STORMWATER REPORT

Detail Center
Town Center Drive & Independence Avenue
Lee's Summit, Missouri 64064

Prepared For:

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

Prepared by:

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Project No. 19076

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GENERAL INFORMATION

The proposed commercial development for Lee's Summit Town Center, LLC is located northwest of the intersection of Town Center Drive and Independence Avenue. The total area for the development is this property is approximately 4.02 acres.

The current site soil condition for this property is classified as "Greenton-Urban, 5 to 9 percent Slopes", with a Map Unit Symbol of '2qky4'. The hydrological soil group for this site is Class D. The site lies entirely within 'Zone X', areas determined to be outside the 0.2% annual chance floodplain as depicted on the FEMA Flood Insurance Rate Map (FIRM) no. 29095C0430G, Revision Date: January 20, 2017.

Figure 1 – Location Map (no scale)

METHODOLOGY

KCAPWA IDF curves were used to determine the rainfall intensity for 1, 10, and 100-year storm events. Hydraflow Hydrographs Extension for AutoCAD 2020 was used to determine runoff flow amounts for existing and proposed site conditions. Hydraflow computes the rational method runoff hydrographs by convoluting a rainfall hyetograph through a unit hydrograph. Convolution is known as linear superpositioning where each ordinate of the rainfall hyetograph is multiplied by each ordinate of the unit hydrograph, thus creating a series of hydrographs. These hydrographs are then summed to form the final runoff hydrograph.

EXISTING CONDITIONS

The existing project site location is 4.02 acres, with the entirety of the property being impervious area. Runoff from this site flows from the northwest of the property to east. For analysis the majority of the undeveloped area, encompassed by NE Town Center Boulevard was taken into consideration for runoff volume contribution. The resulting area is approximately 23.14 acres of impervious area. There is an existing storm inlet at the east end of the property along Independence Avenue, allowing collected runoff to be conveyed east toward an existing dedicated drainage area. Refer to Sheet C3.1 “Existing Drainage Map” in Appendix A for the existing drainage patterns for the property.

Table 1 below shows the peak discharges for the 1, 10, and 100-year rainfall events. Refer to Appendix B for Complete Hydraflows Report and results for the existing site conditions.

Table 1 – Existing Site Runoff Hydraflow Results

Storm Event	Pre-developed site (cfs)
1-Yr	20.27
10-Yr	35.98
100-Yr	54.20

PROPOSED CONDITIONS

The existing property will undergo development for a proposed commercial area for Lee's Summit Town Center LLC. The proposed development will increase the impervious area from 0.00 acres to 2.85 acres, with the remaining 20.29 acres as open grass area. Refer to sheet C3.2 "Proposed Drainage Map" in Appendix A for the proposed drainage patterns for the property. The runoff will be collected and conveyed to a detention pond where the existing storm inlet, at the eastern edge of the property, will further convey the runoff towards the existing dedicated drainage area.

Table 2 shows the increase in peak discharge rates for the 1, 10, and 100-year storms rainfall events, due to the increase in impervious area.

Table 2 – Proposed Site Runoff Hydraflow Results without Detention	
Storm Event	Pre-developed site (cfs)
1-Yr	24.32
10-Yr	43.17
100-Yr	65.04

In order to mitigate the increase in discharge rates from the site due to the increase in impervious area created by the proposed development, two separate storm networks are proposed to direct runoff to the existing drainage area via the existing storm inlet at the east edge of the property.

Table 3 shows the resulting discharge rates for the 1, 10, and 100-year rainfall events with the proposed storm networks and detention pond.

Table 3 – Proposed Site Runoff Hydraflow Results with Detention	
Storm Event	Post-developed site (cfs)
1-Yr	0.43
10-Yr	9.53
100-Yr	23.76

Hydraflow Hydrographs Extension for AutoCAD civil 3D was used to model the post developed site with the proposed storm system. A complete hydrograph can be found in Appendix C.

SUMMARY

The proposed commercial development for Lee's Summit Town Center, LLC is located northwest of the intersection of Town Center Drive and Independence Avenue increases the amount of impervious area within the property. To account for the increase in runoff, storm networks and a detention basin have been designed to maintain the discharge rates below existing conditions flow rates.

Table 4 below provides the discharge rates for the existing and post developed conditions for the 1, 10, and 100-year rainfall events for this site.

Table 4 – Total Runoff Volume Comparison

Storm Event (yr)	Pre-development Discharge (cfs)	Post-development Discharge (cfs)	Difference (cfs)
1	20.27	0.43	19.84
10	35.98	9.53	26.45
100	54.20	23.76	30.44

Appendix A

Supporting Data

Map Scale: 1:961 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 10 20 40 60

Feet
0 45 90 180 270

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

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

Special Point Features

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 20, Sep 16, 2019

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

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

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10024	Greenton-Urban land complex, 5 to 9 percent slopes	4.0	98.8%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	0.0	1.2%
Totals for Area of Interest		**4.0**	**100.0%**

Appendix B

Existing Conditions Hydraflow Hydrograph Output Data

Watershed Model Schematic

Legend

Hyd.	Origin	Description
1	Rational	Existing Conditions

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)							Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	Rational	------	20.27	25.77	-------	-------	35.98	-------	46.49	54.20	Existing Conditions

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	20.27	1	15	18,244	------	------	------	Existing Conditions

Hydrograph Report

Hyd. No. 1

Existing Conditions

Hydrograph type	= Rational	Peak discharge	= 20.27 cfs
Storm frequency	= 1 yrs	Time to peak	= 15 min
Time interval	= 1 min	Hyd. volume	= 18,244 cuft
Drainage area	= 23.140 ac	Runoff coeff.	= 0.3
Intensity	= 2.920 in/hr	Tc by User	= 15.00 min
IDF Curve	= KCAPWA.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	25.77	1	15	23,191	------	------	------	Existing Conditions

Hydrograph Report

Hyd. No. 1

Existing Conditions

Hydrograph type	= Rational	Peak discharge	= 25.77 cfs
Storm frequency	= 2 yrs	Time to peak	= 15 min
Time interval	= 1 min	Hyd. volume	= 23,191 cuft
Drainage area	= 23.140 ac	Runoff coeff.	= 0.3
Intensity	= 3.712 in/hr	Tc by User	= 15.00 min
IDF Curve	= KCAPWA.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	35.98	1	15	32,380	------	------	------	Existing Conditions

Hydrograph Report

Hyd. No. 1

Existing Conditions

Hydrograph type	=	Rational	Peak discharge	=	35.98 cfs
Storm frequency	=	10 yrs	Time to peak	=	15 min
Time interval	=	1 min	Hyd. volume	=	32,380 cuft
Drainage area	=	23.140 ac	Runoff coeff.	=	0.3
Intensity	=	5.183 in/hr	Tc by User	=	15.00 min
IDF Curve	=	KCAPWA.IDF	Asc/Rec limb fact	=	1/1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	54.20	1	15	48,777	------	------	------	Existing Conditions

Hydrograph Report

Hyd. No. 1

Existing Conditions

Hydrograph type	= Rational	Peak discharge	= 54.20 cfs
Storm frequency	= 100 yrs	Time to peak	= 15 min
Time interval	= 1 min	Hyd. volume	= 48,777 cuft
Drainage area	= 23.140 ac	Runoff coeff.	= 0.3
Intensity	= 7.807 in/hr	Tc by User	= 15.00 min
IDF Curve	= KCAPWA.IDF	Asc/Rec limb fact	= 1/1

Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	2.9200	0.1000	0.0000	--------
2	110.7137	16.5000	0.9842	--------
3	0.0000	0.0000	0.0000	--------
5	168.3971	19.5000	1.0189	--------
10	183.3473	19.2000	1.0096	--------
25	103.5313	15.9000	0.8218	--------
50	235.4014	19.9000	1.0020	--------
100	83.7894	6.1000	0.7783	--------

File name: KCAPWA.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92
2	5.41	4.40	3.71	3.21	2.83	2.53	2.29	2.09	1.92	1.78	1.66	1.55
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.47	5.35	4.56	3.98	3.52	3.16	2.86	2.62	2.41	2.24	2.08	1.95
10	7.35	6.08	5.18	4.52	4.00	3.59	3.26	2.98	2.74	2.54	2.37	2.22
25	8.51	7.14	6.17	5.46	4.90	4.46	4.10	3.79	3.54	3.31	3.12	2.95
50	9.39	7.82	6.70	5.86	5.20	4.68	4.25	3.90	3.60	3.34	3.12	2.92
100	12.87	9.64	7.81	6.62	5.77	5.14	4.65	4.25	3.92	3.65	3.41	3.21

Tc = time in minutes. Values may exceed 60.

Precip. file name: P:\DAE Civil\Hydraflow Storm Sewer\SCS Custom Water Quality.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.37	3.50	0.00	4.50	5.30	6.10	6.90	7.50
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	2.90	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

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Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Thursday, 02 / 20 / 2020

Appendix C

Proposed Conditions Hydraflow Output Data

Watershed Model Schematic

Legend

Hyd.	Origin	Description
1	Rational	Developed Conditions
2	Reservoir	Developed Flow

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	Rational	------	24.32	30.92	-------	-------	43.17	-------	55.78	65.04	Developed Conditions
2	Reservoir	1	0.429	2.303	-------	-------	9.530	-------	17.98	23.76	Developed Flow

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	24.32	1	15	21,892	------	------	------	Developed Conditions
2	Reservoir	0.429	1	30	21,613	1	982.39	21,463	Developed Flow

Hydrograph Report

Hyd. No. 1

Developed Conditions

Hydrograph type	= Rational	Peak discharge	= 24.32 cfs
Storm frequency	= 1 yrs	Time to peak	= 15 min
Time interval	= 1 min	Hyd. volume	= 21,892 cuft
Drainage area	= 23.140 ac	Runoff coeff.	= 0.36
Intensity	= 2.920 in/hr	Tc by User	= 15.00 min
IDF Curve	= KCAPWA.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	43.17	1	15	38,856	------	------	------	Developed Conditions
2	Reservoir	9.530	1	27	38,532	1	983.64	34,119	Developed Flow

Hydrograph Report

Hyd. No. 1

Developed Conditions

Hydrograph type	= Rational	Peak discharge	= 43.17 cfs
Storm frequency	= 10 yrs	Time to peak	= 15 min
Time interval	= 1 min	Hyd. volume	= 38,856 cuft
Drainage area	= 23.140 ac	Runoff coeff.	= 0.36
Intensity	= 5.183 in/hr	Tc by User	= 15.00 min
IDF Curve	= KCAPWA.IDF	Asc/Rec limb fact	= 1/1

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

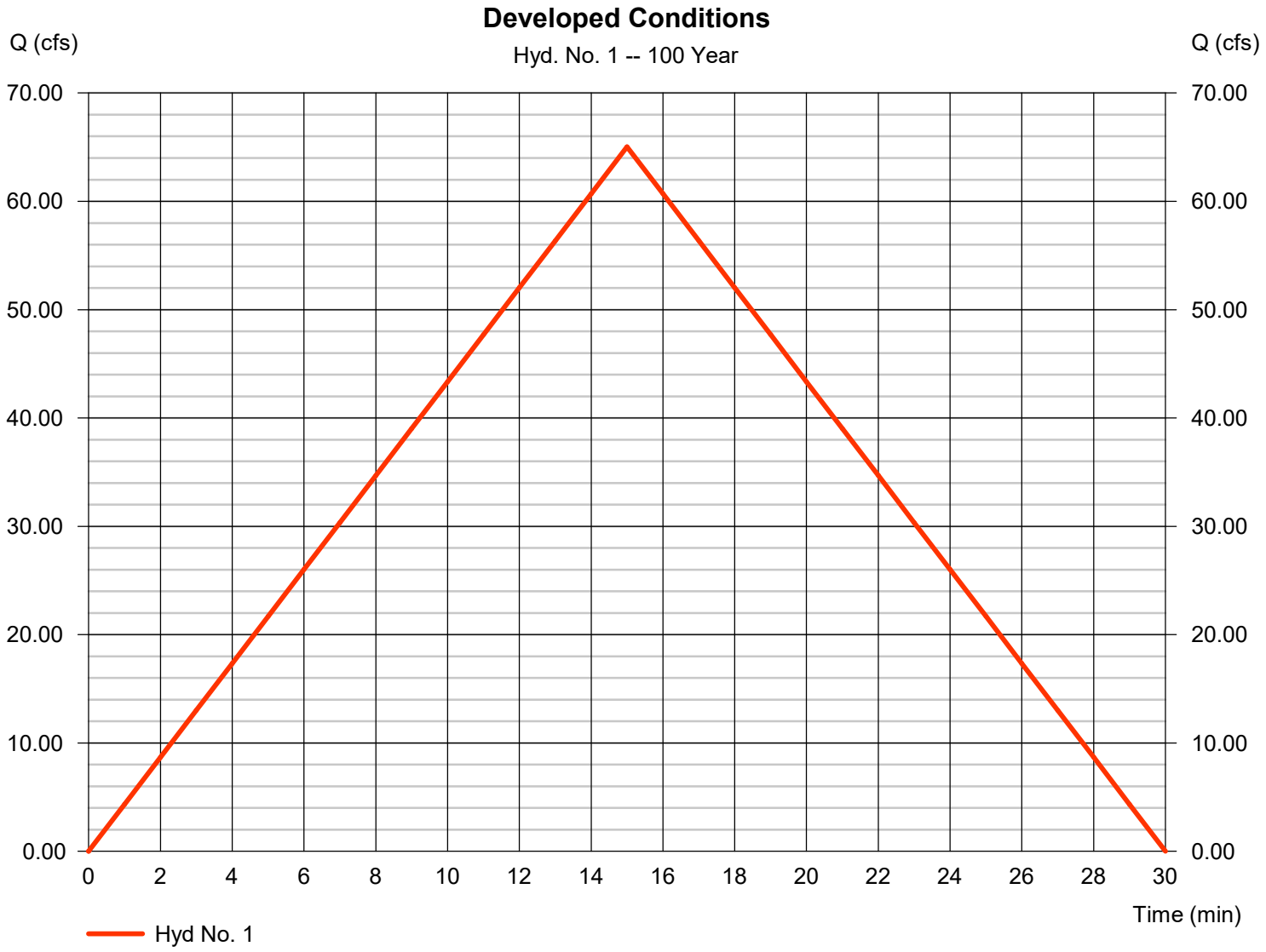
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	65.04	1	15	58,532	------	------	------	Developed Conditions
2	Reservoir	23.76	1	25	58,204	1	984.45	44,434	Developed Flow

Hydrograph Report

Hyd. No. 1

Developed Conditions

Hydrograph type	= Rational	Peak discharge	= 65.04 cfs
Storm frequency	= 100 yrs	Time to peak	= 15 min
Time interval	= 1 min	Hyd. volume	= 58,532 cuft
Drainage area	= 23.140 ac	Runoff coeff.	= 0.36
Intensity	= 7.807 in/hr	Tc by User	= 15.00 min
IDF Curve	= KCAPWA.IDF	Asc/Rec limb fact	= 1/1



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	2.9200	0.1000	0.0000	--------
2	110.7137	16.5000	0.9842	--------
3	0.0000	0.0000	0.0000	--------
5	168.3971	19.5000	1.0189	--------
10	183.3473	19.2000	1.0096	--------
25	103.5313	15.9000	0.8218	--------
50	235.4014	19.9000	1.0020	--------
100	83.7894	6.1000	0.7783	--------

File name: KCAPWA.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92
2	5.41	4.40	3.71	3.21	2.83	2.53	2.29	2.09	1.92	1.78	1.66	1.55
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.47	5.35	4.56	3.98	3.52	3.16	2.86	2.62	2.41	2.24	2.08	1.95
10	7.35	6.08	5.18	4.52	4.00	3.59	3.26	2.98	2.74	2.54	2.37	2.22
25	8.51	7.14	6.17	5.46	4.90	4.46	4.10	3.79	3.54	3.31	3.12	2.95
50	9.39	7.82	6.70	5.86	5.20	4.68	4.25	3.90	3.60	3.34	3.12	2.92
100	12.87	9.64	7.81	6.62	5.77	5.14	4.65	4.25	3.92	3.65	3.41	3.21

Tc = time in minutes. Values may exceed 60.

Precip. file name: P:\DAE Civil\Hydraflow Storm Sewer\SCS Custom Water Quality.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	1.37	3.50	0.00	4.50	5.30	6.10	6.90	7.50
SCS 6-Hr	0.00	1.80	0.00	0.00	2.60	2.90	0.00	4.00
Huff-1st	0.00	1.55	0.00	2.75	4.00	5.38	6.50	8.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	1.75	0.00	2.80	3.90	5.25	6.00	7.10

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