PLANNING
ENGINEERING
IMPLEMENTATION

February 21, 2025

City of Lee's Summit
220 SE Green St
Lee's Summit, MO 64063

Re: Summit Fair, Lot 10D-10F
Stormwater Analysis Report
PEI #250203

Phelps Engineering, Inc. is pleased to submit this Stormwater Analysis Report for the revised preliminary development plan for Summit Fair, Lots 10D-10F.

- Per the attached stormwater report, the maximum allowable impervious area for each lot has been previously established.

- The proposed development of Lot 10D is allowed up to 44,439 S.F. of impervious area. The proposed plan results in a total amount of impervious area equal to 42,143 SF.

- The proposed development of Lot 10E is allowed up to 25,228 S.F. of impervious area. The proposed plan results in a total amount of impervious area equal to 22,228 SF.

- The proposed development of Lot 10F is allowed up to 22,642 S.F. of impervious area. The proposed plan results in a total amount of impervious area equal to 18,840 SF.

Therefore, the proposed plan is in substantial compliance with the previously approved stormwater report. No further analysis is required.

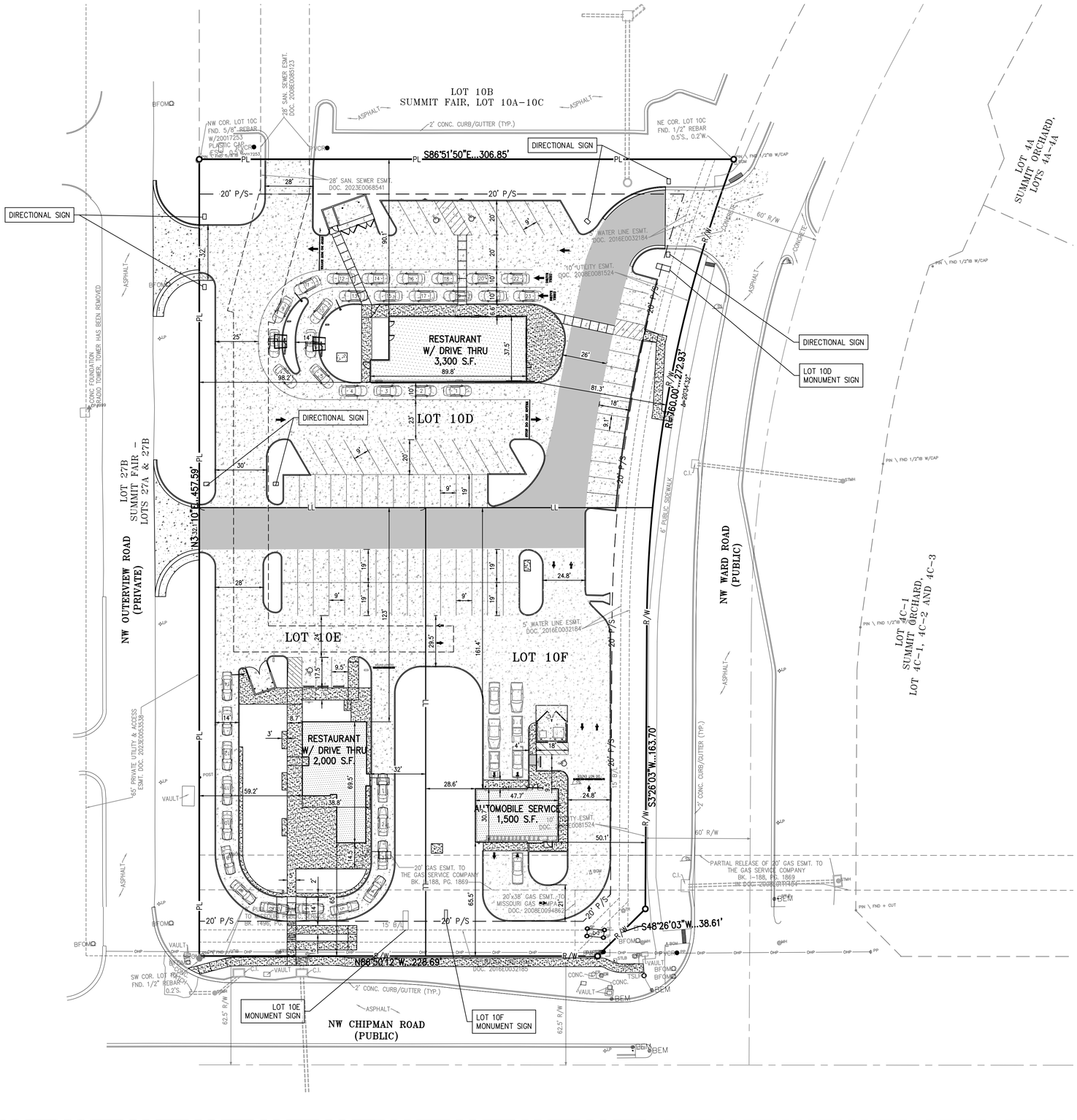
Please feel free to contact PEI at (913) 393-1155 if you require additional information.

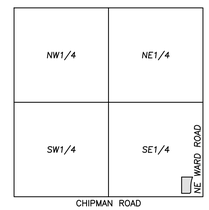
Sincerely,

Phelps Engineering, Inc.

Daniel Finn, P.E.

PHELPS ENGINEERING, INC.
1270 N. Winchester – Olathe, Kansas 66061 – (913) 393-1155 – Fax (913) 393-1166 – www.phelpsengineering.com





VICINITY MAP
SEC. 36–48–32

SCALE: 1"=2000'

SCALE: 1"=30'
0' 30' 60'

LEGAL DESCRIPTION:

SUMMIT FAIR, LOTS 10D–10F, A SUBDIVISION IN THE CITY OF LEE'S SUMMIT, JACKSON COUNTY, MISSOURI, ACCORDING TO THE RECORDED PLAT THEREOF.

LOT DATA TABLE

Zoning	PMIX
Lot 10D	1.28 Ac.
Lot 10E	0.77 Ac.
Lot 10F	0.74 Ac.
Total	2.79 Ac.

BUILDING SUMMARY TABLE

Lot 10D	
Restaurant w/ Drive Thru	3,300 S.F.
FAR	0.0591
Lot 10E	
Restaurant w/ Drive Thru	2,000 S.F.
FAR	0.0597
Lot 10F	
Automobile Service	1,500 S.F.
FAR	0.0464

PARKING SUMMARY

Lot 10D	
Building SF – 3,300 S.F.	
Use – Restaurant Fast Food and Site Down Sales	
Required Parking – 14 / 1,000 S.F.	46 Spaces
Parking Provided	48 Spaces
Lot 10E	
Building SF – 2,000 S.F.	
Use – Carry out, drive up, or drive thru only	
# of employees (max shift) – 8	
Required Parking – 2 + 1 per employee (max shift)	10 Spaces
Parking Provided	21 Spaces
Lot 10F	
Building SF – 1,500 S.F.	
Use – Automobile service	
Required Parking – 2 per 1,000 S.F. indoor sales area	
2 per 1,000 S.F. indoor sales area	3 Spaces
1 per 2,500 S.F. outdoor display	0 Spaces
3 per service bay	6 Spaces
Total Required Parking	9 Spaces
Parking Provided	13 Spaces

IMPERVIOUS AREA SUMMARY

Lot 10D	
Impervious Area	42,143 S.F. (76%)
Open Space	13,655 S.F. (24%)
Lot 10E	
Impervious Area	22,228 S.F. (66%)
Open Space	11,247 S.F. (34%)
Lot 10F	
Impervious Area	18,840 S.F. (58%)
Open Space	13,469 S.F. (42%)

PHELPS ENGINEERING, INC.
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PLANNING
ENGINEERING
IMPLEMENTATION

OVERALL SITE PLAN

REVISED PRELIMINARY DEVELOPMENT PLAN FOR
SUMMIT FAIR LOTS 10D–10F
LEES SUMMIT, MISSOURI

No.	Date	Revisions:	By	App.

PROJECT NO. 250203
DATE: 02-19-2025 DRAWN: AEB
CHECKED: DMF APPROVED: DMF
CERTIFICATE OF AUTHORIZATION
KANSAS LAND SURVEYING – LS-82
KANSAS ENGINEERING – E-391
CERTIFICATE OF AUTHORIZATION
MISSOURI
LAND SURVEYING–2007001128
ENGINEERING–2007005328

SHEET
C1

\\PHELPS-SERVER\Projects\P\250203\Dwg\Preliminary\OVERALL SITE – PAD SITE EXHIBIT.dwg Layout:1 Feb 21, 2025 - 1:45pm Audrey Burks

PLANNING
ENGINEERING
IMPLEMENTATION

April 10, 2024

City of Lee's Summit
220 SE Green St
Lee's Summit, MO 64063

Re: Summit Fair, Lot 10D-10F (currently Summit Fair Lot 10C)
Stormwater Analysis Report
PEI #240017

Phelps Engineering, Inc. is pleased to submit this Stormwater Analysis Report for the future developments of Summit Fair, Lots 10D-10F (currently Summit Fair Lot 10C). Summit Fair Lot 10C was previously analyzed as part of the previously approved "Summit Orchards West" Storwmater Analysis Report which was prepared by SitePoint and dated August 2022.

As part of the previous report, the development of Lots 10A, 10B, and 10C were not to exceed a CN of 92. The proposed impervious areas for Lots 10A, 10B, and 10C were previously calculated as shown below.

Previously Approved Report		
Lot No.	**Total Area**	**Impervious Coverage**
Lot 10A	10.08 AC. (439,085 S.F.)	309,264 S.F. (70%)
Lot 10B	11.83 AC. (515,315 S.F.)	330,446 S.F. (64%)
Lot 10C	2.79 AC. (121,532 S.F.)	70,773 S.F. (58%)
Total	**24.70 AC.** **(1,075,932 S.F.)**	**710,483 S.F.** **(66%)**

Previously Approved CN
(98 x 710,483 + 80 x 365,449) / 1,075,932 = 91.9 → 92

The proposed plan will subdivide Lot 10C into 3 separate lots, creating Lots 10D, 10E, and 10F. Each lot is anticipated to be developed with a restaurant. See the attached preliminary plan for reference. The proposed impervious areas for Lots 10A, 10B, 10D, 10E, and 10F are shown below.

Proposed Conditions		
Lot No.	**Total Area**	**Impervious Coverage**
Lot 10A	10.08 AC. (439,085 S.F.)	309,264 S.F. (70%)
Lot 10B	11.83 AC. (515,315 S.F.)	330,446 S.F. (64%)
Lot 10D	1.28 AC. (55,798 S.F.)	44,439 S.F. (80%)
Lot 10E	0.77 AC. (33,475 S.F.)	25,228 S.F. (75%)
Lot 10F	0.74 AC. (32,309 S.F.)	22,642 S.F. (70%)
Total	**24.70 AC.** **(1,075,932 S.F.)**	**732,019 S.F.** **(68%)**

Proposed CN
(98 x 732,019 + 80 x 343,913) / 1,075,932 = 92.2 → 92

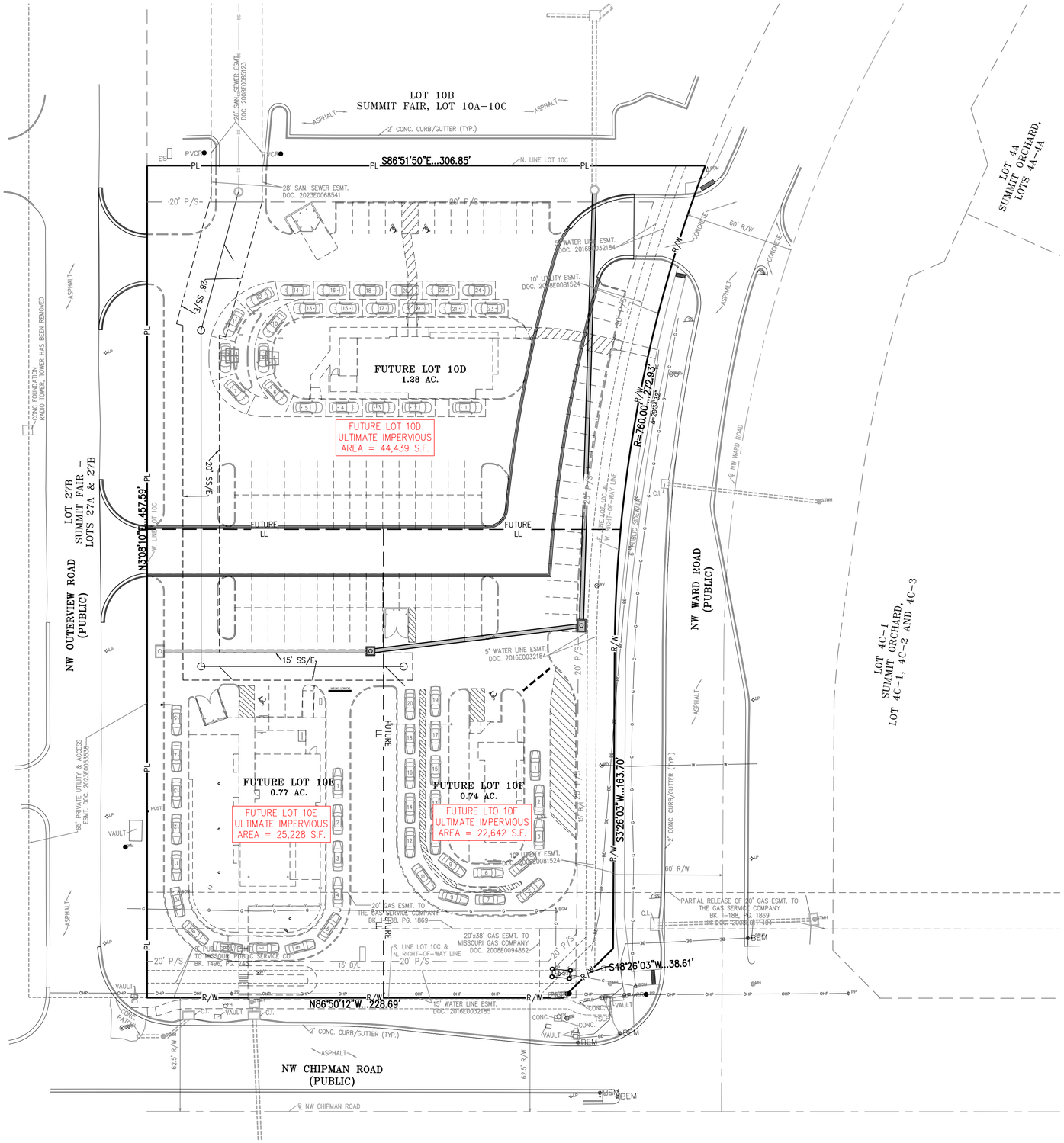
The proposed plan results in an increase in impervious area of 21,536 SF when compared to the previously approved Stormwater Analysis Report. However, given the size of the overall development, the increase in impervious area does not result in an increase in the proposed CN. Therefore, the increase in impervious area is deemed insignificant, and the proposed plan is found to be in substantial compliance with the previously approved Stormwater Analysis Report.

Please feel free to contact PEI at (913) 393-1155 if you require additional information.

Sincerely,

PHELPS ENGINEERING, INC.

Judd Claussen, P.E.



STATE OF MISSOURI
JUDD DAVID CLAUSSEN
NUMBER PE-2010
05/08/24
REGISTERED PROFESSIONAL ENGINEER

PHELPS ENGINEERING, INC.
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PLANNING
ENGINEERING
IMPLEMENTATION

OVERALL SITE PLAN – IMPERVIOUS AREA

SUMMIT FAIR, LOT 10–C
700 NW WARD ROAD
LEE'S SUMMIT, MISSOURI

No.	Revisions:	Date	By	App.

PROJECT NO. 240017
DATE: 03-08-2024 | DRAWN: AEB
CHECKED: DAF | APPROVED: DAF
CERTIFICATE OF AUTHORIZATION KANSAS SURVEYING - LS-82
ENGINEERING - E-391
CERTIFICATE OF AUTHORIZATION MISSOURI SURVEYING LAND 3.3(M)EVNG-2007001128
ENGINEERING-2007003239

SHEET
1

\\PHELPS-SERVER\Projects\P\240017\Dwg\Permit Plans\OVERALL SITE – PAD SITE EXHIBIT IMPERVIOUS.dwg Layout:1 Apr 10, 2024 – 12:03pm Daniel Finn

SUMMIT ORCHARDS WEST

LEE'S SUMMIT, MO

Stormwater Analysis Report

Prepared For:

NorthPoint™ DEVELOPMENT

3315 N Oak Trafficway
Kansas City, MO 64116

Prepared By:

SITEPOINT
A Division of NorthPoint Development

3315 N Oak Trafficway
Kansas City, MO 64116
816.888.7380
sitepoint@northpointkc.com

August 2022

Melissa G. DeGonia 08/26/2022

Table of Contents

Attachments

Exhibit 1: PDP Site Plan

Exhibit 2: PDP Storm Sewer General Layout

Appendix A: THH Inc. Stormwater Drainage Report for Ward Road- Summit Technology Campus (Sep 2006)

Appendix B:

- Red Development Lee's Summit Fair Stormwater Drainage Study (Olsson Associates, Dec 2006)
- Regional Detention Basin Stormwater Flows Analysis (THH, Inc., July 2009)
- Detention Basin Contributing Areas Exhibit (THH, Inc., Sep 2009)
- Summit Innovation Center Stormwater Drainage Report (THH Inc., March 2015)
- Summit Orchard Lot 7A Stormwater Report (April 2016)

1 Site Description

Summit Orchards West is a proposed 24.70-acre mixed-use development consisting of three (3) individual parcels located southeast of the interchange of Interstate-470 and US Highway 50. The project is bounded on the north and east by Ward Road, on the south by NW Chipman Rd, and on the west by Outerview Road. The proposed development is directly east of the existing Summit Technology Campus. This study will focus on the entire development, which will contain a proposed 2.79-acre commercial lot, an 11.83-acre multifamily residential lot, and a 10.08-acre industrial lot. The Preliminary Development Plan (PDP) Site Plan is attached as Exhibit 1. The entirety of the proposed development is within the drainage area for a regional detention basin that was previously completed and approved for the Summit Technology Campus and surrounding area.

Floodplain Summary

FEMA Flood Boundary Map 29095C0417G does not designate any floodplain on the property. The entire property is unshaded Zone X.

Soil Conditions

Soil data was obtained from the NRCS Web Soil Survey. Soils within the watershed are a mixture of Hydrologic Soil Groups C and D. For this study, all Curve Numbers are based on HSG D for proposed conditions. The soils found in the watershed are summarized in the table below.

Table 1 Soil Data

Name	Slopes	HSG
Arisburg-Urban land complex	1-5%	C
Snead-Rock outcrop complex	5-14%	D
Udarents-Urban land-Sampsel complex	5-9%,	C
Urban land, upland	5-9%	C/D

2 Methodology

Analysis of the proposed Summit Orchards West improvements will be compared the findings found in the “Stormwater Drainage Report for Ward Road- Summit Technology Campus (September 2006)” created by THH Inc. This report serves as the Stormwater Master Plan for the area that was approved by the City of Lee’s Summit in 2007, and is attached as Appendix A. The objective of this report is to demonstrate compliance with the anticipated site conditions shown in the approved master plan, ensuring that the downstream regional detention basin will have the necessary capacity to continue functioning as it was originally designed. Since the proposed development is a small portion of the total drainage area contributing to the regional detention basin, the proposed Curve Number (CN) of the development will be compared to the designed CN for the project parcel in the THH Inc. report.

Additionally, the Summit Orchards West property and watershed have been included as a part of numerous stormwater studies created for the Summit Technology Campus and surrounding area. The following studies were provided to Sitepoint at the time of design, and are included in this report for reference in Appendix B:

- Red Development Lee's Summit Fair Stormwater Drainage Study (Olsson Associates, Dec 2006)
- Regional Detention Basin Stormwater Flows Analysis (THH, Inc., July 2009)
- Detention Basin Contributing Areas Exhibit (THH, Inc., Sep 2009)
- Summit Innovation Center Stormwater Drainage Report (THH Inc., March 2015)
- Summit Orchard Lot 7A Stormwater Report (April 2016)

3 Existing Conditions

The Summit Orchards West project property is currently an undeveloped portion of a large mixed-use development, which features a regional detention facility to control stormwater runoff flow rates to downstream systems. The study for this basin was submitted and approved in 2007 (Appendix A). In this study, the basin's entire drainage area is divided into sub-basins. The Summit Orchards West development is in sub-basin 1, 3 and 4, as shown in Exhibit 1 of the attached report. Included in the study are the existing, proposed, and future conditions for the sub-basins. The existing conditions for these sub-basins are as follows:

Existing Conditions (Per THH Inc. Report)				
Sub-Basin	Area (sq. miles)	Area (acres)	CN	Lag Time (hr.)
1	0.0844	54	76	0.65
3	0.0938	60	78	0.80
4	0.0938	60	81	0.62

The "Proposed Conditions" section of the study does not show any changes to the sub-basins, as there were no improvements in the immediate future planned in these areas at the time. These conditions will be considered the existing site conditions in this report.

4 Proposed Conditions

The THH Inc. report lists the "Future Conditions" of Sub-Basins 1, 3, and 4 as follows:

Future Conditions (Per THH Inc. Report)				
Sub-Basin	Area (sq. miles)	Area (acres)	CN	Lag Time (hr.)
1	0.0844	54	92	0.49
3	0.0938	60	94	0.60
4	0.0938	60	94	0.47

These conditions show a change in CN from 76 to 92 for sub-basin 1, 78 to 94 for sub-basin 3, and a change from 81 to 94 for Sub Basin 4. The 1% design storm event was analyzed under these conditions to ensure proper function of the basin. Per the PDP, the proposed conditions of the Summit Orchards West development shall be as follows:

Proposed Conditions (Per PDP)		
Surface	Area (acres)	CN
Pervious	8.02	80
Impervious	16.68	98

Composite CN	92

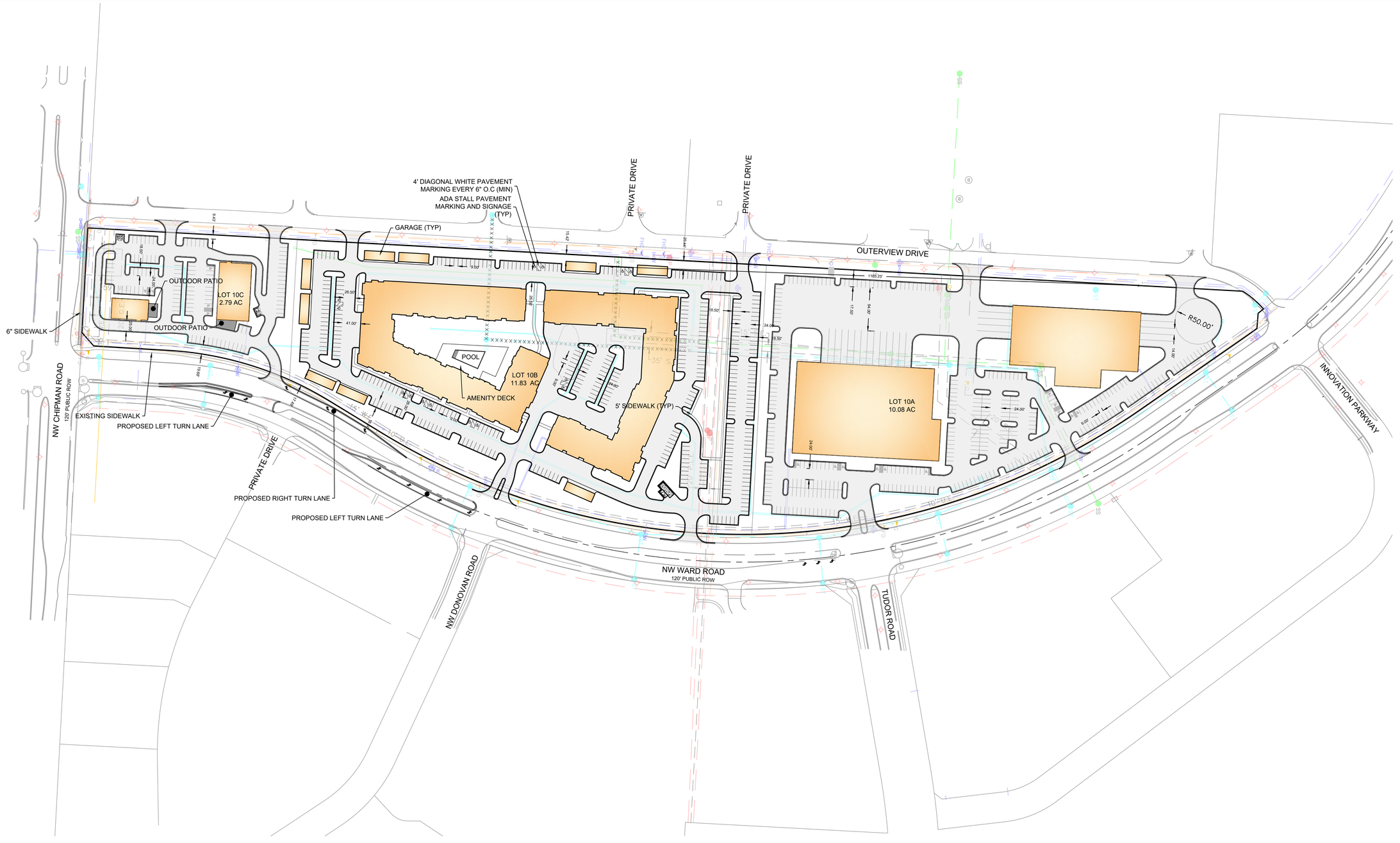
The proposed CN for the development is at or below the planned CN for sub-basins 1, 3, and 4. All runoff from the site will drain to the regional detention basin, which has been modeled to accommodate such an increase in runoff.

To match the existing drainage patterns, all runoff from the proposed development, along with all upstream runoff coming on site, will be routed north towards the existing 5'x5' RCB culvert on the northern end of the project property. Existing and proposed stormwater conveyance systems will be utilized on site to properly drain runoff to the 5'x5' RCB culvert. The preliminary drainage design is attached as Exhibit 2.

5 Summary

The proposed Summit Orchards West commercial, industrial, and multi-family residential development has been designed to match future condition assumption of the area, as specified in the approved basin design and master plan for the Summit Technology Campus by THH, Inc. All stormwater runoff on site will be conveyed to the existing 5'x5' culvert on the northern end of the lot. As seen in the comparison of existing and proposed curve numbers, the proposed improvements are within the design assumptions made in the THH Inc. stormwater master plan, and will not adversely affect the downstream regional detention basin's performance.

Exhibit 1



SITE DATA									
Lot No.	Total Area	Impervious Coverage	Maximum Building Height	Building Area (All stories)	Floor Area Ratio (FAR)	Proposed Building Use	Parking		
							Requirement		Proposed
10A	10.08 AC. (439,085 S.F.)	309,264 S.F. (70%)	60', 2 stories	123,000 S.F. (Building 1, 51,000 S.F. Building 2, 72,000 S.F.)	0.28	Office/Warehouse	4 per 1,000 S.F. of Office plus 1 per 1,000 S.F. of warehouse	243	326
10B	11.83 AC. (515,315 S.F.)	330,466 S.F. (64%)	60', 4 stories	470,000 S.F. (Building 1, 215,000 S.F. Building 2, 255,000 S.F.)	0.91	Multifamily Residential	1.7 per DU	549	562
10C	2.79 AC. (121,532 S.F.)	70,773 S.F. (58%)	45',	12,300 S.F. (Building 1, 8,800 S.F. Building 2, 3,500 S.F.)	0.10	Retail/ Drive-Through Restaurant	5 per 1,000 S.F. of Retail and 14 per 1,000 S.F. of Restaurant	93	114

N

0' 50' 100' 200'
SCALE IN FEET

LEGEND

	STANDARD DUTY ASPHALT PAVEMENT
	CG-1 CURB & GUTTER
	STANDARD DUTY CONCRETE PAVEMENT

SITEPOINT
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3315 N Oak Trafficway
Kansas City, MO 64116
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NO.	REVISIONS/APPROVALS:	DATE:
	INITIAL CITY SUBMITTAL	2022.08.26

REVIEWED BY: M.G.D
DESIGNED BY: R.E.B
DRAFTED BY: D.A.H
SP PROJECT #: 4024
MELISSA G DEGONIA, P.E. 2011006892

SITE PLAN

SUMMIT ORCHARDS WEST
PRELIMINARY DEVELOPMENT PLAN
LEE'S SUMMIT, JACKSON COUNTY, MO

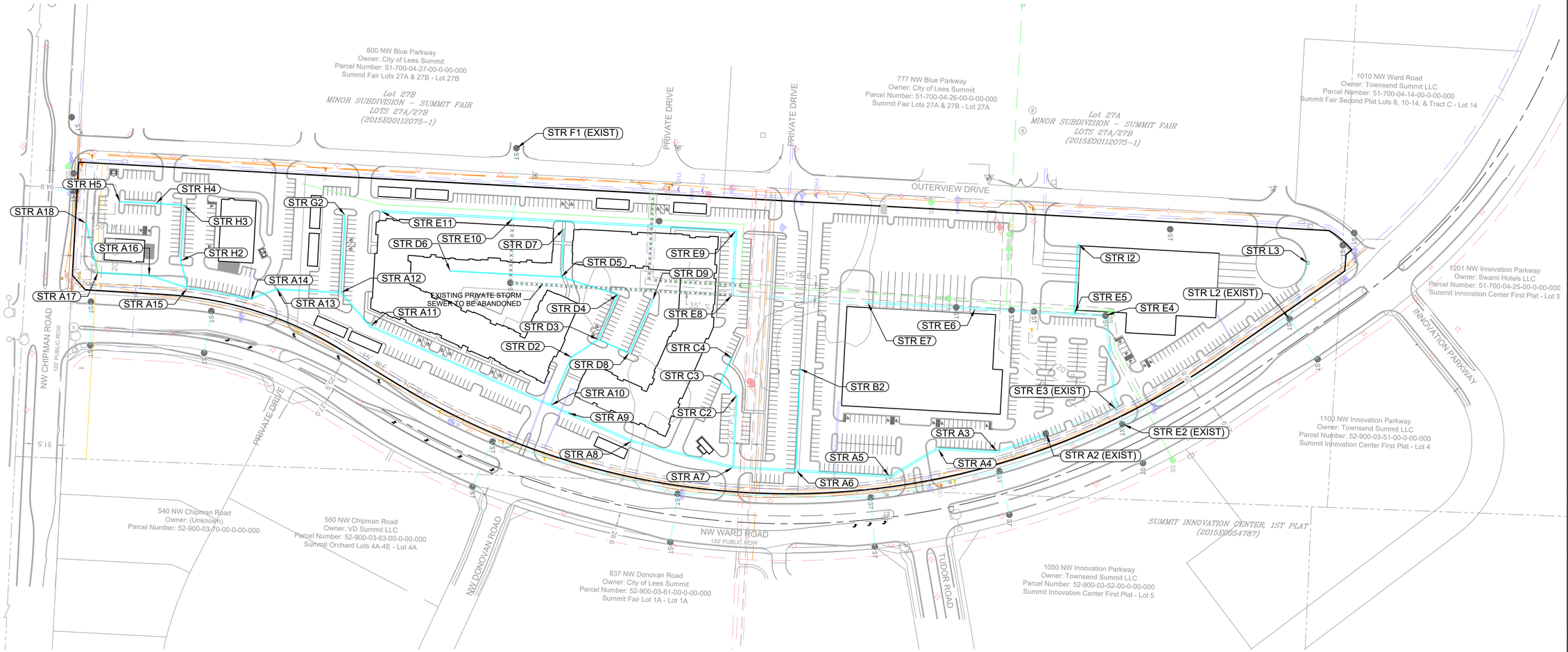
Certificate of Authority # MO 2020018354

SHEET #:

C-0200

S:\DI PROJECTS\MULTI-FAMILY\4024 SUMMIT SQUARE 3\ENTITLEMENTS\PLANS\PRELIMINARY DEVELOPMENT PLAN\C-0200 SITE PLAN.DWG

Exhibit 2



Structure Table	
Structure Name	Structure Details
STR A2 (EXIST)	Inlet (5'x5' Inside) RIM = 978.649 PIPE A2 INV IN = 964.480 PIPE A1 (EXIST) INV OUT = 964.480
STR A3	Inlet (6'x4' Inside) RIM = 980.297 PIPE A3 INV IN = 965.500 PIPE A2 INV OUT = 965.515
STR A4	Inlet (6'x4' Inside) RIM = 980.750 PIPE A4 INV IN = 966.760 PIPE A3 INV OUT = 966.720
STR A5	Inlet (6'x4' Inside) RIM = 978.368 PIPE A5 INV IN = 967.867 PIPE A4 INV OUT = 967.867
STR A6	Inlet (6'x4' Inside) RIM = 984.000 PIPE A6 INV IN = 969.768 PIPE B1 INV IN = 969.760 PIPE A5 INV OUT = 969.768
STR A7	Storm Manhole (4' dia. Inside) RIM = 990.628 PIPE A7 INV IN = 982.090 PIPE C1 INV IN = 983.090 PIPE A6 INV OUT = 971.035
STR A8	Storm Manhole (4' dia. Inside) RIM = 1000.298 PIPE A8 INV IN = 984.350 PIPE A7 INV OUT = 984.350
STR A9	Storm Manhole (5' dia. Inside) RIM = 1000.280 PIPE A9 INV IN = 986.330 PIPE A8 INV OUT = 985.764
STR A10	Storm Manhole (4' dia. Inside) RIM = 1000.253 PIPE A10 INV IN = 986.710 PIPE D1 INV IN = 987.210 PIPE A9 INV OUT = 986.710
STR A11	Storm Manhole (4' dia. Inside) RIM = 1000.680 PIPE A11 INV IN = 990.576 PIPE A10 INV OUT = 990.100

Structure Table	
Structure Name	Structure Details
STR A12	Storm Manhole (4' dia. Inside) RIM = 1000.747 PIPE G1 INV IN = 991.460 PIPE A12 INV IN = 990.960 PIPE A11 INV OUT = 990.960
STR A13	Nyloplast C.I. (30"-3'x2') RIM = 998.270 PIPE A13 INV IN = 992.245 PIPE A12 INV OUT = 992.245
STR A14	Nyloplast C.I. (30"-3'x2') RIM = 998.832 PIPE A14 INV IN = 992.790 PIPE A13 INV OUT = 992.790
STR A15	Inlet (6'x4' Inside) RIM = 998.801 PIPE A15 INV IN = 994.145 PIPE H1 INV IN = 994.650 PIPE A14 INV OUT = 994.145
STR A16	Nyloplast C.I. (30"-3'x2') RIM = 1000.937 PIPE A16 INV IN = 994.916 PIPE A15 INV OUT = 994.920
STR A17	Nyloplast C.I. (30"-3'x2') RIM = 1000.616 PIPE A17 INV IN = 996.500 PIPE A16 INV OUT = 995.952
STR A18	Nyloplast C.I. (30"-3'x2') RIM = 1000.652 PIPE A17 INV OUT = 997.500
STR B2	Nyloplast C.I. (30"-3'x2') RIM = 989.952 PIPE B1 INV OUT = 985.000
STR C2	Nyloplast Drain Basin (30") RIM = 990.105 PIPE C2 INV IN = 985.082 PIPE C1 INV OUT = 984.542
STR C3	Nyloplast C.I. (30"-3'x2') RIM = 990.410 PIPE C3 INV IN = 985.500 PIPE C2 INV OUT = 985.505

Structure Table	
Structure Name	Structure Details
STR C4	Nyloplast C.I. (30"-3'x2') RIM = 990.405 PIPE C3 INV OUT = 986.000
STR D2	Nyloplast Drain Basin (30") RIM = 1000.723 PIPE D2 INV IN = 989.350 PIPE D1 INV OUT = 989.050
STR D3	Nyloplast Drain Basin (30") RIM = 1000.000 PIPE D3 INV IN = 990.500 PIPE D7 INV IN = 990.500 PIPE D2 INV OUT = 990.000
STR D4	Nyloplast Drain Basin (30") RIM = 999.832 PIPE D4 INV IN = 992.254 PIPE D3 INV OUT = 992.000
STR D5	Nyloplast Drain Basin (30") RIM = 1000.500 PIPE D5 INV IN = 994.000 PIPE D6 INV IN = 994.000 PIPE D4 INV OUT = 993.750
STR D6	Nyloplast Drain Basin (30") RIM = 1001.000 PIPE D5 INV OUT = 997.500
STR D7	Nyloplast Drain Basin (30") RIM = 1000.501 PIPE D6 INV OUT = 996.549
STR D8	Nyloplast Drain Basin (30") RIM = 1000.000 PIPE D8 INV IN = 993.000 PIPE D7 INV OUT = 992.750
STR D9	Nyloplast Drain Basin (30") RIM = 1000.000 PIPE D8 INV OUT = 997.000
STR E2 (EXIST)	Inlet (7'x5' Inside) RIM = 966.450 PIPE E2 (EXIST) INV IN = 958.950 PIPE L1 (EXIST) INV IN = 958.920 PIPE E1 (EXIST) INV OUT = 958.750

Structure Table	
Structure Name	Structure Details
STR E3 (EXIST)	Inlet (7'x5' Inside) RIM = 967.825 PIPE E3 INV IN = 962.440 PIPE A1 (EXIST) INV IN = 960.050 PIPE E2 (EXIST) INV OUT = 960.050
STR E4	Storm Manhole (5' dia. Inside) RIM = 982.616 PIPE E4 INV IN = 966.500 PIPE E3 INV OUT = 966.500
STR E5	Storm Manhole (4' dia. Inside) RIM = 982.000 PIPE E5 INV IN = 967.500 PIPE I1 INV IN = 973.000 PIPE E4 INV OUT = 967.500
STR E6	Storm Manhole (5' dia. Inside) RIM = 980.422 PIPE E6 INV IN = 970.500 PIPE E5 INV OUT = 970.500
STR E7	Storm Manhole (4' dia. Inside) RIM = 983.077 PIPE E7 (EXIST) INV IN = 974.707 PIPE E6 INV OUT = 974.000
STR E8	Storm Manhole (4' dia. Inside) RIM = 993.247 PIPE E8 INV IN = 977.590 PIPE E7 (EXIST) INV OUT = 977.590
STR E9	Storm Manhole (4' dia. Inside) RIM = 998.800 PIPE E9 INV IN = 978.522 PIPE E8 INV OUT = 978.520
STR E10	Storm Manhole (4' dia. Inside) RIM = 1001.674 PIPE E10 INV IN = 982.250 PIPE F1 (EXIST) INV IN = 982.120 PIPE E9 INV OUT = 982.120
STR E11	Storm Manhole (4' dia. Inside) RIM = 1001.873 PIPE E10 INV OUT = 990.000
STR F1 (EXIST)	Storm Manhole (5' dia. Inside) RIM = 1004.106 PIPE F1 (EXIST) INV OUT = 987.040

Structure Table	
Structure Name	Structure Details
STR G2	Nyloplast Drain Basin (30") RIM = 1000.746 PIPE G1 INV OUT = 997.500
STR H2	Nyloplast Drain Basin (30") RIM = 999.016 PIPE H2 INV IN = 995.000 PIPE H1 INV OUT = 995.000
STR H3	Nyloplast Drain Basin (30") RIM = 999.010 PIPE H3 INV IN = 995.750 PIPE H2 INV OUT = 995.750
STR H4	Nyloplast Drain Basin (30") RIM = 1000.000 PIPE H4 INV IN = 996.250 PIPE H3 INV OUT = 996.250
STR H5	Nyloplast Drain Basin (30") RIM = 1000.152 PIPE H4 INV OUT = 997.000
STR I2	Storm Manhole (4' dia. Inside) RIM = 982.923 PIPE I1 INV OUT = 975.000
STR L2 (EXIST)	Inlet (4'x4' Inside) RIM = 976.239 PIPE L2 (EXIST) INV IN = 961.880 PIPE L1 (EXIST) INV OUT = 961.880
STR L3	Inlet (6'x4' Inside) RIM = 975.757 PIPE L2 (EXIST) INV OUT = 962.340

Pipe Table		
Pipe Name	Size	Length
PIPE A1 (EXIST)	36.00"	150.158
PIPE A2	36.00"	103.473
PIPE A3	36.00"	122.000
PIPE A4	36.00"	110.720
PIPE A5	36.00"	190.126
PIPE A6	36.00"	126.660
PIPE A7	36.00"	210.826
PIPE A8	36.00"	141.788
PIPE A9	30.00"	37.280
PIPE A10	30.00"	396.387

Pipe Table		
Pipe Name	Size	Length
PIPE A11	24.00"	89.844
PIPE A12	24.00"	129.465
PIPE A13	24.00"	55.567
PIPE A14	24.00"	128.684
PIPE A15	24.00"	81.598
PIPE A16	24.00"	103.529
PIPE A17	18.00"	102.934
PIPE B1	18.00"	205.030
PIPE C1	24.00"	145.196
PIPE C2	18.00"	42.323

Pipe Table		
Pipe Name	Size	Length
PIPE C3	18.00"	52.573
PIPE D1	24.00"	106.000
PIPE D2	24.00"	64.551
PIPE D3	18.00"	99.000
PIPE D4	18.00"	120.112
PIPE D5	18.00"	223.527
PIPE D6	18.00"	96.632
PIPE D7	18.00"	68.000
PIPE D8	18.00"	117.256
PIPE E1 (EXIST)	???"	127.961

Pipe Table		
Pipe Name	Size	Length
PIPE E2 (EXIST)	???"	32.484
PIPE E3	36.00"	189.874
PIPE E4	36.00"	63.403
PIPE E5	36.00"	198.068
PIPE E6	36.00"	219.001
PIPE E7 (EXIST)	33.00"	272.020
PIPE E8	36.00"	129.818
PIPE E9	36.00"	449.780
PIPE E10	36.00"	265.887
PIPE F1 (EXIST)	33.00"	141.992

Pipe Table		
Pipe Name	Size	Length
PIPE G1	18.00"	156.668
PIPE H1	18.00"	56.689
PIPE H2	18.00"	112.358
PIPE H3	18.00"	56.179
PIPE H4	18.00"	72.753
PIPE I1	24.00"	140.701
PIPE L1 (EXIST)	36.00"	398.198
PIPE L2 (EXIST)	24.00"	118.369

Pipe Table		
Pipe Name	Size	Length
PIPE E2 (EXIST)	???"	32.484
PIPE E3	36.00"	189.874
PIPE E4	36.00"	63.403
PIPE E5	36.00"	198.068
PIPE E6	36.00"	219.001
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PIPE E8	36.00"	129.818
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Pipe Table		
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PIPE H3	18.00"	56.179
PIPE H4	18.00"	72.753
PIPE I1	24.00"	140.701
PIPE L1 (EXIST)	36.00"	398.198
PIPE L2 (EXIST)	24.00"	118.369

N

0' 50' 100' 200'
SCALE IN FEET

SITEPOINT
A Division of NorthPoint Development
816.888.7360
sitepoint@northpointkc.com
3315 N Oak Trafficway
Kansas City, MO 64116

NO.	DATE:	REVISIONS/APPROVALS:
	2022.08.26	INITIAL CITY SUBMITTAL

REVIEWED BY: M.G.D
DESIGNED BY: R.E.B
DRAFTED BY: D.A.H
SP PROJECT #: 4024
MELISSA G DEGONIA, P.E.
2017000892

STORM SEWER GENERAL LAYOUT PLAN

SUMMIT ORCHARDS WEST
ENTITLEMENT
PRELIMINARY DEVELOPMENT PLAN
LEE'S SUMMIT, JACKSON COUNTY, MO

Certificate of Authority # MO 2020018354

SHEET #:

C-0500

S:\01 PROJECTS\MULTI-FAMILY\4024 SUMMIT SQUARE 3\ENTITLEMENTS\PLANS\PRELIMINARY DEVELOPMENT PLAN\C-0500 DRAINAGE PLAN.DWG

Appendix A

Stormwater Drainage Report

for

Ward Road - Summit Technology Campus

September 2006

Developer:
Mr. Richard L. Muller
Townsend Capital LLC
777 NW Blue Parkway 3
Lee's Summit, MO 64086

Project No. 063279

Prepared by:

Trabue, Hansen & Hinshaw Inc.
1901 Pennsylvania Drive
Columbia, MO 65202
(573) 814-1568

THHinc . . . . . *about the possibilities*

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Stormwater Drainage Report For
Ward Road – Summit Technology Campus
City of Lee's Summit, Missouri

APPENDICES

Stormwater Drainage Report
For
Ward Road - Summit Technology Campus

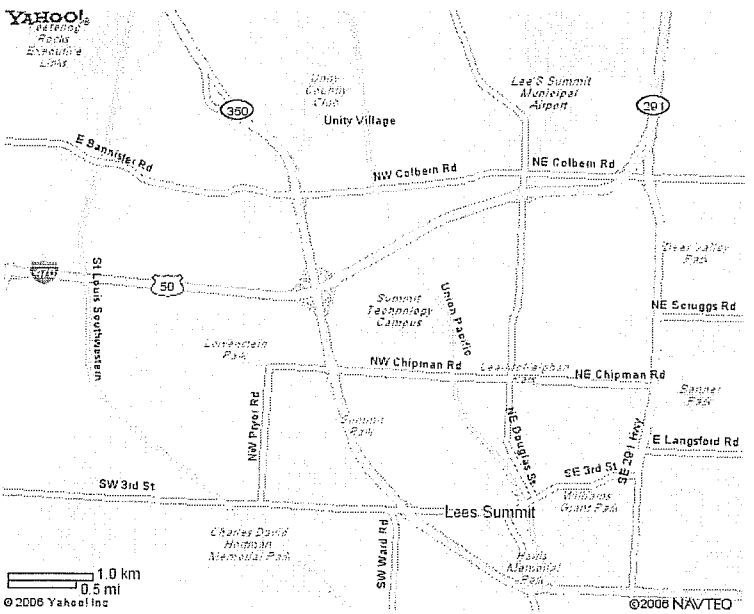
Introduction

This storm drainage study is for the Townsend Development, which is part of the Preliminary Plan for the mixed-use development at Summit Technology Campus. The Campus is located in Lee's Summit, Missouri, and is owned by Townsend Capital LLC. This drainage report follows Section 5600 of the Standard Specifications and Design Criteria of the Kansas City Metropolitan Chapter of the American Public Woks Association (APWA) and the Lee's Summit, Missouri, design supplement to these specifications. HEC-HMS 3.0.1 watershed modeling software was used to generate the drainage values in this report. This drainage report presents estimates of the flow to the proposed regional detention pond generated by the onsite drainage of the entire Technology Campus for the 1-year, 10-year, and 100-year storm events. This study incorporates a Stormwater Drainage Study, prepared by Olsson Engineering for RED Development, as the proposed condition sends a portion of the Red Development drainage through the Townsend Development.

This storm drainage study for the proposed developments evaluates existing and proposed hydraulic conditions to ensure runoff from the developments will not have an adverse impact on downstream tracts.

Project Location

Summit Technology campus is located just southeast of the Interstate 470 / State Highway 50 interchange. The Campus is bound in the south by Chipman Road and in the east by Union Pacific Railroad. The Red Development encompasses the westerly portion of the site and is included by reference only. The Ward Road Development takes up the eastern part of the Campus. The location can be viewed in the below figure.



Project Description

The Townsend Development site measures a total of 259 acres. The proposed development includes the extension of Northwest Ward Road to the Northwest Missouri Road / Northwest Blue Parkway intersection. The proposed development also includes the additional parking spaces; however an obsolete building and wastewater treatment plant will be removed resulting in a net increase of 0.7 acres of impervious surface. The adjacent Red Development measures 79 acres and will be fully developed at this time. The drainage from both developments will be collected in the same regional detention pond. This pond is located at the northeastern corner of the Campus, just southwest of the railroad crossing of Interstate 740. Exhibit 2, located in Appendix A, shows the proposed improvements. Exhibit 2 also shows development around Ward Road that will be constructed in the future, but not with this proposed development.

Drainage Area Description

The current drainage area contributing to the regional detention pond measures 1.13 square miles. 111 acres of drainage area serving Red Development will also be diverted to the regional detention pond. The Red Development drainage has been evaluated by Olsson Engineering in their Stormwater Drainage Study, OA Project No. 2-2005-0451, which is referenced in this report. The Ward Development has been divided into sub-basin areas as illustrated in Exhibit 1, Located in Appendix A.

Methodology

HEC-HMS 3.0.1 watershed modeling software was used to estimate the existing and proposed runoff quantities for the entire watershed contributing to the detention pond for the 1-year, 10-year, and 100-year storm events. The drainage contribution from the RED development was calculated by Olsson Engineering and is included in the total runoff.

City of Lee's Summit, Missouri Bogg's Hollow, Little Cedar Creek Stormwater Master Plan was referenced to determine drainage areas and existing site conditions.

Existing Site Conditions

A 9' X 10' reinforced concrete box (RCB) culvert releases drainage from the site under Interstate 470. Most of the Red Development site is heavily vegetated with brush and trees. The Townsend Site has established vegetation in most areas and also includes parking and portions of the main STC buildings.

Existing Drainage Conditions

The existing Townsend Site was divided into 8 sub-basins. TR-55 Curve Numbers were calculated for each sub-basin assuming Soil Type C. The Curve Number calculations can be viewed in Appendix B. The Lag Time for each basin was calculated using TR-55 recommended equations as shown in Appendix C.

Table 1 below shows the hydrologic properties for each sub-basin.

Table 1 – Existing Sub-Basin Conditions				
Sub-Basin	Area (sq. miles)	Area (acres)	CN	Lag Time (hr)
1	.0844	54	76	.65
2	.1188	76	80	.97
3	.0938	60	78	.80
4	.0938	60	81	.62
5	.0438	28	76	.40
6	.2922	187	86	.83
7	.2406	154	84	.62
8	.1672	107	87	.52

The values for these sub-basins were input into HEC-HMS 3.0.1 to produce the existing hydrographs. SCS Type II 24-hr design storms were used as shown in Table 2 below.

Table 2 – Existing Peak Flows										
Recurrence Interval	Precip Depth (in)	Peak Flow (cfs) per hydraulic element								
		Sub-Basin 1	Sub-Basin 2	Sub-Basin 3	Sub-Basin 4	Sub-Basin 5	Sub-Basin 6	Sub-Basin 7	Sub-Basin 8	9X10 RCB
100%	3.0	40	54	43	62	29	202	187	165	475
10%	5.3	117	140	119	157	82	456	439	360	1008
1%	7.7	206	237	205	262	144	724	709	565	1380

The 9'X10' RCB serves as existing detention for all storms as the box is not large enough to pass the water under I-470. During the 100 yr storm, the RCB would detain enough water to raise the head from 909 ft, to 925 ft. causing a small amount water to go under the I-470 & Railroad grade separated bridge.

Detailed existing conditions can be found in the summary output from HEC-HMS 3.0.1 files, located in Appendix D.

Proposed Drainage Conditions

The proposed Townsend drainage was divided into 10 sub-basins; the 8 existing sub-basins plus 2 sub-basins diverted from Red Development. The Curve Numbers for the impacted sub-basins are shown in Appendix E. The Curve Number and time of concentration discussion for the drainage areas serving Red Development can be found in the aforementioned Olsson Study.

Table 3 below shows the hydrologic properties for each sub-basin for the proposed condition:

Table 3 – Proposed Sub-Basin Conditions				
Sub-Basin	Area (sq. miles)	Area (acres)	CN	Lag Time (hr)
1	.0844	54	76	.65
2	.1188	76	80	.97
3	.0938	60	78	.80
4	.0938	60	81	.62
5	.0438	28	77	.40
6	.2922	187	86	.83
7	.2406	154	84	.62
8	.1672	107	87	.52
1. Prop Site (Red Development)	.123	74	97	.13
2. Ex. Tech. Build. (Red Development)	.049	37	97	.08

The values for these sub-basins were input into HEC-HMS 3.0.1 to produce the proposed hydrographs. SCS Type II 24-hr design storms were used as shown in Table 4 below. For this condition, a regional detention basin was modeled to handle the increase in flow. The basin would need two 8.5 ft Corrugated Metal Pipes, or similar discharge culvert, to release the flow and the basin would need 131 AC-ft. of Storage to hold the 100 yr storm event. The basin would operate as a dry cell.

Table 4 – Proposed Peak Flows												
Recurrence Interval	Precip Depth (in)	Peak Flow (cfs) per hydraulic element										
		Sub-Basin 1	Sub-Basin 2	Sub-Basin 3	Sub-Basin 4	Sub-Basin 5	Sub-Basin 6	Sub-Basin 7	Sub-Basin 8	1 Prop Site	2. Ex. Tech	Regional Detent.
100%	3.0	40	54	43	62	31	202	187	165	243	137	432
10%	5.3	117	140	119	157	85	456	439	360	438	246	864
1%	7.7	206	237	204	262	147	724	709	565	639	359	1300

The regional detention pond would be able to reduce the discharge north of I-470 from 1380 cfs to 1300 cfs during the 1% event. Detailed proposed conditions can be found in the summary output from HEC-HMS files, located in Appendix F.

Future Drainage Conditions

An additional drainage scenario was looked at to determine the size of the regional detention pond if the Townsend Development replaced the unutilized land with urban uses. This analysis was only conducted for the 100 yr storm. The Curve Numbers for the future condition would be different as the amount of impervious areas would increase substantially. The Curve Numbers for the impacted sub-basins are shown in detail in Appendix G. It was assumed that the lag time for the impacted Townsend Development sub-basins would be reduced by 25%.

Table 5 below shows the hydrologic properties for each sub-basin for the proposed condition:

Table 5 – Future Sub-Basin Conditions				
Sub-Basin	Area (sq. miles)	Area (acres)	CN	Lag Time (hr)
1	.0844	54	92	.49
2	.1188	76	93	.73
3	.0938	60	94	.60
4	.0938	60	94	.47
5	.0438	28	94	.30
6	.2922	187	86	.83
7	.2406	154	84	.62
8	.1672	107	87	.52
1. Prop Site (Red Development)	.123	74	97	.13
2. Ex. Tech. Build. (Red Development)	.049	37	97	.08

The values for these sub-basins were input into HEC-HMS 3.0.1 to produce the future hydrographs. SCS Type II 24-hr design storms were used as shown in Table 6 below. The detention pond would need two 8.5 ft Corrugated Metal Pipes, or similar discharge culvert, to release the flow and the basin would need 146 AC-ft. of Storage to hold the 100 yr storm event. The basin would operate as a dry cell.

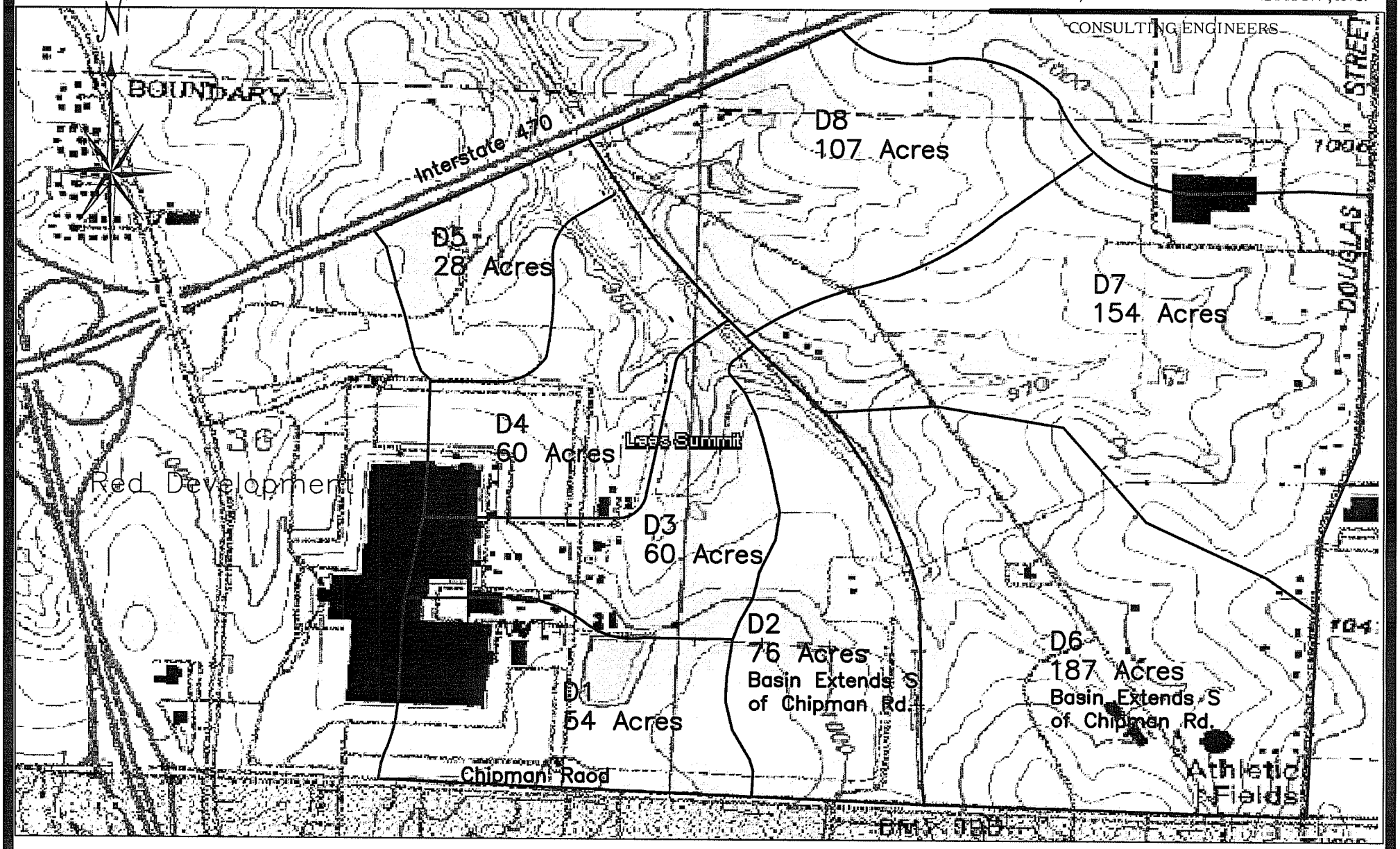
Table 6 – Proposed Peak Flows												
Recurrence Interval	Precip Depth (in)	Peak Flow (cfs) per hydraulic element										
		Sub-Basin 1	Sub-Basin 2	Sub-Basin 3	Sub-Basin 4	Sub-Basin 5	Sub-Basin 6	Sub-Basin 7	Sub-Basin 8	1 Prop Site	2. Ex. Tech	Regional Detent.
1%	7.7	323	353	313	365	211	724	709	565	639	359	1389

The regional detention pond would be able to maintain the pre-development discharge north of I-470 for the 1% event. The calculations show a 9 cfs increase at the 9'X10' RCB; however, no additional storage is recommended as the Olsson Study showed substantial decreases in drainage for the 5'X5' RCB under I-470. Detailed future conditions can be found in the summary output from HEC-HMS file, located in Appendix H.

APPENDIX A

EXHIBITS

TRABUE, HANSEN & HINSHAW, INC.
CONSULTING ENGINEERS



THH inc.

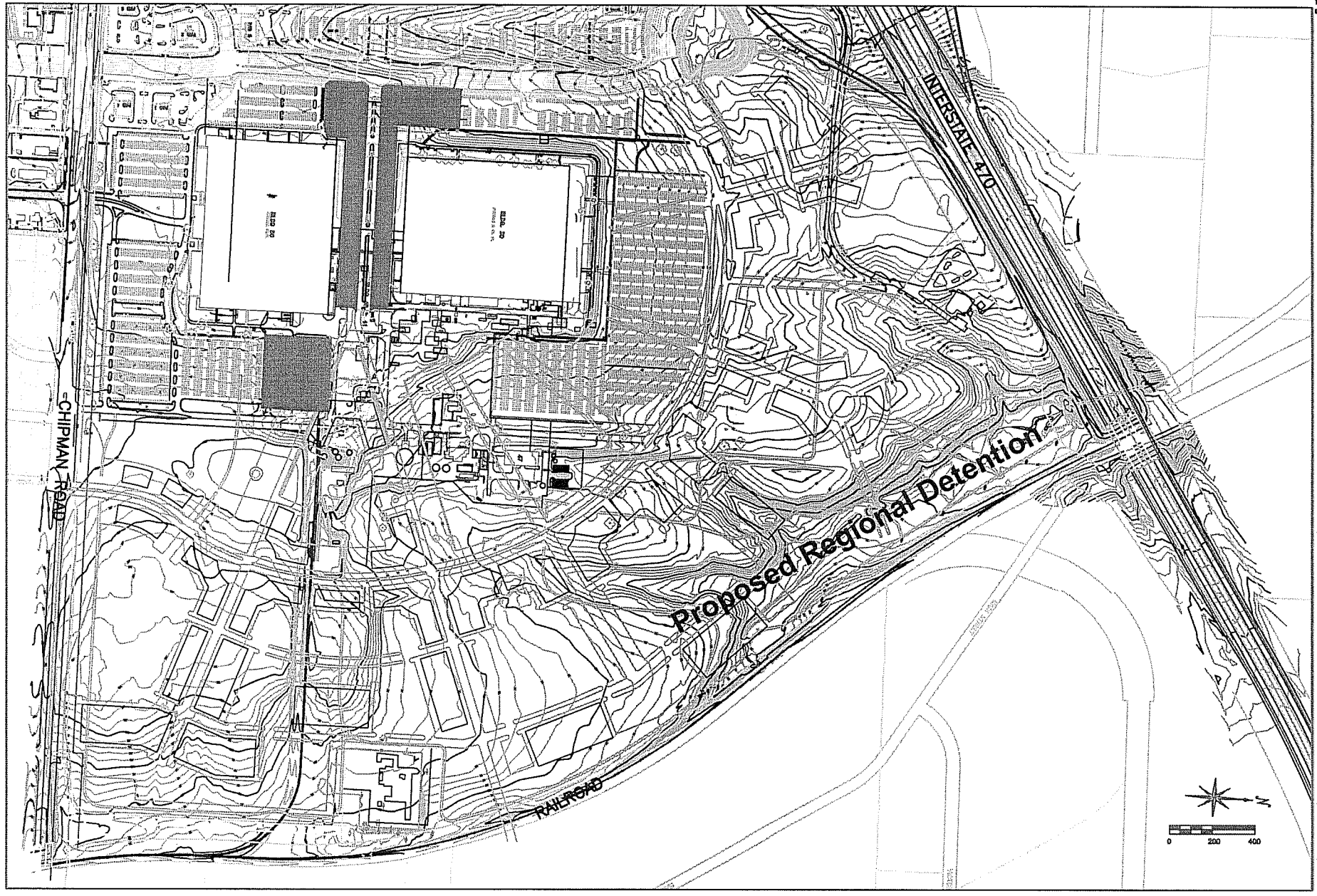
Townsend Capital LLC

Summit Technology Campus

Drainage Sub-Basins

SCALE: 1"=1000'

Exhibit 1



11x17 sheet size

11x17 sheet size

36x24 sheet size

THHinc
Consulting Engineers
TRABUE, HANSEN & HINSHAW, INC.
1201 Pennsylvania Dr
Columbia, MO 65203
Phone (573) 814-1588
Fax (573) 814-1128

Townsend Capital, LLC
Summit Technology Campus
Exhibit 2

Client Proj #	0000
THHinc Proj #	3279
Engineer:	SAB
Designer:	—
Drafter:	GRK
Plotted:	8/31/06

DWG. 000

SHT. 1 OF 1

APPENDIX B

EXISTING SUB-BASIN CURVE NUMBERS

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Existing Conditions

Sub-Basin 1. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	11%	10.23
C	Undeveloped Areas	74	89%	65.86

Use CN = 76

Sub-Basin 2. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	8%	7.44
C	Residential, 1/8 acre or less	92	24%	22.08
C	Undeveloped Areas	74	68%	50.32

Use CN = 80

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Existing Conditions

Sub-Basin 3. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	20%	18.6
C	Undeveloped Areas	74	80%	59.2

Use CN = 78

Sub-Basin 4. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	38%	35.34
C	Undeveloped Areas	74	62%	45.88

Use CN = 81

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Existing Conditions

Sub-Basin 5. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	12%	11.16
C	Undeveloped Areas	74	88%	65.12

Use CN = 76

Sub-Basin 6. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	36%	33.48
C	Residential, 1/8 acre or less	92	28%	25.76
C	Undeveloped Areas	74	36%	26.64

Use CN = 86

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Existing Conditions

Sub-Basin 7. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	53%	49.29
C	Undeveloped Areas	74	47%	34.78

Use CN = **84**

Sub-Basin 8. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Light Areas	88	90%	79.2
C	Undeveloped Areas	74	10%	7.4

Use CN = **87**

APPENDIX C

EXISTING SUB-BASIN TIME OF CONCENTRATION

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 1

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.01	
Tt .....hr	0.44	0.44

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\,s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	1200	
Watercourse slope.....ft/ft	0.01	
Average Velocity, V.....ft/s	1.6	
T_t.....hr	0.21	0.21

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.65 hr**

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 2

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.02	
Tt .....hr	0.34	0.34

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	4600	
Watercourse slope.....ft/ft	0.015	
Average Velocity, V.....ft/s	2	
T_t.....hr	0.64	0.64

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.97 hr**

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 3

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.01	
Tt .....hr	0.44	0.44

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	3300	
Watercourse slope.....ft/ft	0.025	
Average Velocity, V.....ft/s	2.6	
T_t.....hr	0.35	0.35

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.80 hr**

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 4

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.01	
Tt .....hr	0.44	0.44

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\, s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	2200	
Watercourse slope.....ft/ft	0.048	
Average Velocity, V.....ft/s	3.4	
T_t.....hr	0.18	0.18

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.62 hr**

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 5

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.044	
Tt .....hr	0.24	0.24

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	1700	
Watercourse slope.....ft/ft	0.037	
Average Velocity, V.....ft/s	3.1	
T_t.....hr	0.15	0.15

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.40 hr**

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 6

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.027	
Tt .....hr	0.30	0.30

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	3800	
Watercourse slope.....ft/ft	0.015	
Average Velocity, V.....ft/s	2	
T_t.....hr	0.53	0.53

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.83 hr**

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 7

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.053	
Tt .....hr	0.23	0.23

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{\,0.5}\,s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	3100	
Watercourse slope.....ft/ft	0.02	
Average Velocity, V.....ft/s	2.2	
T_t.....hr	0.39	0.39

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.62 hr**

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Sub-Basin 8

E-3. Sheet Flow

Surface description (table3-1).....	Range	
Manning's Roughness Coefficient, n (TR-55 Table 3-1).....	0.13	
Flow Length, L.....ft	300	
Two-year 24-hour rainfall, P_2.....in	3.5	
Land slope.....ft/ft	0.043	
Tt .....hr	0.25	0.25

$$T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$$

E-4. Shallow Surface Flow

Surface description	Unpaved	
Flow Length, L.....ft	2500	
Watercourse slope.....ft/ft	0.025	
Average Velocity, V.....ft/s	2.5	
T_t.....hr	0.28	0.28

$$T_t = \frac{L}{3600\,V}$$

Tc = **0.52 hr**

APPENDIX D

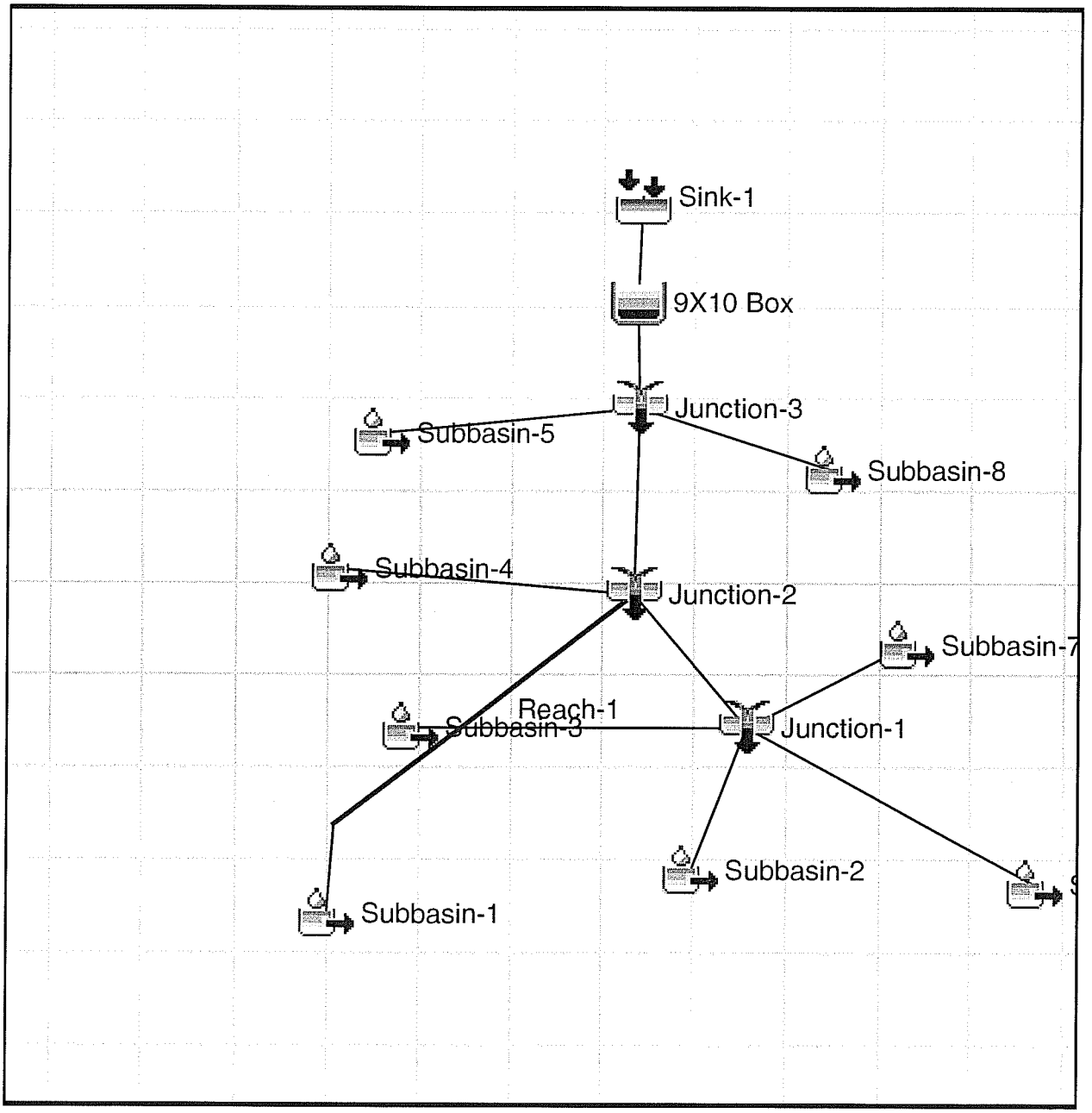
HEC-HMS 3.0.1 PRINTOUTS FOR EXISTING CONDITIONS

HEC-HMS

Project : Townsend Drainage Study

Basin Model : Townsend Exist

Sep 28 13:48:01 CDT 2006



Project: Townsend Drainage Study Simulation Run: Townsend Existing 100 yr

Start of Run: 18Jul2005, 00:00 Basin Model: Townsend Exist
End of Run: 19Jul2005, 01:00 Meteorologic Model: 100 Year storm
Compute Time: 28Sep2006, 08:28:04 Control Specifications: 24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
9X10 Box	1.1344	1380.04	18Jul2005, 12:42	343.51
Junction-1	0.7453	1803.11	18Jul2005, 12:19	227.98
Junction-2	0.9234	2260.44	18Jul2005, 12:18	277.25
Junction-3	1.1344	2869.58	18Jul2005, 12:15	343.56
Reach-1	0.0844	206.21	18Jul2005, 12:17	21.98
Sink-1	1.1344	1380.04	18Jul2005, 12:42	343.51
Subbasin-1	0.0844	206.36	18Jul2005, 12:15	21.98
Subbasin-2	0.1188	237.22	18Jul2005, 12:27	33.81
Subbasin-3	0.0938	204.97	18Jul2005, 12:21	25.56
Subbasin-4	0.0938	261.94	18Jul2005, 12:14	27.30
Subbasin-5	0.0438	144.20	18Jul2005, 12:07	11.40
Subbasin-6	0.2922	723.59	18Jul2005, 12:22	94.09
Subbasin-7	0.2406	709.15	18Jul2005, 12:14	74.52
Subbasin-8	0.1672	564.98	18Jul2005, 12:11	54.91

Project: Townsend Drainage Study Simulation Run: Townsend Existing 10 yr

Start of Run: 18Jul2005, 00:00 Basin Model: Townsend Exist
End of Run: 19Jul2005, 01:00 Meteorologic Model: 10 Year Storm
Compute Time: 28Sep2006, 10:30:06 Control Specifications: 24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
9X10 Box	1.1344	1007.81	18Jul2005, 12:38	208.25
Junction-1	0.7453	1108.71	18Jul2005, 12:19	138.67
Junction-2	0.9234	1376.49	18Jul2005, 12:18	167.45
Junction-3	1.1344	1756.77	18Jul2005, 12:16	208.28
Reach-1	0.0844	117.03	18Jul2005, 12:17	12.53
Sink-1	1.1344	1007.81	18Jul2005, 12:38	208.25
Subbasin-1	0.0844	117.13	18Jul2005, 12:16	12.53
Subbasin-2	0.1188	140.43	18Jul2005, 12:28	19.96
Subbasin-3	0.0938	118.79	18Jul2005, 12:22	14.83
Subbasin-4	0.0938	157.18	18Jul2005, 12:14	16.26
Subbasin-5	0.0438	82.41	18Jul2005, 12:07	6.50
Subbasin-6	0.2922	455.50	18Jul2005, 12:22	58.37
Subbasin-7	0.2406	438.74	18Jul2005, 12:14	45.50
Subbasin-8	0.1672	359.90	18Jul2005, 12:11	34.33

Project: Townsend Drainage Study Simulation Run: Townsend Existing 1 yr

Start of Run: 18Jul2005, 00:00 Basin Model: Townsend Exist
End of Run: 19Jul2005, 01:00 Meteorologic Model: 1 Year Storm
Compute Time: 28Sep2006, 10:27:09 Control Specifications: 24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
9X10 Box	1.1344	475.53	18Jul2005, 12:36	87.87
Junction-1	0.7453	466.24	18Jul2005, 12:20	58.89
Junction-2	0.9234	566.12	18Jul2005, 12:19	70.02
Junction-3	1.1344	732.43	18Jul2005, 12:16	87.90
Reach-1	0.0844	40.08	18Jul2005, 12:19	4.57
Sink-1	1.1344	475.53	18Jul2005, 12:36	87.87
Subbasin-1	0.0844	40.10	18Jul2005, 12:17	4.57
Subbasin-2	0.1188	53.71	18Jul2005, 12:29	7.90
Subbasin-3	0.0938	43.04	18Jul2005, 12:23	5.64
Subbasin-4	0.0938	62.17	18Jul2005, 12:15	6.57
Subbasin-5	0.0438	28.68	18Jul2005, 12:08	2.37
Subbasin-6	0.2922	202.41	18Jul2005, 12:23	25.89
Subbasin-7	0.2406	186.87	18Jul2005, 12:15	19.46
Subbasin-8	0.1672	164.54	18Jul2005, 12:12	15.51

APPENDIX E

PROPOSED SUB-BASIN CURVE NUMBERS

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Proposed Conditions

Sub-Basin 1. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	10%	9.3
C	Pavement/ Parking	98	2%	1.96
C	Undeveloped Areas	74	88%	65.12

Use CN = 76

Sub-Basin 2. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	8%	7.44
C	Residential, 1/8 acre or less	92	24%	22.08
C	Undeveloped Areas	74	68%	50.32

Use CN = 80

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Proposed Conditions

Sub-Basin 3. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	20%	18.6
C	Pavement	98	1%	0.98
C	Undeveloped Areas	74	79%	58.46

Use CN = 78

Sub-Basin 4. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	38%	35.34
C	Pavement	98	1%	0.98
C	Undeveloped Areas	74	61%	45.14

Use CN = 81

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Proposed Conditions

Sub-Basin 5. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	12%	11.16
C	Pavement	98	1%	0.98
C	Undeveloped Areas	74	87%	64.38

Use CN = 77

Sub-Basin 6. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	36%	33.48
C	Residential, 1/8 acre or less	92	28%	25.76
C	Undeveloped Areas	74	36%	26.64

Use CN = 86

APPENDIX F

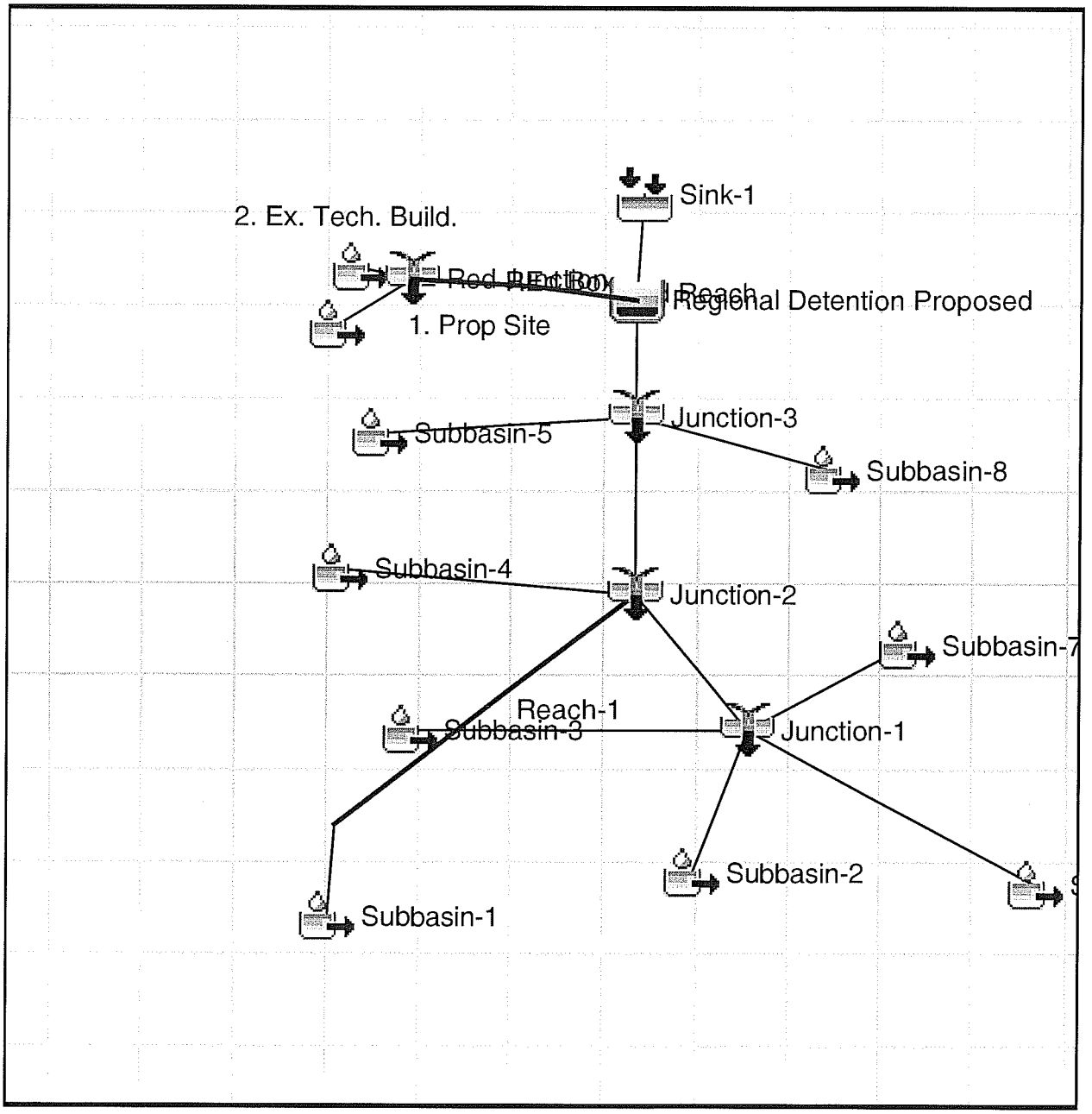
HEC-HMS 3.0.1 PRINTOUTS FOR PROPOSED CONDITIONS

HEC-HMS

Project : Townsend Drainage Study

Basin Model : Townsend Proposed

Sep 28 13:45:55 CDT 2006



Project: Townsend Drainage Study Simulation Run: Townsend Proposed 100 yr

Start of Run: 18Jul2005, 00:00 Basin Model: Townsend Proposed
End of Run: 19Jul2005, 01:00 Meteorologic Model: 100 Year storm
Compute Time: 28Sep2006, 10:18:45 Control Specifications: 24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Prop Site	0.1151	639.35	18Jul2005, 12:01	45.06
2. Ex. Tech. Bldg	0.0581	359.48	18Jul2005, 11:58	22.75
Junction-1	0.7453	1803.11	18Jul2005, 12:19	227.98
Junction-2	0.9234	2260.44	18Jul2005, 12:18	277.25
Junction-3	1.1344	2871.61	18Jul2005, 12:15	343.82
REd Box	0.1732	979.42	18Jul2005, 12:00	67.81
Reach-1	0.0844	206.21	18Jul2005, 12:17	21.98
Red Junction	0.1732	979.85	18Jul2005, 11:59	67.81
Red Reach	0.1732	977.30	18Jul2005, 12:01	67.81
Regional Detention Proposed	1.3076	1299.71	18Jul2005, 12:46	410.66
Sink-1	1.3076	1299.71	18Jul2005, 12:46	410.66
Subbasin-1	0.0844	206.36	18Jul2005, 12:15	21.98
Subbasin-2	0.1188	237.22	18Jul2005, 12:27	33.81
Subbasin-3	0.0938	204.97	18Jul2005, 12:21	25.56
Subbasin-4	0.0938	261.94	18Jul2005, 12:14	27.30
Subbasin-5	0.0438	147.33	18Jul2005, 12:07	11.67
Subbasin-6	0.2922	723.59	18Jul2005, 12:22	94.09
Subbasin-7	0.2406	709.15	18Jul2005, 12:14	74.52
Subbasin-8	0.1672	564.98	18Jul2005, 12:11	54.91

Project: Townsend Drainage Study Simulation Run: Townsend Proposed 10 yr			
Start of Run:	18Jul2005, 00:00	Basin Model:	Townsend Proposed
End of Run:	19Jul2005, 01:00	Meteorologic Model:	10 Year Storm
Compute Time:	28Sep2006, 10:36:09	Control Specifications:	24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Prop Site	0.1151	437.54	18Jul2005, 12:01	30.36
2. Ex. Tech. Bldg	0.0581	246.05	18Jul2005, 11:58	15.33
Junction-1	0.7453	1108.71	18Jul2005, 12:19	138.67
Junction-2	0.9234	1376.49	18Jul2005, 12:18	167.45
Junction-3	1.1344	1758.47	18Jul2005, 12:16	208.50
REd Box	0.1732	670.22	18Jul2005, 12:00	45.69
Reach-1	0.0844	117.03	18Jul2005, 12:17	12.53
Red Junction	0.1732	670.43	18Jul2005, 11:59	45.69
Red Reach	0.1732	668.66	18Jul2005, 12:01	45.69
Regional Detention Proposed	1.3076	863.78	18Jul2005, 12:44	253.65
Sink-1	1.3076	863.78	18Jul2005, 12:44	253.65
Subbasin-1	0.0844	117.13	18Jul2005, 12:16	12.53
Subbasin-2	0.1188	140.43	18Jul2005, 12:28	19.96
Subbasin-3	0.0938	118.79	18Jul2005, 12:22	14.83
Subbasin-4	0.0938	157.18	18Jul2005, 12:14	16.26
Subbasin-5	0.0438	85.17	18Jul2005, 12:07	6.71
Subbasin-6	0.2922	455.50	18Jul2005, 12:22	58.37
Subbasin-7	0.2406	438.74	18Jul2005, 12:14	45.50
Subbasin-8	0.1672	359.90	18Jul2005, 12:11	34.33

Project: Townsend Drainage Study Simulation Run: Townsend Proposed 1 yr

Start of Run: 18Jul2005, 00:00 Basin Model: Townsend Proposed
End of Run: 19Jul2005, 01:00 Meteorologic Model: 1 Year Storm
Compute Time: 28Sep2006, 10:33:58 Control Specifications: 24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Prop Site	0.1151	242.68	18Jul2005, 12:01	16.32
2. Ex. Tech. Bldg	0.0581	136.54	18Jul2005, 11:58	8.24
Junction-1	0.7453	466.24	18Jul2005, 12:20	58.89
Junction-2	0.9234	566.12	18Jul2005, 12:19	70.02
Junction-3	1.1344	733.64	18Jul2005, 12:16	88.03
REd Box	0.1732	371.76	18Jul2005, 12:00	24.56
Reach-1	0.0844	40.08	18Jul2005, 12:19	4.57
Red Junction	0.1732	371.74	18Jul2005, 12:00	24.56
Red Reach	0.1732	371.11	18Jul2005, 12:01	24.56
Regional Detention Proposed	1.3076	432.44	18Jul2005, 12:41	112.38
Sink-1	1.3076	432.44	18Jul2005, 12:41	112.38
Subbasin-1	0.0844	40.10	18Jul2005, 12:17	4.57
Subbasin-2	0.1188	53.71	18Jul2005, 12:29	7.90
Subbasin-3	0.0938	43.04	18Jul2005, 12:23	5.64
Subbasin-4	0.0938	62.17	18Jul2005, 12:15	6.57
Subbasin-5	0.0438	30.54	18Jul2005, 12:08	2.50
Subbasin-6	0.2922	202.41	18Jul2005, 12:23	25.89
Subbasin-7	0.2406	186.87	18Jul2005, 12:15	19.46
Subbasin-8	0.1672	164.54	18Jul2005, 12:12	15.51

APPENDIX G

FUTURE SUB-BASIN CURVE NUMBERS

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Future Conditions

Sub-Basin 1. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	10%	9.3
C	Undeveloped Areas	94	88%	82.72

Use CN = 92

Sub-Basin 2. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	8%	7.44
C	Residential, 1/8 acre or less	92	24%	22.08
C	Undeveloped Areas	94	68%	63.92

Use CN = 93

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Future Conditions

Sub-Basin 3. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	20%	18.6
C	Undeveloped Areas	94	80%	75.2

Use CN = 94

Sub-Basin 4. Runoff curve number				
Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	38%	35.34
C	Undeveloped Areas	94	62%	58.28

Use CN = 94

THHinc TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania Drive
Columbia, MO 65205

Project #: 3279
Project: Townsend Drainage Report
Subject: TR-55 Drainage Calculations, Existing Conditions
Location: Lee's Summit, MO
By: Scott Bitterman

Future Conditions

Sub-Basin 5. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	12%	11.16
C	Undeveloped Areas	94	88%	82.72

Use CN = 94

Sub-Basin 6. Runoff curve number

Hydrolic Soil Group	Land Use	CN Table 5602.3.B	Area	Product of CN and Area
C	Industrial, Heavy Areas	93	36%	33.48
C	Residential, 1/8 acre or less	92	28%	25.76
C	Undeveloped Areas	74	36%	26.64

Use CN = 86

APPENDIX H

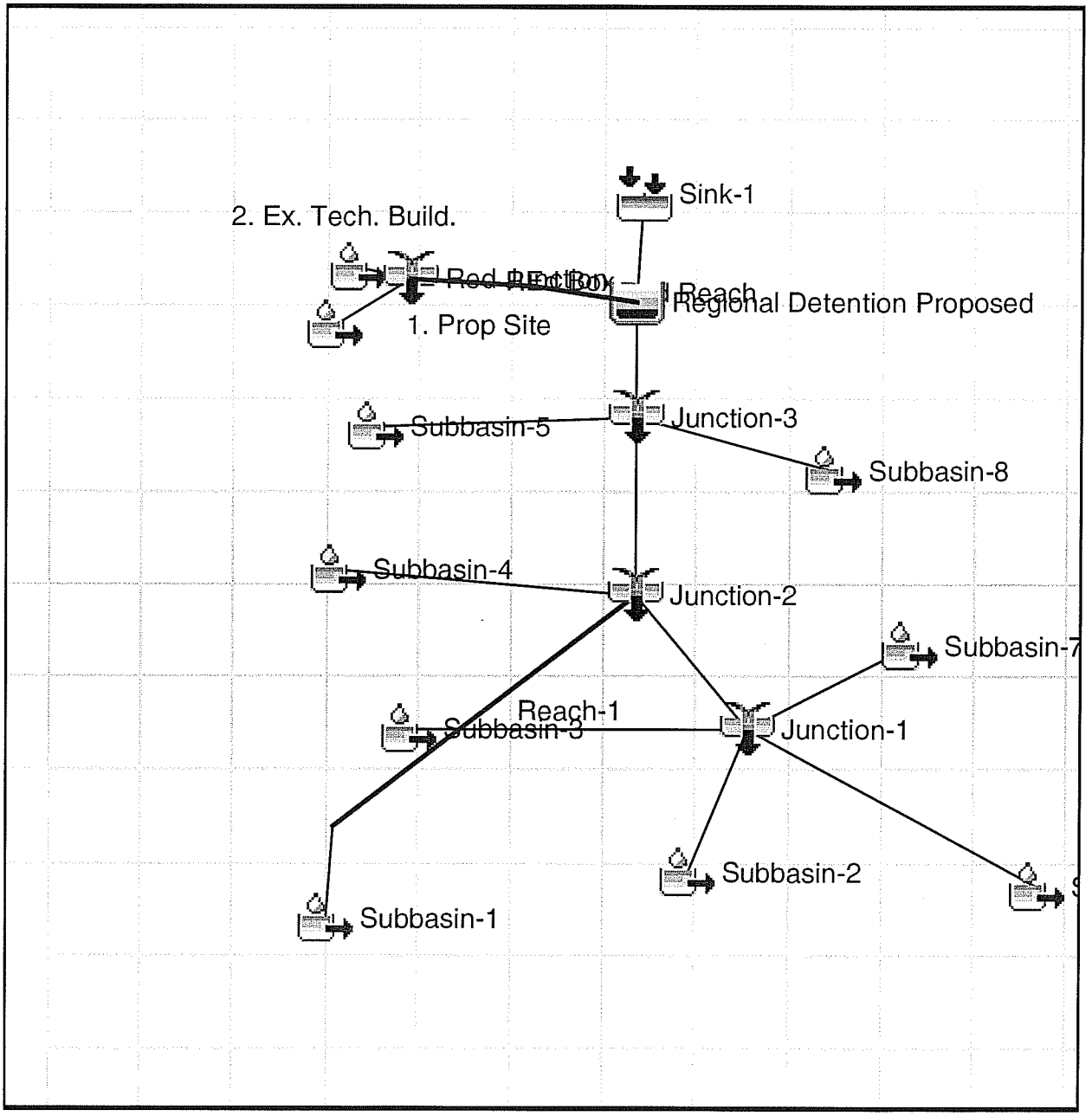
HEC-HMS 3.0.1 PRINTOUTS FOR FUTURE CONDITIONS

HEC-HMS

Project : Townsend Drainage Study

Basin Model : Townsend Future

Sep 28 13:43:28 CDT 2006



Project: Townsend Drainage Study Simulation Run: Townsend Future 100 yr

Start of Run: 18Jul2005, 00:00 Basin Model: Townsend Future
End of Run: 19Jul2005, 01:00 Meteorologic Model: 100 Year storm
Compute Time: 28Sep2006, 09:59:20 Control Specifications: 24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Prop Site	0.1151	639.35	18Jul2005, 12:01	45.06
2. Ex. Tech. Build	0.0581	359.48	18Jul2005, 11:58	22.75
Junction-1	0.7453	2047.69	18Jul2005, 12:17	246.99
Junction-2	0.9234	2661.44	18Jul2005, 12:14	312.26
Junction-3	1.1344	3332.06	18Jul2005, 12:13	383.46
REd Box	0.1732	979.42	18Jul2005, 12:00	67.81
Reach-1	0.0844	322.28	18Jul2005, 12:11	30.36
Red Junction	0.1732	979.85	18Jul2005, 11:59	67.81
Red Reach	0.1732	977.30	18Jul2005, 12:01	67.81
Regional Detention Proposed	1.3076	1389.34	18Jul2005, 12:42	450.36
Sink-1	1.3076	1389.34	18Jul2005, 12:42	450.36
Subbasin-1	0.0844	323.03	18Jul2005, 12:09	30.36
Subbasin-2	0.1188	353.40	18Jul2005, 12:17	43.47
Subbasin-3	0.0938	313.12	18Jul2005, 12:14	34.91
Subbasin-4	0.0938	365.22	18Jul2005, 12:09	34.92
Subbasin-5	0.0438	211.24	18Jul2005, 12:04	16.30
Subbasin-6	0.2922	723.59	18Jul2005, 12:22	94.09
Subbasin-7	0.2406	709.15	18Jul2005, 12:14	74.52
Subbasin-8	0.1672	564.98	18Jul2005, 12:11	54.91

Appendix B

STORMWATER DRAINAGE STUDY

LEE'S SUMMIT FAIR

LEE'S SUMMIT, MISSOURI

Prepared For:
Red Development

PREPARED BY:
OLSSON ASSOCIATES
7301 WEST 133RD STREET, SUITE 200
OVERLAND PARK, KS 66213

December 1, 2006

Olsson No. 2-2005-0451

TABLE OF CONTENTS

FIGURES

APPENDICES

GENERAL INFORMATION

Project Location and Description

The proposed development of Lee's Summit Fair is located South of I-470 and east of Highway 50 in Lee's Summit (see Figure 1), Jackson County, Missouri. The proposed development lies within Section 36, Township 48 North, Range 32 West. The proposed development includes approximately 59 acres of retail commercial property.

Per previous discussion with city staff, two critical points downstream of the project are subject to flooding and were evaluated to determine the site's impact: 1) 8'x6' reinforced concrete box (RCB) culvert beneath NW Technology Dr. and 2) 5'x5' reinforced concrete box culvert beneath I-470 (see Figure 3). These two crossings were analyzed to determine if overtopping exists or will occur after development. No habitable buildings downstream of the project are impacted by existing or proposed 1% flood levels.

The existing Central Summit Center building and parking lot runoff was split down an existing ridgeline with 13.3 acres directly draining to the proposed site and the remaining draining to a 5'x5' RCB under I-470 (referenced City of Lee's Summit, Missouri Bogg's Hollow, Little Cedar Creek Stormwater Master Plan, Panel 4). The existing undeveloped site topography has a sloping terrain generally directing runoff to the east and is heavily vegetated with trees. See Figure 3 for existing drainage conditions.

Study Purpose

The purpose of this study is to evaluate post development stormwater runoff and to establish feasible management practices to control the quantity and quality of stormwater runoff from the project site. The evaluation of post development impacts includes a review of the 1, 10, and 100-year peak discharge rates and runoff volumes associated with the project site watershed catchment area. Based on the results from the evaluation, this study identifies the most applicable Best Management Practices to alleviate increases in stormwater discharge from the Lee's Summit Fair development in accordance with Section 5600 of the *Standard Specifications and Design Criteria* of the Kansas City Metropolitan Chapter of the American Public Works Association (APWA) and Lee's Summit, Missouri's design supplement to APWA Section 5600. In particular, post development peak stormwater discharges from the site must be equal to or less than existing peak discharges from the 1, 10, and 100-year storm events.

Soils Descriptions and Curve Numbers

The watershed soils are predominately of the Sharpsburg silt loam (6B), which is classified in Hydrological Soil Group (HSG) B, Sampsel silty clay loam (13B), which is classified in HSG D, Oska silty clay loam (22C2), which is classified in HSG C, Snead-Rock outcrop complex, which is classified in HSG D, and Urban Land, upland, which does not have a HSG classification but it was assumed a classification of HSG C (see Figure 2). The Curve Numbers used for existing conditions can be found in Appendix A. For proposed development the Curve Number used for hydraulic calculations is 97 for commercial development. Existing areas that will not be disturbed will retain the same Curve Number.

METHODOLOGY

General Criteria and References

The analytical and design criteria used in the study conform to those of "*Section 5600 – Storm Drainage Systems and Facilities*" of the Kansas City Chapter of the American Public Works Association's *"Standard Specifications and Design Criteria"* dated February 2006. Based on these criteria the allowable discharge from the development will be based on limiting 100-year (1%), 10-yr (10%), and 1-yr (100%) post development discharges to no more than existing discharges from the site for each respective storm, with an allowance for passing through stormwater from off-site areas.

Stormwater discharges from the site for existing, proposed and detained conditions were evaluated using the U. S. Army Corps of Engineers "*Hydrological Modeling System – HEC-HMS*" version 3.0.1. HEC-HMS 3.0.1, has the capability to model storage on the upstream side of culverts and was used to analyze the culverts beneath I-470 and NW Technology Drive. Initial sub-basin losses were determined using the NRCS Curve Number method and direct runoff was determined using the SCS Unit Hydrograph (Type II Storm) method. Pre and post development times of concentration (TC) for NRCS lag time calculations (0.6xTC) were determined using the NRCS TR 55 method (see TR55 output Appendix A).

HYDROLOGIC/HYDRAULICS ANALYSES

Existing Conditions Hydrology

Figure 3 illustrates the existing drainage sub-basin delineation for the proposed project and additional downstream watershed. The entire watershed modeled was split into six sub-basins; Existing Central Summit Center, Existing Site 1, Existing Commercial Federal Bank, Existing Site 2, Existing Site 3, and NW Technology Drive to account for the different CN values. Reaches were then added between each sub-basin and connected to a junction to determine peak flows (see Appendix B). Table 1 below displays the hydrologic properties for each sub-basin shown on the existing drainage area map. The "Existing Conditions" Basin Model Schematic and the associated Sub-basin parameters and flood routing results for the 1, 10, and 100-year storm events are provided in Appendix B and are summarized in Table 1 below.

Table 1: Existing Conditions Basin Site Hydrologic Summary

Sub-basin	Area	CN	Tc	Lag	1-Year	10-Year	100-Year
					Q	Q	Q
	(acre)		(min)	(min)	(cfs)	(cfs)	(cfs)
1. Ex. Central Summit Center	48.87	94	13.7	8.2	129.8	245.7	364.7
2. Ex. Site 1	28.84	77	17.4	10.4	32.0	87.7	150.4
3. Ex. Commercial Federal Bank	2.55	92	6.0	3.6	7.3	14.5	21.8
4. Ex. Site 2	21.21	64	21.0	12.6	6.7	35.8	74.6
5. Ex. Site 3	26.34	75	18.2	10.9	25.5	74.5	131.0
Sink-1	127.9	NA	NA	NA	183.5	424.8	696.1
6. NW Technology Drive	35.57	90	11.2	6.7	87.7	178.2	271.4
Sink-2	163.5	NA	NA	NA	228.6	459.8	580.4

The results of the existing conditions evaluation establish the maximum allowable discharge rate for the proposed development. On-site management practices

should mitigate for the changes in the hydrologic conditions resulting from post-development activities.

The existing 5'x5' and 8'x6' RCB culverts were modeled with HEC-HMS to determine if overtopping occurs at each location. The 8'x6' RCB was assumed to have minimal storage capacity. Results show no overtopping at both culvert locations in the 1% storm event. Table 2 shows results for each culvert crossing.

Table 2: Existing Culvert Crossings Conditions

Culvert	1%Storm Peak Flow (cfs)	Roadway Elev.	Water Surface Elev.	Overtopping (ft)
Existing 5'x5' RCB	696.1	958.00	955.2	0.00
Existing 8'x6' RCB	597.0	945.90	945.39	0.00

Proposed Conditions Hydrology

The proposed development of the site includes commercial buildings, associated roadways, parking, utilities, and landscaping. The proposed grading will drain to curb inlets located throughout the development.

Runoff from the site will be collected in an on-site collection and conveyance system and routed to a public storm sewer system along Blue Parkway. The storm sewer system will be designed to convey the 10% chance storm runoff through a series of curb inlets, area inlets, and junction boxes. Approximately 38 acres of the proposed development plus approximately 31 acres of future development will flow north directly to the existing 5'x5' RCB culvert at I-470. The remaining 75 acres

from the proposed site and Summit Center Site will be routed via an 8'x6' reinforced concrete box (RCB) along Ward Road to a Regional Detention Basin located off-site to the northeast (See Figure 4) and constructed with the Summit Center development preceding this project. Runoff directed from this project to this regional detention basin is calculated and presented in Table 5.

The SCS CN value for the proposed site increases to 97 for business, downtown area. The lag time for the proposed development used is based on the proposed storm routing. Table 3 shows updated values for the sub-basins. The "Proposed Conditions" Basin Model Schematic and its sub-basin parameters and flood routing results for the 1, 10 and 100-year storm events investigated are contained in Appendix C and are summarized in Table 3 below.

Table 3: Proposed Conditions Hydrologic Summary

Sub-basin	Area	CN	Tc	Lag	1-Year	10-Year	100-Year
					Q	Q	Q
	(acre)		(min)	(min)	(cfs)	(cfs)	(cfs)
1. Ex. Central Summit Center	75.00	97	12.0	7.2	225.1	406.2	593.6
To Regional Basin	75.00	NA	NA	NA	225.1	406.2	593.6
2. Prop. Site 1	37.63	97	12.0	7.2	112.9	203.8	297.8
3. Prop. Site 2	31.36	87	10.0	6.0	70.3	151.1	235.4
Sink-1	69.00	NA	NA	NA	183.2	354.9	533.3
4. NW Technology Drive	35.57	90	11.2	6.7	87.7	178.2	271.4
Sink-2	104.57	NA	NA	NA	240.9	515.6	776.7

Table 4 displays the hydraulic results for both culverts under proposed conditions. The proposed peak run-off values at each culvert were computed for comparison with the existing conditions peak run-off values to ensure that future development will not cause overtopping conditions. Full development of this drainage basin tributary to "Sink 2" is complete, including MoDOT's improvements to I-470, will cause overtopping at the existing 8'x6' culvert. The reason for the increased water

surface elevation is the future off/on ramp will eliminate current detention volume behind the existing 5'x5' culvert. The construction of the off/on ramp will cause negative effects on the downstream 8'x6' culvert. When improvements are constructed local mitigation should be included with the improvements. The depth of overtopping is subjective and further detailed analysis shall be performed when Sub-basin "Prop. Site 2" is developed by MoDOT.

Note the proposed Regional Detention Basin and outflow must be designed by the Summit Center developer's engineer to control flows such that no net increase in peak discharge rates are caused downstream in the 1, 10, 100-year storm events.

Table 4: Proposed Culvert Crossings Conditions

Culvert	1%Storm Peak Flow (cfs)	Roadway Elev.	Water Surface Elev.	Overtopping (ft)
Existing 5'x5' RCB	533.3	958.00	957.03	0.00
Existing 8'x6' RCB	794.7	945.90	947.2	1.30

Existing and Proposed Condition Comparison

Existing and Proposed condition site peak discharges were derived from the Sink-1 and Sink-2 composite runoff hydrographs synthesized by the HEC-HMS program for the three storm events investigated (see Appendices B & C). The Watershed "Sink-1" and "Sink-2" basin elements in the two models represents the theoretical locus of runoff from the entire watershed modeled. For proposed conditions another sink was added ("Regional Basin") to show the peak runoff to the regional

detention basin. The existing or allowable peak discharges and their corresponding total values for the three storms at Watershed "Sink-1", "Sink-2", and "Regional Basin" are compared with the proposed condition results in Table 5 below:

Table 5: Existing and Proposed Condition Runoff Comparison

Summit Fair Subshed	Storm Event	Exist. Conditions	Prop. Conditions	Prop. - Exist.
		Q (cfs)	Q (cfs)	Q (cfs)
To Regional Basin	1 Year	0	225.1	225.1
To Regional Basin	10 Year	0	406.2	406.2
To Regional Basin	100 Year	0	593.6	593.6
Sink-1	1 Year	183.5	183.2	-0.3
Sink-1	10 Year	424.8	354.9	-69.9
Sink-1	100 Year	696.1	533.3	-162.8
Sink-2	1 Year	228.6	240.9	12.3
Sink-2	10 Year	459.8	515.6	55.8
Sink-2	100 Year	580.4	776.7	196.3

Note flows indicated as "To Regional Detention Basin" do not represent total flow to the regional basin, but rather only that runoff originally discharging to Sink 1 that is being redirected by this development to the Regional Detention Basin. This increase in runoff will be mitigated by the Regional Detention Facility. Existing flows were matched or decreased at Sink 1 by redirecting 75 acres to the Regional Detention Facility. While the existing flows were matched or decreased at Sink 1, flows at Sink 2 increase due to existing detention upstream of the existing 5'x5' culvert underneath I-470 being eliminated by MoDOT ramp construction (previously described in "Proposed Conditions").

CONCLUSIONS AND RECOMMENDATIONS

Any revisions to the proposed site plan or drainage patterns caused by adjacent development will necessitate additional analysis to assess impact and revise management methods if needed. The proposed improvements shall be constructed in accordance with the City of Lee's Summit's Municipal Code. Due to downstream flooding conditions, detention or downstream improvements must be implemented with the project. The proposed regional stormwater detention facility planned on the Summit Center development shall be designed and constructed to accommodate the increased runoff from the Summit Fair site and will maintain or decrease the peak rate of runoff.

.

FIGURE 1 - LOCATION MAP

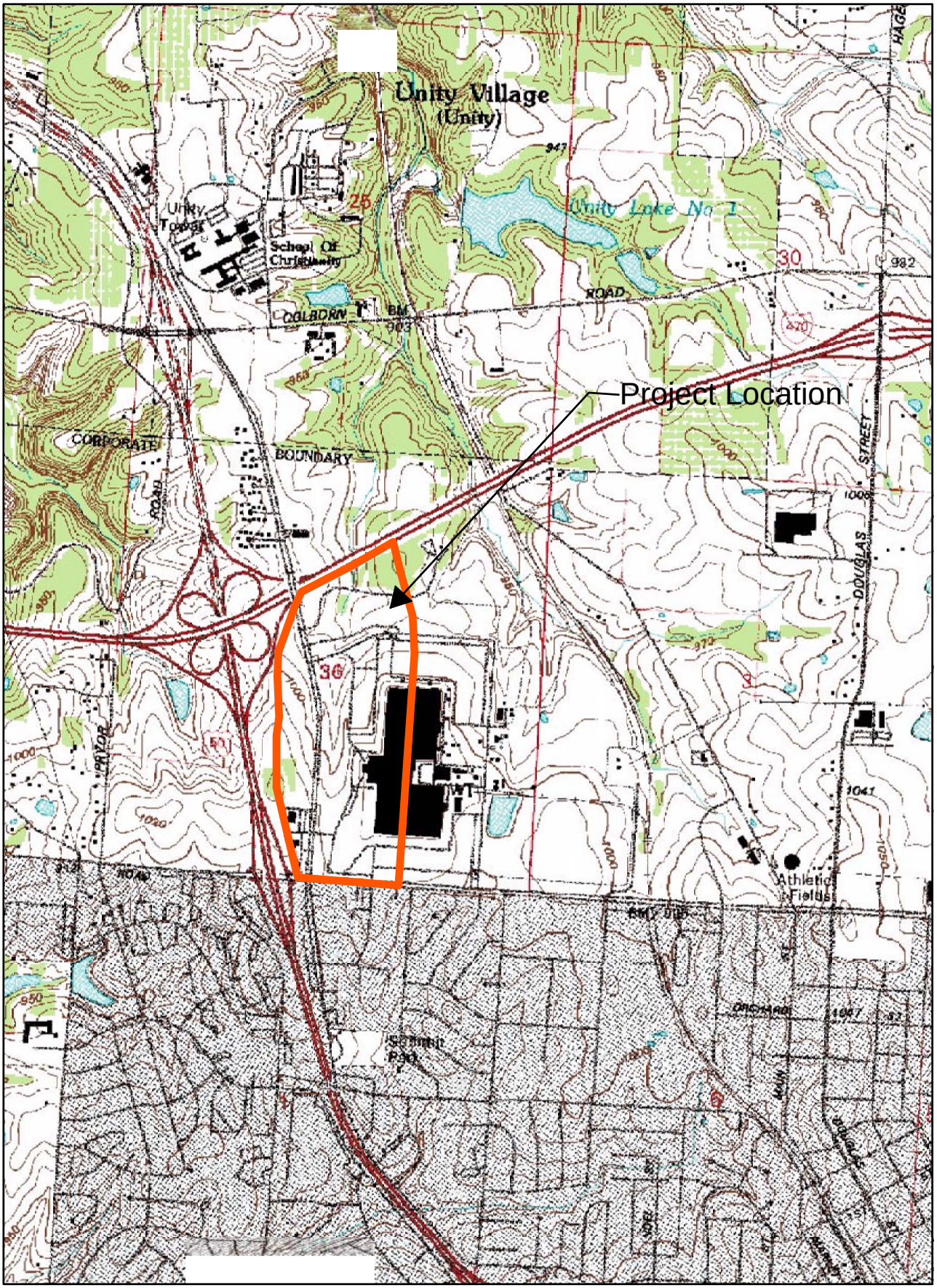
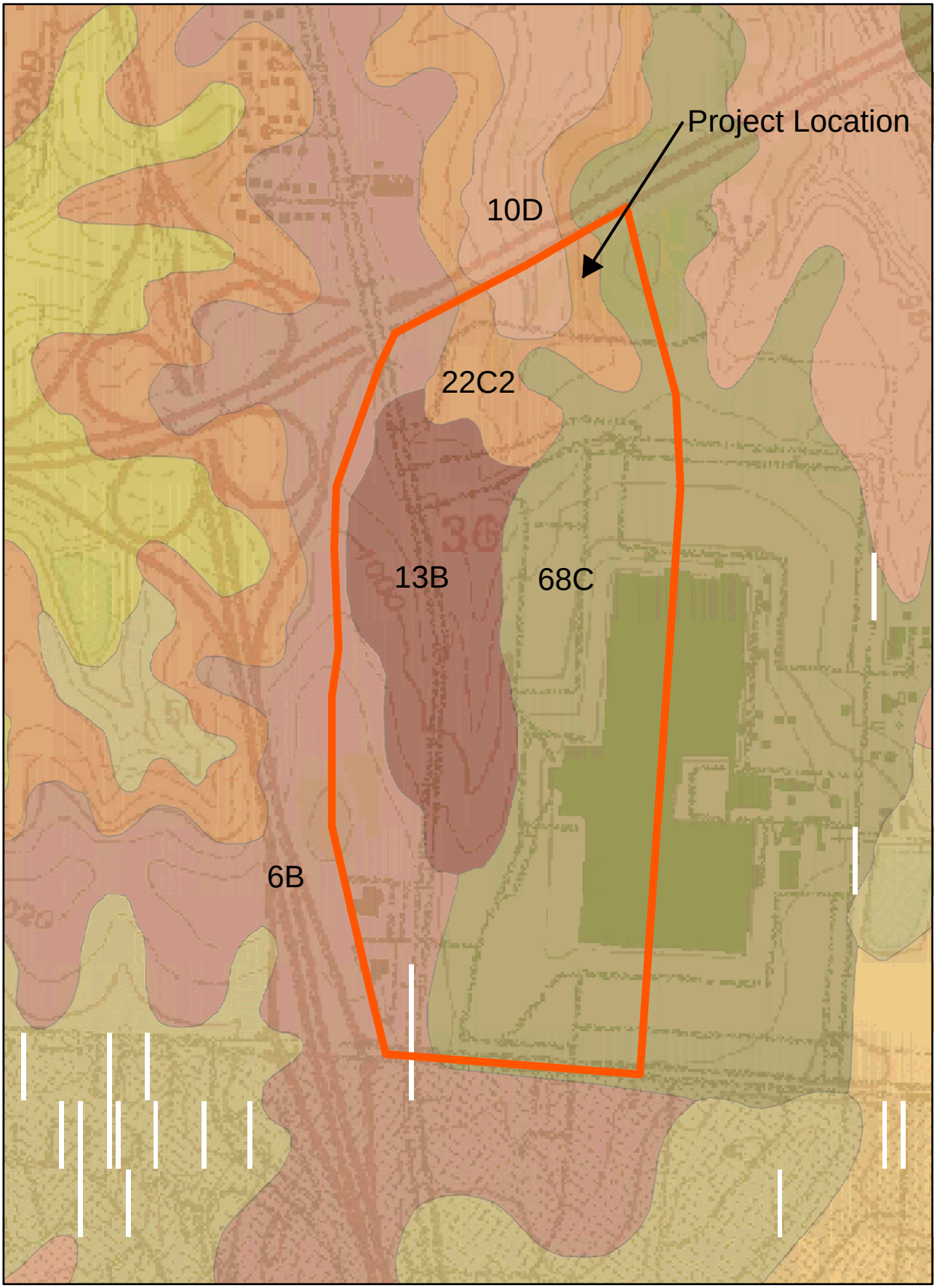


FIGURE 2 - SOILS MAP



3. EXISTING COMMERCIAL
FEDERAL BANK
2.55 ACRES

EXISTING 5'X5' RCB

HIGHWAY 50

4. EXISTING SITE 2
21.21 ACRES

BLUE PARKWAY

2. EXISTING SITE 1
28.84 ACRES

1. EX. CENTRAL SUMMIT CENTER
48.87 ACRES

5. EXISTING SITE 3
26.34 ACRES

6. NW TECH. DR.
35.57 ACRES

SINK 1

SINK 2

EXISTING 8'X6' RCB
APPROXIMATE LOCATION
(LIMITS OF DOWNSTREAM
SYSTEM ANALYSIS)

PRIMARY RIDGE LINE

PRIMARY RIDGE LINE

CHIPMAN

I-470

LEGEND

- Property Line/ROW
- 1002 Existing Contours
- Existing Property Line/ROW
- 1002 Finished Grade Contours
- Drainage Areas

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

FIGURE 3

EXISTING CONDITIONS

OLSSON ASSOCIATES

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Overland Park, KS 66213-4750
TEL 913.381.1170
FAX 913.381.1174
www.oaconsulting.com

DWG: F:\PROJECTS\2005\0451\DOCS\Storm Study\Final Drainage Study\Figures.dwg
DATE: Nov 30, 2006 - 5:32pm
XREFS: 50451_WMA_XCONE_COMBO 50451-public base storm
USER: brk
50451-base-public 2878 Design-Road-Active 50451_PBASE

LEGEND

Existing Property Line/ROW

Property Line/ROW

1002 Existing Contours

1002 Finished Grade Contours

Drainage Areas

EXISTING 5'X5' RCB

HIGHWAY 50

2. PROP. SITE 1
37.63 ACRES

EXISTING 8'X6' RCB
APPROXIMATE LOCATION
(LIMITS OF DOWNSTREAM
SYSTEM ANALYSIS)

4. NW TECH. DR.
35.57 ACRES

SINK 1

SINK 2

MODOT OFF/ON RAMP

BLUE PARKWAY

PROPOSED 8'X6' RCB

3. PROP. SITE 2
31.36 ACRES

1. EX. CENTRAL SUMMIT CENTER
75.00 ACRES
(DRAINAGE ROUTED EAST TO
REGIONAL BASIN)

I-470

REGIONAL DETENTION BASIN
BY OTHERS WITH PROPOSED
DEVELOPMENT.
APPROXIMATE LOCATION

CHIPMAN

WARD ROAD

PROPOSED 12'X6' RCB
BY OTHERS

NORTH

GRAPHIC SCALE

200 0 100 200 400 800

(IN FEET)
1 inch = 200 ft.

FIGURE 4

PROPOSED CONDITIONS

OLSSON ASSOCIATES

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DWG: F:\PROJECTS\2005\0451\OAC\Storm Study\Final Drainage Study\Figures.dwg USER: jphk
DATE: Nov 30, 2006 - 5:31pm XREFS: 50451_WMA_CON_CONREV 50451-public base storm 50451-base-public 2678 Design-Road-Active 50451_PBASE

Appendix A

WinTR-55 Current Data Description

--- Identification Data ---

User: Josh Birk
Project: Lee Summit Fair
SubTitle: Existing Conditions
State: Missouri
County: Jackson
Filename: C:\Lee Summit Fair\Existing Conditions.w55

Date: 11/27/2006
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
1.	Ex. Central Summit Center	Outlet	48.87	94	.228
2.	Existing Site 1	Outlet	28.84	77	.29
3.	Ex. Com Fed Bank	Outlet	2.55	92	0.100
4.	Existing Site 2	Outlet	21.21	64	.35
5.	Existing Site 3	Outlet	26.34	75	.304
6.	NW Tech Dr.	Outlet	35.57	90	.187

Total area: 163.38 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.5	4.6	5.3	6.2	6.9	7.7	3.0

Storm Data Source: Jackson County, MO (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Lee Summit Fair
Existing Conditions
Jackson County, Missouri

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	50-Yr (in)	100-Yr (in)	1-Yr (in)
3.5	4.6	5.3	6.2	6.9	7.7	3.0

Storm Data Source: Jackson County, MO (NRCS)
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

Lee Summit Fair
Existing Conditions
Jackson County, Missouri

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 10-Yr (cfs)	100-Yr (cfs)	1-Yr (cfs)
SUBAREAS			
1.	264.77	392.46	140.58
2.	97.15	167.61	35.26
3.	16.16	24.27	8.28
4.	38.92	80.50	7.80
5.	81.46	143.62	27.78
6.	190.85	290.65	94.04
REACHES			
OUTLET	664.33	1061.45	301.47

Lee Summit Fair
Existing Conditions
Jackson County, Missouri

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period 10-Yr (cfs)	(hr)	100-Yr (cfs)	(hr)	1-Yr (cfs)	(hr)
SUBAREAS						
1.	264.77	12.02	392.46	12.02	140.58	12.01
2.	97.15	12.06	167.61	12.06	35.26	12.07
3.	16.16	11.93	24.27	11.93	8.28	11.93
4.	38.92	12.11	80.50	12.11	7.80	12.15
5.	81.46	12.07	143.62	12.08	27.78	12.10
6.	190.85	11.99	290.65	11.98	94.04	11.99
REACHES						
OUTLET	664.33		1061.45		301.47	

Lee Summit Fair
Existing Conditions
Jackson County, Missouri

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
1.	48.87	0.228	94	Outlet	Ex. Central Summit Center
2.	28.84	0.290	77	Outlet	Existing Site 1
3.	2.55	0.100	92	Outlet	Ex. Com Fed Bank
4.	21.21	0.350	64	Outlet	Existing Site 2
5.	26.34	0.304	75	Outlet	Existing Site 3
6.	35.57	0.187	90	Outlet	NW Tech Dr.

Total Area: 163.38 (ac)

Lee Summit Fair
Existing Conditions
Jackson County, Missouri

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
1.							
SHEET	100	0.0200	0.150				0.156
CHANNEL	2574					10.000	0.072
					Time of Concentration		.228
2.							
SHEET	100	0.0200	0.240				0.227
CHANNEL	2254					10.000	0.063
					Time of Concentration		.29
3.							
User-provided							0.100
					Time of Concentration		0.100
4.							
SHEET	100	0.0310	0.400				0.287
CHANNEL	2250					10.000	0.063
					Time of Concentration		.35
5.							
SHEET	100	0.0390	0.410				0.267
CHANNEL	1315					10.000	0.037
					Time of Concentration		.304
6.							
SHEET	100	0.0200	0.150				0.156
CHANNEL	1132					10.000	0.031
					Time of Concentration		.187

Lee Summit Fair
Existing Conditions
Jackson County, Missouri

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
1.	Commercial & business		C	48.87	94
	Total Area / Weighted Curve Number			48.87	94
2.	Open space; grass cover > 75%	(good)	C	15.38	74
	Open space; grass cover > 75%	(good)	D	13.46	80
	Total Area / Weighted Curve Number			28.84	77
3.	Commercial & business		B	2.55	92
	Total Area / Weighted Curve Number			2.55	92
4.	Woods	(fair)	B	13.96	60
	Woods	(fair)	C	7.25	73
	Total Area / Weighted Curve Number			21.21	64
5.	Woods - grass combination	(fair)	B	4.44	65
	Woods - grass combination	(fair)	C	17.68	76
	Woods - grass combination	(fair)	D	4.22	82
	Total Area / Weighted Curve Number			26.34	75
6.	Industrial		B	18.86	88
	Industrial		C	9.65	91
	Industrial		D	7.06	93
	Total Area / Weighted Curve Number			35.57	90

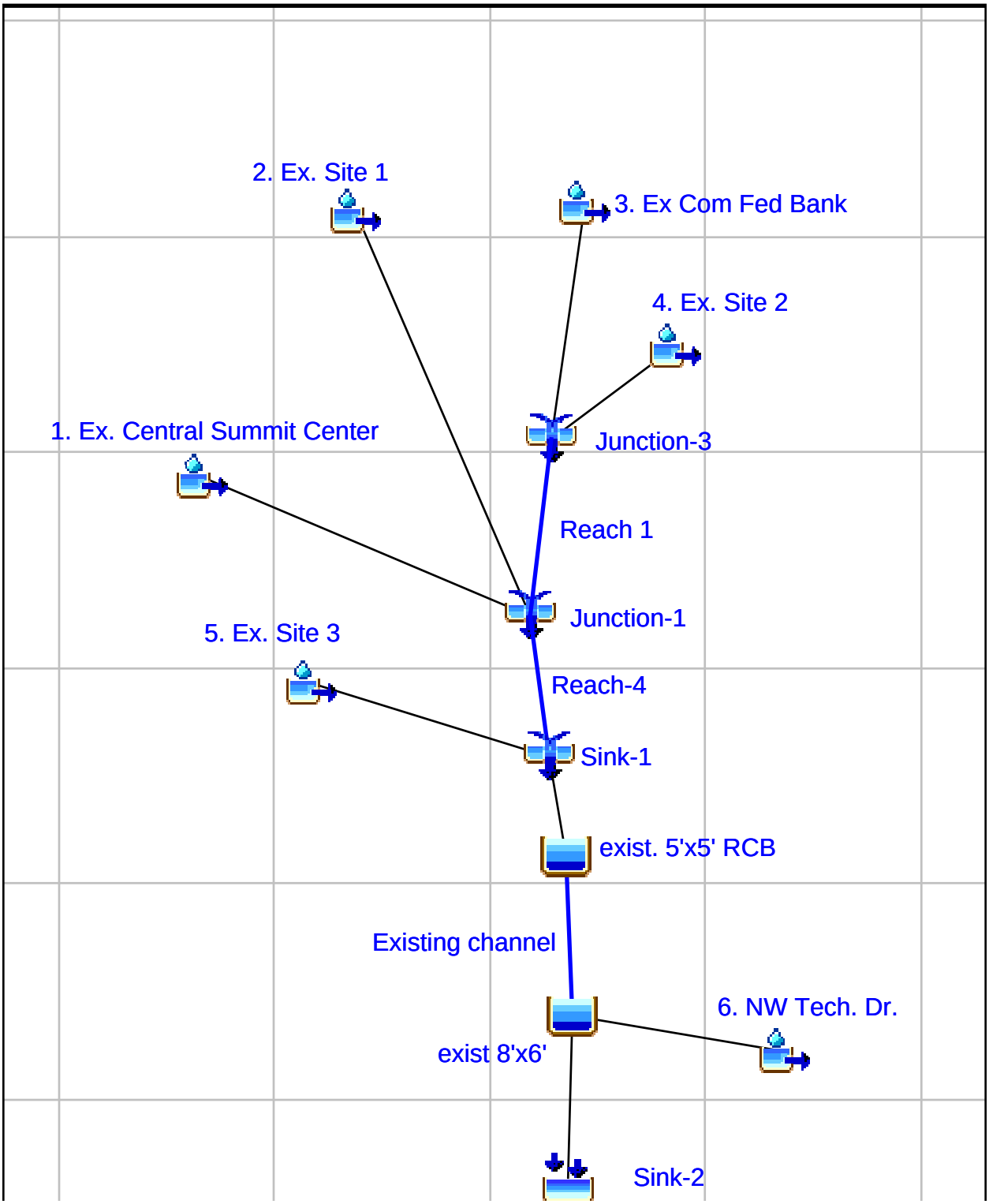
Appendix B

HEC-HMS

Project : Lee Summit Fair

Basin Model : Existing

Nov 26 23:38:22 CST 2006



Project: Lee Summit Fair Simulation Run: Ex 1yr

Start of Run:	18Jul2005, 00:00	Basin Model:	Existing
End of Run:	19Jul2005, 01:00	Meteorologic Model:	1 Year Storm
Compute Time:	27Nov2006, 00:17:11	Control Specifications:	24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Ex. Central Summit Center	0.0764	129.79	18Jul2005, 12:00	9.58
2. Ex. Site 1	0.0451	31.99	18Jul2005, 12:06	2.58
3. Ex Com Fed Bank	0.0040	7.34	18Jul2005, 11:54	0.46
4. Ex. Site 2	0.0331	6.72	18Jul2005, 12:06	0.83
5. Ex. Site 3	0.0412	25.47	18Jul2005, 12:06	2.11
6. NW Tech. Dr.	0.0556	87.74	18Jul2005, 12:00	5.88
Existing channel	0.1998	164.10	18Jul2005, 12:06	15.63
Junction-1	0.1586	168.98	18Jul2005, 12:00	13.44
Junction-3	0.0371	11.04	18Jul2005, 12:00	1.29
Reach 1	0.0371	10.56	18Jul2005, 12:00	1.29
Reach-4	0.1586	161.75	18Jul2005, 12:00	13.46
Sink-1	0.1998	183.45	18Jul2005, 12:00	15.57
Sink-2	0.2554	228.56	18Jul2005, 12:06	23.82
exist 8'x6'	0.2554	228.56	18Jul2005, 12:06	23.82
exist. 5'x5' RCB	0.1998	167.85	18Jul2005, 12:06	15.61

Project : Lee Summit Fair Simulation Run : Ex 1yr Reservoir: exist. 5'x5' RCB

Start of Run :	18Jul2005, 00:00	Basin Model :	Existing
End of Run :	19Jul2005, 01:00	Meteorologic Model :	1 Year Storm
Compute Time :	27Nov2006, 00:17:11	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	183.45 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	167.85 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:06
Total Inflow :	15.57 (AC-FT)	Peak Storage :	0.83 (AC-FT)
Total Outflow :	15.61 (AC-FT)	Peak Elevation :	946.52 (FT)

Project : Lee Summit Fair Simulation Run : Ex 1yr Reservoir: exist 8'x6'

Start of Run :	18Jul2005, 00:00	Basin Model :	Existing
End of Run :	19Jul2005, 01:00	Meteorologic Model :	1 Year Storm
Compute Time :	27Nov2006, 00:17:11	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	229.21 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:06
Peak Outflow :	228.56 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:06
Total Inflow :	21.51 (AC-FT)	Peak Storage :	0.55 (AC-FT)
Total Outflow :	23.82 (AC-FT)	Peak Elevation :	940.58 (FT)

Hydrologic Lee Summit Fage Simulation Run: Existing

Project Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Start of Run:	18Jul2005, 00:00	Basin Model:	Existing	
End of Run:	19Jul2005, 01:00	Meteorologic Model:	10 Year Storm	
Compute Time:	26Nov2006, 23:34:58	Control Specifications:	24 Hour Storm	

Volume Units: AC-FT

1. Ex. Central Summit Center	0.0764	245.66	18Jul2005, 12:00	18.76
2. Ex. Site 1	0.0451	87.65	18Jul2005, 12:06	6.92
3. Ex Com Fed Bank	0.0040	14.47	18Jul2005, 11:54	0.93
4. Ex. Site 2	0.0331	35.81	18Jul2005, 12:06	3.14
5. Ex. Site 3	0.0412	74.51	18Jul2005, 12:06	5.92
6. NW Tech. Dr.	0.0556	178.16	18Jul2005, 12:00	12.35
Existing channel	0.1998	309.87	18Jul2005, 12:12	35.74
Junction-1	0.1586	368.84	18Jul2005, 12:00	29.76
Junction-3	0.0371	41.82	18Jul2005, 12:06	4.07
Reach 1	0.0371	41.79	18Jul2005, 12:06	4.08
Reach-4	0.1586	356.58	18Jul2005, 12:00	29.79
Sink-1	0.1998	424.76	18Jul2005, 12:00	35.72
Sink-2	0.2554	459.79	18Jul2005, 12:00	52.13
exist 8'x6'	0.2554	459.79	18Jul2005, 12:00	52.13
exist. 5'x5' RCB	0.1998	310.89	18Jul2005, 12:12	35.71

Project : Lee Summit Fair Simulation Run : Ex 10yr Reservoir: exist. 5'x5' RCB

Start of Run :	18Jul2005, 00:00	Basin Model :	Existing
End of Run :	19Jul2005, 01:00	Meteorologic Model :	10 Year Storm
Compute Time :	26Nov2006, 23:34:58	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	424.76 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	310.89 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:12
Total Inflow :	35.72 (AC-FT)	Peak Storage :	3.44 (AC-FT)
Total Outflow :	35.71 (AC-FT)	Peak Elevation :	951.03 (FT)

Project : Lee Summit Fair Simulation Run : Ex 10yr Reservoir: exist 8'x6'

Start of Run :	18Jul2005, 00:00	Basin Model :	Existing
End of Run :	19Jul2005, 01:00	Meteorologic Model :	10 Year Storm
Compute Time :	26Nov2006, 23:34:58	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	450.36 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	459.79 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:00
Total Inflow :	48.10 (AC-FT)	Peak Storage :	0.86 (AC-FT)
Total Outflow :	52.13 (AC-FT)	Peak Elevation :	943.89 (FT)

Project: Lee Summit Fair Simulation Run: Ex 100yr

Start of Run:	18Jul2005, 00:00	Basin Model:	Existing
End of Run:	19Jul2005, 01:00	Meteorologic Model:	100 Year storm
Compute Time:	26Nov2006, 23:27:27	Control Specifications:	24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Ex. Central Summit Center	0.0764	364.73	18Jul2005, 12:00	28.46
2. Ex. Site 1	0.0451	150.42	18Jul2005, 12:06	12.03
3. Ex Com Fed Bank	0.0040	21.79	18Jul2005, 11:54	1.44
4. Ex. Site 2	0.0331	74.61	18Jul2005, 12:06	6.26
5. Ex. Site 3	0.0412	131.02	18Jul2005, 12:06	10.49
6. NW Tech. Dr.	0.0556	271.41	18Jul2005, 12:00	19.31
Existing channel	0.1998	385.87	18Jul2005, 12:18	58.76
Junction-1	0.1586	589.96	18Jul2005, 12:00	48.18
Junction-3	0.0371	83.56	18Jul2005, 12:06	7.69
Reach 1	0.0371	83.39	18Jul2005, 12:06	7.70
Reach-4	0.1586	573.14	18Jul2005, 12:00	48.24
Sink-1	0.1998	696.07	18Jul2005, 12:00	58.73
Sink-2	0.2554	580.35	18Jul2005, 12:06	88.06
exist 8'x6'	0.2554	580.35	18Jul2005, 12:06	88.06
exist. 5'x5' RCB	0.1998	385.94	18Jul2005, 12:18	58.72

Project : Lee Summit Fair Simulation Run : Ex 100yr Reservoir: exist. 5'x5' RCB

Start of Run :	18Jul2005, 00:00	Basin Model :	Existing
End of Run :	19Jul2005, 01:00	Meteorologic Model :	100 Year storm
Compute Time :	26Nov2006, 23:27:27	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	696.07 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	385.94 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:18
Total Inflow :	58.73 (AC-FT)	Peak Storage :	8.85 (AC-FT)
Total Outflow :	58.72 (AC-FT)	Peak Elevation :	955.17 (FT)

Project : Lee Summit Fair Simulation Run : Ex 100yr Reservoir: exist 8'x6'

Start of Run :	18Jul2005, 00:00	Basin Model :	Existing
End of Run :	19Jul2005, 01:00	Meteorologic Model :	100 Year storm
Compute Time :	26Nov2006, 23:27:27	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	597.03 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	580.35 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:06
Total Inflow :	78.06 (AC-FT)	Peak Storage :	1.05 (AC-FT)
Total Outflow :	88.06 (AC-FT)	Peak Elevation :	945.39 (FT)

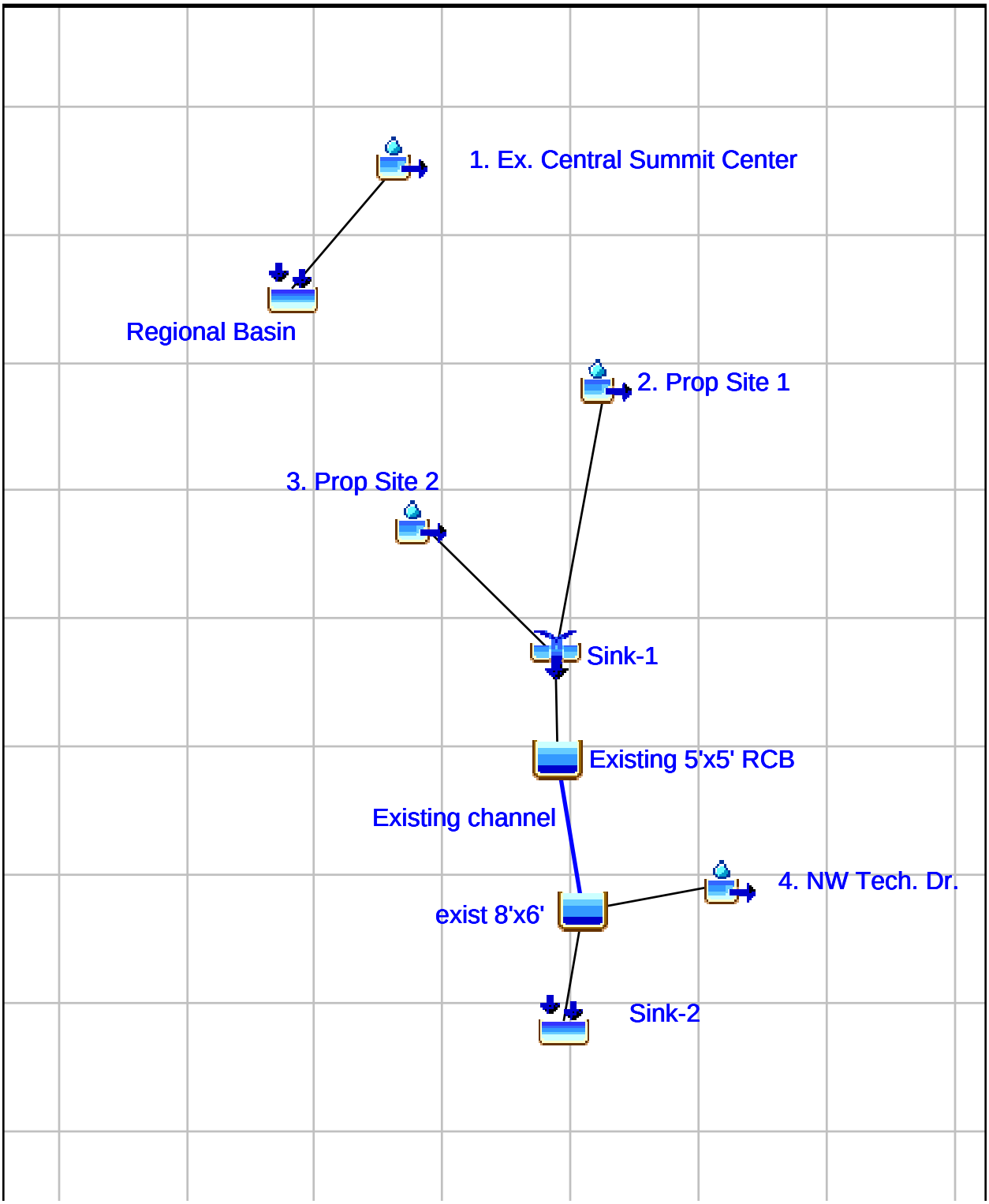
Appendix C

HEC-HMS

Project : Lee Summit Fair

Basin Model : Proposed

Nov 27 00:10:19 CST 2006



Project: Lee Summit Fair Simulation Run: Prop 1yr

Start of Run:	18Jul2005, 00:00	Basin Model:	Proposed
End of Run:	19Jul2005, 01:00	Meteorologic Model:	1 Year Storm
Compute Time:	27Nov2006, 00:34:36	Control Specifications:	24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Ex. Central Summit Center	0.1772	225.07	18Jul2005, 12:00	16.62
2. Prop Site 1	0.0588	112.92	18Jul2005, 12:00	8.34
3. Prop Site 2	0.0490	70.28	18Jul2005, 12:00	4.54
4. NW Tech. Dr.	0.0556	87.74	18Jul2005, 12:00	5.88
Existing 5'x5' RCB	0.1078	184.44	18Jul2005, 12:00	12.88
Existing channel	0.1078	178.94	18Jul2005, 12:00	12.91
Regional Basin	0.1172	225.07	18Jul2005, 12:00	16.62
Sink-1	0.1078	183.20	18Jul2005, 12:00	12.88
Sink-2	0.1634	240.86	18Jul2005, 12:00	19.17
exist 8'x6'	0.1634	240.86	18Jul2005, 12:00	19.17

Project : Lee Summit Fair Simulation Run : Prop 1yr Reservoir: Existing 5'x5' RCB

Start of Run :	18Jul2005, 00:00	Basin Model :	Proposed
End of Run :	19Jul2005, 01:00	Meteorologic Model :	1 Year Storm
Compute Time :	27Nov2006, 00:34:36	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	183.20 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	184.44 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:00
Total Inflow :	12.88 (AC-FT)	Peak Storage :	0.05 (AC-FT)
Total Outflow :	12.88 (AC-FT)	Peak Elevation :	946.57 (FT)

Project : Lee Summit Fair Simulation Run : Prop 1yr Reservoir: exist 8'x6'

Start of Run :	18Jul2005, 00:00	Basin Model :	Proposed
End of Run :	19Jul2005, 01:00	Meteorologic Model :	1 Year Storm
Compute Time :	27Nov2006, 00:34:36	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	266.68 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	240.86 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:00
Total Inflow :	18.79 (AC-FT)	Peak Storage :	0.59 (AC-FT)
Total Outflow :	19.17 (AC-FT)	Peak Elevation :	940.78 (FT)

Project: Lee Summit Fair Simulation Run: Prop 10yr

Start of Run:	18Jul2005, 00:00	Basin Model:	Proposed
End of Run:	19Jul2005, 01:00	Meteorologic Model:	10 Year Storm
Compute Time:	27Nov2006, 00:33:00	Control Specifications:	24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Ex. Central Summit Center	0.1772	406.15	18Jul2005, 12:00	30.92
2. Prop Site 1	0.0588	203.77	18Jul2005, 12:00	15.51
3. Prop Site 2	0.0490	151.13	18Jul2005, 12:00	10.06
4. NW Tech. Dr.	0.0556	178.16	18Jul2005, 12:00	12.35
Existing 5'x5' RCB	0.1078	355.02	18Jul2005, 12:00	25.57
Existing channel	0.1078	347.46	18Jul2005, 12:00	25.62
Regional Basin	0.1172	406.15	18Jul2005, 12:00	30.92
Sink-1	0.1078	354.89	18Jul2005, 12:00	25.57
Sink-2	0.1634	515.62	18Jul2005, 12:00	42.40
exist 8'x6'	0.1634	515.62	18Jul2005, 12:00	42.40

Project : Lee Summit Fair Simulation Run : Prop 10yr Reservoir: Existing 5'x5' RCB

Start of Run :	18Jul2005, 00:00	Basin Model :	Proposed
End of Run :	19Jul2005, 01:00	Meteorologic Model :	10 Year Storm
Compute Time :	27Nov2006, 00:33:00	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	354.89 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	355.02 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:00
Total Inflow :	25.57 (AC-FT)	Peak Storage :	0.05 (AC-FT)
Total Outflow :	25.57 (AC-FT)	Peak Elevation :	952.73 (FT)

Project : Lee Summit Fair Simulation Run : Prop 10yr Reservoir: exist 8'x6'

Start of Run :	18Jul2005, 00:00	Basin Model :	Proposed
End of Run :	19Jul2005, 01:00	Meteorologic Model :	10 Year Storm
Compute Time :	27Nov2006, 00:33:00	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	525.63 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	515.62 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:00
Total Inflow :	37.97 (AC-FT)	Peak Storage :	0.95 (AC-FT)
Total Outflow :	42.40 (AC-FT)	Peak Elevation :	944.60 (FT)

Project: Lee Summit Fair Simulation Run: Prop 100yr

Start of Run:	18Jul2005, 00:00	Basin Model:	Proposed
End of Run:	19Jul2005, 01:00	Meteorologic Model:	100 Year storm
Compute Time:	27Nov2006, 00:27:54	Control Specifications:	24 Hour Storm

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
1. Ex. Central Summit Center	0.1172	593.64	18Jul2005, 12:00	45.89
2. Prop Site 1	0.0588	297.83	18Jul2005, 12:00	23.02
3. Prop Site 2	0.0490	235.43	18Jul2005, 12:00	16.09
4. NW Tech. Dr.	0.0556	271.41	18Jul2005, 12:00	19.31
Existing 5'x5' RCB	0.1078	532.90	18Jul2005, 12:00	39.44
Existing channel	0.1078	523.29	18Jul2005, 12:00	39.54
Regional Basin	0.1172	593.64	18Jul2005, 12:00	45.89
Sink-1	0.1078	533.26	18Jul2005, 12:00	39.11
Sink-2	0.1634	776.66	18Jul2005, 12:00	66.77
exist 8'x6'	0.1634	776.66	18Jul2005, 12:00	66.77

Project : Lee Summit Fair Simulation Run : Prop 100yr Reservoir: Existing 5'x5' RCB

Start of Run :	18Jul2005, 00:00	Basin Model :	Proposed
End of Run :	19Jul2005, 01:00	Meteorologic Model :	100 Year storm
Compute Time :	27Nov2006, 00:27:54	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	533.26 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	532.90 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:00
Total Inflow :	39.11 (AC-FT)	Peak Storage :	0.05 (AC-FT)
Total Outflow :	39.44 (AC-FT)	Peak Elevation :	957.03 (FT)

Project : Lee Summit Fair Simulation Run : Prop 100yr Reservoir: exist 8'x6'

Start of Run :	18Jul2005, 00:00	Basin Model :	Proposed
End of Run :	19Jul2005, 01:00	Meteorologic Model :	100 Year storm
Compute Time :	27Nov2006, 00:27:54	Control Specifications :	24 Hour Storm

Volume Units : AC-FT

Computed Results

Peak Inflow :	794.69 (CFS)	Date/Time of Peak Inflow :	18Jul2005, 12:00
Peak Outflow :	776.66 (CFS)	Date/Time of Peak Outflow :	18Jul2005, 12:00
Total Inflow :	58.85 (AC-FT)	Peak Storage :	1.30 (AC-FT)
Total Outflow :	66.77 (AC-FT)	Peak Elevation :	947.20 (FT)

CONSULTING ENGINEERS

TRABUE, HANSEN & HINSHAW, Inc.

1901 Pennsylvania
Columbia, MO 65202

July 22, 2009

Mr. Steven W. Rich
Townsend Capital, LLC
11311 McCormick Road, Ste. 470
Hunt Valley, MD 21031

Re: Stormwater Regional Detention Basin Association

Dear Steve,

As requested, Trabue, Hansen & Hinshaw Inc. (***THHinc***) completed a review of the regional detention basin stormwater flows analysis for the Summit Technology Campus, located in Lee's Summit, Missouri. The review determined the individual contributions of the flow currently going to the basin.

There are three properties contributing flow to the basin: the original Summit Technology Campus, the Red Development Site, and the remaining undeveloped portion of the site. The attached Figure 1 depicts the drainage areas. ***THHinc*** previously determined the flows in the "Stormwater Drainage Report for Ward Road-Summit Technology Campus" dated May 16, 2007 approved by the City.

The City approved a 1-year storm design for the detention basin because the entire area floods under storms of higher frequency. The Highway 470 culvert controls and provides detention for higher frequency storms. Flows and contribution percentages for higher frequency storms are slightly different. When area C or other area develops with on-site detention, the contributing areas, flows, and percentages will change

Table 1: Current Flow to Regional Detention Basin in July, 2009

	Area (acres)	1yr Flow (cfs)	% of Total 100 yr Flow
Original Summit Technology Campus	97.1	241.9	40.4%
Red Development Site	33.0	122.4	20.4%
Residual Townsend Capital Property	186.5	235.0	39.2%

Please call if you have any questions.

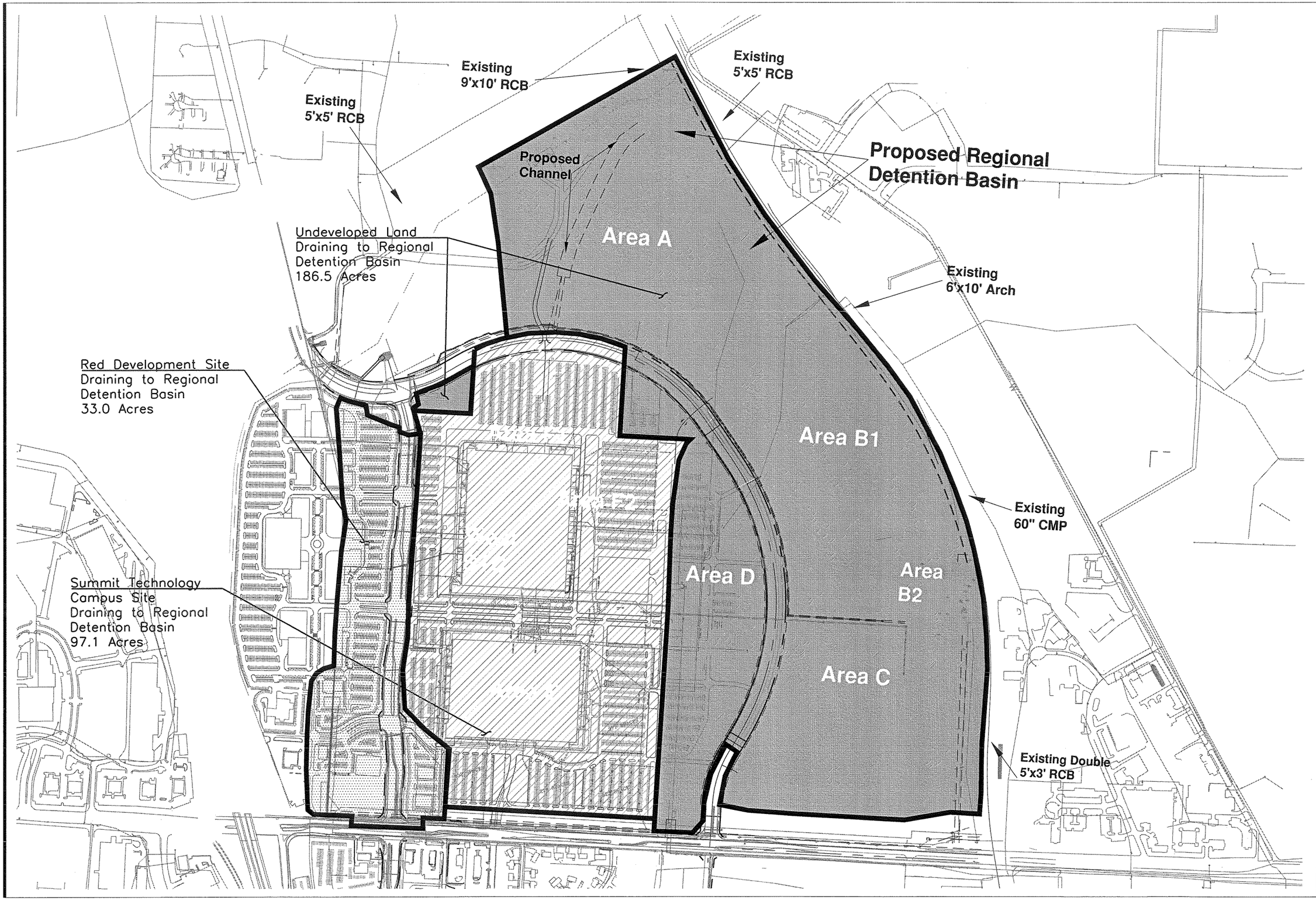
Trabue, Hansen & Hinshaw, Inc.

STATE OF MISSOURI
JOHN V. HUSS
NUMBER E-20579
REGISTERED PROFESSIONAL ENGINEER

John Huss, P.E., CFM
Civil Team Leader/ Principal

7/22/2009

573-814-1568
Fax: 573-814-1128



Revisions			
No.	Date	Description	Initials

THHinc
Consulting Engineers
TRABUE, HANSEN & HINSHAW, INC.
1901 Pennsylvania Dr.
Columbia, MO 65202
Phone (573) 814-1568
Fax (573) 814-1128
Corp. No. MO E-1454-D

Townsend Capital, LLC

Summit Technology Campus
Lee's Summit, MO

Detention Basin Contributing Areas

Client Proj #	—
THHinc Proj #	4907
Engineer:	JVH
Designer:	TBB
Drafter:	—
Plotted:	07/22/2009

DWG. Fig 1

SHT. 1 OF 1

AREAS CONTRIBUTING FLOW TO THE REGIONAL DETENTION BASIN

Parcel	Total Area (ac)	Area Draining to Det. Basin (ac)	Area Draining to Det. Basin (%)	Existing 2-Year Storm Flow (cfs)	Detention Basin (%)
Lot 8	49.561	34.63	69.9%	68.8	**12.2%**
Lot 10	24.698	24.14	97.7%	101	**17.8%**
Lot 11	83.943	77.46	92.3%	80.0	**14.1%**
Lot 12	10.180	4.90	48.1%	10.4	**1.8%**
Lot 13	1.567	1.567	100.0%	4.0	**0.7%**
Lot 14	2.657	2.657	100.0%	10.0	**1.8%**
Lot 27 (old Lot 9)	100.100	97.40	97.3%	292	**51.5%**
			Total of Above Lots:	566	100.0%
Other Areas Contributing Flow to the Regional Detention Basin:					
Summit Fair East	32.9	31.60	96.0%	87.8	–
Tract C (Det. Basin)	15.084	15.08	100.0%	19.7	–
Substation	4.500	4.50	100.0%	20.1	–
Ward Road	7.50	7.50	100.0%	40.1	–

Limits of Totol Area Droining to Regional Detention Basin – 306 Acres

CMP Spillway

Interstate 470

Tract C

Lat 12

Lat 8

Existing 7'x6' RCB

Existing 66" RCP

Existing Summit Fair (East) (RED Development) Droining to Regionol Detention Basin – 31.6 Acres

Shoded Areos Indicote Undeveloped Land Draining to Regional Detention Basin – 145.5 Acres

Lot 13

Lat 14

Existing 5'x5' RCB

Existing STC Site Draining to Regionol Detention Basin – 97.4 Acres

Lat 27

Word Raad Paved Area Droining to Regional Detention Basin – 7.50 Acres

Existing Summit Fair–West (RED Development) Draining to 66" RCP – 34.0 Acres

Blue Parkway

Lot 10

Lot 11

Highway 50

CHIPMAN ROAD

Chipman Road

Revisions

No.	Date	Description	Initials

THHinc
Consulting Engineers
TRABUE, HANSEN & HINSHAW, INC.
1901 Pennsylvania Dr.
Columbia, MO 65202
Phone (573) 814-1568
Fax (573) 814-1128
Corp. No. MO E-1454-D

Townsend Capital, LLC

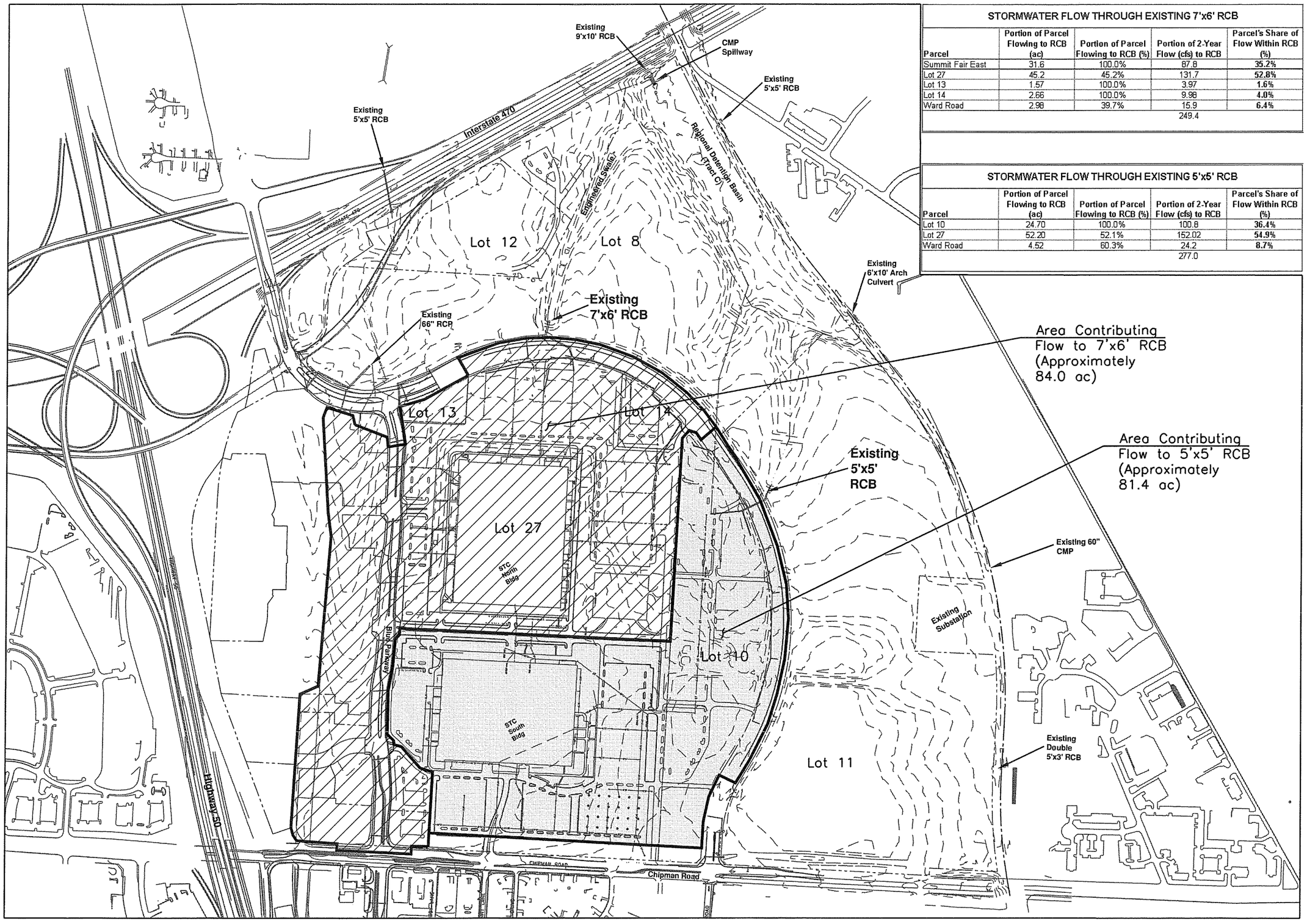
Summit Technology Campus
Lee's Summit, MO

Detention Basin Contributing Areas

Client Proj #	–
THHinc Proj #	4907
Engineer:	CMF
Designer:	TBB
Drafter:	–
Plotted:	09/21/2009

DWG. Fig 1

SHT. 1 OF 2



STORMWATER FLOW THROUGH EXISTING 7'x6' RCB				
Parcel	Portion of Parcel Flowing to RCB (ac)	Portion of Parcel Flowing to RCB (%)	Portion of 2-Year Flow (cfs) to RCB	Parcel's Share of Flow Within RCB (%)
Summit Fair East	31.6	100.0%	87.8	**35.2%**
Lot 27	45.2	45.2%	131.7	**52.8%**
Lot 13	1.57	100.0%	3.97	**1.6%**
Lot 14	2.66	100.0%	9.98	**4.0%**
Ward Road	2.98	39.7%	15.9	**6.4%**
			249.4	

STORMWATER FLOW THROUGH EXISTING 5'x5' RCB				
Parcel	Portion of Parcel Flowing to RCB (ac)	Portion of Parcel Flowing to RCB (%)	Portion of 2-Year Flow (cfs) to RCB	Parcel's Share of Flow Within RCB (%)
Lot 10	24.70	100.0%	100.8	**36.4%**
Lot 27	52.20	52.1%	152.02	**54.9%**
Ward Road	4.52	60.3%	24.2	**8.7%**
			277.0	

Revisions

No.	Date	Description	Initials

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Fax (573) 814-1128

Corp. No. MO E-1454-D

Townsend Capital, LLC
Summit Technology Campus
Lee's Summit, MO

Discharges at Stormwater Boxes

Client Proj #	—
THHinc Proj #	4907
Engineer:	CMF
Designer:	TBB
Drafter:	—
Plotted:	09/14/2009

DWG. Fig 2

SHT. 2 OF 2

STORMWATER REPORT

City of Lee's Summit

Jackson County, Missouri

Summit Technology Campus
Summit Innovation Center

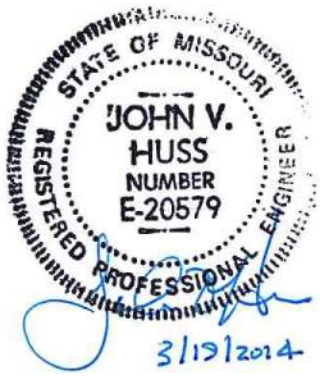
March, 2015

I certify that this report was prepared by me or under my direct supervision, and that I am a duly registered Professional Engineer under the law of the State of Missouri.

John V. Huss, E-20579
Expiration 12.31.2015

3/19/2015

Date



Prepared by:

Trabue, Hansen & Hinshaw Inc.
1901 Pennsylvania Avenue
Columbia, MO 65202
MO Engineering Corporation #001454
Expiration 12.31.2016
(573) 814-1568
Fax: (573) 814-1128

THHinc . . . . . *about the possibilities*

Introduction

This report details the preliminary design of the storm sewer system supporting the Summit Innovation Center Preliminary Development Plan (PDP), a mixed-use development, at the Summit Technology Campus (STC) located in Lee's Summit, Missouri. See Figure 1 for a site location map.

Project Description

The Summit Technology Campus is located southeast of the Interstate-470/State Highway 50 interchange. The entire development covers approximately 367 acres, and is bordered to the south by Chipman Road, to the north by I-470, to the west by Blue Parkway, and to the east by the Union Pacific Railroad. The Summit Technology Campus is split by Ward Road which was opened to traffic in October 2008.

Townsend Capital LLC proposes improvements to the existing Summit Technology Campus, including the addition of a variety of mixed business commercial and residential uses along Ward Road. In this report, the site for these improvements will be referred to as the "35 Acre Tract." The current proposed building layout, grading plan, and storm sewer system drawings for the 35 Acre Tract can be found in the PDP.

Existing System

When Ward Road was constructed the drainage for the roadway and from the western side of the road was collected and discharged from a 5' x 5' concrete box culvert in the middle portion of the site. The stormwater silt basin was left in place. A Stormwater Master Plan and model was prepared for the overall development in 2007 and approved by the City.

The Master plan established a regional detention facility on Tract C at the northeast corner of the development. The improvements were constructed in 2008 and the facility has been in operation since that time.

Proposed Improvements:

This project develops a portion of the site that was modeled for the regional detention facility. The 2007 study assumed this portion of the site would be developed with up to 71% impervious area. The proposed development limits the impervious area to 68%. Therefore, the proposed development is within the parameters of the original study and we do not propose a revision to the hydraulic study for the regional detention basin.

Within the site we will extend the box culvert to the regional detention basin and provide site storm sewers and piping to collect the surface flow and transport it to the detention basin. The layout and drainage areas are depicted on the stormwater masterplan drawing. The peak flows generated by this site are:

	Pre-Development Q (cfs)	Post Development Q (cfs)
1-yr storm	22.6	127.2
10-yr storm	67.7	226.1
100-yr storm	144.4	367.4

Hydrographs for the storm flows are in appendix at the end of this report.

Design and Methodology:

The hydrographs and peak flows were calculated using Hydroflow Hydrograph Extension to AutoCAD Civil 3D 2015. Basin storm calculations and preliminary system sizing was prepared using the Rational Formula and entrance conditions with a maximum of 1.5 HW/D.

Results of Analysis:

The preliminary layout of system and system sizing is depicted on the Stormwater masterplan drawing.

APPENDIX

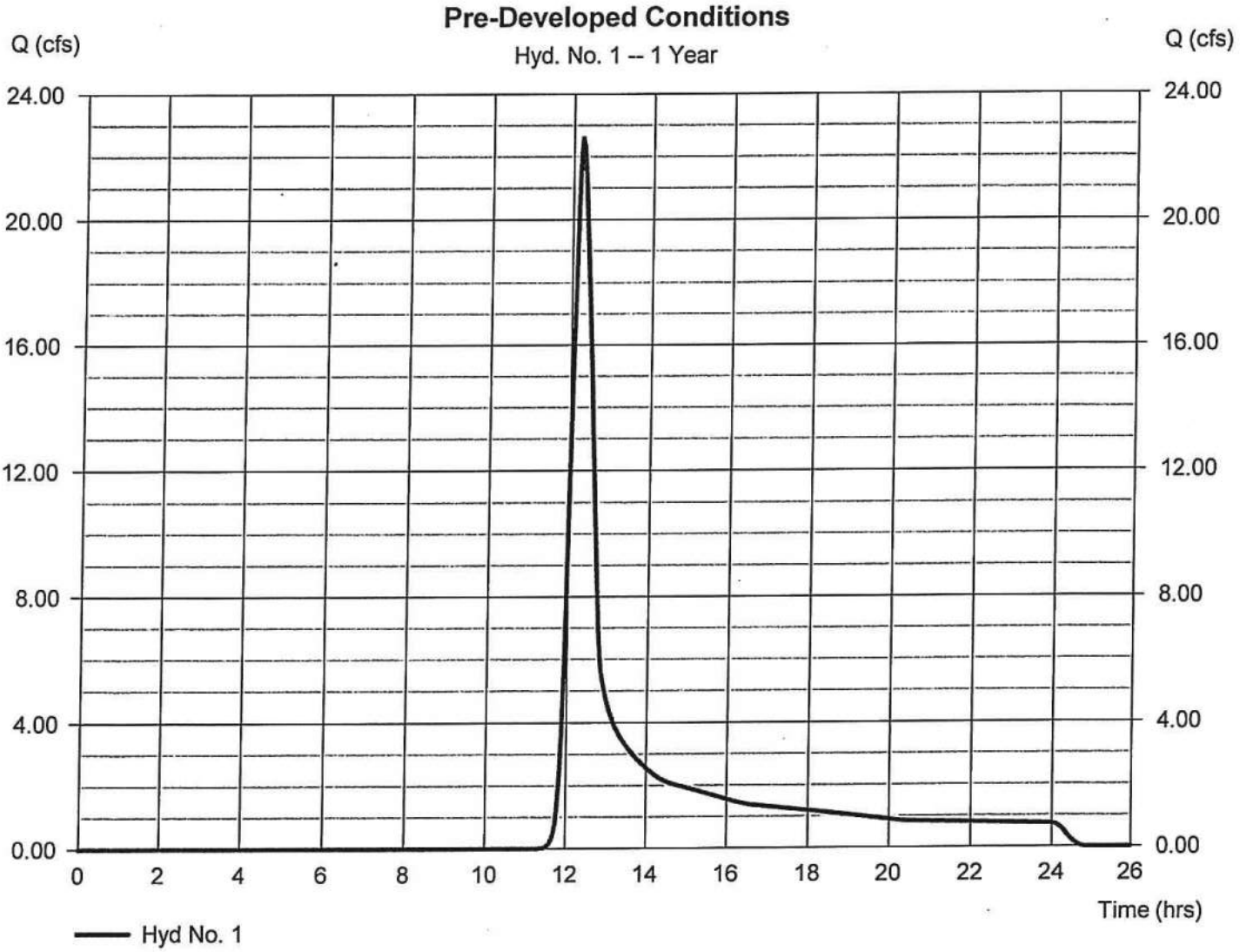
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 03 / 19 / 2015

Hyd. No. 1

Pre-Developed Conditions

Hydrograph type	= SCS Runoff	Peak discharge	= 22.58 cfs
Storm frequency	= 1 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 109,519 cuft
Drainage area	= 37.410 ac	Curve number	= 73
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.50 min
Total precip.	= 2.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



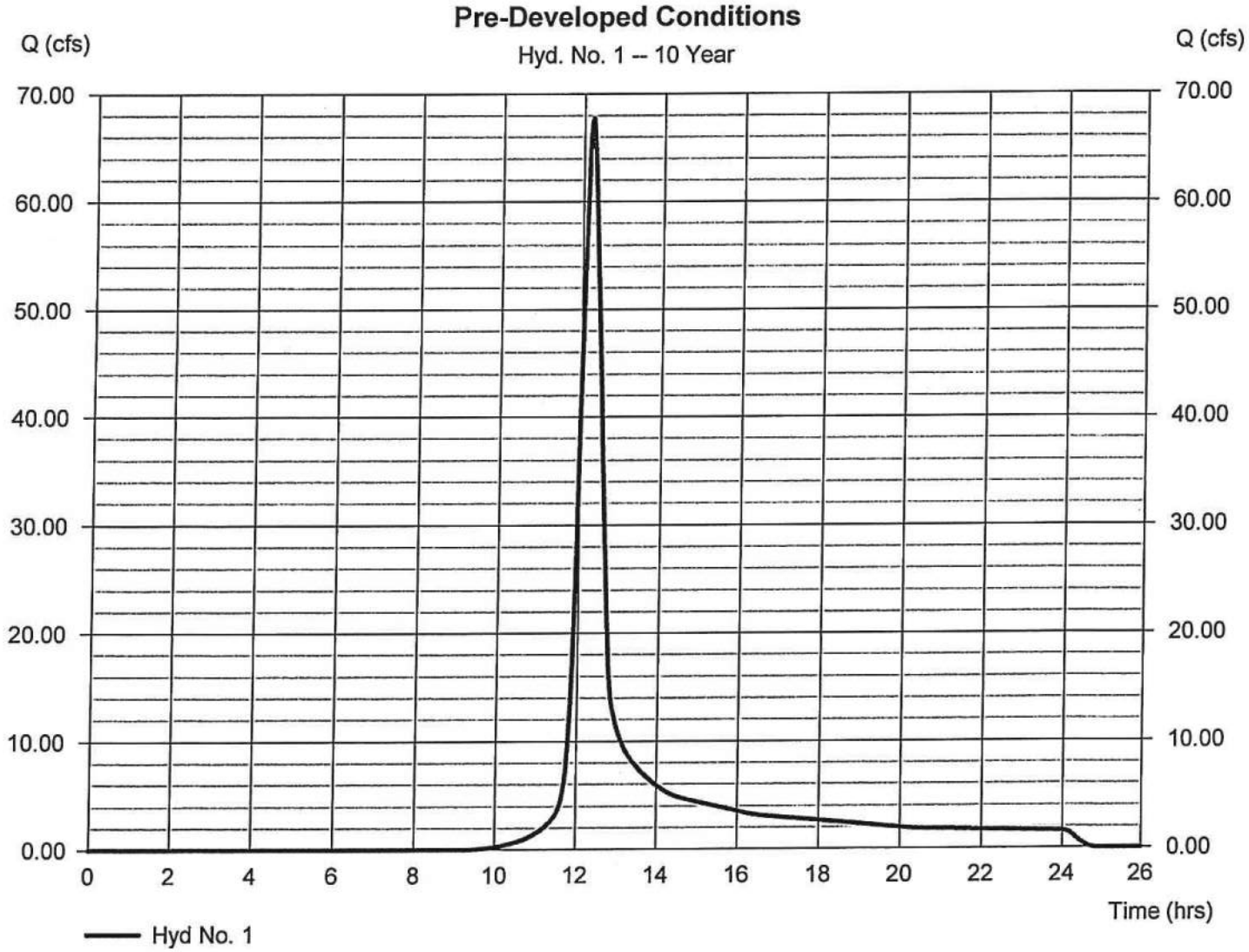
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 03 / 19 / 2015

Hyd. No. 1

Pre-Developed Conditions

Hydrograph type	= SCS Runoff	Peak discharge	= 67.73 cfs
Storm frequency	= 10 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 297,468 cuft
Drainage area	= 37.410 ac	Curve number	= 73
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.50 min
Total precip.	= 4.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



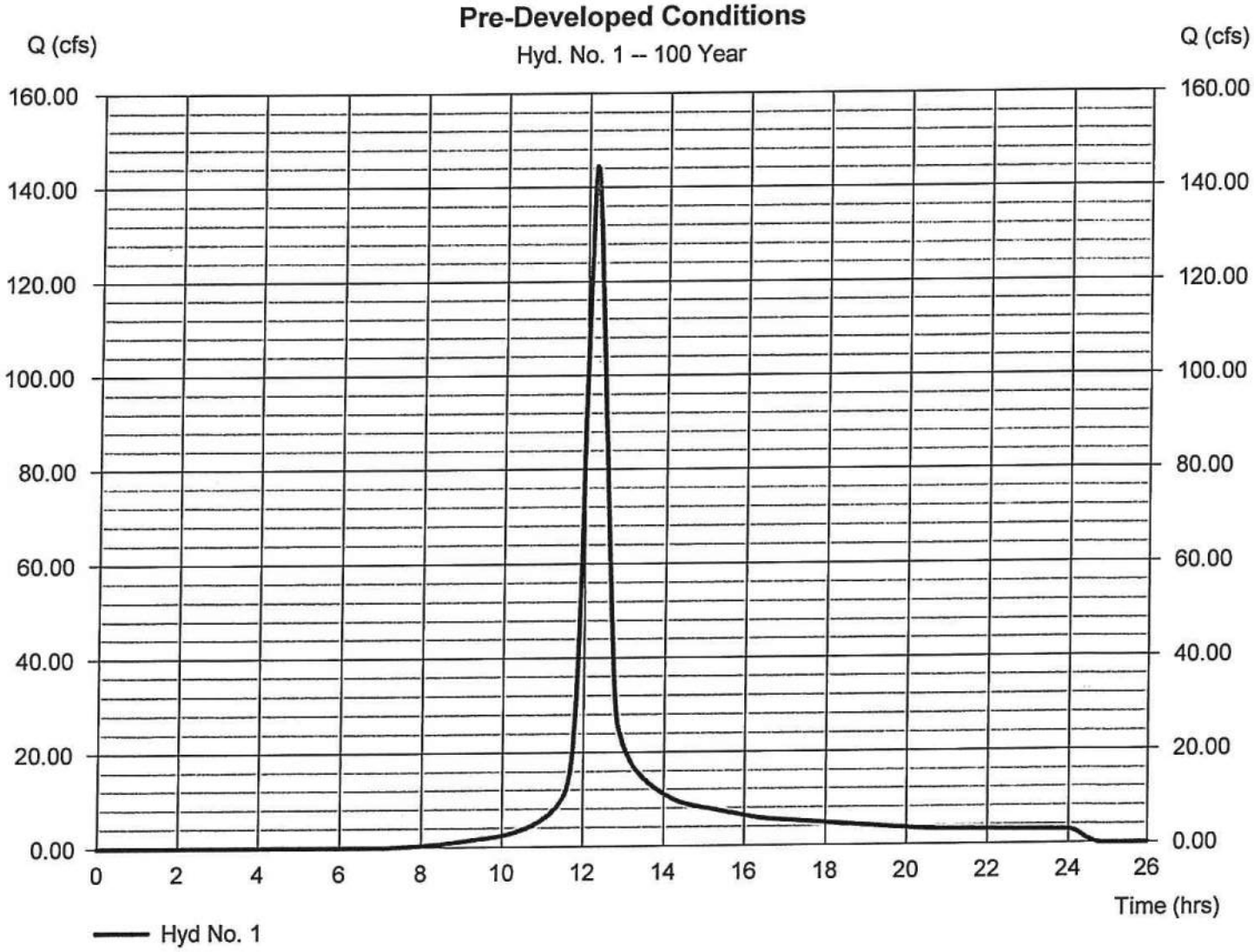
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 03 / 19 / 2015

Hyd. No. 1

Pre-Developed Conditions

Hydrograph type	= SCS Runoff	Peak discharge	= 144.36 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.20 hrs
Time interval	= 2 min	Hyd. volume	= 623,718 cuft
Drainage area	= 37.410 ac	Curve number	= 73
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 30.50 min
Total precip.	= 7.69 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



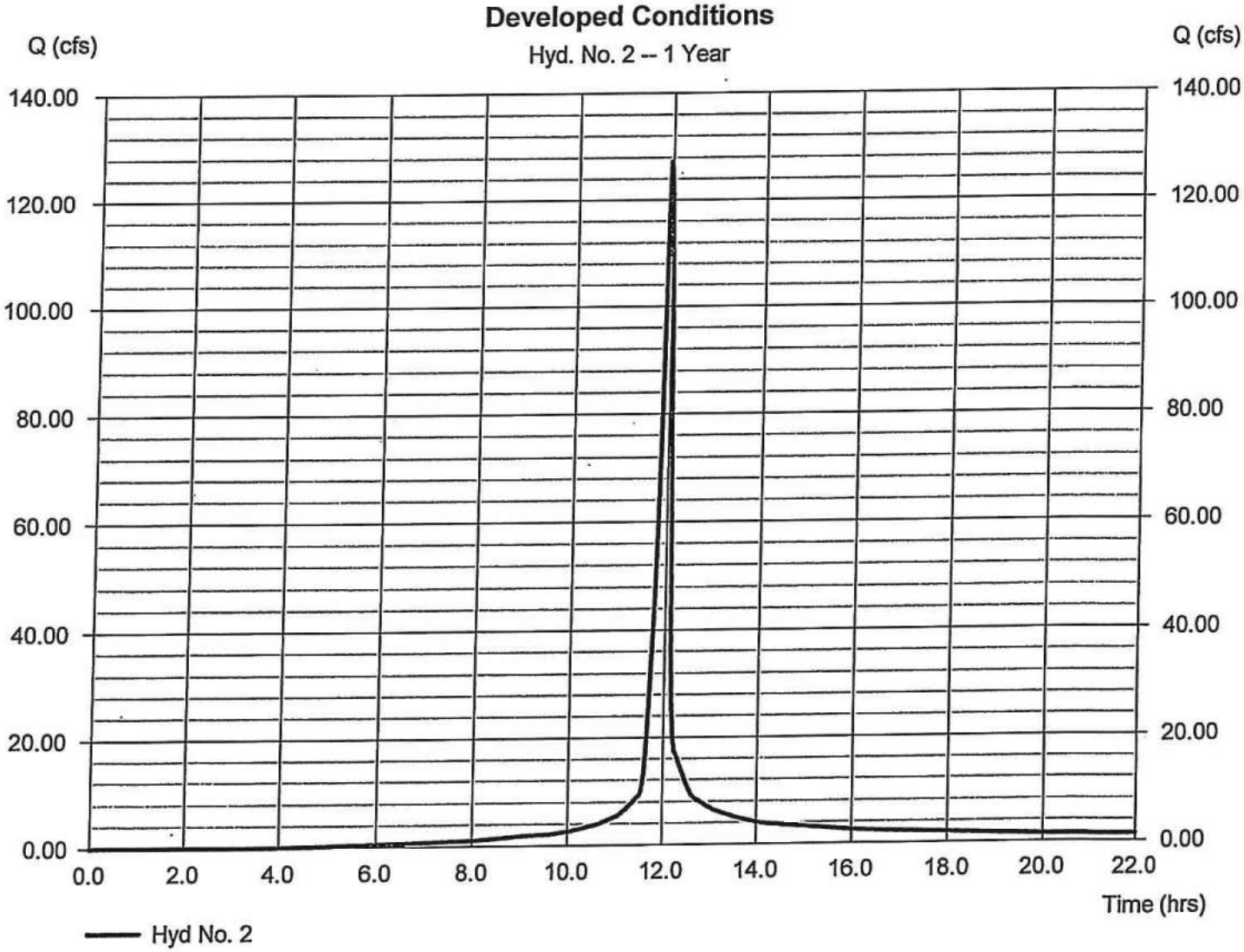
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 03 / 19 / 2015

Hyd. No. 2

Developed Conditions

Hydrograph type	= SCS Runoff	Peak discharge	= 127.15 cfs
Storm frequency	= 1 yrs	Time to peak	= 11.97 hrs
Time interval	= 2 min	Hyd. volume	= 306,021 cuft
Drainage area	= 37.410 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 8.80 min
Total precip.	= 2.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



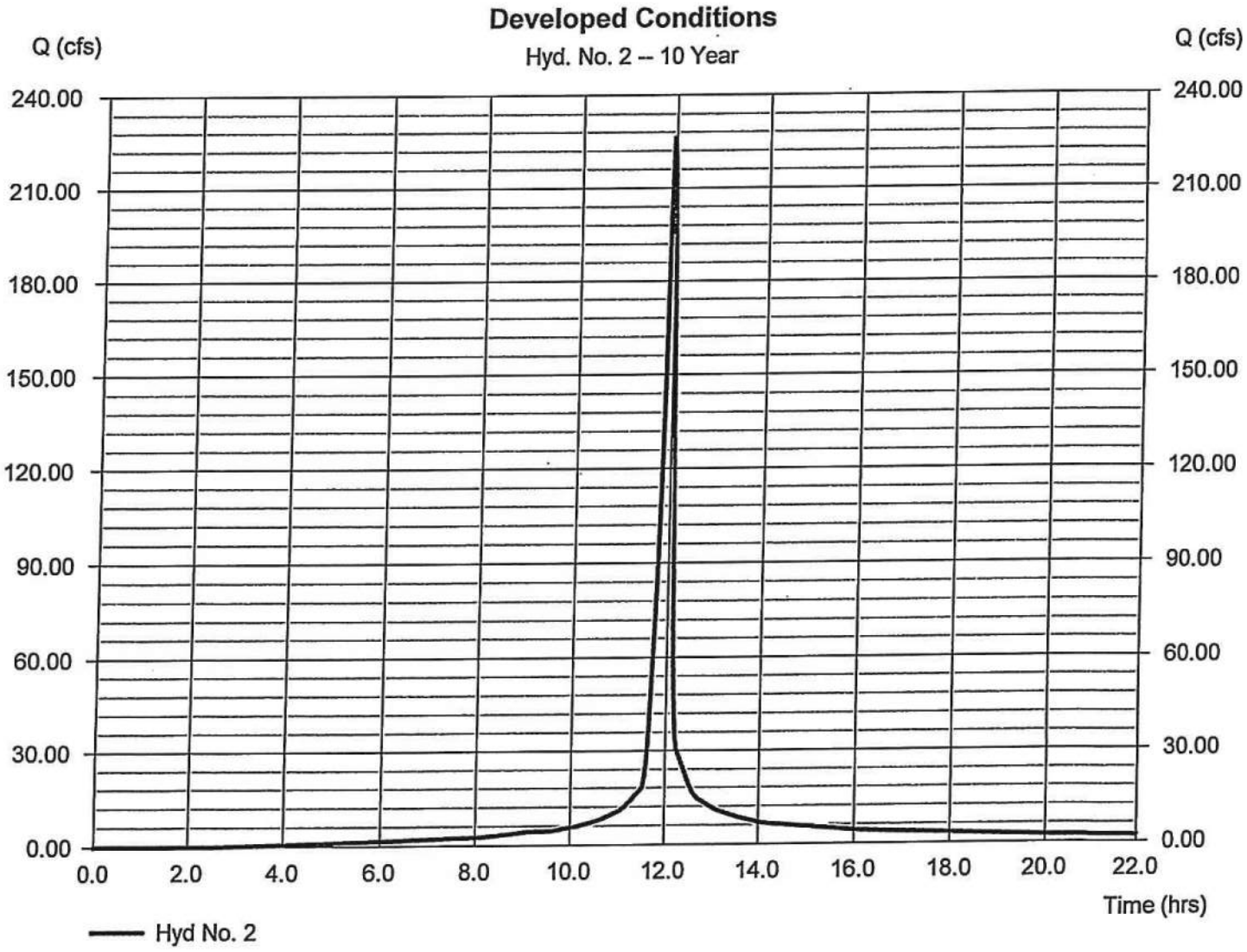
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 03 / 19 / 2015

Hyd. No. 2

Developed Conditions

Hydrograph type	= SCS Runoff	Peak discharge	= 226.12 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.97 hrs
Time interval	= 2 min	Hyd. volume	= 564,927 cuft
Drainage area	= 37.410 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 8.80 min
Total precip.	= 4.85 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



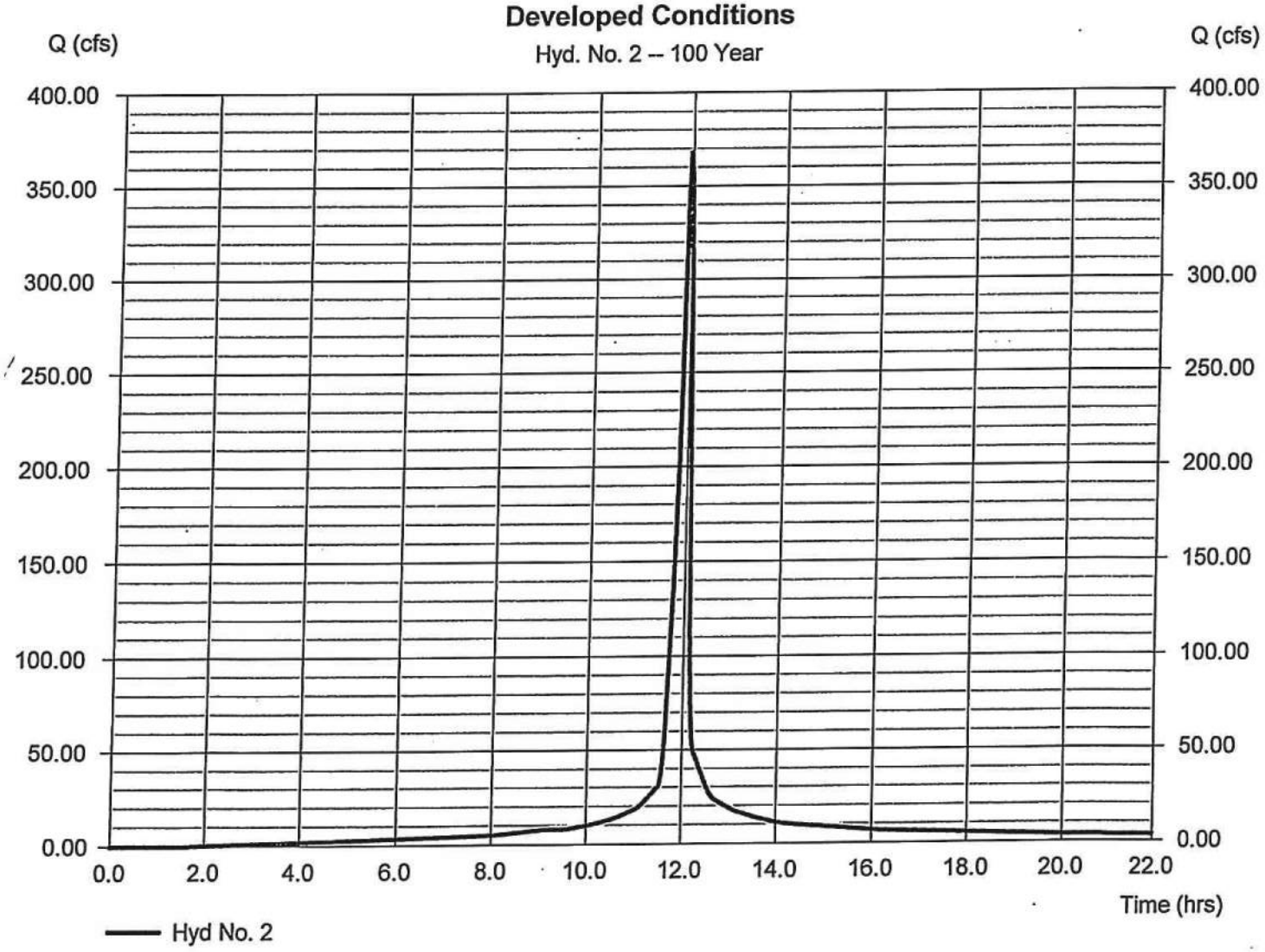
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 — Thursday, 03 / 19 / 2015

Hyd. No. 2

Developed Conditions

Hydrograph type	= SCS Runoff	Peak discharge	= 367.91 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.97 hrs
Time interval	= 2 min	Hyd. volume	= 947,020 cuft
Drainage area	= 37.410 ac	Curve number	= 94
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 8.80 min
Total precip.	= 7.69 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



STORMWATER REPORT

for

Townsend Capital, LLC

Summit Orchard
Lee's Summit, MO

April, 2016

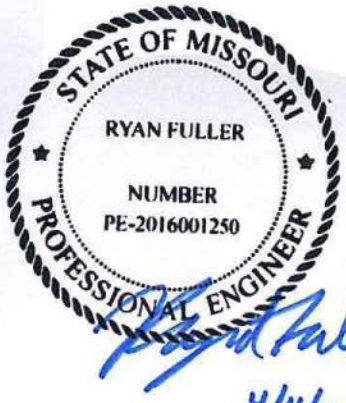
I hereby certify this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Missouri.

Date: 4/4/2016

Ryan Fuller, P.E.

License No. **PE-2016001250**

My renewal date is **December 31, 2016**



4/4/2016

PREPARED BY

THHinc McCLURE™
ENGINEERING Co.

Introduction

This report details the preliminary design of the storm sewer system supporting the Summit Orchard Preliminary Development Plan (PDP), a mixed-use development, at the Summit Technology Campus (STC) located in Lee's Summit, Missouri. See Figure 1 for a site location map

Project Description

The Summit Technology Campus is located southeast of the Interstate-470/State Highway 50 interchange. The entire development covers approximately 367 acres, and is bordered to the south by Chipman Road, to the north by I-470, to the west by Blue Parkway, and to the east by the Union Pacific Railroad. The Summit Technology Campus is split by Ward Road which was opened to traffic in October 2008.

Townsend Capital, LLC proposes improvements to the existing Summit Technology Campus, including the addition of a variety of mixed business commercial and residential uses to the lot northeast of the intersection of Ward Road and Chipman Road. In this report, the site for these improvements is referred to as Lot 7A. The current proposed building and lot layout for Summit Orchard can be found in the PDP.

Existing Drainage Overview

The majority of Lot 7A has been disturbed during borrow activities for the development of the Summit Innovation Center directly North of Lot 7A. A portion of Lot 7A sheet flows stormwater to the storm sewers installed along Ward Rd. This water flows south where it discharges into a ditch along the southern portion of Lot 7A. This water channel flows east to a natural drainage way west of the Union Pacific Railroad. This water flows to the regional detention basin constructed in 2008. Additional information on the regional detention basin can be found in the stormwater master plan prepared for the Summit Technology Campus in 2007.

The remainder of the site sheet flows stormwater east across the site to the natural drainage way west of the Union Pacific Railroad. Stormwater is then routed North to the regional detention basin.

A Stormwater Master Plan and model was prepared for the entire Summit Technology Campus development in 2007 and approved by the City. The Master Plan established a regional detention facility on Tract C at the northeast corner of the development. The improvements were constructed in 2008 and the facility has been in operation since that time.

Proposed Improvements

This project develops Lot 7A from an existing pasture to a mixed use commercial and residential development called Summit Orchard. The 2007 study assumed

this portion of the site would be developed with up to 71% impervious area. The proposed development limits the impervious area to 63%. Therefore, the proposed development is within the parameters of the original study and we do not propose a revision to the hydraulic study for the regional detention basin.

While onsite detention is not necessary based on the 2007 study, we are proposing a detention basin along the Eastern property line west of the Union Pacific Railroad. This will be a shallow basin with a large footprint to minimize the ponding depth. Multiple outlets and overflows will be provided to reduce runoff rates from Summit Orchards.

Within the site we will install storm sewers to convey stormwater west towards Ward Rd and East toward the existing drainage way west of the Union Pacific Railroad. The layout and drainage areas are depicted on the stormwater masterplan drawing. The peak flows generated by this site are:

Storm Return Period	Pre-Development Q (cfs)	Post Development Q (cfs) West to Ward Rd	Post Development Q (cfs) East to Drainage way along Railroad
1 Year	40.5	13.1	92.6
10 Year	115.1	27.7	197.7
100 Year	198.2	42.5	305.5

Hydrographs for the storms listed above were generated using Hydraflow Hydrograph Extension to AutoCAD Civil 3D 2015 and are included in the appendix at the end of this report.

Results of Analysis

The preliminary layout of the system and system sizing is depicted on the Stormwater masterplan drawing included in the PDP.

Appendix

Hydraflow Hydrographs Extension for AutoCAD Civil 3D 2015 Report

Hydraflow Table of Contents

1 - Year

10 - Year

100 - Year

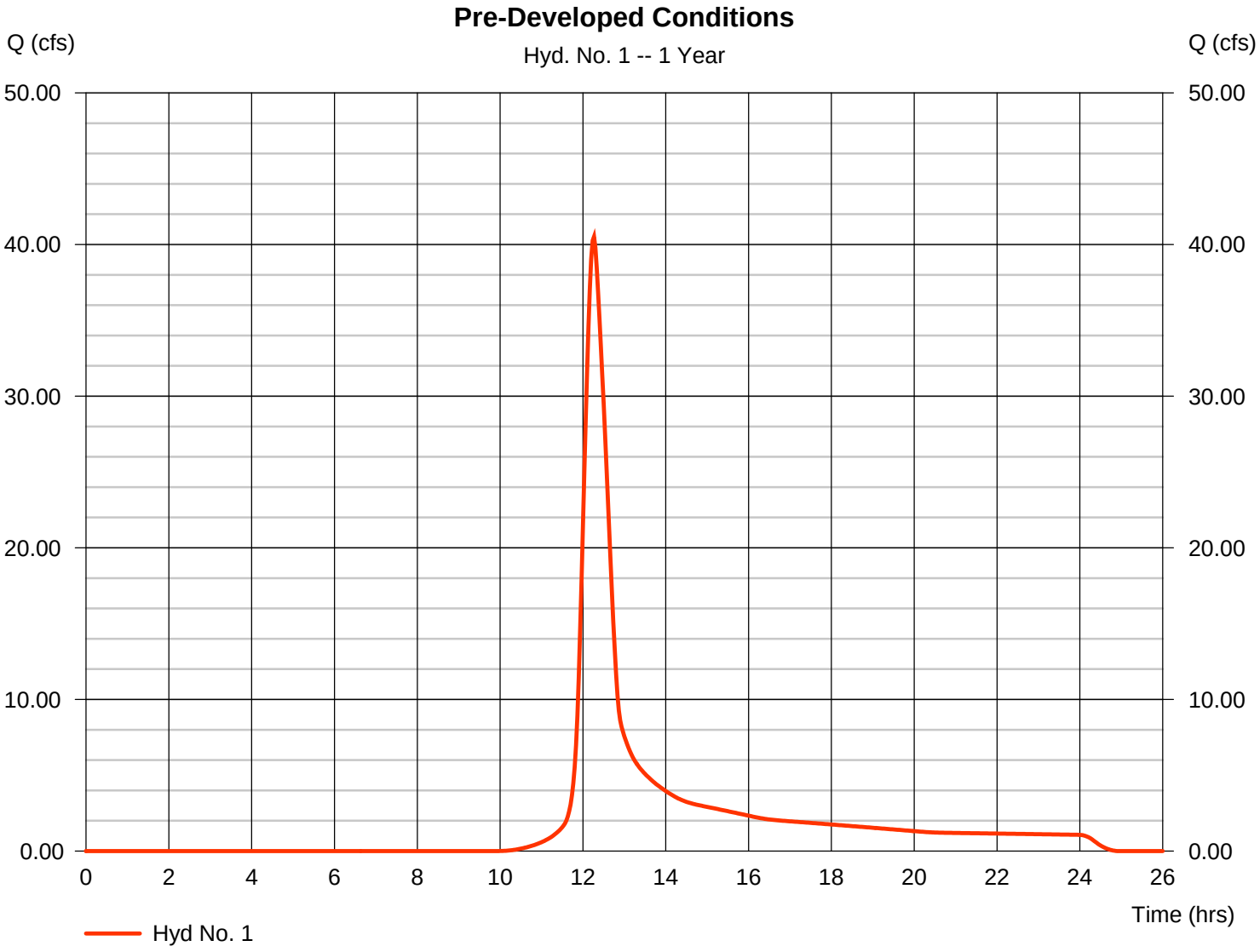
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Monday, 03 / 14 / 2016

Hyd. No. 1

Pre-Developed Conditions

Hydrograph type	=	SCS Runoff	Peak discharge	=	40.51 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.27 hrs
Time interval	=	2 min	Hyd. volume	=	188,909 cuft
Drainage area	=	44.780 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	34.10 min
Total precip.	=	2.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



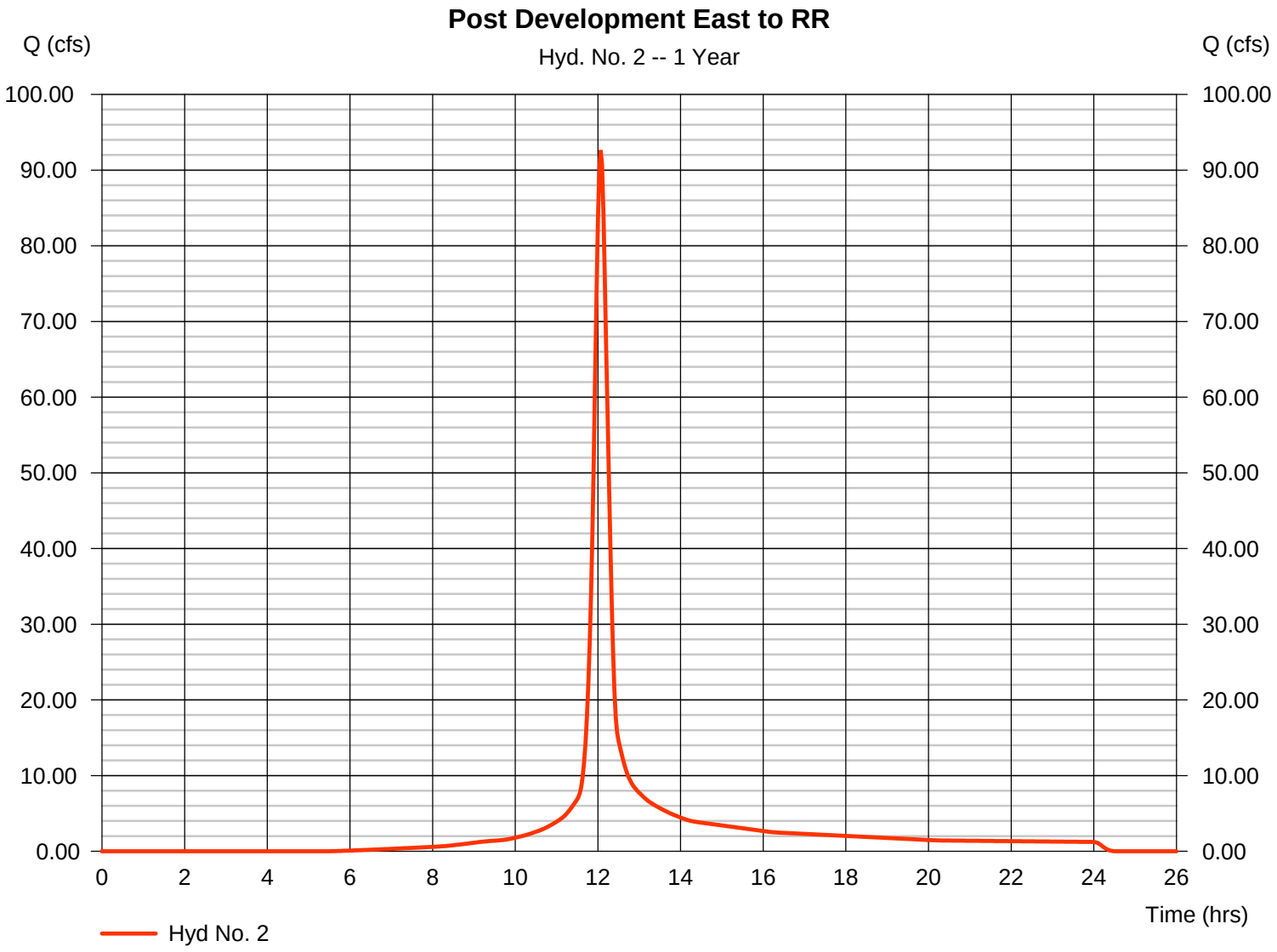
Hydrograph Report

Hyd. No. 2

Post Development East to RR

Hydrograph type	=	SCS Runoff	Peak discharge	=	92.62 cfs
Storm frequency	=	1 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	292,474 cuft
Drainage area	=	40.730 ac	Curve number	=	91*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	19.60 min
Total precip.	=	2.90 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(25.660 x 98) + (15.070 x 80)] / 40.730



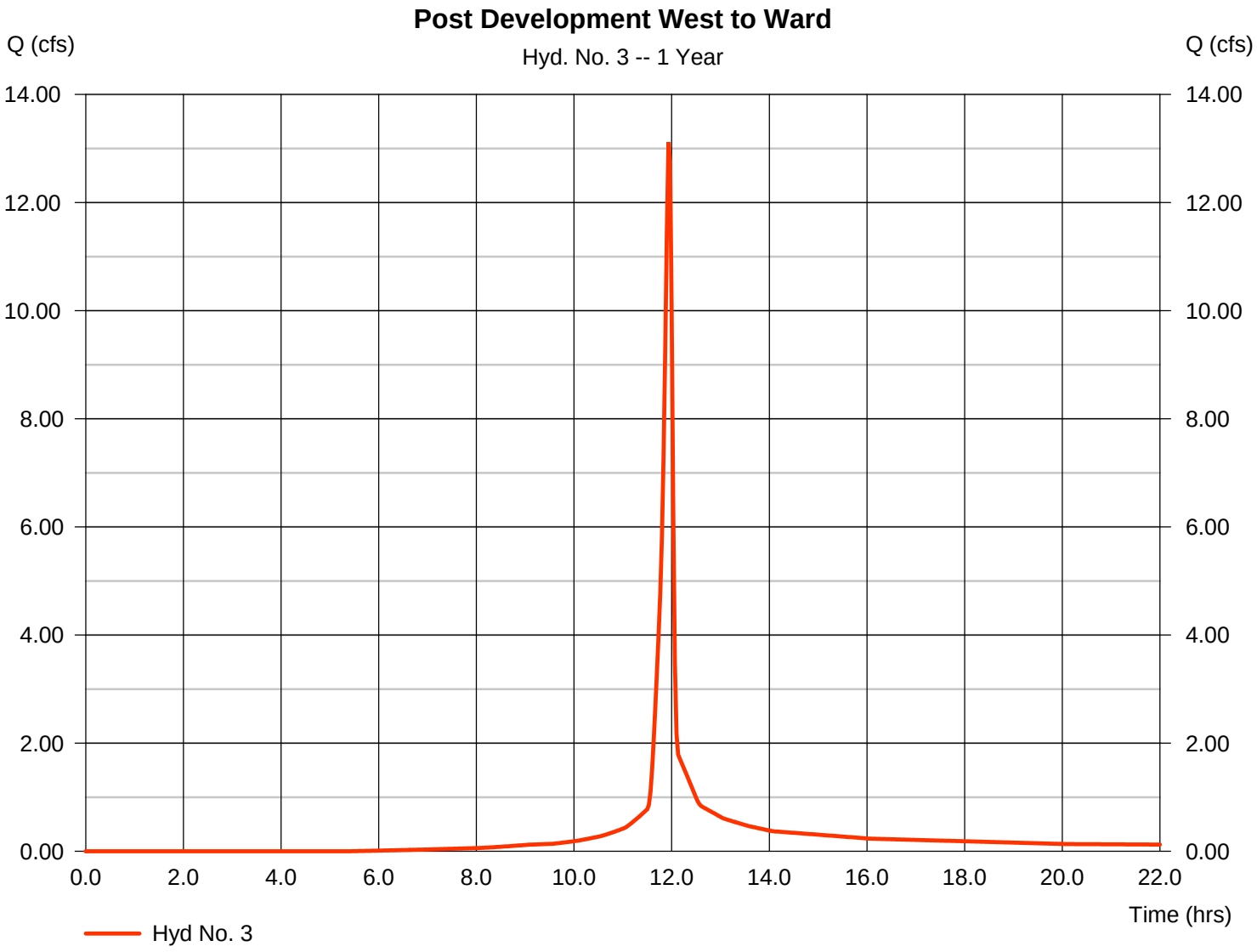
Hydrograph Report

Hyd. No. 3

Post Development West to Ward

Hydrograph type	= SCS Runoff	Peak discharge	= 13.12 cfs
Storm frequency	= 1 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 27,265 cuft
Drainage area	= 4.050 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 2.90 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.550 x 98) + (1.500 x 80)] / 4.050

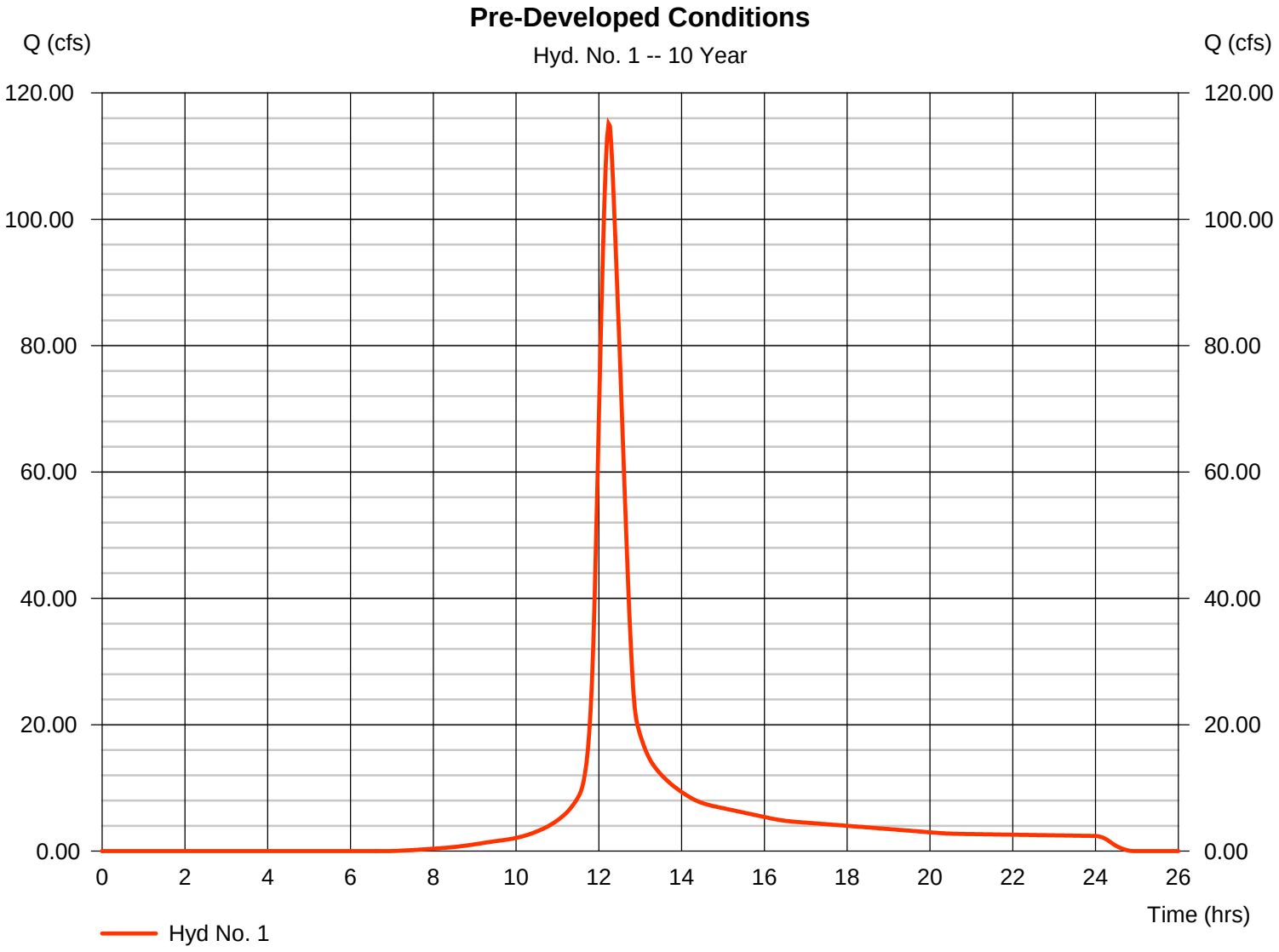


Hydrograph Report

Hyd. No. 1

Pre-Developed Conditions

Hydrograph type	=	SCS Runoff	Peak discharge	=	115.13 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.23 hrs
Time interval	=	2 min	Hyd. volume	=	521,420 cuft
Drainage area	=	44.780 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	34.10 min
Total precip.	=	5.40 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



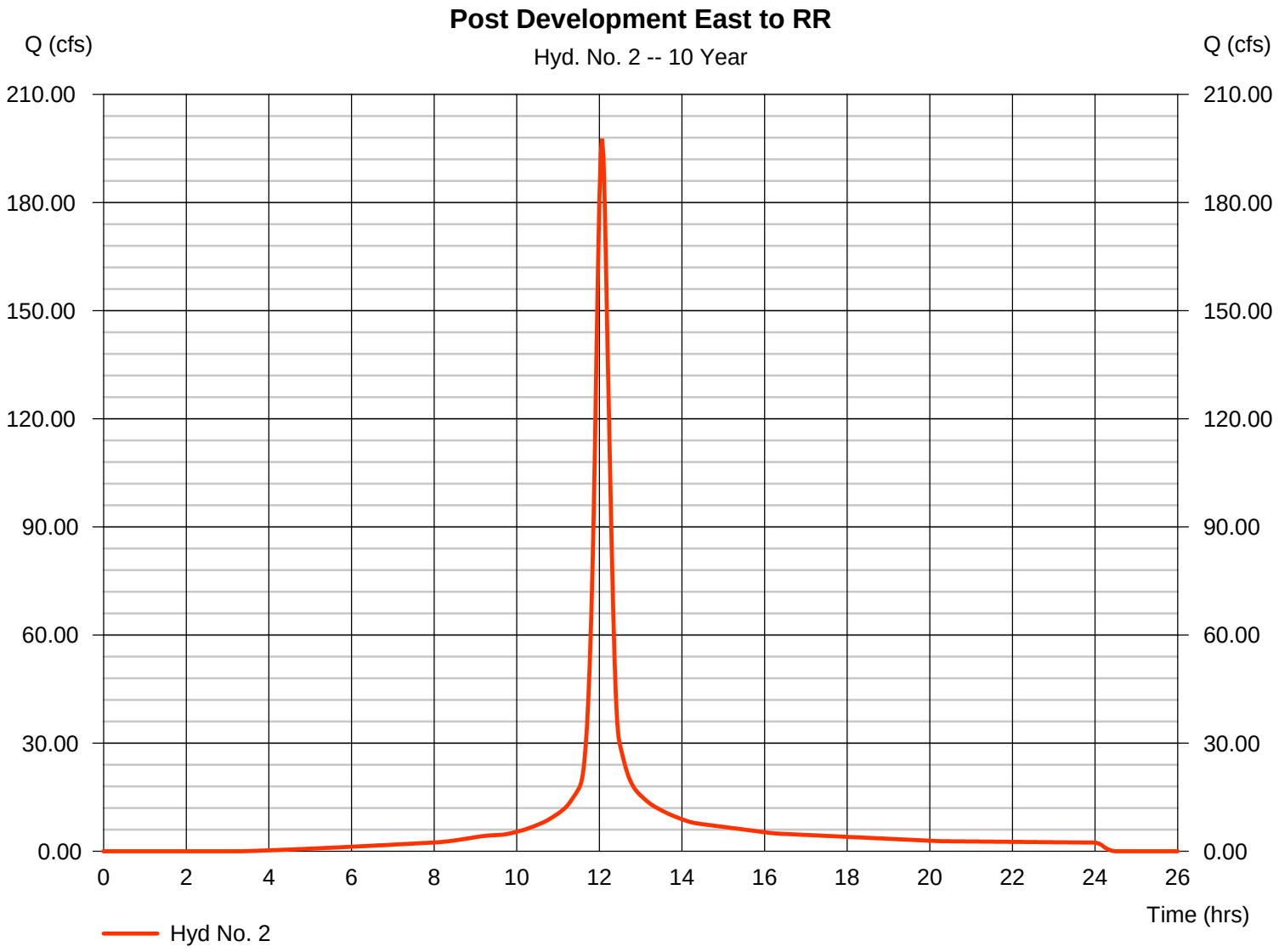
Hydrograph Report

Hyd. No. 2

Post Development East to RR

Hydrograph type	=	SCS Runoff	Peak discharge	=	197.74 cfs
Storm frequency	=	10 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	646,278 cuft
Drainage area	=	40.730 ac	Curve number	=	91*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	19.60 min
Total precip.	=	5.40 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(25.660 x 98) + (15.070 x 80)] / 40.730



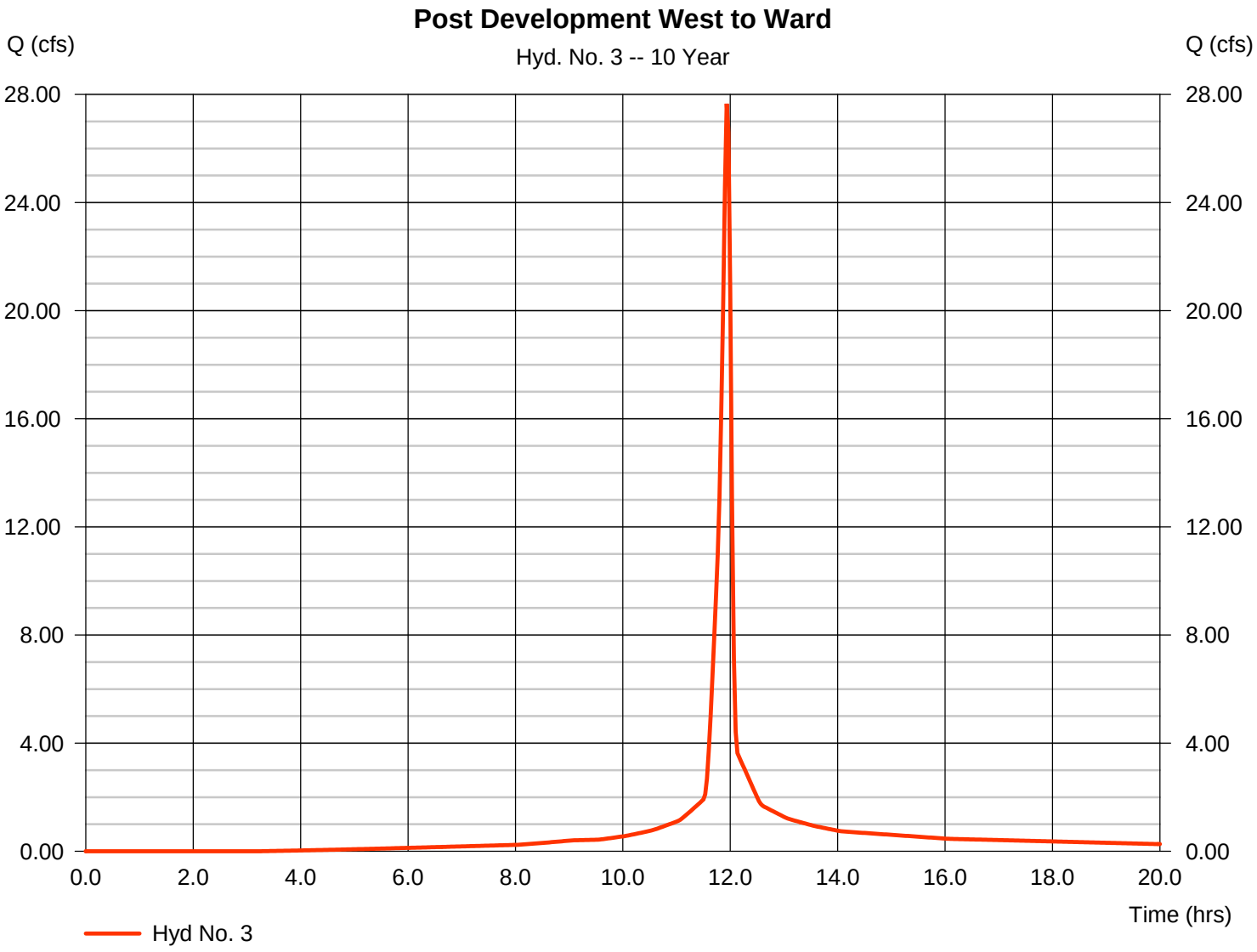
Hydrograph Report

Hyd. No. 3

Post Development West to Ward

Hydrograph type	= SCS Runoff	Peak discharge	= 27.66 cfs
Storm frequency	= 10 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 60,246 cuft
Drainage area	= 4.050 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 5.40 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.550 x 98) + (1.500 x 80)] / 4.050

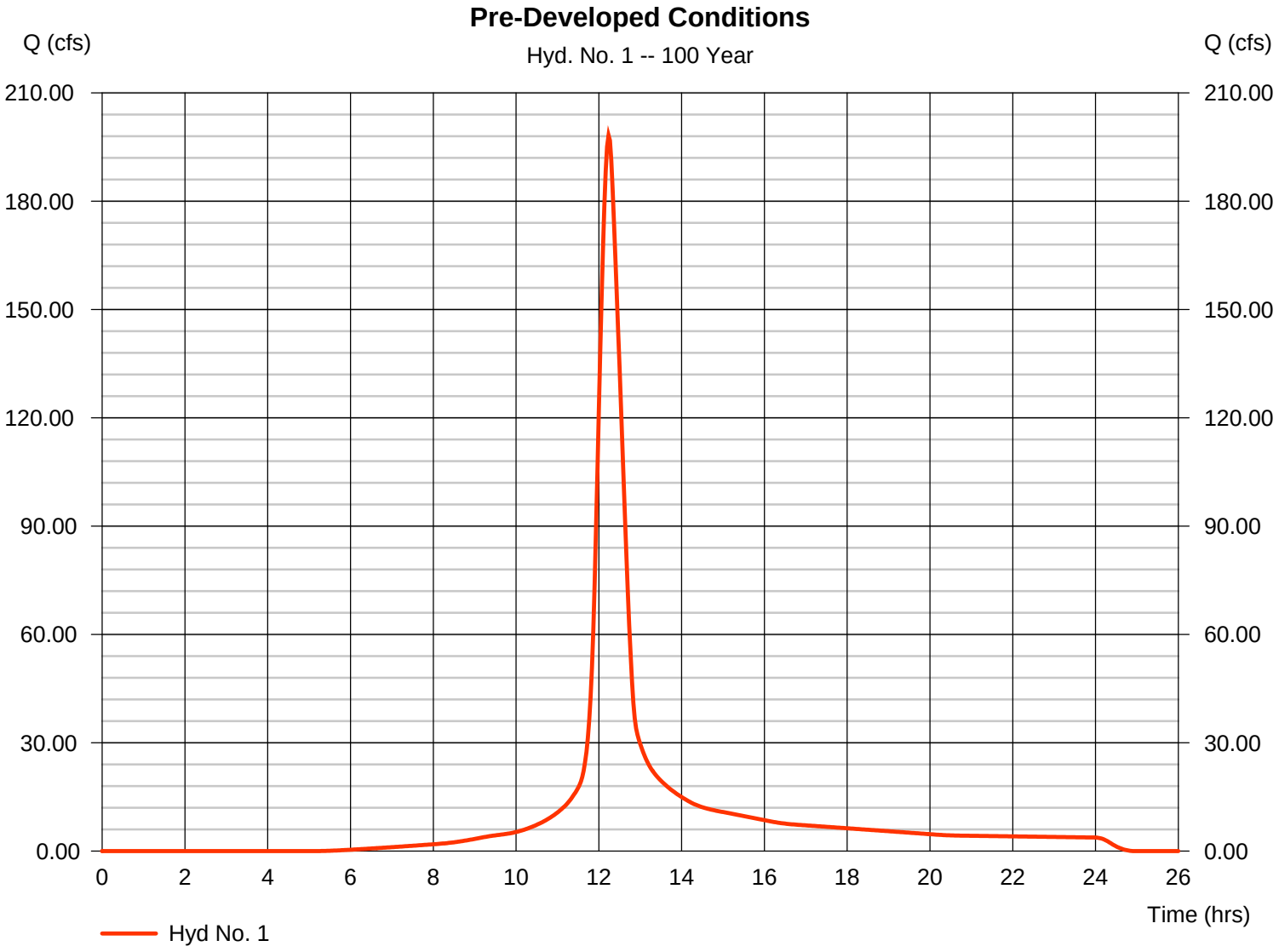


Hydrograph Report

Hyd. No. 1

Pre-Developed Conditions

Hydrograph type	=	SCS Runoff	Peak discharge	=	198.22 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.23 hrs
Time interval	=	2 min	Hyd. volume	=	903,962 cuft
Drainage area	=	44.780 ac	Curve number	=	80
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	34.10 min
Total precip.	=	8.00 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



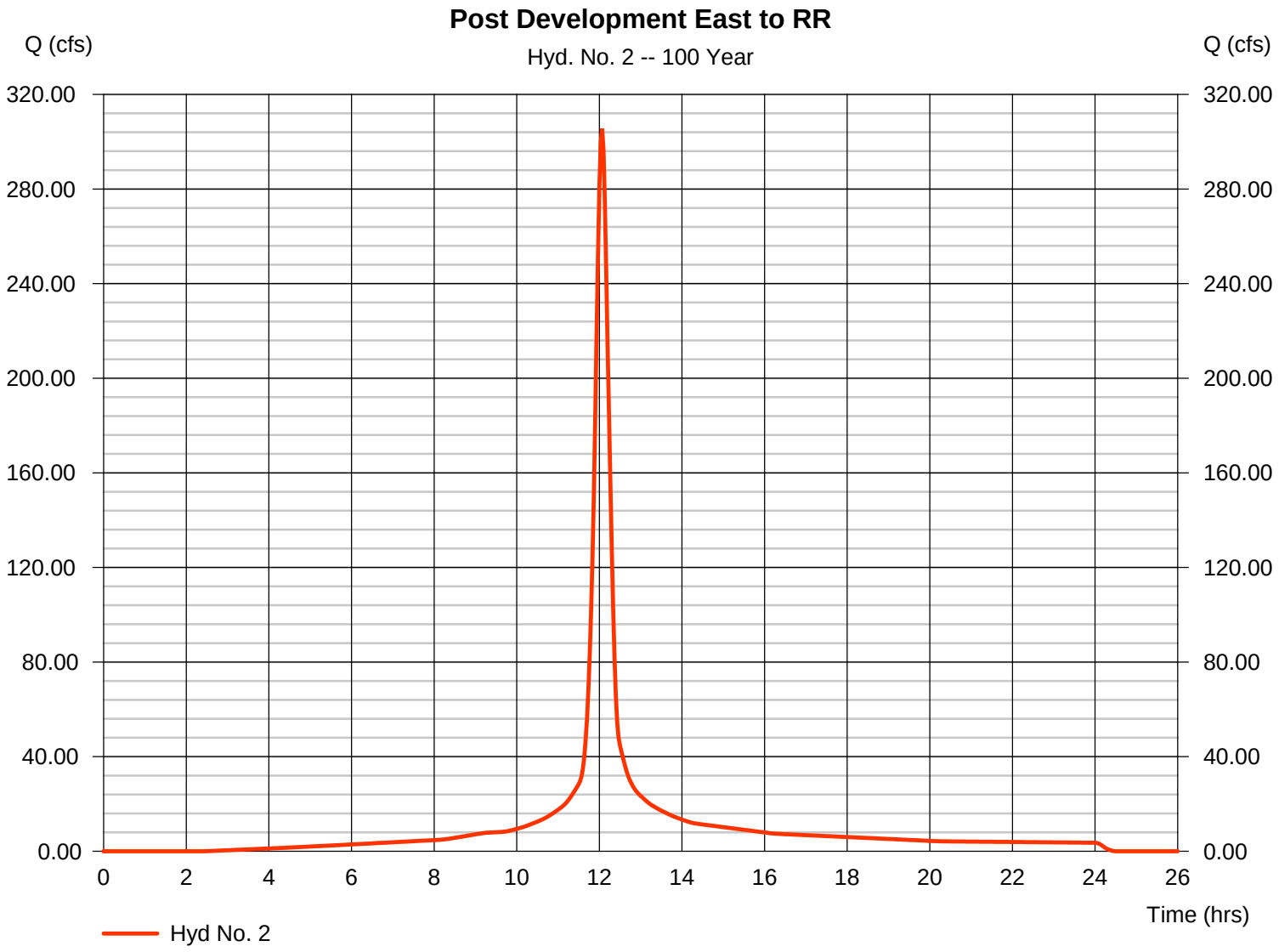
Hydrograph Report

Hyd. No. 2

Post Development East to RR

Hydrograph type	=	SCS Runoff	Peak discharge	=	305.49 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.07 hrs
Time interval	=	2 min	Hyd. volume	=	1,023,779 cuft
Drainage area	=	40.730 ac	Curve number	=	91*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	19.60 min
Total precip.	=	8.00 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(25.660 x 98) + (15.070 x 80)] / 40.730



Hydrograph Report

Hyd. No. 3

Post Development West to Ward

Hydrograph type	= SCS Runoff	Peak discharge	= 42.53 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.93 hrs
Time interval	= 2 min	Hyd. volume	= 95,437 cuft
Drainage area	= 4.050 ac	Curve number	= 91*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.00 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(2.550 x 98) + (1.500 x 80)] / 4.050