STORMWATER MANAGEMENT REPORT

FOR

Saint Luke's East Hospital – ASC Expansion & Renovation

Project Location:
100 NE Saint Luke's Blvd
Lee's Summit, MO 64086

BHC RHODES PROJECT #033570

November 1, 2022

CIVIL ENGINEERING / SURVEYING / UTILITIES

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APPENDICES

1.0 INTRODUCTION

This stormwater management study is in support of an expansion project at Saint Luke's East Hospital. The purpose of this study is to show compliance with the original stormwater study for this site.

2.0 SITE CONDITIONS

The area of the subject site is 40.3 acres. The existing site is a hospital that was built about 20 years ago. A detention basin at the northeast corner of the site was built then to detain stormwater. Since then, an out lot has been developed on the campus, which is now a BOK Financial building. The BOK Financial site is 1.0 acre and has its own above ground detention basin on the Saint Luke's East property. For the analysis in this report, the BOK Financial site is included in the area for the Saint Luke's stormwater design, so the on-site analysis is 41.3 acres.

The entire site consists of two primary drainage areas. The further east drainage area flows to the on-site Saint Luke's detention basin. The further west drainage area bypasses the detention basin. Also, there are two small off-site drainage areas that drain through the site to the detention basin. All stormwater from the site discharges to a right-of-way ditch for the Interstate 470 highway.

There are two different areas of proposed improvements – a building expansion on the north wing of the hospital and a parking expansion at the far north end of the site. The building expansion is to support the surgery center for the hospital. The building expansion is proposed in an existing parking lot area, so the parking lot will need re-configured around the building expansion. The existing detention basin for the BOK Financial site will be filled over with the proposed improvements for the parking expansion. Also, a portion of the existing detention basin is proposed to be filled in to support the parking lot expansion. The entire detention basin is proposed to be regraded to make up for lost volume.

The building expansion area entirely drains to the detention basin in existing and proposed conditions. Most of the stormwater from the proposed parking expansion area bypasses the detention basin in the existing condition. The parking expansion improvements will mostly redirect this stormwater runoff to the detention basin. The BOK Financial site will be directed to the Saint Luke's detention basin. The **Proposed Drainage Map** may be seen in **Appendix A1**.

3.0 STORMWATER MANAGEMENT

3.1 MUNICIPAL REQUIREMENTS

The detention basin for the site was designed in 2003. The required release rate for the site then was the existing 25-year, 24-hour storm event release rate. The 25-year release rate determined in that initial design was 239 cfs, which is the controlling release rate for the site. Storm data for the 100-year, 24-hour storm event was included in the original report. Also, calculations for the 2-year and 10-year 24-hour storm events have been included in stormwater report updates as expansions have taken place across the Saint Luke's site. For this report, the 25-year, 24-hour storm event is shown as the controlling storm event. Calculations are also shown for the 2-year, 10-year, and 100-year storm events.

3.2 PROPOSED DESIGN

The boundaries and the breakdown of the curve numbers used in the original report are unknown. As a part of this report, new drainage areas have been figured. A curve number for the site of 94 has been assumed for design. The actual curve numbers of the proposed drainage areas are less than 94.

The precipitation depths used for the 25-year and 100-year storm events are the same depths used in the original report. The precipitation depths for the 2-year and 10-year storm events are from current data from NOAA Atlas 14. A summary of the 2-year, 10-year, 25-year, and 100-year 24-hour storm events is shown in **Table 1**.

		Pre-developed	Proposed					
Design Storm	Precipitation Depth (in)	Total Q (cfs)	Pond In (cfs)	Pond Out (cfs)	Undetained Q (cfs)	Total Q (cfs)	Storage (ac-ft)	MWSE (ft)
2-year	3.71	-	85.8	65.8	62.5	115.7	0.71	965.76
10-year	5.68	-	137.0	88.3	99.2	169.5	1.47	967.95
25-year	6.20	239	150.4	93.3	108.8	182.5	1.71	968.53
100-year	7.70	327	188.9	158.3	136.5	218.7	2.17	969.55*

Table 1. Storm Event Data

*includes flow through overflow weir

The detention basin will be controlled by the same 36" pipe that controls the existing basin. The flow rate leaving the site in the 25-year, 24-hour storm event is 183 cfs, which is below the pre-developed flow rate of 239 cfs. An overflow weir is proposed for the basin. The weir is to be 90 ft long at an elevation of 969.25 ft. The top of the berm is at an elevation of 971.10 ft.

4.0 ADDITIONAL PERMITS

4.1 FLOODPLAIN

The subject property lies within Flood Zone "X" (unshaded) (Areas determined to be outside the 0.2% annual chance floodplain), as shown on the Jackson County, Missouri, and Incorporated Areas Flood Insurance Rate Map (F.I.R.M). The map number is 29095C0409G, panel 409 of 625, and the map revision date is January 20, 2017. The FEMA FIRMette is included in **Appendix B2**.

No floodplain related permits are required for this development.

4.2 LAND DISTURBANCE

Land disturbance permits are required from the Missouri Department of Natural Resources for projects that disturb at least 1.0 acres of land or for sites that are part of a larger common development. The proposed site disturbance is over one acre. A land disturbance permit is required for this project.

4.3 USACE NATIONWIDE PERMIT

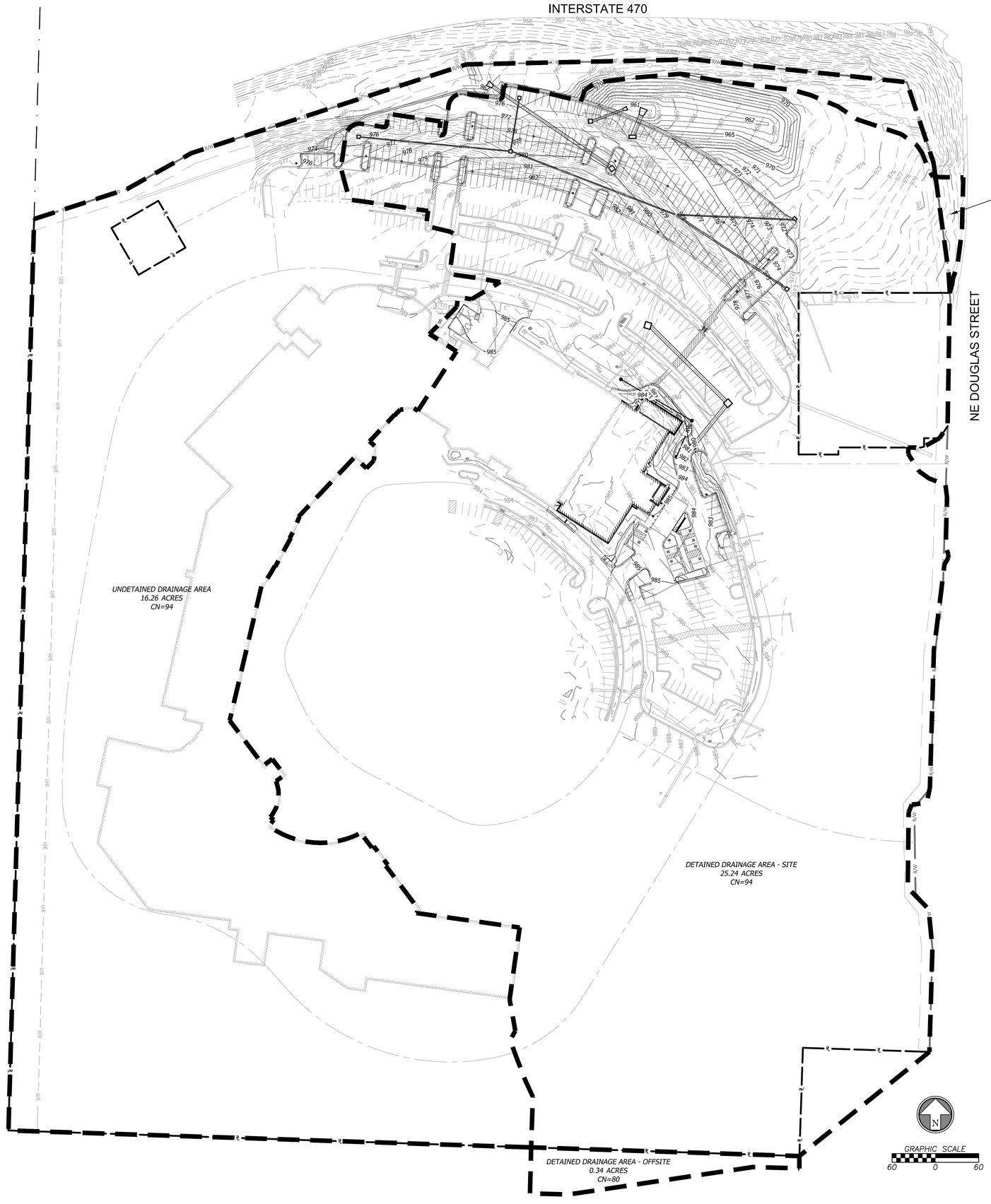
A stream goes through the area that is proposed for the parking expansion improvements. This stream is classified by the Army Corps of Engineers as a Waters of the United States (WOTUS). A storm pipe will

be installed in lieu of the stream and discharge to the Interstate 470 highway right-of-way ditch. A USACE Nationwide Permit (NWP) is to be obtained for this work.

5.0 CONCLUSION

The proposed improvements consist of a building expansion at the north end of the existing hospital and a parking expansion at the north end of the site. The parking expansion will extend into the existing detention basin. The detention basin will be regraded to capture lost volume, and the same 36" outlet pipe will serve as the outlet control structure for the detention basin.

Appendix A



DRAINAGE LEGEND

- DRAINAGE AREA BOUNDARY
- 000 — PROPOSED STRUCTURE IDENTIFIER
- DRAINAGE DIRECTION
- Field — AREA/DIRECTION OF DRAINAGE BOUNDARY
- 980 — PROPOSED FINISH GRADE MAJOR CONTOUR
- 982 — PROPOSED FINISH GRADE MINOR CONTOUR
- 980 — EXISTING GRADE MAJOR CONTOUR
- 982 — EXISTING GRADE MINOR CONTOUR
- STM — PROPOSED STORM SEWER LINE
- RD — PROPOSED ROOF LINE DRAIN
- ℄ — PROPERTY LINE
- R/W — RIGHT-OF-WAY LINE

Oct 31, 2022 - 3:31pm Plotted By: kurtyoder V:\033570-st. lukes east\04-DWG\Eng\Sheet\PDP\033570-SHTS-DMAP.dwg Layout: Overall Drainage Map

STATE OF MISSOURI
KURT M. YODER
NUMBER PE-2021020064
PROFESSIONAL ENGINEER

Kurt M. Yoder, Civil Engineer
License - Missouri #2021020064

ACI BOLAND ARCHITECTS

ACI/Boland, Inc.
Kansas City | St. Louis
1710 Wyandotte
Kansas City, MO 64108
T: 816.763.9600
Licensee's Certificate of Authority Number:
Missouri: #000958

CIVIL CONSULTANT

BHC
7101 College Blvd, Suite 400
Overland Park, KS 66210
913.663.1900
Licensee's Certificate of Authority Number:
Missouri: #000958

STRUCTURAL CONSULTANT

Structural Engineering Associates, Inc.
1000 Walnut, Suit 1570
Kansas City, MO 64106
816.421.1042

MEP CONSULTANT

IMEG
1600 Baltimore Ave, Suite 300
Kansas City, MO 64108
816.842.8437

Saint Luke's EAST HOSPITAL

ASC EXPANSION & RENOVATION

100 NE Saint Luke's Blvd
Lee's Summit, MO 64086
Final Development Plan

Date	10/28/2022
Job Number	3-21037
Drawn By	KMY
Checked By	KMY

Revision

Number	Date	Description

A1

OVERALL DRAINAGE MAP

Appendix B

United States Department of Agriculture

NRCS

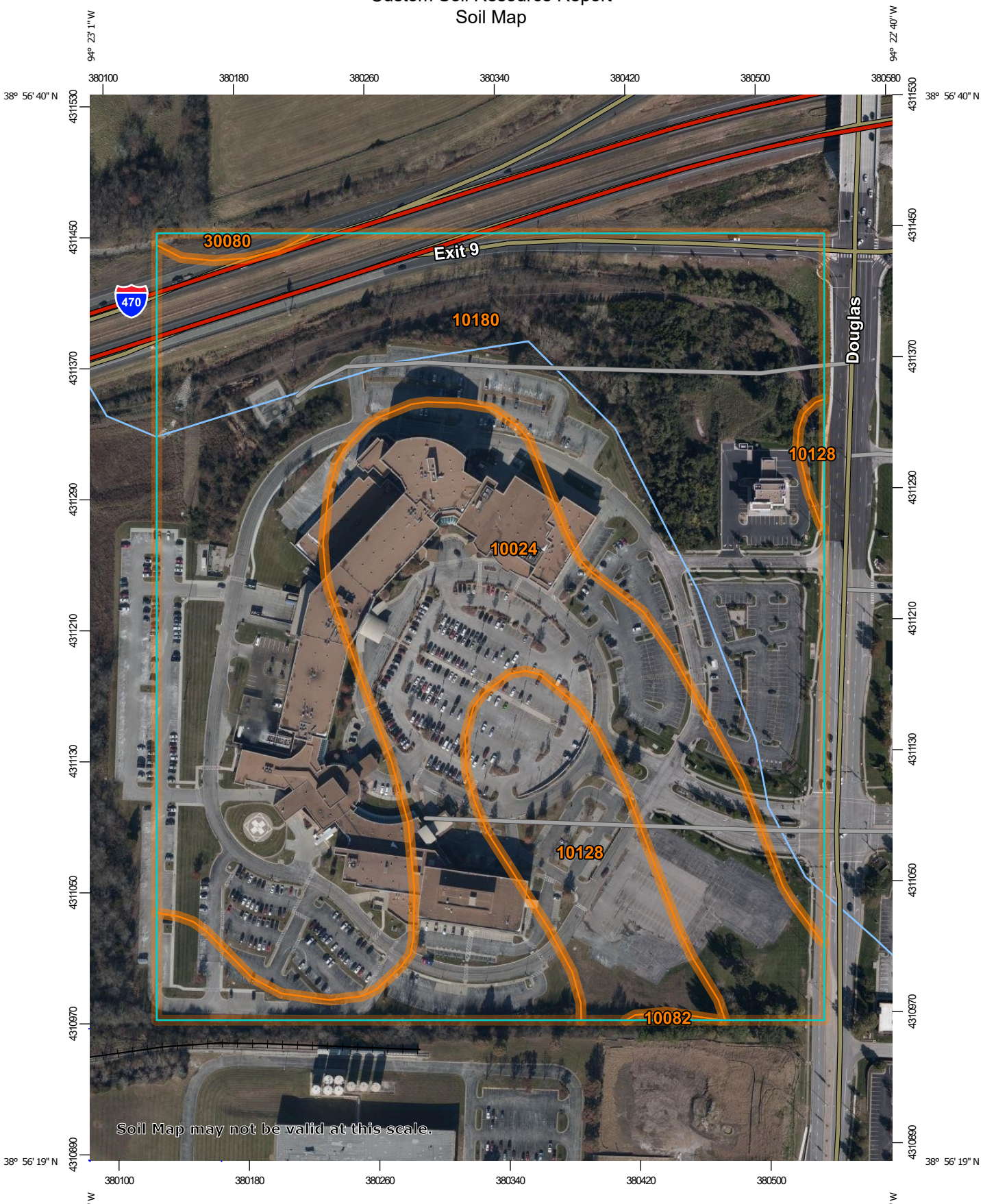
Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Jackson County, Missouri

September 28, 2022

Custom Soil Resource Report
Soil Map



Map Scale: 1:3,170 if printed on A portrait (8.5" x 11") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

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

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MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

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

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

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

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

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Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10024 D	Greenton-Urban land complex, 5 to 9 percent slopes	14.8	30.4%
10082 C	Arisburg-Urban land complex, 1 to 5 percent slopes	0.0	0.1%
10128 D	Sharpsburg-Urban land complex, 2 to 5 percent slopes	4.5	9.1%
10180 C	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	29.2	59.8%
30080 D	Greenton silty clay loam, 5 to 9 percent slopes	0.3	0.6%
Totals for Area of Interest		**48.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it

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Jackson County, Missouri

10024—Greenton-Urban land complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2qky4
Elevation: 800 to 1,100 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Greenton and similar soils: 60 percent
Urban land: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Greenton

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave, convex
Parent material: Loess over residuum weathered from limestone and shale

Typical profile

A - 0 to 16 inches: silty clay loam
Bt1 - 16 to 26 inches: silty clay loam
2Bt2 - 26 to 80 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: R109XY002MO - Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

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Description of Urban Land

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Across-slope shape: Concave, convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10082—Arisburg-Urban land complex, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2w7ld
Elevation: 750 to 1,130 feet
Mean annual precipitation: 39 to 45 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Arisburg and similar soils: 61 percent
Urban land: 30 percent
Minor components: 9 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Arisburg

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

Ap - 0 to 6 inches: silt loam
A - 6 to 13 inches: silt loam
Bt - 13 to 19 inches: silty clay loam
Btg - 19 to 56 inches: silty clay loam
BCg - 56 to 79 inches: silty clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained

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Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 11.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R107BY007MO - Loess Upland Prairie
Hydric soil rating: No

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 3 percent
Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Concave
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna
Hydric soil rating: Yes

Greenton

Percent of map unit: 3 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Sharpsburg

Percent of map unit: 3 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

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10128—Sharpsburg-Urban land complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2ql09
Elevation: 1,000 to 1,300 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 177 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess

Typical profile

A - 0 to 17 inches: silt loam
Bt - 17 to 55 inches: silty clay loam
C - 55 to 60 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 24 to 35 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: D
Ecological site: R109XY002MO - Loess Upland Prairie
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)

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Hydric soil rating: No

Description of Urban Land

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

10180—Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 1n85h
Elevation: 600 to 900 feet
Mean annual precipitation: 33 to 43 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 175 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Udarents and similar soils: 41 percent
Urban land: 39 percent
Sampsel and similar soils: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udarents

Setting

Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Mine spoil or earthy fill

Typical profile

C1 - 0 to 5 inches: silt loam
C2 - 5 to 80 inches: silty clay loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 0.57 in/hr)
Depth to water table: More than 80 inches

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Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R107BY002MO - Deep Loess Upland Prairie
Other vegetative classification: Mixed/Transitional (Mixed Native Vegetation)
Hydric soil rating: No

Description of Urban Land

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Across-slope shape: Convex

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Sampsel

Setting

Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Convex
Parent material: Residuum weathered from shale

Typical profile

Ap - 0 to 13 inches: silty clay loam
Bt - 13 to 80 inches: silty clay

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Ecological site: R109XY010MO - Interbedded Sedimentary Upland Savanna

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Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

30080—Greenton silty clay loam, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2xjd9
Elevation: 640 to 1,120 feet
Mean annual precipitation: 35 to 41 inches
Mean annual air temperature: 50 to 57 degrees F
Frost-free period: 177 to 209 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Greenton and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Greenton

Setting

Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loess over residuum weathered from limestone and shale

Typical profile

Ap - 0 to 12 inches: silty clay loam
Bt - 12 to 28 inches: silty clay
2Bt - 28 to 30 inches: silty clay
2C - 30 to 79 inches: silty clay

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified

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Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C/D
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: No

Minor Components

Sampsel

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: R109XY002MO - Loess Upland Prairie
Hydric soil rating: Yes

B1

National Flood Hazard Layer FIRMette

FEMA

94°23'14"W 38°56'43"N

94°22'36"W 38°56'16"N

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

1:6,000

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

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/31/2022 at 4:43 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

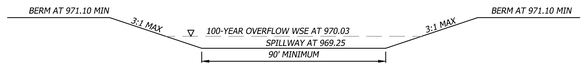
B2

Appendix C

DETENTION NOTES:
24-HOUR, 25-YEAR STORM EVENT
PEAK WATER SURFACE ELEVATION = 968.52 ft
PEAK STORAGE VOLUME = 1.71 ac-ft

SPILLWAY DESIGN:
BOTTOM WIDTH = 90 ft
SIDE SLOPES = 3:1
C = 0.57
Q (4% FLOW) = 189 cfs
V (4% FLOW) = 2.7 ft/s

LINING MATERIAL: TURF GRASS SOD. SEE LANDSCAPING PLAN.



SPILLWAY CROSS-SECTION A-A

SEE WEIR CROSS SECTION A-A THIS SHEET FOR DIMENSIONS.

TOP OF BERM AT 971.10

TOP OF BERM AT 971.10

FLOW LINE OUT = 960.70

FLOW LINE IN = 961.00

BENCHMARKS (DATUM: NAVD88)

BENCHMARK NUMBER: 1
ELEVATION= 982.88

CHISELED SQUARE ON THE FRONT FACE OF A DUAL MANHOLE CURB INLET, LOCATED 49.8 FEET NORTHWEST OF THE NORTHEAST CORNER OF THE NORTH END OF SAINT LUKE'S HOSPITAL.

BENCHMARK NUMBER: 2
ELEVATION= 979.35

CHISELED SQUARE ON THE FRONT FACE OF A CURB INLET, LOCATED ±97.4 FEET SOUTHWEST OF THE SOUTHEAST CORNER ON THE NORTH END SAINT LUKE'S HOSPITAL.

GRAPHIC SCALE
10 0 10

STATE OF MISSOURI
KURT M. YODER
NUMBER PE-2021020064
PROFESSIONAL ENGINEER

Kurt M. Yoder, Civil Engineer
License - Missouri #2021020064

ACI BOLAND ARCHITECTS
ACI/Boland, Inc.
Kansas City | St. Louis
1710 Wyandotte
Kansas City, MO 64108
T: 816.763.9600
Licensee's Certificate of Authority Number:
Missouri: #000958

CIVIL CONSULTANT
BHC
7101 College Blvd, Suite 400
Overland Park, KS 66210
913.663.1900
Licensee's Certificate of Authority Number:
Missouri: #000958

STRUCTURAL CONSULTANT
Structural Engineering Associates, Inc.
1000 Walnut, Suit 1570
Kansas City, MO 64106
816.421.1042

MEP CONSULTANT
IMEG
1600 Baltimore Ave, Suite 300
Kansas City, MO 64108
816.842.8437

Saint Luke's EAST HOSPITAL

ASC EXPANSION & RENOVATION
100 NE Saint Luke's Blvd
Lee's Summit, MO 64086
Final Development Plan

Date	10/28/2022
Job Number	3-21037
Drawn By	KMY
Checked By	KMY

Revision

Number	Date	Description

C1

DETENTION BASIN PLAN

Oct 31, 2022 - 3:57pm Plotted By: kurt.yoder V:\033570-st. lukes east\04-DWG\Engr\Sheet\PDP\033570-SHT5-POND.dwg Layout: Detention Basin Plan

Appendix D

Table of Contents

D1

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
CM-1	Post-Development 2 Year	2	6.378	12.050	84.95
CM-1	Post-Development 10 Year	10	10.447	12.050	135.27
CM-1	Post-Development 25 Year	25	11.527	12.050	148.44
CM-1	Post-Development 100 Year	100	14.652	12.050	186.28
CM-2	Post-Development 2 Year	2	4.112	12.000	62.45
CM-2	Post-Development 10 Year	10	6.735	12.000	99.20
CM-2	Post-Development 25 Year	25	7.432	12.000	108.83
CM-2	Post-Development 100 Year	100	9.446	12.000	136.47
CM-3	Post-Development 2 Year	2	0.012	12.050	0.17
CM-3	Post-Development 10 Year	10	0.023	12.050	0.33
CM-3	Post-Development 25 Year	25	0.026	12.050	0.37
CM-3	Post-Development 100 Year	100	0.036	12.050	0.49
CM-4	Post-Development 2 Year	2	0.051	12.050	0.72
CM-4	Post-Development 10 Year	10	0.099	12.050	1.38
CM-4	Post-Development 25 Year	25	0.112	12.050	1.57
CM-4	Post-Development 100 Year	100	0.151	12.050	2.09

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
O-1	Post-Development 2 Year	2	10.538	12.050	115.71
O-1	Post-Development 10 Year	10	17.284	12.050	169.45
O-1	Post-Development 25 Year	25	19.076	12.050	182.50
O-1	Post-Development 100 Year	100	24.258	12.050	218.66
J-1	Post-Development 2 Year	2	10.542	12.000	115.86

D1

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
J-1	Post-Development 10 Year	10	17.289	12.000	171.58
J-1	Post-Development 25 Year	25	19.082	12.000	185.05
J-1	Post-Development 100 Year	100	24.266	12.000	222.59

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
PO-1 (IN)	Post-Development 2 Year	2	6.441	12.050	85.83	(N/A)	(N/A)
PO-1 (OUT)	Post-Development 2 Year	2	6.429	12.150	65.77	965.76	0.706
PO-1 (IN)	Post-Development 10 Year	10	10.569	12.050	136.98	(N/A)	(N/A)
PO-1 (OUT)	Post-Development 10 Year	10	10.554	12.200	88.27	967.95	1.467
PO-1 (IN)	Post-Development 25 Year	25	11.666	12.050	150.38	(N/A)	(N/A)
PO-1 (OUT)	Post-Development 25 Year	25	11.650	12.200	93.25	968.53	1.706
PO-1 (IN)	Post-Development 100 Year	100	14.838	12.050	188.87	(N/A)	(N/A)
PO-1 (OUT)	Post-Development 100 Year	100	14.820	12.150	158.25	969.55	2.173

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 10 Year

Return Event: 10 years
Storm Event: 10 Year

Time-Depth Curve: 10 Year	
Label	10 Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	10 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.2
2.500	0.2	0.2	0.2	0.2	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.3	0.3
4.000	0.3	0.3	0.3	0.3	0.3
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.4	0.4	0.4	0.4	0.4
5.500	0.4	0.4	0.4	0.4	0.4
6.000	0.5	0.5	0.5	0.5	0.5
6.500	0.5	0.5	0.5	0.5	0.6
7.000	0.6	0.6	0.6	0.6	0.6
7.500	0.6	0.6	0.6	0.7	0.7
8.000	0.7	0.7	0.7	0.7	0.7
8.500	0.8	0.8	0.8	0.8	0.8
9.000	0.8	0.9	0.9	0.9	0.9
9.500	0.9	0.9	1.0	1.0	1.0
10.000	1.0	1.1	1.1	1.1	1.1
10.500	1.2	1.2	1.2	1.3	1.3
11.000	1.3	1.4	1.4	1.5	1.5
11.500	1.6	1.7	2.0	2.4	3.2
12.000	3.8	3.9	4.0	4.1	4.1
12.500	4.2	4.2	4.3	4.3	4.3
13.000	4.4	4.4	4.5	4.5	4.5
13.500	4.5	4.6	4.6	4.6	4.6
14.000	4.7	4.7	4.7	4.7	4.7
14.500	4.8	4.8	4.8	4.8	4.8
15.000	4.8	4.9	4.9	4.9	4.9
15.500	4.9	4.9	5.0	5.0	5.0
16.000	5.0	5.0	5.0	5.0	5.0
16.500	5.1	5.1	5.1	5.1	5.1
17.000	5.1	5.1	5.1	5.2	5.2

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 10 Year

Return Event: 10 years
Storm Event: 10 Year

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	5.2	5.2	5.2	5.2	5.2
18.000	5.2	5.2	5.3	5.3	5.3
18.500	5.3	5.3	5.3	5.3	5.3
19.000	5.3	5.3	5.3	5.4	5.4
19.500	5.4	5.4	5.4	5.4	5.4
20.000	5.4	5.4	5.4	5.4	5.4
20.500	5.4	5.5	5.5	5.5	5.5
21.000	5.5	5.5	5.5	5.5	5.5
21.500	5.5	5.5	5.5	5.5	5.5
22.000	5.5	5.6	5.6	5.6	5.6
22.500	5.6	5.6	5.6	5.6	5.6
23.000	5.6	5.6	5.6	5.6	5.6
23.500	5.6	5.7	5.7	5.7	5.7
24.000	5.7	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 100 Year

Return Event: 100 years
Storm Event: 100 Year

Time-Depth Curve: 100 Year	
Label	100 Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.1	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.2	0.2
2.000	0.2	0.2	0.2	0.2	0.2
2.500	0.2	0.2	0.2	0.2	0.3
3.000	0.3	0.3	0.3	0.3	0.3
3.500	0.3	0.3	0.3	0.3	0.4
4.000	0.4	0.4	0.4	0.4	0.4
4.500	0.4	0.4	0.4	0.5	0.5
5.000	0.5	0.5	0.5	0.5	0.5
5.500	0.5	0.6	0.6	0.6	0.6
6.000	0.6	0.6	0.6	0.7	0.7
6.500	0.7	0.7	0.7	0.7	0.7
7.000	0.8	0.8	0.8	0.8	0.8
7.500	0.8	0.9	0.9	0.9	0.9
8.000	0.9	0.9	1.0	1.0	1.0
8.500	1.0	1.0	1.1	1.1	1.1
9.000	1.1	1.2	1.2	1.2	1.2
9.500	1.3	1.3	1.3	1.3	1.4
10.000	1.4	1.4	1.5	1.5	1.5
10.500	1.6	1.6	1.7	1.7	1.8
11.000	1.8	1.9	1.9	2.0	2.1
11.500	2.2	2.4	2.7	3.3	4.4
12.000	5.1	5.3	5.4	5.5	5.6
12.500	5.7	5.7	5.8	5.8	5.9
13.000	5.9	6.0	6.0	6.1	6.1
13.500	6.2	6.2	6.2	6.3	6.3
14.000	6.3	6.3	6.4	6.4	6.4
14.500	6.4	6.5	6.5	6.5	6.5
15.000	6.6	6.6	6.6	6.6	6.7
15.500	6.7	6.7	6.7	6.7	6.8
16.000	6.8	6.8	6.8	6.8	6.8
16.500	6.9	6.9	6.9	6.9	6.9
17.000	6.9	7.0	7.0	7.0	7.0

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 100 Year

Return Event: 100 years
Storm Event: 100 Year

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	7.0	7.0	7.0	7.1	7.1
18.000	7.1	7.1	7.1	7.1	7.1
18.500	7.2	7.2	7.2	7.2	7.2
19.000	7.2	7.2	7.2	7.3	7.3
19.500	7.3	7.3	7.3	7.3	7.3
20.000	7.3	7.3	7.4	7.4	7.4
20.500	7.4	7.4	7.4	7.4	7.4
21.000	7.4	7.4	7.4	7.5	7.5
21.500	7.5	7.5	7.5	7.5	7.5
22.000	7.5	7.5	7.5	7.6	7.6
22.500	7.6	7.6	7.6	7.6	7.6
23.000	7.6	7.6	7.6	7.6	7.6
23.500	7.7	7.7	7.7	7.7	7.7
24.000	7.7	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

Time-Depth Curve: 2 Year	
Label	2 Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	2 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.0	0.0	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.1
3.000	0.1	0.1	0.1	0.1	0.1
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.2	0.2	0.2	0.2	0.2
5.000	0.2	0.2	0.2	0.3	0.3
5.500	0.3	0.3	0.3	0.3	0.3
6.000	0.3	0.3	0.3	0.3	0.3
6.500	0.3	0.3	0.3	0.4	0.4
7.000	0.4	0.4	0.4	0.4	0.4
7.500	0.4	0.4	0.4	0.4	0.4
8.000	0.4	0.5	0.5	0.5	0.5
8.500	0.5	0.5	0.5	0.5	0.5
9.000	0.5	0.6	0.6	0.6	0.6
9.500	0.6	0.6	0.6	0.6	0.7
10.000	0.7	0.7	0.7	0.7	0.7
10.500	0.8	0.8	0.8	0.8	0.8
11.000	0.9	0.9	0.9	1.0	1.0
11.500	1.0	1.1	1.3	1.6	2.1
12.000	2.5	2.5	2.6	2.6	2.7
12.500	2.7	2.8	2.8	2.8	2.8
13.000	2.9	2.9	2.9	2.9	2.9
13.500	3.0	3.0	3.0	3.0	3.0
14.000	3.0	3.1	3.1	3.1	3.1
14.500	3.1	3.1	3.1	3.1	3.2
15.000	3.2	3.2	3.2	3.2	3.2
15.500	3.2	3.2	3.2	3.2	3.3
16.000	3.3	3.3	3.3	3.3	3.3
16.500	3.3	3.3	3.3	3.3	3.3
17.000	3.3	3.4	3.4	3.4	3.4

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	3.4	3.4	3.4	3.4	3.4
18.000	3.4	3.4	3.4	3.4	3.4
18.500	3.4	3.5	3.5	3.5	3.5
19.000	3.5	3.5	3.5	3.5	3.5
19.500	3.5	3.5	3.5	3.5	3.5
20.000	3.5	3.5	3.5	3.5	3.6
20.500	3.6	3.6	3.6	3.6	3.6
21.000	3.6	3.6	3.6	3.6	3.6
21.500	3.6	3.6	3.6	3.6	3.6
22.000	3.6	3.6	3.6	3.6	3.6
22.500	3.6	3.7	3.7	3.7	3.7
23.000	3.7	3.7	3.7	3.7	3.7
23.500	3.7	3.7	3.7	3.7	3.7
24.000	3.7	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 25 Year

Return Event: 25 years
Storm Event: 25 Year

Time-Depth Curve: 25 Year	
Label	25 Year
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	25 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.1	0.1
1.000	0.1	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.2	0.2	0.2
2.500	0.2	0.2	0.2	0.2	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.3	0.3	0.3	0.3	0.3
4.000	0.3	0.3	0.3	0.3	0.3
4.500	0.3	0.4	0.4	0.4	0.4
5.000	0.4	0.4	0.4	0.4	0.4
5.500	0.4	0.5	0.5	0.5	0.5
6.000	0.5	0.5	0.5	0.5	0.5
6.500	0.6	0.6	0.6	0.6	0.6
7.000	0.6	0.6	0.6	0.7	0.7
7.500	0.7	0.7	0.7	0.7	0.7
8.000	0.7	0.8	0.8	0.8	0.8
8.500	0.8	0.8	0.9	0.9	0.9
9.000	0.9	0.9	1.0	1.0	1.0
9.500	1.0	1.0	1.1	1.1	1.1
10.000	1.1	1.1	1.2	1.2	1.2
10.500	1.3	1.3	1.3	1.4	1.4
11.000	1.5	1.5	1.6	1.6	1.7
11.500	1.8	1.9	2.2	2.7	3.5
12.000	4.1	4.2	4.3	4.4	4.5
12.500	4.6	4.6	4.7	4.7	4.7
13.000	4.8	4.8	4.9	4.9	4.9
13.500	5.0	5.0	5.0	5.0	5.1
14.000	5.1	5.1	5.1	5.2	5.2
14.500	5.2	5.2	5.2	5.3	5.3
15.000	5.3	5.3	5.3	5.3	5.4
15.500	5.4	5.4	5.4	5.4	5.4
16.000	5.5	5.5	5.5	5.5	5.5
16.500	5.5	5.5	5.6	5.6	5.6
17.000	5.6	5.6	5.6	5.6	5.6

Subsection: Time-Depth Curve
Label: Time-Depth - 1
Scenario: Post-Development 25 Year

Return Event: 25 years
Storm Event: 25 Year

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	5.7	5.7	5.7	5.7	5.7
18.000	5.7	5.7	5.7	5.7	5.8
18.500	5.8	5.8	5.8	5.8	5.8
19.000	5.8	5.8	5.8	5.8	5.9
19.500	5.9	5.9	5.9	5.9	5.9
20.000	5.9	5.9	5.9	5.9	5.9
20.500	5.9	6.0	6.0	6.0	6.0
21.000	6.0	6.0	6.0	6.0	6.0
21.500	6.0	6.0	6.0	6.0	6.0
22.000	6.1	6.1	6.1	6.1	6.1
22.500	6.1	6.1	6.1	6.1	6.1
23.000	6.1	6.1	6.1	6.2	6.2
23.500	6.2	6.2	6.2	6.2	6.2
24.000	6.2	(N/A)	(N/A)	(N/A)	(N/A)

Storm Event	2 Year
Return Event	2 years
Duration	24.000 hours
Depth	3.7 in
Time of Concentration (Composite)	0.270 hours
Area (User Defined)	25.24 acres

Computational Time Increment	0.036 hours
Time to Peak (Computed)	12.060 hours
Flow (Peak, Computed)	84.99 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	84.95 ft³/s

Drainage Area	
SCS CN (Composite)	94.000
Area (User Defined)	25.24 acres
Maximum Retention (Pervious)	0.6 in
Maximum Retention (Pervious, 20 percent)	0.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.0 in
Runoff Volume (Pervious)	6.395 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	6.378 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.270 hours
Computational Time Increment	0.036 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	105.92 ft³/s

Subsection: Unit Hydrograph Summary
Label: CM-1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.180 hours
Unit receding limb, Tr	0.720 hours
Total unit time, Tb	0.900 hours

Storm Event	2 Year
Return Event	2 years
Duration	24.000 hours
Depth	3.7 in
Time of Concentration (Composite)	0.170 hours
Area (User Defined)	16.26 acres

Computational Time Increment	0.023 hours
Time to Peak (Computed)	11.968 hours
Flow (Peak, Computed)	63.26 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.000 hours
Flow (Peak Interpolated Output)	62.45 ft³/s

Drainage Area	
SCS CN (Composite)	94.000
Area (User Defined)	16.26 acres
Maximum Retention (Pervious)	0.6 in
Maximum Retention (Pervious, 20 percent)	0.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	3.0 in
Runoff Volume (Pervious)	4.120 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	4.112 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.170 hours
Computational Time Increment	0.023 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	108.37 ft³/s

Subsection: Unit Hydrograph Summary
Label: CM-2
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.113 hours
Unit receding limb, Tr	0.453 hours
Total unit time, Tb	0.567 hours

Storm Event	2 Year
Return Event	2 years
Duration	24.000 hours
Depth	3.7 in
Time of Concentration (Composite)	0.270 hours
Area (User Defined)	0.08 acres

Computational Time Increment	0.036 hours
Time to Peak (Computed)	12.060 hours
Flow (Peak, Computed)	0.17 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	0.17 ft³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	0.08 acres
Maximum Retention (Pervious)	2.5 in
Maximum Retention (Pervious, 20 percent)	0.5 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.8 in
Runoff Volume (Pervious)	0.012 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.012 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.270 hours
Computational Time Increment	0.036 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	0.34 ft³/s

Subsection: Unit Hydrograph Summary
Label: CM-3
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.180 hours
Unit receding limb, Tr	0.720 hours
Total unit time, Tb	0.900 hours

Storm Event	2 Year
Return Event	2 years
Duration	24.000 hours
Depth	3.7 in
Time of Concentration (Composite)	0.270 hours
Area (User Defined)	0.34 acres

Computational Time Increment	0.036 hours
Time to Peak (Computed)	12.060 hours
Flow (Peak, Computed)	0.72 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.050 hours
Flow (Peak Interpolated Output)	0.72 ft³/s

Drainage Area	
SCS CN (Composite)	80.000
Area (User Defined)	0.34 acres
Maximum Retention (Pervious)	2.5 in
Maximum Retention (Pervious, 20 percent)	0.5 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.8 in
Runoff Volume (Pervious)	0.051 ac-ft

Hydrograph Volume (Area under Hydrograph curve)	
Volume	0.051 ac-ft

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.270 hours
Computational Time Increment	0.036 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	1.43 ft³/s

Subsection: Unit Hydrograph Summary
Label: CM-4
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.180 hours
Unit receding limb, Tr	0.720 hours
Total unit time, Tb	0.900 hours

Requested Pond Water Surface Elevations	
Minimum (Headwater)	960.80 ft
Increment (Headwater)	0.50 ft
Maximum (Headwater)	971.00 ft

Outlet Connectivity

Structure Type	Outlet ID	Direction	Outfall	E1 (ft)	E2 (ft)
Culvert-Circular	Culvert - 1	Forward	TW	960.94	971.00
Rectangular Weir	Weir - 1	Forward	TW	969.25	971.00
Tailwater Settings	Tailwater			(N/A)	(N/A)

Subsection: Outlet Input Data
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

Structure ID: Culvert - 1 Structure Type: Culvert-Circular	
Number of Barrels	1
Diameter	36.0 in
Length	47.58 ft
Length (Computed Barrel)	47.58 ft
Slope (Computed)	0.002 ft/ft

Outlet Control Data	
Manning's n	0.013
Ke	0.200
Kb	0.007
Kr	0.000
Convergence Tolerance	0.00 ft

Inlet Control Data	
Equation Form	Form 1
K	0.0045
M	2.0000
C	0.0317
Y	0.6900
T1 ratio (HW/D)	0.000
T2 ratio (HW/D)	1.196
Slope Correction Factor	-0.500

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

T1 Elevation	960.94 ft	T1 Flow	42.85 ft³/s
T2 Elevation	964.53 ft	T2 Flow	48.97 ft³/s

Structure ID: Weir - 1 Structure Type: Rectangular Weir	
Number of Openings	1
Elevation	969.25 ft
Weir Length	90.00 ft
Weir Coefficient	3.00 (ft^0.5)/s

Structure ID: TW Structure Type: TW Setup, DS Channel	
Tailwater Type	Free Outfall

Convergence Tolerances	
Maximum Iterations	30
Tailwater Tolerance (Minimum)	0.01 ft
Tailwater Tolerance (Maximum)	0.50 ft
Headwater Tolerance (Minimum)	0.01 ft
Headwater Tolerance (Maximum)	0.50 ft
Flow Tolerance (Minimum)	0.001 ft³/s
Flow Tolerance (Maximum)	10.000 ft³/s

Subsection: Individual Outlet Curves
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 32.89 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
960.80	0.00	(N/A)	0.00
960.94	0.00	(N/A)	0.00
961.30	0.65	(N/A)	0.00
961.80	3.70	(N/A)	0.00
962.30	8.90	(N/A)	0.00
962.80	15.88	(N/A)	0.00
963.30	24.16	(N/A)	0.00
963.80	33.27	(N/A)	0.00
964.30	42.60	(N/A)	0.00
964.80	51.64	(N/A)	0.00
965.30	59.60	(N/A)	0.00
965.80	66.35	(N/A)	0.00
966.30	72.05	(N/A)	0.00
966.80	77.32	(N/A)	0.00
967.30	82.25	(N/A)	0.00
967.80	86.93	(N/A)	0.00
968.30	91.34	(N/A)	0.00
968.80	95.56	(N/A)	0.00
969.25	99.21	(N/A)	0.00
969.30	99.59	(N/A)	0.00
969.80	103.47	(N/A)	0.00
970.30	107.22	(N/A)	0.00
970.80	110.83	(N/A)	0.00
971.00	112.25	(N/A)	0.00

Computation Messages
Upstream HW & DNstream TW < Inv.El
Upstream HW & DNstream TW < Inv.El
BACKWATER CONTROL.. Vh= .048ft hwDi= .302ft Lbw= 47.6ft Hev= .00ft
BACKWATER CONTROL.. Vh= .139ft hwDi= .693ft Lbw= 47.6ft Hev= .00ft

Subsection: Individual Outlet Curves
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 32.89 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Computation Messages
BACKWATER CONTROL.. Vh= .239ft hwDi= 1.073ft Lbw= 47.6ft Hev= .00ft
BACKWATER CONTROL.. Vh= .343ft hwDi= 1.449ft Lbw= 47.6ft Hev= .00ft
BACKWATER CONTROL.. Vh= .451ft hwDi= 1.819ft Lbw= 47.6ft Hev= .00ft
BACKWATER CONTROL.. Vh= .570ft hwDi= 2.176ft Lbw= 47.6ft Hev= .00ft
BACKWATER CONTROL.. Vh= .707ft hwDi= 2.511ft Lbw= 47.6ft Hev= .00ft
BACKWATER CONTROL.. Vh= .875ft hwDi= 2.809ft Lbw= 47.6ft Hev= .00ft
FULL FLOW...Lfull=5.81ft Vh=1.105ft HL=1.372ft Hev= .00ft
INLET CONTROL... Submerged: HW =4.86
INLET CONTROL... Submerged: HW =5.36
INLET CONTROL... Submerged: HW =5.86
INLET CONTROL... Submerged: HW =6.36
INLET CONTROL... Submerged: HW =6.86
INLET CONTROL... Submerged: HW =7.36
INLET CONTROL... Submerged: HW =7.86
INLET CONTROL... Submerged: HW =8.31

Subsection: Individual Outlet Curves
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Culvert - 1 (Culvert-Circular)

Mannings open channel maximum capacity: 32.89 ft³/s
Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Computation Messages
INLET CONTROL...
Submerged: HW =8.36
INLET CONTROL...
Submerged: HW =8.86
INLET CONTROL...
Submerged: HW =9.36
INLET CONTROL...
Submerged: HW =9.86
INLET CONTROL...
Submerged: HW =10.06

Subsection: Individual Outlet Curves
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Weir - 1 (Rectangular Weir)

Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Water Surface Elevation (ft)	Flow (ft^3/s)	Tailwater Elevation (ft)	Convergence Error (ft)
960.80	0.00	(N/A)	0.00
960.94	0.00	(N/A)	0.00
961.30	0.00	(N/A)	0.00
961.80	0.00	(N/A)	0.00
962.30	0.00	(N/A)	0.00
962.80	0.00	(N/A)	0.00
963.30	0.00	(N/A)	0.00
963.80	0.00	(N/A)	0.00
964.30	0.00	(N/A)	0.00
964.80	0.00	(N/A)	0.00
965.30	0.00	(N/A)	0.00
965.80	0.00	(N/A)	0.00
966.30	0.00	(N/A)	0.00
966.80	0.00	(N/A)	0.00
967.30	0.00	(N/A)	0.00
967.80	0.00	(N/A)	0.00
968.30	0.00	(N/A)	0.00
968.80	0.00	(N/A)	0.00
969.25	0.00	(N/A)	0.00
969.30	3.02	(N/A)	0.00
969.80	110.13	(N/A)	0.00
970.30	290.50	(N/A)	0.00
970.80	521.03	(N/A)	0.00
971.00	625.06	(N/A)	0.00

Computation Messages
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250

Subsection: Individual Outlet Curves
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

RATING TABLE FOR ONE OUTLET TYPE
Structure ID = Weir - 1 (Rectangular Weir)

Upstream ID = (Pond Water Surface)
Downstream ID = Tailwater (Pond Outfall)

Computation Messages
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
HW & TW below Inv.El.=969.250
H=.00; Htw=.00; Qfree=.00;
H=.05; Htw=.00; Qfree=3.02;
H=.55; Htw=.00; Qfree=110.13;
H=1.05; Htw=.00; Qfree=290.50;
H=1.55; Htw=.00; Qfree=521.03;
H=1.75; Htw=.00; Qfree=625.06;

Subsection: Composite Rating Curve
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

Composite Outflow Summary

Water Surface Elevation (ft)	Flow (ft³/s)	Tailwater Elevation (ft)	Convergence Error (ft)
960.80	0.00	(N/A)	0.00
960.94	0.00	(N/A)	0.00
961.30	0.65	(N/A)	0.00
961.80	3.70	(N/A)	0.00
962.30	8.90	(N/A)	0.00
962.80	15.88	(N/A)	0.00
963.30	24.16	(N/A)	0.00
963.80	33.27	(N/A)	0.00
964.30	42.60	(N/A)	0.00
964.80	51.64	(N/A)	0.00
965.30	59.60	(N/A)	0.00
965.80	66.35	(N/A)	0.00
966.30	72.05	(N/A)	0.00
966.80	77.32	(N/A)	0.00
967.30	82.25	(N/A)	0.00
967.80	86.93	(N/A)	0.00
968.30	91.34	(N/A)	0.00
968.80	95.56	(N/A)	0.00
969.25	99.21	(N/A)	0.00
969.30	102.61	(N/A)	0.00
969.80	213.60	(N/A)	0.00
970.30	397.72	(N/A)	0.00
970.80	631.86	(N/A)	0.00
971.00	737.31	(N/A)	0.00

Contributing Structures
None Contributing
None Contributing
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1
Culvert - 1 + Weir - 1

Subsection: Composite Rating Curve
Label: Composite Outlet Structure - 1
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

Composite Outflow Summary

Contributing Structures
Culvert - 1 + Weir - 1
Culvert - 1 + Weir - 1
Culvert - 1 + Weir - 1
Culvert - 1 + Weir - 1
Culvert - 1 + Weir - 1

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

Peak Discharge	65.77 ft³/s
Time to Peak	12.150 hours
Hydrograph Volume	6.429 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
3.400	0.00	0.01	0.02	0.03	0.04
3.650	0.05	0.06	0.07	0.08	0.09
3.900	0.10	0.11	0.12	0.13	0.14
4.150	0.15	0.16	0.17	0.17	0.18
4.400	0.19	0.20	0.21	0.22	0.23
4.650	0.24	0.26	0.27	0.28	0.29
4.900	0.30	0.31	0.32	0.33	0.34
5.150	0.35	0.36	0.37	0.39	0.40
5.400	0.41	0.42	0.43	0.44	0.45
5.650	0.47	0.48	0.49	0.50	0.51
5.900	0.52	0.54	0.55	0.56	0.57
6.150	0.58	0.60	0.61	0.62	0.63
6.400	0.65	0.66	0.68	0.70	0.71
6.650	0.73	0.74	0.75	0.76	0.78
6.900	0.79	0.80	0.82	0.83	0.84
7.150	0.85	0.87	0.88	0.89	0.91
7.400	0.92	0.93	0.94	0.96	0.97
7.650	0.98	1.00	1.01	1.02	1.04
7.900	1.05	1.06	1.07	1.09	1.10
8.150	1.12	1.14	1.16	1.18	1.21
8.400	1.24	1.27	1.30	1.34	1.37
8.650	1.41	1.45	1.48	1.52	1.56
8.900	1.60	1.64	1.68	1.72	1.76
9.150	1.80	1.83	1.86	1.89	1.91
9.400	1.93	1.95	1.96	1.98	1.99
9.650	2.01	2.03	2.06	2.10	2.15
9.900	2.20	2.25	2.31	2.37	2.44
10.150	2.50	2.58	2.65	2.73	2.82
10.400	2.91	3.00	3.10	3.20	3.30
10.650	3.40	3.52	3.64	3.78	3.93
10.900	4.08	4.24	4.40	4.57	4.75
11.150	4.95	5.17	5.42	5.71	6.04
11.400	6.39	6.76	7.15	7.64	8.43
11.650	9.84	12.22	16.01	20.92	27.43
11.900	35.53	44.67	53.41	60.20	64.24
12.150	65.77	64.46	60.93	55.25	48.10
12.400	40.24	32.77	26.09	20.90	17.04
12.650	14.10	11.96	10.46	9.39	8.59
12.900	7.97	7.52	7.16	6.85	6.57

D1

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
13.150	6.32	6.09	5.89	5.70	5.53
13.400	5.38	5.23	5.09	4.96	4.83
13.650	4.70	4.58	4.46	4.35	4.25
13.900	4.15	4.05	3.96	3.86	3.77
14.150	3.69	3.61	3.54	3.48	3.43
14.400	3.38	3.34	3.30	3.27	3.23
14.650	3.20	3.16	3.13	3.10	3.07
14.900	3.03	3.00	2.97	2.94	2.91
15.150	2.87	2.84	2.81	2.78	2.75
15.400	2.71	2.68	2.65	2.62	2.58
15.650	2.55	2.52	2.49	2.46	2.42
15.900	2.39	2.36	2.33	2.29	2.26
16.150	2.23	2.20	2.18	2.16	2.14
16.400	2.12	2.11	2.09	2.08	2.07
16.650	2.06	2.04	2.03	2.02	2.01
16.900	2.00	1.99	1.97	1.96	1.95
17.150	1.94	1.93	1.92	1.91	1.89
17.400	1.88	1.87	1.86	1.85	1.84
17.650	1.83	1.81	1.80	1.79	1.78
17.900	1.77	1.76	1.74	1.73	1.72
18.150	1.71	1.70	1.69	1.67	1.66
18.400	1.65	1.64	1.63	1.62	1.61
18.650	1.59	1.58	1.57	1.56	1.55
18.900	1.54	1.52	1.51	1.50	1.49
19.150	1.48	1.47	1.45	1.44	1.43
19.400	1.42	1.41	1.40	1.39	1.37
19.650	1.36	1.35	1.34	1.33	1.32
19.900	1.30	1.29	1.28	1.27	1.26
20.150	1.25	1.24	1.23	1.22	1.22
20.400	1.21	1.21	1.21	1.20	1.20
20.650	1.20	1.19	1.19	1.19	1.19
20.900	1.19	1.18	1.18	1.18	1.18
21.150	1.17	1.17	1.17	1.17	1.16
21.400	1.16	1.16	1.16	1.16	1.15
21.650	1.15	1.15	1.15	1.14	1.14
21.900	1.14	1.14	1.13	1.13	1.13
22.150	1.13	1.13	1.12	1.12	1.12
22.400	1.12	1.11	1.11	1.11	1.11
22.650	1.10	1.10	1.10	1.10	1.10
22.900	1.09	1.09	1.09	1.09	1.08
23.150	1.08	1.08	1.08	1.07	1.07
23.400	1.07	1.07	1.07	1.06	1.06
23.650	1.06	1.06	1.05	1.05	1.05

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 2 Year

Return Event: 2 years
Storm Event: 2 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
23.900	1.05	1.04	1.04	(N/A)	(N/A)

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 10 Year

Return Event: 10 years
Storm Event: 10 Year

Peak Discharge	88.27 ft³/s
Time to Peak	12.200 hours
Hydrograph Volume	10.554 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
2.350	0.00	0.00	0.02	0.04	0.06
2.600	0.07	0.09	0.11	0.13	0.15
2.850	0.16	0.18	0.20	0.22	0.23
3.100	0.25	0.27	0.29	0.30	0.32
3.350	0.34	0.36	0.37	0.39	0.41
3.600	0.43	0.44	0.46	0.48	0.49
3.850	0.51	0.53	0.54	0.56	0.58
4.100	0.59	0.61	0.63	0.64	0.66
4.350	0.69	0.72	0.74	0.76	0.78
4.600	0.80	0.81	0.83	0.85	0.87
4.850	0.89	0.91	0.93	0.95	0.97
5.100	0.99	1.01	1.03	1.05	1.07
5.350	1.09	1.11	1.13	1.15	1.17
5.600	1.19	1.21	1.23	1.25	1.27
5.850	1.29	1.31	1.33	1.35	1.37
6.100	1.39	1.41	1.43	1.45	1.47
6.350	1.49	1.51	1.53	1.55	1.57
6.600	1.59	1.61	1.63	1.65	1.67
6.850	1.69	1.71	1.73	1.75	1.77
7.100	1.79	1.81	1.83	1.85	1.87
7.350	1.89	1.91	1.94	1.96	1.98
7.600	2.00	2.02	2.04	2.06	2.08
7.850	2.10	2.12	2.14	2.16	2.18
8.100	2.20	2.23	2.25	2.29	2.33
8.350	2.38	2.43	2.49	2.55	2.61
8.600	2.67	2.73	2.80	2.86	2.93
8.850	3.00	3.06	3.13	3.20	3.27
9.100	3.33	3.40	3.45	3.50	3.54
9.350	3.58	3.61	3.63	3.65	3.67
9.600	3.69	3.71	3.75	3.80	3.86
9.850	3.93	4.02	4.11	4.21	4.31
10.100	4.42	4.53	4.65	4.78	4.92
10.350	5.06	5.21	5.37	5.53	5.69
10.600	5.86	6.03	6.22	6.43	6.65
10.850	6.89	7.14	7.39	7.66	7.94
11.100	8.23	8.55	8.91	9.30	9.76
11.350	10.27	10.84	11.44	12.07	12.85
11.600	14.11	16.38	19.98	25.61	33.21
11.850	42.36	52.78	63.18	72.37	79.71

D1

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 10 Year

Return Event: 10 years
Storm Event: 10 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
12.100	85.02	87.86	88.27	86.77	83.62
12.350	79.33	74.08	67.98	60.65	52.08
12.600	42.75	33.99	26.74	21.43	17.71
12.850	15.23	13.46	12.32	11.52	10.91
13.100	10.41	9.98	9.60	9.26	8.96
13.350	8.68	8.42	8.18	7.96	7.75
13.600	7.54	7.34	7.15	6.97	6.80
13.850	6.63	6.48	6.32	6.17	6.03
14.100	5.89	5.75	5.63	5.52	5.42
14.350	5.34	5.27	5.20	5.14	5.09
14.600	5.03	4.98	4.93	4.88	4.83
14.850	4.78	4.73	4.68	4.63	4.57
15.100	4.52	4.47	4.42	4.37	4.32
15.350	4.27	4.22	4.17	4.12	4.07
15.600	4.02	3.97	3.92	3.87	3.82
15.850	3.77	3.72	3.67	3.62	3.57
16.100	3.52	3.48	3.43	3.39	3.36
16.350	3.33	3.30	3.28	3.26	3.24
16.600	3.22	3.20	3.18	3.16	3.15
16.850	3.13	3.11	3.09	3.07	3.06
17.100	3.04	3.02	3.00	2.98	2.97
17.350	2.95	2.93	2.91	2.89	2.88
17.600	2.86	2.84	2.82	2.80	2.79
17.850	2.77	2.75	2.73	2.71	2.70
18.100	2.68	2.66	2.64	2.62	2.60
18.350	2.59	2.57	2.55	2.53	2.51
18.600	2.50	2.48	2.46	2.44	2.42
18.850	2.41	2.39	2.37	2.35	2.33
19.100	2.32	2.30	2.28	2.26	2.24
19.350	2.23	2.21	2.19	2.17	2.15
19.600	2.14	2.12	2.10	2.08	2.06
19.850	2.04	2.03	2.01	1.99	1.97
20.100	1.95	1.94	1.92	1.91	1.90
20.350	1.89	1.88	1.88	1.87	1.87
20.600	1.86	1.86	1.86	1.85	1.85
20.850	1.85	1.84	1.84	1.83	1.83
21.100	1.83	1.82	1.82	1.82	1.81
21.350	1.81	1.81	1.80	1.80	1.79
21.600	1.79	1.79	1.78	1.78	1.78
21.850	1.77	1.77	1.77	1.76	1.76
22.100	1.75	1.75	1.75	1.74	1.74
22.350	1.74	1.73	1.73	1.73	1.72
22.600	1.72	1.72	1.71	1.71	1.70

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 10 Year

Return Event: 10 years
Storm Event: 10 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
22.850	1.70	1.70	1.69	1.69	1.69
23.100	1.68	1.68	1.68	1.67	1.67
23.350	1.66	1.66	1.66	1.65	1.65
23.600	1.65	1.64	1.64	1.64	1.63
23.850	1.63	1.63	1.62	1.62	(N/A)

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 25 Year

Return Event: 25 years
Storm Event: 25 Year

Peak Discharge	93.25 ft³/s
Time to Peak	12.200 hours
Hydrograph Volume	11.650 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
2.200	0.00	0.01	0.03	0.05	0.07
2.450	0.09	0.11	0.13	0.15	0.17
2.700	0.19	0.21	0.23	0.25	0.27
2.950	0.29	0.31	0.33	0.35	0.37
3.200	0.39	0.41	0.43	0.45	0.47
3.450	0.49	0.51	0.53	0.55	0.57
3.700	0.59	0.61	0.62	0.64	0.67
3.950	0.70	0.72	0.74	0.76	0.78
4.200	0.80	0.82	0.84	0.86	0.88
4.450	0.90	0.92	0.94	0.96	0.98
4.700	1.00	1.02	1.05	1.07	1.09
4.950	1.11	1.13	1.15	1.18	1.20
5.200	1.22	1.24	1.26	1.28	1.31
5.450	1.33	1.35	1.37	1.39	1.42
5.700	1.44	1.46	1.48	1.50	1.53
5.950	1.55	1.57	1.59	1.61	1.64
6.200	1.66	1.68	1.70	1.72	1.75
6.450	1.77	1.79	1.81	1.84	1.86
6.700	1.88	1.90	1.93	1.95	1.97
6.950	1.99	2.01	2.04	2.06	2.08
7.200	2.10	2.13	2.15	2.17	2.19
7.450	2.21	2.24	2.26	2.28	2.30
7.700	2.32	2.35	2.37	2.39	2.41
7.950	2.43	2.46	2.48	2.50	2.53
8.200	2.56	2.60	2.65	2.70	2.76
8.450	2.82	2.89	2.95	3.02	3.09
8.700	3.17	3.24	3.31	3.38	3.46
8.950	3.53	3.61	3.68	3.76	3.83
9.200	3.90	3.95	4.00	4.03	4.06
9.450	4.08	4.10	4.12	4.14	4.17
9.700	4.21	4.26	4.33	4.41	4.50
9.950	4.61	4.71	4.83	4.95	5.07
10.200	5.20	5.35	5.50	5.66	5.82
10.450	5.99	6.17	6.35	6.53	6.73
10.700	6.94	7.16	7.41	7.67	7.94
10.950	8.23	8.52	8.82	9.13	9.46
11.200	9.85	10.30	10.82	11.39	12.02
11.450	12.68	13.38	14.24	15.63	17.95
11.700	21.99	27.99	36.05	45.73	56.48

D1

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 25 Year

Return Event: 25 years
Storm Event: 25 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
11.950	67.10	76.22	83.91	89.46	92.54
12.200	93.25	92.05	89.32	85.49	80.73
12.450	75.16	68.80	61.33	52.61	43.13
12.700	34.24	26.94	21.67	18.03	15.68
12.950	13.97	12.86	12.07	11.46	10.96
13.200	10.53	10.15	9.81	9.52	9.24
13.450	8.99	8.74	8.49	8.26	8.04
13.700	7.83	7.63	7.44	7.26	7.09
13.950	6.92	6.76	6.60	6.44	6.29
14.200	6.16	6.04	5.93	5.84	5.77
14.450	5.69	5.63	5.57	5.51	5.45
14.700	5.39	5.34	5.28	5.23	5.17
14.950	5.12	5.06	5.01	4.95	4.89
15.200	4.84	4.78	4.73	4.67	4.62
15.450	4.56	4.51	4.45	4.40	4.34
15.700	4.29	4.23	4.18	4.12	4.07
15.950	4.01	3.96	3.90	3.85	3.80
16.200	3.75	3.71	3.67	3.64	3.61
16.450	3.59	3.57	3.54	3.52	3.50
16.700	3.48	3.46	3.44	3.42	3.40
16.950	3.38	3.36	3.34	3.32	3.30
17.200	3.28	3.26	3.24	3.22	3.20
17.450	3.18	3.16	3.15	3.13	3.11
17.700	3.09	3.07	3.05	3.03	3.01
17.950	2.99	2.97	2.95	2.93	2.91
18.200	2.89	2.87	2.85	2.83	2.81
18.450	2.79	2.77	2.75	2.73	2.71
18.700	2.69	2.67	2.65	2.63	2.61
18.950	2.59	2.57	2.55	2.53	2.51
19.200	2.49	2.47	2.45	2.43	2.41
19.450	2.39	2.37	2.35	2.34	2.32
19.700	2.30	2.28	2.26	2.24	2.22
19.950	2.20	2.18	2.16	2.14	2.12
20.200	2.10	2.09	2.08	2.07	2.06
20.450	2.05	2.05	2.04	2.04	2.03
20.700	2.03	2.03	2.02	2.02	2.01
20.950	2.01	2.01	2.00	2.00	1.99
21.200	1.99	1.99	1.98	1.98	1.97
21.450	1.97	1.97	1.96	1.96	1.95
21.700	1.95	1.95	1.94	1.94	1.93
21.950	1.93	1.93	1.92	1.92	1.92
22.200	1.91	1.91	1.90	1.90	1.90
22.450	1.89	1.89	1.88	1.88	1.88

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 25 Year

Return Event: 25 years
Storm Event: 25 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
22.700	1.87	1.87	1.86	1.86	1.86
22.950	1.85	1.85	1.84	1.84	1.84
23.200	1.83	1.83	1.82	1.82	1.82
23.450	1.81	1.81	1.80	1.80	1.80
23.700	1.79	1.79	1.79	1.78	1.78
23.950	1.77	1.77	(N/A)	(N/A)	(N/A)

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 100 Year

Return Event: 100 years
Storm Event: 100 Year

Peak Discharge	158.25 ft³/s
Time to Peak	12.150 hours
Hydrograph Volume	14.820 ac-ft

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
1.800	0.00	0.00	0.03	0.05	0.08
2.050	0.10	0.13	0.16	0.19	0.21
2.300	0.24	0.27	0.30	0.33	0.36
2.550	0.39	0.41	0.44	0.47	0.50
2.800	0.52	0.55	0.58	0.61	0.63
3.050	0.66	0.71	0.74	0.77	0.80
3.300	0.83	0.85	0.88	0.90	0.93
3.550	0.95	0.98	1.00	1.03	1.05
3.800	1.07	1.10	1.12	1.14	1.17
4.050	1.19	1.21	1.24	1.26	1.28
4.300	1.31	1.34	1.36	1.39	1.41
4.550	1.44	1.47	1.50	1.52	1.55
4.800	1.58	1.61	1.63	1.66	1.69
5.050	1.71	1.74	1.77	1.80	1.82
5.300	1.85	1.88	1.91	1.93	1.96
5.550	1.99	2.02	2.05	2.07	2.10
5.800	2.13	2.16	2.18	2.21	2.24
6.050	2.27	2.29	2.32	2.35	2.38
6.300	2.41	2.43	2.46	2.49	2.52
6.550	2.54	2.57	2.60	2.62	2.65
6.800	2.68	2.71	2.73	2.76	2.79
7.050	2.82	2.84	2.87	2.90	2.92
7.300	2.95	2.98	3.00	3.03	3.06
7.550	3.08	3.11	3.14	3.16	3.19
7.800	3.22	3.24	3.27	3.30	3.32
8.050	3.35	3.38	3.41	3.45	3.50
8.300	3.56	3.63	3.71	3.79	3.88
8.550	3.97	4.06	4.15	4.24	4.33
8.800	4.43	4.52	4.62	4.71	4.81
9.050	4.90	5.00	5.08	5.16	5.23
9.300	5.28	5.32	5.36	5.38	5.41
9.550	5.43	5.45	5.48	5.53	5.59
9.800	5.68	5.78	5.90	6.03	6.17
10.050	6.31	6.46	6.62	6.79	6.97
10.300	7.16	7.36	7.57	7.79	8.01
10.550	8.24	8.47	8.72	8.98	9.25
10.800	9.55	9.87	10.22	10.57	10.94
11.050	11.32	11.72	12.16	12.66	13.24
11.300	13.89	14.62	15.41	16.20	17.01

D1

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 100 Year

Return Event: 100 years
Storm Event: 100 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
11.550	18.03	19.69	22.73	27.54	34.80
11.800	44.08	54.67	65.79	76.20	86.12
12.050	94.43	116.01	158.25	128.08	100.49
12.300	97.55	94.70	91.00	86.56	81.39
12.550	75.55	69.03	61.50	52.79	43.45
12.800	34.88	27.99	23.13	19.66	17.45
13.050	15.96	14.77	13.92	13.26	12.73
13.300	12.29	11.90	11.55	11.23	10.92
13.550	10.63	10.35	10.07	9.81	9.56
13.800	9.32	9.09	8.87	8.65	8.44
14.050	8.24	8.04	7.86	7.69	7.54
14.300	7.41	7.29	7.20	7.11	7.02
14.550	6.95	6.87	6.80	6.73	6.66
14.800	6.59	6.52	6.45	6.38	6.31
15.050	6.24	6.18	6.11	6.04	5.97
15.300	5.90	5.83	5.76	5.69	5.62
15.550	5.56	5.49	5.42	5.35	5.28
15.800	5.21	5.14	5.07	5.00	4.93
16.050	4.87	4.80	4.73	4.68	4.62
16.300	4.58	4.54	4.50	4.47	4.44
16.550	4.42	4.39	4.36	4.34	4.31
16.800	4.29	4.26	4.24	4.21	4.19
17.050	4.17	4.14	4.12	4.09	4.07
17.300	4.04	4.02	3.99	3.97	3.94
17.550	3.92	3.89	3.87	3.85	3.82
17.800	3.80	3.77	3.75	3.72	3.70
18.050	3.67	3.65	3.63	3.60	3.58
18.300	3.55	3.53	3.50	3.48	3.45
18.550	3.43	3.40	3.38	3.36	3.33
18.800	3.31	3.28	3.26	3.23	3.21
19.050	3.18	3.16	3.13	3.11	3.08
19.300	3.06	3.03	3.01	2.99	2.96
19.550	2.94	2.91	2.89	2.86	2.84
19.800	2.81	2.79	2.76	2.74	2.71
20.050	2.69	2.67	2.64	2.62	2.60
20.300	2.59	2.58	2.57	2.56	2.55
20.550	2.55	2.54	2.54	2.53	2.53
20.800	2.52	2.52	2.51	2.51	2.50
21.050	2.50	2.49	2.49	2.48	2.48
21.300	2.47	2.47	2.46	2.46	2.45
21.550	2.45	2.44	2.44	2.43	2.43
21.800	2.42	2.42	2.41	2.41	2.40
22.050	2.40	2.39	2.39	2.38	2.38

Subsection: Pond Routed Hydrograph (total out)
Label: PO-1 (OUT)
Scenario: Post-Development 100 Year

Return Event: 100 years
Storm Event: 100 Year

HYDROGRAPH ORDINATES (ft³/s)
Output Time Increment = 0.050 hours
Time on left represents time for first value in each row.

Time (hours)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)	Flow (ft³/s)
22.300	2.37	2.37	2.36	2.36	2.35
22.550	2.35	2.34	2.34	2.33	2.33
22.800	2.32	2.32	2.31	2.31	2.30
23.050	2.30	2.29	2.29	2.28	2.28
23.300	2.27	2.27	2.26	2.26	2.25
23.550	2.25	2.24	2.24	2.23	2.23
23.800	2.22	2.22	2.21	2.21	2.20

Index

Appendix E

SAINT LUKE'S HOSPITAL OF LEE'S SUMMIT

STORM WATER DETENTION STUDY

Highway I-470 and Douglas Street
Lee's Summit, Missouri

2002-324

Prepared by:

Shafer Kline & Warren, Inc.
December 12, 2002

STORM WATER DETENTION STUDY
SAINT LUKE'S HOSPITAL OF LEE'S SUMMIT, MO
DECEMBER 12, 2002

Project Description

The project consists of a proposed hospital and related medical buildings with parking lots and drives on 41.4 acres located at US Highway I-470 and Douglas Street.

Existing Conditions

The property is currently undeveloped with one residential building, gravel drive and an asphalt drive which leads to an existing pump station. The ground cover consists of weeds and grasses of inconsistent coverage. The site has a ridge line to the south and drains in two directions across the site, from south to north and east to west, at a 4 to 6 percent slope.

Analysis

In accordance with the City of Lee's Summit design criteria the site was analyzed for the 25 year return frequency storm. The storm water runoff detention basin was designed to detain the difference between the existing and proposed peak runoff. The basin is also designed to offset the runoff from a 15.2 acre portion of the site which drains to the offsite drainage ditch without passing through the detention basin. TR55 and Haestad Pond-2 were used to analyze the site and design the detention basin. The results of the analysis are as follows:

The existing 25 year peak runoff for the entire site is 252 cfs.
The full site developed 25 year peak runoff is 301 cfs.
The developed 25 year peak runoff for the portion which bypasses the basin is 110 cfs.
The developed 25 year peak runoff for the portion draining to the detention basin is 190 cfs.
The maximum basin outflow would be (existing minus bypass) 142 cfs.

A detention basin is required to detain the 25 year runoff with a maximum release rate of 142 cfs. The proposed detention basin is designed for a peak storage of 67, 953 cu. ft. (1.56 ac-ft) and a peak outflow of 93.28 cfs for the 25 year storm, which is less than the maximum outflow of 142 cfs. Due to site conditions the storm drainage system is designed to convey the 100 year return frequency storm. The basin outlet and overflow weir are designed convey the 100 year overflow to the offsite drainage ditch. Refer to the attached calculations, tabular hydrographs and routing tables for detailed information on the analysis and design.

REVISIONS TO
STORM WATER DETENTION STUDY
SAINT LUKE'S HOSPITAL OF LEE'S SUMMIT, MO
June 27, 2003

At the request of the City, we have re-evaluated our curve number computations for the Saint Luke's Hospital site by using an older version of TR-55 (version 1.11) which gives a more detailed computation. The curve numbers are calculated using the actual impervious and pervious area for the developed site. The revised curve numbers are slightly different form those previously computed thru TR-55 version 5.46. Attached are the curve number computation summaries along with re-computed hydrographs and basin routings for the 25 year and 100 year return frequency storms. All offsite areas to the south and in Douglas Street are included. A revised summary is as follows:

Total site area is 41.3 acres
St Luke's property draining to the basin is 26.22 acres
Offsite area draining to the basin is 1.63 acres
St Luke's property which bypasses the basin is 15.1 acres

Existing 25 year peak runoff for the entire site is 239 cfs
Full site developed 25 year peak runoff is 302 cfs
The developed 25 year peak runoff which bypasses the basin (15.1 ac) is 105 cfs
The developed 25 year peak runoff draining to the detention basin (26.22 ac) is 197 cfs.
The maximum allowable 25 year release rate (existing - bypass) is 134 cfs

The peak release rate for a 25 year storm from the basin is 94.45 cfs
The peak storage for the detention basin is 72,310 cu ft

SAINT LUKE'S, LEE'S SUMMIT
DECEMBER 11, 02

PRELIMINARY VOLUME COMPUTATION

ELEV.	AREA SQ.FT.	INCREMENTAL VOLUME CU. FT.		STAGE STORAGE CU. FT.	STAGE STORAGE AC-FT
960	0	0		0	0
961	500	250		250	0.0057392103
962	1000	750		1000	0.0229568411
963	2165	1582.5		2582.5	0.0592860422
964	3573	2869		5451.5	0.1251492195
965	6768	5170.5		10622	0.2438475666
966	8463	7615.5		18237.5	0.4186753903
967	13168	10815.5		29053	0.6669651056
968	17873	15520.5		44573.5	1.0232667585
969	21131	19502		64075.5	1.4709710744
970	24388	22759.5		86835	1.9934573003
971	26589	25488.5		112323.5	2.5785927456
972	28789	27689		140012.5	3.2142447199
0	0			140012.5	3.2142447199
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
0	0	ERR		ERR	ERR
					0
		TOTAL VOLUME		140012.5	

OUTFALL SIZING:
ST LUKE'S LEE'S SUMMIT HOSPITAL
12/11/02

ORIFICE PIPE		
	PIPE SIZE (IN)	36
	PIPE ELEV.	960
ELEVATION	HEIGHT	OUTFLOW
	H (FT)	Q (CFS)
962	0.50	23.83
963	1.50	41.27
964	2.50	53.28
965	3.50	63.04
966	4.50	71.48
967	5.50	79.02
968	6.50	85.91
969	7.50	92.28
970	8.50	98.24
971	9.50	103.86
972	10.50	109.19
973	11.50	114.27

OVERFLOW WEIR
$Q=CLH^{3/2}$
C=3
L=40'
H=0.5, 1, 2

$Q(.5)=3*40*(0.5)^{3/2}$
Q(0.5)=42.43 cfs

$Q(1)=3*40*(1)^{3/2}$
Q(1)= 120cfs

$Q(2)=3*40*(2)^{3/2}$
Q(2)= 339.4 cfs

Quick TR-55 Ver.5.46 S/N:
Executed: 14:26:51 06-26-2003

Saint Luke's Lee's Summit Hospital
existing conditions

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
exist	41.44	77

E1

Quick TR-55 Ver.5.46 S/N:
Executed: 14:26:51 06-26-2003

Saint Luke's Lee's Summit Hospital
existing conditions

RUNOFF CURVE NUMBER DATA

Composite Area: exist

SURFACE DESCRIPTION	AREA (acres)	CN	
roads and building	0.47	98	
Type B soil, grass, poor cond	20.49	69	
Type D soil, grass, poor cond.	20.48	84	
COMPOSITE AREA --->	41.44	76.7	(77)

E1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 25EX803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
exist	41.44	77.0	0.10	0.00	6.20	3.65	I.1 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 41.44 acres or 0.06475 sq.mi
Peak discharge = 239 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
exist	0.11	0.00	0.10	0.00	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.

E1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 25EX803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
exist	239	12.1
Composite Watershed	239	12.1

E1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 25EX803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
exist	6	8	13	79	153	239	148	51	35
Total (cfs)	6	8	13	79	153	239	148	51	35

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
exist	29	25	20	18	16	13	12	11	10
Total (cfs)	29	25	20	18	16	13	12	11	10

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
exist	9	8	8	7	6	5	5	5	4
Total (cfs)	9	8	8	7	6	5	5	5	4

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
exist	4	4	3	3	0
Total (cfs)	4	4	3	3	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 25EX803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	6	14.8	8
11.1	7	14.9	7
11.2	7	15.0	7
11.3	8	15.1	7
11.4	10	15.2	7
11.5	11	15.3	6
11.6	13	15.4	6
11.7	35	15.5	6
11.8	57	15.6	6
11.9	79	15.7	6
12.0	153	15.8	5
12.1	239	15.9	5
12.2	148	16.0	5
12.3	51	16.1	5
12.4	35	16.2	5
12.5	29	16.3	5
12.6	25	16.4	5
12.7	20	16.5	5
12.8	18	16.6	5
12.9	17	16.7	5
13.0	16	16.8	5
13.1	14	16.9	5
13.2	13	17.0	5
13.3	12	17.1	5
13.4	12	17.2	5
13.5	12	17.3	4
13.6	11	17.4	4
13.7	10	17.5	4
13.8	10	17.6	4
13.9	9	17.7	4
14.0	9	17.8	4
14.1	9	17.9	4
14.2	8	18.0	4
14.3	8	18.1	4
14.4	8	18.2	4
14.5	8	18.3	4
14.6	8	18.4	4
14.7	8	18.5	4

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 25EX803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	4	22.4	3
18.7	4	22.5	3
18.8	4	22.6	3
18.9	4	22.7	2
19.0	4	22.8	2
19.1	4	22.9	2
19.2	4	23.0	2
19.3	4	23.1	2
19.4	4	23.2	2
19.5	4	23.3	2
19.6	3	23.4	2
19.7	3	23.5	2
19.8	3	23.6	2
19.9	3	23.7	2
20.0	3	23.8	2
20.1	3	23.9	2
20.2	3	24.0	2
20.3	3	24.1	1
20.4	3	24.2	1
20.5	3	24.3	1
20.6	3	24.4	1
20.7	3	24.5	1
20.8	3	24.6	1
20.9	3	24.7	1
21.0	3	24.8	1
21.1	3	24.9	1
21.2	3	25.0	1
21.3	3	25.1	1
21.4	3	25.2	1
21.5	3	25.3	1
21.6	3	25.4	0
21.7	3	25.5	0
21.8	3	25.6	0
21.9	3	25.7	0
22.0	3	25.8	0
22.1	3	25.9	0
22.2	3		
22.3	3		

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 100X803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
exist	41.44	77.0	0.10	0.00	7.70	5.00	I.08 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 41.44 acres or 0.06475 sq.mi
Peak discharge = 327 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
exist	0.11	0.00	0.10	0.00	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.

E1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 100X803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
exist	327	12.1
Composite Watershed	327	12.1

E1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 100X803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
exist	8	11	17	108	209	327	203	70	48
Total (cfs)	8	11	17	108	209	327	203	70	48

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
exist	40	34	28	25	21	18	17	15	14
Total (cfs)	40	34	28	25	21	18	17	15	14

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
exist	12	11	10	9	8	7	7	6	6
Total (cfs)	12	11	10	9	8	7	7	6	6

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
exist	6	5	4	4	0
Total (cfs)	6	5	4	4	0

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 100X803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	8	14.8	9
11.1	9	14.9	9
11.2	10	15.0	9
11.3	11	15.1	9
11.4	13	15.2	9
11.5	15	15.3	8
11.6	17	15.4	8
11.7	47	15.5	8
11.8	78	15.6	8
11.9	108	15.7	8
12.0	209	15.8	7
12.1	327	15.9	7
12.2	203	16.0	7
12.3	70	16.1	7
12.4	48	16.2	7
12.5	40	16.3	7
12.6	34	16.4	7
12.7	28	16.5	7
12.8	25	16.6	7
12.9	23	16.7	7
13.0	21	16.8	6
13.1	20	16.9	6
13.2	18	17.0	6
13.3	18	17.1	6
13.4	17	17.2	6
13.5	16	17.3	6
13.6	15	17.4	6
13.7	14	17.5	6
13.8	14	17.6	6
13.9	13	17.7	6
14.0	12	17.8	6
14.1	12	17.9	6
14.2	11	18.0	6
14.3	11	18.1	6
14.4	11	18.2	6
14.5	10	18.3	6
14.6	10	18.4	6
14.7	10	18.5	6

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 14:29:07
Watershed file: --> EX32803R.MOP
Hydrograph file: --> 100X803R.HYD

Saint Luke's Lee's Summit Hospital
Existing conditions

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	5	22.4	4
18.7	5	22.5	4
18.8	5	22.6	3
18.9	5	22.7	3
19.0	5	22.8	3
19.1	5	22.9	3
19.2	5	23.0	3
19.3	5	23.1	3
19.4	5	23.2	3
19.5	4	23.3	3
19.6	4	23.4	3
19.7	4	23.5	2
19.8	4	23.6	2
19.9	4	23.7	2
20.0	4	23.8	2
20.1	4	23.9	2
20.2	4	24.0	2
20.3	4	24.1	2
20.4	4	24.2	2
20.5	4	24.3	2
20.6	4	24.4	2
20.7	4	24.5	2
20.8	4	24.6	1
20.9	4	24.7	1
21.0	4	24.8	1
21.1	4	24.9	1
21.2	4	25.0	1
21.3	4	25.1	1
21.4	4	25.2	1
21.5	4	25.3	1
21.6	4	25.4	1
21.7	4	25.5	0
21.8	4	25.6	0
21.9	4	25.7	0
22.0	4	25.8	0
22.1	4	25.9	0
22.2	4		
22.3	4		

Quick TR-55 Ver.5.46 S/N:
Executed: 10:52:45 06-26-2003

Saint Luke's Lee's Summit Hospital
Proposed conditions
portion of site draining to
the detention basin (includes offsite)

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
proposed site	27.85	85

E1

Quick TR-55 Ver.5.46 S/N:
Executed: 10:52:45 06-26-2003

Saint Luke's Lee's Summit Hospital
Proposed conditions
portion of site draining to
the detention basin (includes offsite)

RUNOFF CURVE NUMBER DATA

Composite Area: proposed site

SURFACE DESCRIPTION	AREA (acres)	CN	
buildings, drives, parkinglot	13.00	98	
Type B soil, grass area	6.73	61	
Type D soil, grass area	6.72	80	
Douglas St pavement	1.40	98	
COMPOSITE AREA --->	27.85	84.7	(85)

E1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNR25.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
proposed site	27.85	85.0	0.10	0.00	6.20	4.49	I.06 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 27.85 acres or 0.04352 sq.mi
Peak discharge = 197 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
proposed site	0.10	0.00	**	**	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNR25.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
proposed site	197	12.1
Composite Watershed	197	12.1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNR25.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
proposed site	5	7	10	65	126	197	123	42	29
Total (cfs)	5	7	10	65	126	197	123	42	29

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
proposed site	24	20	17	15	13	11	10	9	8
Total (cfs)	24	20	17	15	13	11	10	9	8

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
proposed site	7	7	6	6	5	4	4	4	4
Total (cfs)	7	7	6	6	5	4	4	4	4

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
proposed site	4	3	3	2	0
Total (cfs)	4	3	3	2	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNR25.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	5	14.8	6
11.1	6	14.9	6
11.2	6	15.0	6
11.3	7	15.1	6
11.4	8	15.2	6
11.5	9	15.3	5
11.6	10	15.4	5
11.7	28	15.5	5
11.8	47	15.6	5
11.9	65	15.7	5
12.0	126	15.8	4
12.1	197	15.9	4
12.2	123	16.0	4
12.3	42	16.1	4
12.4	29	16.2	4
12.5	24	16.3	4
12.6	20	16.4	4
12.7	17	16.5	4
12.8	15	16.6	4
12.9	14	16.7	4
13.0	13	16.8	4
13.1	12	16.9	4
13.2	11	17.0	4
13.3	10	17.1	4
13.4	10	17.2	4
13.5	10	17.3	4
13.6	9	17.4	4
13.7	8	17.5	4
13.8	8	17.6	4
13.9	8	17.7	4
14.0	7	17.8	4
14.1	7	17.9	4
14.2	7	18.0	4
14.3	7	18.1	4
14.4	7	18.2	4
14.5	6	18.3	4
14.6	6	18.4	4
14.7	6	18.5	4

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNR25.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	3	22.4	2
18.7	3	22.5	2
18.8	3	22.6	2
18.9	3	22.7	2
19.0	3	22.8	2
19.1	3	22.9	2
19.2	3	23.0	2
19.3	3	23.1	1
19.4	3	23.2	1
19.5	3	23.3	1
19.6	3	23.4	1
19.7	3	23.5	1
19.8	3	23.6	1
19.9	3	23.7	1
20.0	3	23.8	1
20.1	3	23.9	1
20.2	3	24.0	1
20.3	3	24.1	1
20.4	3	24.2	1
20.5	3	24.3	1
20.6	3	24.4	1
20.7	3	24.5	1
20.8	3	24.6	1
20.9	3	24.7	1
21.0	2	24.8	1
21.1	2	24.9	1
21.2	2	25.0	0
21.3	2	25.1	0
21.4	2	25.2	0
21.5	2	25.3	0
21.6	2	25.4	0
21.7	2	25.5	0
21.8	2	25.6	0
21.9	2	25.7	0
22.0	2	25.8	0
22.1	2	25.9	0
22.2	2		
22.3	2		

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNRHU.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
proposed site	27.85	85.0	0.10	0.00	7.70	5.92	I.05 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 27.85 acres or 0.04352 sq.mi
Peak discharge = 260 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	Input Values * Tt (hr)	Rounded Values Tc (hr)	Rounded Values * Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
proposed site	0.10	0.00	**	**	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.
** Tc & Tt are available in the hydrograph tables.

E1

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNRHU.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
proposed site	260	12.1
Composite Watershed	260	12.1

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNRHU.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
proposed site	6	9	14	86	167	260	162	56	38
Total (cfs)	6	9	14	86	167	260	162	56	38

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
proposed site	32	27	22	20	17	15	13	12	11
Total (cfs)	32	27	22	20	17	15	13	12	11

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
proposed site	10	9	8	7	7	6	5	5	5
Total (cfs)	10	9	8	7	7	6	5	5	5

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
proposed site	5	4	3	3	0
Total (cfs)	5	4	3	3	0

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNRHU.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	6	14.8	8
11.1	7	14.9	7
11.2	8	15.0	7
11.3	9	15.1	7
11.4	11	15.2	7
11.5	12	15.3	7
11.6	14	15.4	7
11.7	38	15.5	7
11.8	62	15.6	7
11.9	86	15.7	7
12.0	167	15.8	6
12.1	260	15.9	6
12.2	162	16.0	6
12.3	56	16.1	6
12.4	38	16.2	6
12.5	32	16.3	5
12.6	27	16.4	5
12.7	22	16.5	5
12.8	20	16.6	5
12.9	18	16.7	5
13.0	17	16.8	5
13.1	16	16.9	5
13.2	15	17.0	5
13.3	14	17.1	5
13.4	13	17.2	5
13.5	12	17.3	5
13.6	12	17.4	5
13.7	12	17.5	5
13.8	11	17.6	5
13.9	10	17.7	5
14.0	10	17.8	5
14.1	10	17.9	5
14.2	9	18.0	5
14.3	9	18.1	5
14.4	9	18.2	5
14.5	8	18.3	5
14.6	8	18.4	5
14.7	8	18.5	4

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 10:55:11
Watershed file: --> PR803BNR.MOP
Hydrograph file: --> 803BNRHU.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
portion which drains to the detention basin

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	4	22.4	3
18.7	4	22.5	3
18.8	4	22.6	3
18.9	4	22.7	2
19.0	4	22.8	2
19.1	4	22.9	2
19.2	4	23.0	2
19.3	4	23.1	2
19.4	4	23.2	2
19.5	4	23.3	2
19.6	3	23.4	2
19.7	3	23.5	2
19.8	3	23.6	2
19.9	3	23.7	2
20.0	3	23.8	2
20.1	3	23.9	2
20.2	3	24.0	2
20.3	3	24.1	1
20.4	3	24.2	1
20.5	3	24.3	1
20.6	3	24.4	1
20.7	3	24.5	1
20.8	3	24.6	1
20.9	3	24.7	1
21.0	3	24.8	1
21.1	3	24.9	1
21.2	3	25.0	1
21.3	3	25.1	1
21.4	3	25.2	1
21.5	3	25.3	1
21.6	3	25.4	0
21.7	3	25.5	0
21.8	3	25.6	0
21.9	3	25.7	0
22.0	3	25.8	0
22.1	3	25.9	0
22.2	3		
22.3	3		

Quick TR-55 Ver.5.46 S/N:
Executed: 10:40:32 06-26-2003

Saint Luke's Lee's Summit Hospital
proposed conditions
flow which bypasses the detention basin

RUNOFF CURVE NUMBER SUMMARY

Subarea Description	Area (acres)	CN (weighted)
bypass	15.22	84

E1

Quick TR-55 Ver.5.46 S/N:
Executed: 10:40:32 06-26-2003

Saint Luke's Lee's Summit Hospital
proposed conditions
flow which bypasses the detention basin

RUNOFF CURVE NUMBER DATA

Composite Area: bypass

SURFACE DESCRIPTION	AREA (acres)	CN	
Type B soil, grass area	3.74	61	
Type D soil, grass area	3.74	80	
building, drives, parking lots	7.74	98	
COMPOSITE AREA --->	15.22	84.5	(84)

E1

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> 25OFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
bypass	15.22	84.0	0.10	0.00	6.20	4.38	I.06 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 15.22 acres or 0.02378 sq.mi
Peak discharge = 105 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
bypass	0.13	0.00	0.10	0.00	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.

E1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> 25OFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
bypass	105	12.1
Composite Watershed	105	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> 25OFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
bypass	2	4	6	35	67	105	65	23	15
Total (cfs)	2	4	6	35	67	105	65	23	15

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
bypass	13	11	9	8	7	6	5	5	4
Total (cfs)	13	11	9	8	7	6	5	5	4

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
bypass	4	4	3	3	3	2	2	2	2
Total (cfs)	4	4	3	3	3	2	2	2	2

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
bypass	2	2	1	1	0
Total (cfs)	2	2	1	1	0

Return Frequency: 25 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> 25OFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	2	14.8	3
11.1	3	14.9	3
11.2	3	15.0	3
11.3	4	15.1	3
11.4	5	15.2	3
11.5	5	15.3	3
11.6	6	15.4	3
11.7	16	15.5	3
11.8	25	15.6	3
11.9	35	15.7	3
12.0	67	15.8	2
12.1	105	15.9	2
12.2	65	16.0	2
12.3	23	16.1	2
12.4	15	16.2	2
12.5	13	16.3	2
12.6	11	16.4	2
12.7	9	16.5	2
12.8	8	16.6	2
12.9	8	16.7	2
13.0	7	16.8	2
13.1	6	16.9	2
13.2	6	17.0	2
13.3	6	17.1	2
13.4	5	17.2	2
13.5	5	17.3	2
13.6	5	17.4	2
13.7	4	17.5	2
13.8	4	17.6	2
13.9	4	17.7	2
14.0	4	17.8	2
14.1	4	17.9	2
14.2	4	18.0	2
14.3	4	18.1	2
14.4	4	18.2	2
14.5	3	18.3	2
14.6	3	18.4	2
14.7	3	18.5	2

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> 25OFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	2	22.4	1
18.7	2	22.5	1
18.8	2	22.6	1
18.9	2	22.7	1
19.0	2	22.8	1
19.1	2	22.9	1
19.2	2	23.0	1
19.3	2	23.1	1
19.4	2	23.2	1
19.5	2	23.3	1
19.6	1	23.4	1
19.7	1	23.5	1
19.8	1	23.6	1
19.9	1	23.7	1
20.0	1	23.8	1
20.1	1	23.9	1
20.2	1	24.0	0
20.3	1	24.1	0
20.4	1	24.2	0
20.5	1	24.3	0
20.6	1	24.4	0
20.7	1	24.5	0
20.8	1	24.6	0
20.9	1	24.7	0
21.0	1	24.8	0
21.1	1	24.9	0
21.2	1	25.0	0
21.3	1	25.1	0
21.4	1	25.2	0
21.5	1	25.3	0
21.6	1	25.4	0
21.7	1	25.5	0
21.8	1	25.6	0
21.9	1	25.7	0
22.0	1	25.8	0
22.1	1	25.9	0
22.2	1		
22.3	1		

Return Frequency: 100 years

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> HUOFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

>>>> Input Parameters Used to Compute Hydrograph <<<<

Subarea Description	AREA (acres)	CN	Tc (hrs)	* Tt (hrs)	Precip. (in)	Runoff (in)	Ia/p input/used
bypass	15.22	84.0	0.10	0.00	7.70	5.81	I.05 .10

* Travel time from subarea outfall to composite watershed outfall point.
I -- Subarea where user specified interpolation between Ia/p tables.

Total area = 15.22 acres or 0.02378 sq.mi
Peak discharge = 140 cfs

>>>> Computer Modifications of Input Parameters <<<<<

Subarea Description	Input Values Tc (hr)	* Tt (hr)	Rounded Values Tc (hr)	* Tt (hr)	Ia/p Interpolated (Yes/No)	Ia/p Messages
bypass	0.13	0.00	0.10	0.00	No	Computed Ia/p < .1

* Travel time from subarea outfall to composite watershed outfall point.

E1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> HUOFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

>>>> Summary of Subarea Times to Peak <<<<

Subarea	Peak Discharge at Composite Outfall (cfs)	Time to Peak at Composite Outfall (hrs)
bypass	140	12.1
Composite Watershed	140	12.1

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> HUOFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

Composite Hydrograph Summary (cfs)

Subarea Description	11.0 hr	11.3 hr	11.6 hr	11.9 hr	12.0 hr	12.1 hr	12.2 hr	12.3 hr	12.4 hr
bypass	3	5	7	46	89	140	87	30	20
Total (cfs)	3	5	7	46	89	140	87	30	20

Subarea Description	12.5 hr	12.6 hr	12.7 hr	12.8 hr	13.0 hr	13.2 hr	13.4 hr	13.6 hr	13.8 hr
bypass	17	14	12	11	9	8	7	6	6
Total (cfs)	17	14	12	11	9	8	7	6	6

Subarea Description	14.0 hr	14.3 hr	14.6 hr	15.0 hr	15.5 hr	16.0 hr	16.5 hr	17.0 hr	17.5 hr
bypass	5	5	4	4	4	3	3	3	3
Total (cfs)	5	5	4	4	4	3	3	3	3

Subarea Description	18.0 hr	19.0 hr	20.0 hr	22.0 hr	26.0 hr
bypass	2	2	2	2	0
Total (cfs)	2	2	2	2	0

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> HUOFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
11.0	3	14.8	4
11.1	4	14.9	4
11.2	4	15.0	4
11.3	5	15.1	4
11.4	6	15.2	4
11.5	6	15.3	4
11.6	7	15.4	4
11.7	20	15.5	4
11.8	33	15.6	4
11.9	46	15.7	4
12.0	89	15.8	3
12.1	140	15.9	3
12.2	87	16.0	3
12.3	30	16.1	3
12.4	20	16.2	3
12.5	17	16.3	3
12.6	14	16.4	3
12.7	12	16.5	3
12.8	11	16.6	3
12.9	10	16.7	3
13.0	9	16.8	3
13.1	8	16.9	3
13.2	8	17.0	3
13.3	8	17.1	3
13.4	7	17.2	3
13.5	7	17.3	3
13.6	6	17.4	3
13.7	6	17.5	3
13.8	6	17.6	3
13.9	6	17.7	3
14.0	5	17.8	2
14.1	5	17.9	2
14.2	5	18.0	2
14.3	5	18.1	2
14.4	5	18.2	2
14.5	4	18.3	2
14.6	4	18.4	2
14.7	4	18.5	2

TR-55 TABULAR HYDROGRAPH METHOD
Type II. Distribution
(24 hr. Duration Storm)

Executed: 06-26-2003 13:37:02
Watershed file: --> PR803OFR.MOP
Hydrograph file: --> HUOFR803.HYD

Saint Luke's Lee's Summit Hospital
proposed conditions
area bypassing the detention basin
includes offsite area

Time (hrs)	Flow (cfs)	Time (hrs)	Flow (cfs)
18.6	2	22.4	2
18.7	2	22.5	2
18.8	2	22.6	2
18.9	2	22.7	2
19.0	2	22.8	2
19.1	2	22.9	2
19.2	2	23.0	2
19.3	2	23.1	1
19.4	2	23.2	1
19.5	2	23.3	1
19.6	2	23.4	1
19.7	2	23.5	1
19.8	2	23.6	1
19.9	2	23.7	1
20.0	2	23.8	1
20.1	2	23.9	1
20.2	2	24.0	1
20.3	2	24.1	1
20.4	2	24.2	1
20.5	2	24.3	1
20.6	2	24.4	1
20.7	2	24.5	1
20.8	2	24.6	1
20.9	2	24.7	1
21.0	2	24.8	1
21.1	2	24.9	1
21.2	2	25.0	0
21.3	2	25.1	0
21.4	2	25.2	0
21.5	2	25.3	0
21.6	2	25.4	0
21.7	2	25.5	0
21.8	2	25.6	0
21.9	2	25.7	0
22.0	2	25.8	0
22.1	2	25.9	0
22.2	2		
22.3	2		

E1

Saint Luke's Lee's Summit Hospital
proposed detention basin outfall pipe
36 inch

Inflow Hydrograph: c:\pond55\803BNR25.HYD
Rating Table file: c:\pond55\803OUTFL.PND

----INITIAL CONDITIONS----
Elevation = 960.00 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
960.00	0.0	0.000
961.00	12.0	0.006
962.00	23.8	0.023
963.00	41.3	0.059
964.00	53.3	0.125
965.00	63.0	0.244
966.00	71.5	0.419
967.00	79.0	0.667
968.00	85.9	1.023
969.00	92.3	1.471
970.00	98.2	1.993
970.50	137.7	2.286
971.00	223.9	2.579
972.00	448.0	3.214

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
1.4	13.4
5.5	29.4
14.4	55.6
30.3	83.6
59.0	122.0
101.3	172.8
161.4	240.4
247.6	333.5
356.0	448.3
482.4	580.6
553.2	690.9
624.0	847.9
777.8	1225.8

Time increment (t) = 0.100 hrs.

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNR25.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	5.00	-----	0.0	0.0	0.00	960.00
11.100	6.00	11.0	-8.7	11.0	9.87	960.82
11.200	6.00	12.0	-2.6	3.3	2.93	960.24
11.300	7.00	13.0	-8.3	10.4	9.33	960.78
11.400	8.00	15.0	-5.4	6.7	6.05	960.50
11.500	9.00	17.0	-9.2	11.6	10.45	960.87
11.600	10.00	19.0	-7.7	9.8	8.75	960.73
11.700	28.00	38.0	-18.6	30.3	24.42	962.03
11.800	47.00	75.0	-26.8	56.4	41.61	963.03
11.900	65.00	112.0	-22.2	85.2	53.70	964.04
12.000	126.00	191.0	27.2	168.8	70.81	965.92
12.100	197.00	323.0	176.5	350.2	86.83	968.14
12.200	123.00	320.0	307.6	496.5	94.45	969.36
12.300	42.00	165.0	285.9	472.6	93.38	969.18
12.400	29.00	71.0	182.4	356.9	87.20	968.20
12.500	24.00	53.0	78.5	235.4	78.47	966.93
12.600	20.00	44.0	-3.7	122.5	63.12	965.01
12.700	17.00	37.0	-19.6	33.3	26.42	962.15
12.800	15.00	32.0	-9.9	12.4	11.15	960.93
12.900	14.00	29.0	-13.4	19.1	16.26	961.36
13.000	13.00	27.0	-10.7	13.6	12.18	961.02
13.100	12.00	25.0	-11.0	14.3	12.65	961.06
13.200	11.00	23.0	-9.5	12.0	10.72	960.89
13.300	10.00	21.0	-9.1	11.5	10.32	960.86
13.400	10.00	20.0	-8.6	10.9	9.74	960.81
13.500	10.00	20.0	-9.0	11.4	10.20	960.85
13.600	9.00	19.0	-7.9	10.0	8.94	960.75
13.700	8.00	17.0	-7.2	9.1	8.15	960.68
13.800	8.00	16.0	-7.0	8.8	7.88	960.66
13.900	8.00	16.0	-7.2	9.0	8.09	960.67
14.000	7.00	15.0	-6.2	7.8	7.03	960.59
14.100	7.00	14.0	-6.2	7.8	6.98	960.58
14.200	7.00	14.0	-6.2	7.8	7.02	960.58
14.300	7.00	14.0	-6.2	7.8	6.99	960.58
14.400	7.00	14.0	-6.2	7.8	7.01	960.58
14.500	6.00	13.0	-5.4	6.8	6.09	960.51
14.600	6.00	12.0	-5.2	6.6	5.93	960.49
14.700	6.00	12.0	-5.4	6.8	6.06	960.50
14.800	6.00	12.0	-5.3	6.6	5.95	960.50
14.900	6.00	12.0	-5.3	6.7	6.04	960.50
15.000	6.00	12.0	-5.3	6.7	5.97	960.50
15.100	6.00	12.0	-5.3	6.7	6.02	960.50
15.200	6.00	12.0	-5.3	6.7	5.98	960.50
15.300	5.00	11.0	-4.5	5.7	5.12	960.43
15.400	5.00	10.0	-4.3	5.5	4.91	960.41

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNR25.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	5.00	10.0	-4.5	5.7	5.07	960.42
15.600	5.00	10.0	-4.4	5.5	4.94	960.41
15.700	5.00	10.0	-4.5	5.6	5.05	960.42
15.800	4.00	9.0	-3.6	4.5	4.07	960.34
15.900	4.00	8.0	-3.5	4.4	3.95	960.33
16.000	4.00	8.0	-3.6	4.5	4.04	960.34
16.100	4.00	8.0	-3.5	4.4	3.97	960.33
16.200	4.00	8.0	-3.6	4.5	4.03	960.34
16.300	4.00	8.0	-3.5	4.4	3.98	960.33
16.400	4.00	8.0	-3.6	4.5	4.02	960.33
16.500	4.00	8.0	-3.5	4.4	3.99	960.33
16.600	4.00	8.0	-3.5	4.5	4.01	960.33
16.700	4.00	8.0	-3.5	4.5	3.99	960.33
16.800	4.00	8.0	-3.5	4.5	4.01	960.33
16.900	4.00	8.0	-3.5	4.5	3.99	960.33
17.000	4.00	8.0	-3.5	4.5	4.00	960.33
17.100	4.00	8.0	-3.5	4.5	4.00	960.33
17.200	4.00	8.0	-3.5	4.5	4.00	960.33
17.300	4.00	8.0	-3.5	4.5	4.00	960.33
17.400	4.00	8.0	-3.5	4.5	4.00	960.33
17.500	4.00	8.0	-3.5	4.5	4.00	960.33
17.600	4.00	8.0	-3.5	4.5	4.00	960.33
17.700	4.00	8.0	-3.5	4.5	4.00	960.33
17.800	4.00	8.0	-3.5	4.5	4.00	960.33
17.900	4.00	8.0	-3.5	4.5	4.00	960.33
18.000	4.00	8.0	-3.5	4.5	4.00	960.33
18.100	4.00	8.0	-3.5	4.5	4.00	960.33
18.200	4.00	8.0	-3.5	4.5	4.00	960.33
18.300	4.00	8.0	-3.5	4.5	4.00	960.33
18.400	4.00	8.0	-3.5	4.5	4.00	960.33
18.500	4.00	8.0	-3.5	4.5	4.00	960.33
18.600	3.00	7.0	-2.7	3.5	3.10	960.26
18.700	3.00	6.0	-2.6	3.3	2.92	960.24
18.800	3.00	6.0	-2.7	3.4	3.07	960.26
18.900	3.00	6.0	-2.6	3.3	2.95	960.25
19.000	3.00	6.0	-2.7	3.4	3.04	960.25
19.100	3.00	6.0	-2.6	3.3	2.97	960.25
19.200	3.00	6.0	-2.7	3.4	3.03	960.25
19.300	3.00	6.0	-2.6	3.3	2.98	960.25
19.400	3.00	6.0	-2.7	3.4	3.02	960.25
19.500	3.00	6.0	-2.6	3.3	2.99	960.25
19.600	3.00	6.0	-2.7	3.4	3.01	960.25
19.700	3.00	6.0	-2.6	3.3	2.99	960.25
19.800	3.00	6.0	-2.7	3.4	3.01	960.25
19.900	3.00	6.0	-2.7	3.3	2.99	960.25
20.000	3.00	6.0	-2.7	3.3	3.00	960.25

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNR25.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	3.00	6.0	-2.7	3.3	3.00	960.25
20.200	3.00	6.0	-2.7	3.3	3.00	960.25
20.300	3.00	6.0	-2.7	3.3	3.00	960.25
20.400	3.00	6.0	-2.7	3.3	3.00	960.25
20.500	3.00	6.0	-2.7	3.3	3.00	960.25
20.600	3.00	6.0	-2.7	3.3	3.00	960.25
20.700	3.00	6.0	-2.7	3.3	3.00	960.25
20.800	3.00	6.0	-2.7	3.3	3.00	960.25
20.900	3.00	6.0	-2.7	3.3	3.00	960.25
21.000	2.00	5.0	-1.9	2.3	2.10	960.18
21.100	2.00	4.0	-1.7	2.1	1.92	960.16
21.200	2.00	4.0	-1.8	2.3	2.07	960.17
21.300	2.00	4.0	-1.7	2.2	1.95	960.16
21.400	2.00	4.0	-1.8	2.3	2.04	960.17
21.500	2.00	4.0	-1.7	2.2	1.97	960.16
21.600	2.00	4.0	-1.8	2.3	2.03	960.17
21.700	2.00	4.0	-1.8	2.2	1.98	960.16
21.800	2.00	4.0	-1.8	2.2	2.02	960.17
21.900	2.00	4.0	-1.8	2.2	1.99	960.17
22.000	2.00	4.0	-1.8	2.2	2.01	960.17
22.100	2.00	4.0	-1.8	2.2	1.99	960.17
22.200	2.00	4.0	-1.8	2.2	2.01	960.17
22.300	2.00	4.0	-1.8	2.2	1.99	960.17
22.400	2.00	4.0	-1.8	2.2	2.00	960.17
22.500	2.00	4.0	-1.8	2.2	2.00	960.17
22.600	2.00	4.0	-1.8	2.2	2.00	960.17
22.700	2.00	4.0	-1.8	2.2	2.00	960.17
22.800	2.00	4.0	-1.8	2.2	2.00	960.17
22.900	2.00	4.0	-1.8	2.2	2.00	960.17
23.000	2.00	4.0	-1.8	2.2	2.00	960.17
23.100	1.00	3.0	-1.0	1.2	1.10	960.09
23.200	1.00	2.0	-0.8	1.0	0.92	960.08
23.300	1.00	2.0	-0.9	1.2	1.06	960.09
23.400	1.00	2.0	-0.8	1.1	0.95	960.08
23.500	1.00	2.0	-0.9	1.2	1.04	960.09
23.600	1.00	2.0	-0.9	1.1	0.97	960.08
23.700	1.00	2.0	-0.9	1.1	1.03	960.09
23.800	1.00	2.0	-0.9	1.1	0.98	960.08
23.900	1.00	2.0	-0.9	1.1	1.02	960.08
24.000	1.00	2.0	-0.9	1.1	0.99	960.08
24.100	1.00	2.0	-0.9	1.1	1.01	960.08
24.200	1.00	2.0	-0.9	1.1	0.99	960.08
24.300	1.00	2.0	-0.9	1.1	1.01	960.08
24.400	1.00	2.0	-0.9	1.1	0.99	960.08
24.500	1.00	2.0	-0.9	1.1	1.00	960.08
24.600	1.00	2.0	-0.9	1.1	1.00	960.08

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNR25.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	1.00	2.0	-0.9	1.1	1.00	960.08
24.800	1.00	2.0	-0.9	1.1	1.00	960.08
24.900	1.00	2.0	-0.9	1.1	1.00	960.08
25.000	0.00	1.0	-0.1	0.1	0.10	960.01
25.100	0.00	0.0	-0.1	-0.1	0.00	960.00
25.200	0.00	0.0	-0.1	-0.1	0.00	960.00
25.300	0.00	0.0	-0.1	-0.1	0.00	960.00
25.400	0.00	0.0	-0.1	-0.1	0.00	960.00
25.500	0.00	0.0	-0.1	-0.1	0.00	960.00
25.600	0.00	0.0	-0.1	-0.1	0.00	960.00
25.700	0.00	0.0	-0.1	-0.1	0.00	960.00
25.800	0.00	0.0	-0.1	-0.1	0.00	960.00
25.900	0.00	0.0	-0.1	-0.1	0.00	960.00

********** SUMMARY OF ROUTING COMPUTATIONS **********

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNR25.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

Starting Pond W.S. Elevation = 960.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow	=	197.00 cfs
Peak Outflow	=	94.45 cfs
Peak Elevation	=	969.36 ft

***** Summary of Approximate Peak Storage *****

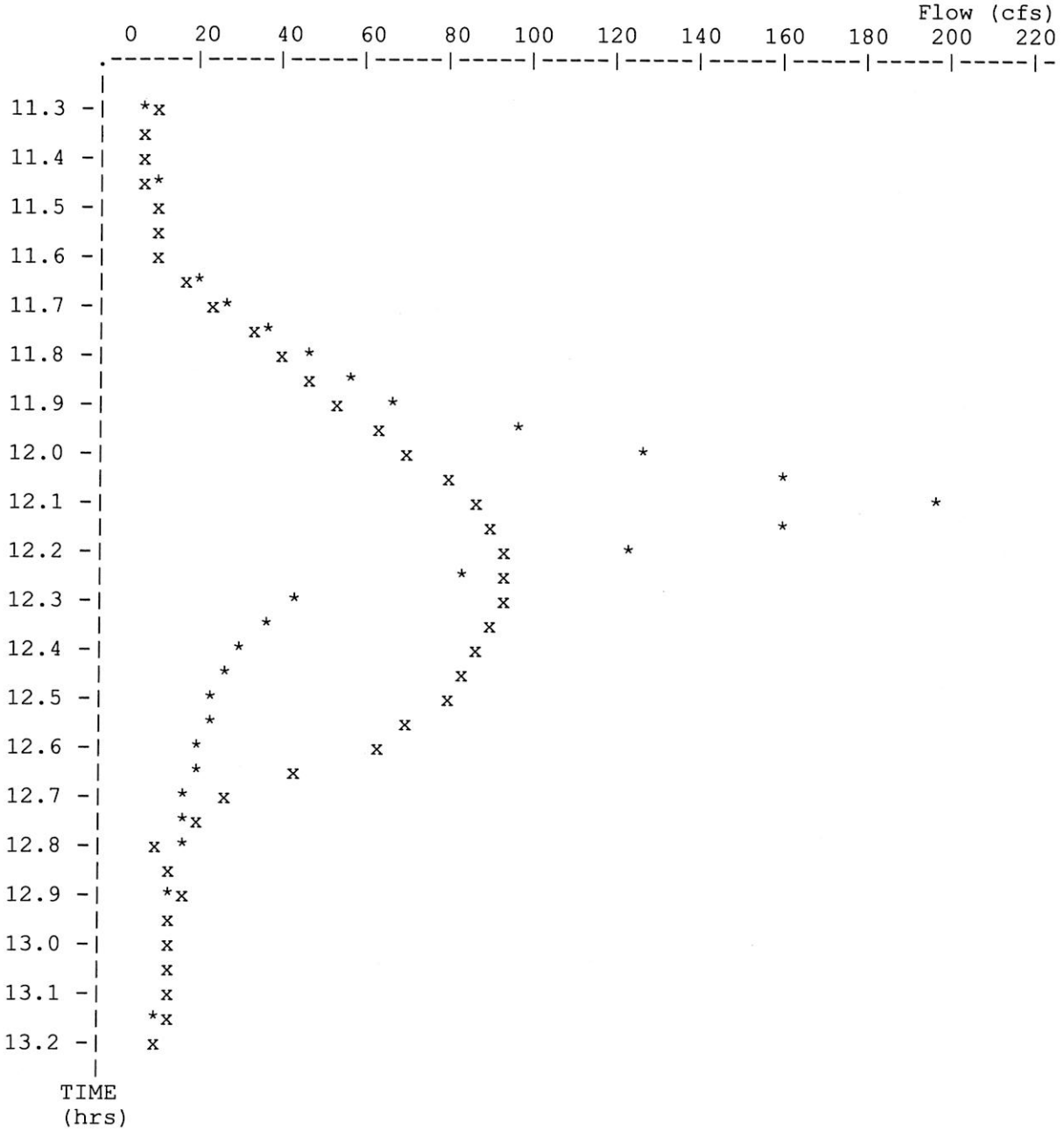
Initial Storage	=	0.00 ac-ft
Peak Storage From Storm	=	1.66 ac-ft
Total Storage in Pond	=	1.66 ac-ft

Warning: Inflow hydrograph truncated on left side.

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNR25.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

EXECUTED: 06-26-2003
13:26:05

Peak Inflow = 197.00 cfs
Peak Outflow = 94.45 cfs
Peak Elevation = 969.36 ft



* File: c:\pond55\803BNR25.HYD Qmax = 197.0 cfs
x File: c:\pond55\803OUTFL.HYD Qmax = 94.4 cfs

E1

****
*
* Saint Luke's Lee's Summit Hospital *
* proposed detention basin outfall pipe *
* 36 inch *
*
*
****

Inflow Hydrograph: c:\pond55\803BNRHU.HYD
Rating Table file: c:\pond55\803OUTFL.PND

----INITIAL CONDITIONS----
Elevation = 960.00 ft
Outflow = 0.00 cfs
Storage = 0.00 ac-ft

GIVEN POND DATA

ELEVATION (ft)	OUTFLOW (cfs)	STORAGE (ac-ft)
960.00	0.0	0.000
961.00	12.0	0.006
962.00	23.8	0.023
963.00	41.3	0.059
964.00	53.3	0.125
965.00	63.0	0.244
966.00	71.5	0.419
967.00	79.0	0.667
968.00	85.9	1.023
969.00	92.3	1.471
970.00	98.2	1.993
970.50	137.7	2.286
971.00	223.9	2.579
972.00	448.0	3.214

INTERMEDIATE ROUTING COMPUTATIONS

2S/t (cfs)	2S/t + O (cfs)
0.0	0.0
1.4	13.4
5.5	29.4
14.4	55.6
30.3	83.6
59.0	122.0
101.3	172.8
161.4	240.4
247.6	333.5
356.0	448.3
482.4	580.6
553.2	690.9
624.0	847.9
777.8	1225.8

Time increment (t) = 0.100 hrs.

E1

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNRHU.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH

ROUTING COMPUTATIONS

TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
11.000	6.00	-----	0.0	0.0	0.00	960.00
11.100	7.00	13.0	-10.3	13.0	11.66	960.97
11.200	8.00	15.0	-3.7	4.7	4.20	960.35
11.300	9.00	17.0	-10.5	13.3	11.91	960.99
11.400	11.00	20.0	-7.5	9.5	8.48	960.71
11.500	12.00	23.0	-11.6	15.5	13.56	961.13
11.600	14.00	26.0	-11.1	14.4	12.73	961.06
11.700	38.00	52.0	-22.1	40.9	31.49	962.44
11.800	62.00	100.0	-23.8	77.9	50.86	963.80
11.900	86.00	148.0	-2.6	124.2	63.40	965.04
12.000	167.00	253.0	90.9	250.4	79.76	967.11
12.100	260.00	427.0	327.1	517.9	95.41	969.53
12.200	162.00	422.0	409.8	749.1	169.61	970.69
12.300	56.00	218.0	397.6	627.8	115.12	970.21
12.400	38.00	94.0	303.1	491.6	94.23	969.33
12.500	32.00	70.0	196.9	373.1	88.11	968.34
12.600	27.00	59.0	95.6	255.9	80.17	967.17
12.700	22.00	49.0	11.0	144.6	66.79	965.44
12.800	20.00	42.0	-26.1	53.0	39.53	962.90
12.900	18.00	38.0	-9.5	11.9	10.71	960.89
13.000	17.00	35.0	-16.4	25.5	20.98	961.76
13.100	16.00	33.0	-12.1	16.6	14.35	961.20
13.200	15.00	31.0	-13.2	18.9	16.05	961.34
13.300	14.00	29.0	-11.8	15.8	13.76	961.15
13.400	13.00	27.0	-11.5	15.2	13.38	961.12
13.500	12.00	25.0	-10.7	13.5	12.08	961.01
13.600	12.00	24.0	-10.6	13.3	11.95	961.00
13.700	12.00	24.0	-10.6	13.4	12.03	961.00
13.800	11.00	23.0	-9.8	12.4	11.09	960.92
13.900	10.00	21.0	-8.9	11.2	10.04	960.84
14.000	10.00	20.0	-8.8	11.1	9.97	960.83
14.100	10.00	20.0	-8.9	11.2	10.02	960.84
14.200	9.00	19.0	-8.0	10.1	9.09	960.76
14.300	9.00	18.0	-7.9	10.0	8.93	960.74
14.400	9.00	18.0	-8.0	10.1	9.05	960.75
14.500	8.00	17.0	-7.1	9.0	8.06	960.67
14.600	8.00	16.0	-7.0	8.9	7.95	960.66
14.700	8.00	16.0	-7.1	9.0	8.04	960.67
14.800	8.00	16.0	-7.1	8.9	7.97	960.66
14.900	7.00	15.0	-6.3	7.9	7.13	960.59
15.000	7.00	14.0	-6.1	7.7	6.90	960.57
15.100	7.00	14.0	-6.3	7.9	7.08	960.59
15.200	7.00	14.0	-6.1	7.7	6.94	960.58
15.300	7.00	14.0	-6.2	7.9	7.05	960.59
15.400	7.00	14.0	-6.2	7.8	6.96	960.58

E1

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNRHU.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
15.500	7.00	14.0	-6.2	7.8	7.03	960.59
15.600	7.00	14.0	-6.2	7.8	6.97	960.58
15.700	7.00	14.0	-6.2	7.8	7.02	960.59
15.800	6.00	13.0	-5.4	6.8	6.09	960.51
15.900	6.00	12.0	-5.2	6.6	5.93	960.49
16.000	6.00	12.0	-5.4	6.8	6.05	960.50
16.100	6.00	12.0	-5.3	6.6	5.96	960.50
16.200	6.00	12.0	-5.3	6.7	6.03	960.50
16.300	5.00	11.0	-4.5	5.7	5.08	960.42
16.400	5.00	10.0	-4.4	5.5	4.94	960.41
16.500	5.00	10.0	-4.5	5.6	5.05	960.42
16.600	5.00	10.0	-4.4	5.5	4.96	960.41
16.700	5.00	10.0	-4.5	5.6	5.03	960.42
16.800	5.00	10.0	-4.4	5.5	4.98	960.41
16.900	5.00	10.0	-4.4	5.6	5.02	960.42
17.000	5.00	10.0	-4.4	5.6	4.98	960.42
17.100	5.00	10.0	-4.4	5.6	5.01	960.42
17.200	5.00	10.0	-4.4	5.6	4.99	960.42
17.300	5.00	10.0	-4.4	5.6	5.01	960.42
17.400	5.00	10.0	-4.4	5.6	4.99	960.42
17.500	5.00	10.0	-4.4	5.6	5.00	960.42
17.600	5.00	10.0	-4.4	5.6	5.00	960.42
17.700	5.00	10.0	-4.4	5.6	5.00	960.42
17.800	5.00	10.0	-4.4	5.6	5.00	960.42
17.900	5.00	10.0	-4.4	5.6	5.00	960.42
18.000	5.00	10.0	-4.4	5.6	5.00	960.42
18.100	5.00	10.0	-4.4	5.6	5.00	960.42
18.200	5.00	10.0	-4.4	5.6	5.00	960.42
18.300	5.00	10.0	-4.4	5.6	5.00	960.42
18.400	5.00	10.0	-4.4	5.6	5.00	960.42
18.500	4.00	9.0	-3.6	4.6	4.10	960.34
18.600	4.00	8.0	-3.5	4.4	3.92	960.33
18.700	4.00	8.0	-3.6	4.5	4.07	960.34
18.800	4.00	8.0	-3.5	4.4	3.95	960.33
18.900	4.00	8.0	-3.6	4.5	4.04	960.34
19.000	4.00	8.0	-3.5	4.4	3.97	960.33
19.100	4.00	8.0	-3.6	4.5	4.03	960.34
19.200	4.00	8.0	-3.5	4.4	3.98	960.33
19.300	4.00	8.0	-3.6	4.5	4.02	960.33
19.400	4.00	8.0	-3.5	4.4	3.99	960.33
19.500	4.00	8.0	-3.5	4.5	4.01	960.33
19.600	3.00	7.0	-2.7	3.5	3.09	960.26
19.700	3.00	6.0	-2.6	3.3	2.92	960.24
19.800	3.00	6.0	-2.7	3.4	3.06	960.25
19.900	3.00	6.0	-2.6	3.3	2.95	960.25
20.000	3.00	6.0	-2.7	3.4	3.04	960.25

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNRHU.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
20.100	3.00	6.0	-2.6	3.3	2.97	960.25
20.200	3.00	6.0	-2.7	3.4	3.02	960.25
20.300	3.00	6.0	-2.6	3.3	2.98	960.25
20.400	3.00	6.0	-2.7	3.4	3.01	960.25
20.500	3.00	6.0	-2.6	3.3	2.99	960.25
20.600	3.00	6.0	-2.7	3.4	3.01	960.25
20.700	3.00	6.0	-2.6	3.3	2.99	960.25
20.800	3.00	6.0	-2.7	3.4	3.01	960.25
20.900	3.00	6.0	-2.7	3.3	3.00	960.25
21.000	3.00	6.0	-2.7	3.3	3.00	960.25
21.100	3.00	6.0	-2.7	3.3	3.00	960.25
21.200	3.00	6.0	-2.7	3.3	3.00	960.25
21.300	3.00	6.0	-2.7	3.3	3.00	960.25
21.400	3.00	6.0	-2.7	3.3	3.00	960.25
21.500	3.00	6.0	-2.7	3.3	3.00	960.25
21.600	3.00	6.0	-2.7	3.3	3.00	960.25
21.700	3.00	6.0	-2.7	3.3	3.00	960.25
21.800	3.00	6.0	-2.7	3.3	3.00	960.25
21.900	3.00	6.0	-2.7	3.3	3.00	960.25
22.000	3.00	6.0	-2.7	3.3	3.00	960.25
22.100	3.00	6.0	-2.7	3.3	3.00	960.25
22.200	3.00	6.0	-2.7	3.3	3.00	960.25
22.300	3.00	6.0	-2.7	3.3	3.00	960.25
22.400	3.00	6.0	-2.7	3.3	3.00	960.25
22.500	3.00	6.0	-2.7	3.3	3.00	960.25
22.600	3.00	6.0	-2.7	3.3	3.00	960.25
22.700	2.00	5.0	-1.9	2.3	2.10	960.18
22.800	2.00	4.0	-1.7	2.1	1.92	960.16
22.900	2.00	4.0	-1.8	2.3	2.06	960.17
23.000	2.00	4.0	-1.7	2.2	1.95	960.16
23.100	2.00	4.0	-1.8	2.3	2.04	960.17
23.200	2.00	4.0	-1.7	2.2	1.97	960.16
23.300	2.00	4.0	-1.8	2.3	2.03	960.17
23.400	2.00	4.0	-1.8	2.2	1.98	960.16
23.500	2.00	4.0	-1.8	2.2	2.02	960.17
23.600	2.00	4.0	-1.8	2.2	1.99	960.17
23.700	2.00	4.0	-1.8	2.2	2.01	960.17
23.800	2.00	4.0	-1.8	2.2	1.99	960.17
23.900	2.00	4.0	-1.8	2.2	2.01	960.17
24.000	2.00	4.0	-1.8	2.2	1.99	960.17
24.100	1.00	3.0	-1.0	1.2	1.11	960.09
24.200	1.00	2.0	-0.8	1.0	0.91	960.08
24.300	1.00	2.0	-0.9	1.2	1.07	960.09
24.400	1.00	2.0	-0.8	1.1	0.95	960.08
24.500	1.00	2.0	-0.9	1.2	1.04	960.09
24.600	1.00	2.0	-0.9	1.1	0.97	960.08

E1

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNRHU.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

INFLOW HYDROGRAPH		ROUTING COMPUTATIONS				
TIME (hrs)	INFLOW (cfs)	I1+I2 (cfs)	2S/t - O (cfs)	2S/t + O (cfs)	OUTFLOW (cfs)	ELEVATION (ft)
24.700	1.00	2.0	-0.9	1.1	1.03	960.09
24.800	1.00	2.0	-0.9	1.1	0.98	960.08
24.900	1.00	2.0	-0.9	1.1	1.02	960.08
25.000	1.00	2.0	-0.9	1.1	0.99	960.08
25.100	1.00	2.0	-0.9	1.1	1.01	960.08
25.200	1.00	2.0	-0.9	1.1	0.99	960.08
25.300	1.00	2.0	-0.9	1.1	1.01	960.08
25.400	0.00	1.0	-0.1	0.1	0.10	960.01
25.500	0.00	0.0	-0.1	-0.1	0.00	960.00
25.600	0.00	0.0	-0.1	-0.1	0.00	960.00
25.700	0.00	0.0	-0.1	-0.1	0.00	960.00
25.800	0.00	0.0	-0.1	-0.1	0.00	960.00
25.900	0.00	0.0	-0.1	-0.1	0.00	960.00

E1

****************** SUMMARY OF ROUTING COMPUTATIONS ******************

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNRHU.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

Starting Pond W.S. Elevation = 960.00 ft

***** Summary of Peak Outflow and Peak Elevation *****

Peak Inflow	=	260.00 cfs
Peak Outflow	=	169.61 cfs
Peak Elevation	=	970.69 ft

***** Summary of Approximate Peak Storage *****

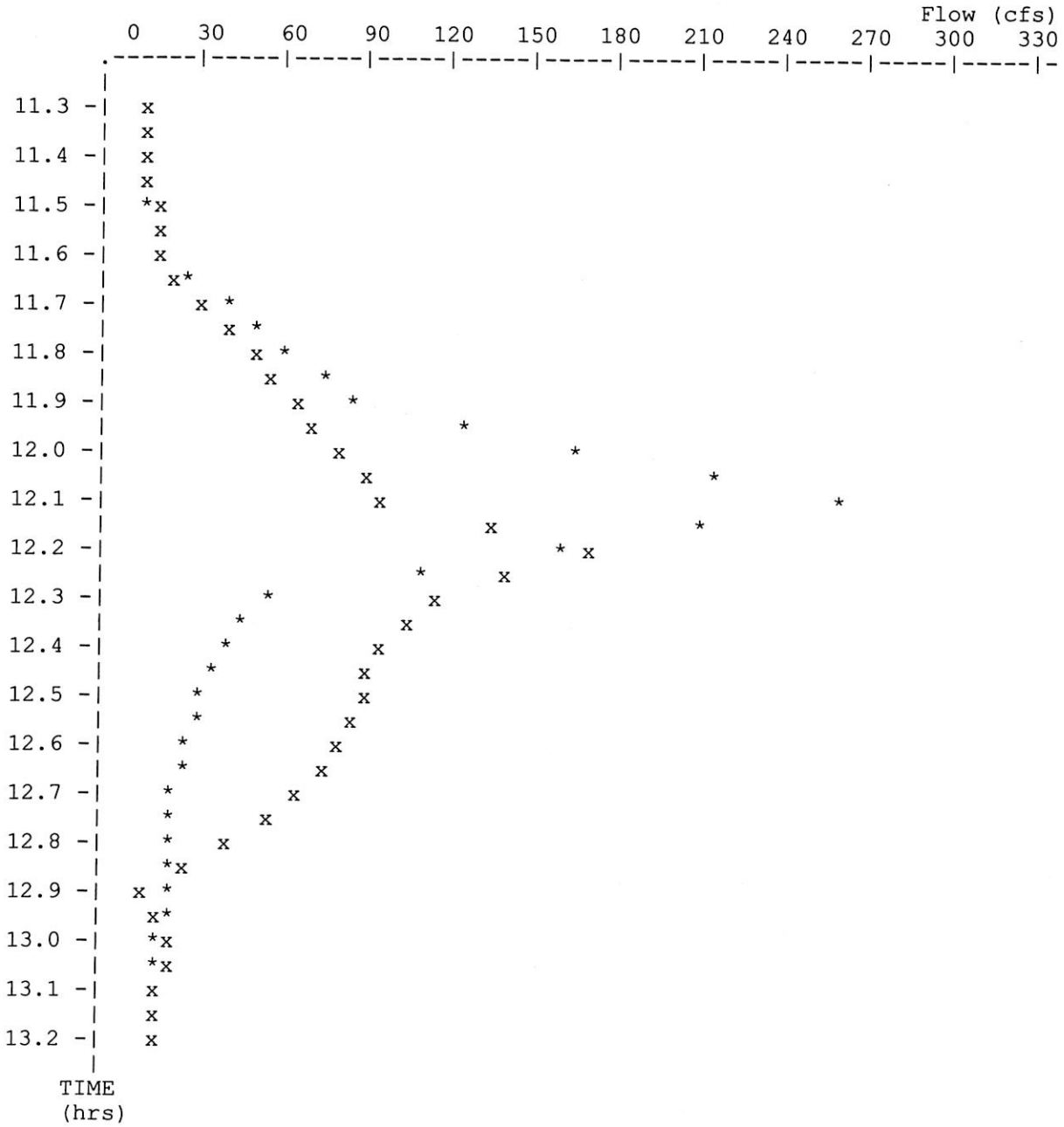
Initial Storage	=	0.00 ac-ft
Peak Storage From Storm	=	2.39 ac-ft
Total Storage in Pond	=	2.39 ac-ft

Warning: Inflow hydrograph truncated on left side.

Pond File: c:\pond55\803OUTFL.PND
Inflow Hydrograph: c:\pond55\803BNRHU.HYD
Outflow Hydrograph: c:\pond55\803OUTFL.HYD

EXECUTED: 06-26-2003
13:30:36

Peak Inflow = 260.00 cfs
Peak Outflow = 169.61 cfs
Peak Elevation = 970.69 ft



* File: c:\pond55\803BNRHU.HYD Qmax = 260.0 cfs
x File: c:\pond55\803OUTFL.HYD Qmax = 169.6 cfs

E1

-2010-001-

SHAFER, KLINE & WARREN, INC.

December 18, 2009

Mr. Kent Monter
Development Review Manager
City of Lee's Summit
220 SE Green St
Lee's Summit, Missouri 64083

Re: Stormwater Calculations—Building F (Saint Luke's East Hospital)

Dear Mr. Monter:

We have performed the stormwater runoff calculations for the new Building "F" on the Saint Luke's hospital site on the southwest corner of Interstate 470 and Douglas Road.

Existing runoff patterns in the Building "F" area drained westerly into storm sewers and bypassed the detention basin. Proposed runoff patterns show approximately two-thirds (0.42 acres) of the runoff from the Building "F" area draining westerly into the previously mentioned storm sewers, eventually going off-site without passing through the existing detention basin. The remaining one-third (0.21 acres) of the runoff from the Building "F" area drains northerly via new storm sewer and ties in to the existing detention basin. The detention basin was initially designed so that the post-development flow was equal to or below the pre-development flow for the 25-year storm (per City of Lee's Summit design criteria at the time). The maximum release rate based on previous analysis was 142cfs, but the detention basin was designed with a peak outflow of 93.28cfs for the 25-year storm.

The attached Pondpack and CulvertMaster calculations are provided to show the effects of the increased impervious area on the site and the subsequent flows going toward the detention basin and the culvert immediately downstream on the northwest corner of the site (an 8' x 5' RCB heading north under Interstate-470).

The following table summarizes the flows before and after Building "F" is placed. These flows take an area larger than the footprint affected by Building "F", but they do show the changes in runoff as a result of the Building "F" construction.

Flow Location-----Pondpack Node Name (Hydrology)	Flow Case	Flows (cfs)	
		25-year	100-year
Undetained-----"EX-DEV-UNDET2" (DA=12.70ac, CN=83, t_c =10min)	Existing	72.30	96.25
Undetained-----"PRO-DEV-UNDET2" (DA=12.49ac, CN=84, t_c =10min)	Proposed	72.52	96.06
Detained-----"EX-DEV-DET" (DA=26.11ac, CN=87, t_c =15min)	Existing	142.97	186.89
Detained-----"PRO-DEV-DET" (DA=26.32ac, CN=87, t_c =15min)	Proposed	144.12	188.39
RCB Under Interstate 470	Existing		502.97
RCB Under Interstate 470	Proposed		502.87

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SHAFER, KLINE & WARREN, INC.

If runoff from both detained and undetained areas were added together, the 25-year storm flows change from 215.27cfs to 216.64cfs (higher by 0.6%) and the 100-year storm flows change from 283.14cfs to 284.45cfs (higher by 0.4%).

All of the flow from the building addition will be captured via roof drains and storm sewers. None of the existing on-site storm sewer pipes will be effected as a result of the increased impervious area. The 25-year flow leaving the detention basin is 96.21cfs, which is 3.1% higher than the outflow from the initial analysis of 93.28cfs.

Based on the timing of all of the flows going toward the downstream culvert, the 100-year flow increases from 502.97cfs to 502.87cfs (lower by 0.02%). As the effects on amount of flow toward the culvert are essentially unchanged, previous capacity analysis is included. The attached CulvertMaster output shows the 503cfs that would be heading to the 8' x 5' RCB to be well within the capacity of the culvert before it overtops (overtopping flow is 720cfs).

Please contact me if you should have questions about this letter.

SHAFER, KLINE & WARREN, INC.

Matt Eblen

By: Matt Eblen, P.E.
Director, Stormwater Management

Enclosure(s)

E2

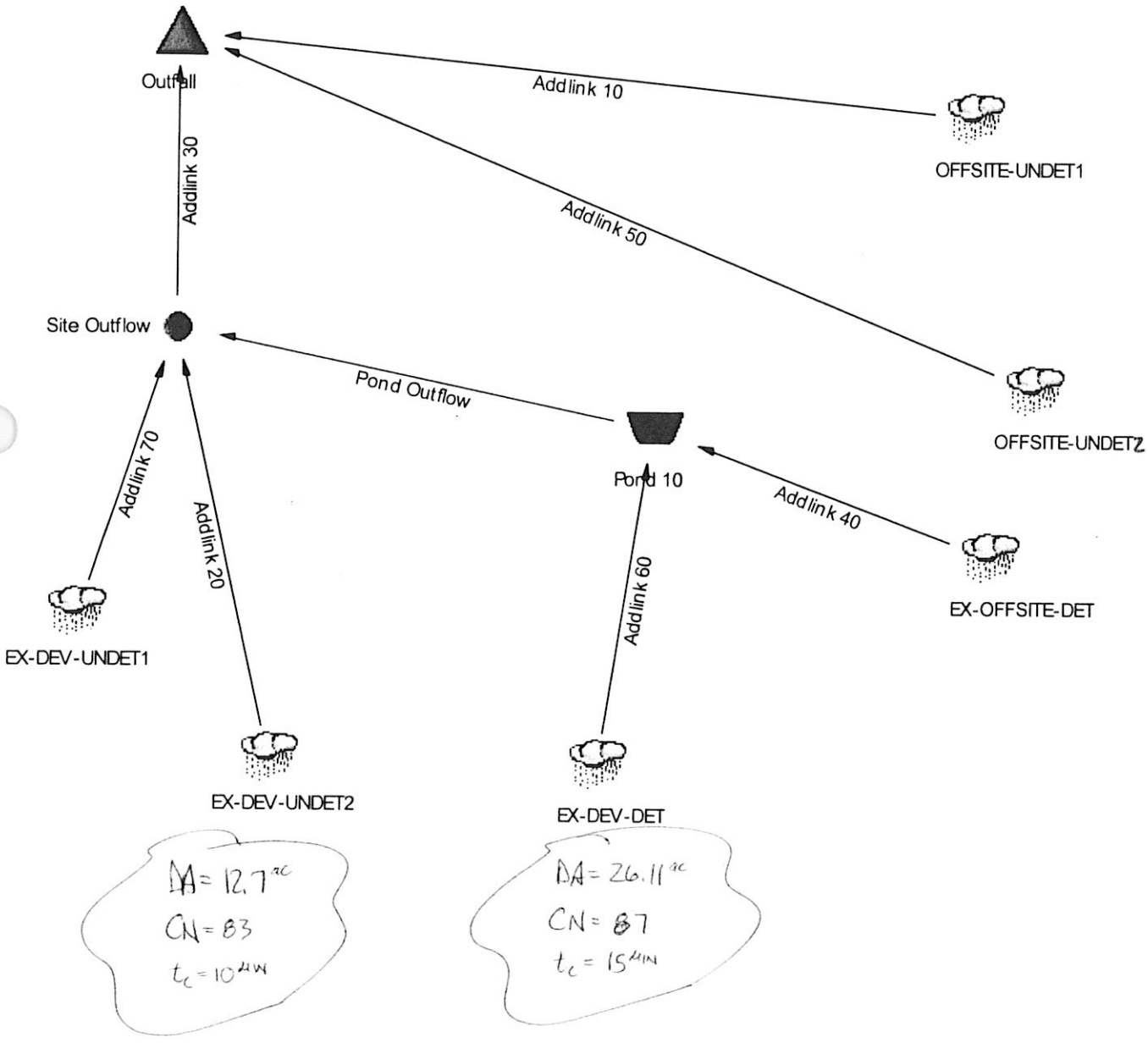
-2010-001-

PONDPACK

OUTPUT

E2

EXISTING



E2

MASTER DESIGN STORM SUMMARY

Network Storm Collection: KC-ALL

Return Event	Total Depth in	Rainfall Type	RNF ID
2 YR	3.6000	Synthetic Curve	TypeII 24hr
5 YR	4.6000	Synthetic Curve	TypeII 24hr
10 YR	5.4000	Synthetic Curve	TypeII 24hr
25 YR	6.2000	Synthetic Curve	TypeII 24hr
50 YR	6.9000	Synthetic Curve	TypeII 24hr
100 YR	7.8000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
EX-DEV-DET	AREA	2	4.945		12.0500	71.21		
EX-DEV-DET	AREA	5	6.946		12.0500	98.79		
EX-DEV-DET	AREA	10	8.585		12.0500	120.90		
EX-DEV-DET	AREA	25	10.246		12.0500	142.97		
EX-DEV-DET	AREA	50	11.712		12.0500	162.22		
EX-DEV-DET	AREA	100	13.610		12.0500	186.89		
EX-DEV-UNDET1	AREA	2	.492		11.9500	8.36		
EX-DEV-UNDET1	AREA	5	.686		11.9500	11.52		
EX-DEV-UNDET1	AREA	10	.844		11.9500	14.05		
EX-DEV-UNDET1	AREA	25	1.004		11.9500	16.57		
EX-DEV-UNDET1	AREA	50	1.145		11.9500	18.76		
EX-DEV-UNDET1	AREA	100	1.328		11.9500	21.58		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
EX-DEV-UNDET2	AREA	2	2.056		12.0000	33.71		
EX-DEV-UNDET2	AREA	5	2.979		12.0000	48.40		
EX-DEV-UNDET2	AREA	10	3.745		12.0000	60.32		
EX-DEV-UNDET2	AREA	25	4.527		12.0000	72.30		
EX-DEV-UNDET2	AREA	50	5.221		12.0000	82.78		
EX-DEV-UNDET2	AREA	100	6.124		12.0000	96.25		
EX-OFFSITE-DET	AREA	2	.880		12.0500	12.75		
EX-OFFSITE-DET	AREA	5	1.255		12.0500	18.01		
EX-OFFSITE-DET	AREA	10	1.564		12.0500	22.26		
EX-OFFSITE-DET	AREA	25	1.879		12.0500	26.51		
EX-OFFSITE-DET	AREA	50	2.157		12.0500	30.23		
EX-OFFSITE-DET	AREA	100	2.519		12.0500	34.99		
OFFSITE-UNDET1	AREA	2	2.002		12.0500	29.08		
OFFSITE-UNDET1	AREA	5	2.972		12.0500	43.16		
OFFSITE-UNDET1	AREA	10	3.785		12.0500	54.75		
OFFSITE-UNDET1	AREA	25	4.623		12.0500	66.49		
OFFSITE-UNDET1	AREA	50	5.369		12.0500	76.83		
OFFSITE-UNDET1	AREA	100	6.344		12.0500	90.16		
OFFSITE-UNDET2	AREA	2	5.789		12.1000	73.82		
OFFSITE-UNDET2	AREA	5	8.386		12.1000	106.51		
OFFSITE-UNDET2	AREA	10	10.542		12.1000	133.12		
OFFSITE-UNDET2	AREA	25	12.745		12.1000	159.91		
OFFSITE-UNDET2	AREA	50	14.700		12.1000	183.38		
OFFSITE-UNDET2	AREA	100	17.242		12.1000	213.56		
*OUTFALL	JCT	2	16.164		12.0500	206.42		
*OUTFALL	JCT	5	23.223		12.0500	278.99		
*OUTFALL	JCT	10	29.065		12.0500	335.65		
*OUTFALL	JCT	25	35.023		12.0500	391.82		
*OUTFALL	JCT	50	40.305		12.0500	440.63		
*OUTFALL	JCT	100	47.167		12.0500	502.97		

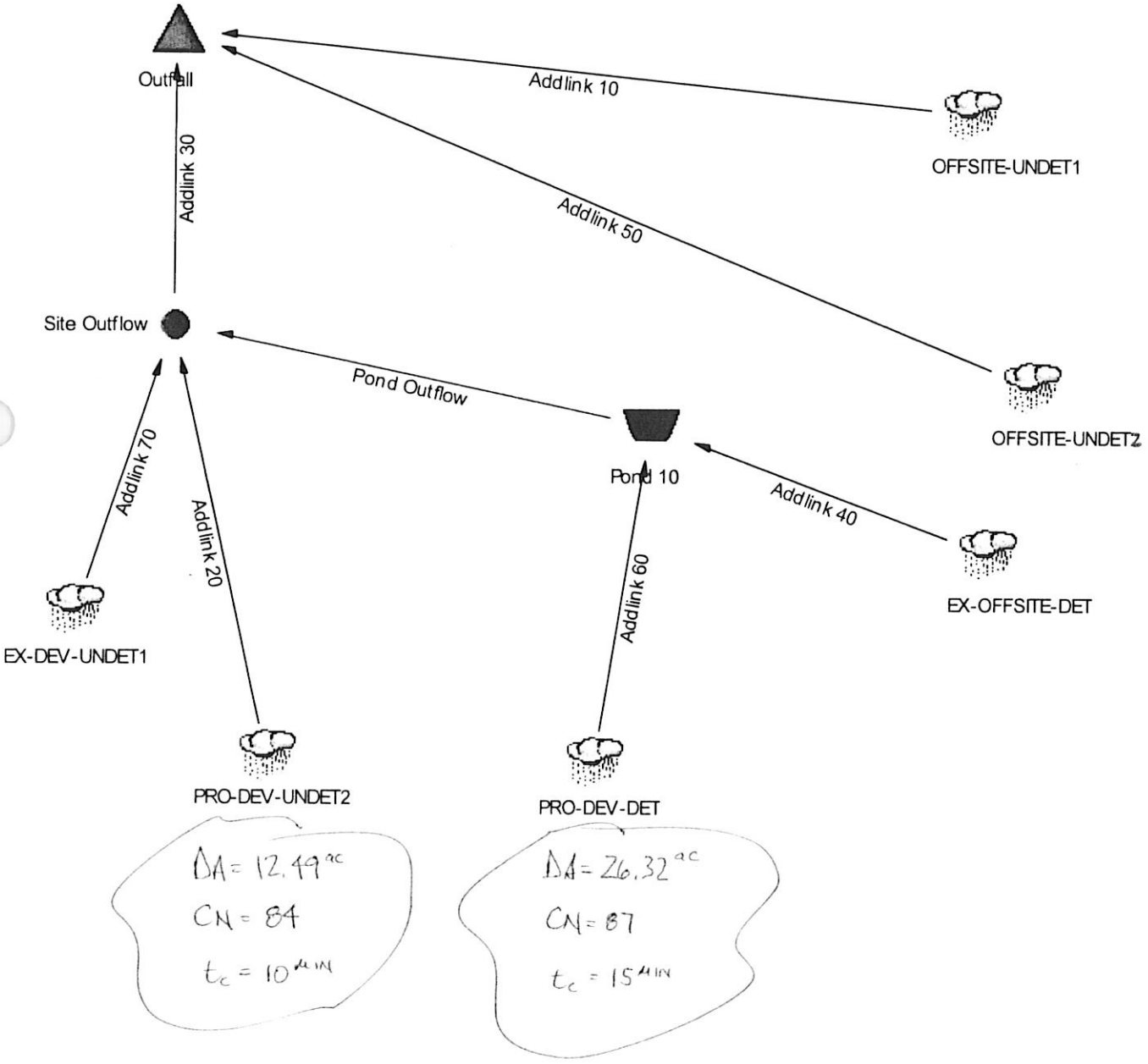
MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID		Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
POND 10	IN	POND	2	5.825		12.0500	83.97		
POND 10	IN	POND	5	8.201		12.0500	116.80		
POND 10	IN	POND	10	10.149		12.0500	143.15		
POND 10	IN	POND	25	12.125		12.0500	169.48		
POND 10	IN	POND	50	13.869		12.0500	192.45		
POND 10	IN	POND	100	16.129		12.0500	221.88		
POND 10	OUT	POND	2	5.825		12.1000	70.26	965.86	.297
POND 10	OUT	POND	5	8.201		12.1500	82.58	967.52	.731
POND 10	OUT	POND	10	10.149		12.2000	89.53	968.57	1.159
POND 10	OUT	POND	25	12.125		12.2000	95.96	969.62	1.673
POND 10	OUT	POND	50	13.869		12.2000	100.79	970.45	2.149
POND 10	OUT	POND	100	16.129		12.2000	130.82	971.22	2.664
SITE OUTFLOW		JCT	2	8.373		12.0000	105.79		
SITE OUTFLOW		JCT	5	11.865		12.0000	132.85		
SITE OUTFLOW		JCT	10	14.738		12.0000	153.08		
SITE OUTFLOW		JCT	25	17.656		12.0000	172.23		
SITE OUTFLOW		JCT	50	20.236		12.0000	188.42		
SITE OUTFLOW		JCT	100	23.581		12.0000	208.87		

-2010-001-

PROPOSED



E2

MASTER DESIGN STORM SUMMARY

Network Storm Collection: KC-ALL

Return Event	Total Depth in	Rainfall Type	RNF ID
2 YR	3.6000	Synthetic Curve	TypeII 24hr
5 YR	4.6000	Synthetic Curve	TypeII 24hr
10 YR	5.4000	Synthetic Curve	TypeII 24hr
25 YR	6.2000	Synthetic Curve	TypeII 24hr
50 YR	6.9000	Synthetic Curve	TypeII 24hr
100 YR	7.8000	Synthetic Curve	TypeII 24hr

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
EX-DEV-UNDET1	AREA	2	.492		11.9500	8.36		
EX-DEV-UNDET1	AREA	5	.686		11.9500	11.52		
EX-DEV-UNDET1	AREA	10	.844		11.9500	14.05		
EX-DEV-UNDET1	AREA	25	1.004		11.9500	16.57		
EX-DEV-UNDET1	AREA	50	1.145		11.9500	18.76		
EX-DEV-UNDET1	AREA	100	1.328		11.9500	21.58		
EX-OFFSITE-DET	AREA	2	.880		12.0500	12.75		
EX-OFFSITE-DET	AREA	5	1.255		12.0500	18.01		
EX-OFFSITE-DET	AREA	10	1.564		12.0500	22.26		
EX-OFFSITE-DET	AREA	25	1.879		12.0500	26.51		
EX-OFFSITE-DET	AREA	50	2.157		12.0500	30.23		
EX-OFFSITE-DET	AREA	100	2.519		12.0500	34.99		

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
OFFSITE-UNDET1	AREA	2	2.002		12.0500	29.08		
OFFSITE-UNDET1	AREA	5	2.972		12.0500	43.16		
OFFSITE-UNDET1	AREA	10	3.785		12.0500	54.75		
OFFSITE-UNDET1	AREA	25	4.623		12.0500	66.49		
OFFSITE-UNDET1	AREA	50	5.369		12.0500	76.83		
OFFSITE-UNDET1	AREA	100	6.344		12.0500	90.16		
OFFSITE-UNDET2	AREA	2	5.789		12.1000	73.82		
OFFSITE-UNDET2	AREA	5	8.386		12.1000	106.51		
OFFSITE-UNDET2	AREA	10	10.542		12.1000	133.12		
OFFSITE-UNDET2	AREA	25	12.745		12.1000	159.91		
OFFSITE-UNDET2	AREA	50	14.700		12.1000	183.38		
OFFSITE-UNDET2	AREA	100	17.242		12.1000	213.56		
*OUTFALL	JCT	2	16.253		12.0500	207.20		
*OUTFALL	JCT	5	23.326		12.0500	279.63		
*OUTFALL	JCT	10	29.177		12.0500	336.11		
*OUTFALL	JCT	25	35.142		12.0500	392.10		
*OUTFALL	JCT	50	40.429		12.0500	440.76		
*OUTFALL	JCT	100	47.297		12.0500	502.87		
POND 10 IN	POND	2	5.865		12.0500	84.54		
POND 10 IN	POND	5	8.257		12.0500	117.59		
POND 10 IN	POND	10	10.218		12.0500	144.13		
POND 10 IN	POND	25	12.207		12.0500	170.63		
POND 10 IN	POND	50	13.964		12.0500	193.75		
POND 10 IN	POND	100	16.238		12.0500	223.38		
POND 10 OUT	POND	2	5.865		12.1000	70.53	965.89	.303
POND 10 OUT	POND	5	8.257		12.1500	82.80	967.55	.742
POND 10 OUT	POND	10	10.218		12.2000	89.78	968.61	1.177
POND 10 OUT	POND	25	12.207		12.2000	96.21	969.66	1.695
POND 10 OUT	POND	50	13.964		12.2000	101.05	970.50	2.178
POND 10 OUT	POND	100	16.238		12.2000	133.16	971.23	2.678

MASTER NETWORK SUMMARY
SCS Unit Hydrograph Method

(*Node=Outfall; +Node=Diversion;)
(Trun= HYG Truncation: Blank=None; L=Left; R=Rt; LR=Left&Rt)

Node ID	Type	Return Event	HYG Vol ac-ft	Trun	Qpeak hrs	Qpeak cfs	Max WSEL ft	Max Pond Storage ac-ft
PRO-DEV-DET	AREA	2	4.984		12.0500	71.79		
PRO-DEV-DET	AREA	5	7.002		12.0500	99.58		
PRO-DEV-DET	AREA	10	8.654		12.0500	121.87		
PRO-DEV-DET	AREA	25	10.328		12.0500	144.12		
PRO-DEV-DET	AREA	50	11.806		12.0500	163.53		
PRO-DEV-DET	AREA	100	13.720		12.0500	188.39		
PRO-DEV-UNDET2	AREA	2	2.105		12.0000	34.44		
PRO-DEV-UNDET2	AREA	5	3.025		12.0000	48.97		
PRO-DEV-UNDET2	AREA	10	3.787		12.0000	60.73		
PRO-DEV-UNDET2	AREA	25	4.563		12.0000	72.52		
PRO-DEV-UNDET2	AREA	50	5.251		12.0000	82.83		
PRO-DEV-UNDET2	AREA	100	6.144		12.0000	96.06		
SITE OUTFLOW	JCT	2	8.461		12.0000	106.69		
SITE OUTFLOW	JCT	5	11.968		12.0000	133.63		
SITE OUTFLOW	JCT	10	14.849		12.0000	153.67		
SITE OUTFLOW	JCT	25	17.774		12.0000	172.64		
SITE OUTFLOW	JCT	50	20.360		12.0000	188.66		
SITE OUTFLOW	JCT	100	23.710		12.0000	208.86		

CulverMaster Output

E2

Culvert Designer/Analyzer Report
Culvert-1-8x5

Analysis Component			
Storm Event	Design	Discharge	503.00 cfs

100 YR PROPOSED SITE OUTFLOW

-2010-001-

Peak Discharge Method: User-Specified			
Design Discharge	503.00 cfs	Check Discharge	720.00 cfs

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00	908.58
0+50	905.48
0+61	905.18
0+77	904.43
0+88	903.01
1+01	901.95
1+05	898.29
1+09	898.36
1+17	898.00
1+32	902.00
1+50	903.38
2+00	907.18
2+03	907.58

Tailwater conditions for Design Storm.			
Discharge	503.00 cfs	Actual Depth	5.03 ft
Velocity	3.96 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-8 x 5 ft Box	502.98 cfs	909.35 ft	16.13 ft/s
Weir	Roadway	0.00 cfs	909.35 ft	N/A
Total	----------	502.98 cfs	909.35 ft	N/A

Culvert Designer/Analyzer Report
Culvert-1-8x5

-2010-001-

Component:Culvert-1

Culvert Summary			
Computed Headwater Elev	909.35 ft	Discharge	502.98 cfs
Inlet Control HW Elev.	909.35 ft	Tailwater Elevation	903.03 ft
Outlet Control HW Elev.	908.70 ft	Control Type	Inlet Control
Headwater Depth/Height	1.87		

Grades			
Upstream Invert	900.00 ft	Downstream Invert	898.50 ft
Length	150.00 ft	Constructed Slope	0.010000 ft/ft

Hydraulic Profile			
Profile	S2	Depth, Downstream	3.90 ft
Slope Type	Steep	Normal Depth	3.59 ft
Flow Regime	Supercritical	Critical Depth	4.97 ft
Velocity Downstream	16.13 ft/s	Critical Slope	0.004236 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	8.00 ft
Section Size	8 x 5 ft	Rise	5.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	908.70 ft	Upstream Velocity Head	2.49 ft
Ke	0.50	Entrance Loss	1.24 ft

Inlet Control Properties			
Inlet Control HW Elev.	909.35 ft	Flow Control	Submerged
Inlet Type 45° non-offset wingwall flares		Area Full	40.0 ft²
K	0.49700	HDS 5 Chart	12
M	0.66700	HDS 5 Scale	1
C	0.03390	Equation Form	2
Y	0.80300		

Shafer, Kline & Warren, Inc.
37 Brookside Road Waterbury, CT 06708 USA +1-203-755-1666

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Weir

Hydraulic Component(s): Roadway				
Discharge	0.00 cfs	Allowable HW Elevation	909.35	ft
Roadway Width	100.00 ft	Overtopping Coefficient	2.90	US
Low Point	915.00 ft	Headwater Elevation	N/A	ft
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00	
Tailwater Elevation	903.03 ft			

Sta (ft)	Elev. (ft)
0.00	917.08
50.00	916.04
100.00	915.38
117.53	915.00
150.00	915.50
200.00	916.00
250.00	916.87

Culvert Designer/Analyzer Report
Culvert-1-8x5

Analysis Component			
Storm Event	Check	Discharge	720.00 cfs

→ CAPACITY BEFORE OVERTOPPING

-2010-001-

Peak Discharge Method: User-Specified			
Design Discharge	503.00 cfs	Check Discharge	720.00 cfs

Tailwater properties: Irregular Channel

Roughness Segments		
Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points	
Station (ft)	Elevation (ft)
0+00	908.58
0+50	905.48
0+61	905.18
0+77	904.43
0+88	903.01
1+01	901.95
1+05	898.29
1+09	898.36
1+17	898.00
1+32	902.00
1+50	903.38
2+00	907.18
2+03	907.58

Tailwater conditions for Check Storm.			
Discharge	720.00 cfs	Actual Depth	5.64 ft
Velocity	4.33 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-8 x 5 ft Box	720.02 cfs	914.97 ft	18.00 ft/s
Weir	Roadway	0.00 cfs	914.97 ft	N/A
Total	----------	720.02 cfs	914.97 ft	N/A

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Culvert-1

-2010-001-

Culvert Summary			
Computed Headwater Elev	914.97 ft	Discharge	720.02 cfs
Inlet Control HW Elev.	914.97 ft	Tailwater Elevation	903.64 ft
Outlet Control HW Elev.	913.29 ft	Control Type	Inlet Control
Headwater Depth/Height	2.99		

Grades			
Upstream Invert	900.00 ft	Downstream Invert	898.50 ft
Length	150.00 ft	Constructed Slope	0.010000 ft/ft

Hydraulic Profile			
Profile	PressureProfile	Depth, Downstream	5.14 ft
Slope Type	N/A	Normal Depth	N/A ft
Flow Regime	N/A	Critical Depth	5.00 ft
Velocity Downstream	18.00 ft/s	Critical Slope	0.013964 ft/ft

Section			
Section Shape	Box	Mannings Coefficient	0.013
Section Material	Concrete	Span	8.00 ft
Section Size	8 x 5 ft	Rise	5.00 ft
Number Sections	1		

Outlet Control Properties			
Outlet Control HW Elev.	913.29 ft	Upstream Velocity Head	5.04 ft
Ke	0.50	Entrance Loss	2.52 ft

Inlet Control Properties			
Inlet Control HW Elev.	914.97 ft	Flow Control	Submerged
Inlet Type	45° non-offset wingwall flares	Area Full	40.0 ft²
K	0.49700	HDS 5 Chart	12
M	0.66700	HDS 5 Scale	1
C	0.03390	Equation Form	2
Y	0.80300		

Culvert Designer/Analyzer Report
Culvert-1-8x5

-2010-001-

Component:Weir

Hydraulic Component(s): Roadway			
Discharge	0.00 cfs	Allowable HW Elevation	914.97 ft
Roadway Width	100.00 ft	Overtopping Coefficient	2.90 US
Low Point	915.00 ft	Headwater Elevation	N/A ft
Discharge Coefficient (Cr)	2.90	Submergence Factor (Kt)	1.00
Tailwater Elevation	903.64 ft		

Sta (ft)	Elev. (ft)
0.00	917.08
50.00	916.04
100.00	915.38
117.53	915.00
150.00	915.50
200.00	916.00
250.00	916.87

McCLURE

February 21, 2020
Updated April 1, 2020

Mr. Kent Monter
Development Review Manager
City of Lee's Summit
220 SE Green St
Lee's Summit, Missouri 64083

Re: Stormwater Calculations—Flex Facility Expansion on St Luke's East campus

Dear Mr. Monter:

We have performed the stormwater runoff calculations for the Flex Facility Expansion on the Saint Luke's hospital site on the southwest corner of Interstate 470 and Douglas Road.

Existing runoff patterns for the area in question drained northerly into storm sewers and bypassed the detention basin on-site. Proposed runoff patterns for the new building and adjacent areas are similar to the existing runoff patterns. The detention basin was initially designed so that the post-development flow was equal to or below the pre-development flow for the 25-year storm (per City of Lee's Summit design criteria at the time). The maximum release rate based on previous analysis was 142cfs, but the detention basin was designed with a peak outflow of 93.28cfs for the 25-year storm.

The attached Pondpack and CulvertMaster calculations are provided to show the effects of the increased impervious area on the site and the subsequent flows going toward the detention basin and the culvert immediately downstream on the northwest corner of the site (an 8' x 5' RCB heading north under Interstate-470).

The table below summarizes the flows before and after the parking lots are placed.

Flow Location--Pondpack Node Name (Hydrology)	Flow Case	Flows (cfs)			
		2-year	10-year	25-year	100-year
Undetained--"EX-DEV-UNDET2" (DA=12.49ac, CN=84, t_c =10min)	Existing	34.44	60.73	72.52	96.06
Undetained--"PRO-DEV-UNDET2" (DA=12.49ac, CN=85, t_c =10min)	Proposed	35.73	62.12	73.90	97.40
Detained--"EX-DEV-DET" (DA=26.32ac, CN=89, t_c =15min)	Existing	76.66	126.75	148.88	192.87
Detained--"PRO-DEV-DET" (DA=26.32ac, CN=89, t_c =15min)	Proposed	76.66	126.75	148.88	192.87
RCB Under Interstate 470	Existing	231.91	384.54		594.01
RCB Under Interstate 470	Proposed	233.20	385.93		595.35

1700 Swift Ave., Suite 100, North Kansas City, MO 64116

All of the flow from the building addition will be captured via roof drains and storm sewers. None of the existing on-site storm sewer pipes will be effected as a result of the increased impervious area. The 25-year flow leaving the detention basin remains 97.35cfs, which is unchanged from the Surgicenter Expansion submittal in August of 2011.

Based on the timing of all of the flows going toward the downstream culvert, the 100-year flow remains unchanged at 595.35cfs. As the effects on amount of flow toward the culvert are unchanged, previous capacity analysis is included. The attached CulvertMaster output shows the 595.35cfs that would be heading to the 8' x 5' RCB to be well within the capacity of the culvert before it overtops (overtopping flow is 720cfs).

Please contact me if you should have questions about this letter.

SHAFER, KLINE & WARREN, INC.

By: Matt Eblen, P.E.
Senior Project Manager

Enclosure(s)

1700 Swift Ave., Suite 100, North Kansas City, MO 64116

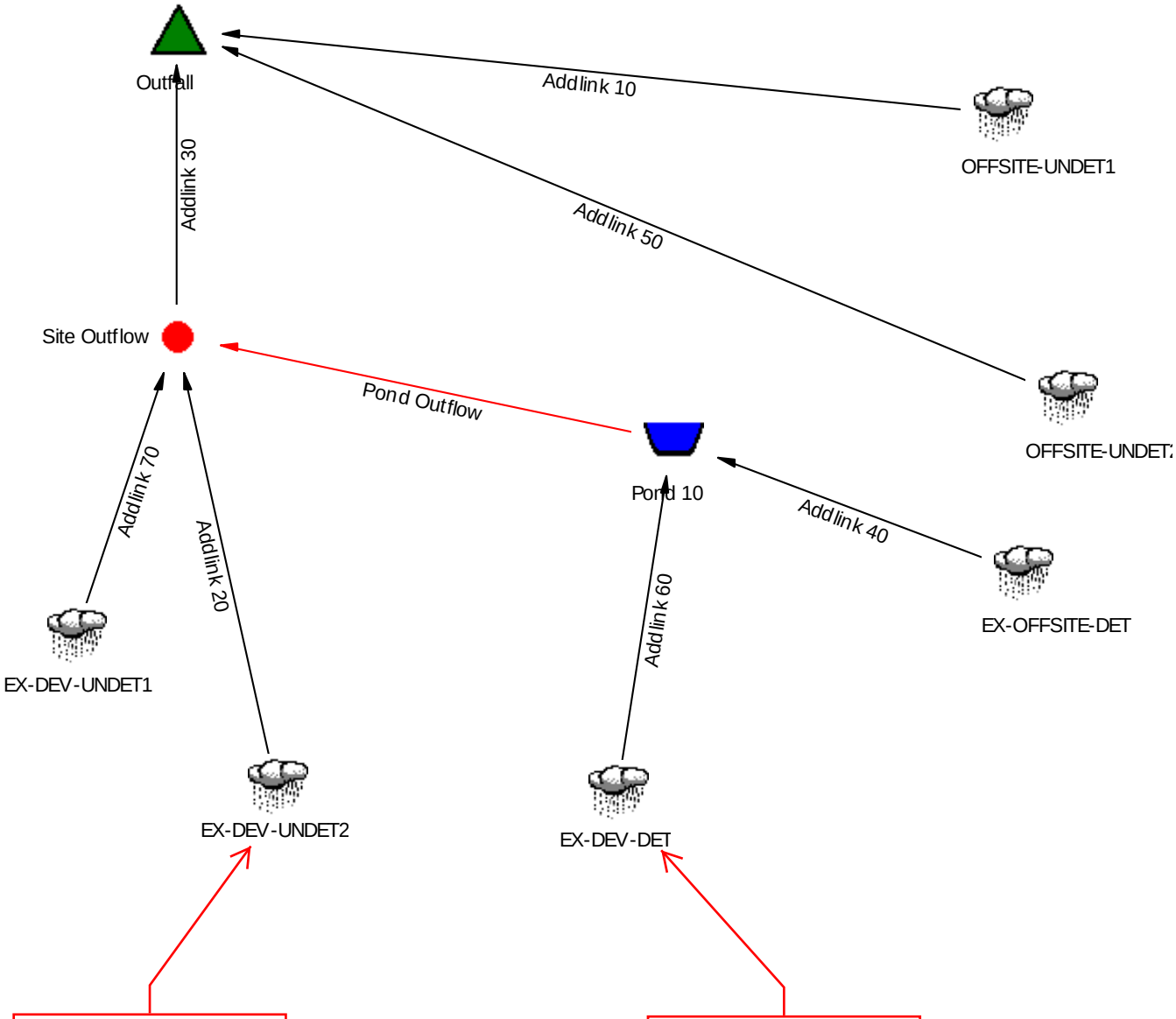
PONDPACK OUTPUT

SPECIFIC TO CURRENT CAMPUS AND WORK
RELATED TO PROPOSED FLEX FACILITY EXPANSION
(ANALYSIS LOOKED AT FLOWS FOR 2-, 5-,
10-, 25-, 50- & 100-YEAR STORM EVENTS)

This work was done in 2013 as part of the Radiation/Oncology/Urology addition

E3

EXISTING CONDITIONS



DA = 12.49 acres
CN = 84
Tc = 10 minutes
Effected Subbasin

DA = 26.32 acres
CN = 87
Tc = 15 minutes

E3

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	2.105	12.000	34.44
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	3.025	12.000	48.97
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	3.787	12.000	60.73
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	4.563	12.000	72.52
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	5.251	12.000	82.83
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	6.144	12.000	96.06
EX-DEV-DET	KC-ALL - Synthetic Curve, 2 yrs	2	5.373	12.050	76.66
EX-DEV-DET	KC-ALL - Synthetic Curve, 5 yrs	5	7.436	12.050	104.52
EX-DEV-DET	KC-ALL - Synthetic Curve, 10 yrs	10	9.115	12.050	126.75
EX-DEV-DET	KC-ALL - Synthetic Curve, 25 yrs	25	10.812	12.050	148.89
EX-DEV-DET	KC-ALL - Synthetic Curve, 50 yrs	50	12.306	12.050	168.18
EX-DEV-DET	KC-ALL - Synthetic Curve, 100 yrs	100	14.236	12.050	192.88
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	5.789	12.100	73.82
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	8.386	12.100	106.51
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	10.542	12.100	133.13
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	12.745	12.100	159.91
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	14.700	12.100	183.39
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	17.242	12.100	213.57
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	2.002	12.050	29.08
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	2.972	12.050	43.16
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	3.785	12.050	54.75
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	4.623	12.050	66.49
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	5.369	12.050	76.83
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	6.344	12.050	90.16

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	0.492	11.950	8.36
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	0.686	11.950	11.52
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	0.844	11.950	14.05
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	1.004	11.950	16.57
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	1.145	11.950	18.76
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	1.328	11.950	21.58
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 2 yrs	2	0.880	12.050	12.75
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 5 yrs	5	1.255	12.050	18.01
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 10 yrs	10	1.564	12.050	22.26
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 25 yrs	25	1.879	12.050	26.51
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 50 yrs	50	2.157	12.050	30.23
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 100 yrs	100	2.519	12.050	34.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	8.850	12.000	108.48
Site Outflow	KC-ALL - Synthetic Curve, 5 yrs	5	12.402	12.000	135.14
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	15.311	12.000	154.83
Site Outflow	KC-ALL - Synthetic Curve, 25 yrs	25	18.258	12.000	173.68
Site Outflow	KC-ALL - Synthetic Curve, 50 yrs	50	20.859	12.000	189.59
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	24.227	12.000	209.64
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	16.641	12.050	209.26
Outfall	KC-ALL - Synthetic Curve, 5 yrs	5	23.760	12.050	280.97
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	29.639	12.050	337.37

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 25 yrs	25	35.625	12.050	393.11
Outfall	KC-ALL - Synthetic Curve, 50 yrs	50	40.929	12.050	441.71
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	47.813	12.050	503.65

Pond Summary

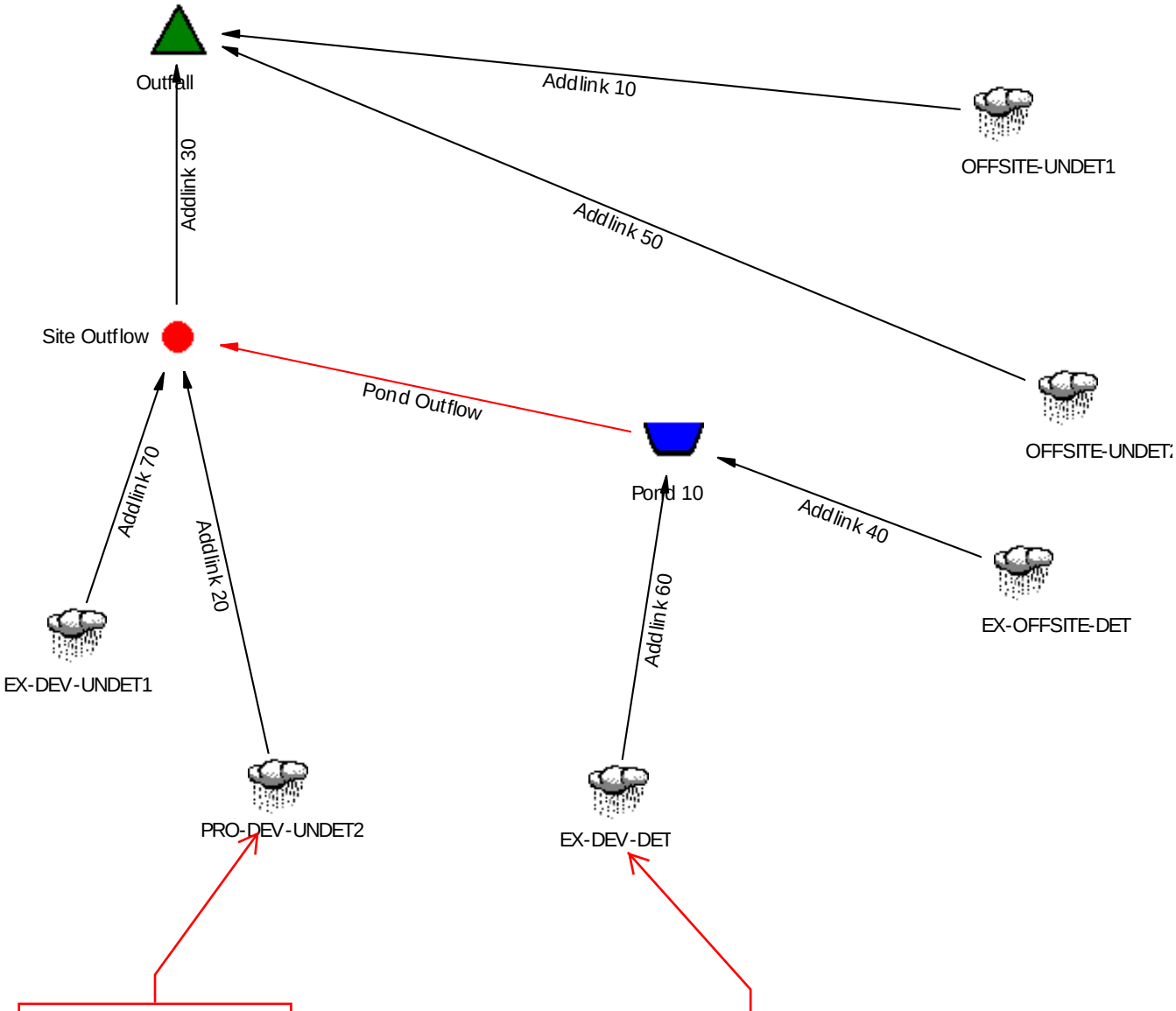
Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.050	89.41	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.150	72.69	966.16	0.356
Pond 10 (IN)	KC-ALL - Synthetic Curve, 5 yrs	5	8.691	12.050	122.53	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 5 yrs	5	8.691	12.150	84.27	967.76	0.821
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.050	149.01	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.200	91.13	968.82	1.275
Pond 10 (IN)	KC-ALL - Synthetic Curve, 25 yrs	25	12.691	12.050	175.40	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 25 yrs	25	12.691	12.200	97.35	969.85	1.798
Pond 10 (IN)	KC-ALL - Synthetic Curve, 50 yrs	50	14.463	12.050	198.40	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 50 yrs	50	14.463	12.200	101.98	970.66	2.283
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.050	227.87	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.200	140.86	971.30	2.724

PROPOSED CONDITIONS



DA = 12.49 acres
CN = 85
Tc = 10 minutes
Effected Subbasin

DA = 26.32 acres
CN = 87
Tc = 15 minutes

E3

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	2.190	12.000	35.73	+1.29
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	3.123	12.000	50.34	
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	3.892	12.000	62.12	+1.39
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	4.675	12.000	73.90	
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	5.368	12.000	84.20	
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	6.266	12.000	97.40	+1.34
EX-DEV-DET	KC-ALL - Synthetic Curve, 2 yrs	2	5.373	12.050	76.66	
EX-DEV-DET	KC-ALL - Synthetic Curve, 5 yrs	5	7.436	12.050	104.52	
EX-DEV-DET	KC-ALL - Synthetic Curve, 10 yrs	10	9.115	12.050	126.75	
EX-DEV-DET	KC-ALL - Synthetic Curve, 25 yrs	25	10.812	12.050	148.89	
EX-DEV-DET	KC-ALL - Synthetic Curve, 50 yrs	50	12.306	12.050	168.18	
EX-DEV-DET	KC-ALL - Synthetic Curve, 100 yrs	100	14.236	12.050	192.88	
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	5.789	12.100	73.82	
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	8.386	12.100	106.51	
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	10.542	12.100	133.13	
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	12.745	12.100	159.91	
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	14.700	12.100	183.39	
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	17.242	12.100	213.57	
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	2.002	12.050	29.08	
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	2.972	12.050	43.16	
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	3.785	12.050	54.75	
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	4.623	12.050	66.49	
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	5.369	12.050	76.83	
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	6.344	12.050	90.16	

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	0.492	11.950	8.36
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	0.686	11.950	11.52
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	0.844	11.950	14.05
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	1.004	11.950	16.57
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	1.145	11.950	18.76
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	1.328	11.950	21.58
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 2 yrs	2	0.880	12.050	12.75
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 5 yrs	5	1.255	12.050	18.01
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 10 yrs	10	1.564	12.050	22.26
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 25 yrs	25	1.879	12.050	26.51
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 50 yrs	50	2.157	12.050	30.23
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 100 yrs	100	2.519	12.050	34.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	8.935	12.000	109.77
Site Outflow	KC-ALL - Synthetic Curve, 5 yrs	5	12.500	12.000	136.50
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	15.416	12.000	156.22
Site Outflow	KC-ALL - Synthetic Curve, 25 yrs	25	18.370	12.000	175.06
Site Outflow	KC-ALL - Synthetic Curve, 50 yrs	50	20.976	12.000	190.96
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	24.349	12.000	210.98
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	16.726	12.050	210.33
Outfall	KC-ALL - Synthetic Curve, 5 yrs	5	23.858	12.050	282.09
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	29.744	12.050	338.50

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 25 yrs	25	35.737	12.050	394.23
Outfall	KC-ALL - Synthetic Curve, 50 yrs	50	41.045	12.050	442.82
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	47.935	12.050	504.73

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.050	89.41	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.150	72.69	966.16	0.356
Pond 10 (IN)	KC-ALL - Synthetic Curve, 5 yrs	5	8.691	12.050	122.53	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 5 yrs	5	8.691	12.150	84.27	967.76	0.821
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.050	149.01	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.200	91.13	968.82	1.275
Pond 10 (IN)	KC-ALL - Synthetic Curve, 25 yrs	25	12.691	12.050	175.40	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 25 yrs	25	12.691	12.200	97.35	969.85	1.798
Pond 10 (IN)	KC-ALL - Synthetic Curve, 50 yrs	50	14.463	12.050	198.40	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 50 yrs	50	14.463	12.200	101.98	970.66	2.283
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.050	227.87	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.200	140.86	971.30	2.724

PONDPACK OUTPUT

SPECIFIC TO FLOW GOING TOWARD
8’ X 5’ RCB UNDER INTERSTATE 470
ANALYSIS LOOKED AT FLOW FOR 1-, 10-,
& 100-YEAR STORM EVENTS

This work was done in November 2016 as part of a parking expansion west of the current campus

E3

1700 Swift Ave., Suite 100, North Kansas City, MO 64116

APPENDIX I

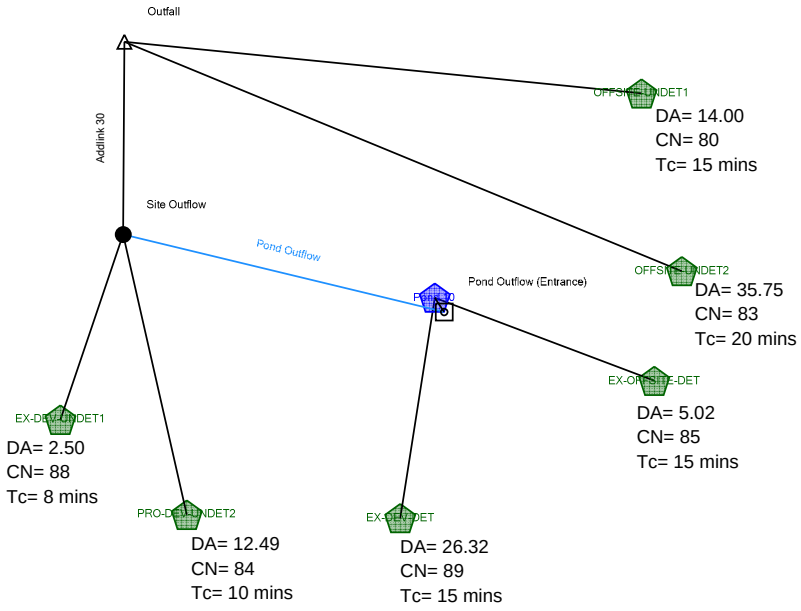
Pondpack Calculations (Site Storm Runoff)
&
CulvertMaster Calculations

NOTE: We noticed that all areas had not been accounted for in the finalizing outflows to the culvert under Interstate 470. The accompanying Pondpack schematics and calculation summaries in this report show all drainage areas associated with the current campus, proposed campus addition to the west and off-site areas to the east, south and west.

As shown in the CulvertMaster output, the culvert is still shown as being within capacity of the incoming flows.

1700 Swift Ave., Suite 100, North Kansas City, MO 64116

Scenario: KC-ALL - Synthetic Curve, 100 yrs



Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	2.105	12.000	34.44
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	3.787	12.000	60.73
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	6.144	12.000	96.06
EX-DEV-DET	KC-ALL - Synthetic Curve, 2 yrs	2	5.373	12.050	76.66
EX-DEV-DET	KC-ALL - Synthetic Curve, 10 yrs	10	9.115	12.050	126.75
EX-DEV-DET	KC-ALL - Synthetic Curve, 100 yrs	100	14.236	12.050	192.88
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	5.789	12.100	73.82
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	10.542	12.100	133.13
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	17.242	12.100	213.57
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	2.002	12.050	29.08
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	3.785	12.050	54.75
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	6.344	12.050	90.16
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	0.492	11.950	8.36
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	0.844	11.950	14.05
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	1.328	11.950	21.58
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 2 yrs	2	0.880	12.050	12.75
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 10 yrs	10	1.564	12.050	22.26
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 100 yrs	100	2.519	12.050	34.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	8.850	12.000	108.48
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	15.311	12.000	154.83
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	24.227	12.000	209.64

Subsection: Master Network Summary

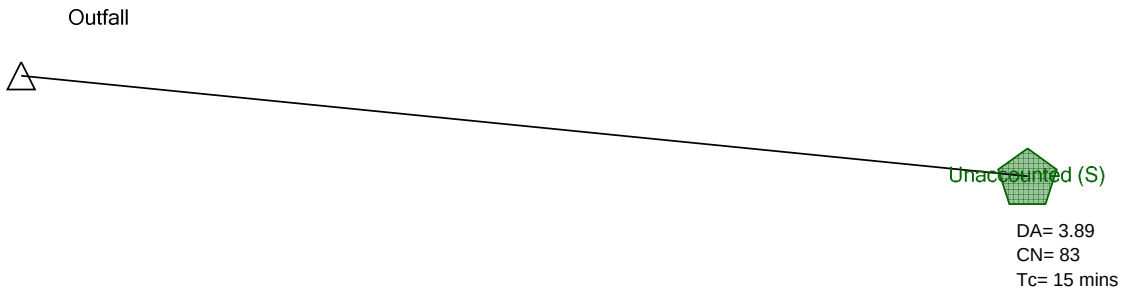
Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	16.641	12.050	209.26
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	29.639	12.050	337.37
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	47.813	12.050	503.65

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.050	89.41	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.150	72.69	966.16	0.356
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.050	149.01	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.200	91.13	968.82	1.275
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.050	227.87	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.200	140.86	971.30	2.724

Scenario: KC-ALL - Synthetic Curve, 100 yrs



Subsection: Master Network Summary

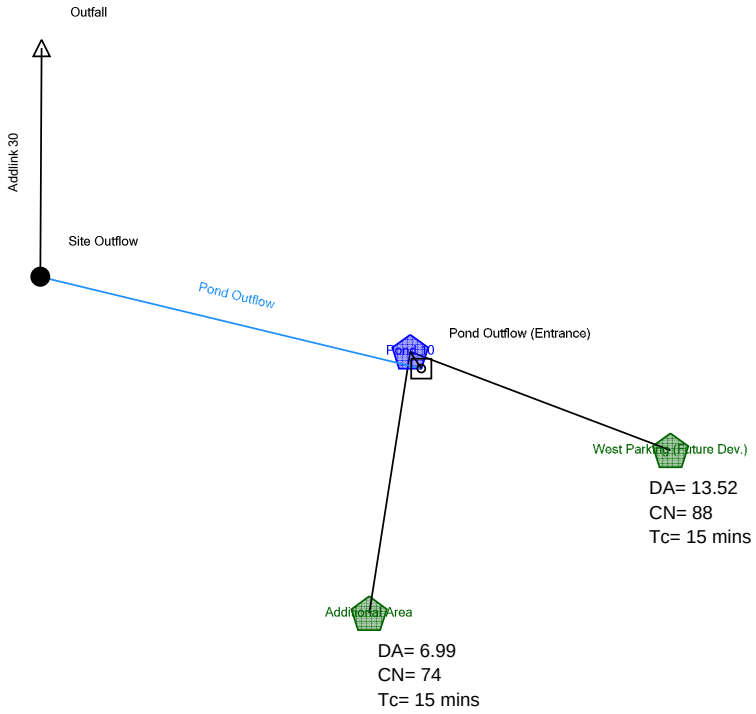
Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Unaccounted (S)	KC-ALL - Synthetic Curve, 2 yrs	2	0.630	12.050	9.15
Unaccounted (S)	KC-ALL - Synthetic Curve, 10 yrs	10	1.147	12.050	16.45
Unaccounted (S)	KC-ALL - Synthetic Curve, 100 yrs	100	1.876	12.050	26.33

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	0.630	12.050	9.15
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	1.147	12.050	16.45
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	1.876	12.050	26.33

Scenario: KC-ALL - Synthetic Curve, 100 yrs



Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Additional Area	KC-ALL - Synthetic Curve, 2 yrs	2	0.763	12.050	10.85
Additional Area	KC-ALL - Synthetic Curve, 10 yrs	10	1.565	12.050	22.76
Additional Area	KC-ALL - Synthetic Curve, 100 yrs	100	2.765	12.050	39.96
West Parking (Future Dev.)	KC-ALL - Synthetic Curve, 2 yrs	2	2.659	12.050	38.13
West Parking (Future Dev.)	KC-ALL - Synthetic Curve, 10 yrs	10	4.563	12.050	63.88
West Parking (Future Dev.)	KC-ALL - Synthetic Curve, 100 yrs	100	7.180	12.050	97.96

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.350	13.50
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.300	30.72
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.250	64.03
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.350	13.50
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.300	30.72
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.250	64.03

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.050	48.99	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.350	13.50	960.69	1.309
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.050	86.63	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.300	30.72	962.13	2.255
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.050	137.91	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.250	64.03	963.59	3.337

Culvert Designer/Analyzer Report
Culvert-1-8x5

Analysis Component			
Storm Event	Design	Discharge	595.35 cfs

Peak Discharge Method: User-Specified			
Design Discharge	595.35 cfs	Check Discharge	720.00 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	908.58
0+50	905.48
0+61	905.18
0+77	904.43
0+88	903.01
1+01	901.95
1+05	898.29
1+09	898.36
1+17	898.00
1+32	902.00
1+50	903.38
2+00	907.18
2+03	907.58

Tailwater conditions for Design Storm.			
Discharge	595.35 cfs	Actual Depth	5.20 ft
Velocity	4.35 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-8 x 5 ft Box	595.36 cfs	911.50 ft	16.80 ft/s
Weir	Roadway	0.00 cfs	911.50 ft	N/A
Total	----------	595.36 cfs	911.50 ft	N/A

E3

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	911.50	ft	Discharge	595.36	cfs
Inlet Control HW Elev.	911.50	ft	Tailwater Elevation	903.20	ft
Outlet Control HW Elev.	910.16	ft	Control Type	Inlet Control	
Headwater Depth/Height	2.30				

Grades					
Upstream Invert	900.00	ft	Downstream Invert	898.50	ft
Length	150.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	4.43	ft
Slope Type	Steep		Normal Depth	4.08	ft
Flow Regime	Supercritical		Critical Depth	5.00	ft
Velocity Downstream	16.80	ft/s	Critical Slope	0.009548	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 5 ft		Rise	5.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	910.16	ft	Upstream Velocity Head	3.44	ft
Ke	0.50		Entrance Loss	1.72	ft

Inlet Control Properties					
Inlet Control HW Elev.	911.50	ft	Flow Control	Submerged	
Inlet Type	45° non-offset wingwall flares		Area Full	40.0	ft²
K	0.49700		HDS 5 Chart	12	
M	0.66700		HDS 5 Scale	1	
C	0.03390		Equation Form	2	
Y	0.80300				

E3

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.00	cfs	Allowable HW Elevation	911.50	ft
Roadway Width	100.00	ft	Overtopping Coefficient	2.90	US
Low Point	915.00	ft	Headwater Elevation	N/A	ft
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00	
Tailwater Elevation	903.20	ft			

Sta (ft)	Elev. (ft)
0.00	917.08
50.00	916.04
100.00	915.38
117.53	915.00
150.00	915.50
200.00	916.00
250.00	916.87

E3

Culvert Designer/Analyzer Report
Culvert-1-8x5

Analysis Component			
Storm Event	Check	Discharge	720.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	595.35 cfs	Check Discharge	720.00 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	908.58
0+50	905.48
0+61	905.18
0+77	904.43
0+88	903.01
1+01	901.95
1+05	898.29
1+09	898.36
1+17	898.00
1+32	902.00
1+50	903.38
2+00	907.18
2+03	907.58

Tailwater conditions for Check Storm.			
Discharge	720.00 cfs	Actual Depth	5.64 ft
Velocity	4.33 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-8 x 5 ft Box	720.02 cfs	914.97 ft	18.00 ft/s
Weir	Roadway	0.00 cfs	914.97 ft	N/A
Total	----------	720.02 cfs	914.97 ft	N/A

E3

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Culvert-1

Culvert Summary					
Computed Headwater Eleva	914.97	ft	Discharge	720.02	cfs
Inlet Control HW Elev.	914.97	ft	Tailwater Elevation	903.64	ft
Outlet Control HW Elev.	913.29	ft	Control Type	Inlet Control	
Headwater Depth/Height	2.99				

Grades					
Upstream Invert	900.00	ft	Downstream Invert	898.50	ft
Length	150.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.14	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	5.00	ft
Velocity Downstream	18.00	ft/s	Critical Slope	0.013964	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 5 ft		Rise	5.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	913.29	ft	Upstream Velocity Head	5.04	ft
Ke	0.50		Entrance Loss	2.52	ft

Inlet Control Properties					
Inlet Control HW Elev.	914.97	ft	Flow Control	Submerged	
Inlet Type	45° non-offset wingwall flares		Area Full	40.0	ft²
K	0.49700		HDS 5 Chart	12	
M	0.66700		HDS 5 Scale	1	
C	0.03390		Equation Form	2	
Y	0.80300				

E3

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.00	cfs	Allowable HW Elevation	914.97	ft
Roadway Width	100.00	ft	Overtopping Coefficient	2.90	US
Low Point	915.00	ft	Headwater Elevation	N/A	ft
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00	
Tailwater Elevation	903.64	ft			

Sta (ft)	Elev. (ft)
0.00	917.08
50.00	916.04
100.00	915.38
117.53	915.00
150.00	915.50
200.00	916.00
250.00	916.87

E3

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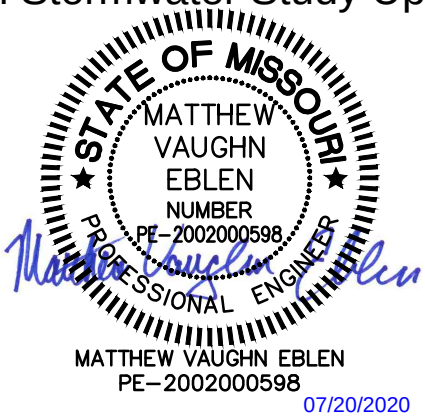


July 20, 2020

Mr. Kent Monter
Development Review Manager
City of Lee's Summit
220 SE Green St
Lee's Summit, Missouri 64083

Re: Stormwater Calculations—Parking Expansion at NE Corner of St Luke's East campus

Dear Mr. Monter:

We have performed the stormwater runoff calculations for the Parking Expansion at the NE Corner of the Saint Luke's hospital site on the southwest corner of Interstate 470 and Douglas Road.

Existing runoff patterns for the area in question drained northerly overland and bypassed the detention site. Proposed runoff patterns for the new parking areas will be routed through the detention basin. The detention basin was initially designed so that the post-development flow was equal to or below the pre-development flow for the 25-year storm (per City of Lee's Summit design criteria at the time). The maximum release rate based on previous analysis was 142cfs, but the detention basin was designed with a peak outflow of 93.28cfs for the 25-year storm.

The attached Pondpack and CulvertMaster calculations are provided to show the effects of the increased impervious area on the site and the subsequent flows going toward the detention basin and the culvert immediately downstream on the northwest corner of the site (an 8' x 5' RCB heading north under Interstate-470). Note that the additional area going into the basin resulted in less site outflow going toward the 8' x 5' RCB.

The table below summarizes the flows before and after the parking lots are placed.

Flow Location--Pondpack Node Name (Hydrology)	Flow Case	Flows (cfs)			
		2-year	10-year	25-year	100-year
Undetained--"EX-DEV-UNDET2" (DA=12.49ac, CN=85, t_c =10min)	Existing	35.73	62.12	73.90	97.40
Undetained--"PRO-DEV-UNDET2" (DA=11.50ac, CN=86, t_c =10min)	Proposed	34.08	58.44	69.28	90.87
Detained--"EX-DEV-DET" (DA=26.32ac, CN=89, t_c =15min)	Existing	76.66	126.75	148.89	192.88
Detained--"PRO-DEV-DET" (DA=27.31ac, CN=89, t_c =15min)	Proposed	79.55	131.52	154.49	200.13
RCB Under Interstate 470	Existing	233.20	385.93		595.35
RCB Under Interstate 470	Proposed	232.98	385.67		595.09

1700 Swift Ave., Suite 100, North Kansas City, MO 64116

All of the flow from the parking expansion will be captured via storm sewers. None of the existing on-site storm sewer pipes will be effected as a result of the increased impervious area. The 25-year flow leaving the detention basin is 98.49cfs.

Based on the timing of all of the flows going toward the downstream culvert, the 100-year flow decreases to 595.09cfs (compared to previous value of 595.35cfs). As the effects on amount of flow toward the culvert are unchanged, previous capacity analysis is included. The attached CulvertMaster output shows the 595.35cfs that would be heading to the 8' x 5' RCB to be well within the capacity of the culvert before it overtops (overtopping flow is 720cfs).

Please contact me if you should have questions about this letter.

SHAFER, KLINE & WARREN, INC.

By: Matt Eblen, P.E.
Senior Project Manager

Enclosure(s)

E4

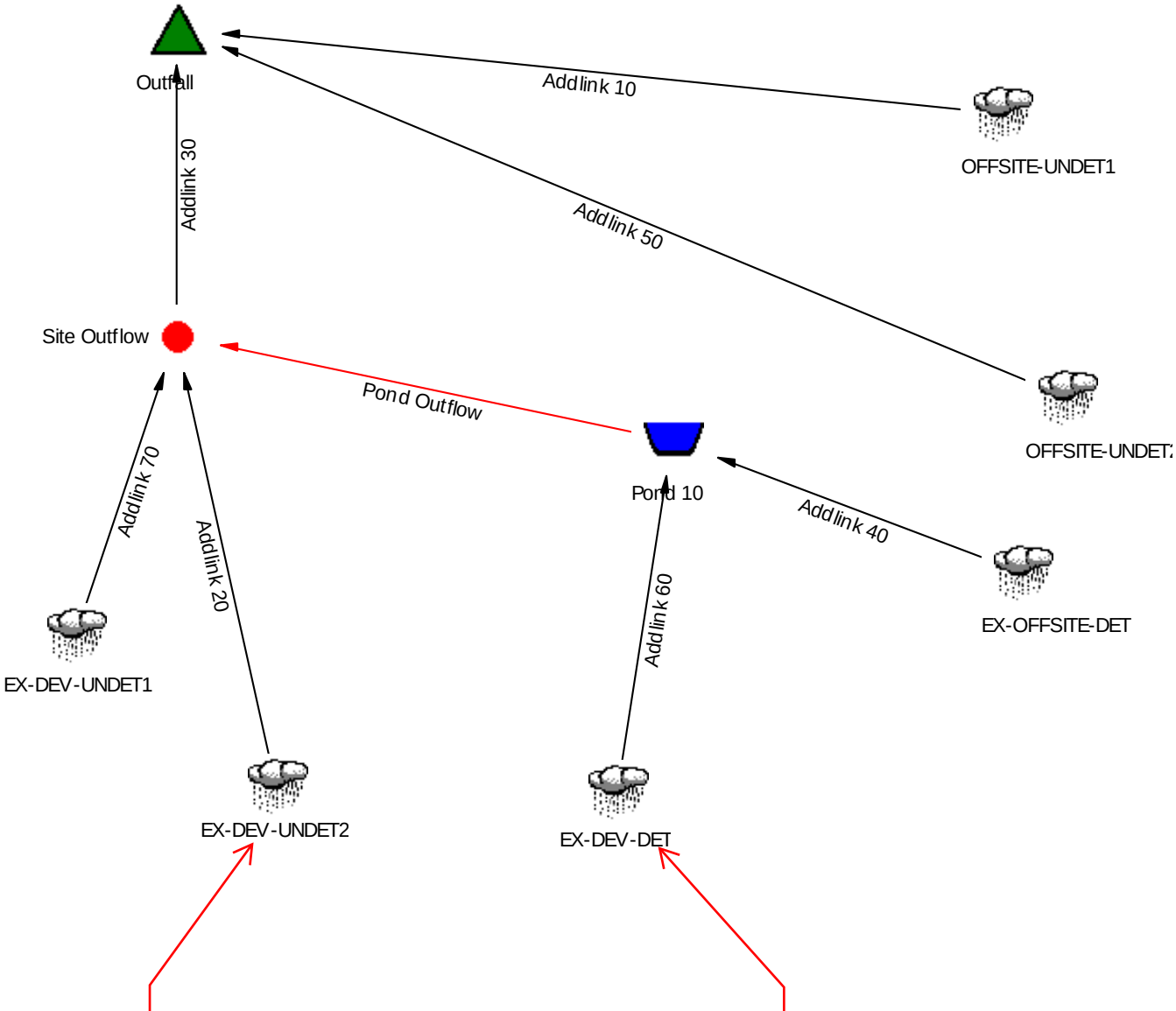
PONDPACK OUTPUT

SPECIFIC TO CURRENT CAMPUS AND WORK
RELATED TO PROPOSED FLEX FACILITY EXPANSION
(ANALYSIS LOOKED AT FLOWS FOR 2-, 5-,
10-, 25-, 50- & 100-YEAR STORM EVENTS)

This work was done in 2013 as part of the Radiation/Oncology/Urology addition

E4

EXISTING CONDITIONS



DA = 12.49 acres
CN = 85
Tc = 10 minutes
Effected Subbasin

DA = 26.32 acres
CN = 89
Tc = 15 minutes
Effected Subbasin

E4

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	2.190	12.000	35.73
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	3.123	12.000	50.34
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	3.892	12.000	62.12
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	4.675	12.000	73.90
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	5.368	12.000	84.20
EX-DEV-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	6.266	12.000	97.40
EX-DEV-DET	KC-ALL - Synthetic Curve, 2 yrs	2	5.373	12.050	76.66
EX-DEV-DET	KC-ALL - Synthetic Curve, 5 yrs	5	7.436	12.050	104.52
EX-DEV-DET	KC-ALL - Synthetic Curve, 10 yrs	10	9.115	12.050	126.75
EX-DEV-DET	KC-ALL - Synthetic Curve, 25 yrs	25	10.812	12.050	148.89
EX-DEV-DET	KC-ALL - Synthetic Curve, 50 yrs	50	12.306	12.050	168.18
EX-DEV-DET	KC-ALL - Synthetic Curve, 100 yrs	100	14.236	12.050	192.88
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	5.789	12.100	73.82
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	8.386	12.100	106.51
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	10.542	12.100	133.13
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	12.745	12.100	159.91
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	14.700	12.100	183.39
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	17.242	12.100	213.57
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	2.002	12.050	29.08
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	2.972	12.050	43.16
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	3.785	12.050	54.75
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	4.623	12.050	66.49
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	5.369	12.050	76.83
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	6.344	12.050	90.16

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	0.492	11.950	8.36
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	0.686	11.950	11.52
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	0.844	11.950	14.05
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	1.004	11.950	16.57
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	1.145	11.950	18.76
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	1.328	11.950	21.58
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 2 yrs	2	0.880	12.050	12.75
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 5 yrs	5	1.255	12.050	18.01
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 10 yrs	10	1.564	12.050	22.26
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 25 yrs	25	1.879	12.050	26.51
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 50 yrs	50	2.157	12.050	30.23
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 100 yrs	100	2.519	12.050	34.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	8.935	12.000	109.77
Site Outflow	KC-ALL - Synthetic Curve, 5 yrs	5	12.500	12.000	136.50
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	15.416	12.000	156.22
Site Outflow	KC-ALL - Synthetic Curve, 25 yrs	25	18.370	12.000	175.06
Site Outflow	KC-ALL - Synthetic Curve, 50 yrs	50	20.976	12.000	190.96
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	24.349	12.000	210.98
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	16.726	12.050	210.33
Outfall	KC-ALL - Synthetic Curve, 5 yrs	5	23.858	12.050	282.09
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	29.744	12.050	338.50

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 25 yrs	25	35.737	12.050	394.23
Outfall	KC-ALL - Synthetic Curve, 50 yrs	50	41.045	12.050	442.82
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	47.935	12.050	504.73

Pond Summary

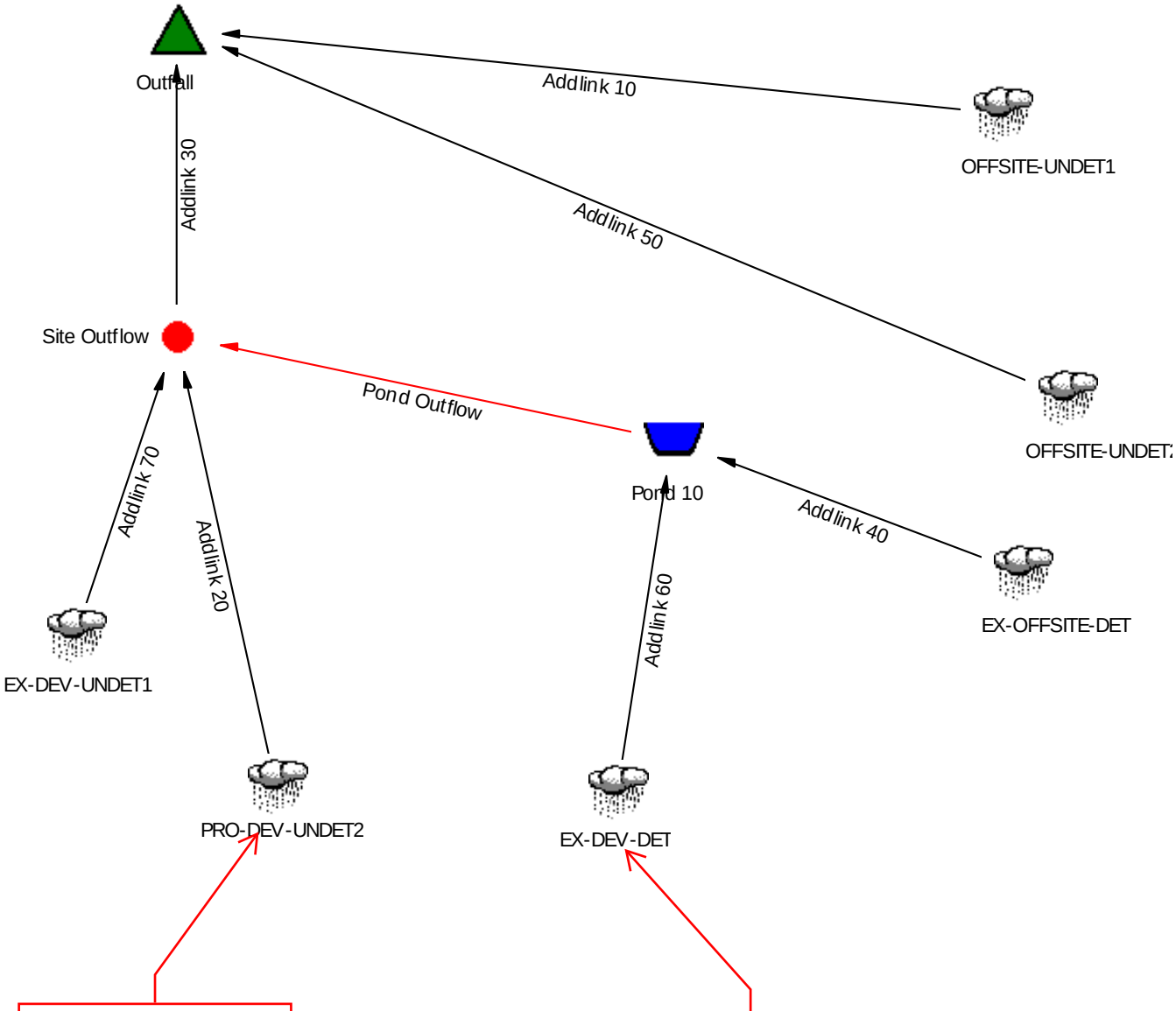
Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.050	89.41	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.150	72.69	966.16	0.356
Pond 10 (IN)	KC-ALL - Synthetic Curve, 5 yrs	5	8.691	12.050	122.53	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 5 yrs	5	8.691	12.150	84.27	967.76	0.821
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.050	149.01	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.200	91.13	968.82	1.275
Pond 10 (IN)	KC-ALL - Synthetic Curve, 25 yrs	25	12.691	12.050	175.40	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 25 yrs	25	12.691	12.200	97.35	969.85	1.798
Pond 10 (IN)	KC-ALL - Synthetic Curve, 50 yrs	50	14.463	12.050	198.40	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 50 yrs	50	14.463	12.200	101.98	970.66	2.283
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.050	227.87	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.200	140.86	971.30	2.724

PROPOSED CONDITIONS



DA = 11.50 acres
CN = 86
Tc = 10 minutes
Effected Subbasin

DA = 27.31 acres
CN = 89
Tc = 15 minutes
Effected Subbasin

E4

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	2.096	12.000	34.08
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	2.967	12.000	47.59
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	3.682	12.000	58.44
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	4.408	12.000	69.28
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	5.050	12.000	78.75
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	5.882	12.000	90.87
PRO-DEV-DET	KC-ALL - Synthetic Curve, 2 yrs	2	5.575	12.050	79.55
PRO-DEV-DET	KC-ALL - Synthetic Curve, 5 yrs	5	7.716	12.050	108.45
PRO-DEV-DET	KC-ALL - Synthetic Curve, 10 yrs	10	9.458	12.050	131.52
PRO-DEV-DET	KC-ALL - Synthetic Curve, 25 yrs	25	11.218	12.050	154.49
PRO-DEV-DET	KC-ALL - Synthetic Curve, 50 yrs	50	12.769	12.050	174.50
PRO-DEV-DET	KC-ALL - Synthetic Curve, 100 yrs	100	14.772	12.050	200.13
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	5.789	12.100	73.82
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 5 yrs	5	8.386	12.100	106.51
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	10.542	12.100	133.13
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 25 yrs	25	12.745	12.100	159.91
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 50 yrs	50	14.700	12.100	183.39
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	17.242	12.100	213.57
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	2.002	12.050	29.08
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	2.972	12.050	43.16
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	3.785	12.050	54.75
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	4.623	12.050	66.49
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	5.369	12.050	76.83
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	6.344	12.050	90.16

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	0.492	11.950	8.36
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 5 yrs	5	0.686	11.950	11.52
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	0.844	11.950	14.05
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 25 yrs	25	1.004	11.950	16.57
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 50 yrs	50	1.145	11.950	18.76
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	1.328	11.950	21.58
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 2 yrs	2	0.880	12.050	12.75
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 5 yrs	5	1.255	12.050	18.01
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 10 yrs	10	1.564	12.050	22.26
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 25 yrs	25	1.879	12.050	26.51
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 50 yrs	50	2.157	12.050	30.23
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 100 yrs	100	2.519	12.050	34.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	9.043	12.000	109.02
Site Outflow	KC-ALL - Synthetic Curve, 5 yrs	5	12.623	12.000	134.56
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	15.548	12.000	153.43
Site Outflow	KC-ALL - Synthetic Curve, 25 yrs	25	18.510	12.000	171.28
Site Outflow	KC-ALL - Synthetic Curve, 50 yrs	50	21.121	12.000	186.41
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	24.500	12.000	205.39
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	16.834	12.050	209.84
Outfall	KC-ALL - Synthetic Curve, 5 yrs	5	23.981	12.050	280.40
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	29.876	12.050	335.96

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 25 yrs	25	35.877	12.050	390.99
Outfall	KC-ALL - Synthetic Curve, 50 yrs	50	41.191	12.050	438.85
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	48.086	12.050	499.81

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	6.455	12.050	92.30	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	6.455	12.150	73.89	966.32	0.391
Pond 10 (IN)	KC-ALL - Synthetic Curve, 5 yrs	5	8.971	12.050	126.46	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 5 yrs	5	8.971	12.150	85.39	967.92	0.884
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	11.023	12.050	153.77	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	11.023	12.200	92.37	969.02	1.368
Pond 10 (IN)	KC-ALL - Synthetic Curve, 25 yrs	25	13.097	12.050	181.00	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 25 yrs	25	13.097	12.200	98.55	970.06	1.912
Pond 10 (IN)	KC-ALL - Synthetic Curve, 50 yrs	50	14.926	12.050	204.73	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 50 yrs	50	14.926	12.200	103.13	970.87	2.421
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	17.290	12.050	235.12	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	17.290	12.150	153.63	971.40	2.800

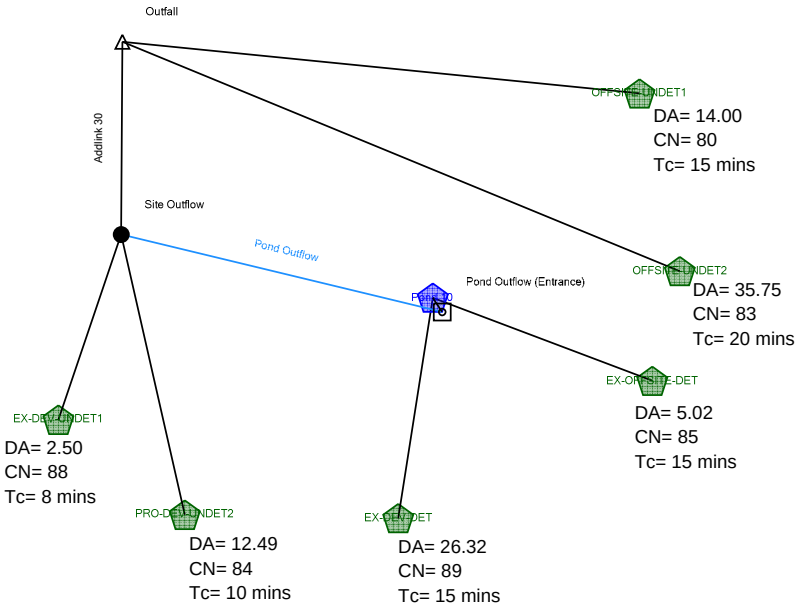
PONDPACK OUTPUT

SPECIFIC TO FLOW GOING TOWARD
8’ X 5’ RCB UNDER INTERSTATE 470
ANALYSIS LOOKED AT FLOW FOR 1-, 10-,
& 100-YEAR STORM EVENTS

This work was done in November 2016 as part of a parking expansion west of the current campus

1700 Swift Ave., Suite 100, North Kansas City, MO 64116

Scenario: KC-ALL - Synthetic Curve, 100 yrs



Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	2.105	12.000	34.44
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	3.787	12.000	60.73
PRO-DEV-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	6.144	12.000	96.06
EX-DEV-DET	KC-ALL - Synthetic Curve, 2 yrs	2	5.373	12.050	76.66
EX-DEV-DET	KC-ALL - Synthetic Curve, 10 yrs	10	9.115	12.050	126.75
EX-DEV-DET	KC-ALL - Synthetic Curve, 100 yrs	100	14.236	12.050	192.88
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 2 yrs	2	5.789	12.100	73.82
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 10 yrs	10	10.542	12.100	133.13
OFFSITE-UNDET2	KC-ALL - Synthetic Curve, 100 yrs	100	17.242	12.100	213.57
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	2.002	12.050	29.08
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	3.785	12.050	54.75
OFFSITE-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	6.344	12.050	90.16
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 2 yrs	2	0.492	11.950	8.36
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 10 yrs	10	0.844	11.950	14.05
EX-DEV-UNDET1	KC-ALL - Synthetic Curve, 100 yrs	100	1.328	11.950	21.58
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 2 yrs	2	0.880	12.050	12.75
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 10 yrs	10	1.564	12.050	22.26
EX-OFFSITE-DET	KC-ALL - Synthetic Curve, 100 yrs	100	2.519	12.050	34.99

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	8.850	12.000	108.48
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	15.311	12.000	154.83
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	24.227	12.000	209.64

Subsection: Master Network Summary

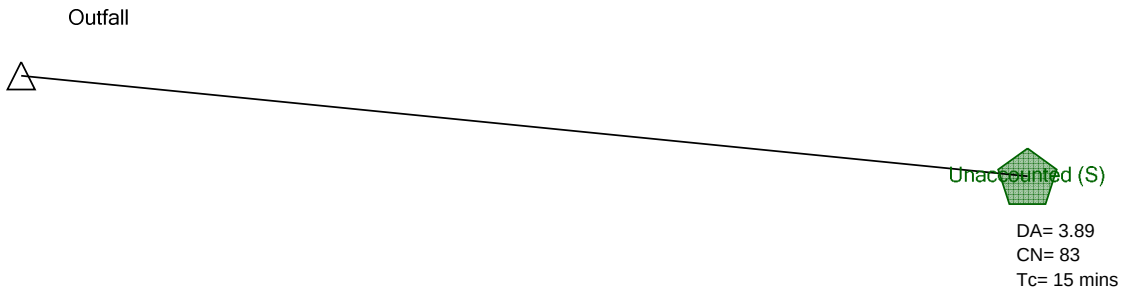
Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	16.641	12.050	209.26
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	29.639	12.050	337.37
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	47.813	12.050	503.65

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.050	89.41	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	6.253	12.150	72.69	966.16	0.356
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.050	149.01	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	10.680	12.200	91.13	968.82	1.275
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.050	227.87	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	16.755	12.200	140.86	971.30	2.724

Scenario: KC-ALL - Synthetic Curve, 100 yrs



Subsection: Master Network Summary

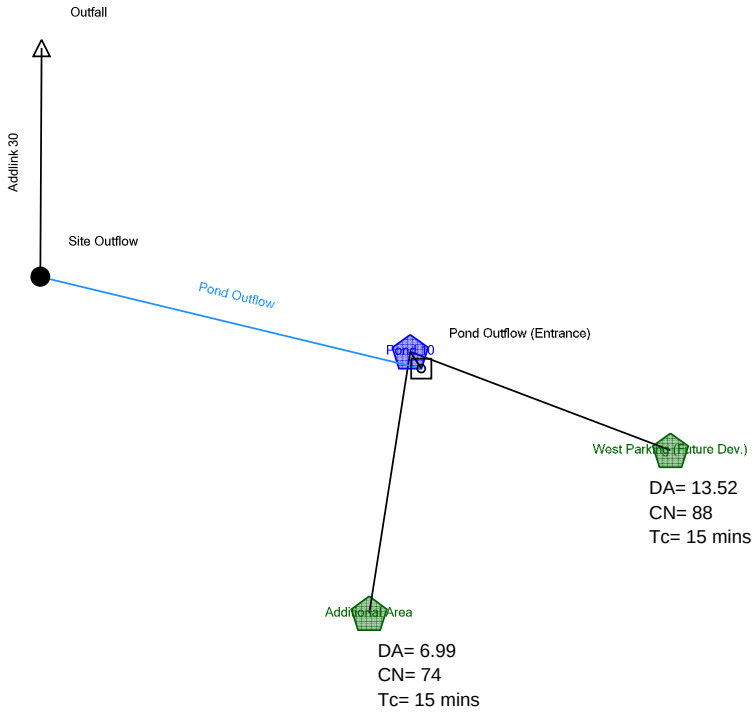
Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Unaccounted (S)	KC-ALL - Synthetic Curve, 2 yrs	2	0.630	12.050	9.15
Unaccounted (S)	KC-ALL - Synthetic Curve, 10 yrs	10	1.147	12.050	16.45
Unaccounted (S)	KC-ALL - Synthetic Curve, 100 yrs	100	1.876	12.050	26.33

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	0.630	12.050	9.15
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	1.147	12.050	16.45
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	1.876	12.050	26.33

Scenario: KC-ALL - Synthetic Curve, 100 yrs



Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Additional Area	KC-ALL - Synthetic Curve, 2 yrs	2	0.763	12.050	10.85
Additional Area	KC-ALL - Synthetic Curve, 10 yrs	10	1.565	12.050	22.76
Additional Area	KC-ALL - Synthetic Curve, 100 yrs	100	2.765	12.050	39.96
West Parking (Future Dev.)	KC-ALL - Synthetic Curve, 2 yrs	2	2.659	12.050	38.13
West Parking (Future Dev.)	KC-ALL - Synthetic Curve, 10 yrs	10	4.563	12.050	63.88
West Parking (Future Dev.)	KC-ALL - Synthetic Curve, 100 yrs	100	7.180	12.050	97.96

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)
Site Outflow	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.350	13.50
Site Outflow	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.300	30.72
Site Outflow	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.250	64.03
Outfall	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.350	13.50
Outfall	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.300	30.72
Outfall	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.250	64.03

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft³/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (IN)	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.050	48.99	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 2 yrs	2	3.422	12.350	13.50	960.69	1.309
Pond 10 (IN)	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.050	86.63	(N/A)	(N/A)

Subsection: Master Network Summary

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft^3/s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 10 yrs	10	6.129	12.300	30.72	962.13	2.255
Pond 10 (IN)	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.050	137.91	(N/A)	(N/A)
Pond 10 (OUT)	KC-ALL - Synthetic Curve, 100 yrs	100	9.945	12.250	64.03	963.59	3.337

Culvert Designer/Analyzer Report
Culvert-1-8x5

Analysis Component			
Storm Event	Design	Discharge	595.35 cfs

Peak Discharge Method: User-Specified			
Design Discharge	595.35 cfs	Check Discharge	720.00 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	908.58
0+50	905.48
0+61	905.18
0+77	904.43
0+88	903.01
1+01	901.95
1+05	898.29
1+09	898.36
1+17	898.00
1+32	902.00
1+50	903.38
2+00	907.18
2+03	907.58

Tailwater conditions for Design Storm.

Discharge	595.35 cfs	Actual Depth	5.20 ft
Velocity	4.35 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-8 x 5 ft Box	595.36 cfs	911.50 ft	16.80 ft/s
Weir	Roadway	0.00 cfs	911.50 ft	N/A
Total	----------	595.36 cfs	911.50 ft	N/A

E4

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	911.50	ft	Discharge	595.36	cfs
Inlet Control HW Elev.	911.50	ft	Tailwater Elevation	903.20	ft
Outlet Control HW Elev.	910.16	ft	Control Type	Inlet Control	
Headwater Depth/Height	2.30				

Grades					
Upstream Invert	900.00	ft	Downstream Invert	898.50	ft
Length	150.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	S2		Depth, Downstream	4.43	ft
Slope Type	Steep		Normal Depth	4.08	ft
Flow Regime	Supercritical		Critical Depth	5.00	ft
Velocity Downstream	16.80	ft/s	Critical Slope	0.009548	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 5 ft		Rise	5.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	910.16	ft	Upstream Velocity Head	3.44	ft
Ke	0.50		Entrance Loss	1.72	ft

Inlet Control Properties					
Inlet Control HW Elev.	911.50	ft	Flow Control	Submerged	
Inlet Type	45° non-offset wingwall flares		Area Full	40.0	ft²
K	0.49700		HDS 5 Chart	12	
M	0.66700		HDS 5 Scale	1	
C	0.03390		Equation Form	2	
Y	0.80300				

E4

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.00	cfs	Allowable HW Elevation	911.50	ft
Roadway Width	100.00	ft	Overtopping Coefficient	2.90	US
Low Point	915.00	ft	Headwater Elevation	N/A	ft
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00	
Tailwater Elevation	903.20	ft			

Sta (ft)	Elev. (ft)
0.00	917.08
50.00	916.04
100.00	915.38
117.53	915.00
150.00	915.50
200.00	916.00
250.00	916.87

E4

Culvert Designer/Analyzer Report
Culvert-1-8x5

Analysis Component			
Storm Event	Check	Discharge	720.00 cfs

Peak Discharge Method: User-Specified			
Design Discharge	595.35 cfs	Check Discharge	720.00 cfs

Tailwater properties: Irregular Channel

Roughness Segments

Start Station	End Station	Mannings Coefficient
0+00	1+01	0.080
1+01	1+32	0.040
1+32	2+03	0.080

Natural Channel Points

Station (ft)	Elevation (ft)
0+00	908.58
0+50	905.48
0+61	905.18
0+77	904.43
0+88	903.01
1+01	901.95
1+05	898.29
1+09	898.36
1+17	898.00
1+32	902.00
1+50	903.38
2+00	907.18
2+03	907.58

Tailwater conditions for Check Storm.			
Discharge	720.00 cfs	Actual Depth	5.64 ft
Velocity	4.33 ft/s		

Name	Description	Discharge	HW Elev.	Velocity
Culvert-1	1-8 x 5 ft Box	720.02 cfs	914.97 ft	18.00 ft/s
Weir	Roadway	0.00 cfs	914.97 ft	N/A
Total	----------	720.02 cfs	914.97 ft	N/A

E4

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Culvert-1

Culvert Summary					
Computed Headwater Elev	914.97	ft	Discharge	720.02	cfs
Inlet Control HW Elev.	914.97	ft	Tailwater Elevation	903.64	ft
Outlet Control HW Elev.	913.29	ft	Control Type	Inlet Control	
Headwater Depth/Height	2.99				

Grades					
Upstream Invert	900.00	ft	Downstream Invert	898.50	ft
Length	150.00	ft	Constructed Slope	0.010000	ft/ft

Hydraulic Profile					
Profile	PressureProfile		Depth, Downstream	5.14	ft
Slope Type	N/A		Normal Depth	N/A	ft
Flow Regime	N/A		Critical Depth	5.00	ft
Velocity Downstream	18.00	ft/s	Critical Slope	0.013964	ft/ft

Section					
Section Shape	Box		Mannings Coefficient	0.013	
Section Material	Concrete		Span	8.00	ft
Section Size	8 x 5 ft		Rise	5.00	ft
Number Sections	1				

Outlet Control Properties					
Outlet Control HW Elev.	913.29	ft	Upstream Velocity Head	5.04	ft
Ke	0.50		Entrance Loss	2.52	ft

Inlet Control Properties					
Inlet Control HW Elev.	914.97	ft	Flow Control	Submerged	
Inlet Type	45° non-offset wingwall flares		Area Full	40.0	ft²
K	0.49700		HDS 5 Chart	12	
M	0.66700		HDS 5 Scale	1	
C	0.03390		Equation Form	2	
Y	0.80300				

E4

Culvert Designer/Analyzer Report
Culvert-1-8x5

Component:Weir

Hydraulic Component(s): Roadway					
Discharge	0.00	cfs	Allowable HW Elevation	914.97	ft
Roadway Width	100.00	ft	Overtopping Coefficient	2.90	US
Low Point	915.00	ft	Headwater Elevation	N/A	ft
Discharge Coefficient (Cr)	2.90		Submergence Factor (Kt)	1.00	
Tailwater Elevation	903.64	ft			

Sta (ft)	Elev. (ft)
0.00	917.08
50.00	916.04
100.00	915.38
117.53	915.00
150.00	915.50
200.00	916.00
250.00	916.87

E4