Stormwater Report

Tudor Multi-Family

NE Tudor Road & NE Douglas Street
Lee's Summit, Jackson County, Missouri

Prepared:
August 5th, 2024

Prepared by:

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General Information

A. Project Description

The proposed site is located at the SW corner of NE Tudor Road and NE Douglas Street in Lee's Summit, Jackson County, Missouri. The 13.07-acre property will be a residential development consisting of multiple apartment buildings, a clubhouse, parking lots, utilities, and ancillary stormwater facilities. The property is in Section 31, Township 48 North, Range 31 West.

B. Floodplain Information

According to the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) map number 29095C0417G (Dated: January 20, 2017), the site lies outside of the 100-year inundation zone, in Zone X, defined to be an area of minimal flood hazard. Refer to Appendix A for site location map and Appendix B for the FEMA FIRM panel.

C. Soil Classification

Soil classifications published by the United States Department of Agriculture/Natural Resources Conservation Service (USDA/NRCS) website for Jackson County, MO on August 22, 2023, indicate the existing site is made up of four soil types:

10082	*Arisburg-Urban land complex, 1 to 5 percent slopes* *Hydrologic Soil Group (HSG) Type C*
10128	*Sharpsburg-Urban land complex, 2 to 5 percent slopes* *Hydrologic Soil Group (HSG) Type D*
10129	*Sharpsburg-Urban land complex, 5 to 9 percent slopes* *Hydrologic Soil Group (HSG) Type D*
10180	*Udarents-Urban land Sampsel-complex, 2 to 5 percent slopes* *Hydrologic Soil Group (HSG) Type C*

Soil Groups were all decreased to HSG Type D for proposed conditions. Refer to Appendix C for a detailed soil report.

D. Site Hydrology

On-site stormwater runoff is collected on the property in an on-site extended dry detention basin in the southwest corner of the site. From there, runoff discharges into the existing storm pipe system that runs along NW Commerce Drive on the west side of the lot. According to the Missouri Department of Conservation, the entire property and contributing drainage area(s) are tributary to the Blue River watershed.

E. Additional Permit Requirements

USACE Jurisdictional Determination was not completed for this project; according to the EPA watershed map, there are no "Waters of the United States" on the property or adjacent properties. As referenced above, the site is not located within any Special Flood Hazard Areas (SFHA).

Design Methodology

Stormwater routing was performed utilizing the NRCS TR-55 hydrology methodology in accordance with MoDOT Engineering Policy Guide, June 2022 Edition. Rainfall depths for the 2-year, 10-year and 100-year events were taken from NRCS TR-55. These rainfall depths were distributed using the SCS type II rainfall intensity curve for 24-hr analysis. Stormwater modeling and detention calculations were performed using Autodesk Storm and Sanitary Analysis 2022.

Table 1 - Rainfall Depths for Jackson County, Missouri

Storm Return	24hr (in)
2-yr	3.50
10-yr	5.30
100-yr	7.70

Existing Conditions

The 13.071-acre property is undeveloped, grassland and woodland area. Stormwater runoff currently flows from the east side of the property to either the north or the southwest sides of the property where it is collected by existing storm sewer along NE Tudor Road and NW Commerce Drive, respectively – drainage areas, time of concentration path, and discharge point(s) are identified on the Pre-Development Drainage Map on Appendix D.

According to NRCS Web Soil Survey, 70.10% of the property consists of 10082 – Arisburg-Urban land complex, 1 to 5 percent slopes in Hydrologic Soil Group (HSG) C, and 24.90% of the property consists of Sharpsburg-Urban land complex, 5 to 9 percent slopes (HSG D). Less than 5% of the property consists of Sharpsburg-Urban land complex, 2 to 5 percent slopes (HSG D) and Udarents-Urban land-Sampsel complex, 2 to 5 percents slopes (HSG C). The existing site was broken into two separate drainage areas, one for the North and one for the South. A composite CN was calculated for each of the pre-development areas using the following land types: Woods & grass combination with good coverage and a soil HSG Type D having a CN of 79, woods & grass combination with good coverage and a soil HSG Type C having a CN of 72, and woods with good coverage and a soil HSG Type C having a CN of 70. The existing conditions calculations are summarized in Tables 2 and 3 below.

Table 2 - Existing Site Conditions

	North	South
Area (Ac)	3.506	9.563
CN	72.00	73.44
Time of Concentration (T_c) (min)	23.70	32.06

Table 3 - Existing Peak Runoff Summary

Storm Event	Peak Discharge (cfs)
2-yr	12.69
10-yr	28.52
100-yr	52.02

Refer to Appendix E for supporting calculations for Existing Conditions.

Following the "Comprehensive Control" method of mitigating additional runoff, the proposed development must meet the allowable release rate requirements. The requirements for the site are 0.5 CFS of runoff per acre for the 2-year storm, 2.0 CFS per acre for the 10-year storm, and 3.0 CFS per acre for the 100-year storm. The allowable release rates for the 13.071-acre site can be seen in Table 4 below.

Table 4 - Allowable Peak Runoff Summary

Storm Event	Allowable Discharge (cfs)
2-yr	6.54
10-yr	26.14
100-yr	39.21

Proposed Conditions

Construction generated by the proposed project consists of multiple new apartment buildings with associated parking infrastructure, utilities, and drainage facilities. The 13.071-acre contributing drainage area is divided into two drainage types, detained and undetained. Each side of the lot has a portion of undetained area, broken down as follows: North (consisting of 0.754 acres) sheet flows into NE Tudor Road and collects into the existing storm system, East (consisting of 0.164 acres) sheet flows east into NE Douglas Street and collects into the existing storm system, South (consisting of 0.261 acres) sheet flows into southern property before collecting into existing storm system along NW Main Street, and West (consisting of 0.599 acres) sheet flows west into NW Commerce Drive and collects into the existing storm system. For the remainder of the report, the undetained areas are combined and listed as Undetained.

Stormwater runoff generated on site will be collected by wet curb and gutter, conveyed through a proposed storm pipe network, and eventually discharged into an extended dry detention basin in the southwest corner of the property. Runoff will ultimately be released into the existing storm system (Total-Outfall) running along NW Commerce Drive. The proposed conditions calculations are summarized in Tables 5 and 6.

The proposed extended dry detention basin (ProposedDetention) has one outfall (ControlStructure). Proposed detention has been designed to meet the requirements for the "Comprehensive Control" method prior to discharging into the existing storm sewer system. Composite CNs were utilized for the proposed site; land cover description for the proposed site is a combination of Urban commercial (85% impervious) which has a CN of 95 for Soil HSG Type D and new grass cover (> 75% cover) which has a CN of 80 for Soil HSG Type D. The roofs of the buildings will route through downspouts, which are collected by the curb and gutter and conveyed to the proposed detention basins. Time of concentration for the site was calculated as 19.29 min for the detained areas (see Exhibit F for

runoff route), while the undetained areas were set at the minimum of 5 minutes to obtain the most conservative values. The tables below show the peak runoff generated from the site for each design storm.

Table 5 - Proposed Site Conditions

	Detained	Undetained
Area (Ac)	11.293	1.778
CN	95.00	80.00
T_c (min)	19.29	5*

Table 6 - Proposed Peak Runoff Summary

Storm Event	Pre-Detained	Undetained
2-yr Q_{out} (cfs)	34.98	4.62
10-yr Q_{out} (cfs)	54.70	8.89
100-yr Q_{out} (cfs)	80.76	14.80

Refer to Appendix G for supporting runoff calculations for proposed conditions.

Detention

The proposed detention will include a single extended dry detention basin. Runoff accumulated into the extended dry detention basin will exit the system through a control structure. The control structure will have a 24" diameter dome grate top set at 1000.50'. There will be 10 different perforations sized at 1.33" that are spaced 4" apart vertically with the lowest invert of 995.00' (see Appendix H) to meet the water quality event detention and release rate requirement of 40 hours. The runoff will exit the control structure through a proposed 24" HDPE connecting to the existing storm system along NW Commerce Drive.

Table 7 outlines the stage-storage volume for the proposed extended dry detention basin:

Table 7 – Extended Dry Detention Basin Volume

Elevation (FT)	Area (SF)	Cumulative Vol (CF)
0	364	0.00
1	3,938	2,151.00
2	10,242	9,241.00
3	11,584	20,154.00
4	13,000	32,446.00
5	14,488	46,190.00
6	16,051	61,459.50
7	17,692	78,331.00
8	19,416	96,885.00
9	21,195	117,190.50
10	22,977	139,276.50
11	24,826	163,178.00

Below is a summary of the extended dry detention basin characteristics:

Bottom Elevation – 995.00'
Top Elevation – 1006.00'
Outlet – 1.33" Perforations spaced 4" vertically on center @ 995.00', 995.33', 995.67', 996.00', 996.33', 996.67', 997.00', 997.33', 997.67', and 998.00' on a 24" diameter basin with a dome grate top set at 1000.50' and a proposed 24" HDPE leading to the existing storm system.

Primary Outfall – 24" RCP, 68.50 LF @ 2.19%
FL Upstream – 992.00'
FL Downstream – 990.50'

Tables 8 below give a summary of the peak basin stages for each design storm. Refer to the attached storm modeling results in Appendix G for supporting basin routing calculations.

Table 8 – Extended Dry Detention Basin Routing Results

Storm Event	Max Water Depth (ft)	WSEL Proposed	Freeboard (ft)	Peak Qin (cfs)	Peak Qout (cfs)
1.37" Storm	3.18	998.18	7.82	11.19	**0.57**
2-yr	6.40	1001.40	4.60	34.82	**5.71**
10-yr	7.85	1002.85	3.15	54.40	**19.16**
100-yr	9.70	1004.70	1.30	80.37	**29.05**

Detention Analysis

The results of the extended dry detention basin routing were analyzed for the 2-yr, 10-yr and 100-yr design storms. The following Table 9 compares peak flows for the Allowable Release Rate requirements and Proposed Conditions. Detailed results of the routing analysis can be found in Appendix G. Proposed Out includes a combination of the peak outflows from the extended dry detention basin and the undetained areas.

Table 9 - Release Rate Summary

Storm Event	Allowable Peak Runoff – Total Site (cfs)	Proposed Peak Runoff – Total Site (cfs)	Net Discharge Pre vs. Post – Total Site (cfs)
2-yr	6.54	6.10	**-0.44**
10-yr	26.14	20.23	**-5.91**
100-yr	39.21	30.79	**-8.42**

Water Quality – Macro Analysis

Along with the detention analysis, the site was also analyzed per the MARC BMP Manual to ensure that the quality of the stormwater would also be considered. The existing conditions of the site consist of woodlands and grass, with soil conditions of HSG C and HSG D, producing an existing area-weighted curve number for the property of 73. The proposed conditions of the site include urban commercial development leading to the detention basin and areas of undetained grass cover, both with soil conditions of HSG D, producing a proposed area-weighted curve number of 93. Per the MARC BMP Manual, a Level of Service (LS) of 7.4 must be met to comply with water quality standards. The 7.4 LS is to be met through a combination of a BMP train of two ADS Barracuda Max Basins running into an extended dry detention basin and the planting of native vegetation. See Appendix H to see the BMP Worksheets.

The outlet structure for the detention basin was designed using the Design Procedure Form: Extended Dry Detention Basin (EDDB) Main Worksheet to ensure that the basin met water quality storage volume and release rates. Using the design storm of 1.37”, the outlet structure was designed to release the storm after more than 40 hours to ensure greater water quality leaving the site. See Appendix G for the analysis of the 1.37” storm event and Appendix H for the EDDB worksheet.

Conclusion & Recommendations

The proposed residential development consists of multiple proposed apartment buildings, associated parking lots, utilities, and drainage facilities. The total property area consists of 13.07 acres of total area. Installation of an extended dry detention basin on the site is recommended to meet release rate and BMP requirements. As shown in Table 9 above and the supporting detention calculations, release rate is reduced for the 2-yr, 10-yr, and 100-yr storm events when comparing the post-development versus pre-development conditions and meets the allowable release rate requirements for detention as outlined in the “Comprehensive Control” detention method found in APWA 5600. Therefore, we recommend approval of this Storm Drainage Study.

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Appendix A

Site Location Map

Site Location

Exhibit A.1

Scale: 1" = 1000'

24-0166 Tudor Multi-Family
Prepared: 08/01/2024

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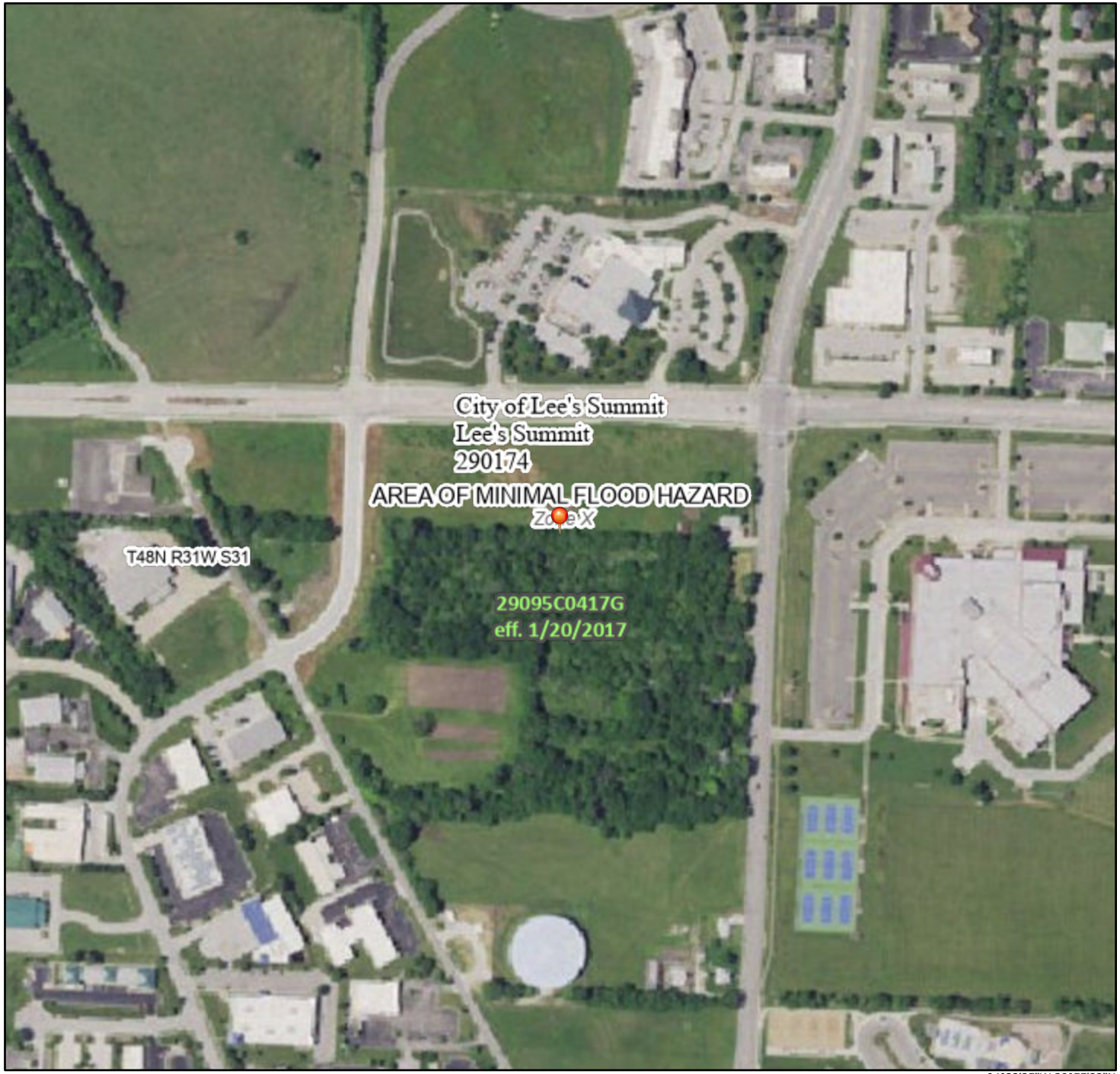
Appendix B

FEMA Firmette Map

National Flood Hazard Layer FIRMette

FEMA

94°23'12"W 38°56'1"N



94°22'35"W 38°55'33"N

Feet

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 7/25/2024 at 9:32 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

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Appendix C

NRCS Soil Report

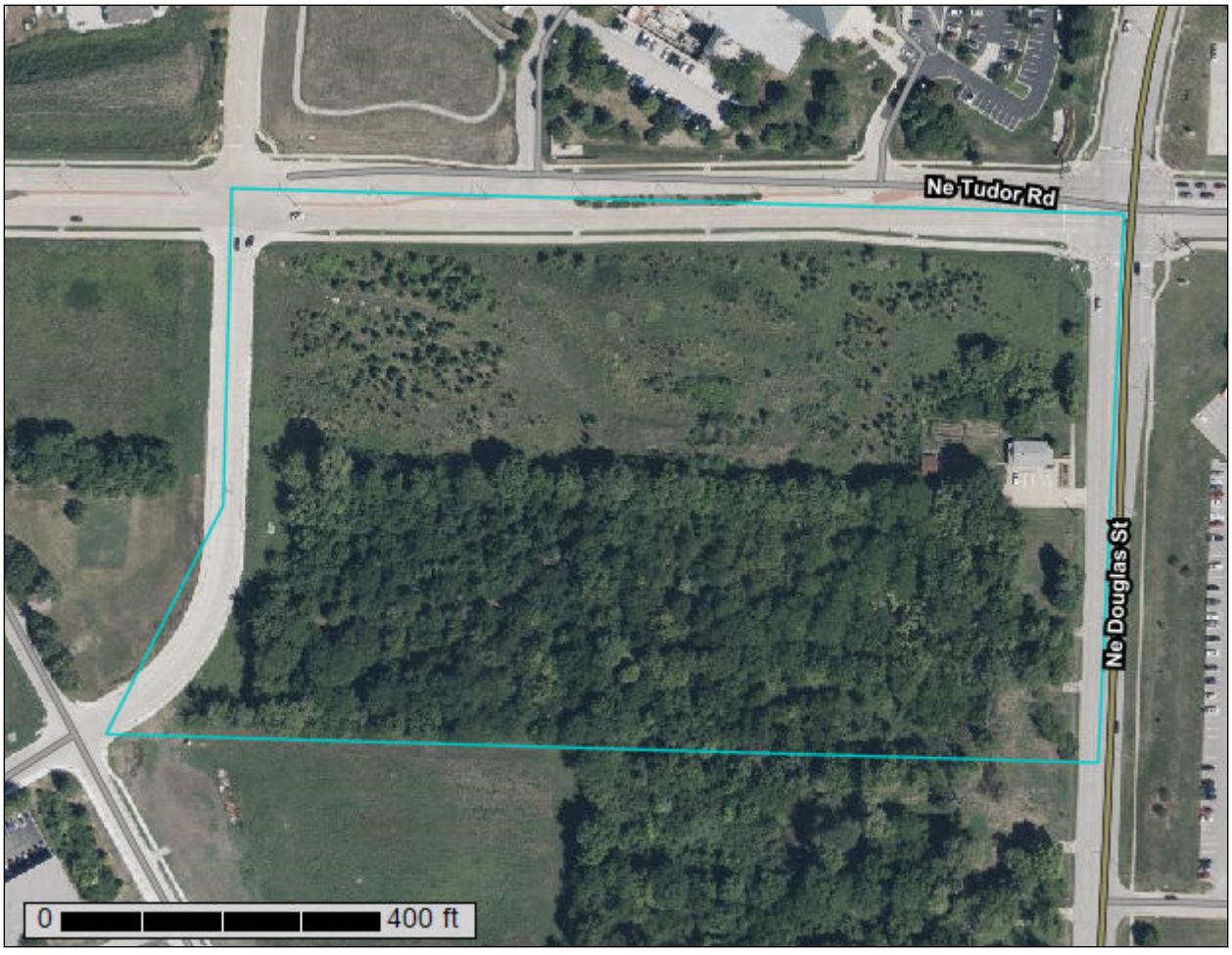
United States Department of Agriculture

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



July 24, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:2,130 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 30 60 120 180

Feet: 0 100 200 400 600

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Jackson County, Missouri
Survey Area Data: Version 25, Aug 22, 2023

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

Date(s) aerial images were photographed: Aug 30, 2022—Sep 8, 2022

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
10082	Arisburg-Urban land complex, 1 to 5 percent slopes	12.6	70.1%
10128	Sharpsburg-Urban land complex, 2 to 5 percent slopes	0.6	3.4%
10129	Sharpsburg-Urban land complex, 5 to 9 percent slopes	4.5	24.9%
10180	Udarents-Urban land-Sampsel complex, 2 to 5 percent slopes	0.3	1.6%
Totals for Area of Interest		**18.0**	**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

was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Jackson County, Missouri

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
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: R107XB007MO - 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

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

Map Unit Setting

National map unit symbol: 2ql09
Elevation: 1,000 to 1,320 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 155 to 220 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Minor components: 5 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)
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

Minor Components

Macksburg

Percent of map unit: 5 percent
Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R108XD860IA - Loess Upland Prairie
Hydric soil rating: No

10129—Sharpsburg-Urban land complex, 5 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2ql0b
Elevation: 990 to 1,320 feet
Mean annual precipitation: 33 to 41 inches
Mean annual air temperature: 50 to 55 degrees F
Frost-free period: 155 to 220 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Sharpsburg and similar soils: 60 percent
Urban land: 35 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Sharpsburg

Setting

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

Typical profile

A - 0 to 7 inches: silt loam
Bt - 7 to 48 inches: silty clay loam
C - 48 to 60 inches: silty clay loam

Properties and qualities

Slope: 5 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well 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 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: High (about 11.6 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

Description of Urban Land

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Crest

Interpretive groups

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

Minor Components

Macksburg

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: R108XD860IA - Loess Upland Prairie
Hydric soil rating: No

Lagonda, eroded

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: R108XD860IA - Loess Upland Prairie
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: 46 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
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: R107XB002MO - 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
Other vegetative classification: Grass/Prairie (Herbaceous Vegetation)
Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

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Appendix D

Pre-Development Drainage Map

Storm Study Exhibit

24-0166
Tudor Multi-Family
Lee's Summit, Jackson County, Missouri

Pre-Development
Drainage Map

Ex-North
Area: 3.506 ac
CN: 72.00
ToC: 23.70 min

Ex-South
Area: 9.563 ac
CN: 73.44
ToC: 32.06 min

Primary Discharge Point (Ex-North)
Existing Storm System

Primary Discharge Point (Ex-South)
Existing Storm System

NE Tudor Rd

NW Commerce Dr

NE Douglas St

LOT 1A
LEE'S SUMMIT POLICE AND COURT FACILITY
OWNER: CITY OF LEE'S SUMMIT

LOT 11
SUMMIT PARK
813 NW MAIN ST.
OWNER: JOHN WALTON
GILBERT DEC OF TRUST

LOT 10
SUMMIT PARK

LOT 10
SUMMIT PARK
OWNER: LARRY E. & BEATRICE M. FINKEMEIER

LOT 4
SUMMIT PARK

LOT 3 SUMMIT PARK
OWNER: MAKOL PROPERTIES, LLC

FND. 1/2" REBAR W/OLSSON MOLS 366 PLASTIC CAP

FND. 1/2" REBAR W/OLSSON MOLS 366 PLASTIC CAP

FND. 1/2" REBAR W/OLSSON MOLS 366 PLASTIC CAP

S1°59'47"W 626.27'

I.T.B.=S89°24'46"E

R=2055.00'...53.07'

S89°24'16"E...294.23'

N89°06'54"E...401.11'

I.T.B.=S88°24'34"E

R=1936.00'...17.84'

S85°35'40"E...117.21'

S87°52'53"E...133.38'

S4°03'31"E 42.53'

S1°47'50"E...181.57'

N1°59'47"E...288.45'

N87°44'32"W...5.00'

N1°59'41"E...86.24'

I.T.B.=N53°18'46"E

R=280.00'...235.67'

N87°41'50"W...557.31'

S1°39'56"W...98.11'

N87°44'22"W...595.16'

S1°47'13"W...210.65'

N87°44'22"W...227.00'

S1°47'50"W...106.00'

S87°44'22"E...227.10'

1720.57'
S1°59'47"W

RIGHT-OF-WAY DEDICATION
TO CITY OF LEE'S SUMMIT
DOC. NO. 2018E0058211 (#20)

TEMPORARY CONSTRUCTION ESMT.
TO CITY OF LEE'S SUMMIT
DOC. NO. 2018E0058212 (#21)

RIGHT-OF-WAY DEDICATION
TO CITY OF LEE'S SUMMIT
DOC. NO. 2018E0020780

RIGHT-OF-WAY EASEMENT FOR PUBLIC USE AS DOC. NO. 2013E0115521 (#14)

40' RIGHT-OF-WAY DEDICATION
BK. 555, PG. 20

15' WATER LINE ESMT.
TO CITY OF LEE'S SUMMIT
DOC. NO. 97M0074 BK. 0099, PG. 381 (#5)

ANGLE POINT S. LINE LOT 2A
FND. 1/2" REBAR W/BROKEN ANDERSON PLASTIC CAP

SE COR. LOT 2A
FND. 1/2" REBAR W/ BROKEN ANDERSON MOLS 76D PLASTIC CAP

FND. 5/8" REBAR W/ SDE INC. 320D PLASTIC CAP

ANGLE POINT S. LINE LOT 2A
FND. 1/2" REBAR W/PLASTIC CAP

SW COR. LOT 2A
FND. 1" PIPE 0.6'S.

FND. 1/2" REBAR
MO LS 311D PLASTIC
CAP 0.3'E.

FND. 1" PIPE

FND. 1/2" REBAR
MO LS 371D
PLASTIC CAP

FND. 1/8" REBAR

E. PLAT LINE

WATER METER PIT
(NO METER)

FIBER OPTIC VAULT

FENCE ON LINE

WIRE FENCE

UNDERGROUND

OVERHEAD

30' R/W

25' R/W

40'

NO. | DATE | REVISION

DRAWN BY: %%
CHECKED BY: %%

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MO Certificate of Authority: E-2010033630

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Appendix E

Existing Conditions Analysis

Project Description

File Name 24-0166 SWR-EXISTING-01.SPF

Project Options

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

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2-Year	Cumulative	inches	Missouri	Jackson	2.00	3.50	SCS Type II 24

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Ex-North	3.51	484.00	72.00	3.50	1.12	3.93	3.88	0 00:22:21
2	Ex-South	9.56	484.00	73.44	3.50	1.21	11.53	9.25	0 00:32:03

Link Summary

SN	From (Inlet) Node	To (Outlet) Node	Outlet Invert Elevation (ft)	Peak Flow (cfs)
1	Outfall	Tot-Out	990.50	12.69

Subbasin Hydrology

Subbasin : Ex-North

Input Data

Area (ac)	3.51
Peak Rate Factor	484
Weighted Curve Number	72
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Good	3.18	C	72
Composite Area & Weighted CN	3.18		72

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

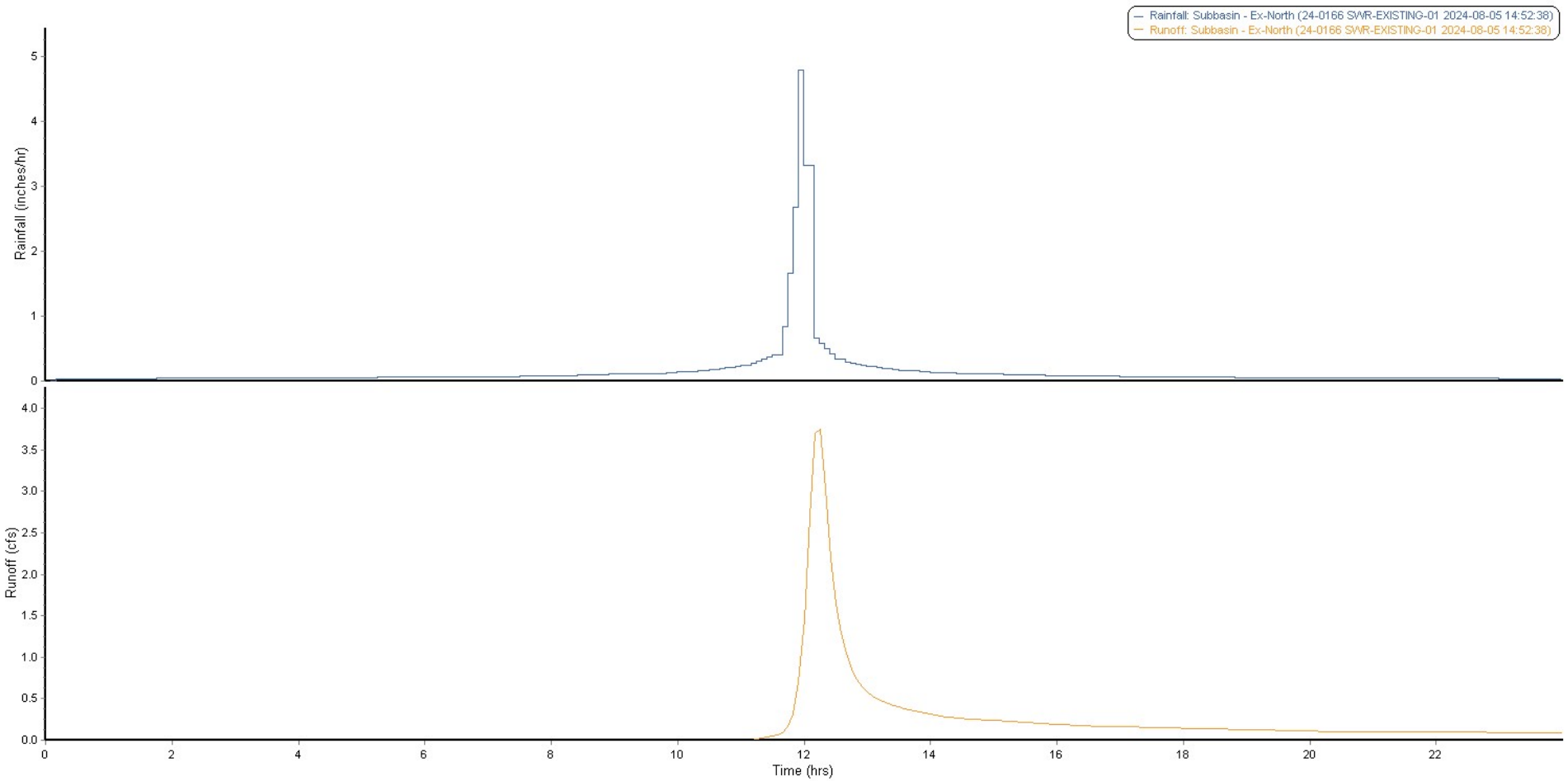
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2.75	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	18.08	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	426	0	0
Slope (%) :	5.6	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	4.28	0	0

Total TOC (min) 22.35

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	1.12
Peak Runoff (cfs)	3.88
Weighted Curve Number	72
Time of Concentration (days hh:mm:ss)	0 00:22:21


Rainfall: Subbasin - Ex-North (24-0166 SWR-EXISTING-01 2024-08-05 14:52:38)
Runoff: Subbasin - Ex-North (24-0166 SWR-EXISTING-01 2024-08-05 14:52:38)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Subbasin : Ex-South

Input Data

Area (ac)	9.56
Peak Rate Factor	484
Weighted Curve Number	73.44
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Good	3.65	D	79
Woods, Good	5.91	C	70
Composite Area & Weighted CN	9.56		73.44

Time of Concentration

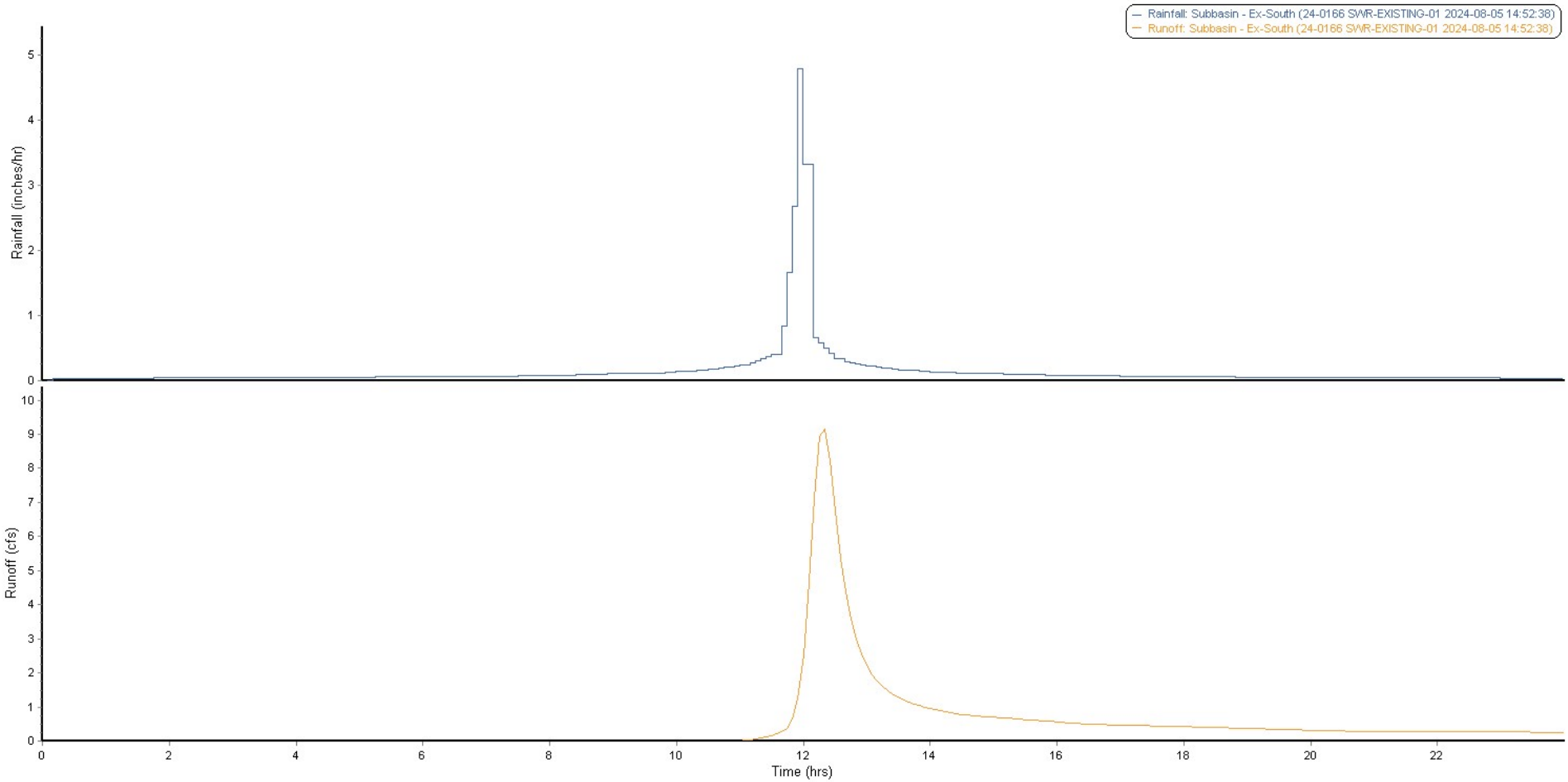
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.6	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.5	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	20.53	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	788.24	0	0
Slope (%) :	5.2	0	0
Surface Type :	Woodland	Unpaved	Unpaved
Velocity (ft/sec) :	1.14	0	0
Computed Flow Time (min) :	11.52	0	0

Total TOC (min) 32.06

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	1.21
Peak Runoff (cfs)	9.25
Weighted Curve Number	73.44
Time of Concentration (days hh:mm:ss)	0 00:32:04


Rainfall: Subbasin - Ex-South (24-0166 SWR-EXISTING-01 2024-08-05 14:52:38)
Runoff: Subbasin - Ex-South (24-0166 SWR-EXISTING-01 2024-08-05 14:52:38)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Project Description

File Name 24-0166 SWR-EXISTING-01.SPF

Project Options

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

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10-Year	Cumulative	inches	Missouri	Jackson	10.00	5.30	SCS Type II 24

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Ex-North	3.51	484.00	72.00	5.30	2.43	8.52	8.83	0 00:22:21
2	Ex-South	9.56	484.00	73.44	5.30	2.56	24.44	20.54	0 00:32:03

Link Summary

SN	From (Inlet) Node	To (Outlet) Node	Outlet Invert Elevation (ft)	Peak Flow (cfs)
1	Outfall	Tot-Out	990.50	28.52

Subbasin Hydrology

Subbasin : Ex-North

Input Data

Area (ac)	3.51
Peak Rate Factor	484
Weighted Curve Number	72
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Good	3.18	C	72
Composite Area & Weighted CN	3.18		72

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

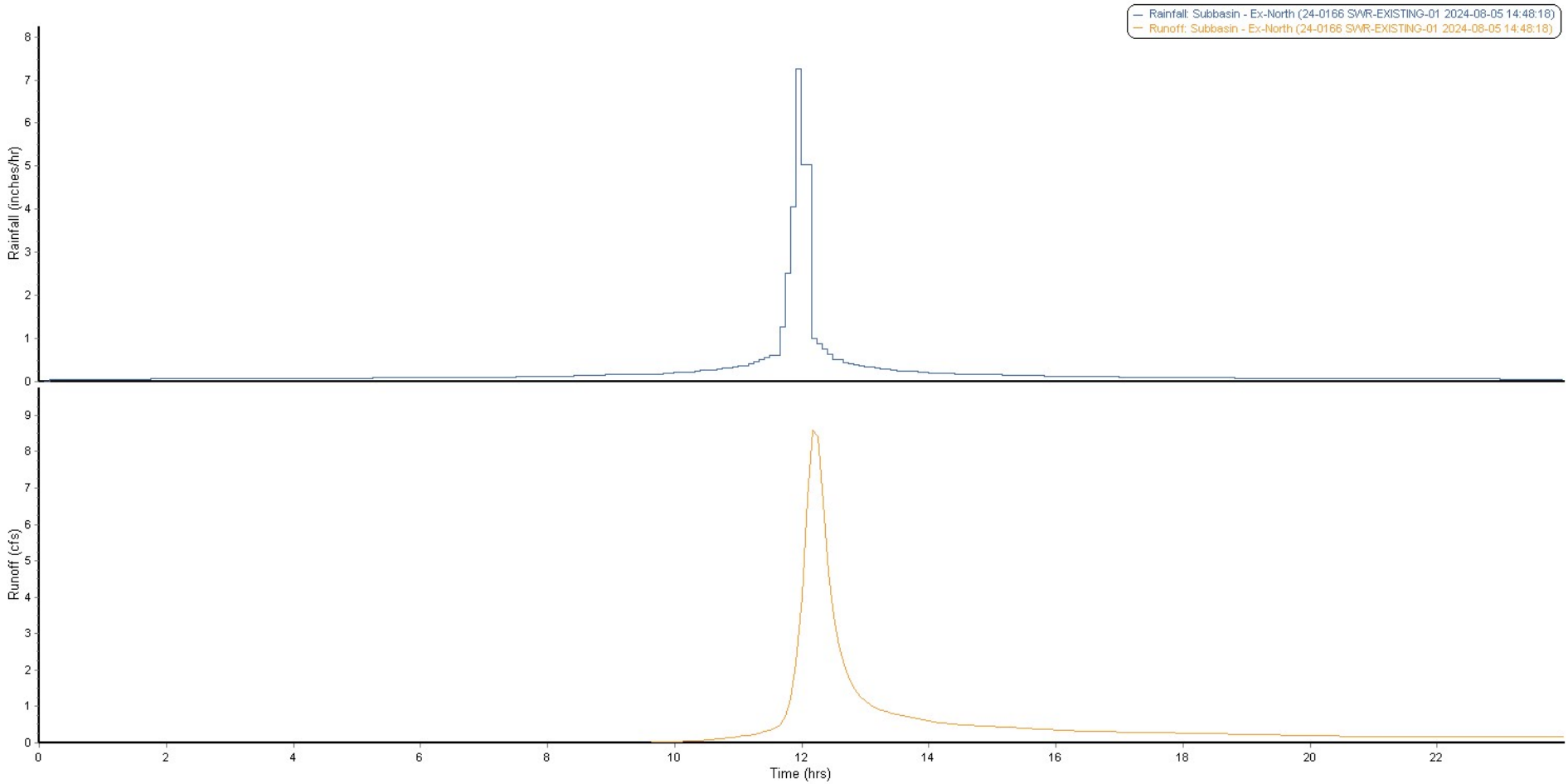
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2.75	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	18.08	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	426	0	0
Slope (%) :	5.6	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	4.28	0	0

Total TOC (min) 22.35

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	2.43
Peak Runoff (cfs)	8.83
Weighted Curve Number	72
Time of Concentration (days hh:mm:ss)	0 00:22:21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Runoff: Subbasin - Ex-North (24-0166 SWR-EXISTING-01 2024-08-05 14:48:18)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Subbasin : Ex-South

Input Data

Area (ac)	9.56
Peak Rate Factor	484
Weighted Curve Number	73.44
Rain Gage ID	Rain Gage-01

Composite Curve Number

32	Area	Soil	Curve
Soil/Surface Description	(acres)	Group	Number
Woods & grass combination, Good	3.65	D	79
Woods, Good	5.91	C	70
Composite Area & Weighted CN	9.56		73.44

Time of Concentration

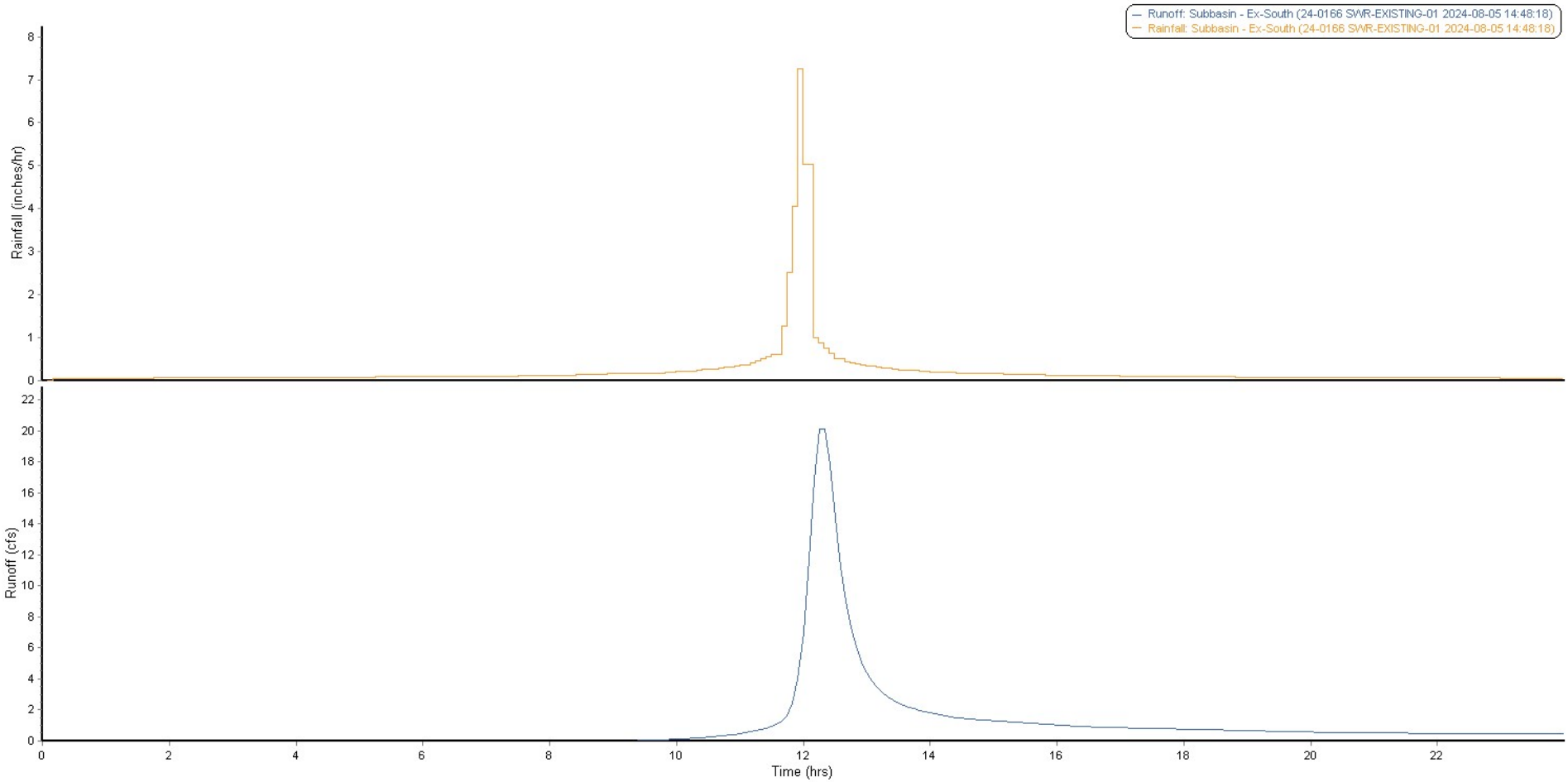
	Subarea	Subarea	Subarea
Sheet Flow Computations	A	B	C
Manning's Roughness :	0.6	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.5	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	20.53	0	0

	Subarea	Subarea	Subarea
Shallow Concentrated Flow Computations	A	B	C
Flow Length (ft) :	788.24	0	0
Slope (%) :	5.2	0	0
Surface Type :	Woodland	Unpaved	Unpaved
Velocity (ft/sec) :	1.14	0	0
Computed Flow Time (min) :	11.52	0	0

Total TOC (min) 32.06

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	2.56
Peak Runoff (cfs)	20.54
Weighted Curve Number	73.44
Time of Concentration (days hh:mm:ss)	0 00:32:04


Runoff: Subbasin - Ex-South (24-0166 SWR-EXISTING-01 2024-08-05 14:48:18)
Rainfall: Subbasin - Ex-South (24-0166 SWR-EXISTING-01 2024-08-05 14:48:18)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Project Description

File Name 24-0166 SWR-EXISTING-01.SPF

Project Options

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

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100-Year	Cumulative	inches	Missouri	Jackson	100.00	7.70	SCS Type II 2

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Ex-North	3.51	484.00	72.00	7.70	4.43	15.54	16.20	0 00:22:21
2	Ex-South	9.56	484.00	73.44	7.70	4.60	43.94	37.28	0 00:32:03

Link Summary

SN	From (Inlet) Node	To (Outlet) Node	Outlet Invert Elevation (ft)	Peak Flow (cfs)
1	Outfall	Tot-Out	990.50	52.02

Subbasin Hydrology

Subbasin : Ex-North

Input Data

Area (ac)	3.51
Peak Rate Factor	484
Weighted Curve Number	72
Rain Gage ID	Rain Gage-01

Composite Curve Number

32

Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Good	3.18	C	72
Composite Area & Weighted CN	3.18		72

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

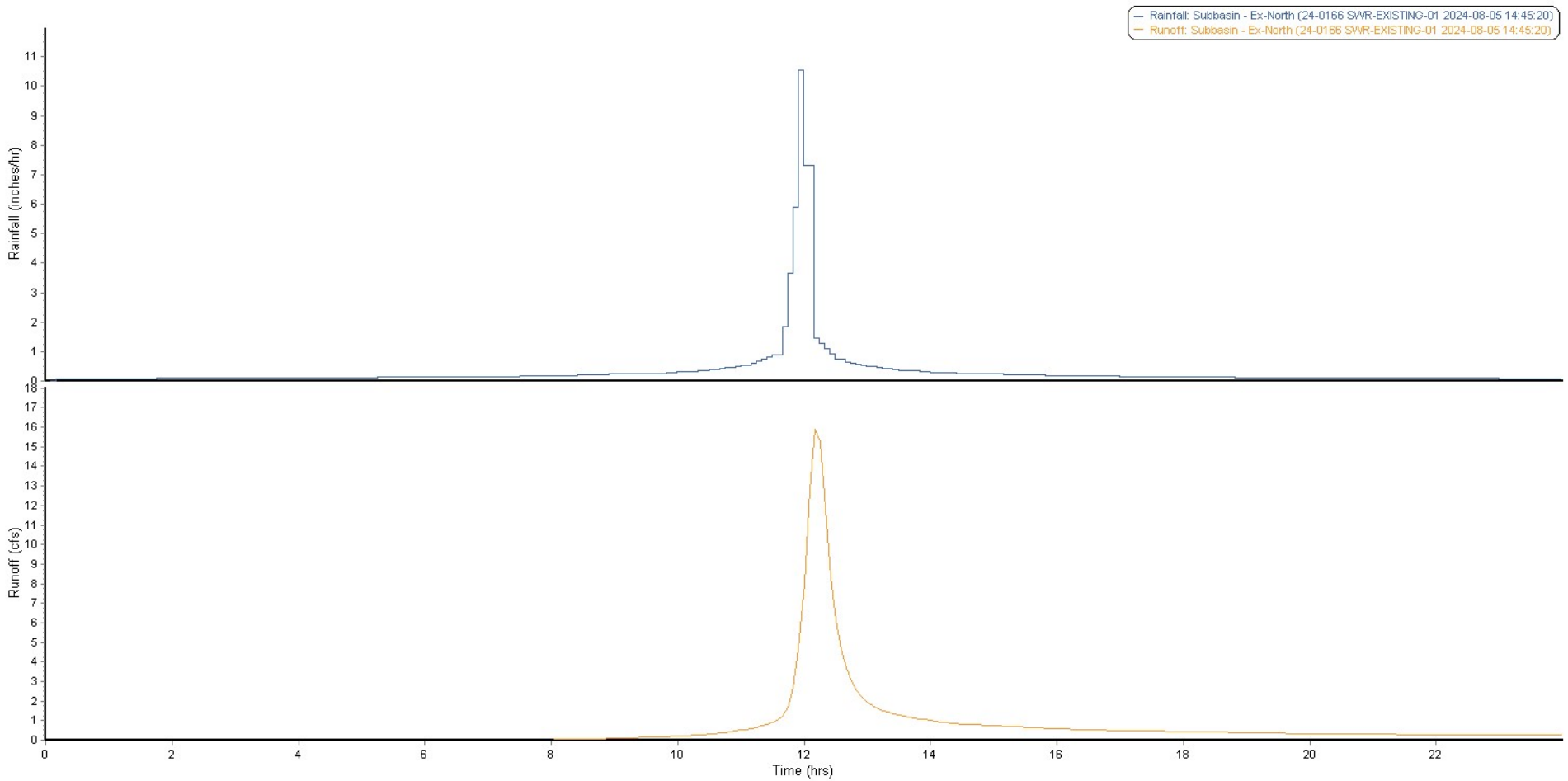
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	2.75	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.09	0	0
Computed Flow Time (min) :	18.08	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	426	0	0
Slope (%) :	5.6	0	0
Surface Type :	Grass pasture	Unpaved	Unpaved
Velocity (ft/sec) :	1.66	0	0
Computed Flow Time (min) :	4.28	0	0

Total TOC (min) 22.35

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	4.43
Peak Runoff (cfs)	16.2
Weighted Curve Number	72
Time of Concentration (days hh:mm:ss)	0 00:22:21


Rainfall: Subbasin - Ex-North (24-0166 SWR-EXISTING-01 2024-08-05 14:45:20)
Runoff: Subbasin - Ex-North (24-0166 SWR-EXISTING-01 2024-08-05 14:45:20)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Subbasin : Ex-South

Input Data

Area (ac)	9.56
Peak Rate Factor	484
Weighted Curve Number	73.44
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Woods & grass combination, Good	3.65	D	79
Woods, Good	5.91	C	70
Composite Area & Weighted CN	9.56		73.44

Time of Concentration

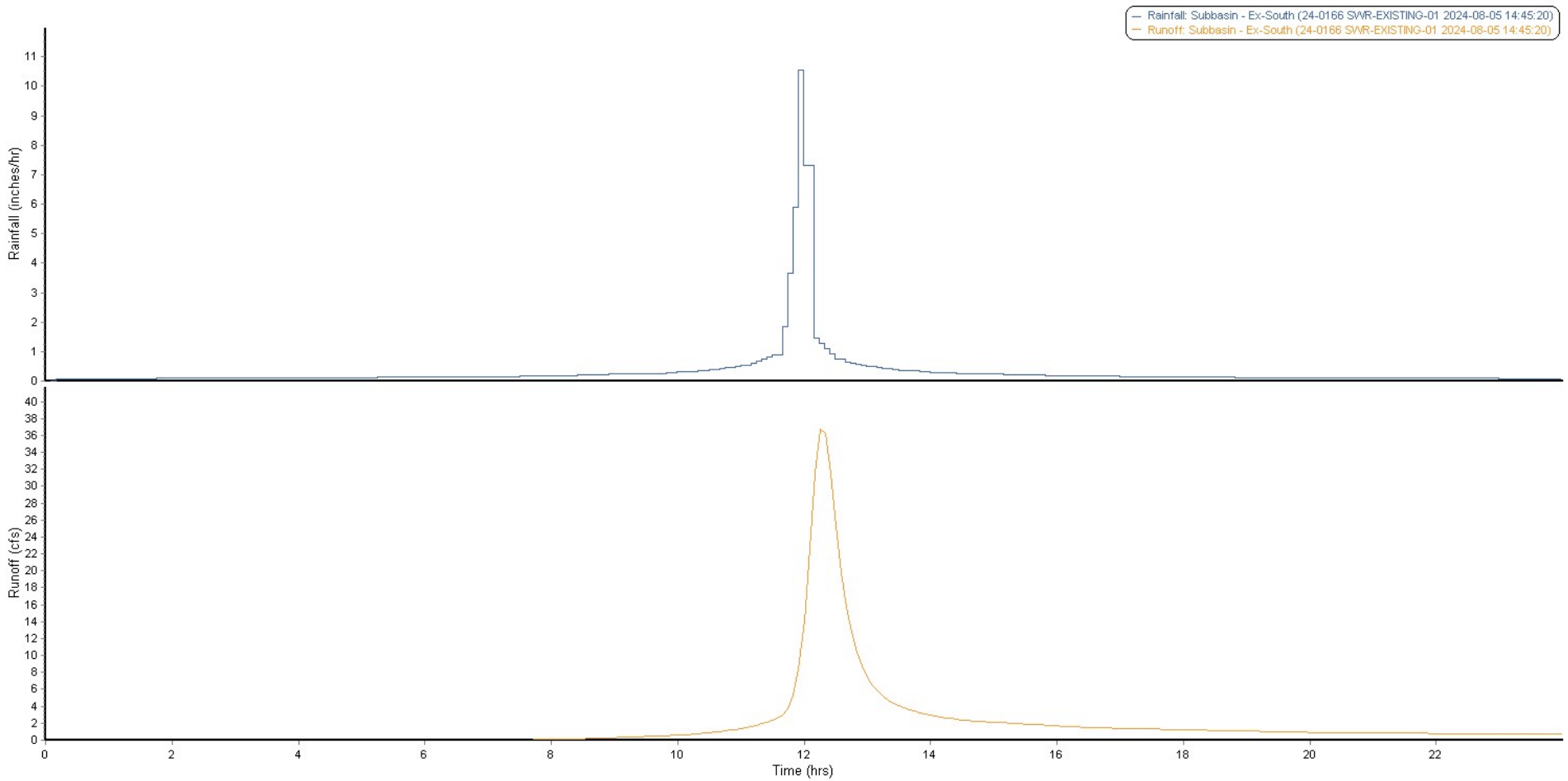
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.6	0	0
Flow Length (ft) :	100	0	0
Slope (%) :	4.5	0	0
2 yr, 24 hr Rainfall (in) :	3.5	0	0
Velocity (ft/sec) :	0.08	0	0
Computed Flow Time (min) :	20.53	0	0

Shallow Concentrated Flow Computations	Subarea A	Subarea B	Subarea C
Flow Length (ft) :	788.24	0	0
Slope (%) :	5.2	0	0
Surface Type :	Woodland	Unpaved	Unpaved
Velocity (ft/sec) :	1.14	0	0
Computed Flow Time (min) :	11.52	0	0

Total TOC (min) 32.06

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	4.6
Peak Runoff (cfs)	37.28
Weighted Curve Number	73.44
Time of Concentration (days hh:mm:ss)	0 00:32:04

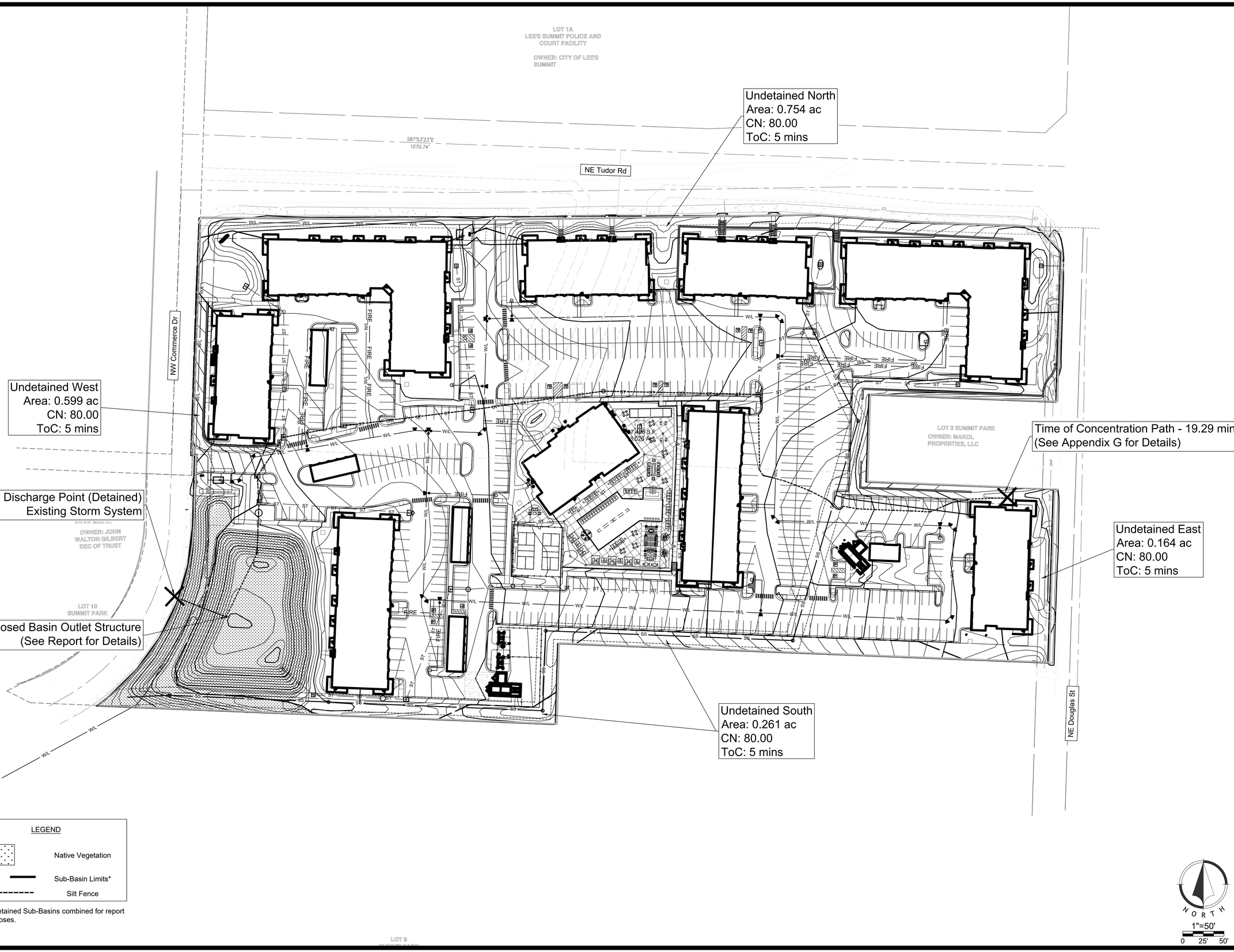

Rainfall: Subbasin - Ex-South (24-0166 SWR-EXISTING-01 2024-08-05 14:45:20)
Runoff: Subbasin - Ex-South (24-0166 SWR-EXISTING-01 2024-08-05 14:45:20)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Renaissance Infrastructure Consulting

8653 Penrose Lane
Lenexa, KS 66219
P: 913.317.9500
ric-consult.com

Appendix F

Post-Development Drainage Map



Storm Study Exhibit

24-0166
Tudor Multi-Family
Lee's Summit, Jackson County, Missouri

Post-Development
Drainage Map

NO.	DATE	REVISION

DRAWN BY %%

CHECKED BY %%

Renaissance Infrastructure Consulting
400 E. 17th Street
Kansas City, Missouri 64108
816.800.0950
www.ric-consult.com
MO Certificate of Authority: E-2010033630

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Renaissance Infrastructure Consulting

8653 Penrose Lane
Lenexa, KS 66219
P: 913.317.9500
ric-consult.com

Appendix G

Proposed Conditions Analysis

Project Description

File Name 24-0166 SWR-PROP-01.SPF

Project Options

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

Analysis Options

Start Analysis On 00:00:00 0:00:00
End Analysis On 00:00:00 0:00:00
Start Reporting On 00:00:00 0:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	1.37" Storm	Cumulative	inches					User Defined

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Pre-Detention	11.29	484.00	95.00	1.37	0.89	10.08	11.21	0 00:19:17
2	Undetained	1.78	484.00	80.00	1.37	0.23	0.40	0.53	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation	Ground/Rim (Max) Elevation	Initial Water Elevation	Peak Inflow	Max HGL Elevation Attained
			(ft)	(ft)	(ft)	(cfs)	(ft)
1	ControlStructure	Junction	995.00	1000.50	995.00	0.57	995.15
2	Total-Outfall	Outfall	990.50			0.79	990.65
3	ProposedDetention	Storage Node	995.00	1006.00	995.00	11.19	998.18

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)
1	Post-Detention	Pipe	ControlStructure	Total-Outfall	68.50	992.00	990.50	2.1900	24.000	0.0150	0.57	50.25	0.01	5.32
2	GrateTop	Orifice	ProposedDetention	ControlStructure		995.00	995.00		24.000		0.00			
3	Perforation01	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.08			
4	Perforation02	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.08			
5	Perforation03	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.07			
6	Perforation04	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.07			
7	Perforation05	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.06			
8	Perforation06	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.06			
9	Perforation07	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.05			
10	Perforation08	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.04			
11	Perforation09	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.03			
12	Perforation10	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.02			

Subbasin Hydrology

Subbasin : Pre-Detention

Input Data

Area (ac)	11.29
Peak Rate Factor	484
Weighted Curve Number	95
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	11.29	D	95
Composite Area & Weighted CN	11.29		95

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0.012	0
Flow Length (ft) :	50	370	0
Slope (%) :	1	3.76	0
2 yr, 24 hr Rainfall (in) :	3.5	3.5	0
Velocity (ft/sec) :	0.05	2.24	0
Computed Flow Time (min) :	15.56	2.75	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.012	0	0
Flow Length (ft) :	763	0	0
Channel Slope (%) :	0.81	0	0
Cross Section Area (ft^2) :	9.82	0	0
Wetted Perimeter (ft) :	7.85	0	0
Velocity (ft/sec) :	12.97	0	0
Computed Flow Time (min) :	0.98	0	0

Total TOC (min) 19.29

Subbasin Runoff Results

Total Rainfall (in)	1.37
Total Runoff (in)	0.89
Peak Runoff (cfs)	11.21
Weighted Curve Number	95
Time of Concentration (days hh:mm:ss)	0 00:19:17

Subbasin : Undetained

Input Data

Area (ac)	1.78
Peak Rate Factor	484
Weighted Curve Number	80
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	1.78	D	80
Composite Area & Weighted CN	1.78		80

Time of Concentration

User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in)	1.37
Total Runoff (in)	0.23
Peak Runoff (cfs)	0.53
Weighted Curve Number	80
Time of Concentration (days hh:mm:ss)	0 00:05:00

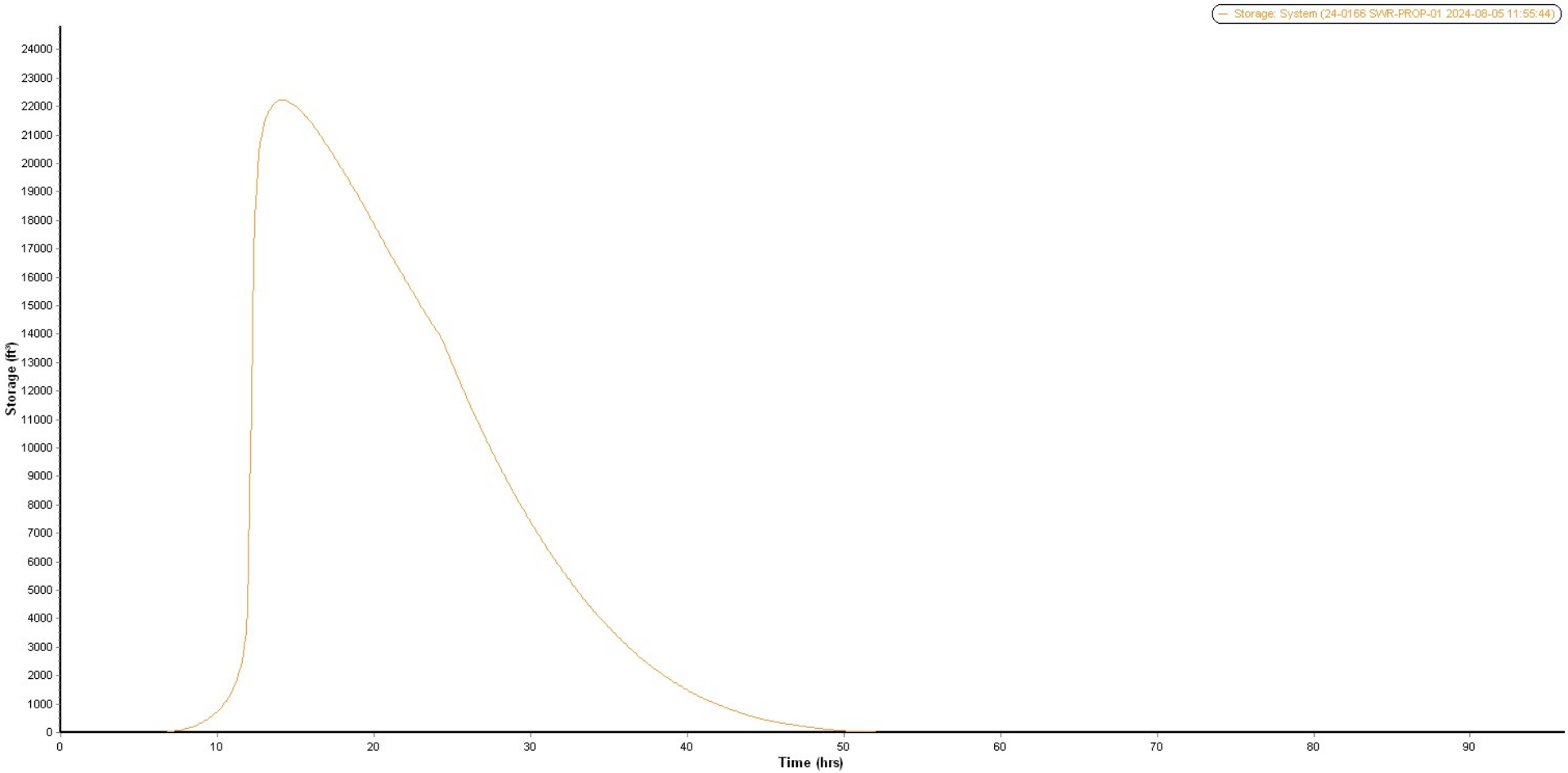
Storage Node : ProposedDetention (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	GrateTop	Side	CIRCULAR	24.00	1000.50	0.61
2	Perforation01	Side	CIRCULAR	1.33	995.00	0.61
3	Perforation02	Side	CIRCULAR	1.33	995.33	0.61
4	Perforation03	Side	CIRCULAR	1.33	995.67	0.61
5	Perforation04	Side	CIRCULAR	1.33	996.00	0.61
6	Perforation05	Side	CIRCULAR	1.33	996.33	0.61
7	Perforation06	Side	CIRCULAR	1.33	996.67	0.61
8	Perforation07	Side	CIRCULAR	1.33	997.00	0.61
9	Perforation08	Side	CIRCULAR	1.33	997.33	0.61
10	Perforation09	Side	CIRCULAR	1.33	997.67	0.61
11	Perforation10	Side	CIRCULAR	1.33	998.00	0.61

Output Summary Results

Peak Inflow (cfs)	11.19
Peak Lateral Inflow (cfs)	11.19
Peak Outflow (cfs)	0.57
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	998.18
Max HGL Depth Attained (ft)	3.18
Average HGL Elevation Attained (ft)	995.7
Average HGL Depth Attained (ft)	0.7
Time of Max HGL Occurrence (days hh:mm)	0 14:07
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0


Storage: System (24-0166 SWR-PROP-01 2024-08-05 11:55:44)
Storage (ft³)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000
15000
16000
17000
18000
19000
20000
21000
22000
23000
24000
0
10
20
30
40
50
60
70
80
90
Time (hrs)

Project Description

File Name 24-0166 SWR-PROP-01.SPF

Project Options

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

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	2-Year	Cumulative	inches	Missouri	Jackson	2.00	3.50	SCS Type II 24

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Pre-Detention	11.29	484.00	95.00	3.50	2.94	33.19	34.98	0 00:19:17
2	Undetained	1.78	484.00	80.00	3.50	1.64	2.91	4.62	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)
1	ControlStructure	Junction	995.00	1000.50	995.00	5.71	995.46
2	Total-Outfall	Outfall	990.50			6.10	990.95
3	ProposedDetention	Storage Node	995.00	1006.00	995.00	34.82	1001.40

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)
1	Post-Detention	Pipe	ControlStructure	Total-Outfall	68.50	992.00	990.50	2.1900	24.000	0.0150	5.71	50.25	0.11	10.61
2	GrateTop	Orifice	ProposedDetention	ControlStructure		995.00	995.00		24.000		4.67			
3	Perforation01	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.12			
4	Perforation02	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.12			
5	Perforation03	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.11			
6	Perforation04	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.11			
7	Perforation05	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.11			
8	Perforation06	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.10			
9	Perforation07	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.10			
10	Perforation08	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.10			
11	Perforation09	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.09			
12	Perforation10	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.09			

Subbasin Hydrology

Subbasin : Pre-Detention

Input Data

Area (ac)	11.29
Peak Rate Factor	484
Weighted Curve Number	95
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	11.29	D	95
Composite Area & Weighted CN	11.29		95

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

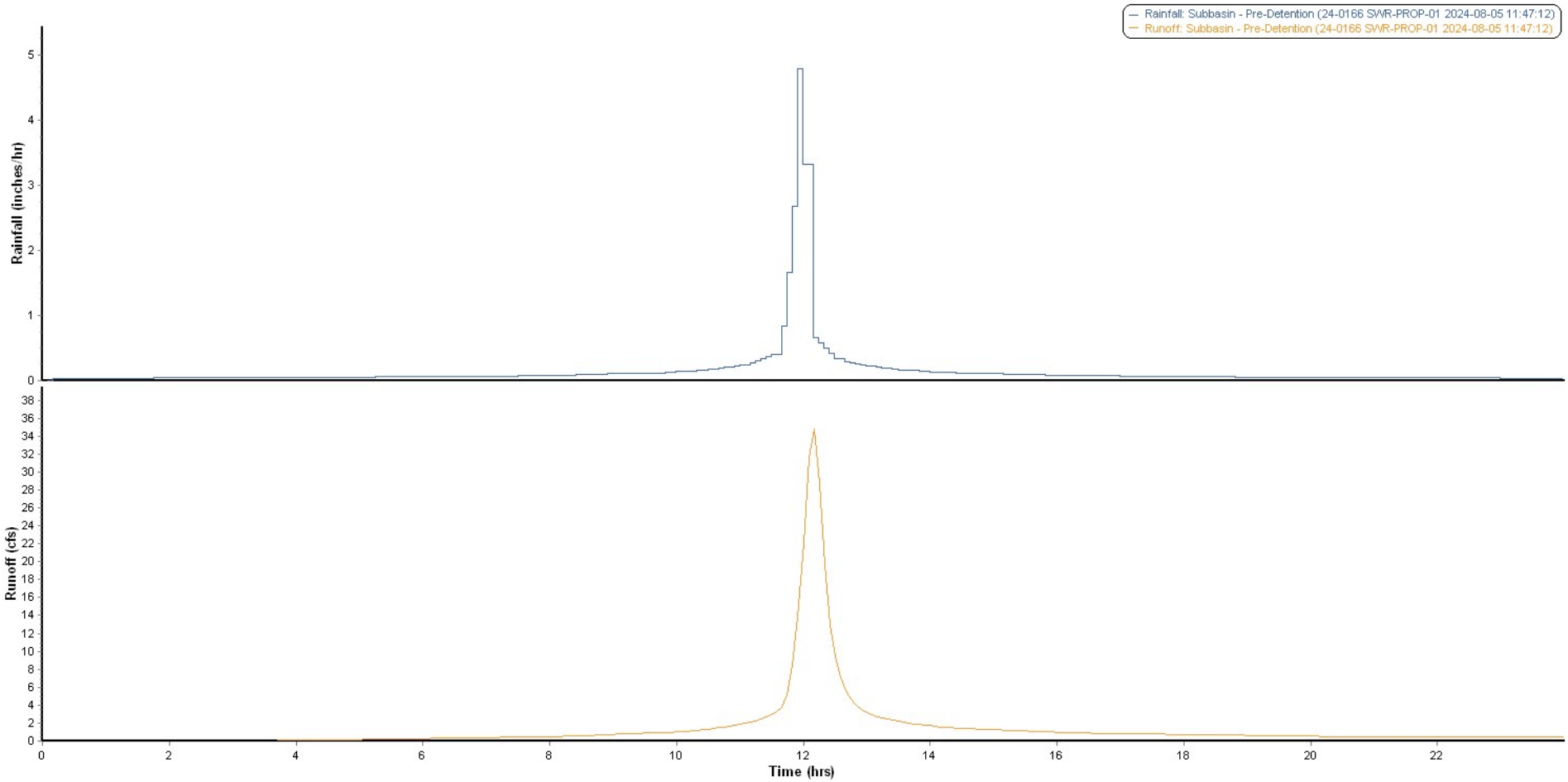
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0.012	0
Flow Length (ft) :	50	370	0
Slope (%) :	1	3.76	0
2 yr, 24 hr Rainfall (in) :	3.5	3.5	0
Velocity (ft/sec) :	0.05	2.24	0
Computed Flow Time (min) :	15.56	2.75	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.012	0	0
Flow Length (ft) :	763	0	0
Channel Slope (%) :	0.81	0	0
Cross Section Area (ft^2) :	9.82	0	0
Wetted Perimeter (ft) :	7.85	0	0
Velocity (ft/sec) :	12.97	0	0
Computed Flow Time (min) :	0.98	0	0

Total TOC (min) 19.29

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	2.94
Peak Runoff (cfs)	34.98
Weighted Curve Number	95
Time of Concentration (days hh:mm:ss)	0 00:19:17


Rainfall: Subbasin - Pre-Detention (24-0166 SWR-PROP-01 2024-08-05 11:47:12)
Runoff: Subbasin - Pre-Detention (24-0166 SWR-PROP-01 2024-08-05 11:47:12)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Subbasin : Undetained

Input Data

Area (ac)	1.78
Peak Rate Factor	484
Weighted Curve Number	80
Rain Gage ID	Rain Gage-01

Composite Curve Number

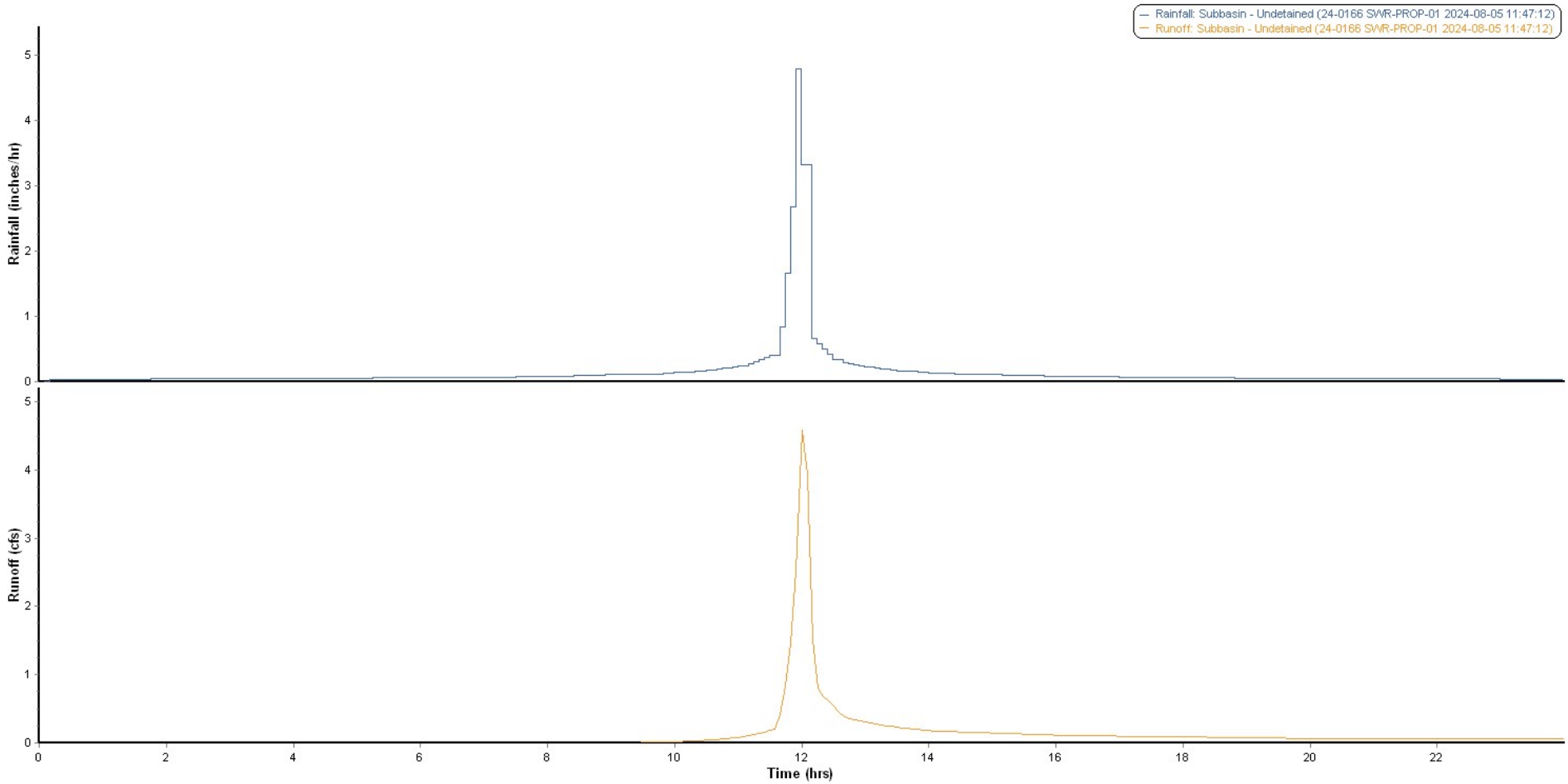
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	1.78	D	80
Composite Area & Weighted CN	1.78		80

Time of Concentration

User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in)	3.5
Total Runoff (in)	1.64
Peak Runoff (cfs)	4.62
Weighted Curve Number	80
Time of Concentration (days hh:mm:ss)	0 00:05:00


Rainfall: Subbasin - Undetained (24-0166 SWR-PROP-01 2024-08-05 11:47:12)
Runoff: Subbasin - Undetained (24-0166 SWR-PROP-01 2024-08-05 11:47:12)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)
0
1
2
3
4
5
0
2
4
6
8
10
12
14
16
18
20
22

Storage Node : ProposedDetention (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	GrateTop	Side	CIRCULAR	24.00	1000.50	0.61
2	Perforation01	Side	CIRCULAR	1.33	995.00	0.61
3	Perforation02	Side	CIRCULAR	1.33	995.33	0.61
4	Perforation03	Side	CIRCULAR	1.33	995.67	0.61
5	Perforation04	Side	CIRCULAR	1.33	996.00	0.61
6	Perforation05	Side	CIRCULAR	1.33	996.33	0.61
7	Perforation06	Side	CIRCULAR	1.33	996.67	0.61
8	Perforation07	Side	CIRCULAR	1.33	997.00	0.61
9	Perforation08	Side	CIRCULAR	1.33	997.33	0.61
10	Perforation09	Side	CIRCULAR	1.33	997.67	0.61
11	Perforation10	Side	CIRCULAR	1.33	998.00	0.61

Output Summary Results

Peak Inflow (cfs)	34.82
Peak Lateral Inflow (cfs)	34.82
Peak Outflow (cfs)	5.71
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	1001.4
Max HGL Depth Attained (ft)	6.4
Average HGL Elevation Attained (ft)	998.21
Average HGL Depth Attained (ft)	3.21
Time of Max HGL Occurrence (days hh:mm)	0 12:40
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name 24-0166 SWR-PROP-01.SPF

Project Options

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

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	10-Year	Cumulative	inches	Missouri	Jackson	10.00	5.30	SCS Type II 24

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Pre-Detention	11.29	484.00	95.00	5.30	4.72	53.27	54.70	0 00:19:17
2	Undetained	1.78	484.00	80.00	5.30	3.16	5.61	8.89	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)
1	ControlStructure	Junction	995.00	1000.50	995.00	19.16	995.86
2	Total-Outfall	Outfall	990.50			20.23	991.36
3	ProposedDetention	Storage Node	995.00	1006.00	995.00	54.40	1002.85

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)
1	Post-Detention	Pipe	ControlStructure	Total-Outfall	68.50	992.00	990.50	2.1900	24.000	0.0150	19.16	50.25	0.38	14.91
2	GrateTop	Orifice	ProposedDetention	ControlStructure		995.00	995.00		24.000		17.97			
3	Perforation01	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.13			
4	Perforation02	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.13			
5	Perforation03	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.13			
6	Perforation04	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.12			
7	Perforation05	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.12			
8	Perforation06	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.12			
9	Perforation07	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.11			
10	Perforation08	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.11			
11	Perforation09	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.11			
12	Perforation10	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.10			

Subbasin Hydrology

Subbasin : Pre-Detention

Input Data

Area (ac)	11.29
Peak Rate Factor	484
Weighted Curve Number	95
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	11.29	D	95
Composite Area & Weighted CN	11.29		95

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

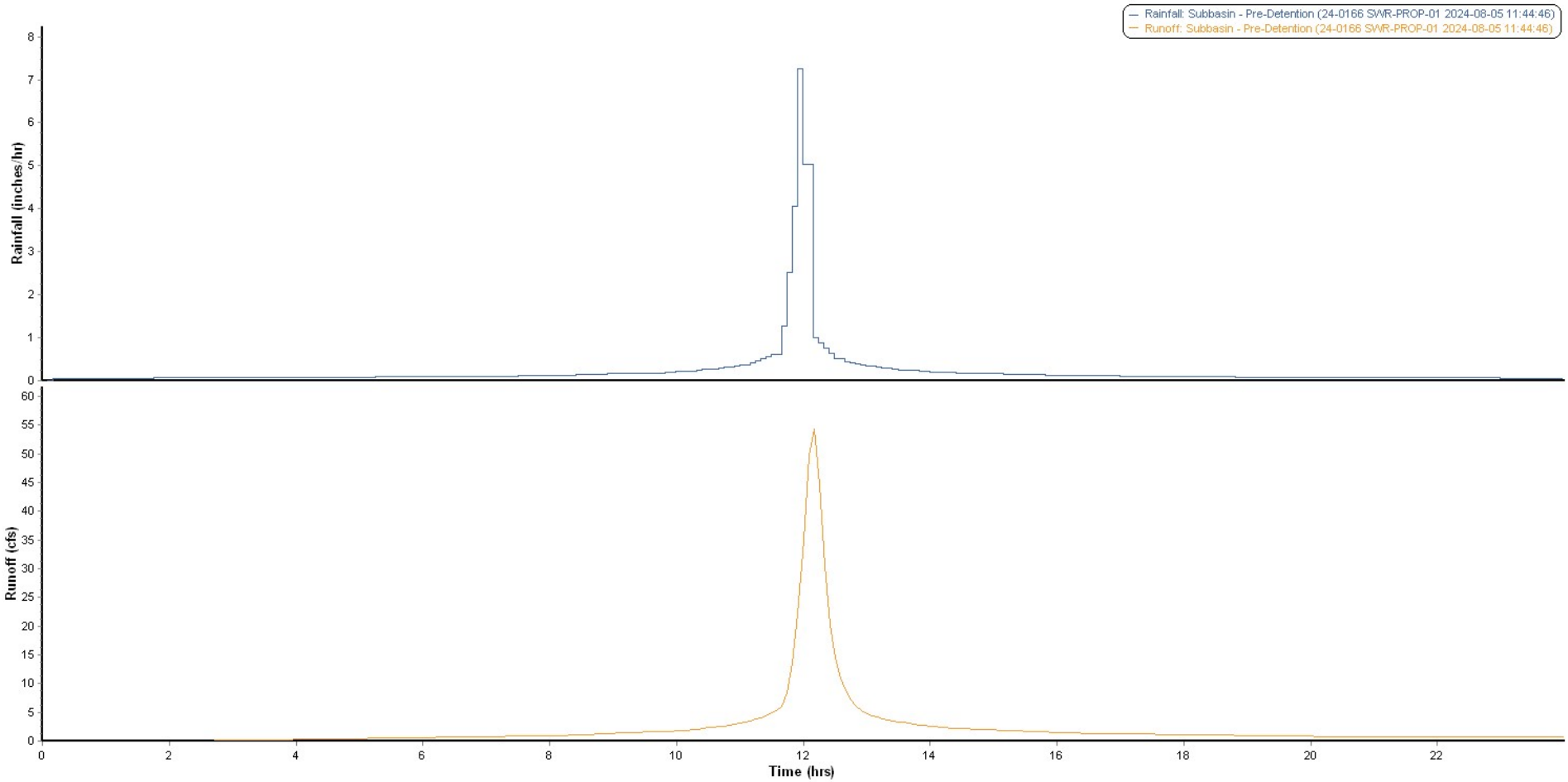
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0.012	0
Flow Length (ft) :	50	370	0
Slope (%) :	1	3.76	0
2 yr, 24 hr Rainfall (in) :	3.5	3.5	0
Velocity (ft/sec) :	0.05	2.24	0
Computed Flow Time (min) :	15.56	2.75	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.012	0	0
Flow Length (ft) :	763	0	0
Channel Slope (%) :	0.81	0	0
Cross Section Area (ft^2) :	9.82	0	0
Wetted Perimeter (ft) :	7.85	0	0
Velocity (ft/sec) :	12.97	0	0
Computed Flow Time (min) :	0.98	0	0

Total TOC (min) 19.29

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	4.72
Peak Runoff (cfs)	54.7
Weighted Curve Number	95
Time of Concentration (days hh:mm:ss)	0 00:19:17


Rainfall: Subbasin - Pre-Detention (24-0166 SWR-PROP-01 2024-08-05 11:44:46)
Runoff: Subbasin - Pre-Detention (24-0166 SWR-PROP-01 2024-08-05 11:44:46)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Subbasin : Undetained

Input Data

Area (ac)	1.78
Peak Rate Factor	484
Weighted Curve Number	80
Rain Gage ID	Rain Gage-01

Composite Curve Number

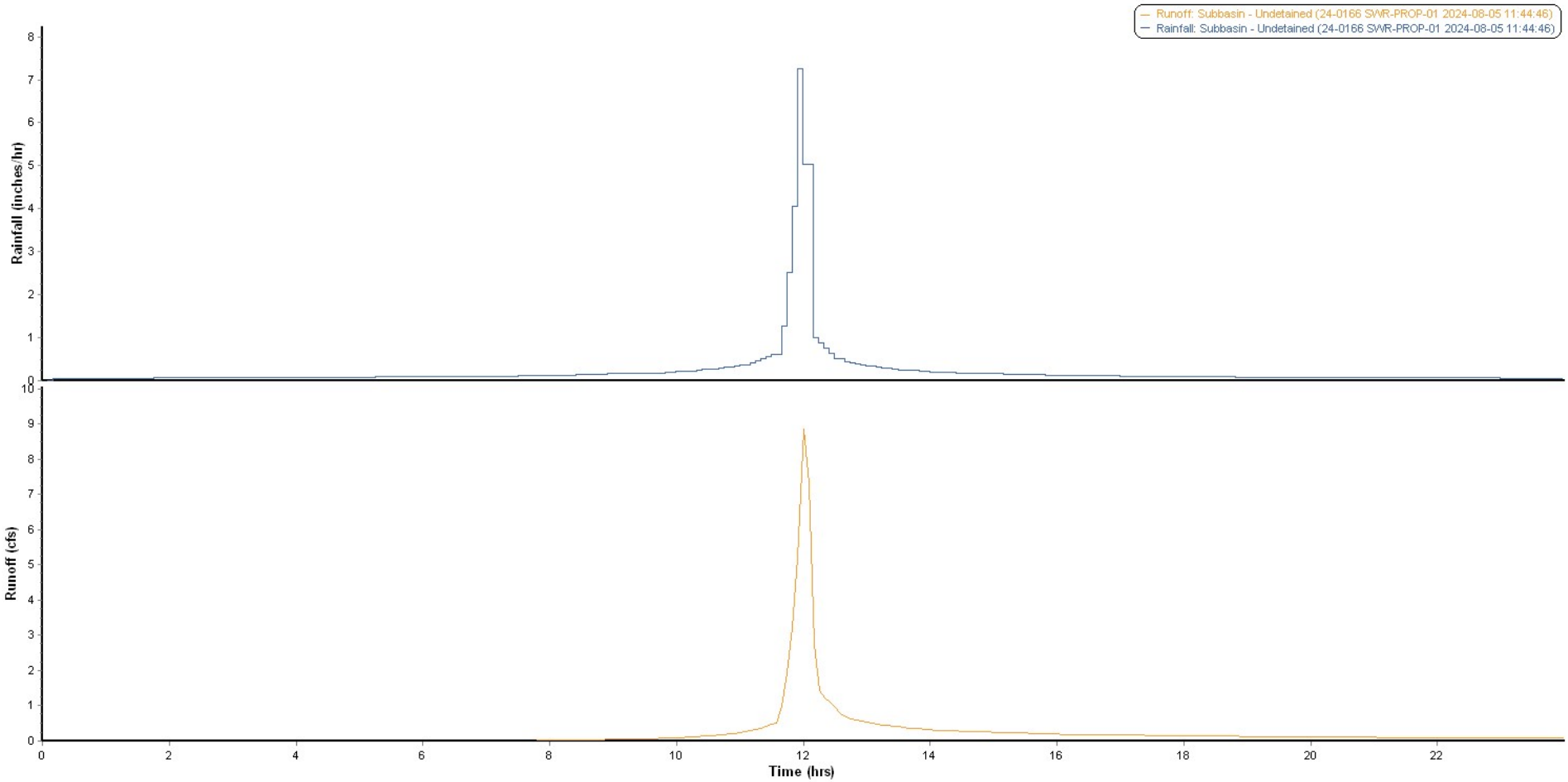
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	1.78	D	80
Composite Area & Weighted CN	1.78		80

Time of Concentration

User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in)	5.3
Total Runoff (in)	3.16
Peak Runoff (cfs)	8.89
Weighted Curve Number	80
Time of Concentration (days hh:mm:ss)	0 00:05:00


Runoff: Subbasin - Undetained (24-0166 SWR-PROP-01 2024-08-05 11:44:46)
Rainfall: Subbasin - Undetained (24-0166 SWR-PROP-01 2024-08-05 11:44:46)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Storage Node : ProposedDetention (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	GrateTop	Side	CIRCULAR	24.00	1000.50	0.61
2	Perforation01	Side	CIRCULAR	1.33	995.00	0.61
3	Perforation02	Side	CIRCULAR	1.33	995.33	0.61
4	Perforation03	Side	CIRCULAR	1.33	995.67	0.61
5	Perforation04	Side	CIRCULAR	1.33	996.00	0.61
6	Perforation05	Side	CIRCULAR	1.33	996.33	0.61
7	Perforation06	Side	CIRCULAR	1.33	996.67	0.61
8	Perforation07	Side	CIRCULAR	1.33	997.00	0.61
9	Perforation08	Side	CIRCULAR	1.33	997.33	0.61
10	Perforation09	Side	CIRCULAR	1.33	997.67	0.61
11	Perforation10	Side	CIRCULAR	1.33	998.00	0.61

Output Summary Results

Peak Inflow (cfs)	54.4
Peak Lateral Inflow (cfs)	54.4
Peak Outflow (cfs)	19.16
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	1002.85
Max HGL Depth Attained (ft)	7.85
Average HGL Elevation Attained (ft)	998.61
Average HGL Depth Attained (ft)	3.61
Time of Max HGL Occurrence (days hh:mm)	0 12:26
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

Project Description

File Name 24-0166 SWR-PROP-01.SPF

Project Options

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

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
49		Time Series	100-Year	Cumulative	inches	Missouri	Jackson	100.00	7.70	SCS Type II 2

Subbasin Summary

SN	Subbasin ID	Area (ac)	Peak Rate Factor	Weighted Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Pre-Detention	11.29	484.00	95.00	7.70	7.10	80.20	80.76	0 00:19:17
2	Undetained	1.78	484.00	80.00	7.70	5.34	9.50	14.80	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)
1	ControlStructure	Junction	995.00	1000.50	995.00	29.05	996.09
2	Total-Outfall	Outfall	990.50			30.79	991.59
3	ProposedDetention	Storage Node	995.00	1006.00	995.00	80.37	1004.70

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)
1	Post-Detention	Pipe	ControlStructure	Total-Outfall	68.50	992.00	990.50	2.1900	24.000	0.0150	29.05	50.25	0.58	16.56
2	GrateTop	Orifice	ProposedDetention	ControlStructure		995.00	995.00		24.000		27.69			
3	Perforation01	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.15			
4	Perforation02	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.15			
5	Perforation03	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.14			
6	Perforation04	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.14			
7	Perforation05	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.14			
8	Perforation06	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.13			
9	Perforation07	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.13			
10	Perforation08	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.13			
11	Perforation09	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.330		0.13			
12	Perforation10	Orifice	ProposedDetention	ControlStructure		995.00	995.00		1.333		0.12			

Subbasin Hydrology

Subbasin : Pre-Detention

Input Data

Area (ac)	11.29
Peak Rate Factor	484
Weighted Curve Number	95
Rain Gage ID	Rain Gage-01

Composite Curve Number

32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
Urban commercial, 85% imp	11.29	D	95
Composite Area & Weighted CN	11.29		95

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

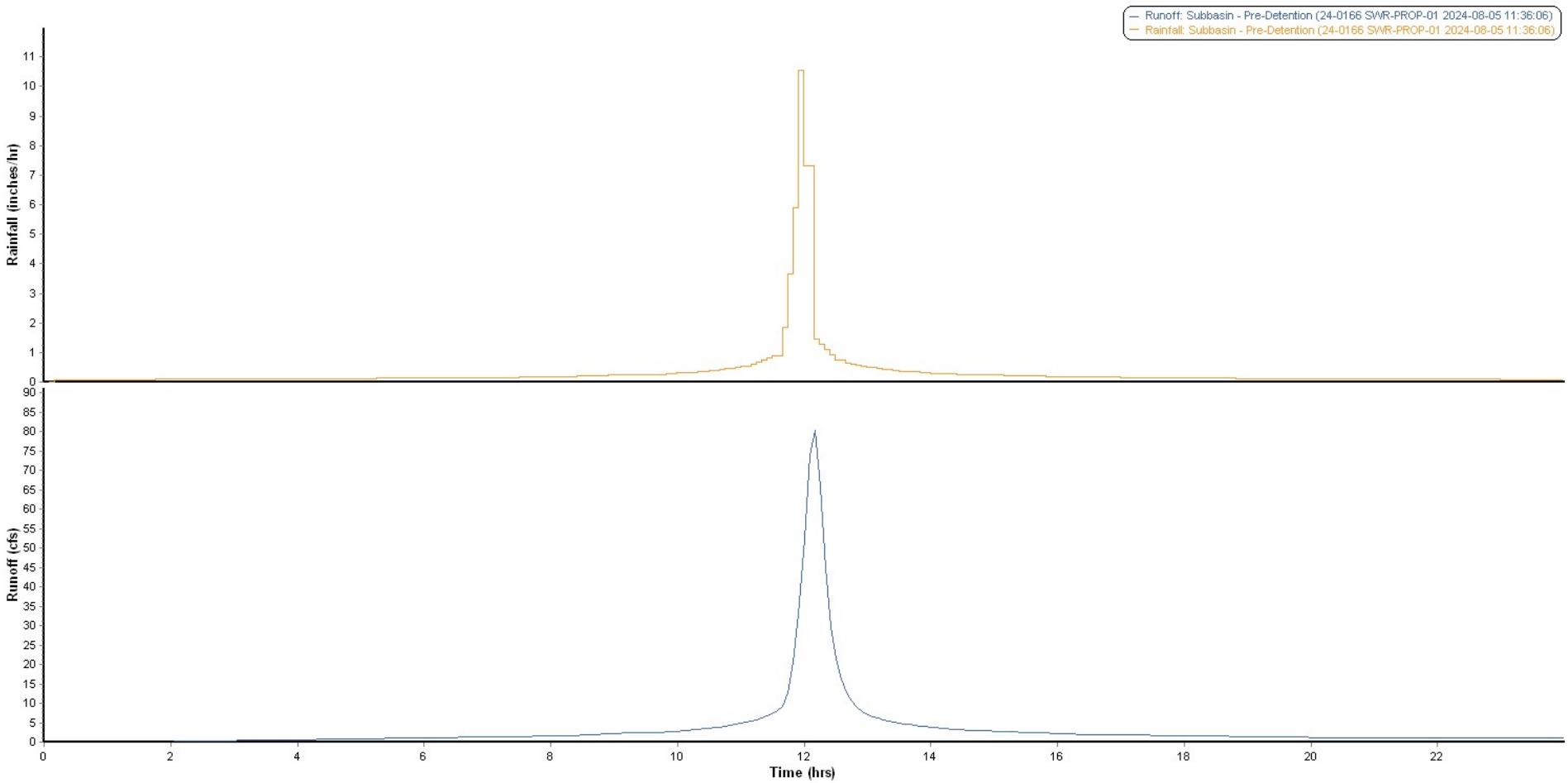
Sheet Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.4	0.012	0
Flow Length (ft) :	50	370	0
Slope (%) :	1	3.76	0
2 yr, 24 hr Rainfall (in) :	3.5	3.5	0
Velocity (ft/sec) :	0.05	2.24	0
Computed Flow Time (min) :	15.56	2.75	0

Channel Flow Computations	Subarea A	Subarea B	Subarea C
Manning's Roughness :	0.012	0	0
Flow Length (ft) :	763	0	0
Channel Slope (%) :	0.81	0	0
Cross Section Area (ft^2) :	9.82	0	0
Wetted Perimeter (ft) :	7.85	0	0
Velocity (ft/sec) :	12.97	0	0
Computed Flow Time (min) :	0.98	0	0

Total TOC (min) 19.29

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	7.1
Peak Runoff (cfs)	80.76
Weighted Curve Number	95
Time of Concentration (days hh:mm:ss)	0 00:19:17


Runoff: Subbasin - Pre-Detention (24-0166 SWR-PROP-01 2024-08-05 11:36:06)
Rainfall: Subbasin - Pre-Detention (24-0166 SWR-PROP-01 2024-08-05 11:36:06)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Subbasin : Undetained

Input Data

Area (ac)	1.78
Peak Rate Factor	484
Weighted Curve Number	80
Rain Gage ID	Rain Gage-01

Composite Curve Number

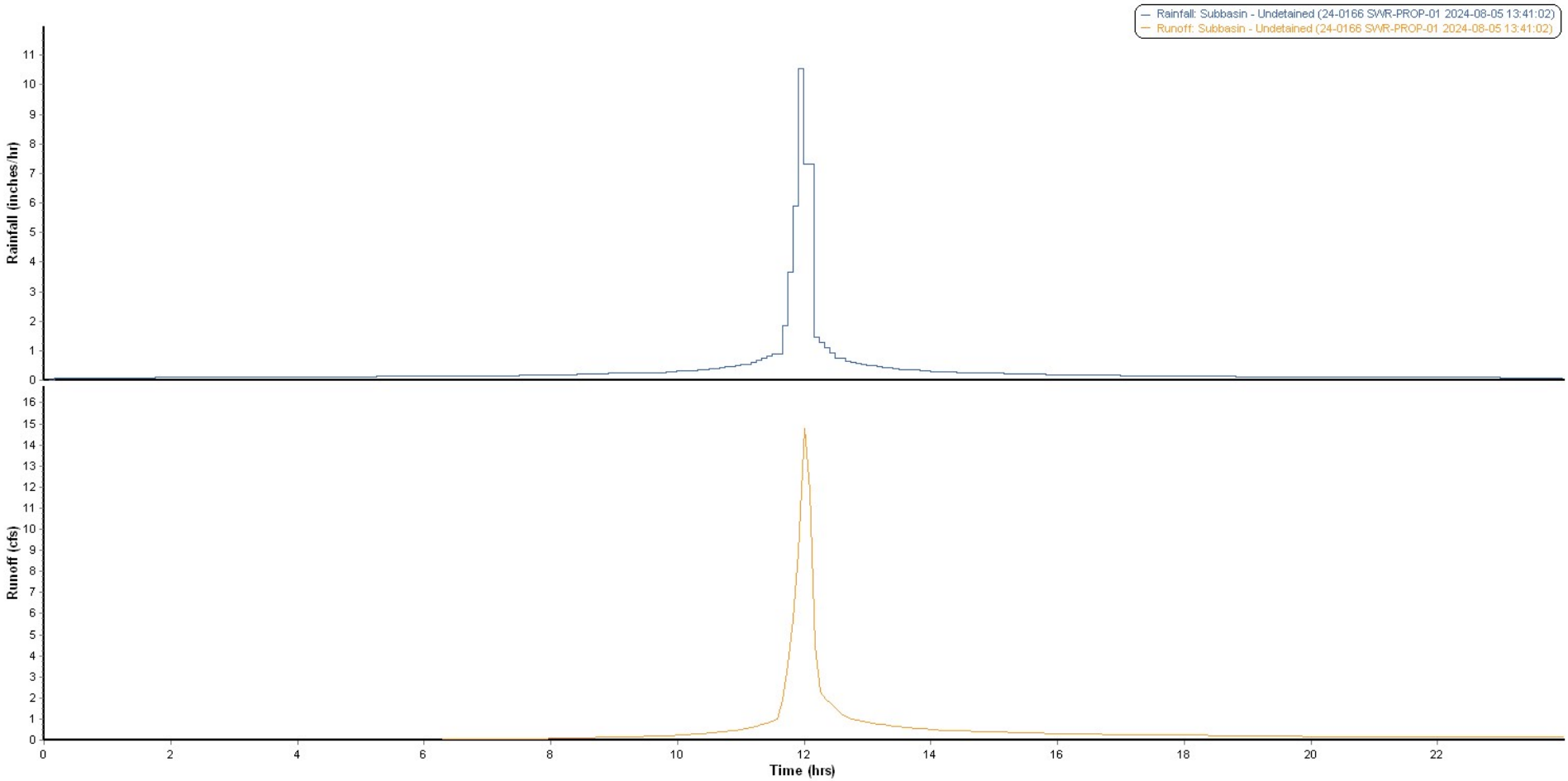
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
> 75% grass cover, Good	1.78	D	80
Composite Area & Weighted CN	1.78		80

Time of Concentration

User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

Total Rainfall (in)	7.7
Total Runoff (in)	5.34
Peak Runoff (cfs)	14.8
Weighted Curve Number	80
Time of Concentration (days hh:mm:ss)	0 00:05:00


Rainfall: Subbasin - Undetained (24-0166 SWR-PROP-01 2024-08-05 13:41:02)
Runoff: Subbasin - Undetained (24-0166 SWR-PROP-01 2024-08-05 13:41:02)
Rainfall (inches/hr)
Runoff (cfs)
Time (hrs)

Storage Nodes

Storage Node : ProposedDetention

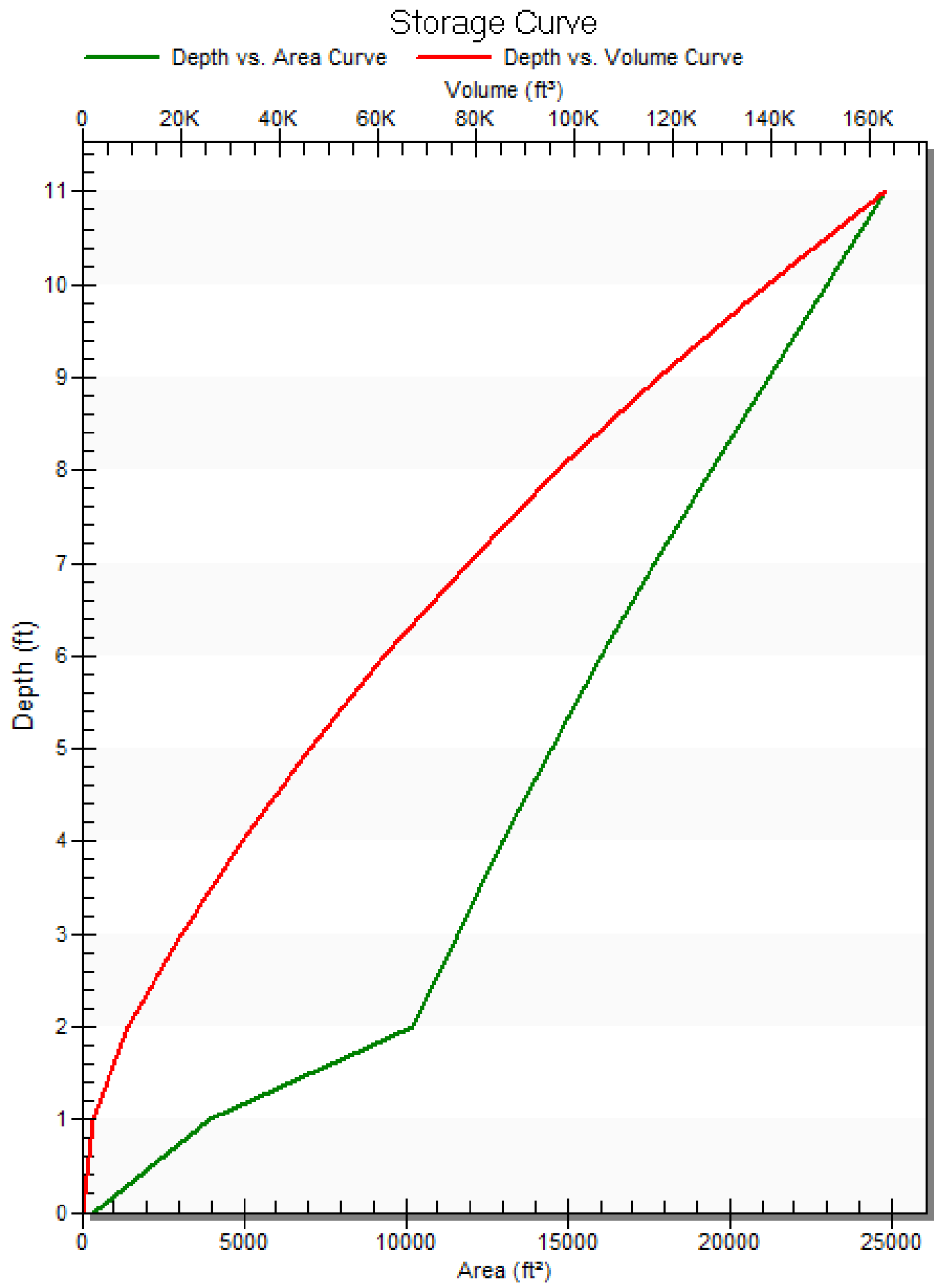
Input Data

Invert Elevation (ft)	995.00
Max (Rim) Elevation (ft)	1006.00
Max (Rim) Offset (ft)	11.00
Initial Water Elevation (ft)	995.00
Initial Water Depth (ft)	0.00
Ponded Area (ft²)	0.00
Evaporation Loss	0.00

Storage Area Volume Curves

Storage Curve : Prop-Det

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	364	0
1	3938	2151
2	10242	9241
3	11584	20154
4	13000	32446
5	14488	46190
6	16051	61459.5
7	17692	78331
8	19416	96885
9	21195	117190.5
10	22977	139276.5
11	24826	163178


Storage Curve
Depth vs. Area Curve
Depth vs. Volume Curve
Volume (ft³)
0
20K
40K
60K
80K
100K
120K
140K
160K
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
0
5000
10000
15000
20000
25000
Area (ft²)

Storage Node : ProposedDetention (continued)

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Circular Orifice Diameter (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	GrateTop	Side	CIRCULAR	24.00	1000.50	0.61
2	Perforation01	Side	CIRCULAR	1.33	995.00	0.61
3	Perforation02	Side	CIRCULAR	1.33	995.33	0.61
4	Perforation03	Side	CIRCULAR	1.33	995.67	0.61
5	Perforation04	Side	CIRCULAR	1.33	996.00	0.61
6	Perforation05	Side	CIRCULAR	1.33	996.33	0.61
7	Perforation06	Side	CIRCULAR	1.33	996.67	0.61
8	Perforation07	Side	CIRCULAR	1.33	997.00	0.61
9	Perforation08	Side	CIRCULAR	1.33	997.33	0.61
10	Perforation09	Side	CIRCULAR	1.33	997.67	0.61
11	Perforation10	Side	CIRCULAR	1.33	998.00	0.61

Output Summary Results

Peak Inflow (cfs)	80.37
Peak Lateral Inflow (cfs)	80.37
Peak Outflow (cfs)	29.05
Peak Exfiltration Flow Rate (cfm)	0
Max HGL Elevation Attained (ft)	1004.7
Max HGL Depth Attained (ft)	9.7
Average HGL Elevation Attained (ft)	999.07
Average HGL Depth Attained (ft)	4.07
Time of Max HGL Occurrence (days hh:mm)	0 12:25
Total Exfiltration Volume (1000-ft³)	0
Total Flooded Volume (ac-in)	0
Total Time Flooded (min)	0
Total Retention Time (sec)	0

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Appendix H

BMP Worksheets

BMP WORKSHEET 1: REQUIRED LEVEL OF SERVICE - UNDEVELOPED SITE

Project:	24-0166 Lee's Summit Apartments
Location:	Lee's Summit, Jackson County, MO
Option:	LS for Undeveloped Site
Date:	July 25, 2024
By:	ZMM

I. Runoff Curve Number

A. Predevelopment CN

Cover Description	Soil HSG	CN from Table 1*	Area, acres	Product of CN x Area
Woods & Grass Combination, Good	C	72	3.51	252.43
Woods, Good	C	70	5.91	413.63
Woods & Grass Combination, Good	D	79	3.65	288.67
		Totals:	13.07	954.73

Area-Weighted CN = total product/total area =	73	(Round to Integer)

* Based on BMP Manual Table 4.1

B. Post development CN

Cover Description	Soil HSG*	CN from Table 1*	Area, acres	Product of CN x Area
Urban Commercial, 85% impervious	D	95	11.29	1072.84
> 75% grass cover, Good	D	80	1.78	142.24
		Totals:	13.07	1215.08

**Postdevelopment CN is one HSG higher for all cover types except preserved vegetation, absent documentation showing how postdevelopment soil structure will be preserved.

Area-Weighted CN = total product/total area =	93	(Round to integer)

C. Level of Service (LS) Calculation

Predevelopment CN	**73**
Postdevelopment CN	**93**
Difference	**20**
LS Required (see scale at right):	**7.4**

Table 4.2
LS for Previously Undeveloped Sites

Change in CN	LS		Change in CN	LS
1	4.3		17	7.1
2	4.7		18	7.2
3	5		19	7.3
4	5.3		20	7.4
5	5.7		21	7.6
6	6		22	7.7
7	6.1		23	7.8
8	6.2		24	7.9
9	6.3		25	8
10	6.4		25+	8
11	6.5			
12	6.6			
13	6.7			
14	6.8			
15	6.9			
16	7			

BMP WORKSHEET: DEVELOP MITITGATION PACKAGE(S) THAT MEET THE REQUIRED LS OR VR

Project:	24-0166 Lee's Summit Apartments
Location:	Lee's Summit, Jackson County, MO
Option:	LS for Undeveloped Site
Date:	July 25, 2024
By:	ZMM

I. Required LS OR VR 7.4

Note: Various BMP's May Alter CN of Proposed Development and LS; Recalculate Both if Applicable

II. Proposed BMP Option Package No. 1

Cover/BMP Description	Treatment Area	VR from Table 4.4 or Table 4.6*	Product of VR x Area
Native Vegetation	0.68	9.25	6.29
ADS Barracuda Max to Dry Detention Basin	11.29	8.00	90.34
Untreated	1.10	0.00	0.00
Total	**13.07**	**Total**	**96.63**

Weighted VR:** 7.4

*	Based on BMP Manual Tables 4.4 and 4.6
**	Blank in Redevelopment

=Total Product/Total Area

1. Refer to Mitigation Instructions and Tables 2 and 4 as Appropriate When Determining VR.***
2. Total Treatment Area Cannot Exceed 100 Percent of the Actual Site Area

***	Based on BMP Manual Section 4: BMP Selection Criteria (Tables 4.2 and 4.4)

Meets Required Total LS or VR (Yes/No)? Yes

13.07 **Area of Site, acres**

Design Procedure Form: Extended Dry Detention Basin (EDDB)
Main Worksheet

Designer:	ZMM	Date	8/1/2024
Checked By:	MES	Project	Tudor Multi-Family
Company:	RIC	Location	Lee's Summit, Missouri
		Page:	1 of 1

I. Basin Water Quality Storage Volume

Step 1)	Tributary area to EDDB, A_T	A_T (ac) =	11.293
Step 2)	Calculate WQv using methodology in Section 6	WQ_V (ac-ft) =	1.117
Step 3)	Add 20 percent to account for silt and sediment deposition in the basin	V_{design} (ac-ft) =	1.340

IIa. Basin Water Quality Storage Volume

Step 1)	Set water outlet type	Outlet Type =	2
	Type 1 = Single Orifice		
	Type 2 = Perforated Riser or plate		
	Type 3 = v-notch weir		
Step 2)	Proceed to Step IIb, IIc or IId		

IIc. Water Quality Outlet, Perforated Riser

Step 1)	Depth at outlet above lowest perforation, Z_{WQ} (ft)	Z_{WQ} (ft) =	3.18
Step 2)	Recommended maximum outlet area per row, A_0 (in^2)	A_0 (in^2) =	1.527
	$A_0 = (WQ_V)/(0.013 * Z_{WQ}^2 + 0.22 * Z_{WQ} - 0.10)$		
Step 3)	Circular perforation diameter per row assuming a single column, D_1	D_1 (ft) =	1.394
Step 4)	Number of columns, n_c	n_c =	1
Step 5)	Design circular perforation diameter (should be between 1 and 2 inches), D_{perf} (in)	D_{perf} (in) =	1.333
Step 6)	Horizontal perforation column spacing when $n_c > 1$, center to center, S_c	S_c (in) =	N/A
	If $D_{perf} \geq 1.0$ inch, $S_c = 4$		
Step 7)	Number of rows (4" vertical spacing between perforations, center to center), n_r	n_r =	10

III. Flood Control

Refer to APWA Specifications Section 5608

VII. Basin side slopes

Basin side slopes should be at least (4:1) — Side Slope (H:V) = 3

VII. Dam Embankment side slopes

Basin side slopes should be at least (3:1) — Dam Embankment Slope (H:V) = 3

IX. Vegetation

Check the method of vegetation planted in the EDDB or desribe "other"

Native Grass: x
Irrigated Turf Grass: ___
Other:

X. Inlet Protetion

Indicate method of inlet protectionenergy dissipation at EDDB inlet

XI. Access

Indicate that access has been provided for maintenance vehicles