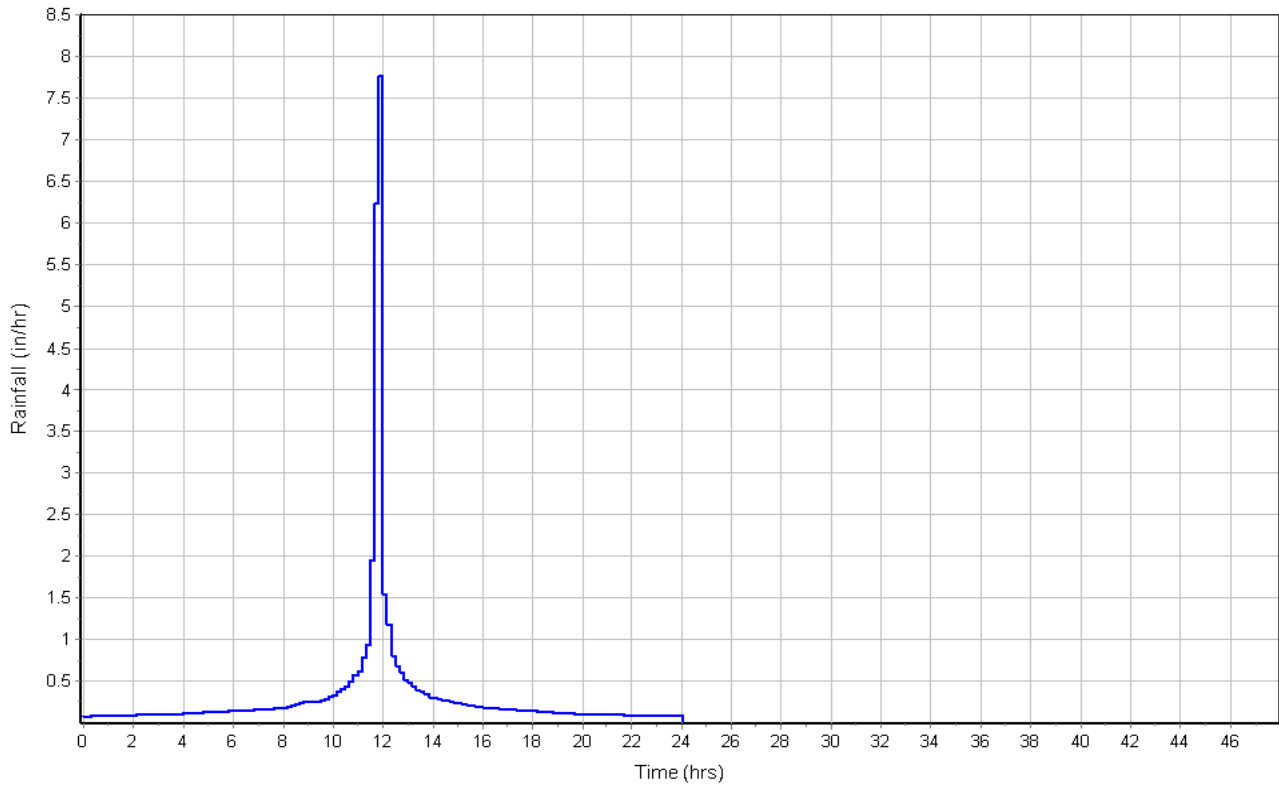


Runoff Hydrograph

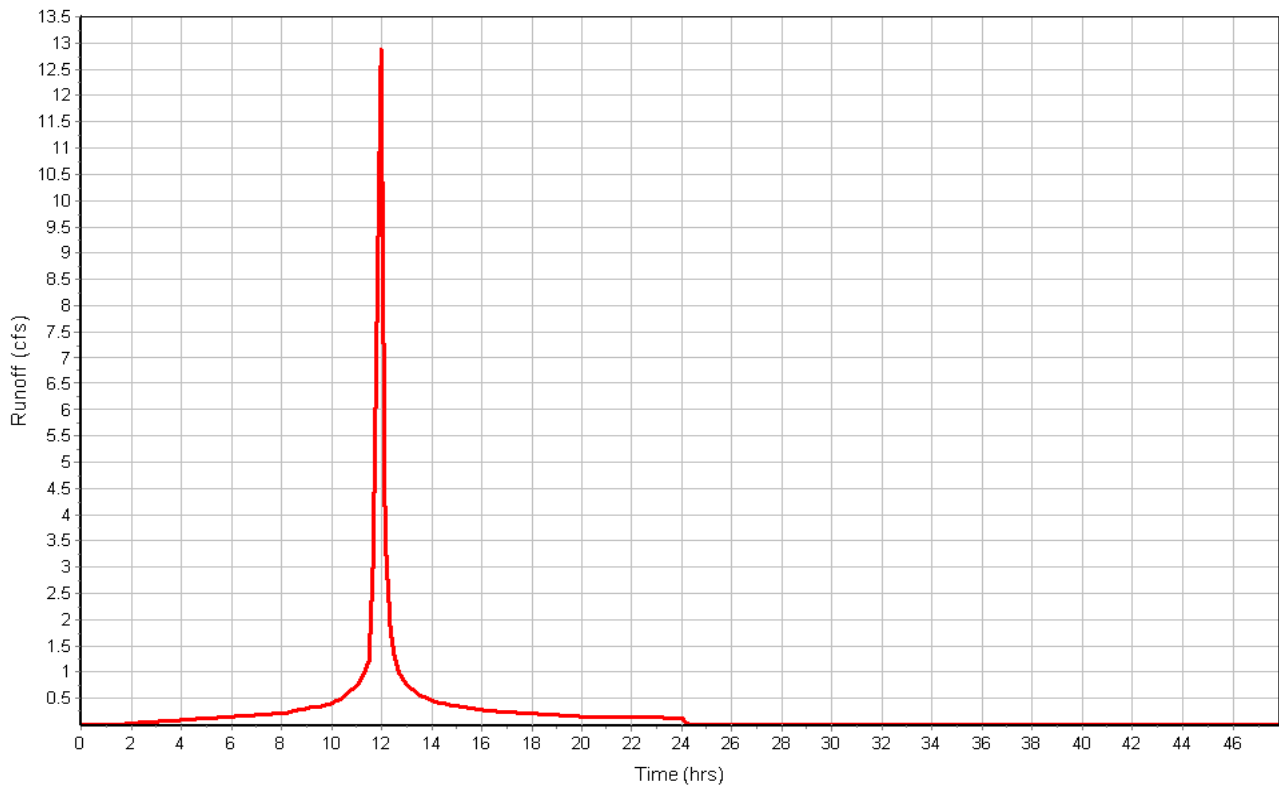


Subbasin : A1-3

Rainfall Intensity Graph

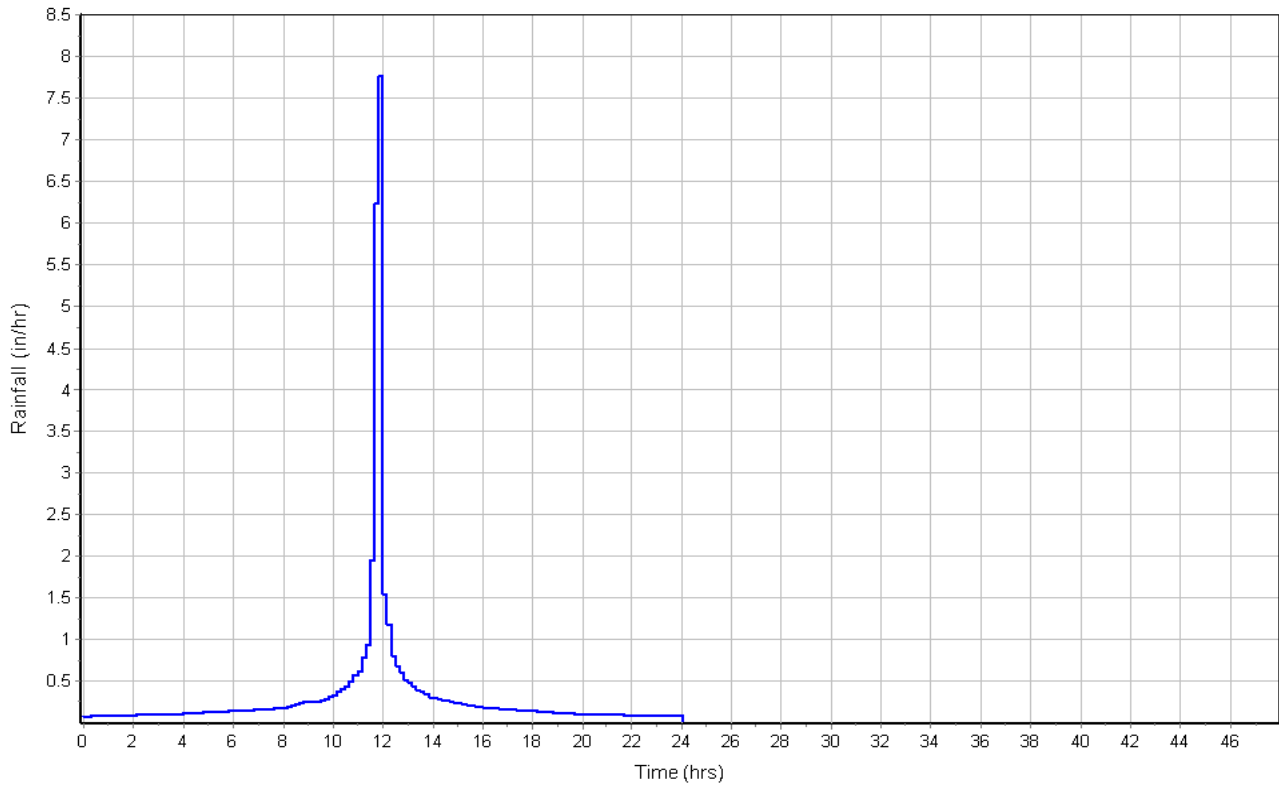


Runoff Hydrograph

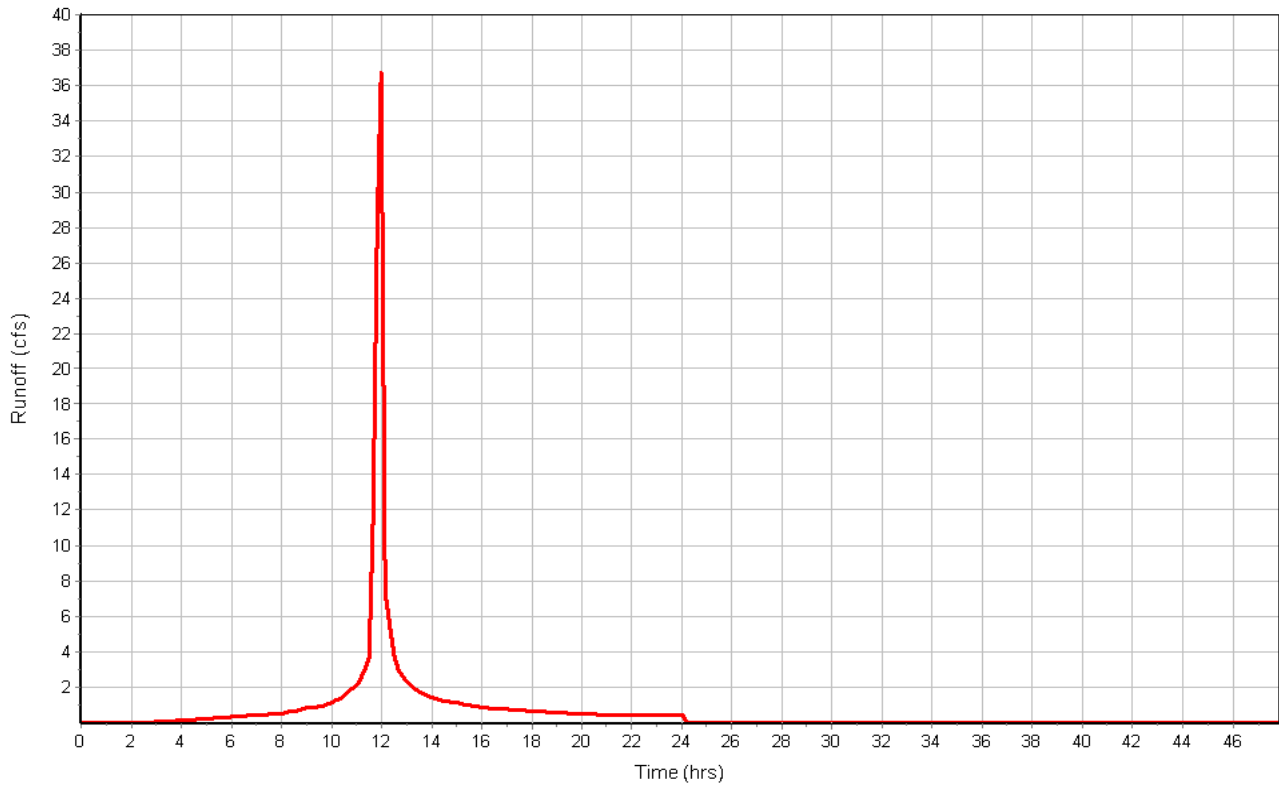


Subbasin : A2-1

Rainfall Intensity Graph

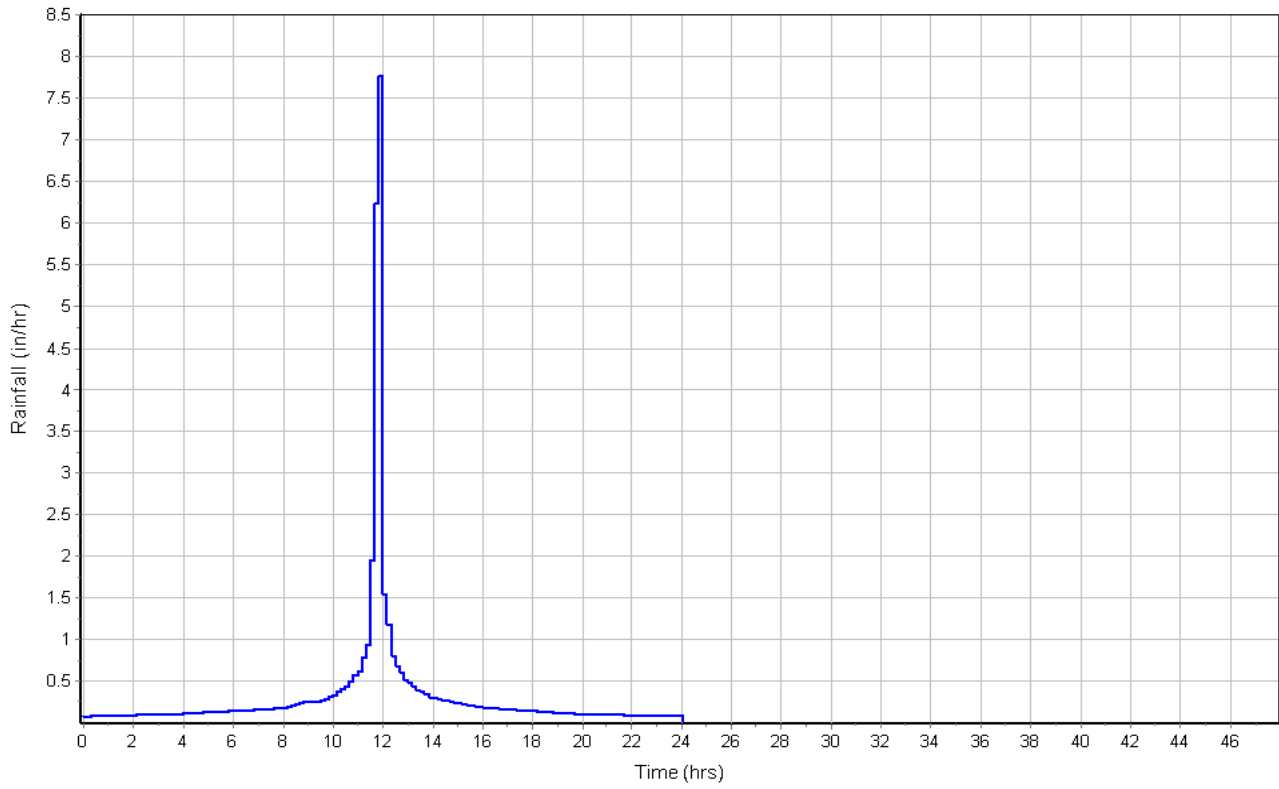


Runoff Hydrograph

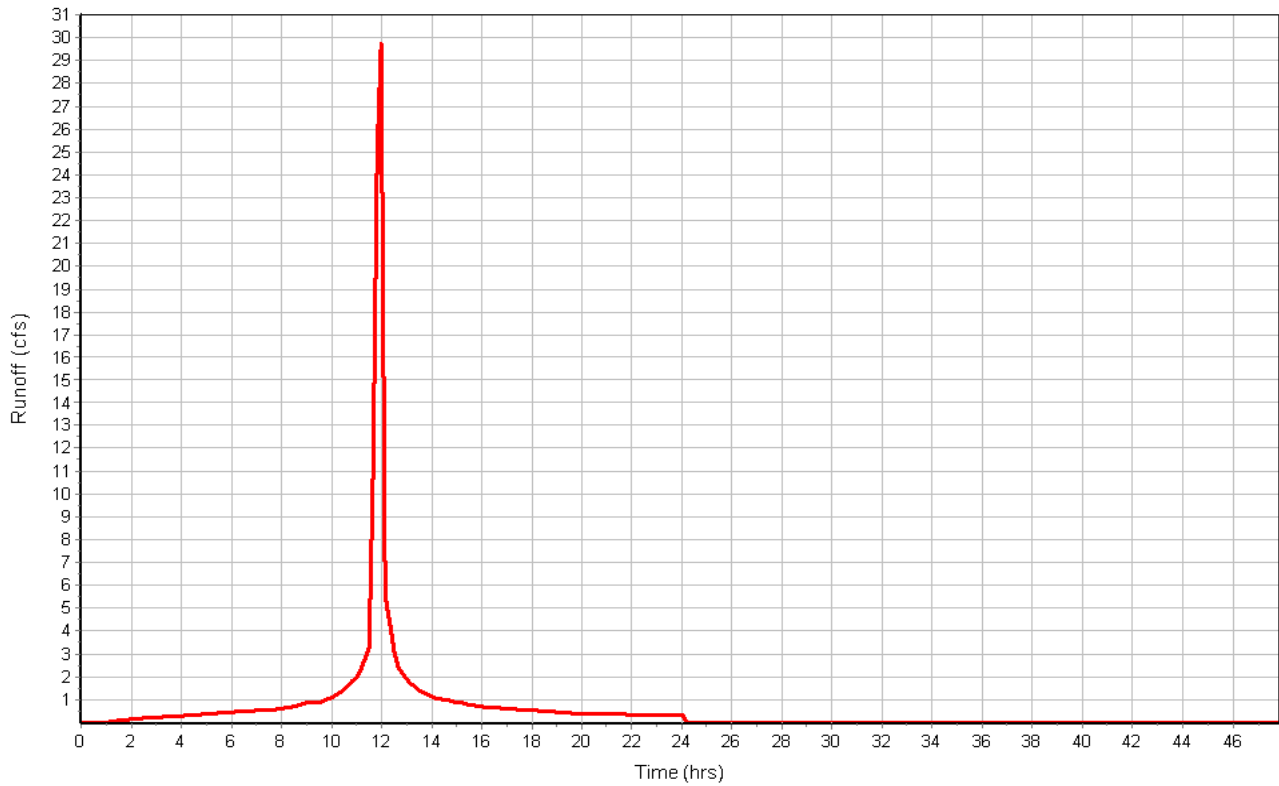


Subbasin : A2-2&B2

Rainfall Intensity Graph

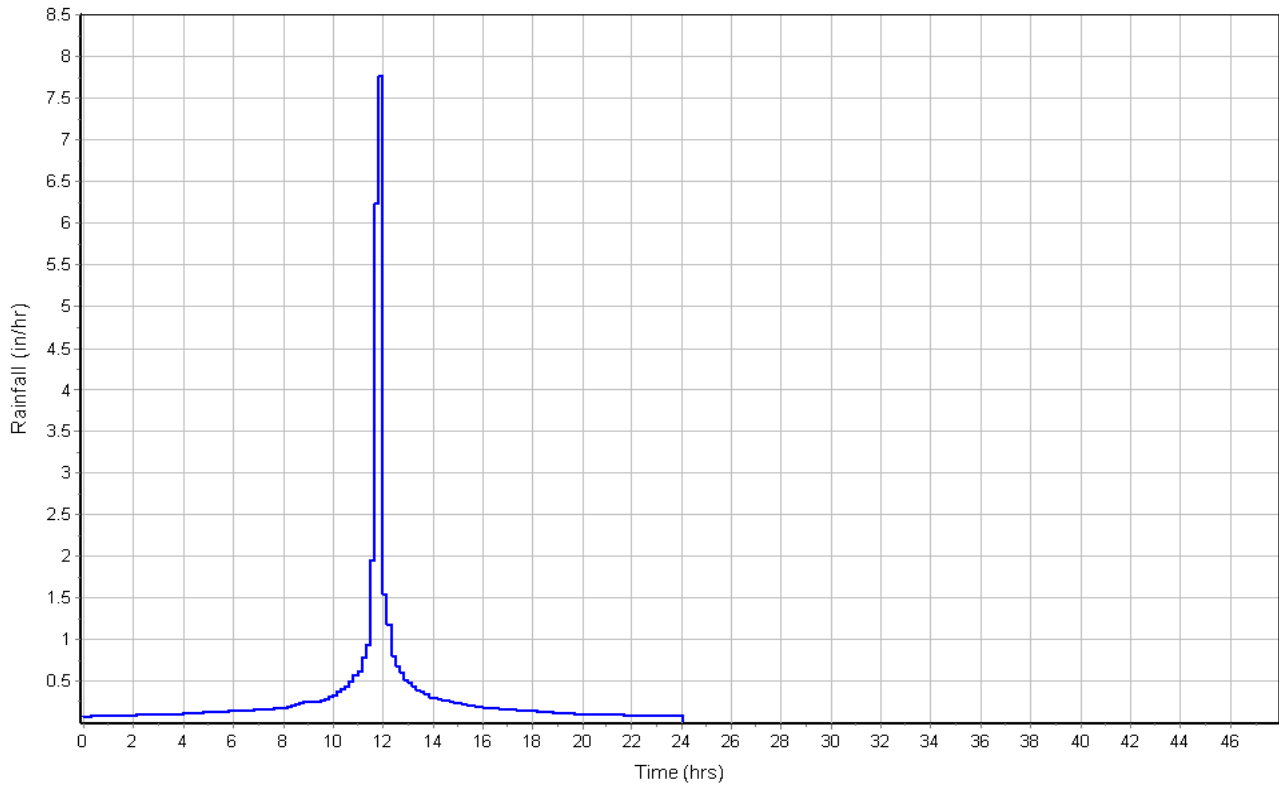


Runoff Hydrograph

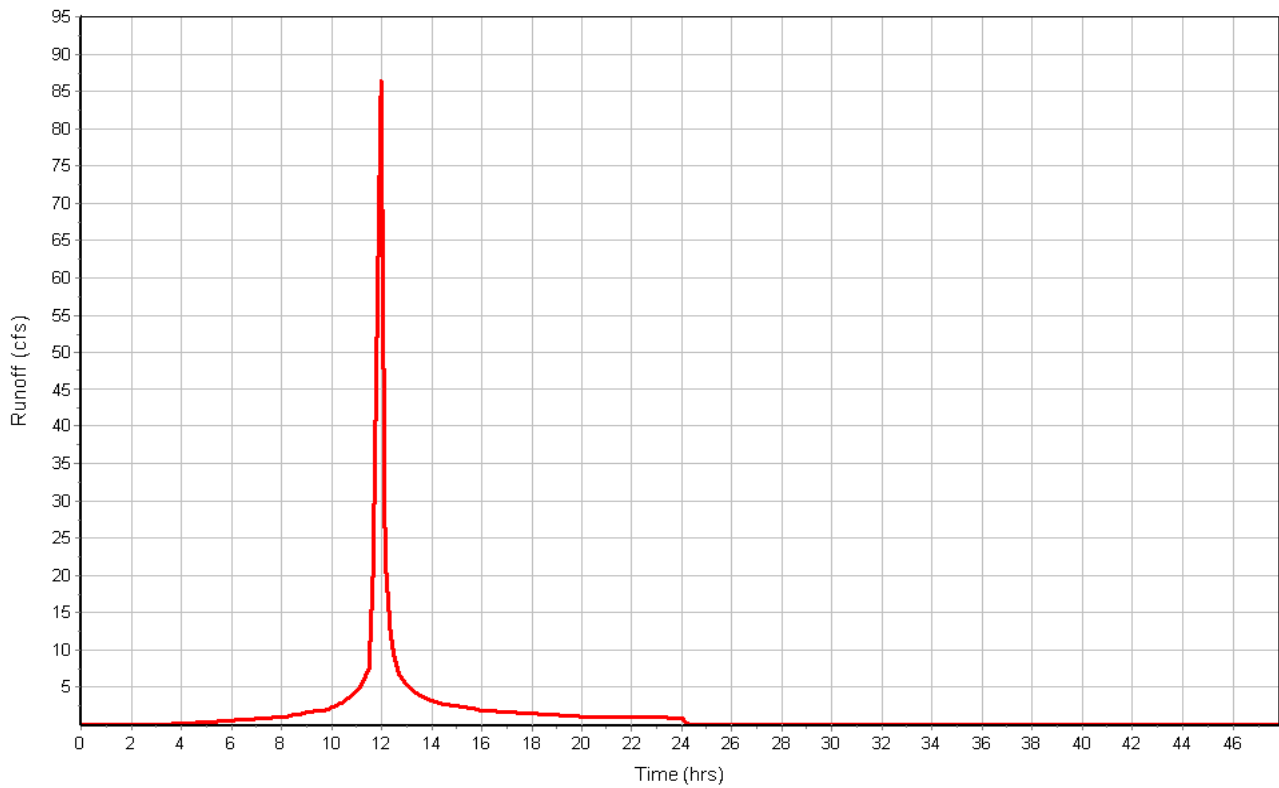


Subbasin : A3&B3

Rainfall Intensity Graph



Runoff Hydrograph



Junction Results

SN Element ID	Peak Inflow	Peak Lateral Inflow	Max HGL Elevation Attained	Max HGL Depth Attained	Max Surcharge Depth Attained	Min Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Max HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-in)	(min)
1 Jun-01	49.12	49.12	821.89	5.89	0.00	0.11	820.43	4.43	0 12:10	0 00:00	0.00	0.00

Pipe Results

SN Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
	(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1 EXISTIN-48INCH	0.00	0 00:00	145.23	0.00	0.00		4.00	1.00	2160.00		SURCHARGED
2 Link-02	48.69	0 12:10	41.30	1.18	7.75	0.26	2.00	1.00	2156.00		SURCHARGED

Storage Nodes

Storage Node : DETENTION POND

Input Data

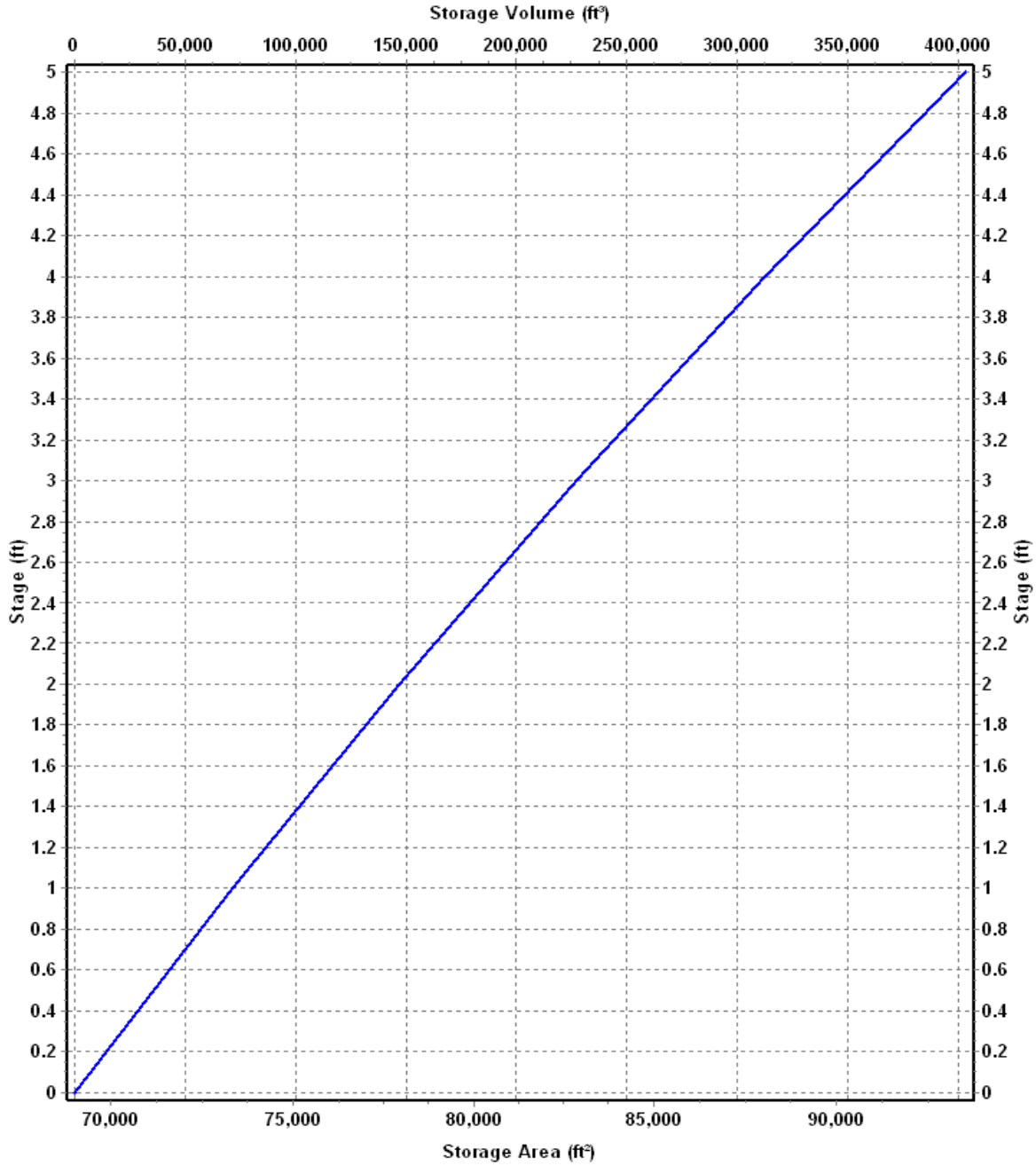
Invert Elevation (ft) 817.00
Max (Rim) Elevation (ft) 822.00
Max (Rim) Offset (ft) 5.00
Initial Water Elevation (ft) 817.00
Initial Water Depth (ft) 0.00
Ponded Area (ft²) 93568.00
Evaporation Loss 0.00

Storage Area Volume Curves

Storage Curve : DETENTION POND

Stage	Storage Area	Storage Volume
(ft)	(ft ²)	(ft ³)
0	69000	0.000
1	73334	71167.00
2	77940	146804.00
3	82835	227191.50
4	88039	312628.50
5	93568	403432.00

Storage Area Volume Curves



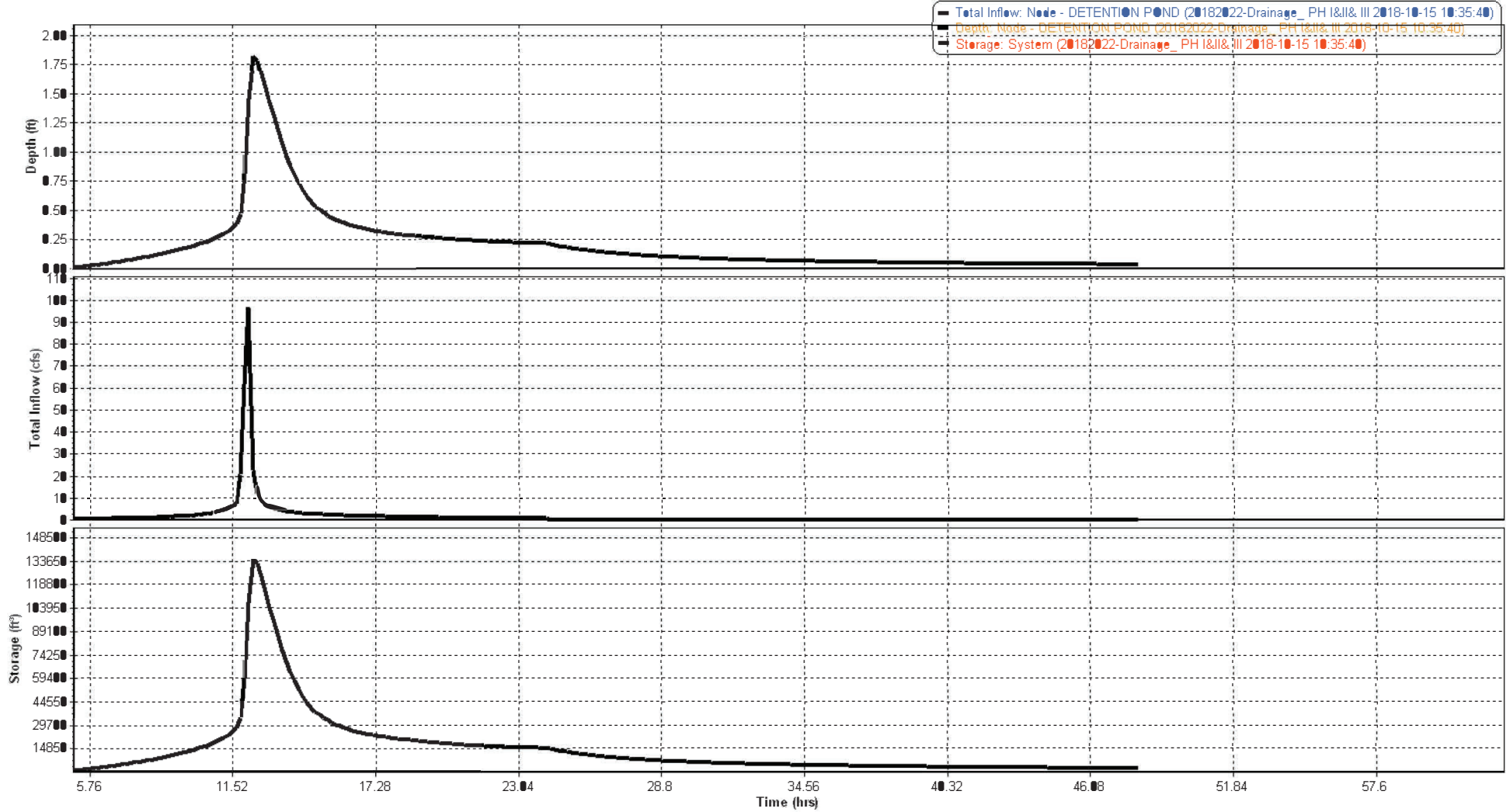
— Storage Area — Storage Volume

Storage Node : DETENTION POND (continued)

Output Summary Results

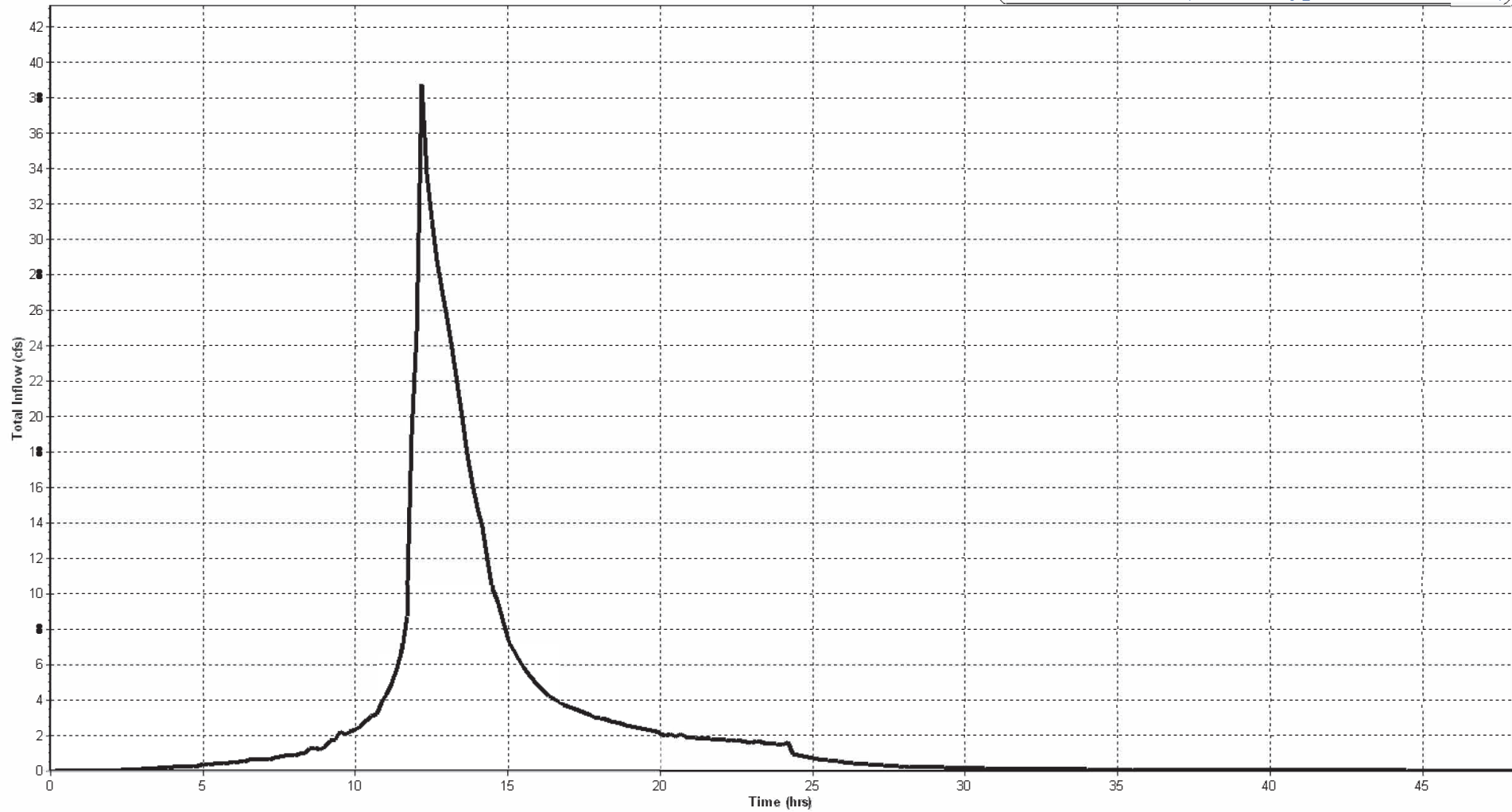
Peak Inflow (cfs)	134.08
Peak Lateral Inflow (cfs)	85.39
Peak Outflow (cfs)	0.00
Peak Exfiltration Flow Rate (cfm)	0.00
Max HGL Elevation Attained (ft)	821.88
Max HGL Depth Attained (ft)	4.88
Average HGL Elevation Attained (ft)	820.45
Average HGL Depth Attained (ft)	3.45
Time of Max HGL Occurrence (days hh:mm)	1 18:10
Total Exfiltration Volume (1000-ft ³)	0.000
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0.00

DETENTION POND SLUICE GATE : OPEN



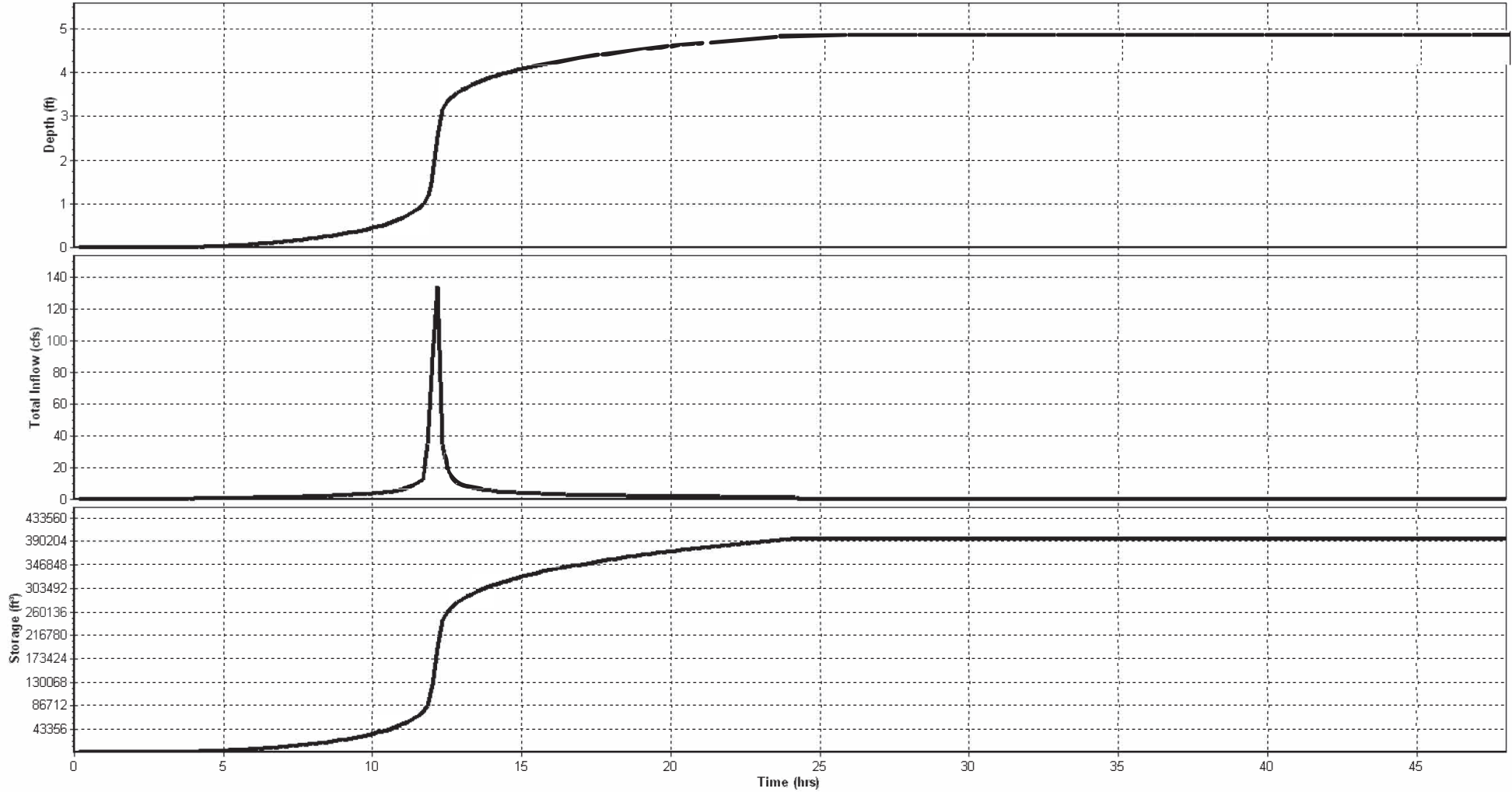
DETENTION POND- SLUICE GATE : OPEN

— Total Inflow: Node - ● Out-2-1 (2018-2022: Drainage_ PH I&II & III 2018-10-15 10:37:40)



DETENTION POND- SLUICE GATE: CLOSED

- Total Inflow: Node - DETENTION POND (20182022-Drainage_ PH I&II& III 2018-10-15 10:40:00)
- Depth: Node - DETENTION POND (20182022-Drainage_ PH I&II& III 2018-10-15 10:40:00)
- Storage: System (20182022-Drainage_ PH I&II& III 2018-10-15 10:40:00)



APPENDIX D
FEMA FIRM PANEL

National Flood Hazard Layer FIRMette



Legend

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

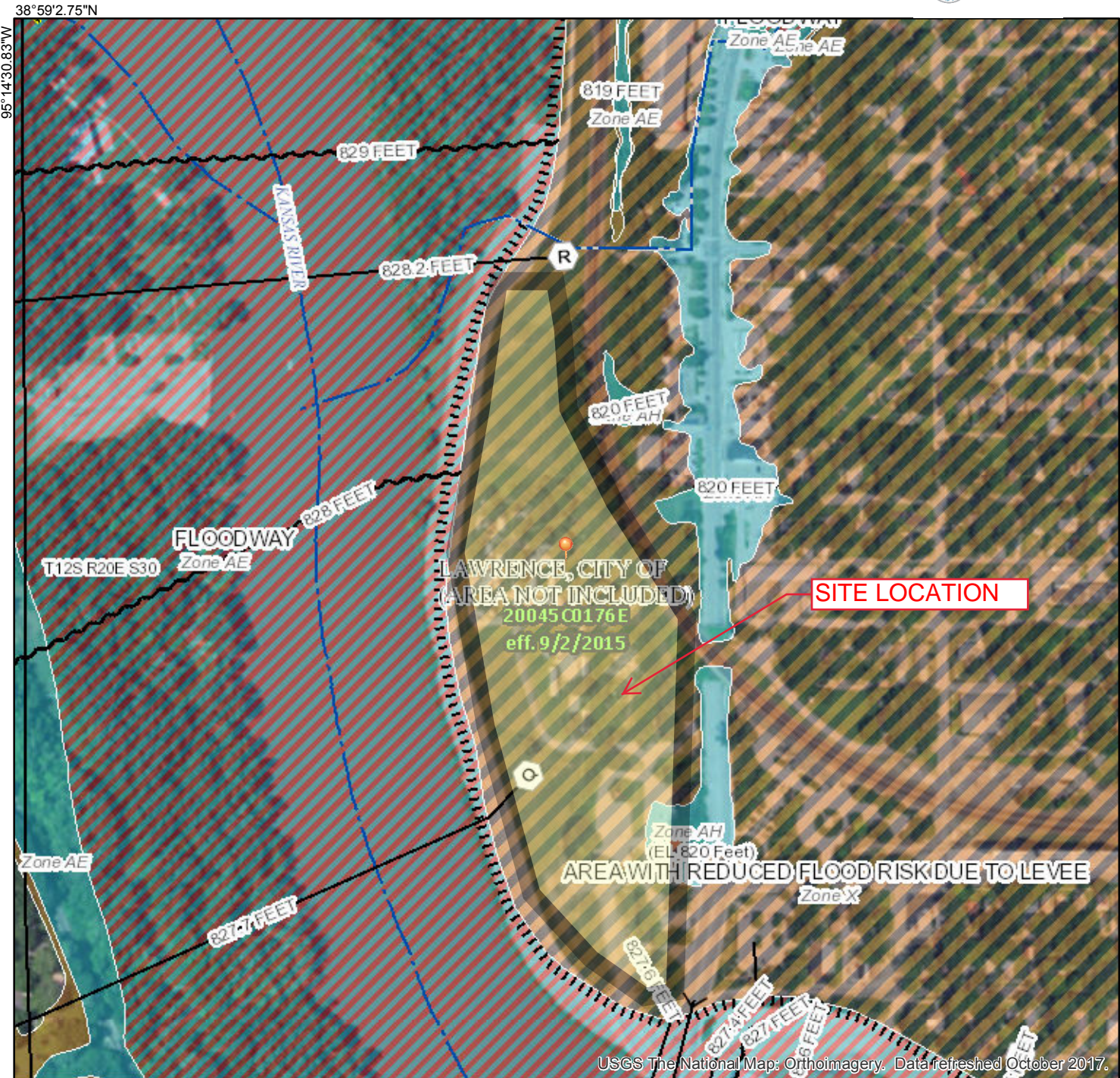
SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of 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		Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
OTHER FEATURES		Levee, Dike, or Floodwall
		Cross Sections with 1% Annual Chance Water Surface Elevation
MAP PANELS		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped

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 **10/15/2018 at 11:11:51 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.



38°59'2.75"N

95°14'30.83"W

USGS The National Map: Orthoimagery. Data refreshed October 2017.

1:6,000

38°58'34.78"N

95°13'53.37"W

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