raSmith

CREATIVITY BEYOND ENGINEERING

Storm Water Management Report for

Kwik Trip #527

1700 Pewaukee Rd, Waukesha, WI 53188

Project No. 3190494

April 27, 2020

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PURPOSE

raSmith has been retained by Kwik Trip to prepare a Stormwater Management Plan for redevelopment of their store #527 located at 1700 Pewaukee Rd, Waukesha, WI 53188. The project is located northwest of the corner of Gascoigne Dr and Pewaukee Rd. The site is almost entirely classified by USGS Web Soil Survey as silt loam soils (hydraulic soil group D). The geotechnical report has been included in the appendix of this report for more detail. The site is currently developed with the south section of the property being a current gas station and the north section with two commercial buildings. The site's existing drainage patterns are generally split down the center of the parcel with half draining west and half draining east. Both watersheds enter the public storm sewer then drain south. For the purposes of this storm water report, the existing conditions is considered one watershed. This site is within the Pewaukee River-Fox River basin.

No floodplains or environmental corridors have been identified near this site. The surface water data viewer has wetland indicator soils on the property. A wetland study has determined that no wetlands are present onsite. A separate wetland report is available. Copies of the FIRMette and WDNR surface data water viewer can be found in the appendix of this report.

The proposed project consists of the construction of a new convenience store, gas pump area, parking areas, landscaped areas and a wet underground detention tank to provide storm water quality and quantity treatment. The outfall from the underground detention tank is controlled by an outlet control structure. The outfall from the underground detention tank discharges to public storm sewer in Gascoigne Dr. The last structure in each storm sewer run has a submerged snout for oil and grease control.

Storm water management for this redevelopment site is regulated by the City of Waukesha Municipal Code Chapter 32 and the Wisconsin Department of Natural Resources NR 151. The analysis presented in this report addresses post-construction water quantity, water quality, and infiltration requirements. This report also include the site's storm sewer design.

RUNOFF MANAGEMENT REGULATIONS

The property is 1.34 acres. The total site under investigation is 1.33 acres (onsite disturbance limits). The existing site has 0.74 acres of impervious area and 1.09 acres are impervious surfaces in the proposed condition. This site is considered redevelopment as it relates to storm water requirements.

Water Quantity: Chapter 32 of the Waukesha code requires that the proposed peak discharge rate for the 1-yr, 2-yr, 10-yr, and 100-yr 24-hr storm events must be no more than the existing peak discharge rate the same storm event

Water Quality: Chapter 32 of the Waukesha code and NR 151.122, total suspended solids (TSS) in the runoff from redevelopment pavement areas from the must be reduced by 40% as compared with no controls.

Site Infiltration: Per NR 151, redevelopment sites are exempt from infiltration requirements.

METHODS OF ANALYSIS

Hydrologic analysis included in this report was performed using the HydroCAD hydrologic simulation computer model, version 10.00 by HydroCAD Software Solutions LLC. The discharges were generated using the SCS Dimensionless Unit Hydrograph Method for a 24-hour duration storm. Model parameters include drainage area, SCS runoff curve number, time of concentration and 24-hour precipitation with an MSE Type III distribution.

Table 1 – Design Storm Events

Per Chapter 32.10 Table 3

Frequency (years)	Duration (hours)	Rainfall Depth (inches)
1	24	2.40
2	24	2.70
10	24	3.81
100	24	6.18

WATER QUANTITY DESIGN

Table 2 summarizes the pre-development site parameters and peak discharge rates for the 1-yr, 2-yr, 10-yr, and 100-yr storm events. The existing site is considered a single developed watershed that runoff eventually discharges to public storm sewer towards the south. See the attached hydrographs and existing hydrology exhibit for additional information.

Table 2 – Pre-Development Stormwater Quantity Summary

Watershed ID	**Watershed Characteristics**			**Peak Discharge (cfs)**			
	Area	CN	Tc	1-year	2-year	10-year	100-year
E-1	1.33	90	6.0	3.39	3.99	6.24	11.01

To meet the required discharge rates and storm water quality requirements (discussed later), a wet underground detention tank is proposed as the site's main BMP. An outlet control structure will detain the runoff with a steel weir plate and allow for the sediment in the runoff to settle in the permanent pool.

Table 3 summarizes the post-development site parameters and peak discharge rates for the studied storm events. The proposed site is split up between two watersheds. Watershed P-1 drains the majority of the redevelopment impervious area to the wet underground detention tank for stormwater treatment. Watershed P-2 containing the store's roof, some parking lot area and the fringe greenspace drains undetained and untreated off site towards the southwest. Table 4 is a summary of the discharge rates from the underground tank with the addition of offsite areas passing though the underground tank. See the attached hydrographs and proposed hydrology exhibit for additional information.

Table 3 – Post-Development Stormwater Quantity Summary

Watershed ID	**Watershed Characteristics**			**Peak Discharge (cfs)**			
	Area	CN	Tc	1-year	2-year	10-year	100-year
P-1	0.88	97	6.0	2.93	3.32	4.76	7.82
Underground Tank	-	-	-	2.28	2.54	3.44	5.62
P-2	0.45	90	6.0	1.14	1.34	2.10	3.70
Required	-	-	-	3.39	3.99	6.24	11.01
Total	1.33	-	-	3.34	3.78	5.34	8.96

Table 4 – Post-Development Stormwater Quantity Summary with Offsite Areas

Watershed ID	Watershed Characteristics			Peak Discharge (cfs)			
	Area	CN	Tc	1-year	2-year	10-year	100-year
P-1	0.88	97	6.0	2.93	3.32	4.76	7.82
P-3 (offsite)	0.09	80	6.0	0.14	0.17	0.32	0.65
Underground Tank	-	-	-	2.34	2.65	3.62	5.90
P-2	0.45	90	6.0	1.14	1.34	2.10	3.70
Total	1.33	-	-	3.42	3.88	5.50	9.37

WATER QUALITY DESIGN

Water quality treatment was obtained through the use the wet underground detention tank. The wet underground detention tank was designed to reduce the average annual total suspended solids (TSS) load for the redevelopment pavement areas onsite only. Runoff from non-pavement areas such as roofs, sidewalks, and grass has been accounted for while excluding pollutant loading. Storm water quality was evaluated using the Source Loading and Management Model (WinSLAMM). The results are shown in Table 5 with the applicable computer generated information located in the appendix.

Table 5 – Post-Development TSS Load

TSS Before (lbs)	TSS After (lbs)	Removal (%)
538.1	262.9	51.14%

EXISTING LOW POINT ANALYSIS

There is an existing low point between this property and the neighboring property to the east. This low point will remain after the proposed site improvements. A hydrology exhibit has been created to show the reduction area and runoff that is directed towards this low point. Please refer to the Low Point Hydrology Exhibit (sheet HX200) in the appendix of this report for additional information.

STORM SEWER DESIGN

The site storm sewer has been designed using the rational method. Each proposed storm sewer run has been analyzed using the 10-year and 100-year storm events using “Hydraflow Storm Sewers Extension for AutoCAD Civil 3D, Version 12”. See appendix for results of the Storm Sewer Calculations and storm sewer plan.

CONSTRUCTION COST ESTIMATE OF STORMWATER BMP

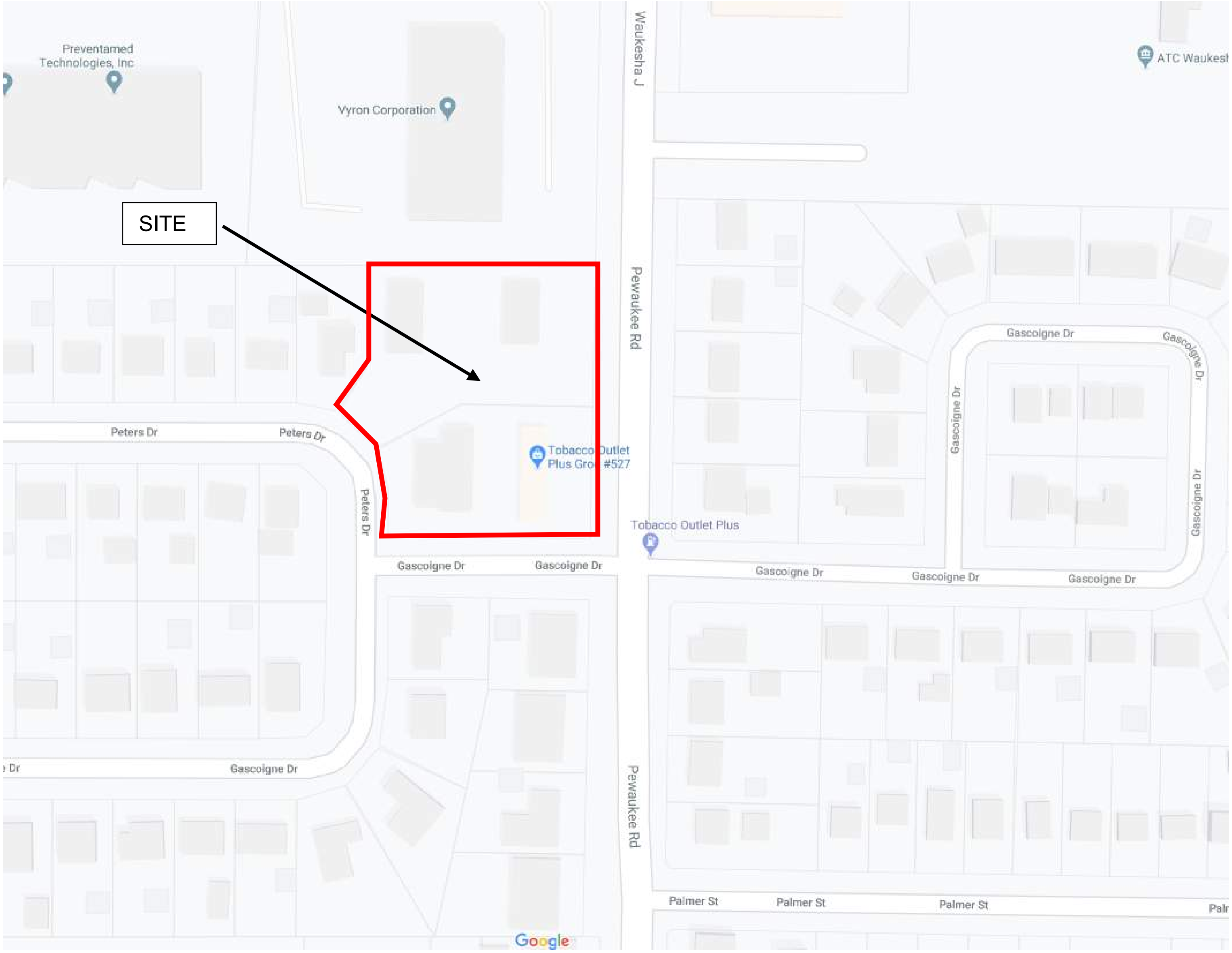
For the purpose of financial assurance per City code section 32.08(c), it is estimated that the wet underground detention tank basin shall cost $125,000.

SUMMARY

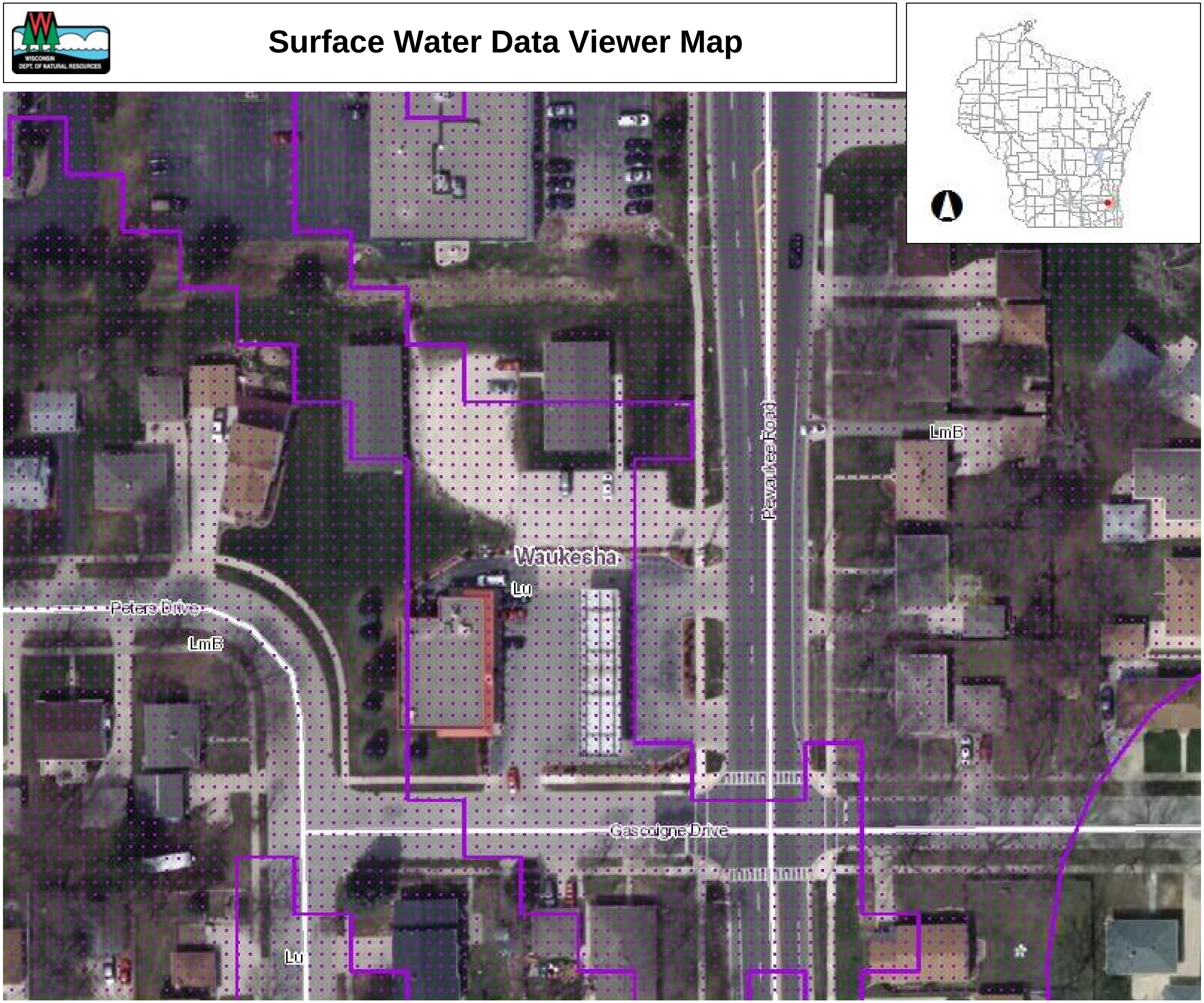
This analysis of the proposed wet detention basin indicates that the requirements of the City of Waukesha Chapter 32 and the Wisconsin Department of Natural Resources NR 151 have been satisfied.

Appendix A – General Project Information

Vicinity Maps



Surface Water Data Viewer Map



Legend

◆ Wetland Identifications and Confirmations

Wetland Class Points

- △ Dammed pond
- ▣ Excavated pond
- ▣ Filled excavated pond
- △ Filled/drained wetland
- ○ Wetland too small to delineate

▨ Filled Points

Wetland Class Areas

- ▣ Wetland
- ☐ Upland

▨ Filled Areas

✱ NRCS Wetspots

▣ Maximum Extent Wetland Indicators

Notes

0.0 0 0.02 0.0 Miles

NAD_1983_HARN_Wisconsin_TM

1: 990

National Flood Hazard Layer FIRMette

FEMA

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 17.5	Cross Sections with 1% Annual Chance Water Surface Elevation
	⑧— — —	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

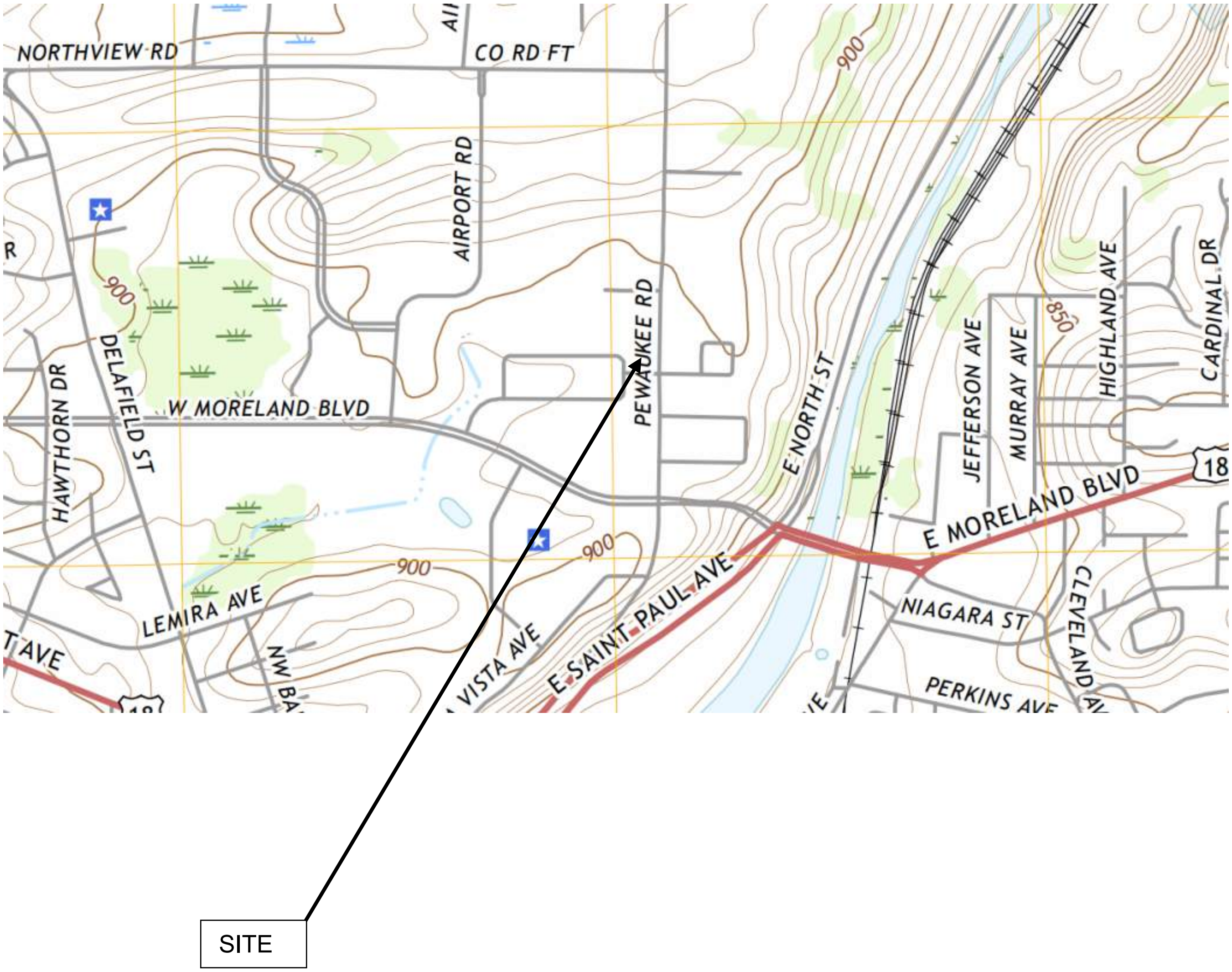
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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 2/21/2020 at 10:52:26 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.

USGS 7.5 min Map



WAUKESHA COUNTY LAND INFORMATION SYSTEMS DIVISION

Waukesha County GIS Map

Legend

- Parcels (Click for details)
- Plats (Click for details)
- Retired Parcels (Click for
- Retired Plats (Click for de
- DNR Wetlands < .25 Acre
- 🟩 DNR Wetlands > .25 Acre
- Environmental Corridors 2
  - ▨ Water
  - ▨ Isolated Natural Resource A
  - ▨ Isolated Natural Resource A
  - 🟩 Primary Env. Corridor
  - ▨ Primary Env. Corridor Water
  - 🟩 Secondary Env. Corridor
  - ▨ Secondary Env. Corridor Wa
- ☐ Municipal Boundary_2K
- FacilitySites_2K_Labels
- Lots_2K
  - ☐ Lot
  - ☐ Outlot
- SimultaneousConveyance
  - ☐ Assessor Plat
  - ☐ CSM
  - ☐ Condominium
  - 🟥 Subdivision
- Cartoline_2K
  - <all other values>
  - EA-Easement_Line
  - PL-DA
  - PL-Extended_Tie_line
  - PL-Meander_Line
  - PL-Note
  - PL-Tie
  - PL-Tie_Line
- Road Centerlines_2K
- Railroad_2K
- TaxParcel_2K
- Waterbodies_2K_Labels
- Waterlines_2K_Labels

0 153.08 Feet

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Notes:

Printed: 2/21/2020

Appendix B – Soils Information

United States
Department of
Agriculture

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

Milwaukee and Waukesha Counties, Wisconsin

February 19, 2020

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.

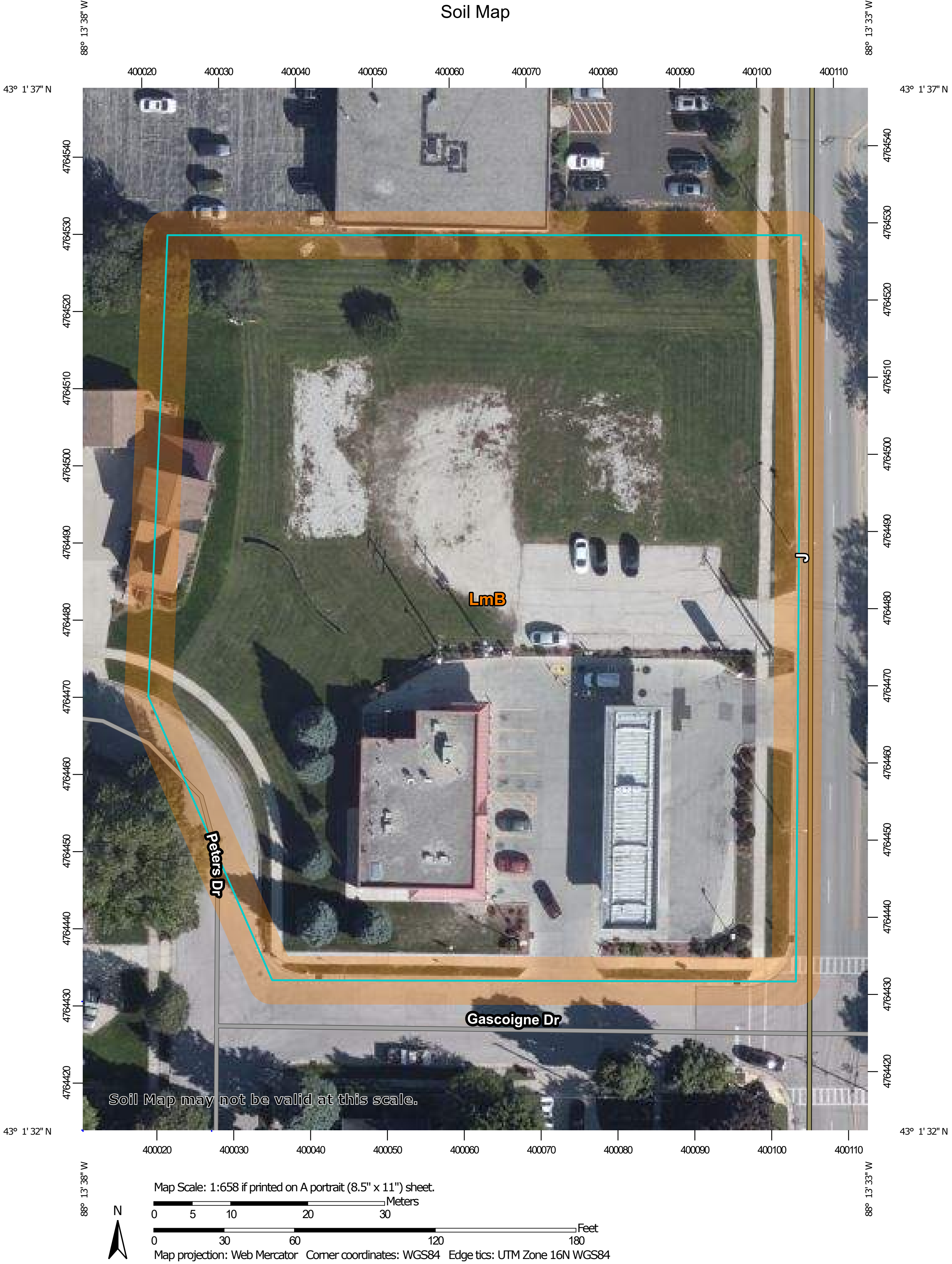
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

Contents

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.

Soil Map



Map Scale: 1:658 if printed on A portrait (8.5" x 11") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N 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 1:15,800.

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: Milwaukee and Waukesha Counties, Wisconsin
Survey Area Data: Version 15, Sep 16, 2019

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

Date(s) aerial images were photographed: Aug 1, 2019—Oct 12, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	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
LmB	Lamartine silt loam, 0 to 3 percent slopes	1.9	100.0%
Totals for Area of Interest		**1.9**	**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.

Milwaukee and Waukesha Counties, Wisconsin

LmB—Lamartine silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2t043
Elevation: 590 to 1,140 feet
Mean annual precipitation: 29 to 35 inches
Mean annual air temperature: 37 to 46 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Lamartine and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lamartine

Setting

Landform: Interdrumlins
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loess over loamy till

Typical profile

Ap - 0 to 8 inches: silt loam
Bt1 - 8 to 20 inches: silty clay loam
2Bt2 - 20 to 28 inches: clay loam
2C - 28 to 79 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 30 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Forage suitability group: High AWC, high water table (G095BY007WI)
Hydric soil rating: No

Minor Components

Pella

Percent of map unit: 8 percent
Landform: Drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Ossian

Percent of map unit: 7 percent
Landform: Depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

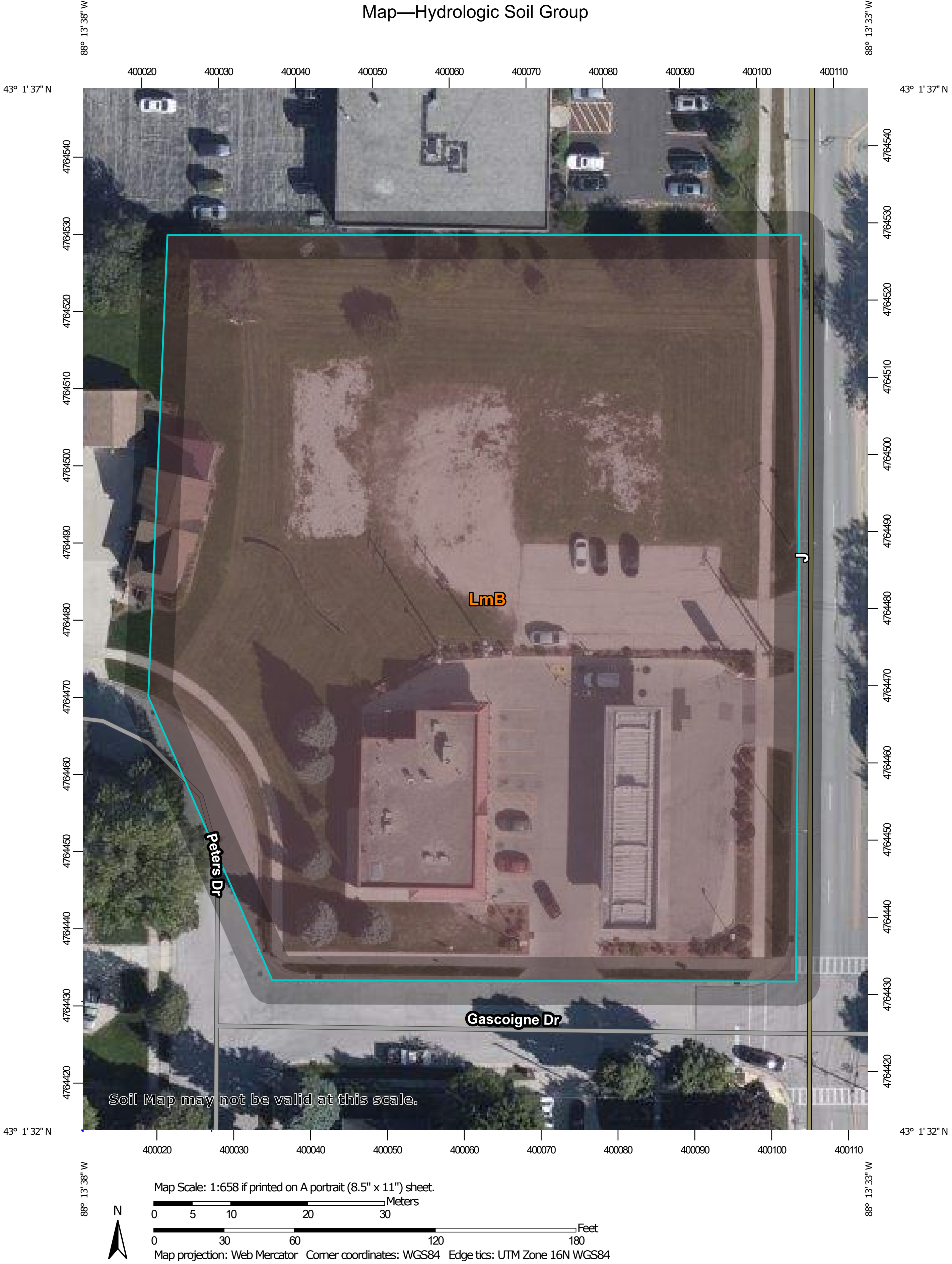
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Map—Hydrologic Soil Group



Map Scale: 1:658 if printed on A portrait (8.5" x 11") sheet.

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 16N WGS84

MAP LEGEND

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

Soils

Soil Rating Polygons
- 🟪 A
- 🟩 A/D
- 🟦 B
- 🟫 B/D
- 🟦 C
- 🟨 C/D
- 🟥 D
- ⬜ Not rated or not available

Soil Rating Lines
- 〰 A
- 〰 A/D
- 〰 B
- 〰 B/D
- 〰 C
- 〰 C/D
- 〰 D
- 〰 Not rated or not available

Soil Rating Points
- ■ A
- ■ A/D
- ■ B
- ■ B/D
- ■ C
- ■ C/D
- ■ D
- ▣ Not rated or not available

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 1:15,800.

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: Milwaukee and Waukesha Counties, Wisconsin
Survey Area Data: Version 15, Sep 16, 2019

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

Date(s) aerial images were photographed: Aug 1, 2019—Oct 12, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
LmB	Lamartine silt loam, 0 to 3 percent slopes	B/D	1.9	100.0%
Totals for Area of Interest			**1.9**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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IMPORTANT

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GILES ENGINEERING ASSOCIATES, INC.

● **Yellow**

Geotechnical Engineering Exploration and Analysis

Proposed Canopy
Proposed Kwik Trip No. 527
1700 Pewaukee Road
Waukesha, Wisconsin

Prepared for:

Kwik Trip, Inc.
La Crosse, Wisconsin

September 26, 2016
Project No. 1G-1606015-1

GILES
ENGINEERING ASSOCIATES, INC.

GILES
ENGINEERING ASSOCIATES, INC.
GEOTECHNICAL, ENVIRONMENTAL & CONSTRUCTION MATERIALS CONSULTANTS

- Atlanta, GA
- Baltimore, MD
- Dallas, TX
- Los Angeles, CA
- Manassas, VA
- Milwaukee, WI

September 26, 2016

Kwik Trip, Inc.
P.O. Box 2107
1626 Oak Street
La Crosse, WI 54602

Attention: Mr. Troy Batzel

Subject: Geotechnical Engineering Exploration and Analysis
Proposed Canopy
Proposed Kwik Trip No. 527
1700 Pewaukee Road
Waukesha, Wisconsin
Project No. 1G-1606015-1

Dear Mr. Batzel:

As requested, Giles Engineering Associates, Inc. conducted a *Geotechnical Engineering Exploration and Analysis* for the proposed canopy project. The accompanying report describes the services that were performed, and it provides geotechnical-related findings, conclusions, and recommendations that were derived from those services.

Giles previously prepared a *Geotechnical Site Feasibility Study* report for the Kwik Trip No. 527 development. That report is dated July 21, 2016 and is referenced by Giles Project No. 1G-1606015. It is understood that when that report was prepared, the new canopy (covered by the attached report) was not planned for the site. Because a new canopy is now planned, the attached report was prepared to provide design and construction recommendations.

We sincerely appreciate the opportunity to provide continued service for the proposed project. Please contact the undersigned if there are questions concerning the report, or if we may be of further service.

Very truly yours,

GILES ENGINEERING ASSOCIATES, INC.

Alexander M. Javes, E.I.T.
Staff Professional I

Anthony C. Giles, P.E.
Vice President

9/26/16

WISCONSIN
ANTHONY C. GILES
29561-6
OCONOMOWOC
WIS.
PROFESSIONAL ENGINEER

Distribution: Pioneer Environmental, Inc.
Attn: Mr. Joseph Drapeau (1 unsecured via email: jdrapeau@pei-wisc.com)
(1 unsecured Figures 1 and 2 PDF; 1 unsecured Test Boring Logs PDF)

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GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

PROPOSED CANOPY
PROPOSED KWIK TRIP NO. 527
1700 PEWAUKEE ROAD
WAUKESHA, WISCONSIN
PROJECT NO. 1G-1606015-1

YELLOW – This site has been given a Yellow designation, from a geotechnical perspective, due to potential increased development costs associated with existing construction, existing fill materials, and perched groundwater.

GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSIS

PROPOSED CANOPY
PROPOSED KWIK TRIP NO. 527
1700 PEWAUKEE ROAD
WAUKESHA, WISCONSIN
PROJECT NO. 1G-1606015-1

1.0 SCOPE OF SERVICES

This report provides the results of the *Geotechnical Engineering Exploration and Analysis* that Giles Engineering Associates, Inc. (“Giles”) conducted regarding the proposed development. The *Geotechnical Engineering Exploration and Analysis* included a Geotechnical Subsurface Exploration Program, Geotechnical Laboratory Services, and Geotechnical Engineering Services. The scope of each service area was narrow and limited, as directed by our client, and based on our understanding and assumptions about the project. Service areas are briefly described later.

Geotechnical-related recommendations for design and construction of the foundations for the proposed canopy structure are provided in this report. Site preparation recommendations are also given, but are only preliminary since the means and methods of site preparation will depend on factors that were unknown when this report was prepared. Those factors include, but are not limited to, the weather before and during construction, subsurface conditions that are exposed during construction, and finalized details of the proposed development. Pioneer Environmental, Inc. is providing environmental services regarding the site.

Giles previously prepared a *Geotechnical Site Feasibility Study* report for the Kwik Trip No. 527 development. That report is dated July 21, 2016 and is referenced by Giles Project No. 1G-1606015. It is understood that when that report was prepared, the new canopy (covered by this report) was not planned for the site. Because a new canopy is now planned, this report was prepared to provide design and construction recommendations.

2.0 SITE DESCRIPTION

The site is at the northwest corner of the intersection of Pewaukee Road and Gascoigne Drive in Waukesha, Wisconsin. The address of the site is 1700 Pewaukee Road, and the site is currently occupied by a Citgo fueling station. The existing development includes a convenience store, canopy-covered fuel pumps (east of the store), and underground storage tanks (northeast of the store). The majority of the site is asphalt-paved, with Portland cement concrete pavement in the UST areas and beneath the canopy. The existing structures are depicted on the *Test Boring Location Plan* (Figure 1), enclosed in Appendix A. Review of aerial photographs from the *Waukesha County GIS* reveals that prior to the existing development the site was developed. Aerial photographs from 1941 and 1950 indicate that the site was occupied by a farmstead. The site appears to have been occupied by a commercial structure in the photographs between 1963 and 2000. Photographs also reveal that the existing fueling station was constructed between 2000 and 2005. The topography at the site was relatively flat; there was about 1 foot of elevation difference among the test boring locations. At the time of the subsurface explorations, the site was surrounded by a staffing agency to the north, Pewaukee Road to the east, Gascoigne Drive to the south, and Peters Drive to the west.

3.0 PROJECT DESCRIPTION

A new canopy over fuel-pump islands is planned to be constructed at the site in the location of the existing canopy. The location of the proposed canopy is shown on the *Test Boring Location Plan*. Based on previous information provided by the client, it is understood that the canopy will have metal decking and steel-bar joists, and will be column-supported. It is also understood that each column is typically supported by a reinforced cast-in-place concrete pad, about 7½ feet square and 4 feet thick. It is assumed that the maximum (downward) foundation loads from columns will be about 50,000 pounds. The maximum lateral load and maximum overturning moment are not known. It is understood that Portland cement concrete pavement will be beneath the canopy area. This report assumes that only minor grade changes will be needed to construct the proposed canopy, and that the future pavement grades beneath the canopy will be within ½-foot of the existing grades.

4.0 GEOTECHNICAL SUBSURFACE EXPLORATION PROGRAM

To complete the *Geotechnical Site Feasibility Study* (referenced above), six geotechnical test borings were conducted at the site to evaluate subsurface conditions. The test borings, which are referenced as Test Borings B1 through B6, were performed at locations designated by Pioneer Environmental. The test borings were drilled to depths between ±21 and ±23½ feet below-ground. Approximate test boring locations are shown on the *Test Boring Location Plan*.

Samples were collected from the test borings, at certain depths, using a split-barrel sampler during Standard Penetration Testing (SPT), which is described in Appendix B, along with descriptions of other field procedures. Immediately after sampling, select portions of the SPT samples were retained in jars that were labeled at the site for identification. The retained samples were transported to Giles' geotechnical laboratory as part of the Geotechnical Subsurface Exploration Program.

The ground elevations at the test borings were determined as part of the Geotechnical Subsurface Exploration Program using survey methods referenced to the temporary benchmark shown on the *Test Boring Location Plan*. The test boring elevations are noted on the *Test Boring Logs*, enclosed in Appendix A, and are considered accurate within about one foot.

5.0 GEOTECHNICAL LABORATORY SERVICES

Samples that were retained at the site were classified using the descriptive terms and particle-size criteria shown on the *General Notes* in Appendix D, and by using the Unified Soil Classification System (ASTM D 2488-75) as a general guide. The classifications are shown on the *Test Boring Logs*, along with horizontal lines that show estimated depths of material change. Field-related information pertaining to the test borings is also shown on the *Test Boring Logs*. For simplicity and abbreviation, terms and symbols are used on the *Test Boring Logs;* the terms and symbols are defined on the *General Notes*.

Unconfined compressive strength (without controlled strain), calibrated penetrometer resistance, and moisture content tests were performed on select cohesive soil samples to evaluate their general engineering properties. The test results are on the *Test Boring Logs*. Because the tests were conducted on SPT samples, the results of strength-related tests (unconfined compression and penetration resistance) are considered approximate and were used as supplemental information. Laboratory procedures are briefly described in Appendix C.

An apparent petroleum-related odor was noticed during classification of a retained sample from Test Boring B6 (19½ to 21 feet below grade). As part of the Geotechnical Laboratory Services, the retained samples from each test boring were screened with a Photoionization Detector (PID) to check for Volatile Organic Compound (VOC) vapors, such as vapors associated with gasoline. Results of the PID screening are on the *Test Boring Logs*. It should be noted that the PID screening results reported on the *Test Boring Logs* are lab-screened values and may reflect differently from field-recorded values.

6.0 MATERIAL CONDITIONS

Since material sampling at the test borings was discontinuous, it was necessary for Giles to estimate conditions between sample intervals. The estimated conditions at the test borings are briefly discussed in this section and are described in detail on the *Test Boring Logs*. A summary of the subsurface conditions encountered in the test borings is also depicted on the enclosed *Fence Diagram* (Figure 2).

6.1. Surface Materials

About 4 inches of asphalt-concrete pavement, underlain by approximately 5 to 6 inches of crushed limestone base course, was at the ground surface at Test Borings B1 through B4, and at Test Boring B6. At Test Boring B5, performed west to southwest of the proposed canopy area, a ±6-inch-thick layer of topsoil fill was at the ground surface.

6.2. Fill Materials

Fill materials were encountered beneath the surface materials at each test boring. The fill was highly variable, generally consisting of silty clay, clayey silt, clayey sand, sand, and sand and gravel. Fill materials were present to about 6½ feet below-ground at Test Borings B1 through B3, and to about 7½, 2, and 4 feet below-ground at Test Borings B4, B5, and B6, respectively. In general, the fill materials exhibited variable strength characteristic ranging between somewhat low to moderate.

6.3. Native Soils

Native soils were below the fill materials, and extended to the maximum exploration depths. The native soils were variable, but generally consisted of silty clay, clayey silt, and sandy silt. The granular native soils typically exhibited firm to very dense relative densities, based on N-values. The cohesive native soils typically exhibited stiff to hard comparative consistencies based on observation and laboratory testing. Cobbles and boulders were present within the native soils, and could be numerous and nested.

7.0 GROUNDWATER CONDITIONS

It is estimated that the water table was about 9 to 15 feet below-grade at the test boring locations, when the Geotechnical Subsurface Exploration Program was conducted. Additionally, because of the variable fill materials, and the variable native soils, the site is likely subject to shallow, perched groundwater. Perched groundwater could be significant. Groundwater conditions will likely fluctuate depending on precipitation, surface run-off, and other factors.

The estimated water-table depth is only an approximation based on encountered groundwater, the moisture conditions of retained soil samples, and the gray colorations of the retained soil samples. The actual water-table depth might be higher or lower than estimated. If a more precise estimate of the water-table depth is needed, groundwater observation wells are recommended to be installed and observed at the site.

8.0 CONCLUSIONS AND RECOMMENDATIONS

YELLOW **– This site has been given a Yellow designation, from a geotechnical perspective, due to potential increased development costs associated with existing construction, existing fill materials, and perched groundwater.**

8.1. Petroleum Odors

As described above, petroleum odors were identified when classifying a soil sample recovered from Test Boring B6. Care must be taken to protect workers and others during construction of the proposed development. Special safety methods and equipment might be necessary. Special handling and disposal of petroleum-impacted soil and groundwater might also be necessary.

8.2. Site Design Considerations

An existing canopy and fuel-pump islands cover the proposed canopy area. Also, fill materials were encountered in each of the test borings. Furthermore, as discussed above, the site was formerly developed. Considering the existing/former developments, and the existing fill, unsuitable materials might exist away from the test borings, or might not have been identified by the test borings. Furthermore, remnants of previous construction might have been buried at the site. Accordingly, removal of unsuitable fill materials and/or remnants of former construction, as well as the existing structures, followed by replacement with engineered fill might be necessary. Following removal of all remnants of former and existing construction, an evaluation of the exposed subgrade soils (by a geotechnical engineer) is recommended prior to any backfilling with engineered fill. Over-excavation of construction remnants, unsuitable existing fill, and disturbed native soils might be necessary during foundation excavation and site preparation.

8.3. Seismic Design Considerations

A soil Site Class C is recommended for seismic design. By definition, Site Class is based on the average properties of subsurface materials to 100 feet below-ground. Since 100-foot test borings were not requested or authorized for the project, it was necessary to estimate the Site Class based on the test borings, presumed area geology, and the International Building Code.

8.4. Canopy Foundation Recommendations

This following recommendations assume that only minor grade changes will be needed to construct the proposed canopy, and that the future pavement grades beneath the canopy will be within ½-foot of the existing grades. Using Giles' adopted benchmark shown on the *Test Boring Location Plan*, it is assumed that pavement grades beneath the proposed canopy will be at about El. 101.5. Based on that elevation, a spread-footing foundation is recommended for the proposed canopy. However, existing fill is unsuitable for direct or indirect support of foundations. Foundations must be directly supported by suitable-bearing native soil, or by new engineered fill placed directly on suitable-bearing native soil. Because existing fill is unsuitable for foundation support, over-excavation beneath planned foundation-bearing grades should be expected and budgeted. The foundations are recommended to be designed using a 2,000 pound per square foot (psf) maximum, net, allowable soil bearing capacity, which is understood to be the bearing capacity typically used for Kwik Trip canopy foundations. For geotechnical considerations, it is recommended that the canopy foundations have a minimum side dimension of 24 inches, regardless of the calculated foundation-bearing stress. It is recommended and assumed that a structural engineer or architect will provide specific foundation details including footing dimensions, reinforcing, and other details.

Embedment Depth

It is understood that a minimum 48-inch foundation depth is required by the local building code. Therefore, footings for the proposed canopy are recommended to bear at least 4 feet below the pavement surface elevations. Considering the assumed pavement surface elevation (El. 101.5), and the minimum 4-foot foundation bearing depth, it is assumed that the canopy footings will bear at El. 96.5; but may be deeper for structural requirements.

The following table provides the estimated depths and elevations of suitable-bearing native soil at Test Borings B2 through B5, which were conducted in the proposed canopy area, as shown on the *Test Boring Location Plan*. However, suitable-bearing native soil might be at variable and deeper depths between the test borings, especially due to the existing fill, and the current and former developments. Because over-excavation is expected to be necessary, a geotechnical engineer must evaluate and approve support soil at the time of construction.

TABLE 1
ESTIMATED DEPTH/ELEVATION OF SUITABLE BEARING NATIVE SOIL (a)

Test Boring	Depth Below Current Surface (feet) (b)	Elevation (c)
B2	6½±	94.9±
B3	6½±	94.5±
B4	7½±	93.4±
B5	2±	98.5±

(a) For direct foundation support and/or for placement of engineered fill or lean mix concrete; based on a 2,000 psf maximum, net, allowable soil bearing capacity.
(b) Referenced to the existing site grades during drilling.
(c) Referenced to Giles' temporary benchmark shown on Figure 1 enclosed in Appendix A.

Considering the assumed foundation-bearing elevation (El. 96.5), and the elevations of suitable bearing native soil shown in Table 1, over-excavations are expected to be up to about 3 feet deep, but will be variable and might need to be deeper depending on the conditions that are encountered. Actual over-excavation depths are recommended to the determined with the assistance of a geotechnical engineer during construction.

Foundation excavations are recommended to be dug with a smooth-edge backhoe bucket to develop a relatively undisturbed bearing grade. A toothed bucket will likely disturb foundation-bearing soil more than a smooth-edge bucket, thereby making soil at the excavation base more susceptible to saturation and instability, especially during adverse weather. It is critical that contractors protect foundation support soil and foundation construction materials (concrete and reinforcing). In addition, engineered fill is recommended to be placed and compacted in benched excavations along foundations immediately after the foundations are capable of supporting lateral pressures from backfill, compaction, and compaction equipment. Footings will likely need to be formed due to expected trench caving and instability associated with granular soil.

Foundation Support Soil Requirements

Existing fill is unsuitable for direct or indirect support of foundations. Foundations must be directly supported by suitable-bearing native soil, or by new engineered fill placed directly on suitable-bearing native soil. Based on the recommended 2,000 psf bearing capacity, the unconfined compressive strength of native cohesive (clayey) foundation support-soil, such as silty clay and clayey silt, is recommended to be at least 1.0 ton per square foot (tsf). For native non-cohesive (granular) foundation support-soil, such as sand, the average corrected N-value (determined from SPTs and correlated from other in-situ tests) is recommended to be at least 7 based upon a 2,000 psf maximum bearing capacity. It is further recommended that the strength characteristics of soil within all foundation influence zones (determined by Giles during construction) meet or exceed the recommended values, unless Giles approves lesser values.

Due to the existing fill, and the current and former developments, a geotechnical engineer must evaluate and approve foundation support soil (at each foundation) immediately before foundation construction. The evaluation is recommended to confirm that the foundations will be properly supported, to determine over-excavation depths, and to confirm that the support soil is similar to the conditions described on the *Test Boring Logs*. If another firm performs the recommended evaluation, they should use appropriate means and methods, and Giles must be notified if the composition or strength characteristics of foundation support soil differ from those shown on the *Test Boring Logs*, allowing us the opportunity to revise this report, if needed.

Unsuitable materials beneath foundation areas could be replaced with engineered fill, such as well-graded aggregate that has low water-sensitivity. If engineered fill is used as backfill, lateral over-excavation of the unsuitable materials will also be required. The amount of lateral over-excavation will depend on the vertical over-excavation. For budgeting purposes, the minimum lateral over-excavation could be determined by extending an imaginary line outward and downward at a ratio of 1(horizontal):2(vertical) from the bottom edges of a footing pad, but the actual lateral extents of over-excavation must be approved by a geotechnical engineer. To reduce the required lateral over-excavation, unsuitable materials beneath foundation areas could be replaced with lean Portland cement concrete (minimum 28-day compressive strength of 500 psi). Excavations for lean concrete should extend laterally at least 3 inches beyond all sides of a footing pad, and the excavation sidewalls should be plumb and parallel. It is recommended that a geotechnical engineer provide specific recommendations pertaining to over-excavation of unsuitable materials within foundation areas at the time of construction.

Frictional Resistance

Based on the assumed foundation-bearing elevation, passive resistance of soil along foundations is recommended to be neglected due to seasonal freeze-thaw cycles, and due to the amount of lateral movement that would be needed to mobilize full passive pressure. However, friction at the base of foundations will provide some resistance to lateral movement, depending on the bearing stress at the base of the canopy foundations. Because of the variable soils encountered at the test borings, a relatively low frictional coefficient of 0.28 is recommended. That value is only for concrete cast directly on suitable-bearing soil that has been tested and approved by a geotechnical engineer. Resistance to lateral movement is recommended to be determined based on dead load only.

Estimated Foundation Settlement

The post-construction total and differential settlements of spread footing foundations designed and constructed based on the recommendations of this report are estimated to be less than about 1.0 inch and 0.5 inch, respectively. The post-construction angular distortion is estimated to be less than about 0.002 inch per inch across a distance of 20 feet or more. Estimated settlements are based on the assumption that foundation support soil will be tested and approved by a geotechnical engineer during construction.

8.5. Canopy-Area Preparation Recommendations

This section deals with preparation of the proposed canopy area. The means and methods of site preparation will greatly depend on the weather conditions before and during construction, the subsurface conditions that are exposed during earthwork operations, and the finalized details of the proposed development. Therefore, only generalized site preparation recommendations are given.

In addition to being generalized, the following site preparation recommendations are abbreviated; the *Guide Specifications* in Appendix D gives further recommendations. The *Guide Specifications* should be read along with this section. Also, the *Guide Specifications* are recommended to be used as an aid to develop the project specifications.

Demolition and Removal

An existing canopy currently exists at the proposed canopy location. Site preparation will, therefore, require complete removal and proper disposal of all above- and below-grade components of the existing canopy, and any remnants of previous structures, including all foundations, floor slabs, etc. Disposal of debris should be in accordance with local, state and federal regulations for the material type. All excavations must be backfilled with engineered fill. It is also expected to be necessary to bench into the surrounding soils, as noted in Item No. 3 of the Guide Specifications enclosed in Appendix D.

It is recommended that a geotechnical engineer observe (on a full-time basis) the removal of the existing structure, and the backfilling of excavations made during the removal operations. Depending on the conditions that are encountered during the removal operations, this report might need to be revised.

At the perimeter of the proposed canopy area, existing pavement is recommended to be saw-cut. Pavement within the saw-cut area is then recommended to be removed, taking care not to damage pavement that will remain. Removed pavement is recommended to be properly disposed of off-site. However, pavement should be left in-place as long as possible to help protect the subgrade from construction traffic disturbance.

Proof Rolling and Fill Placement

After the recommended demolition and removal, and once the canopy area is cut (lowered) as needed, the subgrade is recommended to be proof-rolled with a fully-loaded, tandem-axle dump truck or other suitable construction equipment to help locate unstable soil based on subgrade deflection caused by the wheel loads of the proof-roll equipment. The entire canopy area is recommended to be proof-rolled, except that proof-roll equipment should be kept a sufficient distance from pavement that will remain. It is recommended that a geotechnical engineer observe proof-roll operations and evaluate subgrade stability based on those observations. Areas that are not accessible to proof-roll equipment (such as along existing pavement) are recommended to be evaluated (and approved) by a geotechnical engineer using appropriate means and methods. Care must be taken not to damage remaining pavement (or other structures) during the proof-roll operations.

Considering the existing fill, and current/former developments, unstable soil will likely be encountered during proof-rolling/testing. Over-excavation and/or mechanical stabilization (possibly with geotextile or geogrid) of unstable soil will likely be needed. Areas requiring improvement could be large and improvement methods might need to extend a significant depth below the planned subgrade. Areas requiring improvement should be defined during construction with the assistance of a geotechnical engineer. Also, specific improvement methods should be determined during construction on an area-by-area basis depending on the site conditions and results of proof-rolling/testing.

The canopy area is recommended to be raised, where necessary, to the planned finished grade with engineered fill immediately after the subgrade is confirmed to be stable and suitable to support the proposed improvements. Engineered fill is recommended to be placed in uniform, relatively thin layers (lifts). Each layer of engineered fill is recommended to be compacted to at least 95 percent of the fill material's maximum dry density determined from the Standard Proctor compaction test (ASTM D698). As an exception, the in-place dry density of engineered fill within one foot of the pavement subgrade is recommended to be compacted to at least 100 percent of the fill's maximum dry density. Item Nos. 4 and 5 of the *Guide Specifications* give more information pertaining to selection and compaction of engineered fill.

The water content of fill material is recommended to be uniform and within a narrow range of the optimum moisture content, as described in Item No. 5 of the *Guide Specifications*. The optimum moisture content is to be determined by the Standard Proctor compaction test. Engineered fill that does not meet the density and water content requirements is recommended to be replaced or scarified to a sufficient depth (likely 6 to 12 inches, or more), moisture-conditioned, and compacted to the required density. A subsequent lift of fill should only be placed after a geotechnical engineer confirms that the previous lift was properly placed and compacted. Subgrade soil may need to be recompacted immediately before construction since equipment traffic and adverse weather may reduce soil stability.

Engineered fill that does not meet the density and water content requirements is recommended to be replaced with new fill or scarified to a sufficient depth (likely 6 to 12 inches, or more), moisture-conditioned, and compacted to the required density. A subsequent lift of fill should only be placed after a geotechnical engineer confirms that the previous lift was properly placed and compacted. Subgrade soil will likely need to be recompacted immediately before construction since equipment traffic and adverse weather may reduce soil stability.

Use of Site Soil as Engineered Fill

Site soil that does not contain adverse organic content or other deleterious materials, as noted in the *Guide Specifications*, could be used as engineered fill. Sorting to remove rubble and debris from on-site soil used as engineered fill might be necessary considering the existing fill that was encountered at the test borings, and considering the current and former developments. Moisture-content adjustment will likely also be required prior to use of site soil as engineered fill. If construction is during adverse weather (discussed in the following section), drying site soil will likely not be feasible. In that case, aggregate fill (or other fill material with a low water-sensitivity) will likely need to be imported to the site. Additional recommendations regarding fill selection, placement and compaction are given in the *Guide Specifications*.

8.6. Generalized Construction Considerations

Adverse Weather

Site soil is moisture sensitive and will become unstable when exposed to adverse weather such as rain, snow, and freezing temperatures. Therefore, it might be necessary to remove or stabilize the upper 6 to 12 inches (or more) of soil due to adverse weather, which commonly occurs during late fall, winter, and early spring. At least some over-excavation and/or stabilization of unstable soil should be expected if construction is during or after adverse weather. Because site preparation is weather dependent, bids for site preparation, and other earthwork activities, should consider the time of year that construction will be conducted.

To protect soil from adverse weather, the canopy area is recommended to be smoothly graded and contoured during construction to divert surface water away from construction areas. Contoured subgrades are recommended to be rolled with a smooth-drum compactor, before precipitation, to “seal” the surface. Care must be taken not to damage remaining pavement (or other structures) during the subgrade-sealing operations. Construction traffic should be restricted to certain aggregate-covered areas in an effort to reduce traffic-related soil disturbance. Construction should begin immediately after suitable support is confirmed.

Dewatering

It is estimated that the water table was about 9 to 15 feet below-grade at the test boring locations, when the Geotechnical Subsurface Exploration Program was conducted. Additionally, because of the variable fill materials, and the variable native soils, the site is likely subject to shallow, perched groundwater. Perched groundwater could be significant. Based on the assumed foundation bearing grades, it is expected that excavations for the canopy foundations will be above the water table. Water that collects in construction areas is recommended to be removed, along with unstable soil, as soon as possible. Filtered sump pumps, drawing water from sump pits excavated in the bottom of construction trenches, will likely be adequate to remove water that collects in excavations for the canopy columns. Excavated sump pits should be fully-lined with a geotextile and filled with open-graded, free-draining aggregate. More specialized dewatering methods might be necessary for excavations that extend below the water table.

Existing Fill Considerations

Structures currently exist at the site, and the site was formerly developed. Additionally, existing fill was encountered in the test borings. Unsuitable materials may have been buried beneath the site surface during previous site grading and fill placement. Questionable fill materials, where encountered, are recommended to be evaluated by a geotechnical engineer to determine if removal and replacement with engineered fill is necessary. Disposal of unsuitable material should be in accordance with local, state and federal regulations. Alteration to the recommendations of this report may be needed, if conditions different than those noted on the *Test Boring Logs* are revealed.

Excavation Stability

Excavations are recommended to be made in accordance with current OSHA excavation and trench safety standards, and other applicable requirements. Sides of excavations will need to be sloped or braced to maintain or develop a safe work environment. Temporary shoring must be designed according to applicable regulatory requirements. Contractors are responsible for excavation safety.

Existing Utilities

All existing utilities are recommended to be located, and any planned to be maintained should be relocated outside the proposed canopy foundation areas. Utilities that are not reused should be capped-off and removed or properly abandoned in-place in accordance with local codes and ordinances. The excavations for utilities to be removed are recommended to be backfilled with engineered fill. Underground utilities that are to be reused or abandoned in-place should be evaluated by the plumbing contractor, and utility backfill should be evaluated by a geotechnical engineer. Grading operations must be done carefully so that existing utilities are not damaged or disturbed. Utility invert elevations, depths and sizes should be checked relative to the planned foundation elevations.

8.7. Recommended Construction Materials Testing Services

This report was prepared assuming that a geotechnical engineer will perform Construction Materials Testing ("CMT") services during construction of the proposed development. It might be necessary for Giles to provide supplemental geotechnical recommendations based on the results of CMT services and specific details of the project not known at this time. Therefore, if another firm provides CMT services for the project, the results of those services should be provided to Giles on a timely basis, allowing us the opportunity to revise this report, if needed.

9.0 BASIS OF REPORT

This report is strictly based on the project description given earlier in this report. Giles must be notified if any parts of the project description or our assumptions are not accurate so that this report can be amended, if needed. This report is based on the assumption that the facility will be designed and constructed according to the codes that govern construction at the site.

The conclusions and recommendations in this report are based on estimated subsurface conditions as shown on the *Test Boring Logs*. Giles must be notified if the subsurface conditions that are encountered during construction of the proposed development differ from those shown on the *Test Boring Logs* because this report will likely need to be revised. General comments and limitations of this report are given in the appendix.

The conclusions and recommendations presented in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.

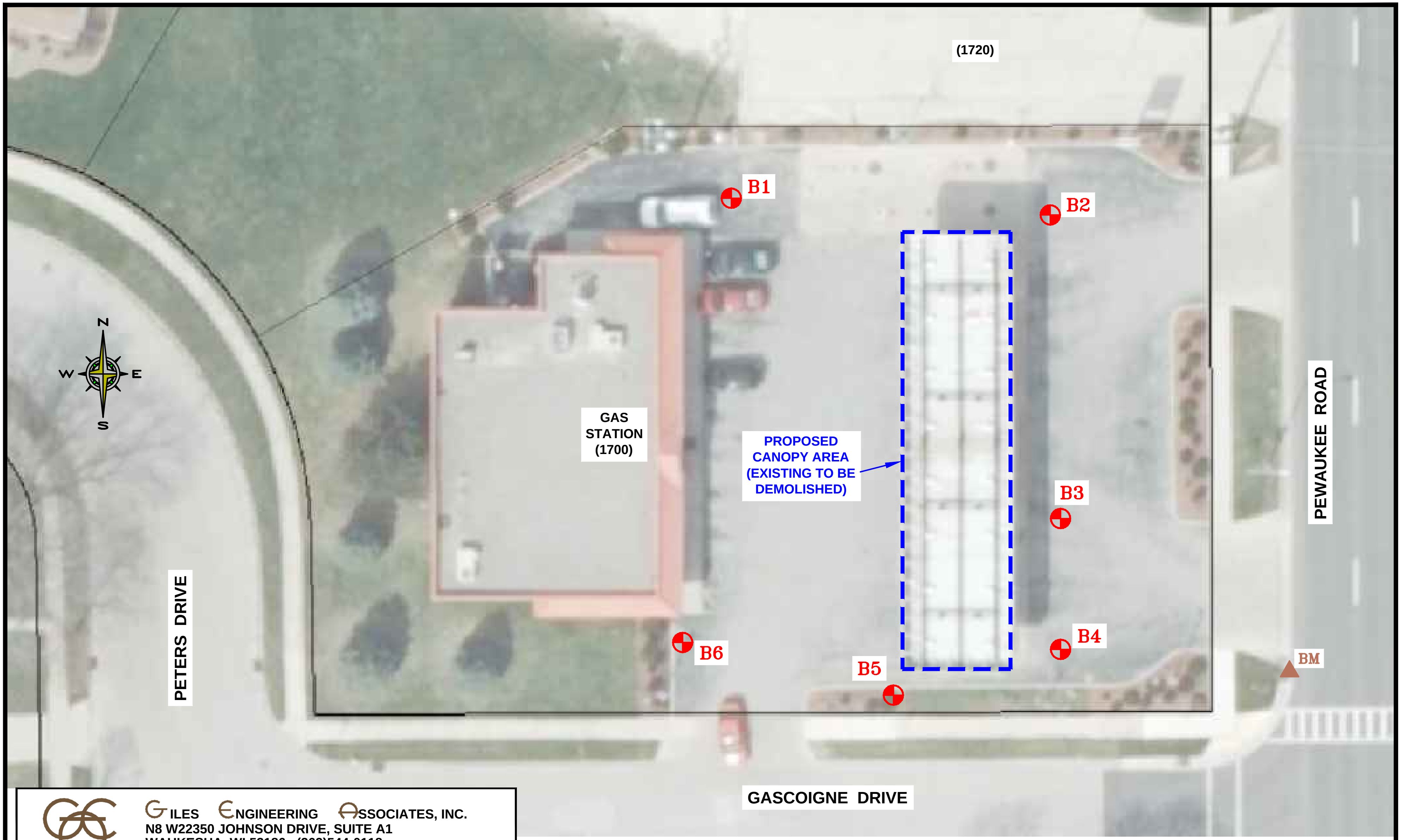
1G-1606015-1/16Geo02/amj/acg/pmm

APPENDIX A

FIGURES AND TEST BORING LOGS

The Test Boring Location Plan contained herein was prepared based upon information supplied by *Giles'* client, or others, along with *Giles'* field measurements and observations. The diagram is presented for conceptual purposes only and is intended to assist the reader in report interpretation.

The Test Boring Logs and related information enclosed herein depict the subsurface (soil and water) conditions encountered at the specific boring locations on the date that the exploration was performed. Subsurface conditions may differ between boring locations and within areas of the site that were not explored with test borings. The subsurface conditions may also change at the boring locations over the passage of time.



0 15' 30'

APPROXIMATE SCALE

GILES ENGINEERING ASSOCIATES, INC.
N8 W22350 JOHNSON DRIVE, SUITE A1
WAUKESHA, WI 53186 (262)544-0118

FIGURE 1
TEST BORING LOCATION PLAN
PROPOSED CANOPY
PROPOSED KWIK TRIP NO. 527
1700 PEWAUKEE ROAD
WAUKESHA, WISCONSIN

DESIGNED	DRAWN	SCALE	DATE	REVISED
AMJ	JSZ	approx. 1"=30'	09-22-16	--
PROJECT NO.: 1G-1606015-1			CAD No. 1g1606015-1blp	

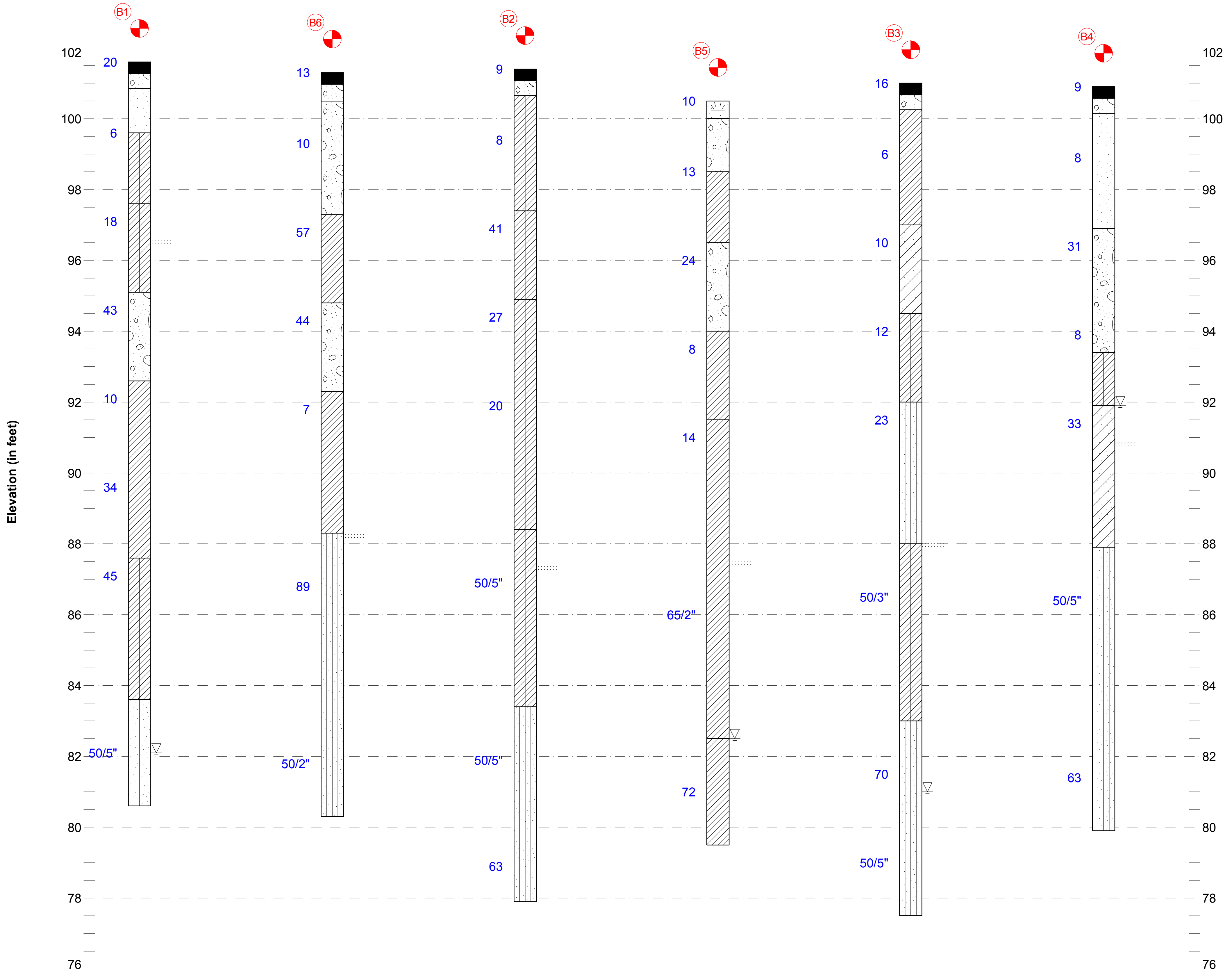
LEGEND:

B1 ⊕	GEOTECHNICAL TEST BORING
▲ BM	BENCHMARK: STORM DRAIN. ASSUMED ELEVATION = 100.0'

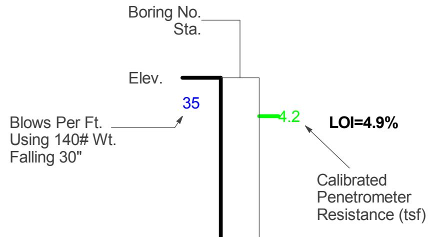
NOTES:
1.) TEST BORING LOCATIONS ARE APPROXIMATE.
2.) BASE MAP DEVELOPED FROM A WAUKESHA COUNTY GIS MAP.

FENCE DIAGRAM

SCALE: VERTICAL: 1" = 3.15'
HORIZONTAL: N.T.S.



LEGEND OF BORING



Unless otherwise specified, the blows per foot at the locations indicated are based on driving a 2" O.D.x 1. 4" I.D. split spoon sampler with a 140# hammer having a free fall of 30". The blow count is taken in undisturbed soil immediately below a cased or open hole eliminating side friction on the drive pipe.

MATERIAL SYMBOLS

■ ASPHALT - Asphalt
▨ SPG - USCS Poorly-graded Gravelly Sand
□ SP - USCS Poorly-graded Sand
▨ CL-ML - USCS Low Plasticity Silty Clay
▨ CL - USCS Low Plasticity Clay
▥ MLS - USCS Sandy Silt
▨ SC - USCS Clayey Sand
□ TOPSOIL - Topsoil

FIGURE 2
Proposed Canopy
Proposed Kwik Trip No. 527
1700 Pewaukee Road
Waukesha, Wisconsin
Project No. 1G-1606015-1

GILES ENGINEERING ASSOCIATES, INC.

GILES FENCE REPORT 11 X 17 1G1606015.GPJ GILES.GDT 9/26/16

NOTES:

BORING NO. & LOCATION:
B1

SURFACE ELEVATION:
101.6 feet

COMPLETION DATE:
07/06/16

FIELD REP:
KEITH FLOWERS

TEST BORING LOG

PROPOSED CANOPY

PROPOSED KWIK TRIP NO. 527
1700 PEWAUKEE ROAD
WAUKESHA, WISCONSIN

PROJECT NO: 1G-1606015-1

GILES ENGINEERING ASSOCIATES, INC.

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
4"± Asphalt Concrete										
5"± Gray Sand and Gravel (Crushed Limestone Base Course) - Damp		100	1-SS	20					*BDL	
Gray to Gray-Brown fine to medium Sand, little coarse Sand and Gravel (Fill) - Moist			2-SS	6				24	*BDL	
Gray and Brown Clayey Silt, trace Sand and Gravel (Fill) - Moist	5		3-SS	18					*BDL	
Dark Brown Clayey Silt with Sand and Gravel (Fill) - Moist		95								
Light Brown fine to coarse Sand and Gravel (includes Cobbles and Boulders) - Damp			4-SS	43					*BDL	
Gray-Brown to Brown Silty Clay, little Sand and Gravel - Moist	10		5-SS	10					*BDL	No Recovery
		90	6-SS	34		4.2		9	*BDL	
Gray-Brown Clayey Silt, little Sand and Gravel (includes Cobbles and Boulders) - Moist	15		7-SS	45					*BDL	
		85								
Gray fine to medium Sandy Silt with coarse Sand and Gravel (includes Cobbles and Boulders) - Wet	▽ 20		8-SS	50/5"					*BDL	

Boring Terminated at about 21 feet (EL. 80.6')

	Water Observation Data	Remarks:
▽	Water Encountered During Drilling: 19.5 ft.	*PID results are lab screened results that may reflect differently from field screened results.
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling: 5 ft.	
▼	Water Level After Drilling:	
▒	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: B2

SURFACE ELEVATION: 101.4 feet

COMPLETION DATE: 07/06/16

FIELD REP: KEITH FLOWERS

TEST BORING LOG

PROPOSED CANOPY

PROPOSED KWIK TRIP NO. 527
1700 PEWAUKEE ROAD
WAUKESHA, WISCONSIN

PROJECT NO: 1G-1606015-1

GILES ENGINEERING ASSOCIATES, INC.

MATERIAL DESCRIPTION

- 4"± Asphalt Concrete
- 5"± Gray Sand and Gravel (Crushed Limestone Base Course) - Damp
- Gray-Brown and Brown Clayey Silt, trace Sand and Gravel (Fill) - Moist
- Brown and Dark Brown Clayey Silt with Sand and Gravel (includes Cobbles and Boulders) (Fill) - Damp
- Gray-Brown Silty Clay to Clayey Silt, little Sand and Gravel (includes Cobbles and Boulders) - Moist
- Gray-Brown Clayey Silt, trace to little Sand and Gravel (includes Cobbles and Boulders) - Damp
- Gray-Brown to Gray fine Sandy Silt, little to some coarse Sand and Gravel (includes Cobbles and Boulders) - Damp

Depth (ft)	Elevation	Sample No. & Type	N	Qu (tsf)	Qp (tsf)	Qs (tsf)	W (%)	PID	NOTES
	100	1-SS	9					*BDL	
		2-SS	8				28	*BDL	
5		3-SS	41					*BDL	
	95								
		4-SS	27					*BDL	
10		5-SS	20				9	*BDL	
	90								
15		6-SS	50/5"					*BDL	
	85								
20		7-SS	50/5"					*BDL	
	80								
		8-SS	63					*BDL	

Boring Terminated at about 23.5 feet (EL. 77.9')

Water Observation Data

- ▽ Water Encountered During Drilling:
- ▼ Water Level At End of Drilling:
- ░ Cave Depth At End of Drilling: 14 ft.
- ▼ Water Level After Drilling:
- ▒ Cave Depth After Drilling:

Remarks:

*PID results are lab screened results that may reflect differently from field screened results.

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: B3	# TEST BORING LOG	**GILES ENGINEERING ASSOCIATES, INC.**
SURFACE ELEVATION: 101 feet	PROPOSED CANOPY	
COMPLETION DATE: 07/06/16	PROPOSED KWIK TRIP NO. 527 1700 PEWAUKEE ROAD WAUKESHA, WISCONSIN	
FIELD REP: KEITH FLOWERS	PROJECT NO: 1G-1606015-1	

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
4"± Asphalt Concrete 5"± Gray Sand and Gravel (Crushed Limestone Base Course) - Damp Gray and Brown Silty Clay, little Sand, trace Gravel (Fill) - Moist		100	1-SS	16					*BDL	
			2-SS	6	1.1	0.9		31	*BDL	
Gray-Brown Clayey fine to coarse Sand, little to some Gravel (Fill) - Moist	5	95	3-SS	10					*BDL	
Gray-Brown Silty Clay to Clayey Silt, little to some Sand and Gravel - Moist			4-SS	12				9	*BDL	
Gray-Brown fine Sandy Silt, some coarse Sand and Gravel - Damp	10	90	5-SS	23				8	*BDL	
Gray-Brown Clayey Silt with Sand and Gravel (includes Cobbles and Boulders) - Damp	15	85	6-SS	50/3"					*BDL	
Gray-Brown fine Sandy Silt, some medium to coarse Sand and Gravel (includes Cobbles and Boulders) - Damp	∇ 20	80	7-SS	70					*BDL	
			8-SS	50/5"				15	*BDL	

Boring Terminated at about 23.5 feet (EL. 77.5')

	Water Observation Data	**Remarks:**
∇	Water Encountered During Drilling: 20 ft.	*PID results are lab screened results that may reflect differently from field screened results. Temporary well set at 20 feet.
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling: 13 ft.	
▼	Water Level After Drilling:	
▒	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:	# TEST BORING LOG	
B4		
SURFACE ELEVATION: 100.9 feet	PROPOSED CANOPY	**GILES ENGINEERING ASSOCIATES, INC.**
COMPLETION DATE: 07/06/16	PROPOSED KWIK TRIP NO. 527 1700 PEWAUKEE ROAD WAUKESHA, WISCONSIN	
FIELD REP: KEITH FLOWERS	PROJECT NO: 1G-1606015-1	

MATERIAL DESCRIPTION	**Depth (ft)**	**Elevation**	**Sample No. & Type**	**N**	**Q_u (tsf)**	**Q_p (tsf)**	**Q_s (tsf)**	**W (%)**	**PID**	**NOTES**
4"± Asphalt Concrete										
5"± Gray Sand and Gravel (Crushed Limestone Base Course) - Damp		100	1SS	9					*BDL	
Gray-Brown fine to medium Sand, little Silt and Gravel (Fill) - Moist			2-SS	8					*BDL	
Dark Gray-Brown Silty fine to coarse Sand and Gravel (Fill) - Moist	5	95	3-SS	31					*BDL	
Gray-Brown Clayey Silt, little Sand and Gravel - Moist			4-SS	8					*BDL	
Brown fine to medium Sandy Clay, little Sand and Gravel (includes Cobbles and Boulders) - Wet	∇ 10	90	5-SS	33				11	*BDL	
Gray fine to medium Sandy Silt, some coarse Sand and Gravel (includes Cobbles and Boulders) - Damp to Moist	15	85	6-SS	50/5"					*BDL	
	20	80	7-SS	63				8	*BDL	

Boring Terminated at about 21 feet (EL. 79.9')

	Water Observation Data	**Remarks:**
∇	Water Encountered During Drilling: 9 ft.	*PID results are lab screened results that may reflect differently from field screened results. Tempoary well set at 20 feet.
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling: 10 ft.	
▼	Water Level After Drilling:	
▒	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION: B5	# TEST BORING LOG	**GILES ENGINEERING ASSOCIATES, INC.**
SURFACE ELEVATION: 100.5 feet	PROPOSED CANOPY	
COMPLETION DATE: 07/06/16	PROPOSED KWIK TRIP NO. 527 1700 PEWAUKEE ROAD WAUKESHA, WISCONSIN	
FIELD REP: KEITH FLOWERS	PROJECT NO: 1G-1606015-1	

MATERIAL DESCRIPTION	**Depth (ft)**	**Elevation**	**Sample No. & Type**	**N**	**Q_u (tsf)**	**Q_p (tsf)**	**Q_s (tsf)**	**W (%)**	**PID**	**NOTES**
6"± Dark Brown Clayey Silt, little Sand and Organic Matter (Fill) - Moist		100	1SS	10					*BDL	
Gray Silty Sand and Gravel (Crushed Limestone Fill) - Moist			2-SS	13	1.9	1.6		31	*BDL	
Dark Gray and Yellow-Brown mottled Silty Clay, trace to little Sand - Moist										
Gray-Brown Silty fine to coarse Sand and Gravel - Moist	5	95	3-SS	24					*BDL	
Brown to Gray-Brown Clayey Silt to Silty Clay, little Sand and Gravel - Moist			4-SS	8				12	*BDL	
Gray-Brown Clayey Silt with Sand and Gravel (includes Cobbles and Boulders) - Moist	10	90	5-SS	14				10	*BDL	
	15	85	6-SS	65/2"					*BDL	No Recovery
Gray Clayey Silt, little Sand and Gravel (includes Cobbles and Boulders) - Wet	20	80	7-SS	72				10	*BDL	

Boring Terminated at about 21 feet (EL. 79.5')

	Water Observation Data	**Remarks:**
▽	Water Encountered During Drilling: 18 ft.	*PID results are lab screened results that may reflect differently from field screened results.
▼	Water Level At End of Drilling:	
░	Cave Depth At End of Drilling: 13 ft.	
▼	Water Level After Drilling:	
▒	Cave Depth After Drilling:	

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

BORING NO. & LOCATION:
B6

TEST BORING LOG

SURFACE ELEVATION:
101.3 feet

PROPOSED CANOPY

COMPLETION DATE:
07/06/16

PROPOSED KWIK TRIP NO. 527
1700 PEWAUKEE ROAD
WAUKESHA, WISCONSIN

FIELD REP:
KEITH FLOWERS

PROJECT NO: 1G-1606015-1

GILES ENGINEERING ASSOCIATES, INC.

MATERIAL DESCRIPTION	Depth (ft)	Elevation	Sample No. & Type	N	Q_u (tsf)	Q_p (tsf)	Q_s (tsf)	W (%)	PID	NOTES
4" Asphalt Concrete 6" Gray Sand and Gravel (Crushed Limestone Base Course) - Moist		100	1-SS	13					*BDL	
Gray-Brown fine to coarse Sand and Gravel (Fill) - Moist			2-SS	10					*BDL	
Dark Brown and Brown Silty Clay, trace to little Sand and Gravel (includes Cobbles and Boulders) - Moist	5		3-SS	57		0.8		38	*BDL	
Gray Silty fine to coarse Sand and Gravel (includes Cobbles and Boulders) - Moist		95	4-SS	44					*BDL	
Gray-Brown Silty Clay, little Sand and Gravel (includes Cobbles and Boulders) - Moist	10	90	5-SS	7		1.5		9	*BDL	
Gray-Brown to Gray fine to coarse Sandy Silt and Gravel (includes Cobbles and Boulders) - Damp	15	85	6-SS	89					*BDL	
	20		7-SS	50/2"					*10	(a)

Boring Terminated at about 21 feet (EL. 80.3')

Water Observation Data

▽ Water Encountered During Drilling:
▼ Water Level At End of Drilling:
░ Cave Depth At End of Drilling: 13 ft.
▼ Water Level After Drilling:
▒ Cave Depth After Drilling:

Remarks:

*PID results are lab screened results that may reflect differently from field screened results.

Temporary well set at 20 feet.

(a) Petroleum odor observed during classification.

Changes in strata indicated by the lines are approximate boundary between soil types. The actual transition may be gradual and may vary considerably between test borings. Location of test boring is shown on the Boring Location Plan.

APPENDIX B

FIELD PROCEDURES

The field operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) designation D 420 entitled “Standard Guide for Sampling Rock and Rock” and/or other relevant specifications. Soil samples were preserved and transported to *Giles’* laboratory in general accordance with the procedures recommended by ASTM designation D 4220 entitled “Standard Practice for Preserving and Transporting Soil Samples.” Brief descriptions of the sampling, testing and field procedures commonly performed by *Giles* are provided herein.

GENERAL FIELD PROCEDURES

Test Boring Elevations

The ground surface elevations reported on the Test Boring Logs are referenced to the assumed benchmark shown on the Boring Location Plan (Figure 1). Unless otherwise noted, the elevations were determined with a conventional hand-level and are accurate to within about 1 foot.

Test Boring Locations

The test borings were located on-site based on the existing site features and/or apparent property lines. Dimensions illustrating the approximate boring locations are reported on the Boring Location Plan (Figure 1).

Water Level Measurement

The water levels reported on the Test Boring Logs represent the depth of "free" water encountered during drilling and/or after the drilling tools were removed from the borehole. Water levels measured within a granular (sand and gravel) soil profile are typically indicative of the water table elevation. It is usually not possible to accurately identify the water table elevation with cohesive (clayey) soils, since the rate of seepage is slow. The water table elevation within cohesive soils must therefore be determined over a period of time with groundwater observation wells.

It must be recognized that the water table may fluctuate seasonally and during periods of heavy precipitation. Depending on the subsurface conditions, water may also become perched above the water table, especially during wet periods.

Borehole Backfilling Procedures

Each borehole was backfilled upon completion of the field operations. If potential contamination was encountered, and/or if required by state or local regulations, boreholes were backfilled with an "impervious" material (such as bentonite slurry). Borings that penetrated pavements, sidewalks, etc. were "capped" with Portland Cement concrete, asphaltic concrete, or a similar surface material. It must, however, be recognized that the backfill material may settle, and the surface cap may subside, over a period of time. Further backfilling and/or re-surfacing by *Giles'* client or the property owner may be required.

FIELD SAMPLING AND TESTING PROCEDURES

Auger Sampling (AU)

Soil samples are removed from the auger flights as an auger is withdrawn above the ground surface. Such samples are used to determine general soil types and identify approximate soil stratifications. Auger samples are highly disturbed and are therefore not typically used for geotechnical strength testing.

Split-Barrel Sampling (SS) – (ASTM D-1586)

A split-barrel sampler with a 2-inch outside diameter is driven into the subsoil with a 140-pound hammer free-falling a vertical distance of 30 inches. The summation of hammer-blows required to drive the sampler the final 12-inches of an 18-inch sample interval is defined as the "Standard Penetration Resistance" or N-value is an index of the relative density of granular soils and the comparative consistency of cohesive soils. A soil sample is collected from each SPT interval.

Shelby Tube Sampling (ST) – (ASTM D-1587)

A relatively undisturbed soil sample is collected by hydraulically advancing a thin-walled Shelby Tube sampler into a soil mass. Shelby Tubes have a sharp cutting edge and are commonly 2 to 5 inches in diameter.

Bulk Sample (BS)

A relatively large volume of soils is collected with a shovel or other manually-operated tool. The sample is typically transported to *Giles'* materials laboratory in a sealed bag or bucket.

Dynamic Cone Penetration Test (DC) – (ASTM STP 399)

This test is conducted by driving a 1.5-inch-diameter cone into the subsoil using a 15-pound steel ring (hammer), free-falling a vertical distance of 20 inches. The number of hammer-blows required to drive the cone 1¾ inches is an indication of the soil strength and density, and is defined as "N". The Dynamic Cone Penetration test is commonly conducted in hand auger borings, test pits and within excavated trenches.

- Continued -

Ring-Lined Barrel Sampling – (ASTM D 3550)

In this procedure, a ring-lined barrel sampler is used to collect soil samples for classification and laboratory testing. This method provides samples that fit directly into laboratory test instruments without additional handling/disturbance.

Sampling and Testing Procedures

The field testing and sampling operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the field testing (i.e. N-values) are reported on the Test Boring Logs. Explanations of the terms and symbols shown on the logs are provided on the appendix enclosure entitled “General Notes”.

APPENDIX C

LABORATORY TESTING AND CLASSIFICATION

The laboratory testing was conducted under the supervision of a geotechnical engineer in accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Brief descriptions of laboratory tests commonly performed by *Giles* are provided herein.

LABORATORY TESTING AND CLASSIFICATION

Photoionization Detector (PID)

In this procedure, soil samples are “scanned” in *Giles’* analytical laboratory using a Photoionization Detector (PID). The instrument is equipped with an 11.7 eV lamp calibrated to a Benzene Standard and is capable of detecting a minute concentration of **certain** Volatile Organic Compound (VOC) vapors, such as those commonly associated with petroleum products and some solvents. Results of the PID analysis are expressed in HNu (manufacturer’s) units rather than actual concentration.

Moisture Content (w) (ASTM D 2216)

Moisture content is defined as the ratio of the weight of water contained within a soil sample to the weight of the dry solids within the sample. Moisture content is expressed as a percentage.

Unconfined Compressive Strength (qu) (ASTM D 2166)

An axial load is applied at a uniform rate to a cylindrical soil sample. The unconfined compressive strength is the maximum stress obtained or the stress when 15% axial strain is reached, whichever occurs first.

Calibrated Penetrometer Resistance (qp)

The small, cylindrical tip of a hand-held penetrometer is pressed into a soil sample to a prescribed depth to measure the soils capacity to resist penetration. This test is used to evaluate unconfined compressive strength.

Vane-Shear Strength (qs)

The blades of a vane are inserted into the flat surface of a soil sample and the vane is rotated until failure occurs. The maximum shear resistance measured immediately prior to failure is taken as the vane-shear strength.

Loss-on-Ignition (ASTM D 2974; Method C)

The Loss-on-Ignition (L.O.I.) test is used to determine the organic content of a soil sample. The procedure is conducted by heating a dry soil sample to 440°C in order to burn-off or “ash” organic matter present within the sample. The L.O.I. value is the ratio of the weight loss due to ignition compared to the initial weight of the dry sample. L.O.I. is expressed as a percentage.

Particle Size Distribution (ASTB D 421, D 422, and D 1140)

This test is performed to determine the distribution of specific particle sizes (diameters) within a soil sample. The distribution of coarse-grained soil particles (sand and gravel) is determined from a “sieve analysis,” which is conducted by passing the sample through a series of nested sieves. The distribution of fine-grained soil particles (silt and clay) is determined from a “hydrometer analysis” which is based on the sedimentation of particles suspended in water.

Consolidation Test (ASTM D 2435)

In this procedure, a series of cumulative vertical loads are applied to a small, laterally confined soil sample. During each load increment, vertical compression (consolidation) of the sample is measured over a period of time. Results of this test are used to estimate settlement and time rate of settlement.

Classification of Samples

Each soil sample was visually-manually classified, based on texture and plasticity, in general accordance with the Unified Soil Classification System (ASTM D-2488-75). The classifications are reported on the Test Boring Logs.

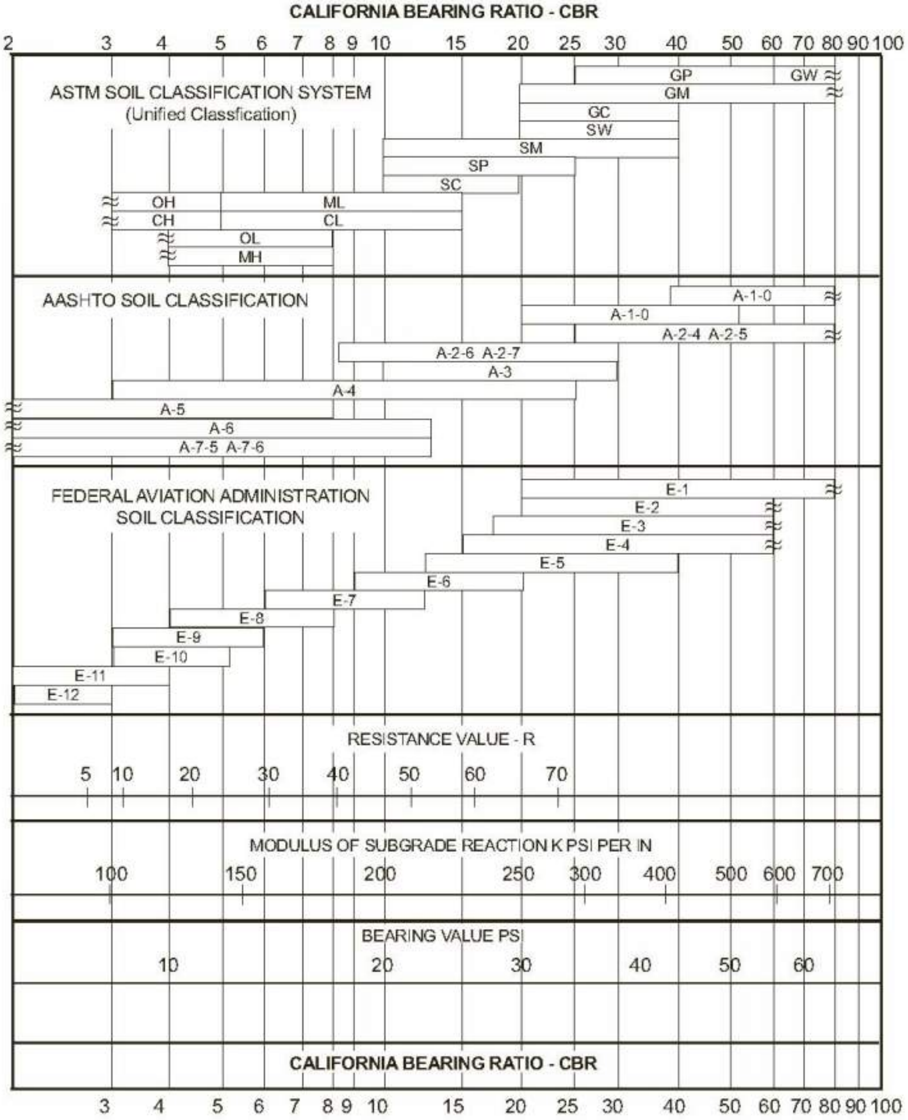
Laboratory Testing

The laboratory testing operations were conducted in general accordance with the procedures recommended by the American Society for Testing and Materials (ASTM) and/or other relevant specifications. Results of the laboratory tests are provided on the Test Boring Logs or other appendix enclosures. Explanation of the terms and symbols used on the logs is provided on the appendix enclosure entitled “General Notes.”

California Bearing Ratio (CBR) Test ASTM D-1833

The CBR test is used for evaluation of a soil subgrade for pavement design. The test consists of measuring the force required for a 3-square-inch cylindrical piston to penetrate 0.1 or 0.2 inch into a compacted soil sample. The result is expressed as a percent of force required to penetrate a standard compacted crushed stone.

Unless a CBR test has been specifically requested by the client, the CBR is estimated from published charts, based on soil classification and strength characteristics. A typical correlation chart is below.



APPENDIX D

GENERAL INFORMATION

GUIDE SPECIFICATIONS FOR SUBGRADE AND GRADE PREPARATION FOR FILL, FOUNDATION, FLOOR SLAB AND PAVEMENT SUPPORT; AND SELECTION, PLACEMENT AND COMPACTION OF FILL SOILS USING STANDARD PROCTOR PROCEDURES

1. Construction monitoring and testing of subgrades and grades for fill, foundation, floor slab and pavement; and fill selection, placement and compaction shall be performed by an experienced soils engineer and/or his representatives.

2. All compaction fill, subgrades and grades shall be (a) underlain by suitable bearing material; (b) free of all organic, frozen, or other deleterious material, and (c) observed, tested and approved by qualified engineering personnel representing an experienced soils engineer. Preparation of subgrades after stripping vegetation, organic or other unsuitable materials shall consist of (a) proof-rolling to detect soil, wet yielding soils or other unstable materials that must be undercut, (b) scarifying top 6 to 8 inches, (c) moisture conditioning the soils as required, and (d) recompaction to same minimum in-situ density required for similar materials indicated under Item 5. Note: compaction requirements for pavement subgrade are higher than other areas. Weather and construction equipment may damage compacted fill surface and reworking and retesting may be necessary to assure proper performance.

3. In overexcavation and fill areas, the compacted fill must extend (a) a minimum 1 foot lateral distance beyond the exterior edge of the foundation at bearing grade or pavement subgrade and down to compacted fill subgrade on a maximum 0.5(H):1(V) slope, (b) 1 foot above footing grade outside the building, and (c) to floor subgrade inside the building. Fill shall be placed and compacted on a 5(H):1(V) slope or must be stepped or benched as required to flatten if not specifically approved by qualified personnel under the direction of an experienced soil engineer.

4. The compacted fill materials shall be free of deleterious, organic, or frozen matter, shall contain no chemicals that may result in the material being classified as "contaminated", and shall be low-expansive with a maximum Liquid Limit (ASTM D-423) and Plasticity Index (ASTM D-424) of 30 and 15, respectively, unless specifically tested and found to have low expansive properties and approved by an experienced soils engineer. The top 12 inches of compacted fill should have a maximum 3-inch-particle diameter and all underlying compacted fill a maximum 6-inch-diameter unless specifically approved by an experienced soils engineer. All fill materials must be tested and approved under the direction of an experienced soils engineer prior to placement. If the fill is to provide non-frost susceptible characteristics, it must be classified as a clean GW, GP, SW or SP per the Unified Soil Classification System (ASTM D-2487).

5. For structural fill depths less than 20 feet, the density of the structural compacted fill and scarified subgrade and grades shall not be less than 95 percent of the maximum dry density as determined by Standard Proctor (ASTM-698) with the exception of the top 12 inches of pavement subgrade which shall have a minimum in-situ density of 100 percent of maximum dry density, or 5 percent higher than underlying fill materials. Where the structural fill depth is greater than 20 feet, the portions below 20 feet should have a minimum in-place density of 100 percent of its maximum dry density of 5 percent greater than the top 20 feet. The moisture content of cohesive soil shall not vary by more than -1 to +3 percent and granular soil ±3 percent of the optimum when placed and compacted or recompacted, unless specifically recommended/approved by the soils engineer monitoring the placement and compaction. Cohesive soils with moderate to high expansion potentials (PI>15) should, however, be placed, compacted and maintained prior to construction at a moisture content 3±1 percent above optimum moisture content to limit further heave. The fill shall be placed in layers with a maximum loose thickness of 8 inches for foundations and 10 inches for floor slabs and pavement, unless specifically approved by the soils engineer taking into consideration the type of materials and compaction equipment being used. The compaction equipment should consist of suitable mechanical equipment specifically designed for soil compaction. Bulldozers or similar tracked vehicles are typically not suitable for compaction.

6. Excavation, filling, subgrade and grade preparation shall be performed in a manner and sequence that will provide drainage at all times and proper control of erosion. Precipitation, springs and seepage water encountered shall be pumped or drained to provide a suitable working platform. Springs or water seepage encountered during grading/foundation construction must be called to the soil engineer's attention immediately for possible construction procedure revision or inclusion of an underdrain system.

7. Non-structural fill adjacent to structural fill should typically be placed in unison to provide lateral support. Backfill along walls must be placed and compacted with care to ensure excessive unbalanced lateral pressures do not develop. The type of fill material placed adjacent to below-grade walls (i.e. basement walls and retaining walls) must be properly tested and approved by an experienced soils engineer with consideration for the lateral pressure used in the wall design.

8. Whenever, in the opinion of the soils engineer or the Owner's Representatives, an unstable condition is being created either by cutting or filling, the work shall not proceed into that area until an appropriate geotechnical exploration and analysis has been performed and the grading plan revised, if found necessary.

GENERAL COMMENTS

The soil samples obtained during the subsurface exploration will be retained for a period of thirty days. If no instructions are received, they will be disposed of at that time.

This report has been prepared exclusively for the client in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. Copies of this report may be provided to contractor(s), with contract documents, to disclose information relative to this project. The report, however, has not been prepared to serve as the plans and specifications for actual construction without the appropriate interpretation by the project architect, structural engineer, and/or civil engineer. Reproduction and distribution of this report must be authorized by the client and *Giles*.

This report has been based on assumed conditions/characteristics of the proposed development where specific information was not available. It is recommended that the architect, civil engineer and structural engineer along with any other design professionals involved in this project carefully review these assumptions to ensure they are consistent with the actual planned development. When discrepancies exist, they should be brought to our attention to ensure they do not affect the conclusions and recommendations provided herein. The project plans and specifications may also be submitted to *Giles* for review to ensure that the geotechnical related conclusions and recommendations provided herein have been correctly interpreted.

The analysis of this site was based on a subsoil profile interpolated from a limited subsurface exploration. If the actual conditions encountered during construction vary from those indicated by the borings, *Giles* must be contacted immediately to determine if the conditions alter the recommendations contained herein.

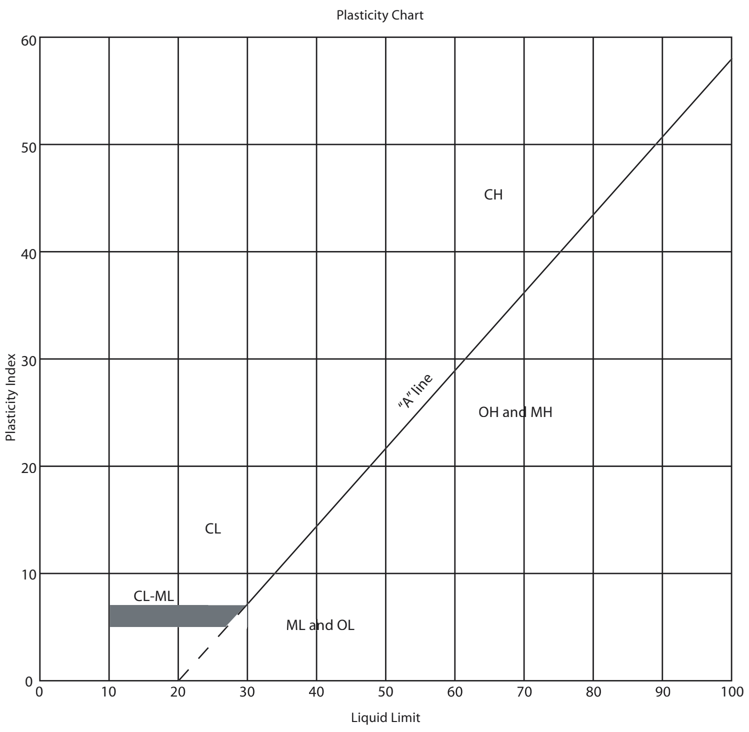
The conclusions and recommendations presented in this report have been promulgated in accordance with generally accepted professional engineering practices in the field of geotechnical engineering. No other warranty is either expressed or implied.

CHARACTERISTICS AND RATINGS OF UNIFIED SOIL SYSTEM CLASSES FOR SOIL CONSTRUCTION *									
Class	**Compaction Characteristics**	**Max. Dry Density Standard Proctor (pcf)**	**Compressibility and Expansion**	**Drainage and Permeability**	**Value as an Embankment Material**	**Value as Subgrade When Not Subject to Frost**	**Value as Base Course**	**Value as Temporary Pavement**	
								With Dust Palliative	**With Bituminous Treatment**
GW	Good: tractor, rubber-tired, steel wheel or vibratory roller	125-135	Almost none	Good drainage, pervious	Very stable	Excellent	Good	Fair to poor	Excellent
GP	Good: tractor, rubber-tired, steel wheel or vibratory roller	115-125	Almost none	Good drainage, pervious	Reasonably stable	Excellent to good	Poor to fair	Poor	
GM	Good: rubber-tired or light sheepsfoot roller	120-135	Slight	Poor drainage, semipervious	Reasonably stable	Excellent to good	Fair to poor	Poor	Poor to fair
GC	Good to fair: rubber-tired or sheepsfoot roller	115-130	Slight	Poor drainage, impervious	Reasonably stable	Good	Good to fair **	Excellent	Excellent
SW	Good: tractor, rubber-tired or vibratory roller	110-130	Almost none	Good drainage, pervious	Very stable	Good	Fair to poor	Fair to poor	Good
SP	Good: tractor, rubber-tired or vibratory roller	100-120	Almost none	Good drainage, pervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SM	Good: rubber-tired or sheepsfoot roller	110-125	Slight	Poor drainage, impervious	Reasonably stable when dense	Good to fair	Poor	Poor	Poor to fair
SC	Good to fair: rubber-tired or sheepsfoot roller	105-125	Slight to medium	Poor drainage, impervious	Reasonably stable	Good to fair	Fair to poor	Excellent	Excellent
ML	Good to poor: rubber-tired or sheepsfoot roller	95-120	Slight to medium	Poor drainage, impervious	Poor stability, high density required	Fair to poor	Not suitable	Poor	Poor
CL	Good to fair: sheepsfoot or rubber-tired roller	95-120	Medium	No drainage, impervious	Good stability	Fair to poor	Not suitable	Poor	Poor
OL	Fair to poor: sheepsfoot or rubber-tired roller	80-100	Medium to high	Poor drainage, impervious	Unstable, should not be used	Poor	Not suitable	Not suitable	Not suitable
MH	Fair to poor: sheepsfoot or rubber-tired roller	70-95	High	Poor drainage, impervious	Poor stability, should not be used	Poor	Not suitable	Very poor	Not suitable
CH	Fair to poor: sheepsfoot roller	80-105	Very high	No drainage, impervious	Fair stability, may soften on expansion	Poor to very poor	Not suitable	Very poor	Not suitable
OH	Fair to poor: sheepsfoot roller	65-100	High	No drainage, impervious	Unstable, should not be used	Very poor	Not suitable	Not suitable	Not suitable
Pt	Not suitable		Very high	Fair to poor drainage	Should not be used	Not suitable	Not suitable	Not suitable	Not suitable

* "The Unified Classification: Appendix A - Characteristics of Soil, Groups Pertaining to Roads and Airfields, and Appendix B - Characteristics of Soil Groups Pertaining to Embankments and Foundations," Technical Memorandum 357, U.S. Waterways Ixperiment Station, Vicksburg, 1953.

** Not suitable if subject to frost.

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

Major Divisions			*Group Symbols*		*Typical Names*	*Laboratory Classification Criteria*		
Coarse-grained soils (more than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (little or no fines)	GW		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent: GW, GP, SW, SP More than 12 percent: GM, GC, SM, SC 5 to 12 percent: *Borderline* cases requiring dual symbols[b]	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtrues, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (appreciable amount of fines)	GM[a]	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW		Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM[a]	d	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting within shaded area, above "A" line with P.I. between 4 and 7 are *borderline* cases requiring use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" line or P.I. greater than 7	
Fine-grained soils (More than half material is smaller than No. 200 sieve size)	Silts and clays (Liquid limit less than 50)		ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity			
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays			
			OL		Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH		Inorganic clays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		Pt		Peat and other highly organic soils			

[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits, suffix d used when L.L. is 28 or less and the P.I. is 6 or less; the suffix u is used when L.L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group sympols. For example GW-GC, well-graded gravel-sand mixture with clay binder.

GENERAL NOTES

SAMPLE IDENTIFICATION

All samples are visually classified in general accordance with the Unified Soil Classification System (ASTM D-2487-75 or D-2488-75)

DESCRIPTIVE TERM (% BY DRY WEIGHT)

Trace:	1-10%
Little:	11-20%
Some:	21-35%
And/Adjective	36-50%

PARTICLE SIZE (DIAMETER)

Boulders:	8 inch and larger
Cobbles:	3 inch to 8 inch
Gravel:	coarse - ¾ to 3 inch
	fine – No. 4 (4.76 mm) to ¾ inch
Sand:	coarse – No. 4 (4.76 mm) to No. 10 (2.0 mm)
	medium – No. 10 (2.0 mm) to No. 40 (0.42 mm)
	fine – No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt:	No. 200 (0.074 mm) and smaller (non-plastic)
Clay:	No 200 (0.074 mm) and smaller (plastic)

SOIL PROPERTY SYMBOLS

Dd:	Dry Density (pcf)
LL:	Liquid Limit, percent
PL:	Plastic Limit, percent
PI:	Plasticity Index (LL-PL)
LOI:	Loss on Ignition, percent
Gs:	Specific Gravity
K:	Coefficient of Permeability
w:	Moisture content, percent
qp:	Calibrated Penetrometer Resistance, tsf
qs:	Vane-Shear Strength, tsf
qu:	Unconfined Compressive Strength, tsf
qc:	Static Cone Penetrometer Resistance (correlated to Unconfined Compressive Strength, tsf)
PID:	Results of vapor analysis conducted on representative samples utilizing a Photoionization Detector calibrated to a benzene standard. Results expressed in HNU-Units. (BDL=Below Detection Limit)
N:	Penetration Resistance per 12 inch interval, or fraction thereof, for a standard 2 inch O.D. (1⅜ inch I.D.) split spoon sampler driven with a 140 pound weight free-falling 30 inches. Performed in general accordance with Standard Penetration Test Specifications (ASTM D-1586). N in blows per foot equals sum of N-Values where plus sign (+) is shown.
Nc:	Penetration Resistance per 1¾ inches of Dynamic Cone Penetrometer. Approximately equivalent to Standard Penetration Test N-Value in blows per foot.
Nr:	Penetration Resistance per 12 inch interval, or fraction thereof, for California Ring Sampler driven with a 140 pound weight free-falling 30 inches per ASTM D-3550. Not equivalent to Standard Penetration Test N-Value.

DRILLING AND SAMPLING SYMBOLS

SS:	Split-Spoon
ST:	Shelby Tube – 3 inch O.D. (except where noted)
CS:	3 inch O.D. California Ring Sampler
DC:	Dynamic Cone Penetrometer per ASTM Special Technical Publication No. 399
AU:	Auger Sample
DB:	Diamond Bit
CB:	Carbide Bit
WS:	Wash Sample
RB:	Rock-Roller Bit
BS:	Bulk Sample
Note:	Depth intervals for sampling shown on Record of Subsurface Exploration are not indicative of sample recovery, but position where sampling initiated

SOIL STRENGTH CHARACTERISTICS

COHESIVE (CLAYEY) SOILS

COMPARATIVE CONSISTENCY	**BLOWS PER FOOT (N)**	**UNCONFINED COMPRESSIVE STRENGTH (TSF)**
Very Soft	0 - 2	0 - 0.25
Soft	3 - 4	0.25 - 0.50
Medium Stiff	5 – 8	0.50 - 1.00
Stiff	9 – 15	1.00 - 2.00
Very Stiff	16 – 30	2.00 - 4.00
Hard	31+	4.00+

NON-COHESIVE (GRANULAR) SOILS

RELATIVE DENSITY	**BLOWS PER FOOT (N)**
Very Loose	0 - 4
Loose	5 - 10
Firm	11 - 30
Dense	31 - 50
Very Dense	51+

DEGREE OF PLASTICITY	**PI**
None to Slight	0 - 4
Slight	5 - 10
Medium	11 - 30
High to Very High	31+

DEGREE OF EXPANSIVE POTENTIAL	**PI**
Low	0 - 15
Medium	15 - 25
High	25+

Important Information About Your
Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you —* should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

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Geotechnical, Environmental & Construction Materials Consultants

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Appendix C – Storm Water Quantity Calculations

HydroCAD - Existing Conditions

1, 2, 10, & 100 Year Storm Events

Summary for Subcatchment 5S: E-1

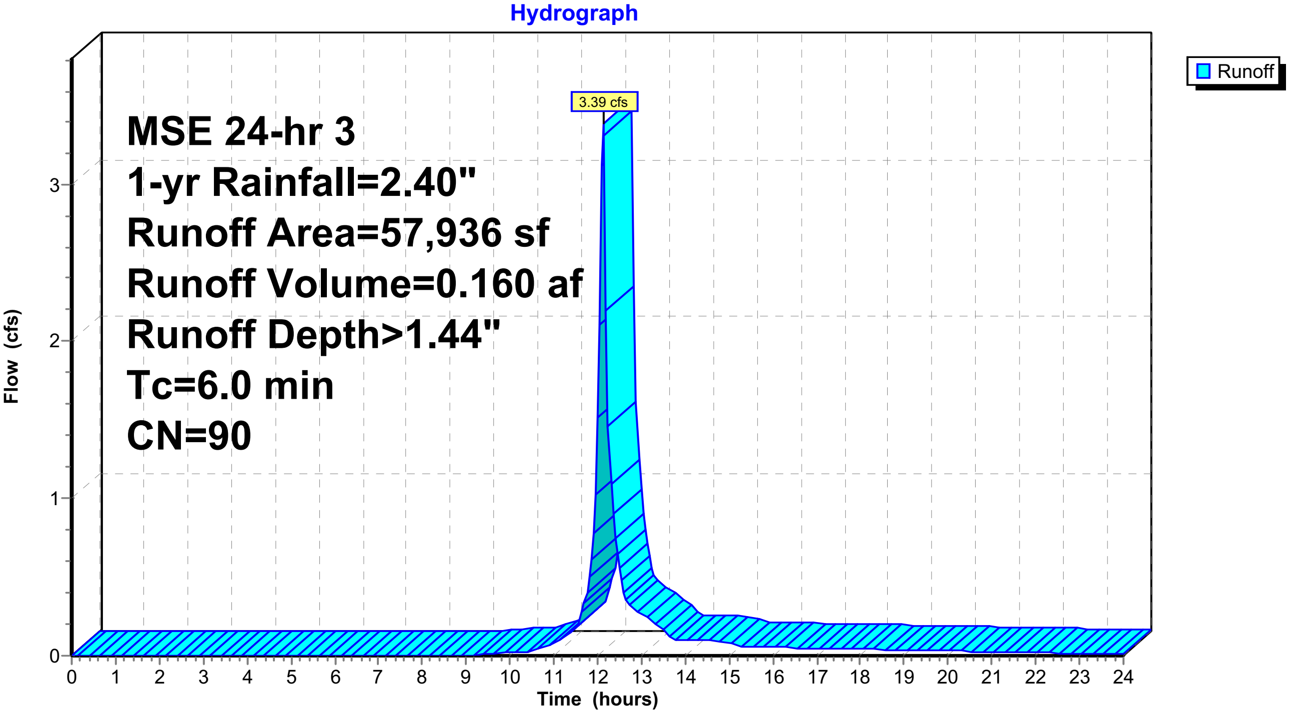
Runoff = 3.39 cfs @ 12.13 hrs, Volume= 0.160 af, Depth> 1.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-yr Rainfall=2.40"

Area (sf)	CN	Description
25,633	80	>75% Grass cover, Good, HSG D
32,303	98	Paved parking, HSG D
57,936	90	Weighted Average
25,633		44.24% Pervious Area
32,303		55.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 5S: E-1



Summary for Subcatchment 5S: E-1

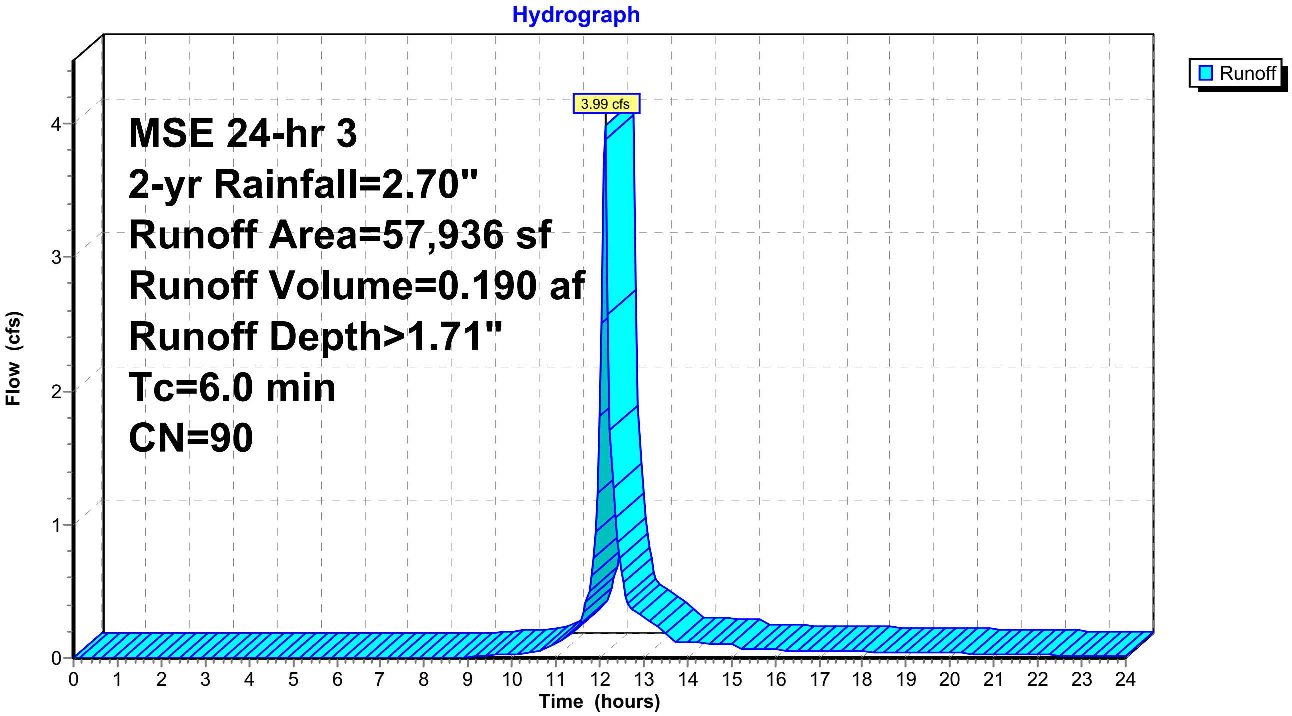
Runoff = 3.99 cfs @ 12.13 hrs, Volume= 0.190 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.70"

Area (sf)	CN	Description
25,633	80	>75% Grass cover, Good, HSG D
32,303	98	Paved parking, HSG D
57,936	90	Weighted Average
25,633		44.24% Pervious Area
32,303		55.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 5S: E-1



Summary for Subcatchment 5S: E-1

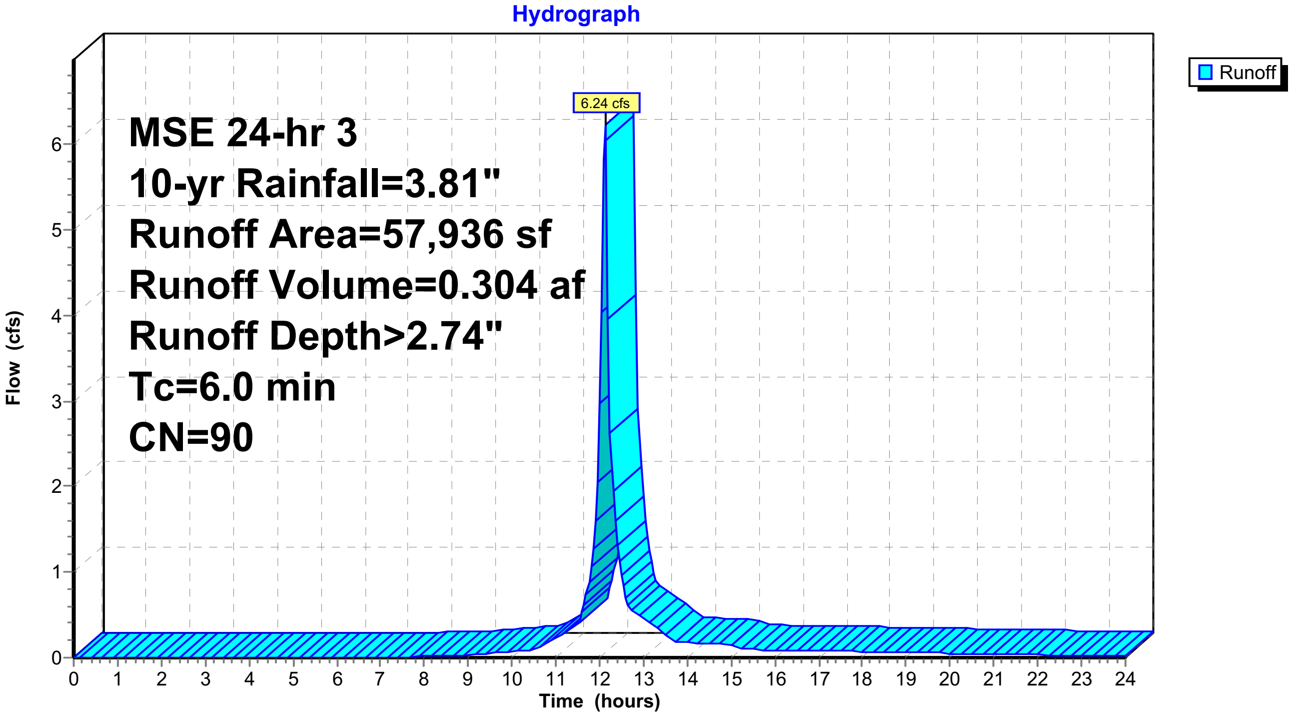
Runoff = 6.24 cfs @ 12.13 hrs, Volume= 0.304 af, Depth> 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.81"

Area (sf)	CN	Description
25,633	80	>75% Grass cover, Good, HSG D
32,303	98	Paved parking, HSG D
57,936	90	Weighted Average
25,633		44.24% Pervious Area
32,303		55.76% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 5S: E-1



Summary for Subcatchment 5S: E-1

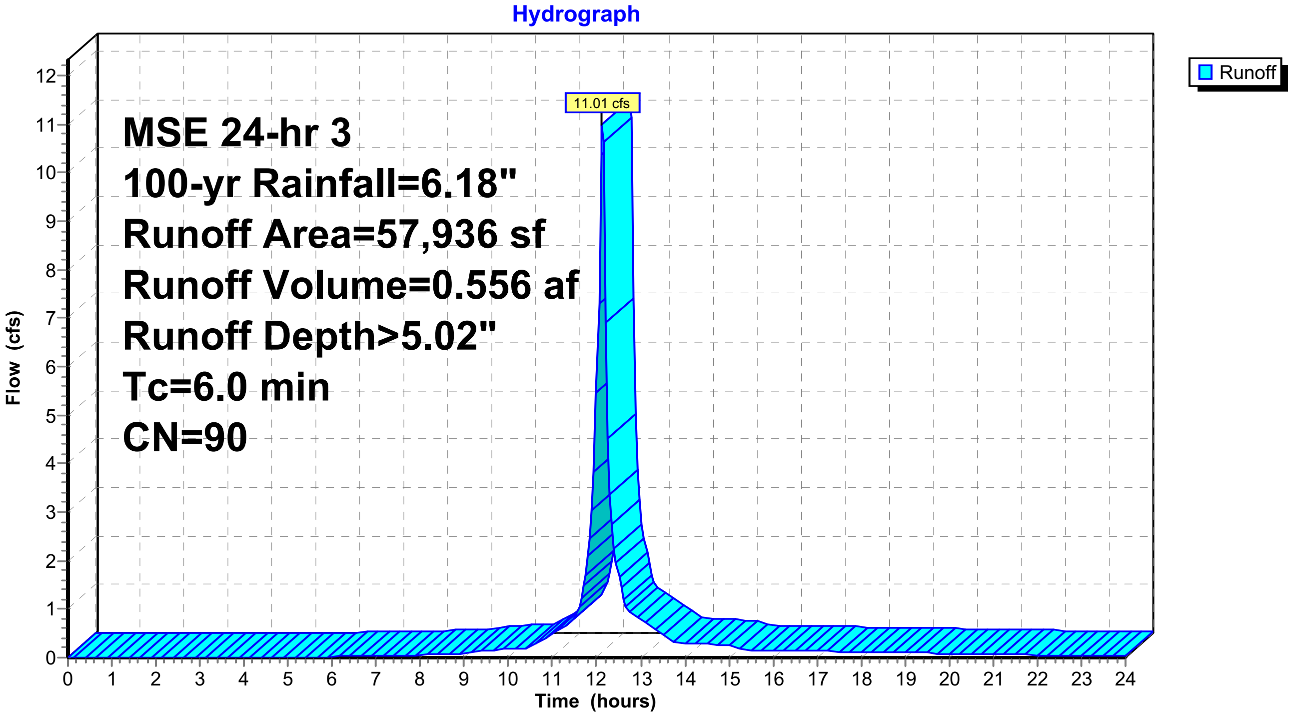
Runoff = 11.01 cfs @ 12.13 hrs, Volume= 0.556 af, Depth> 5.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.18"

Area (sf)	CN	Description
25,633	80	>75% Grass cover, Good, HSG D
32,303	98	Paved parking, HSG D
57,936	90	Weighted Average
25,633		44.24% Pervious Area
32,303		55.76% Impervious Area

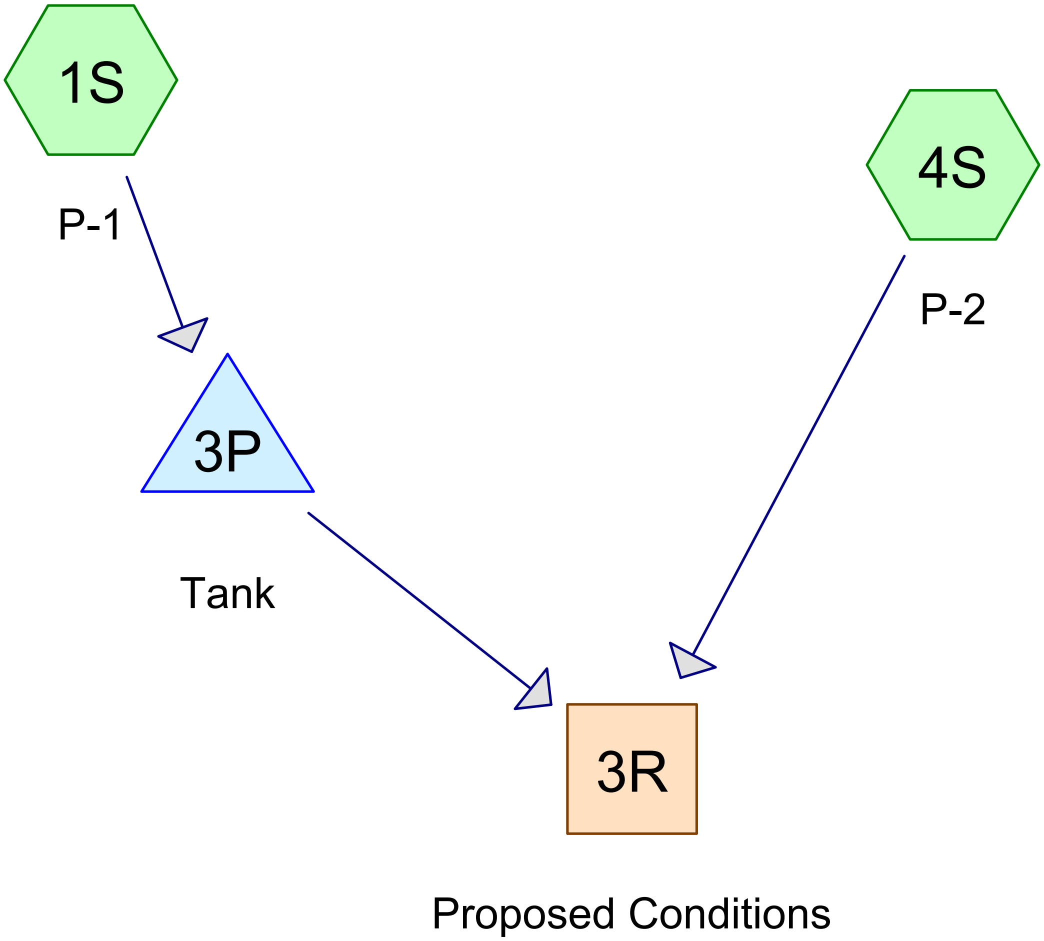
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

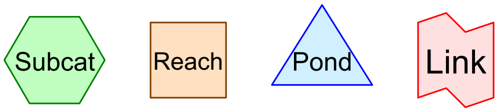
Subcatchment 5S: E-1



HydroCAD - Proposed Conditions

1, 2, 10, & 100 Year Storm Events





Routing Diagram for 3190494_KT 527
Prepared by R.A. Smith, Inc., Printed 2/21/2020
HydroCAD® 10.00-20 s/n 02878 © 2017 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.259	80	>75% Grass cover, Good, HSG D (1S, 4S)
0.068	98	Paved parking (4S)
0.795	98	Paved parking, HSG D (1S)
0.168	98	Roof (4S)
0.011	98	Sidewalk (4S)
0.030	98	Sidewalk, HSG D (1S)
1.330	**94**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
1.084	HSG D	1S, 4S
0.246	Other	4S
1.330		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.259	0.000	0.259	>75% Grass cover, Good	1S, 4S
0.000	0.000	0.000	0.795	0.068	0.862	Paved parking	1S, 4S
0.000	0.000	0.000	0.000	0.168	0.168	Roof	4S
0.000	0.000	0.000	0.030	0.011	0.041	Sidewalk	1S, 4S
0.000	**0.000**	**0.000**	**1.084**	**0.246**	**1.330**	**TOTAL AREA**	

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	109.75	108.86	150.0	0.0059	0.009	12.0	0.0	0.0

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: P-1 Runoff Area=38,480 sf 93.34% Impervious Runoff Depth>2.06"
Tc=6.0 min CN=97 Runoff=2.93 cfs 0.152 af

Subcatchment4S: P-2 Runoff Area=19,456 sf 55.16% Impervious Runoff Depth>1.44"
Tc=6.0 min CN=90 Runoff=1.14 cfs 0.054 af

Reach 3R: Proposed Conditions Inflow=3.34 cfs 0.205 af
Outflow=3.34 cfs 0.205 af

Pond 3P: Tank Peak Elev=110.72' Storage=0.077 af Inflow=2.93 cfs 0.152 af
Outflow=2.28 cfs 0.151 af

Total Runoff Area = 1.330 ac Runoff Volume = 0.206 af Average Runoff Depth = 1.86"
19.48% Pervious = 0.259 ac 80.52% Impervious = 1.071 ac

Summary for Subcatchment 1S: P-1

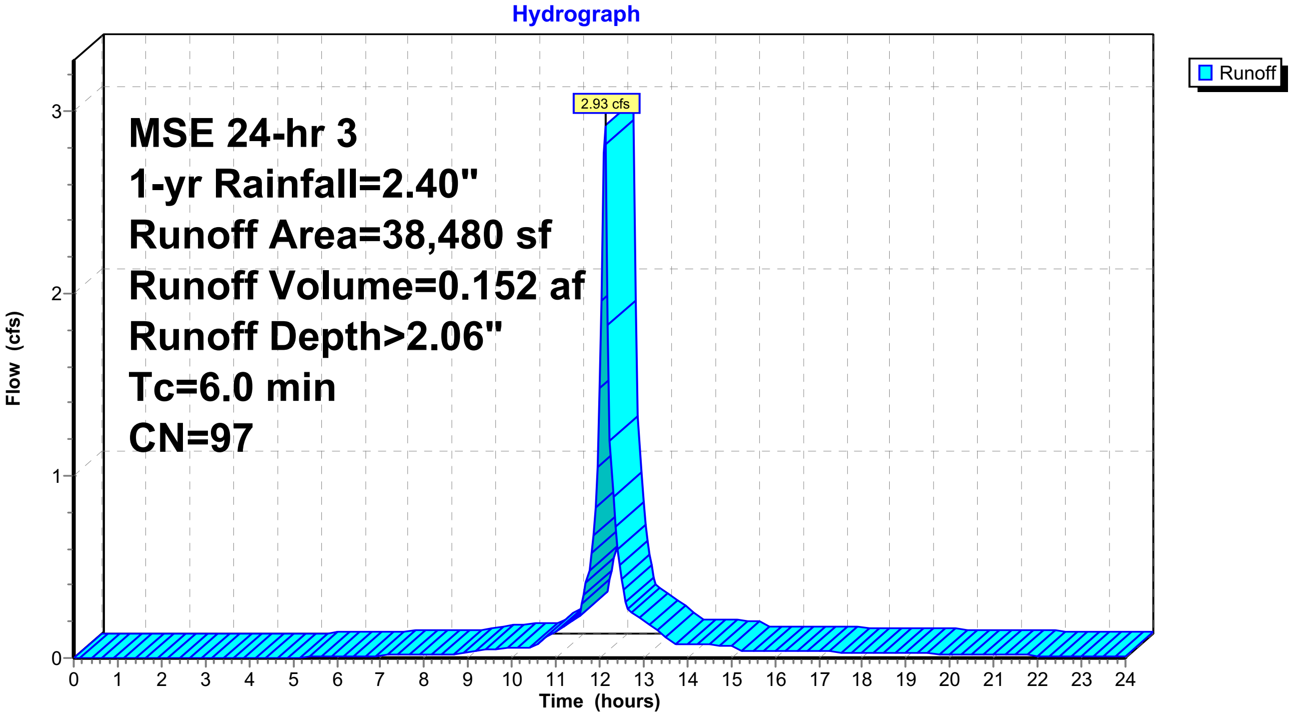
Runoff = 2.93 cfs @ 12.13 hrs, Volume= 0.152 af, Depth> 2.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-yr Rainfall=2.40"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

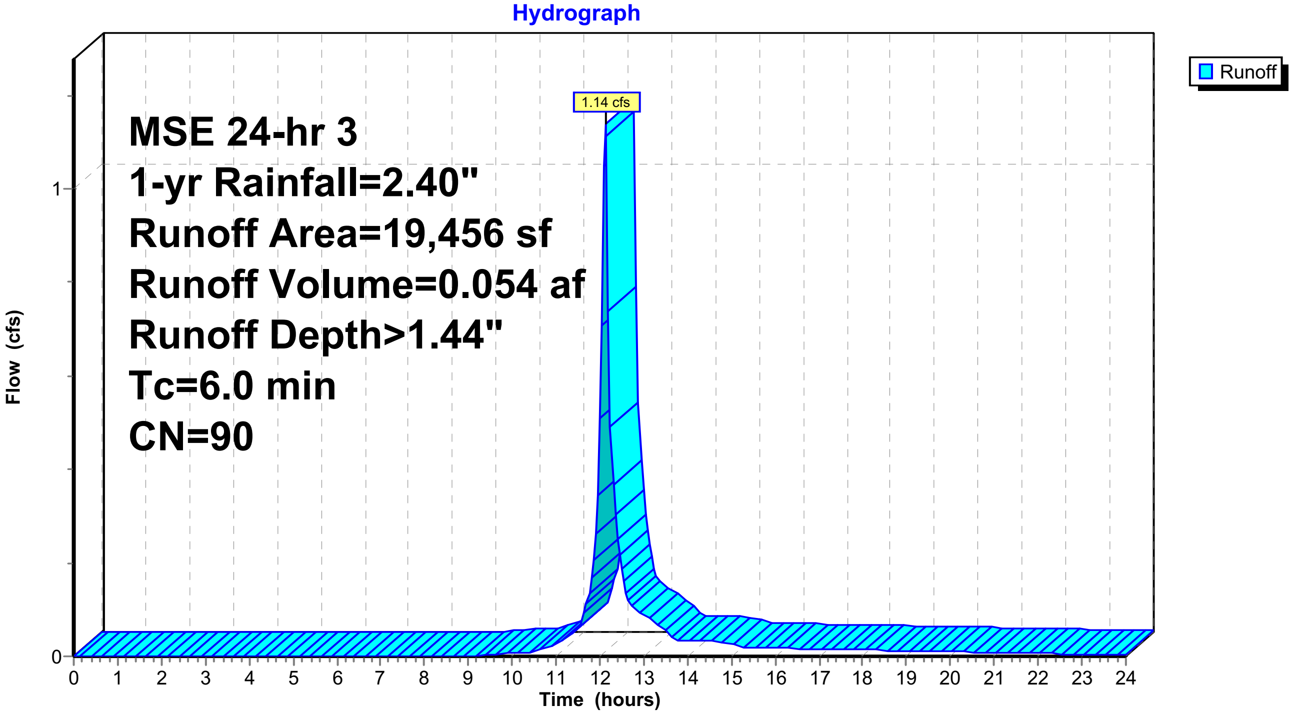
Runoff = 1.14 cfs @ 12.13 hrs, Volume= 0.054 af, Depth> 1.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-yr Rainfall=2.40"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



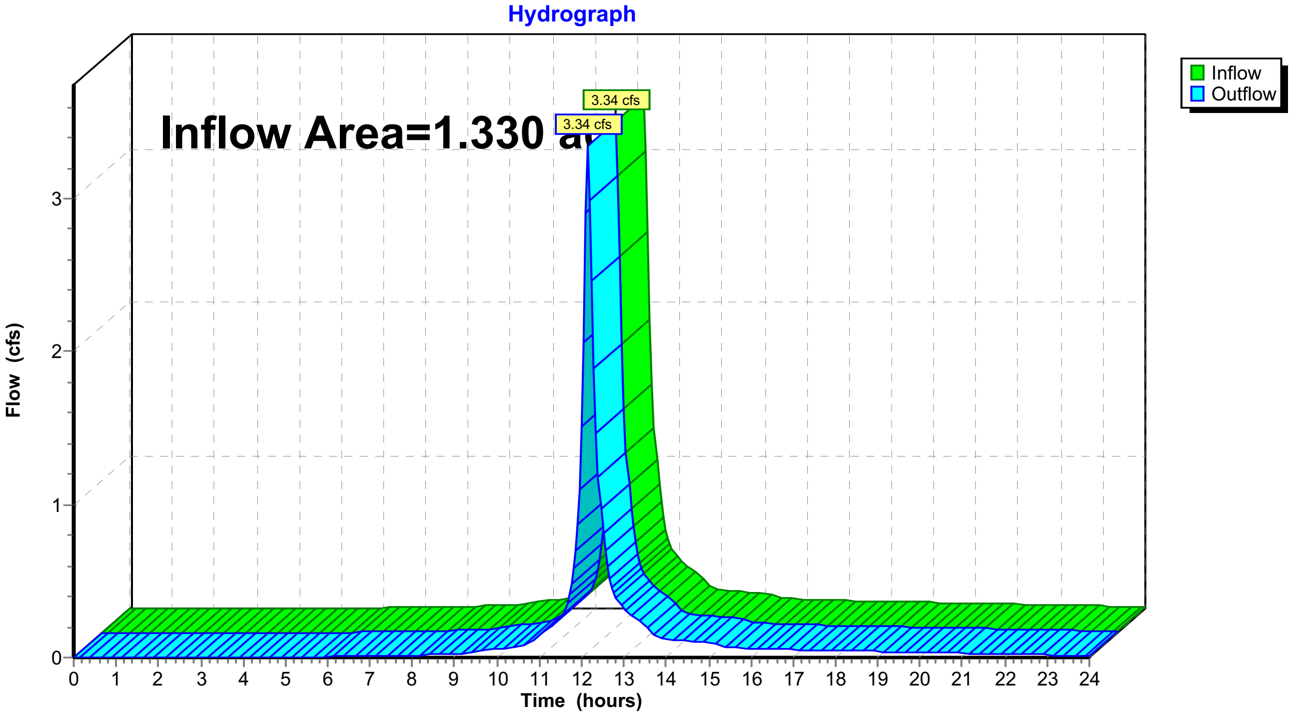
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.330 ac, 80.52% Impervious, Inflow Depth > 1.85" for 1-yr event
Inflow = 3.34 cfs @ 12.15 hrs, Volume= 0.205 af
Outflow = 3.34 cfs @ 12.15 hrs, Volume= 0.205 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

Inflow Area = 0.883 ac, 93.34% Impervious, Inflow Depth > 2.06" for 1-yr event
Inflow = 2.93 cfs @ 12.13 hrs, Volume= 0.152 af
Outflow = 2.28 cfs @ 12.18 hrs, Volume= 0.151 af, Atten= 22%, Lag= 3.1 min
Primary = 2.28 cfs @ 12.18 hrs, Volume= 0.151 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75' Surf.Area= 0.021 ac Storage= 0.057 af
Peak Elev= 110.72' @ 12.18 hrs Surf.Area= 0.020 ac Storage= 0.077 af (0.020 af above start)

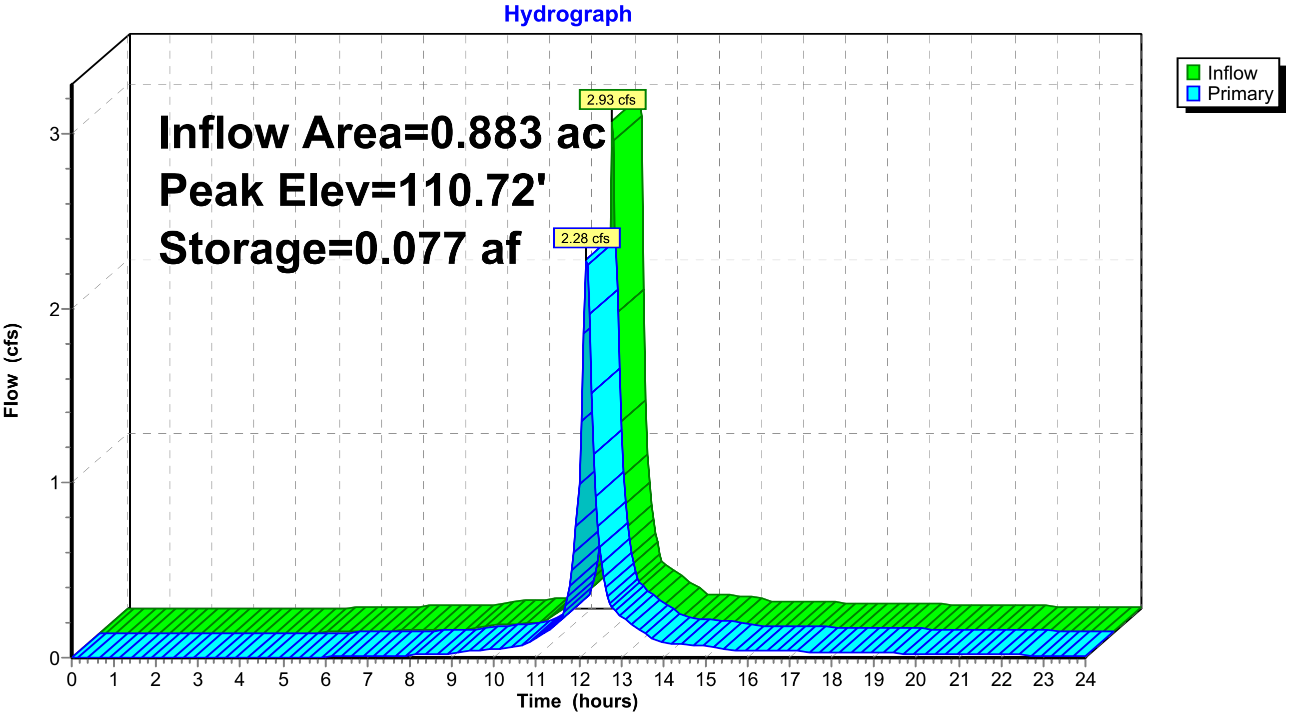
Plug-Flow detention time= 148.0 min calculated for 0.094 af (62% of inflow)
Center-of-Mass det. time= 14.4 min (779.4 - 765.0)

Volume	Invert	Avail.Storage	Storage Description
#1	106.25'	0.115 af	**84.0" Round Pipe Storage** L= 130.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	109.75'	**12.0" Round Culvert** L= 150.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 109.75' / 108.86' S= 0.0059 '/' Cc= 0.900 n= 0.009, Flow Area= 0.79 sf
#2	Device 1	109.75'	**11.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	112.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=2.24 cfs @ 12.18 hrs HW=110.71' (Free Discharge)
└—**1=Culvert** (Passes 2.24 cfs of 2.58 cfs potential flow)
  ├—**2=Orifice/Grate** (Orifice Controls 2.24 cfs @ 3.40 fps)
  └—**3=Sharp-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 3P: Tank


Hydrograph
Inflow Area=0.883 ac
Peak Elev=110.72'
Storage=0.077 af
2.93 cfs
2.28 cfs
Inflow
Primary
Flow (cfs)
0
1
2
3
Time (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
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18
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20
21
22
23
24

```
                    Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
                  Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
     Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment1S: P-1            Runoff Area=38,480 sf   93.34% Impervious   Runoff Depth>2.36"
                                                 Tc=6.0 min   CN=97   Runoff=3.32 cfs  0.174 af

Subcatchment4S: P-2            Runoff Area=19,456 sf   55.16% Impervious   Runoff Depth>1.71"
                                                 Tc=6.0 min   CN=90   Runoff=1.34 cfs  0.064 af

Reach 3R: Proposed Conditions                                       Inflow=3.78 cfs  0.237 af
                                                                   Outflow=3.78 cfs  0.237 af

Pond 3P: Tank                   Peak Elev=110.85'  Storage=0.080 af   Inflow=3.32 cfs  0.174 af
                                                                   Outflow=2.54 cfs  0.173 af

       Total Runoff Area = 1.330 ac   Runoff Volume = 0.237 af   Average Runoff Depth = 2.14"
                                  19.48% Pervious = 0.259 ac     80.52% Impervious = 1.071 ac
```

Summary for Subcatchment 1S: P-1

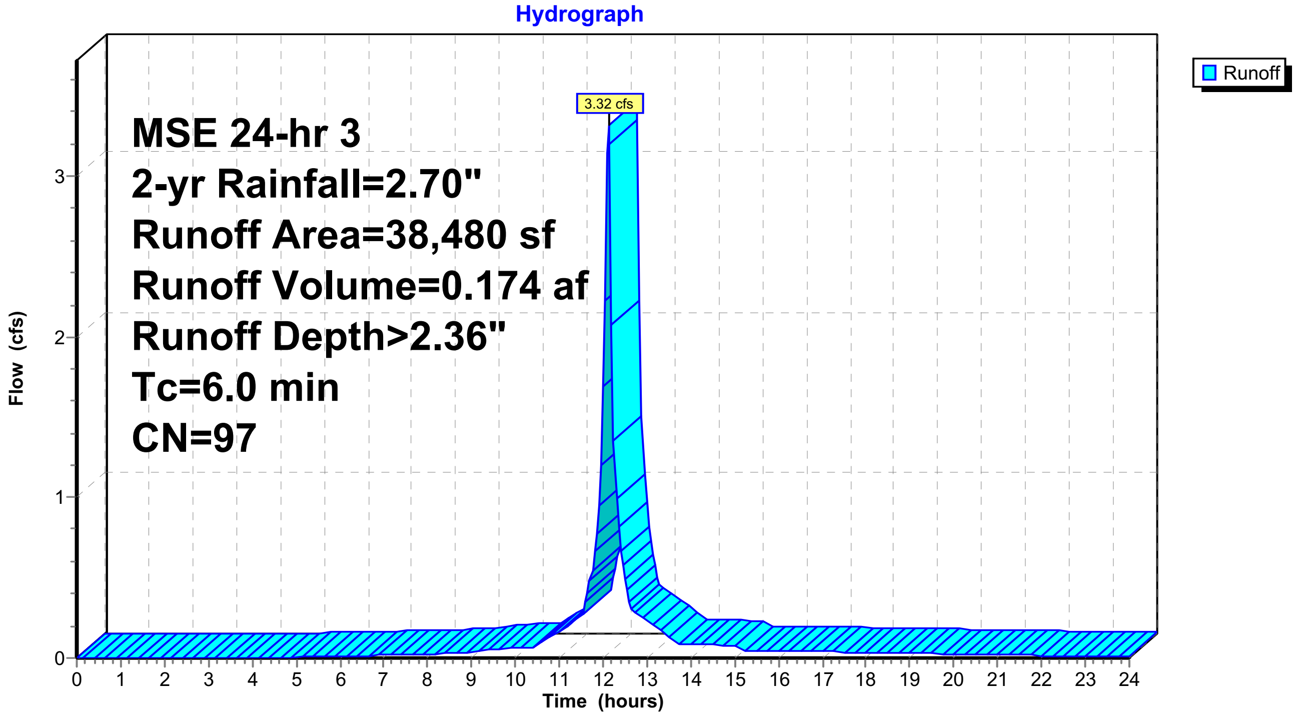
Runoff = 3.32 cfs @ 12.13 hrs, Volume= 0.174 af, Depth> 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.70"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

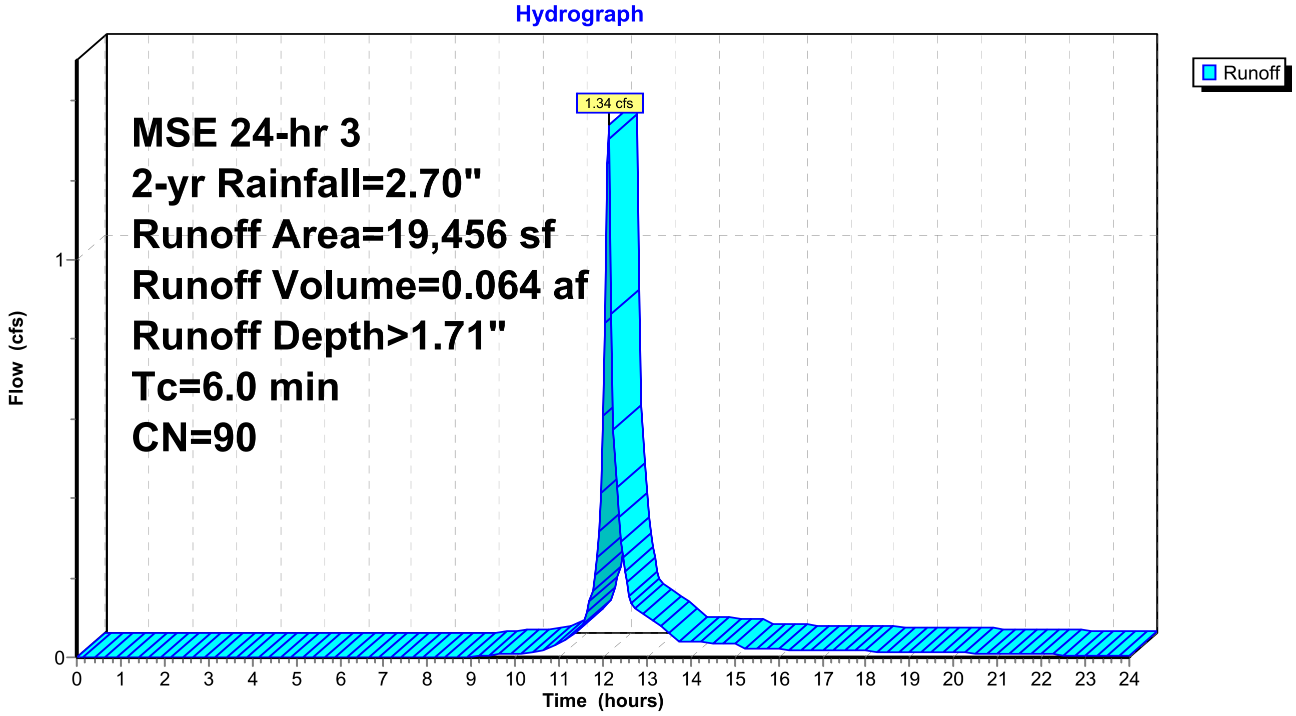
Runoff = 1.34 cfs @ 12.13 hrs, Volume= 0.064 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.70"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



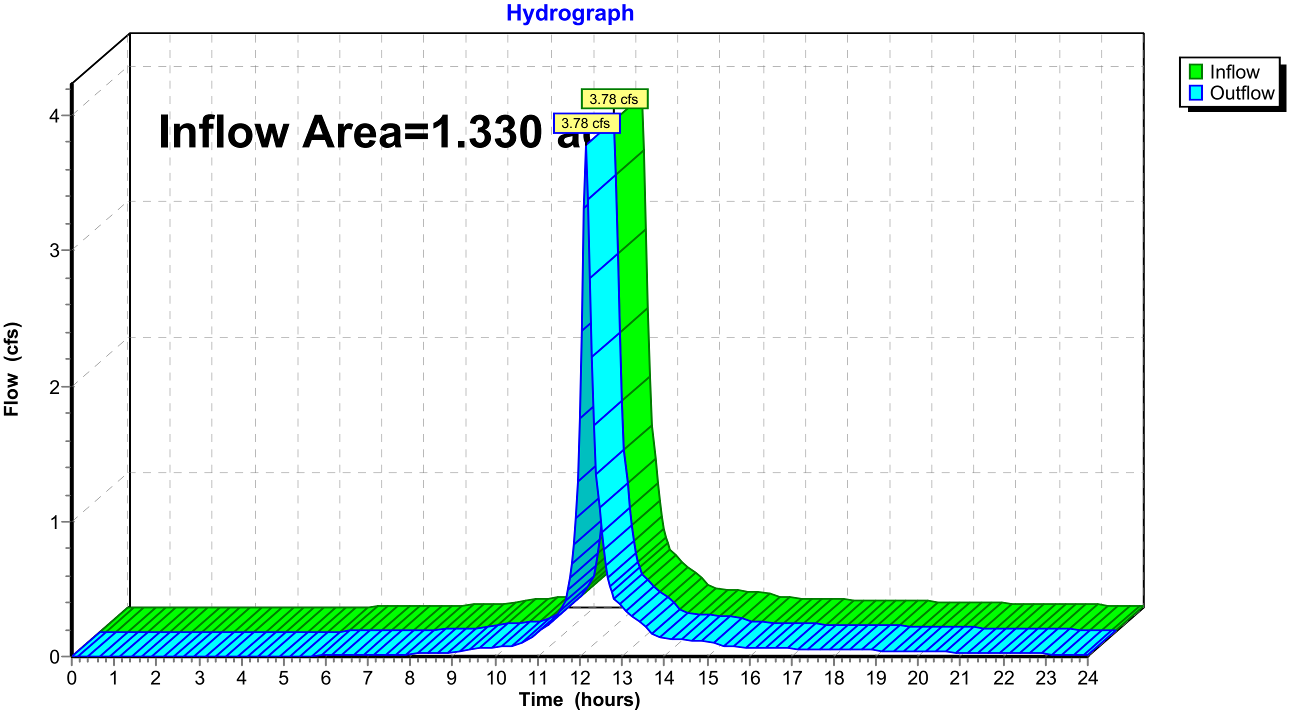
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.330 ac, 80.52% Impervious, Inflow Depth > 2.14" for 2-yr event
Inflow = 3.78 cfs @ 12.15 hrs, Volume= 0.237 af
Outflow = 3.78 cfs @ 12.15 hrs, Volume= 0.237 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

Inflow Area = 0.883 ac, 93.34% Impervious, Inflow Depth > 2.36" for 2-yr event
Inflow = 3.32 cfs @ 12.13 hrs, Volume= 0.174 af
Outflow = 2.54 cfs @ 12.18 hrs, Volume= 0.173 af, Atten= 24%, Lag= 3.2 min
Primary = 2.54 cfs @ 12.18 hrs, Volume= 0.173 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75' Surf.Area= 0.021 ac Storage= 0.057 af
Peak Elev= 110.85' @ 12.18 hrs Surf.Area= 0.020 ac Storage= 0.080 af (0.023 af above start)

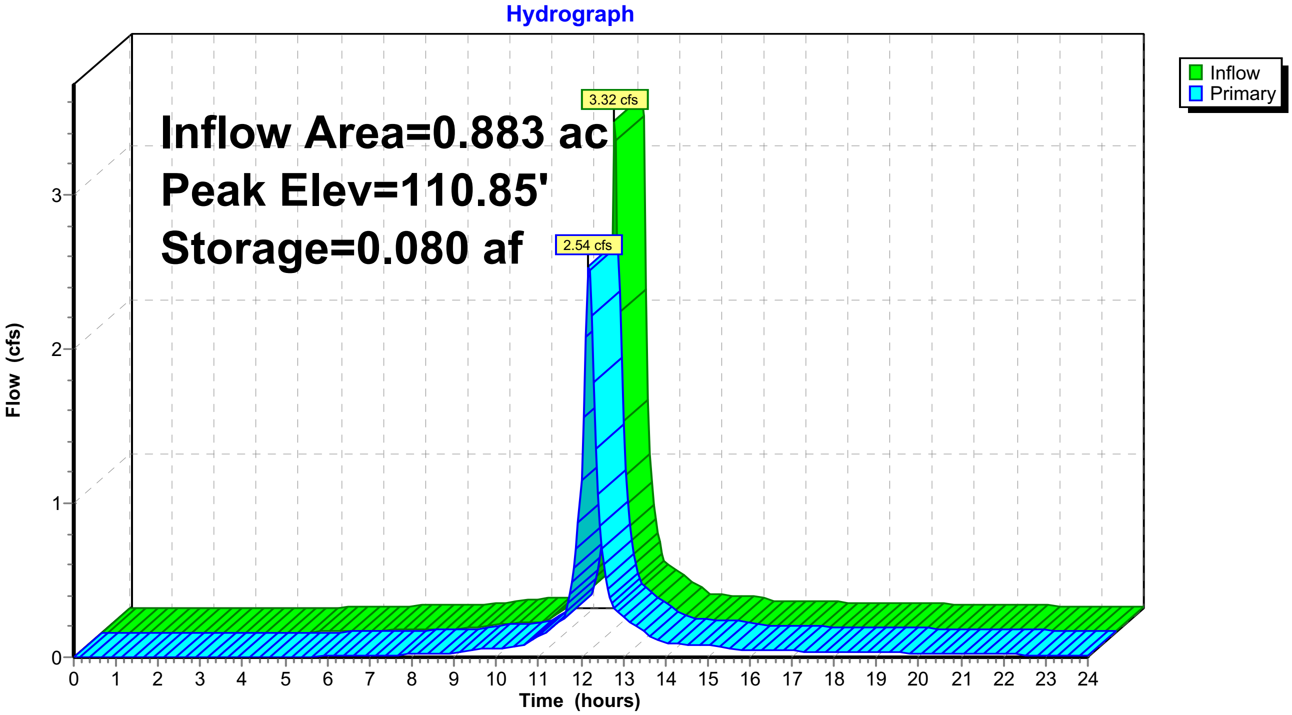
Plug-Flow detention time= 137.1 min calculated for 0.116 af (67% of inflow)
Center-of-Mass det. time= 13.7 min (776.2 - 762.5)

Volume	Invert	Avail.Storage	Storage Description
#1	106.25'	0.115 af	**84.0" Round Pipe Storage** L= 130.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	109.75'	**12.0" Round Culvert** L= 150.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 109.75' / 108.86' S= 0.0059 '/' Cc= 0.900 n= 0.009, Flow Area= 0.79 sf
#2	Device 1	109.75'	**11.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	112.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=2.50 cfs @ 12.18 hrs HW=110.83' (Free Discharge)
↑—**1=Culvert** (Passes 2.50 cfs of 2.88 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 2.50 cfs @ 3.79 fps)
  └—**3=Sharp-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 3P: Tank


Hydrograph
Inflow Area=0.883 ac
Peak Elev=110.85'
Storage=0.080 af
3.32 cfs
2.54 cfs
Inflow
Primary
Flow (cfs)
0
1
2
3
Time (hours)
0
1
2
3
4
5
6
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Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: P-1 Runoff Area=38,480 sf 93.34% Impervious Runoff Depth>3.46"
Tc=6.0 min CN=97 Runoff=4.76 cfs 0.255 af

Subcatchment4S: P-2 Runoff Area=19,456 sf 55.16% Impervious Runoff Depth>2.74"
Tc=6.0 min CN=90 Runoff=2.10 cfs 0.102 af

Reach 3R: Proposed Conditions Inflow=5.34 cfs 0.356 af
Outflow=5.34 cfs 0.356 af

Pond 3P: Tank Peak Elev=111.38' Storage=0.090 af Inflow=4.76 cfs 0.255 af
Outflow=3.44 cfs 0.254 af

Total Runoff Area = 1.330 ac Runoff Volume = 0.357 af Average Runoff Depth = 3.22"
19.48% Pervious = 0.259 ac 80.52% Impervious = 1.071 ac

Summary for Subcatchment 1S: P-1

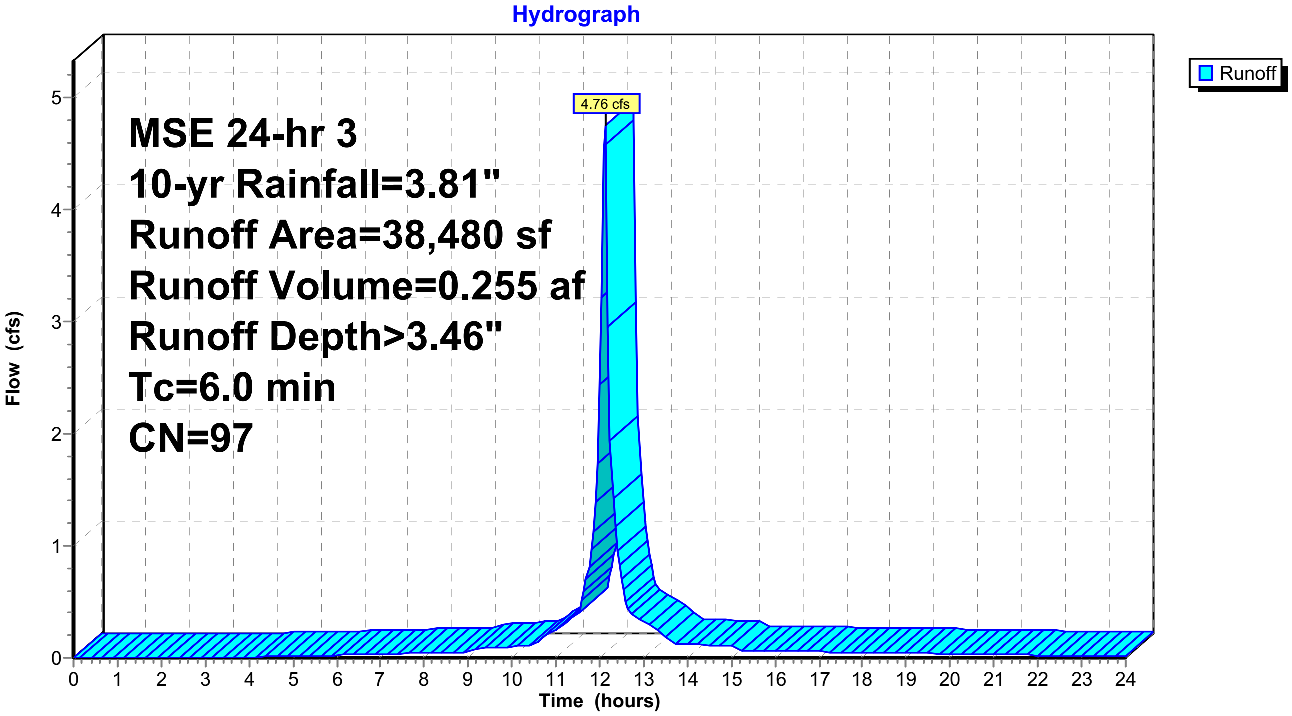
Runoff = 4.76 cfs @ 12.13 hrs, Volume= 0.255 af, Depth> 3.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.81"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

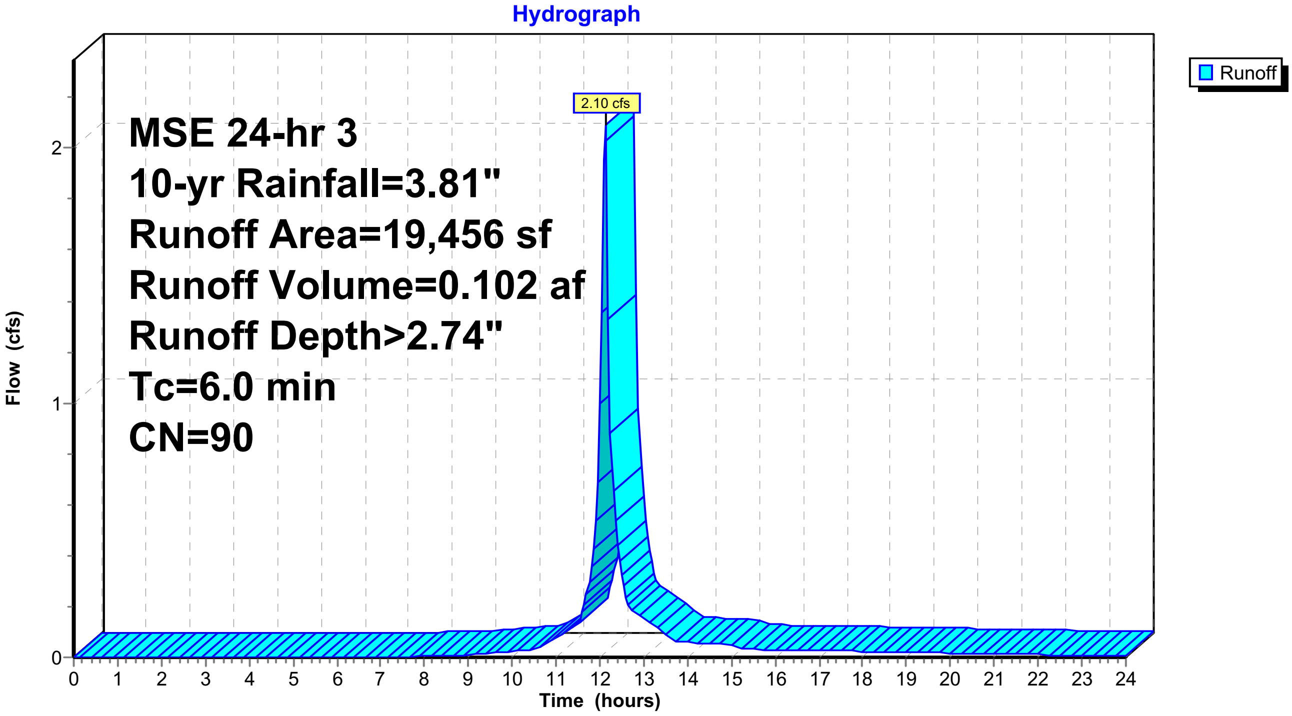
Runoff = 2.10 cfs @ 12.13 hrs, Volume= 0.102 af, Depth> 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.81"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



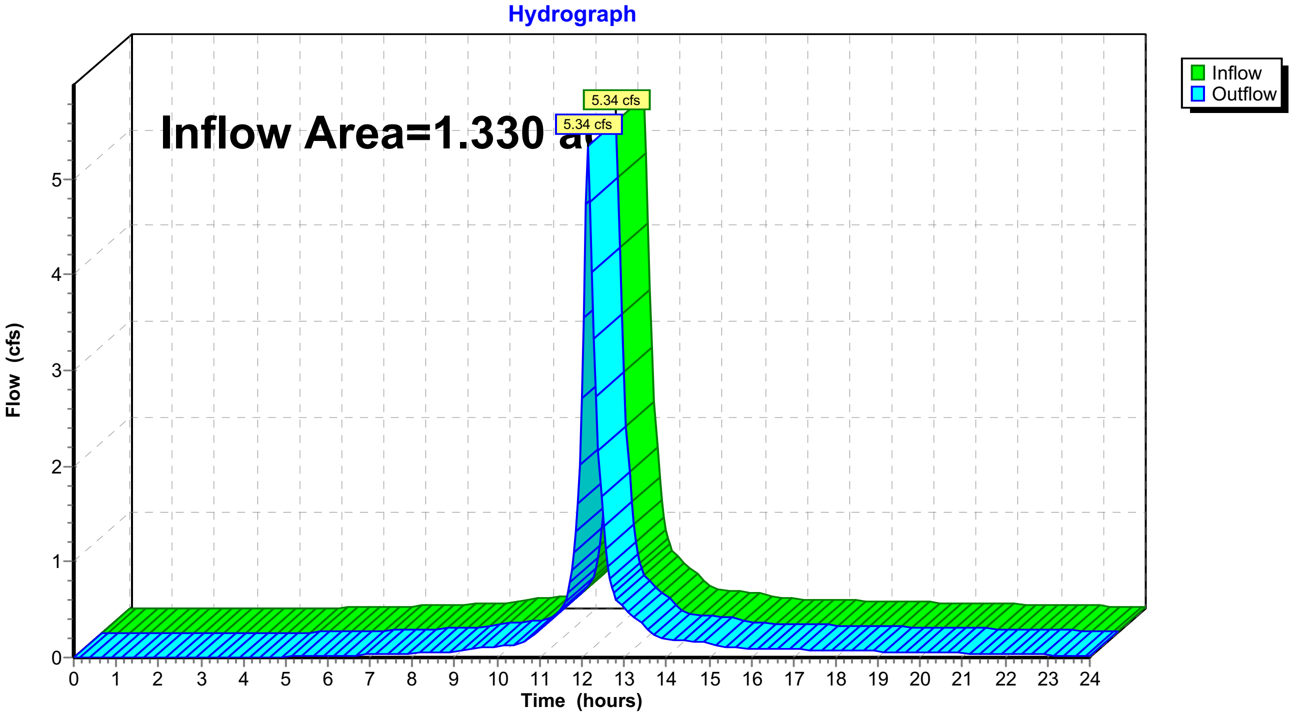
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.330 ac, 80.52% Impervious, Inflow Depth > 3.21" for 10-yr event
Inflow = 5.34 cfs @ 12.15 hrs, Volume= 0.356 af
Outflow = 5.34 cfs @ 12.15 hrs, Volume= 0.356 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

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Inflow Area =       0.883 ac, 93.34% Impervious,  Inflow Depth >  3.46"   for  10-yr event
Inflow      =       4.76 cfs @   12.13 hrs,  Volume=          0.255 af
Outflow     =       3.44 cfs @   12.19 hrs,  Volume=          0.254 af,  Atten= 28%,  Lag= 3.8 min
Primary     =       3.44 cfs @   12.19 hrs,  Volume=          0.254 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75'  Surf.Area= 0.021 ac  Storage= 0.057 af
Peak Elev= 111.38' @ 12.19 hrs   Surf.Area= 0.018 ac   Storage= 0.090 af   (0.033 af above start)

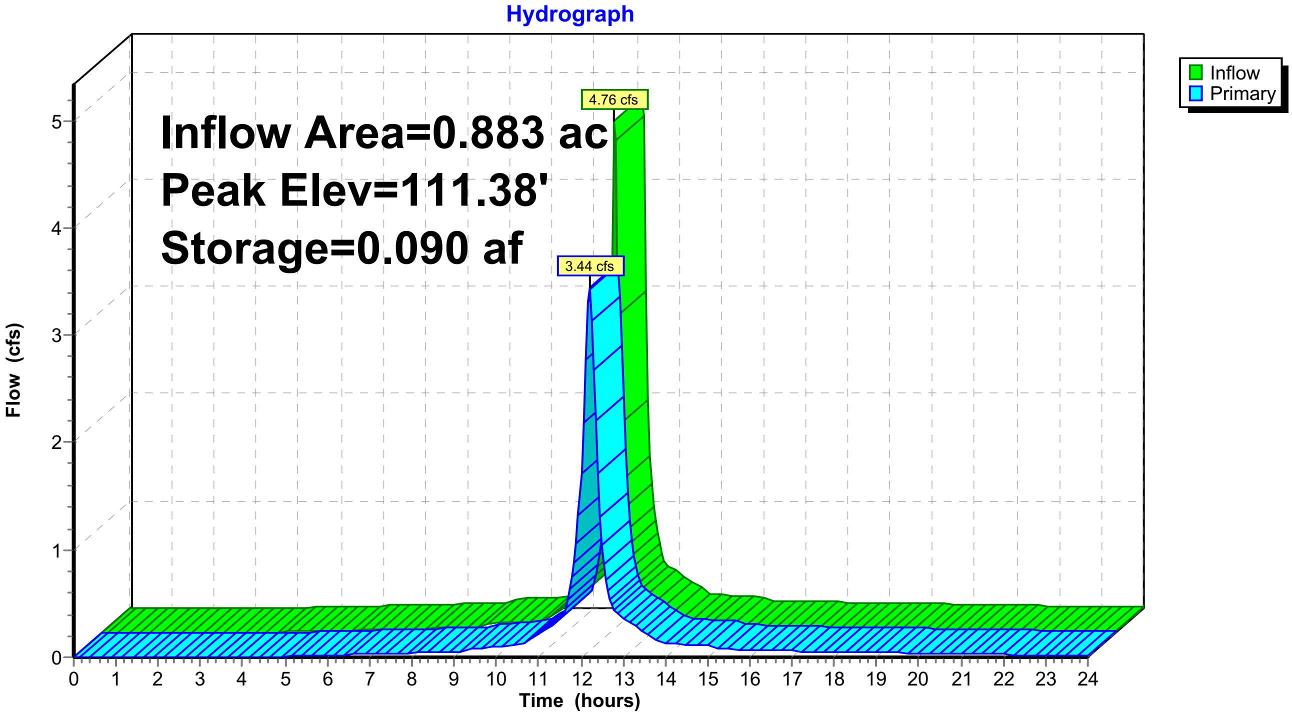
Plug-Flow detention time= 114.5 min calculated for 0.196 af (77% of inflow)
Center-of-Mass det. time= 11.9 min ( 767.8 - 755.9 )

Volume       Invert    Avail.Storage   Storage Description
   #1        106.25'        0.115 af   84.0"  Round Pipe Storage
                                       L= 130.0'

Device   Routing          Invert   Outlet Devices
   #1    Primary         109.75'   12.0"  Round Culvert
                                   L= 150.0'   RCP, sq.cut end projecting,  Ke= 0.500
                                   Inlet / Outlet Invert= 109.75' / 108.86'   S= 0.0059 '/'   Cc= 0.900
                                   n= 0.009,  Flow Area= 0.79 sf
   #2    Device 1        109.75'   11.0" Vert. Orifice/Grate   C= 0.600
   #3    Device 1        112.00'   6.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=3.41 cfs @ 12.19 hrs  HW=111.36'   (Free Discharge)
└─1=Culvert  (Passes 3.41 cfs of 3.98 cfs potential flow)
   ├─2=Orifice/Grate  (Orifice Controls 3.41 cfs @ 5.16 fps)
   └─3=Sharp-Crested Rectangular Weir( Controls 0.00 cfs)
```

Pond 3P: Tank


Hydrograph
Inflow Area=0.883 ac
Peak Elev=111.38'
Storage=0.090 af
4.76 cfs
3.44 cfs
🟩 Inflow
🟦 Primary
Flow (cfs)
0
1
2
3
4
5
Time (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: P-1 Runoff Area=38,480 sf 93.34% Impervious Runoff Depth>5.82"
Tc=6.0 min CN=97 Runoff=7.82 cfs 0.429 af

Subcatchment4S: P-2 Runoff Area=19,456 sf 55.16% Impervious Runoff Depth>5.02"
Tc=6.0 min CN=90 Runoff=3.70 cfs 0.187 af

Reach 3R: Proposed Conditions Inflow=8.96 cfs 0.613 af
Outflow=8.96 cfs 0.613 af

Pond 3P: Tank Peak Elev=112.84' Storage=0.112 af Inflow=7.82 cfs 0.429 af
Outflow=5.62 cfs 0.427 af

Total Runoff Area = 1.330 ac Runoff Volume = 0.615 af Average Runoff Depth = 5.55"
19.48% Pervious = 0.259 ac 80.52% Impervious = 1.071 ac

Summary for Subcatchment 1S: P-1

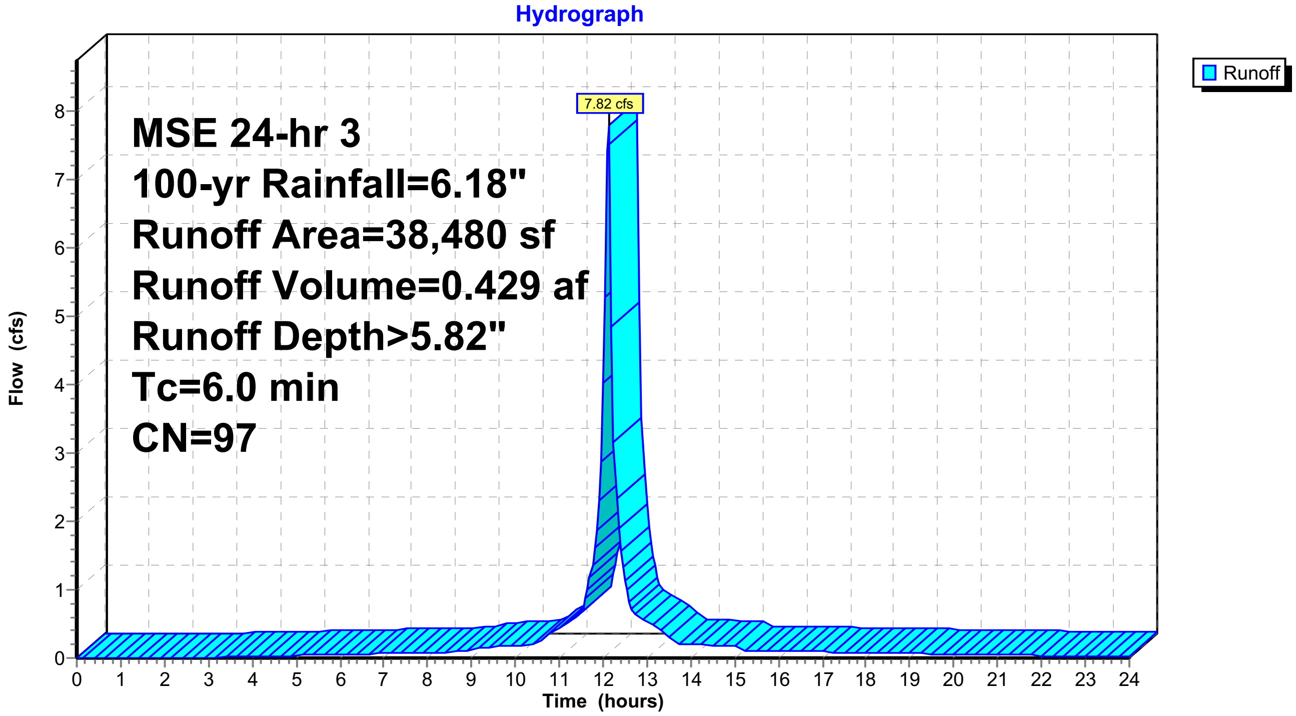
Runoff = 7.82 cfs @ 12.13 hrs, Volume= 0.429 af, Depth> 5.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.18"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

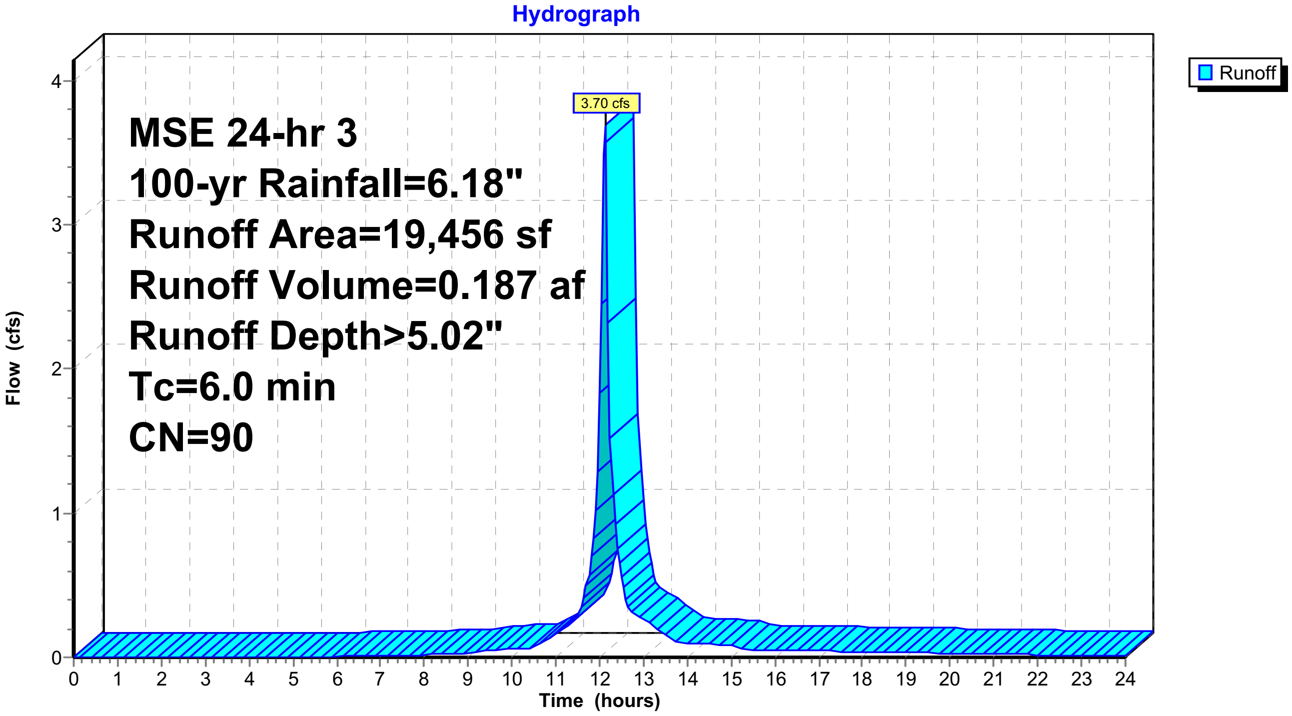
Runoff = 3.70 cfs @ 12.13 hrs, Volume= 0.187 af, Depth> 5.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.18"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



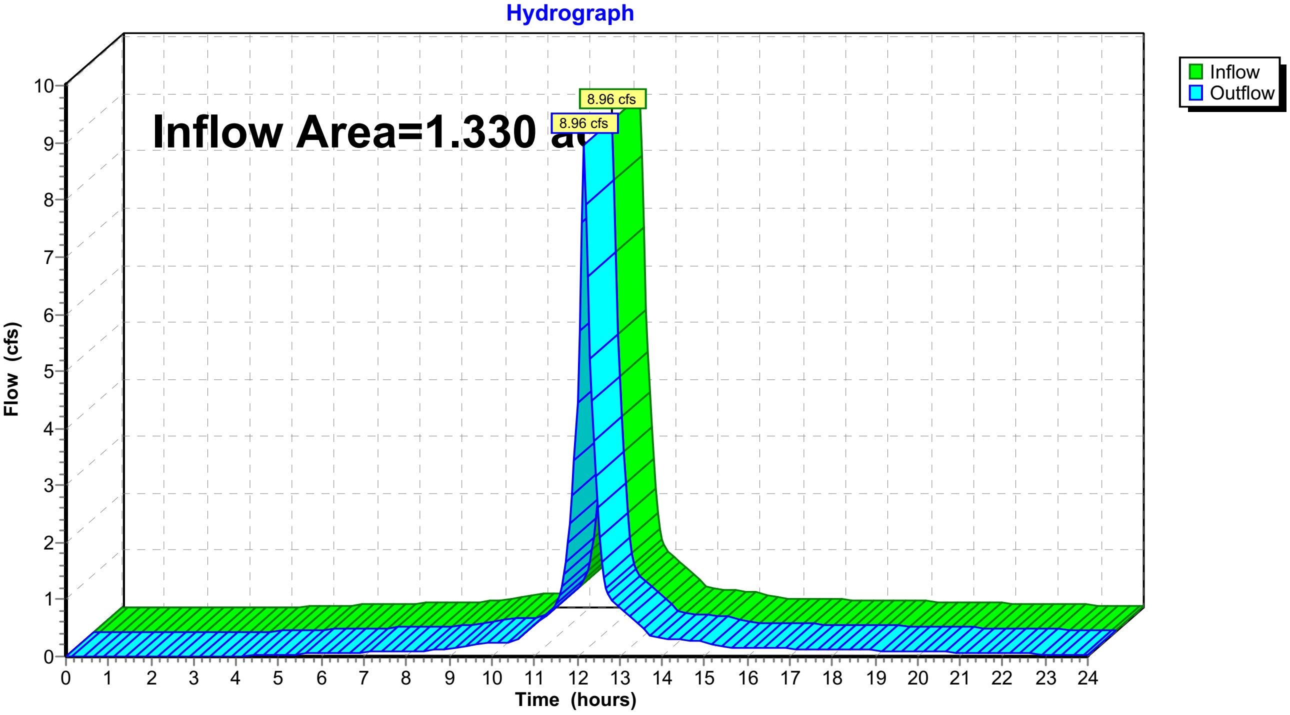
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	1.330 ac,	80.52% Impervious,	Inflow Depth > 5.53"	for 100-yr event
Inflow =	8.96 cfs @	12.15 hrs, Volume=	0.613 af	
Outflow =	8.96 cfs @	12.15 hrs, Volume=	0.613 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

```
Inflow Area =       0.883 ac, 93.34% Impervious, Inflow Depth >  5.82"   for 100-yr event
Inflow      =      7.82 cfs @  12.13 hrs, Volume=        0.429 af
Outflow     =      5.62 cfs @  12.19 hrs, Volume=        0.427 af, Atten= 28%, Lag= 3.8 min
Primary     =      5.62 cfs @  12.19 hrs, Volume=        0.427 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75'  Surf.Area= 0.021 ac  Storage= 0.057 af
Peak Elev= 112.84' @ 12.19 hrs  Surf.Area= 0.010 ac  Storage= 0.112 af  (0.055 af above start)

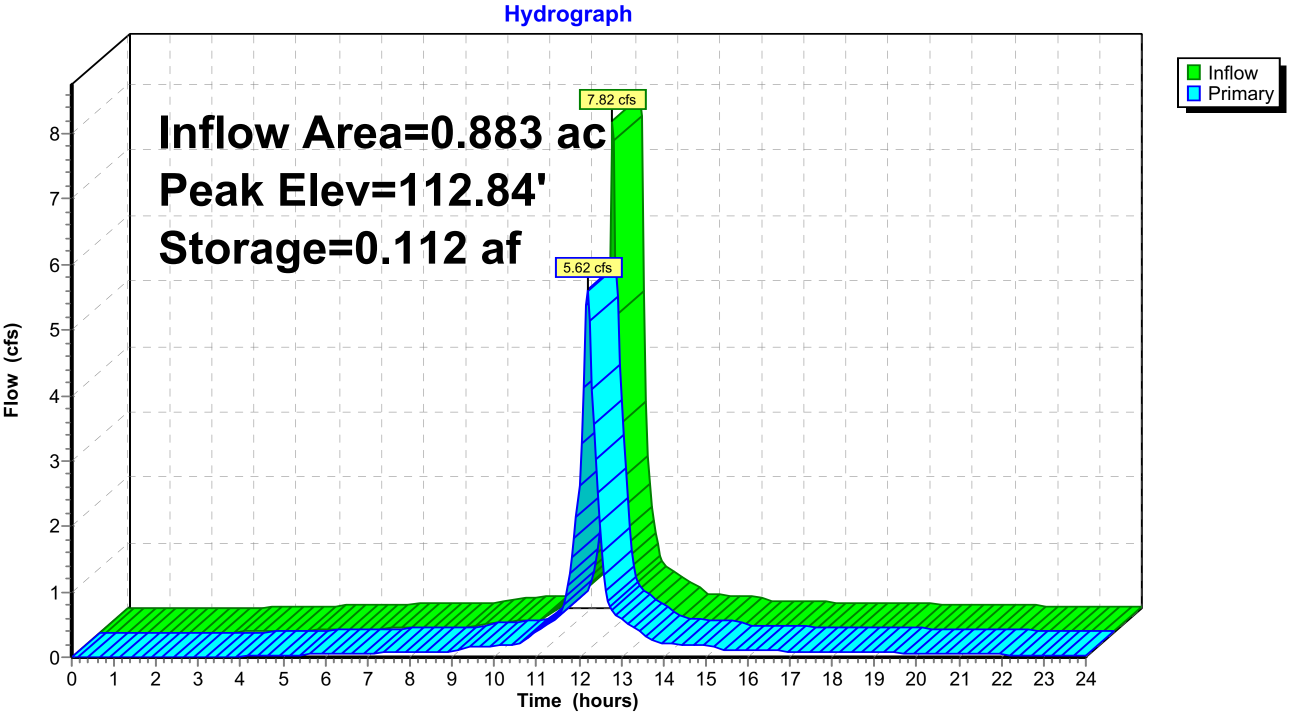
Plug-Flow detention time= 94.1 min calculated for 0.368 af (86% of inflow)
Center-of-Mass det. time= 10.3 min ( 758.2 - 747.9 )

Volume      Invert   Avail.Storage  Storage Description
  #1       106.25'        0.115 af  84.0" Round Pipe Storage
                                    L= 130.0'

Device  Routing        Invert  Outlet Devices
  #1    Primary       109.75'  12.0" Round Culvert
                               L= 150.0'  RCP, sq.cut end projecting, Ke= 0.500
                               Inlet / Outlet Invert= 109.75' / 108.86'  S= 0.0059 '/'  Cc= 0.900
                               n= 0.009, Flow Area= 0.79 sf
  #2    Device 1      109.75'  11.0" Vert. Orifice/Grate  C= 0.600
  #3    Device 1      112.00'  6.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

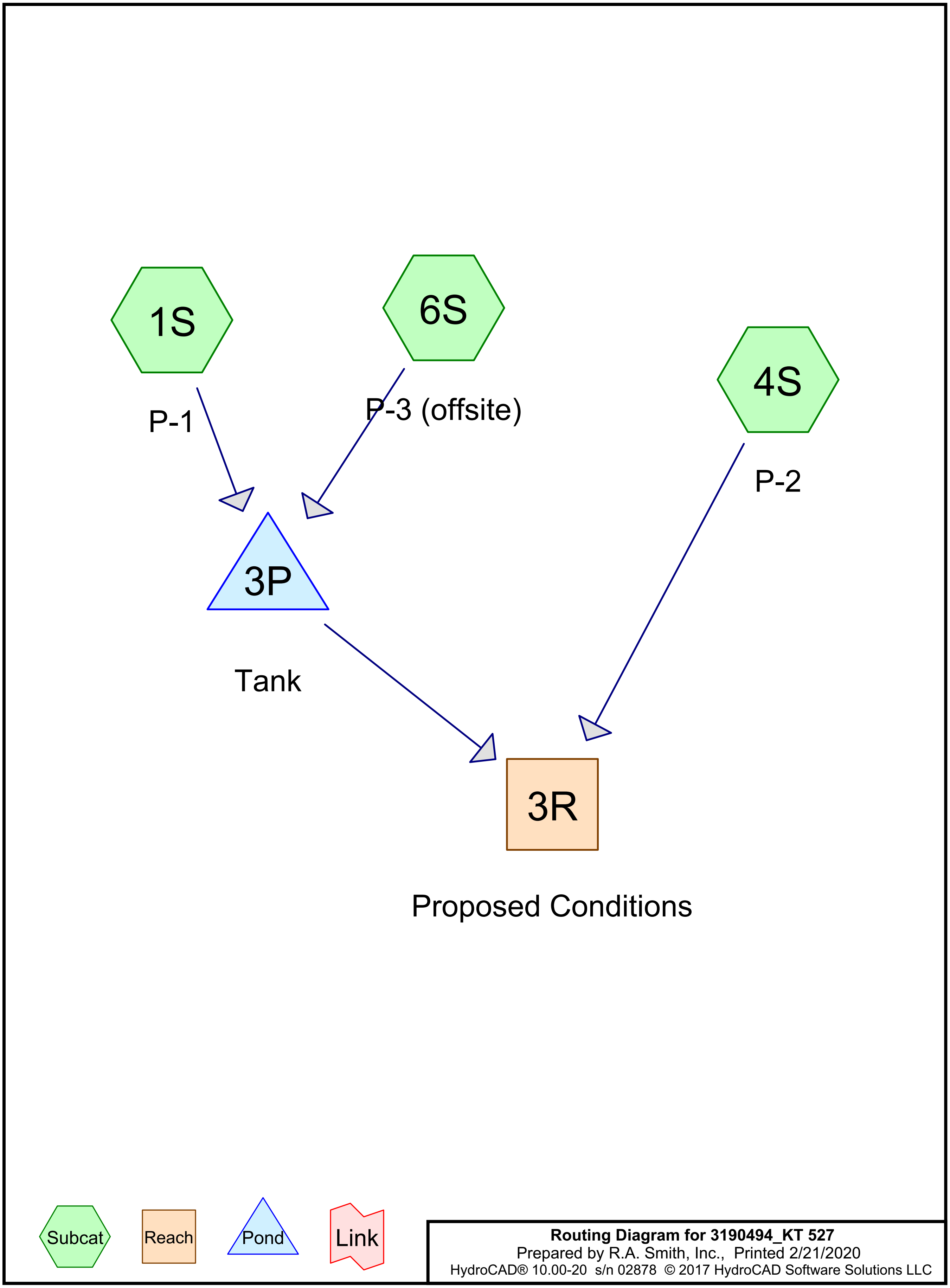
Primary OutFlow Max=5.57 cfs @ 12.19 hrs  HW=112.79'  (Free Discharge)
└─1=Culvert (Barrel Controls 5.57 cfs @ 7.09 fps)
   ├─2=Orifice/Grate (Passes < 5.11 cfs potential flow)
   └─3=Sharp-Crested Rectangular Weir(Passes < 13.44 cfs potential flow)
```

Pond 3P: Tank


Hydrograph
Inflow
Primary
7.82 cfs
5.62 cfs
Inflow Area=0.883 ac
Peak Elev=112.84'
Storage=0.112 af
Flow (cfs)
0
1
2
3
4
5
6
7
8
Time (hours)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

HydroCAD - Proposed Conditions with Offsite Areas

1, 2, 10, & 100 Year Storm Events



Routing Diagram for 3190494_KT 527
Prepared by R.A. Smith, Inc., Printed 2/21/2020
HydroCAD® 10.00-20 s/n 02878 © 2017 HydroCAD Software Solutions LLC

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.353	80	>75% Grass cover, Good, HSG D (1S, 4S, 6S)
0.068	98	Paved parking (4S)
0.795	98	Paved parking, HSG D (1S)
0.168	98	Roof (4S)
0.011	98	Sidewalk (4S)
0.030	98	Sidewalk, HSG D (1S)
1.424	**94**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
1.178	HSG D	1S, 4S, 6S
0.246	Other	4S
1.424		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.353	0.000	0.353	>75% Grass cover, Good	1S, 4S, 6S
0.000	0.000	0.000	0.795	0.068	0.862	Paved parking	1S, 4S
0.000	0.000	0.000	0.000	0.168	0.168	Roof	4S
0.000	0.000	0.000	0.030	0.011	0.041	Sidewalk	1S, 4S
0.000	**0.000**	**0.000**	**1.178**	**0.246**	**1.424**	**TOTAL AREA**	

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	109.75	108.86	150.0	0.0059	0.009	12.0	0.0	0.0

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: P-1	Runoff Area=38,480 sf 93.34% Impervious Runoff Depth>2.06" Tc=6.0 min CN=97 Runoff=2.93 cfs 0.152 af
Subcatchment4S: P-2	Runoff Area=19,456 sf 55.16% Impervious Runoff Depth>1.44" Tc=6.0 min CN=90 Runoff=1.14 cfs 0.054 af
Subcatchment6S: P-3 (offsite)	Runoff Area=4,093 sf 0.00% Impervious Runoff Depth>0.82" Tc=6.0 min CN=80 Runoff=0.14 cfs 0.006 af
Reach 3R: Proposed Conditions	Inflow=3.42 cfs 0.211 af Outflow=3.42 cfs 0.211 af
Pond 3P: Tank	Peak Elev=110.76' Storage=0.078 af Inflow=3.07 cfs 0.158 af Outflow=2.37 cfs 0.158 af

Total Runoff Area = 1.424 ac Runoff Volume = 0.212 af Average Runoff Depth = 1.79"
24.80% Pervious = 0.353 ac 75.20% Impervious = 1.071 ac

Summary for Subcatchment 1S: P-1

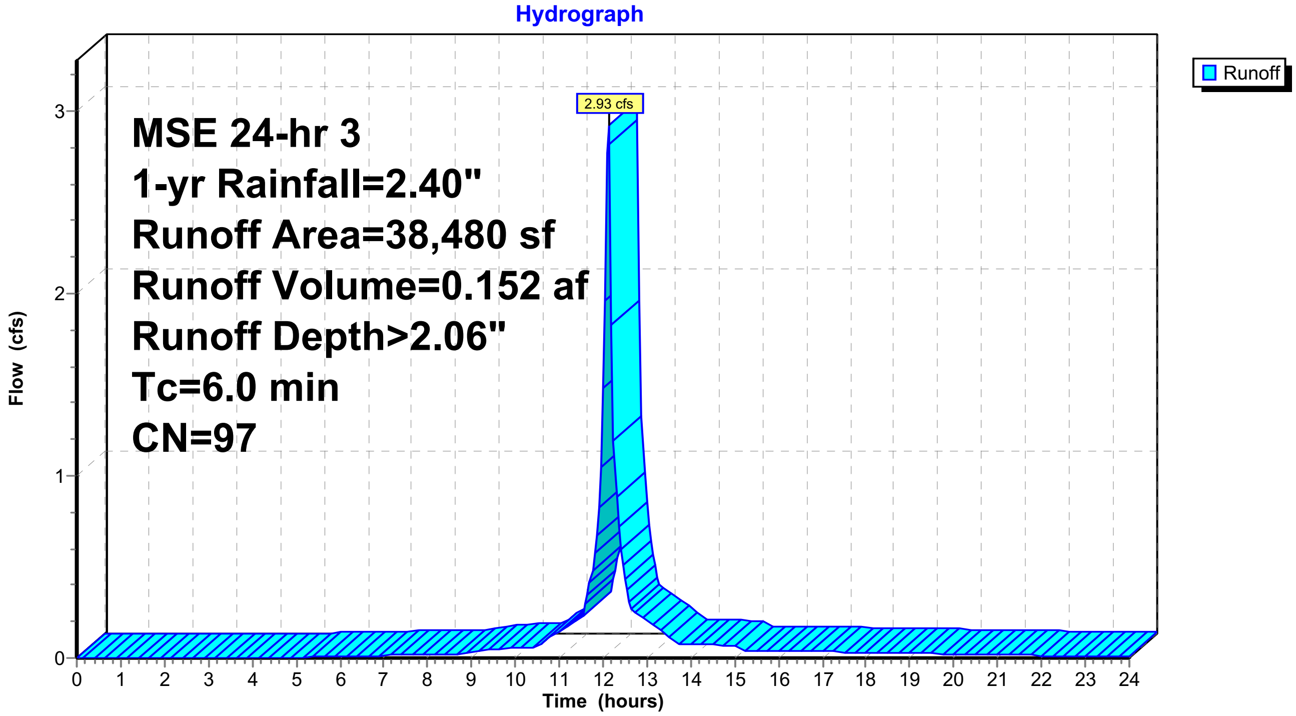
Runoff = 2.93 cfs @ 12.13 hrs, Volume= 0.152 af, Depth> 2.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-yr Rainfall=2.40"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

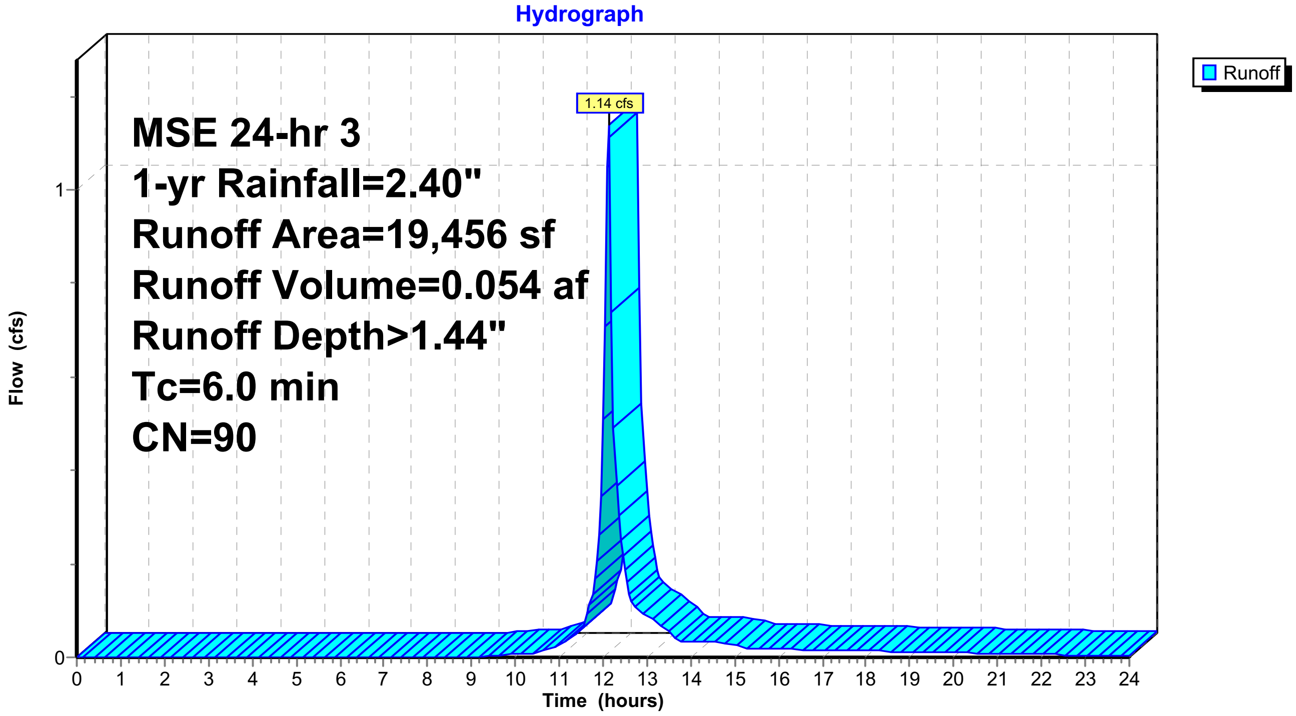
Runoff = 1.14 cfs @ 12.13 hrs, Volume= 0.054 af, Depth> 1.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-yr Rainfall=2.40"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



Summary for Subcatchment 6S: P-3 (offsite)

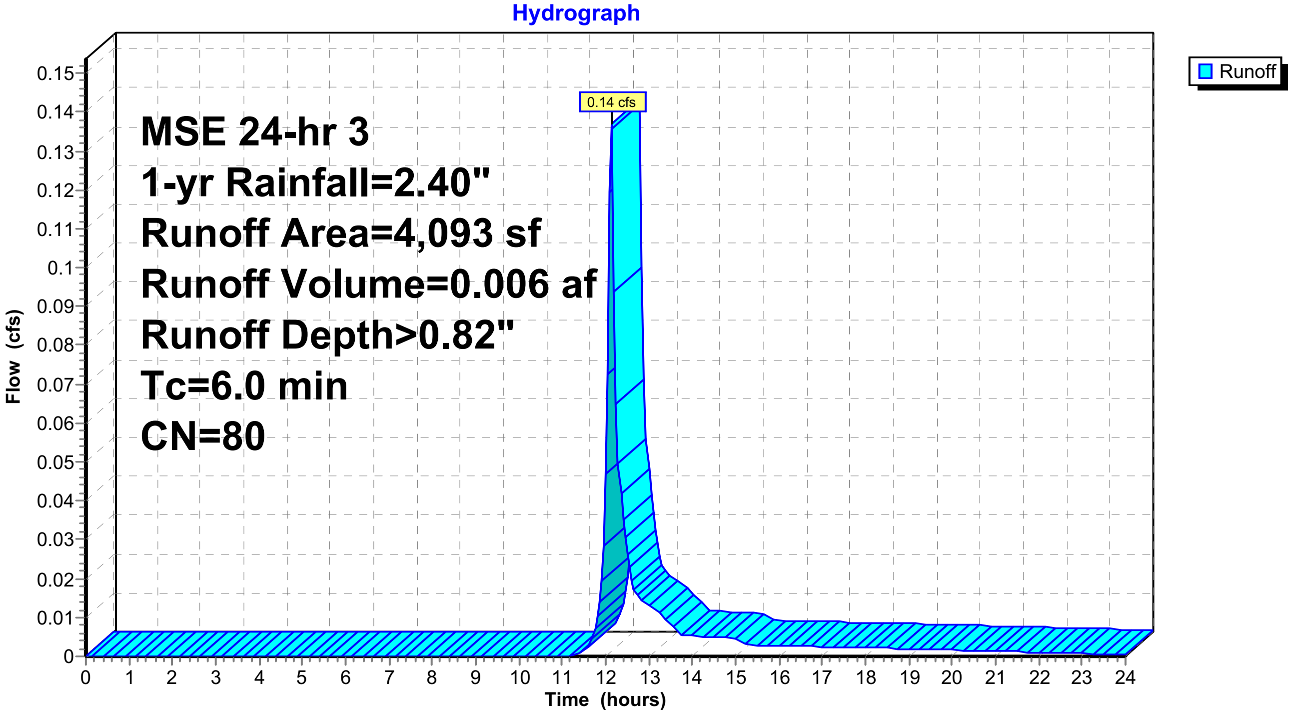
Runoff = 0.14 cfs @ 12.14 hrs, Volume= 0.006 af, Depth> 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 1-yr Rainfall=2.40"

Area (sf)	CN	Description
4,093	80	>75% Grass cover, Good, HSG D
4,093		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: P-3 (offsite)



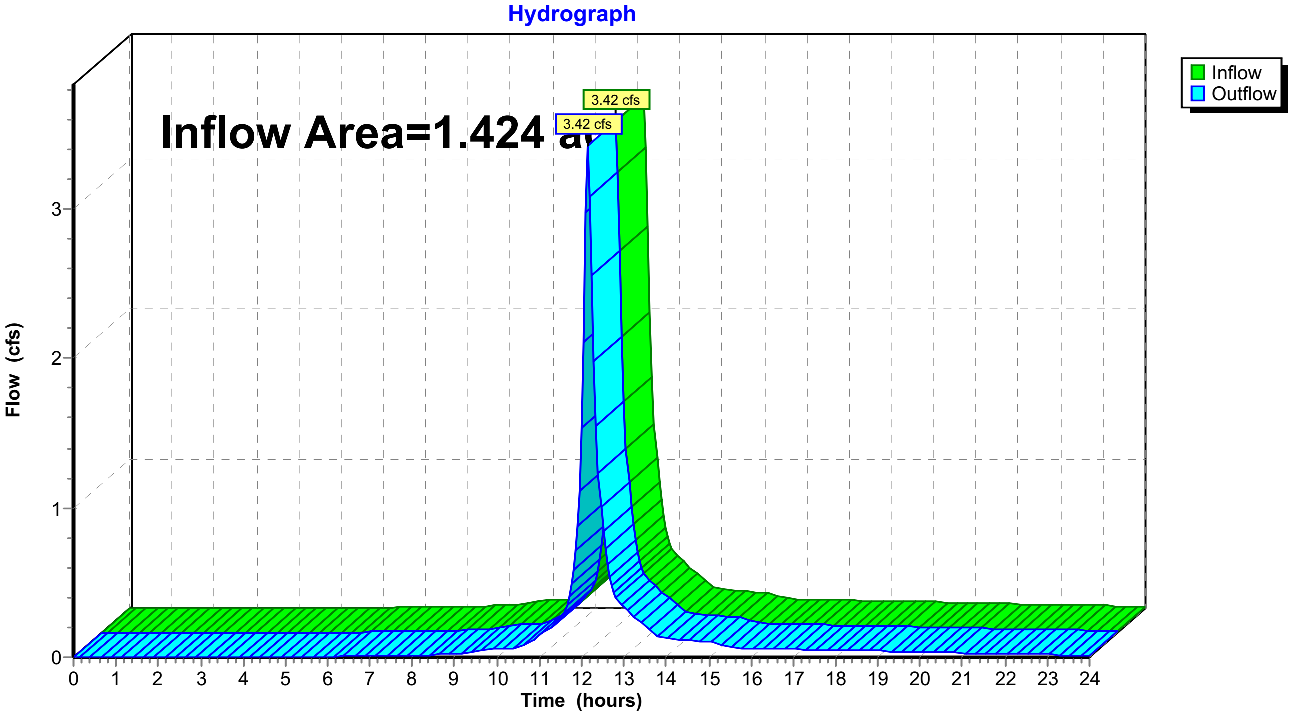
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.424 ac, 75.20% Impervious, Inflow Depth > 1.78" for 1-yr event
Inflow = 3.42 cfs @ 12.15 hrs, Volume= 0.211 af
Outflow = 3.42 cfs @ 12.15 hrs, Volume= 0.211 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

Inflow Area = 0.977 ac, 84.37% Impervious, Inflow Depth > 1.94" for 1-yr event
Inflow = 3.07 cfs @ 12.13 hrs, Volume= 0.158 af
Outflow = 2.37 cfs @ 12.18 hrs, Volume= 0.158 af, Atten= 23%, Lag= 3.1 min
Primary = 2.37 cfs @ 12.18 hrs, Volume= 0.158 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75' Surf.Area= 0.021 ac Storage= 0.057 af
Peak Elev= 110.76' @ 12.18 hrs Surf.Area= 0.020 ac Storage= 0.078 af (0.021 af above start)

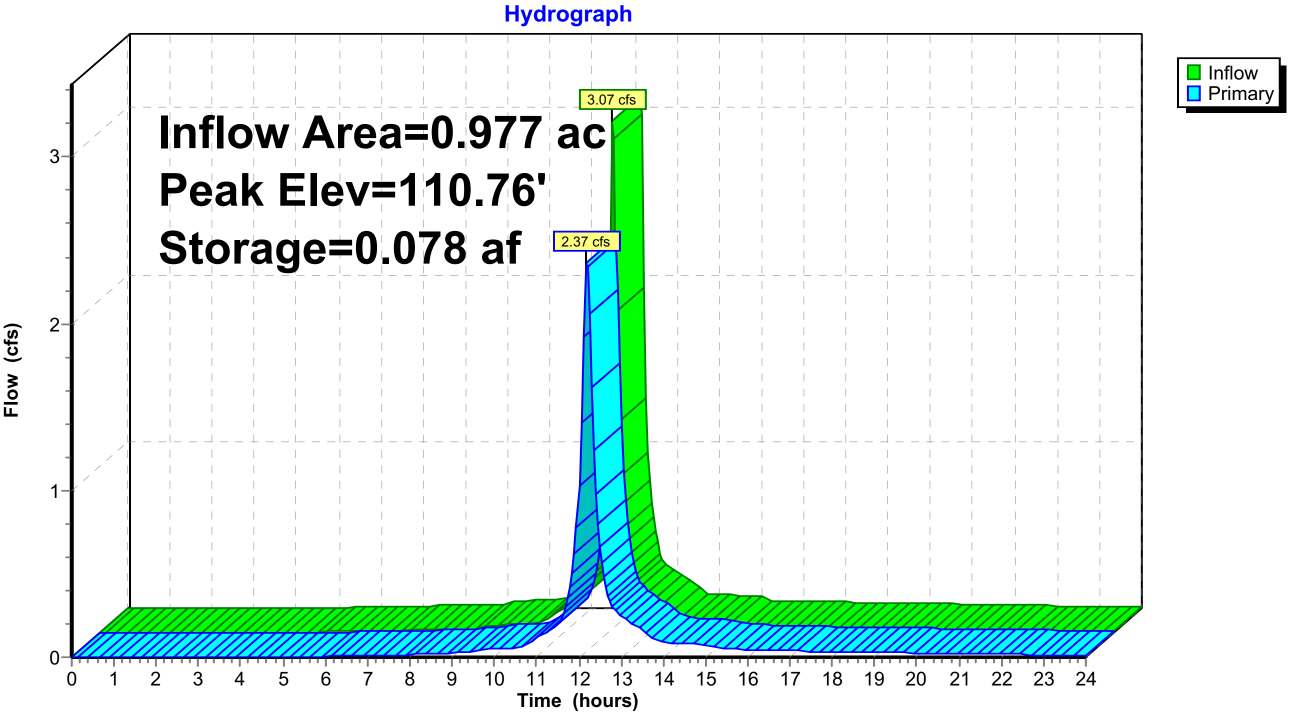
Plug-Flow detention time= 145.0 min calculated for 0.100 af (63% of inflow)
Center-of-Mass det. time= 14.1 min (781.5 - 767.4)

Volume	Invert	Avail.Storage	Storage Description
#1	106.25'	0.115 af	**84.0" Round Pipe Storage** L= 130.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	109.75'	**12.0" Round Culvert** L= 150.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 109.75' / 108.86' S= 0.0059 '/' Cc= 0.900 n= 0.009, Flow Area= 0.79 sf
#2	Device 1	109.75'	**11.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	112.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

```
Primary OutFlow Max=2.33 cfs @ 12.18 hrs HW=110.75' (Free Discharge)
└─1=Culvert (Passes 2.33 cfs of 2.67 cfs potential flow)
   ├─2=Orifice/Grate (Orifice Controls 2.33 cfs @ 3.53 fps)
   └─3=Sharp-Crested Rectangular Weir( Controls 0.00 cfs)
```

Pond 3P: Tank


Hydrograph
Inflow Area=0.977 ac
Peak Elev=110.76'
Storage=0.078 af
3.07 cfs
2.37 cfs
Inflow
Primary
Flow (cfs)
0
1
2
3
Time (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

```
                      Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
                      Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
            Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment1S: P-1                  Runoff Area=38,480 sf   93.34% Impervious   Runoff Depth>2.36"
                                                   Tc=6.0 min   CN=97   Runoff=3.32 cfs  0.174 af

Subcatchment4S: P-2                  Runoff Area=19,456 sf   55.16% Impervious   Runoff Depth>1.71"
                                                   Tc=6.0 min   CN=90   Runoff=1.34 cfs  0.064 af

Subcatchment6S: P-3 (offsite)          Runoff Area=4,093 sf   0.00% Impervious   Runoff Depth>1.03"
                                                   Tc=6.0 min   CN=80   Runoff=0.17 cfs  0.008 af

Reach 3R: Proposed Conditions                                               Inflow=3.88 cfs  0.245 af
                                                                           Outflow=3.88 cfs  0.245 af

Pond 3P: Tank                          Peak Elev=110.90'  Storage=0.081 af  Inflow=3.49 cfs  0.182 af
                                                                           Outflow=2.65 cfs  0.181 af

              Total Runoff Area = 1.424 ac   Runoff Volume = 0.246 af   Average Runoff Depth = 2.07"
                                             24.80% Pervious = 0.353 ac     75.20% Impervious = 1.071 ac
```

Summary for Subcatchment 1S: P-1

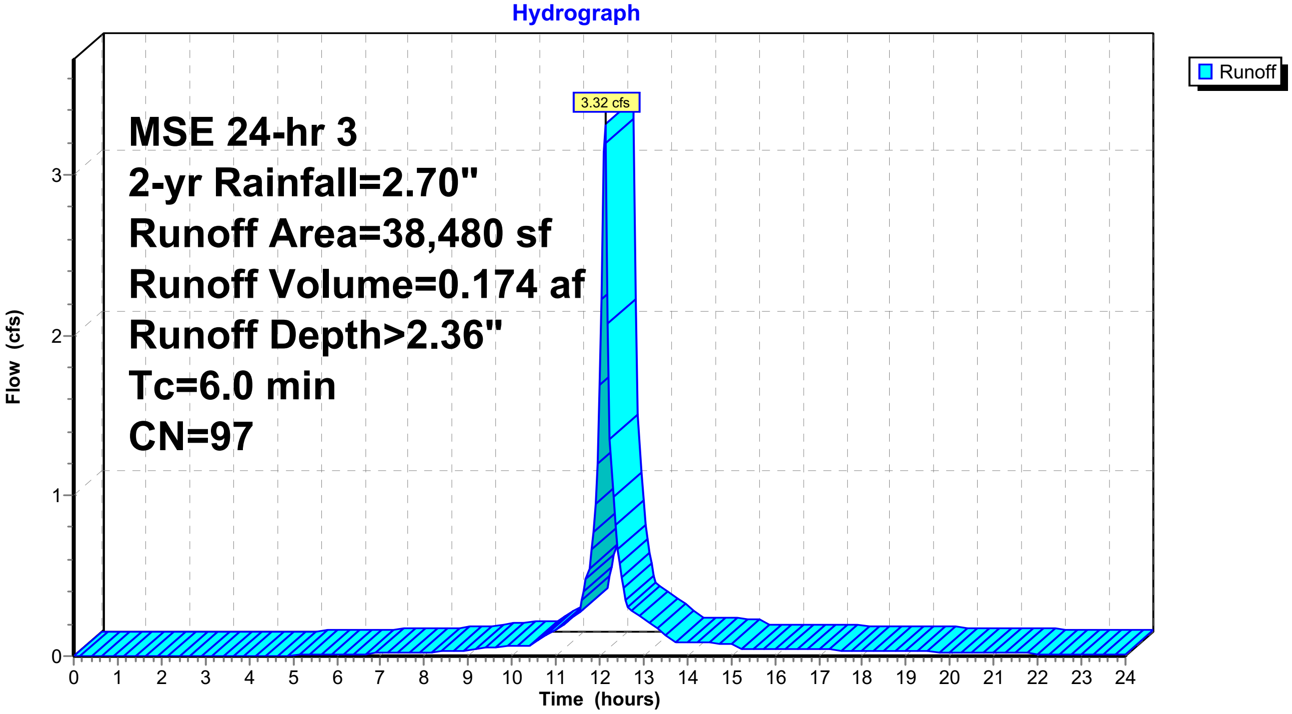
Runoff = 3.32 cfs @ 12.13 hrs, Volume= 0.174 af, Depth> 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.70"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

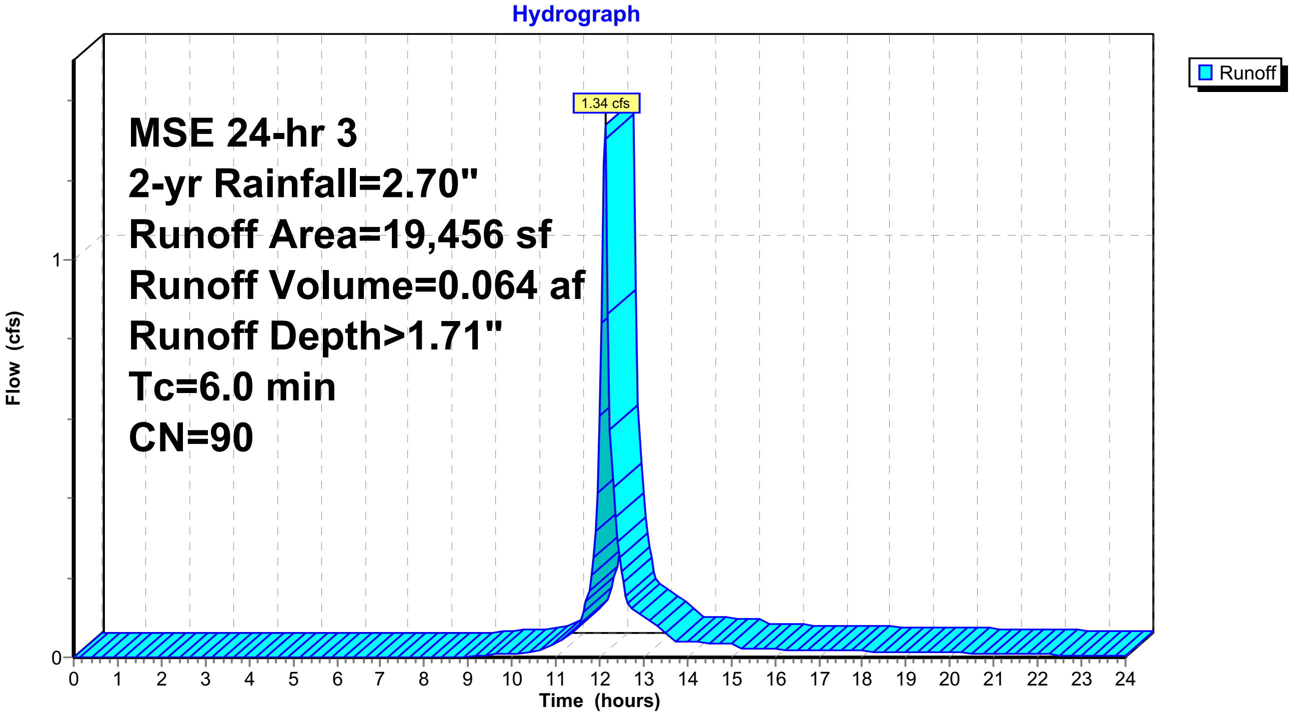
Runoff = 1.34 cfs @ 12.13 hrs, Volume= 0.064 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.70"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



Summary for Subcatchment 6S: P-3 (offsite)

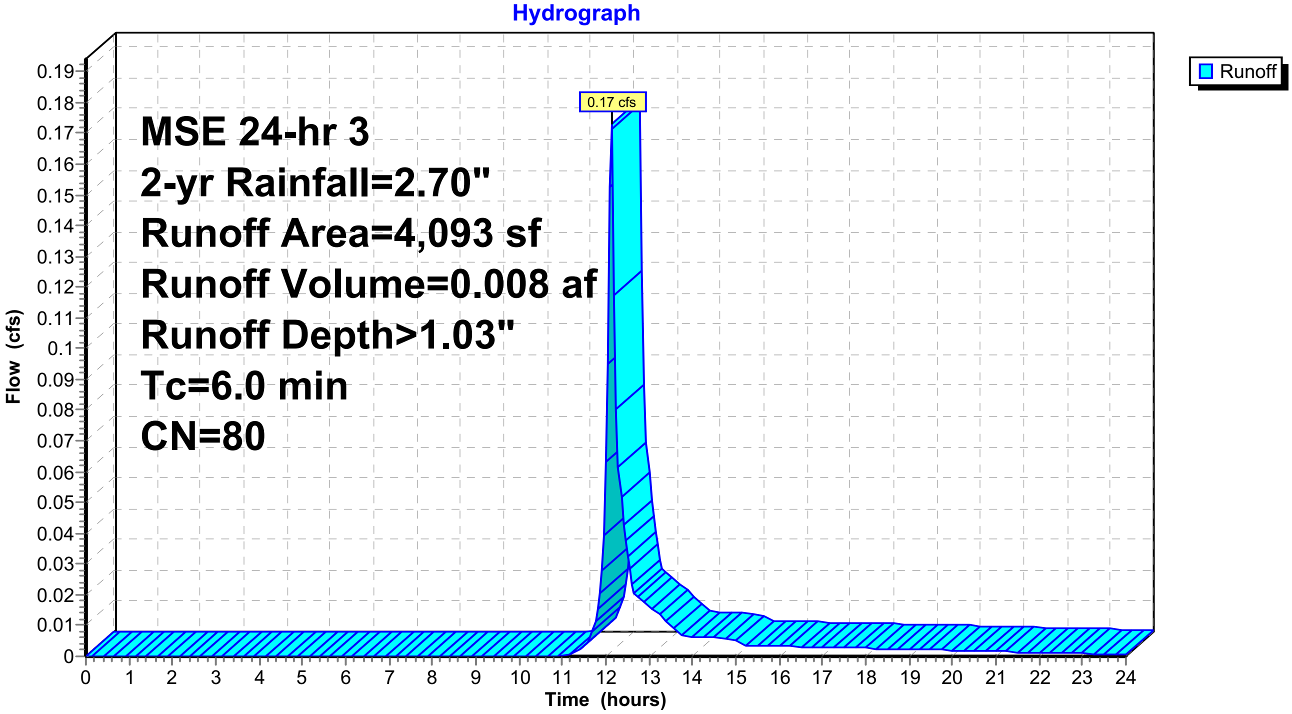
Runoff = 0.17 cfs @ 12.14 hrs, Volume= 0.008 af, Depth> 1.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 2-yr Rainfall=2.70"

Area (sf)	CN	Description
4,093	80	>75% Grass cover, Good, HSG D
4,093		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: P-3 (offsite)



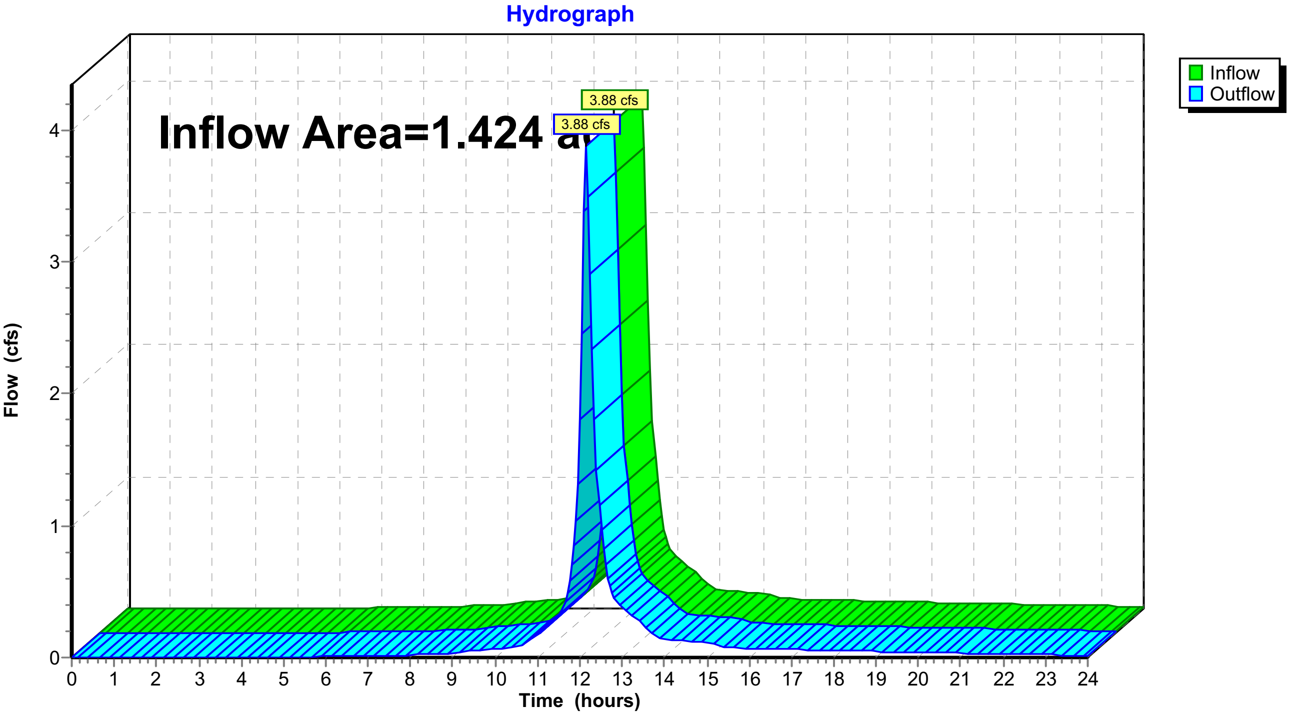
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.424 ac, 75.20% Impervious, Inflow Depth > 2.06" for 2-yr event
Inflow = 3.88 cfs @ 12.15 hrs, Volume= 0.245 af
Outflow = 3.88 cfs @ 12.15 hrs, Volume= 0.245 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

Inflow Area = 0.977 ac, 84.37% Impervious, Inflow Depth > 2.23" for 2-yr event
Inflow = 3.49 cfs @ 12.13 hrs, Volume= 0.182 af
Outflow = 2.65 cfs @ 12.18 hrs, Volume= 0.181 af, Atten= 24%, Lag= 3.3 min
Primary = 2.65 cfs @ 12.18 hrs, Volume= 0.181 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75' Surf.Area= 0.021 ac Storage= 0.057 af
Peak Elev= 110.90' @ 12.18 hrs Surf.Area= 0.020 ac Storage= 0.081 af (0.024 af above start)

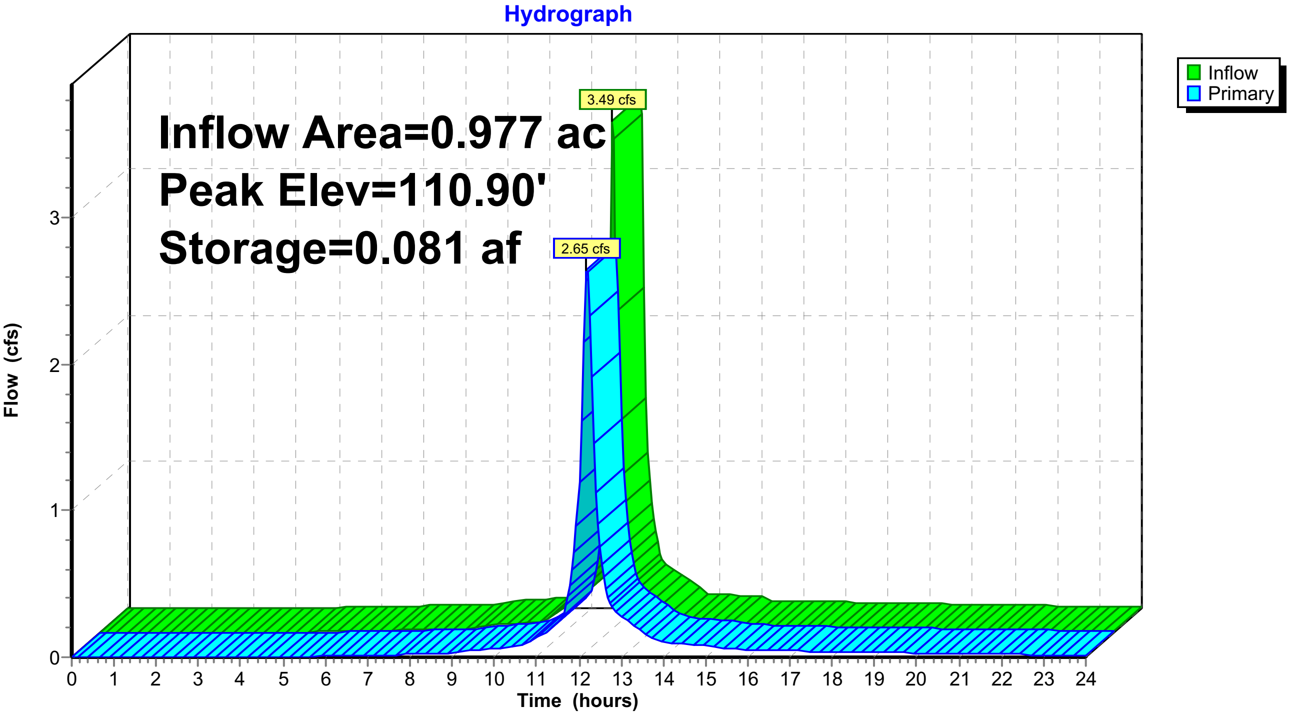
Plug-Flow detention time= 134.2 min calculated for 0.124 af (68% of inflow)
Center-of-Mass det. time= 13.3 min (778.4 - 765.1)

Volume	Invert	Avail.Storage	Storage Description
#1	106.25'	0.115 af	**84.0" Round Pipe Storage** L= 130.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	109.75'	**12.0" Round Culvert** L= 150.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 109.75' / 108.86' S= 0.0059 '/' Cc= 0.900 n= 0.009, Flow Area= 0.79 sf
#2	Device 1	109.75'	**11.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	112.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=2.61 cfs @ 12.18 hrs HW=110.88' (Free Discharge)
↑—**1=Culvert** (Passes 2.61 cfs of 3.01 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 2.61 cfs @ 3.95 fps)
  └—**3=Sharp-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 3P: Tank


Hydrograph
Inflow Area=0.977 ac
Peak Elev=110.90'
Storage=0.081 af
3.49 cfs
2.65 cfs
🟩 Inflow
🟦 Primary
Flow (cfs)
0
1
2
3
Time (hours)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

```
                         Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
                         Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
               Reach routing by Stor-Ind+Trans method  -  Pond routing by Stor-Ind method

Subcatchment1S: P-1                 Runoff Area=38,480 sf   93.34% Impervious   Runoff Depth>3.46"
                                                   Tc=6.0 min   CN=97   Runoff=4.76 cfs  0.255 af

Subcatchment4S: P-2                 Runoff Area=19,456 sf   55.16% Impervious   Runoff Depth>2.74"
                                                   Tc=6.0 min   CN=90   Runoff=2.10 cfs  0.102 af

Subcatchment6S: P-3 (offsite)         Runoff Area=4,093 sf   0.00% Impervious   Runoff Depth>1.89"
                                                   Tc=6.0 min   CN=80   Runoff=0.32 cfs  0.015 af

Reach 3R: Proposed Conditions                                               Inflow=5.50 cfs  0.370 af
                                                                           Outflow=5.50 cfs  0.370 af

Pond 3P: Tank                        Peak Elev=111.51'  Storage=0.093 af   Inflow=5.08 cfs  0.270 af
                                                                           Outflow=3.62 cfs  0.269 af

              Total Runoff Area = 1.424 ac   Runoff Volume = 0.372 af   Average Runoff Depth = 3.13"
                                           24.80% Pervious = 0.353 ac     75.20% Impervious = 1.071 ac
```

Summary for Subcatchment 1S: P-1

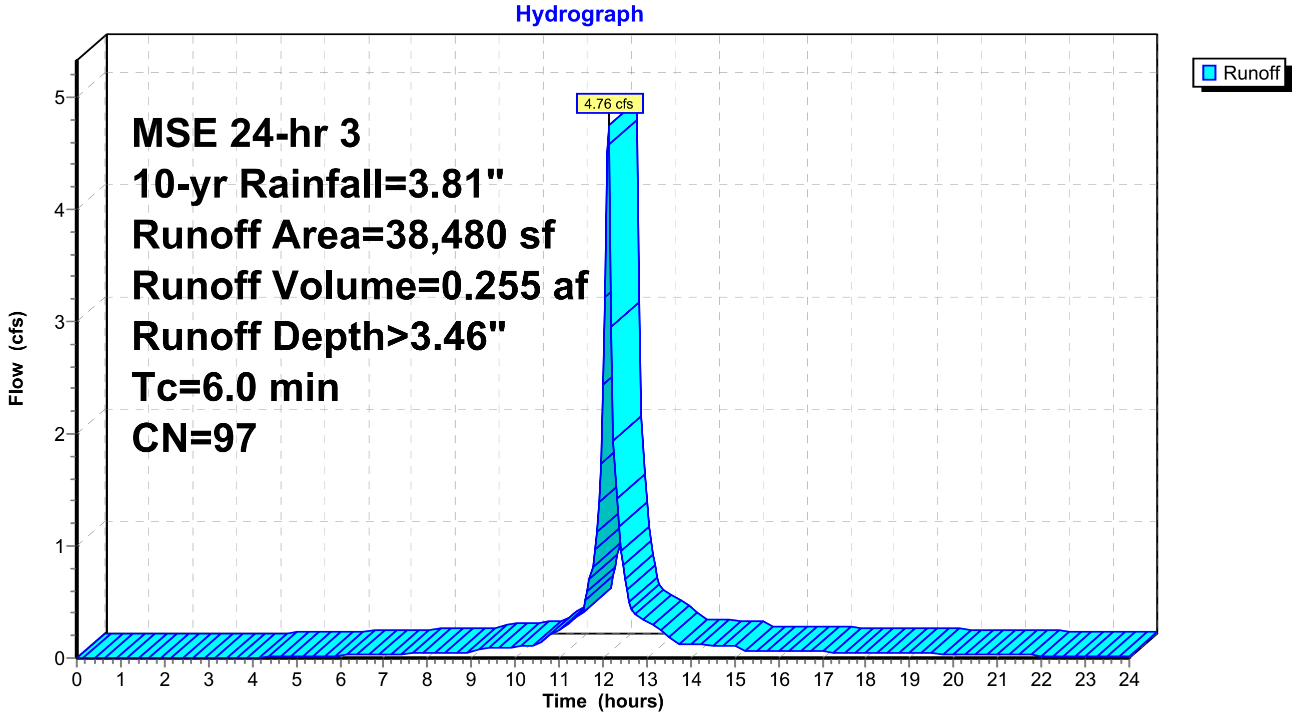
Runoff = 4.76 cfs @ 12.13 hrs, Volume= 0.255 af, Depth> 3.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.81"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

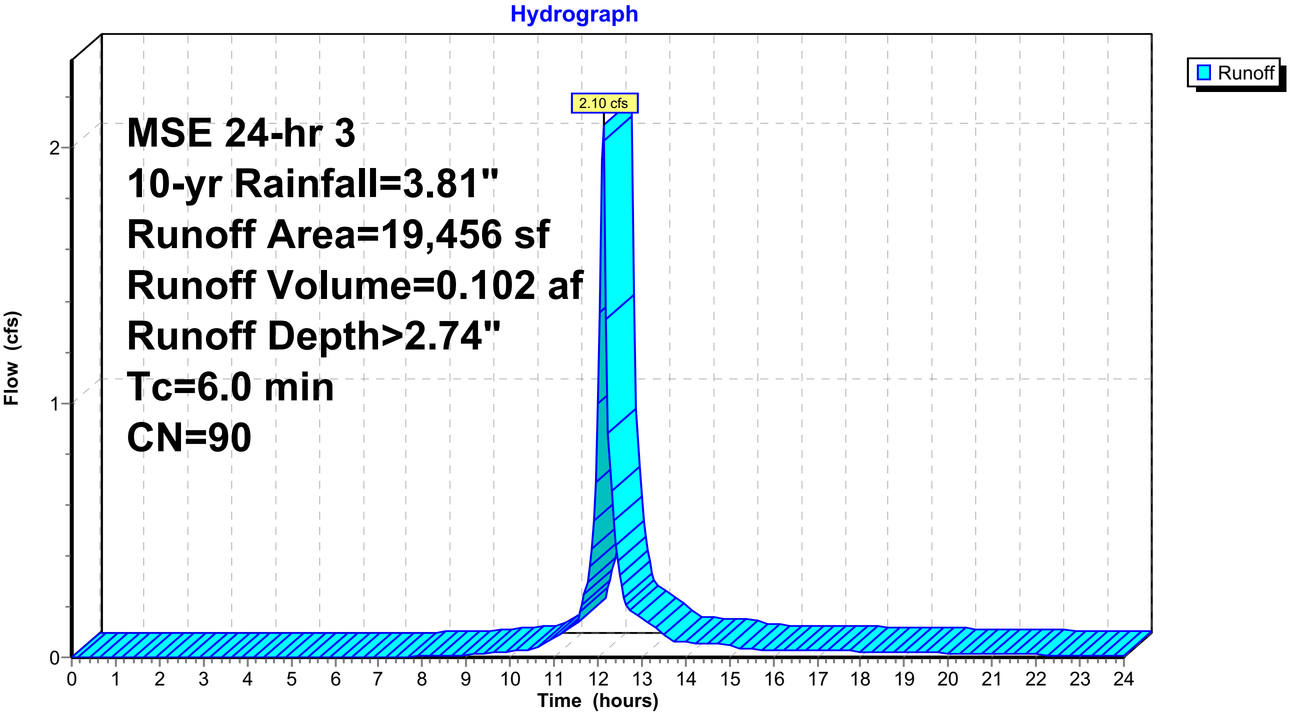
Runoff = 2.10 cfs @ 12.13 hrs, Volume= 0.102 af, Depth> 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.81"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



Summary for Subcatchment 6S: P-3 (offsite)

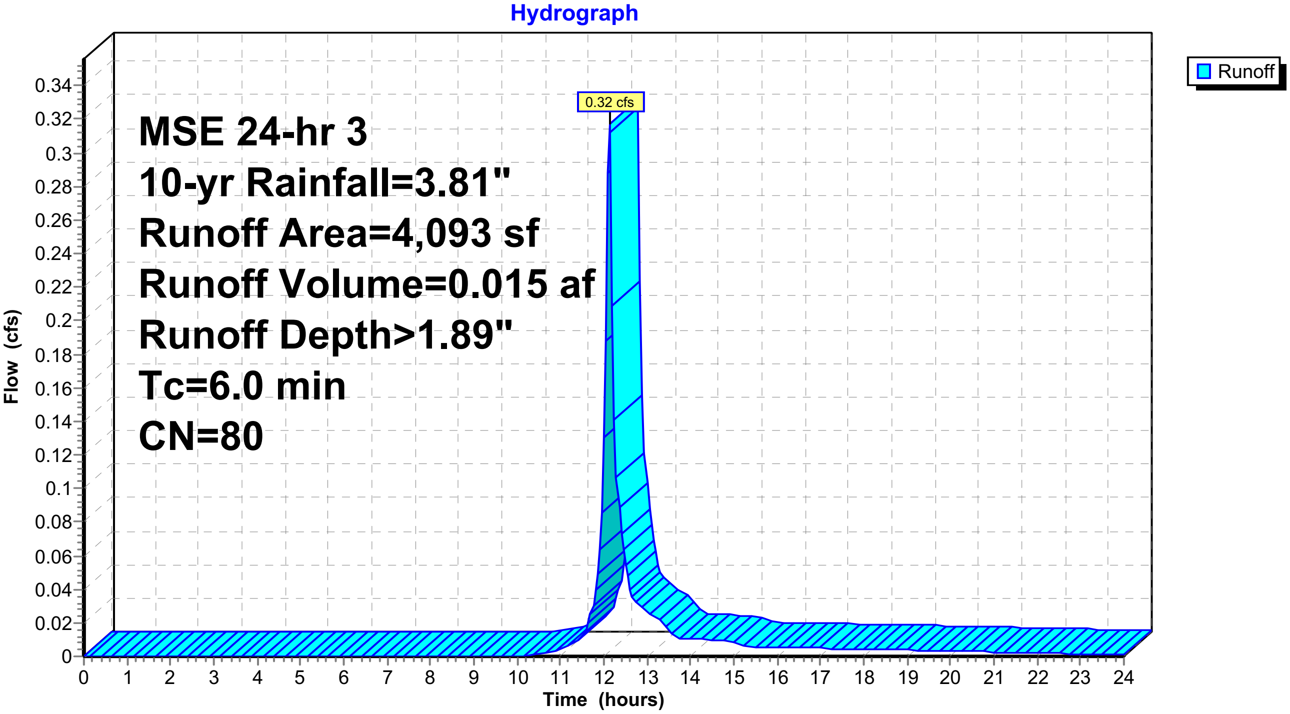
Runoff = 0.32 cfs @ 12.13 hrs, Volume= 0.015 af, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 10-yr Rainfall=3.81"

Area (sf)	CN	Description
4,093	80	>75% Grass cover, Good, HSG D
4,093		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: P-3 (offsite)



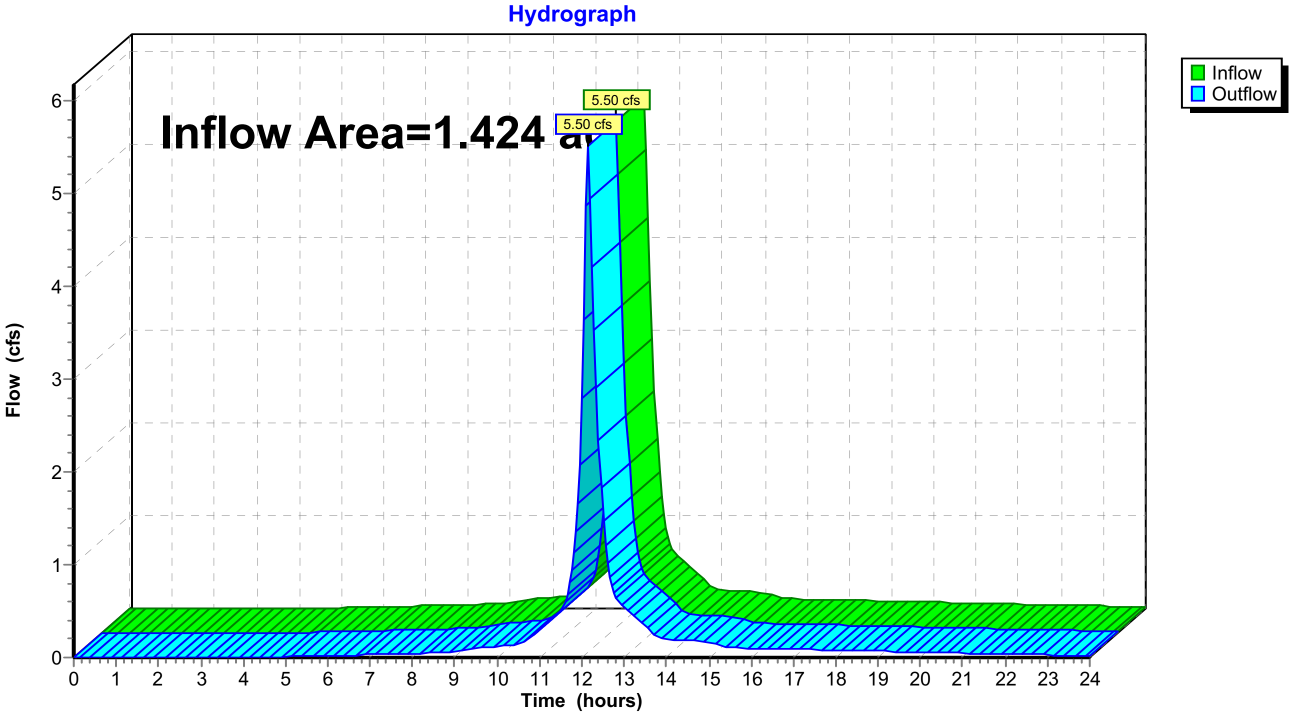
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.424 ac, 75.20% Impervious, Inflow Depth > 3.12" for 10-yr event
Inflow = 5.50 cfs @ 12.15 hrs, Volume= 0.370 af
Outflow = 5.50 cfs @ 12.15 hrs, Volume= 0.370 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

Inflow Area = 0.977 ac, 84.37% Impervious, Inflow Depth > 3.31" for 10-yr event
Inflow = 5.08 cfs @ 12.13 hrs, Volume= 0.270 af
Outflow = 3.62 cfs @ 12.19 hrs, Volume= 0.269 af, Atten= 29%, Lag= 3.9 min
Primary = 3.62 cfs @ 12.19 hrs, Volume= 0.269 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75' Surf.Area= 0.021 ac Storage= 0.057 af
Peak Elev= 111.51' @ 12.19 hrs Surf.Area= 0.018 ac Storage= 0.093 af (0.035 af above start)

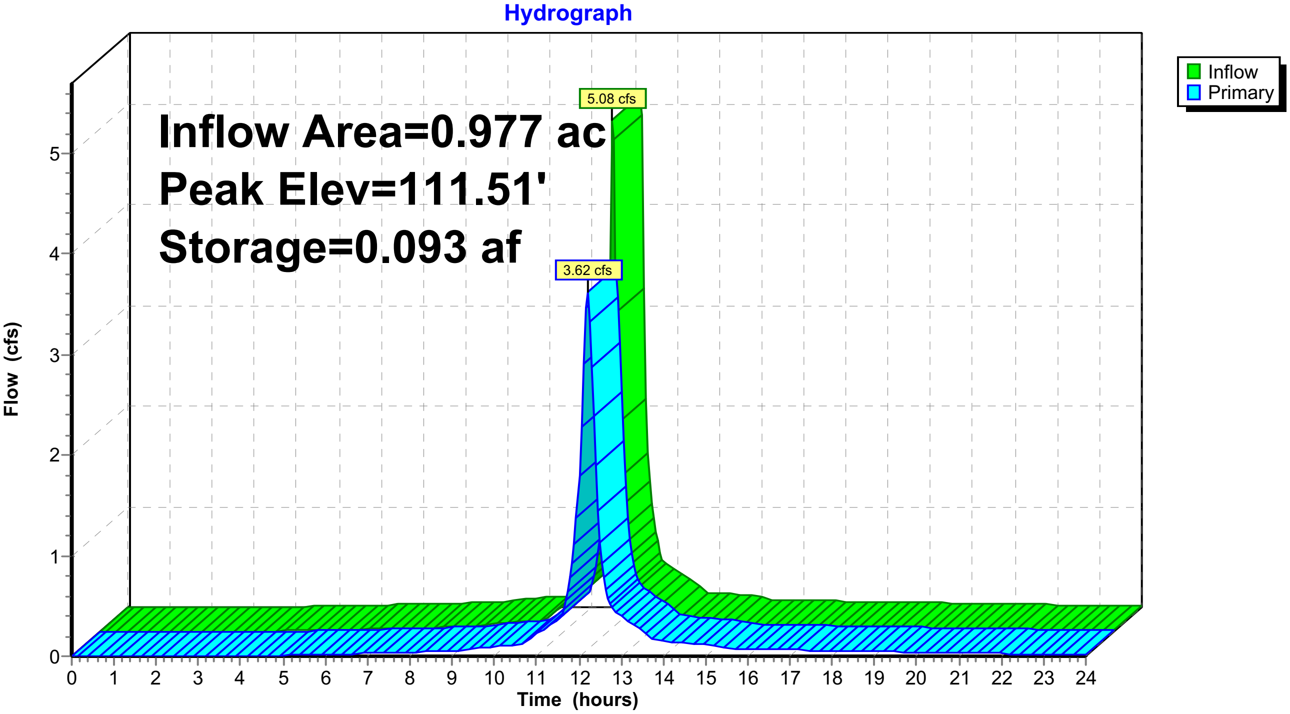
Plug-Flow detention time= 112.4 min calculated for 0.211 af (78% of inflow)
Center-of-Mass det. time= 11.6 min (770.4 - 758.7)

Volume	Invert	Avail.Storage	Storage Description
#1	106.25'	0.115 af	**84.0" Round Pipe Storage** L= 130.0'

Device	Routing	Invert	Outlet Devices
#1	Primary	109.75'	**12.0" Round Culvert** L= 150.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 109.75' / 108.86' S= 0.0059 '/' Cc= 0.900 n= 0.009, Flow Area= 0.79 sf
#2	Device 1	109.75'	**11.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	112.00'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=3.59 cfs @ 12.19 hrs HW=111.49' (Free Discharge)
↑—**1=Culvert** (Passes 3.59 cfs of 4.15 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 3.59 cfs @ 5.44 fps)
  └—**3=Sharp-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 3P: Tank


Hydrograph
Inflow Area=0.977 ac
Peak Elev=111.51'
Storage=0.093 af
5.08 cfs
3.62 cfs
🟩 Inflow
🟦 Primary
Flow (cfs)
0
1
2
3
4
5
Time (hours)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

```
Subcatchment1S: P-1            Runoff Area=38,480 sf   93.34% Impervious   Runoff Depth>5.82"
                                                Tc=6.0 min   CN=97   Runoff=7.82 cfs  0.429 af

Subcatchment4S: P-2            Runoff Area=19,456 sf   55.16% Impervious   Runoff Depth>5.02"
                                                Tc=6.0 min   CN=90   Runoff=3.70 cfs  0.187 af

Subcatchment6S: P-3 (offsite)     Runoff Area=4,093 sf   0.00% Impervious   Runoff Depth>3.94"
                                                Tc=6.0 min   CN=80   Runoff=0.65 cfs  0.031 af

Reach 3R: Proposed Conditions                                        Inflow=9.37 cfs  0.642 af
                                                                    Outflow=9.37 cfs  0.642 af

Pond 3P: Tank                   Peak Elev=113.15'  Storage=0.115 af  Inflow=8.46 cfs  0.460 af
                                                                    Outflow=5.90 cfs  0.455 af

          Total Runoff Area = 1.424 ac   Runoff Volume = 0.646 af   Average Runoff Depth = 5.45"
                                    24.80% Pervious = 0.353 ac     75.20% Impervious = 1.071 ac
```

Summary for Subcatchment 1S: P-1

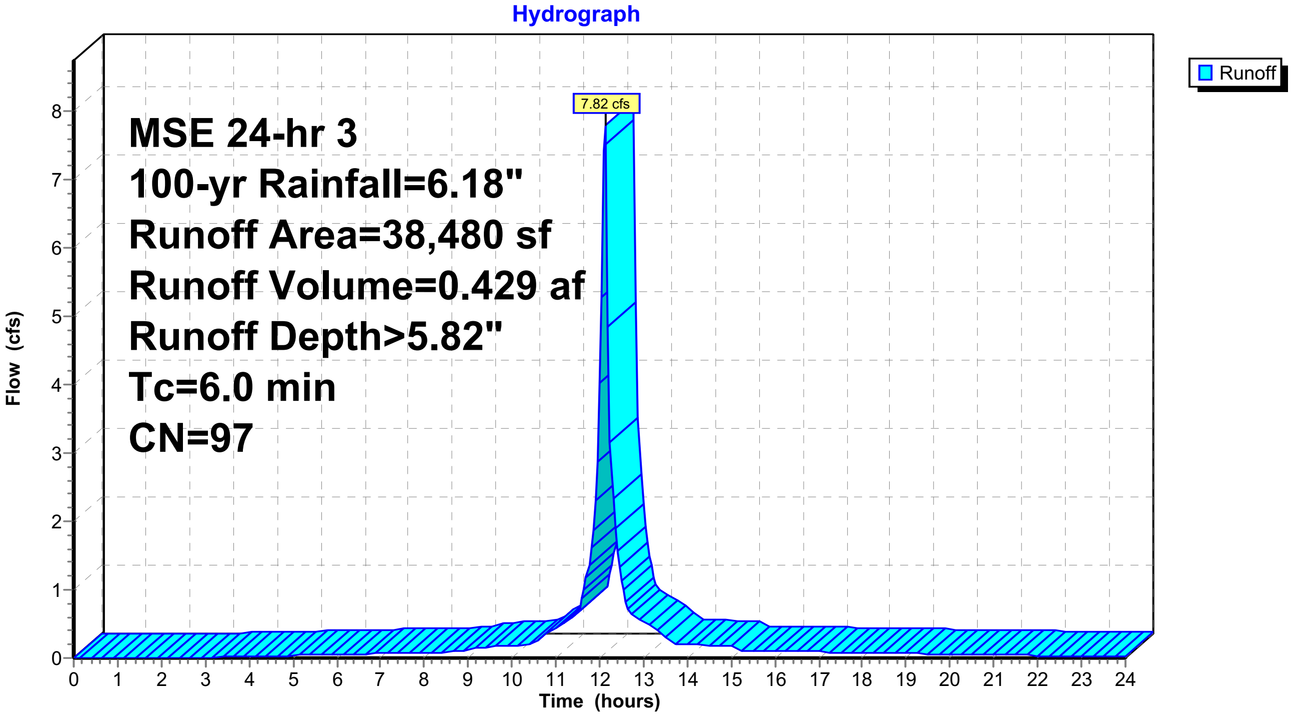
Runoff = 7.82 cfs @ 12.13 hrs, Volume= 0.429 af, Depth> 5.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.18"

	Area (sf)	CN	Description
	2,563	80	>75% Grass cover, Good, HSG D
	34,621	98	Paved parking, HSG D
*	1,296	98	Sidewalk, HSG D
	38,480	97	Weighted Average
	2,563		6.66% Pervious Area
	35,917		93.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 1S: P-1



Summary for Subcatchment 4S: P-2

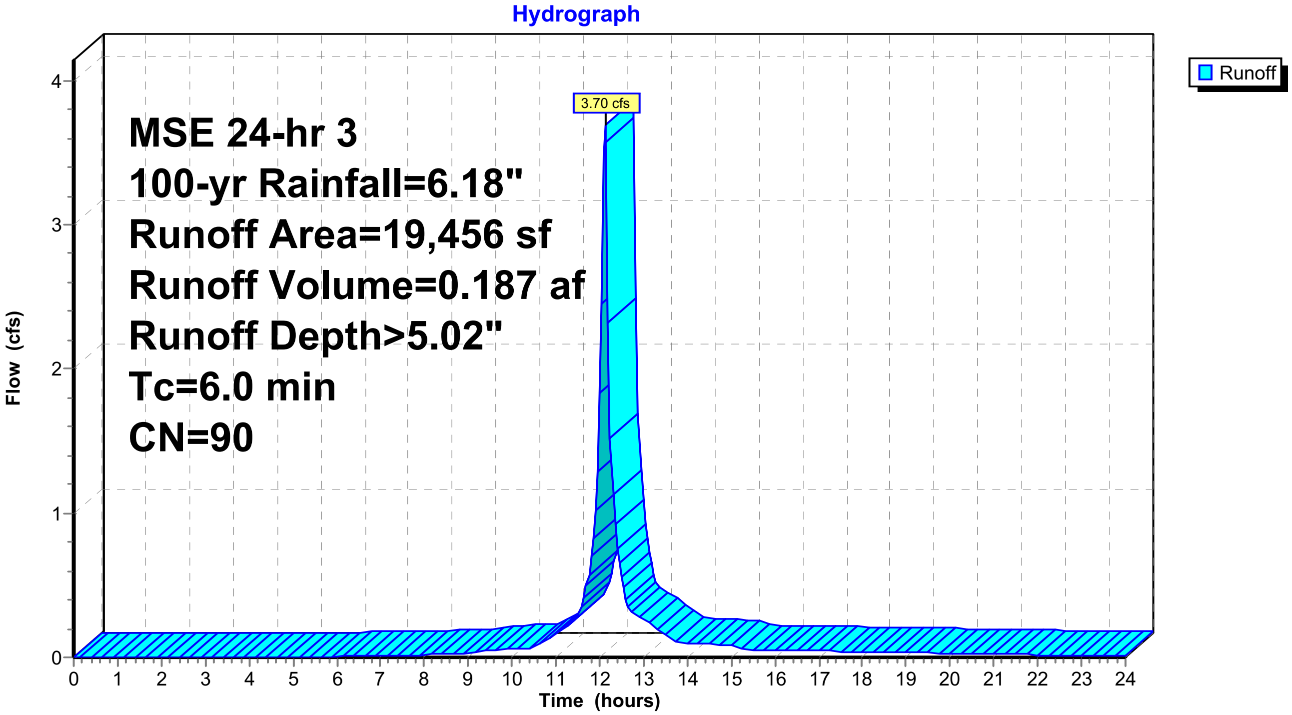
Runoff = 3.70 cfs @ 12.13 hrs, Volume= 0.187 af, Depth> 5.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.18"

	Area (sf)	CN	Description
	8,725	80	>75% Grass cover, Good, HSG D
*	2,948	98	Paved parking
*	474	98	Sidewalk
*	7,309	98	Roof
	19,456	90	Weighted Average
	8,725		44.84% Pervious Area
	10,731		55.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 4S: P-2



Summary for Subcatchment 6S: P-3 (offsite)

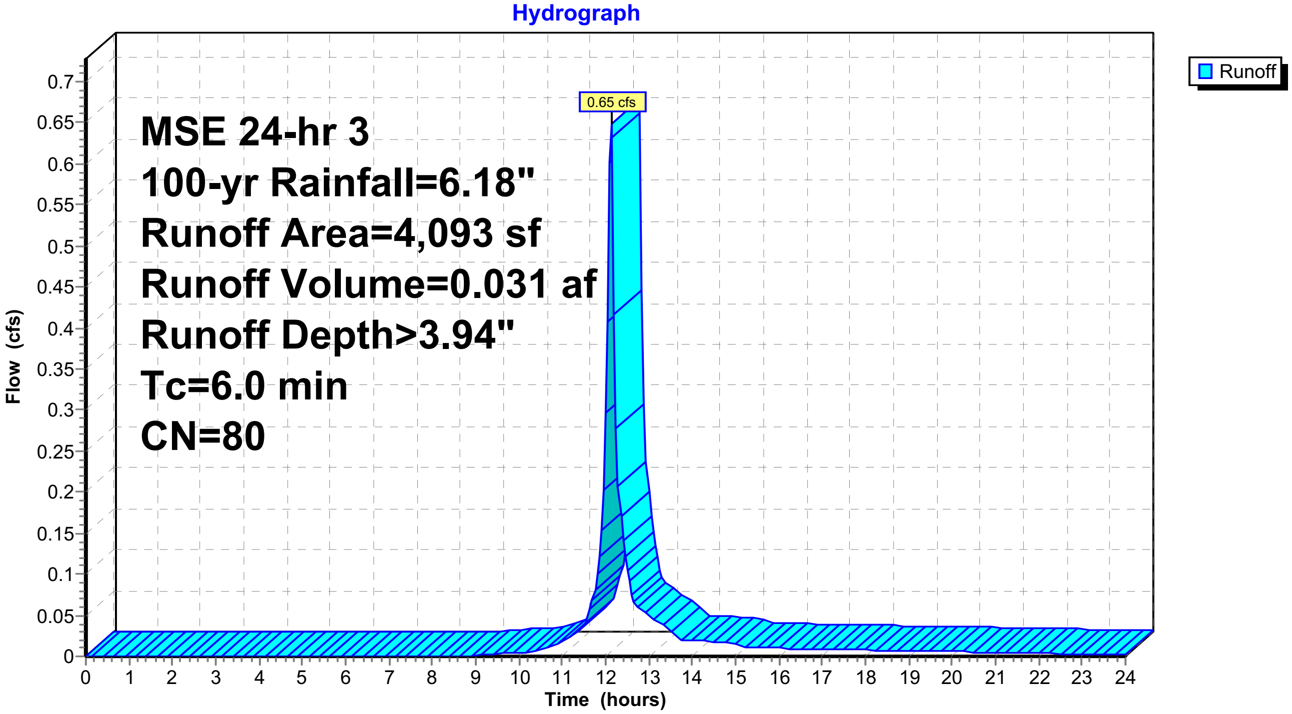
Runoff = 0.65 cfs @ 12.13 hrs, Volume= 0.031 af, Depth> 3.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
MSE 24-hr 3 100-yr Rainfall=6.18"

Area (sf)	CN	Description
4,093	80	>75% Grass cover, Good, HSG D
4,093		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment 6S: P-3 (offsite)



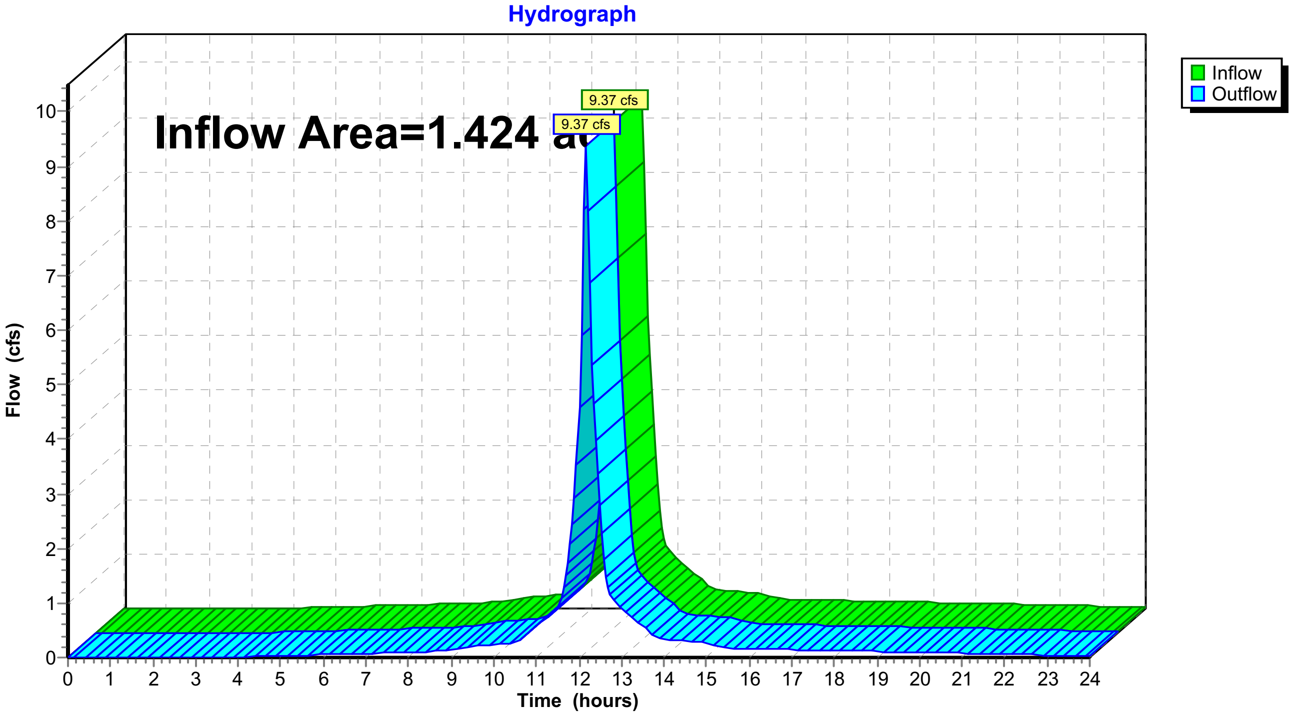
Summary for Reach 3R: Proposed Conditions

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.424 ac, 75.20% Impervious, Inflow Depth > 5.41" for 100-yr event
Inflow = 9.37 cfs @ 12.15 hrs, Volume= 0.642 af
Outflow = 9.37 cfs @ 12.15 hrs, Volume= 0.642 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Reach 3R: Proposed Conditions



Summary for Pond 3P: Tank

```
Inflow Area =        0.977 ac,  84.37% Impervious,  Inflow Depth >   5.64"    for  100-yr event
Inflow      =       8.46 cfs @   12.13 hrs,  Volume=           0.460 af
Outflow     =       5.90 cfs @   12.18 hrs,  Volume=           0.455 af,  Atten= 30%,  Lag= 3.2 min
Primary     =       5.90 cfs @   12.18 hrs,  Volume=           0.455 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 109.75'   Surf.Area= 0.021 ac   Storage= 0.057 af
Peak Elev= 113.15' @ 12.18 hrs   Surf.Area= 0.005 ac   Storage= 0.115 af   (0.057 af above start)

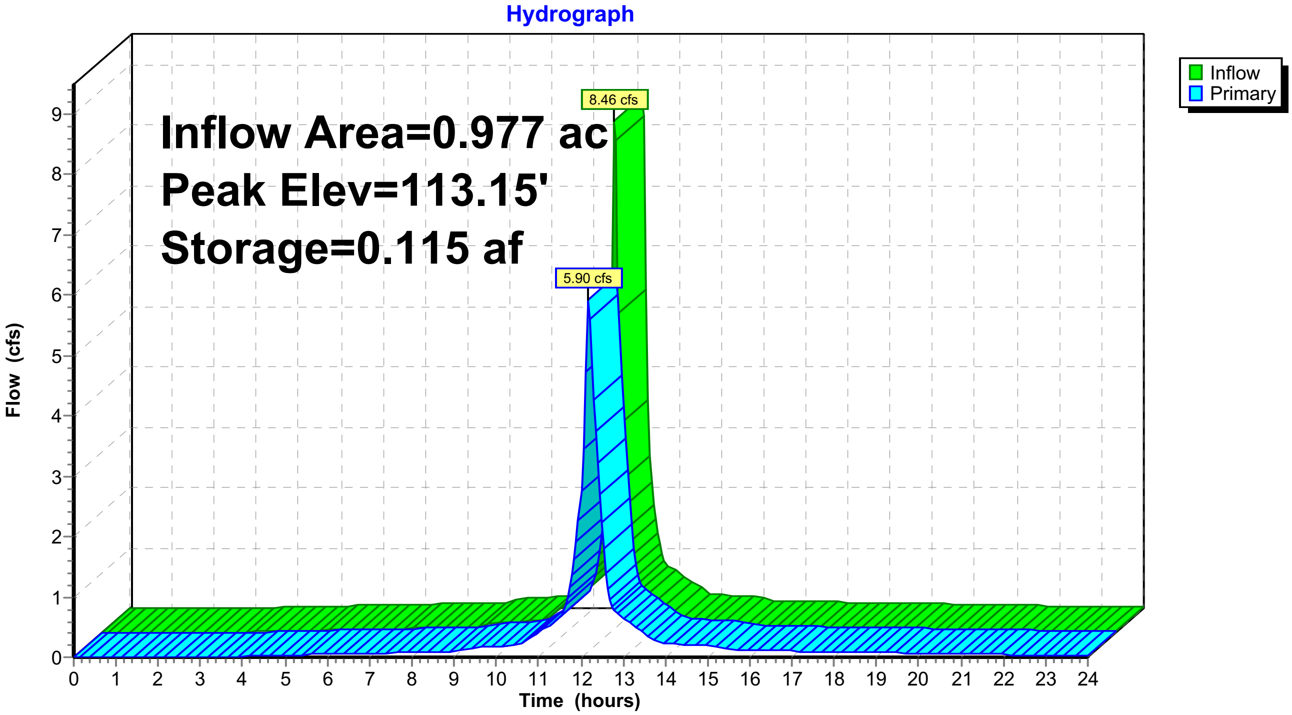
Plug-Flow detention time= 92.5 min calculated for 0.398 af (87% of inflow)
Center-of-Mass det. time= 10.2 min ( 761.1 - 751.0 )

Volume       Invert    Avail.Storage   Storage Description
   #1       106.25'         0.115 af   84.0"  Round Pipe Storage
                                       L= 130.0'

Device   Routing          Invert   Outlet Devices
    #1   Primary          109.75'  12.0"  Round Culvert
                                   L= 150.0'   RCP, sq.cut end projecting,  Ke= 0.500
                                   Inlet / Outlet Invert= 109.75' / 108.86'   S= 0.0059 '/'   Cc= 0.900
                                   n= 0.009,  Flow Area= 0.79 sf
    #2   Device 1         109.75'  11.0" Vert. Orifice/Grate   C= 0.600
    #3   Device 1         112.00'  6.0' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

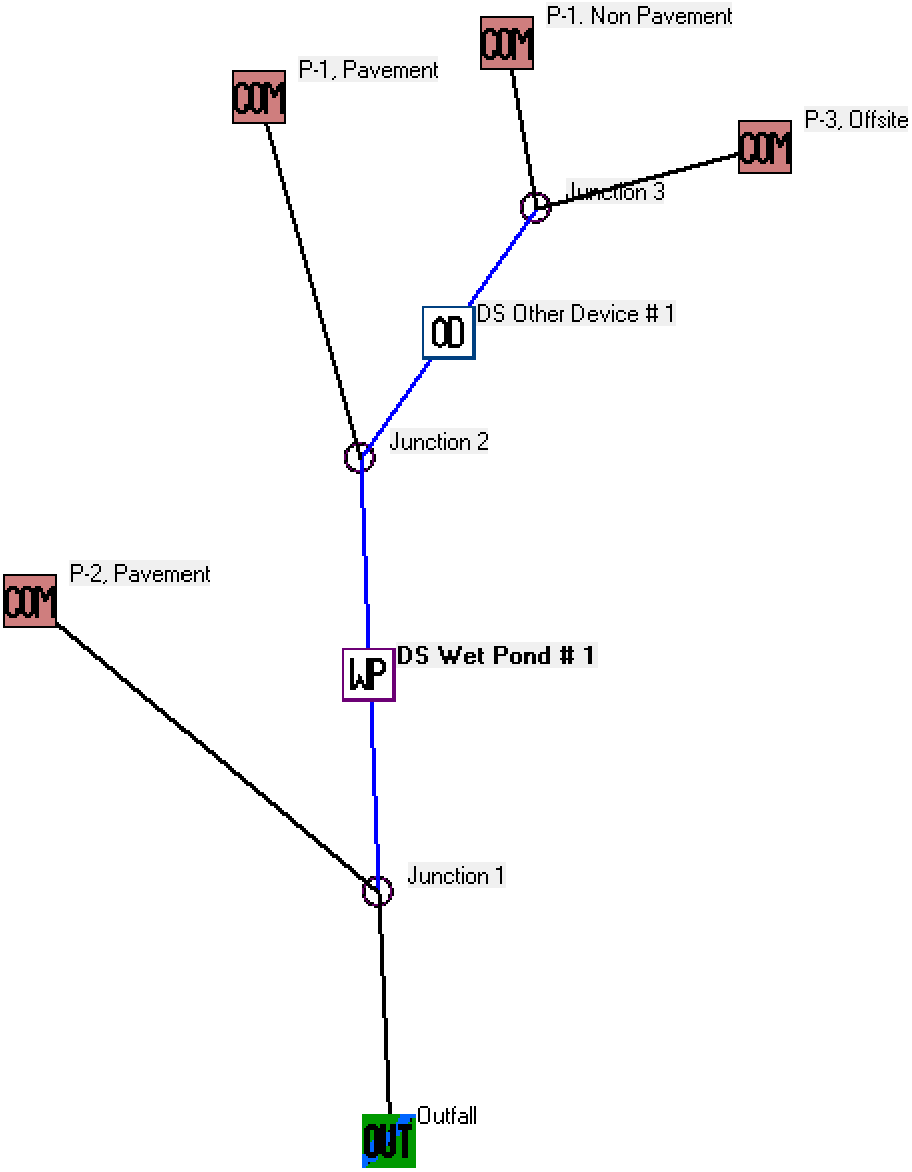
Primary OutFlow Max=5.84 cfs @ 12.18 hrs  HW=113.08'   (Free Discharge)
└─1=Culvert  (Barrel Controls 5.84 cfs @ 7.43 fps)
   ├─2=Orifice/Grate  (Passes < 5.39 cfs potential flow)
   └─3=Sharp-Crested Rectangular Weir(Passes < 21.24 cfs potential flow)
```

Pond 3P: Tank


Hydrograph
Inflow
Primary
8.46 cfs
5.90 cfs
Inflow Area=0.977 ac
Peak Elev=113.15'
Storage=0.115 af
Flow (cfs)
0
1
2
3
4
5
6
7
8
9
Time (hours)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Appendix D – Water Quality Calculations

WinSLAMM Model



```
Data file name:  P:\3190494\Eng Data\Hydrology\SLAMM_KT 527.mdb
WinSLAMM Version 10.4.1
Rain file name:  C:\WinSLAMM Files\Rain Files\WisReg - Milwaukee WI 1969.RAN
Particulate Solids Concentration file name:  C:\WinSLAMM Files\v10.1 WI_AVG01.pscx
Runoff Coefficient file name:  C:\WinSLAMM Files\WI_SL06 Dec06.rsvx
Residential Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name:  C:\WinSLAMM Files\Freeway Dec06.std
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance:  False
Pollutant Relative Concentration file name:  C:\WinSLAMM Files\WI_GEO03.ppdx
Source Area PSD and Peak to Average Flow Ratio File:  C:\WinSLAMM Files\NURP Source Area PSD Files.csv
Cost Data file name:
If Other Device Pollutant Load Reduction Values = 1, Off-site Pollutant Loads are Removed from Pollutant Load % Reduction calculations
Seed for random number generator:  -42
Study period starting date:  01/05/69          Study period ending date:  12/31/69
Start of Winter Season:  12/06                 End of Winter Season:  03/28
Date:  02-21-2020                              Time:  09:34:45
Site information:

LU# 1 - Commercial:  P-1, Pavement     Total area (ac):  0.795
      13 - Paved Parking 1:  0.795 ac.    Connected    PSD File: C:\WinSLAMM Files\NURP.cpz

LU# 2 - Commercial:  P-3, Offsite     Total area (ac):  0.094
      45 - Large Landscaped Areas 1:  0.094 ac.    Normal Clayey    Low Density    PSD File: C:\WinSLAMM Files\NURP.cpz

LU# 3 - Commercial:  P-1. Non Pavement     Total area (ac):  0.089
      31 - Sidewalks 1:  0.030 ac.    Connected    PSD File: C:\WinSLAMM Files\NURP.cpz
      45 - Large Landscaped Areas 1:  0.059 ac.    Normal Clayey    Low Density    PSD File: C:\WinSLAMM Files\NURP.cpz

LU# 4 - Commercial:  P-2, Pavement     Total area (ac):  0.068
      13 - Paved Parking 1:  0.068 ac.    Connected    PSD File: C:\WinSLAMM Files\NURP.cpz

  Control Practice 1:  Wet Detention Pond CP# 1 (DS) - DS Wet Pond # 1
        Particle Size Distribution file name:  Not needed - calculated by program
        Initial stage elevation (ft):  3.5
        Peak to Average Flow Ratio:  3.8
        Maximum flow allowed into pond (cfs):  No maximum value entered
        Outlet Characteristics:
             Outlet type:  Sharp Crested Weir
                 1.  Sharp crested weir length (ft):   6
                 2.  Sharp crested weir height from invert:   1.25
                 3.  Sharp crested weir invert elevation above datum (ft):   5.75
             Outlet type:  Orifice 1
                 1.  Orifice diameter (ft):   0.91
                 2.  Number of orifices:   1
                 3.  Invert elevation above datum (ft):   3.5
             Outlet type:  Broad Crested Weir
                 1.  Weir crest length (ft):   10
                 2.  Weir crest width (ft):   10
                 3.  Height from datum to bottom of weir opening:   6.99
        Pond stage and surface area
               Entry     Stage    Pond Area   Natural Seepage   Other Outflow
               Number     (ft)     (acres)        (in/hr)           (cfs)
                 0        0.00     0.0000         0.00              0.00
                 1        0.01     0.0164         0.00              0.00
                 2        1.00     0.0164         0.00              0.00
                 3        2.00     0.0164         0.00              0.00
                 4        3.00     0.0164         0.00              0.00
                 5        4.00     0.0164         0.00              0.00
                 6        5.00     0.0164         0.00              0.00
                 7        6.00     0.0164         0.00              0.00
                 8        7.00     0.0164         0.00              0.00
  Control Practice 2:  Other Device CP# 1 (DS) - DS Other Device # 1
        Fraction of drainage area served by device (ac) = 1.00
        Particulate Concentration reduction fraction = 1.00
        Filterable Concentration reduction fraction = 0.00
        Runoff volume reduction fraction = 0
```

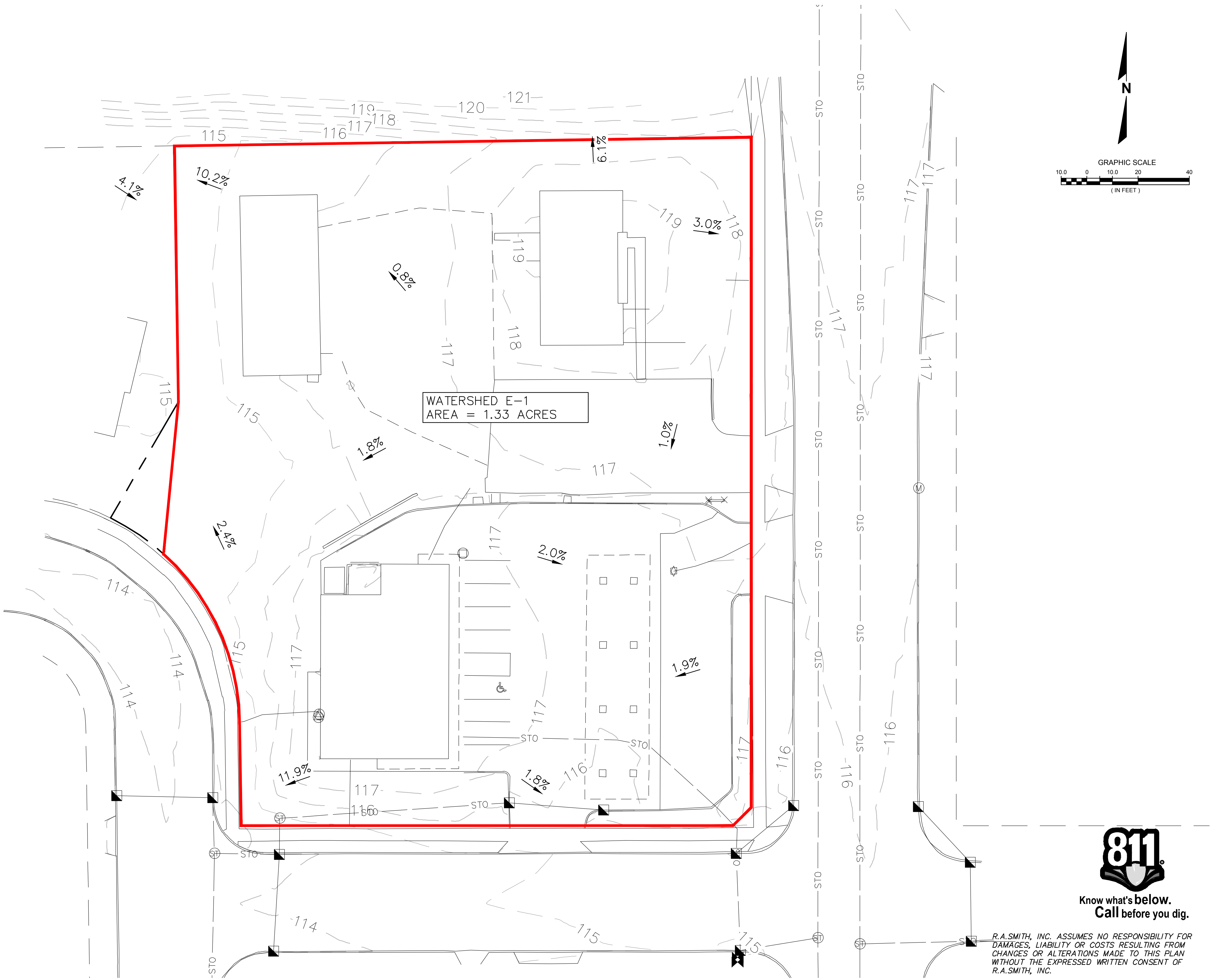
```
SLAMM for Windows Version 10.4.1
(c) Copyright Robert Pitt and John Voorhees 2019, All Rights Reserved

Data file name:  P:\3190494\Eng Data\Hydrology\SLAMM_KT 527.mdb
WinSLAMM Version 10.4.1
Rain file name:  C:\WinSLAMM Files\Rain Files\WisReg - Milwaukee WI 1969.RAN
Particulate Solids Concentration file name:  C:\WinSLAMM Files\v10.1 WI_AVG01.pscx
Runoff Coefficient file name:  C:\WinSLAMM Files\WI_SL06 Dec06.rsvx
Pollutant Relative Concentration file name:  C:\WinSLAMM Files\WI_GEO03.ppdx
Residential Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Institutional Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Commercial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Industrial Street Delivery file name:  C:\WinSLAMM Files\WI_Com Inst Indust Dec06.std
Other Urban Street Delivery file name:  C:\WinSLAMM Files\WI_Res and Other Urban Dec06.std
Freeway Street Delivery file name:  C:\WinSLAMM Files\Freeway Dec06.std
Apply Street Delivery Files to Adjust the After Event Load Street Dirt Mass Balance:  False
Source Area PSD and Peak to Average Flow Ratio File:  C:\WinSLAMM Files\NURP Source Area PSD Files.csv
Cost Data file name:
If Other Device Pollutant Load Reduction Values = 1, Off-site Pollutant Loads are Removed from Pollutant Load % Reduction calculations
Seed for random number generator:  -42
Study period starting date:  01/05/69          Study period ending date:  12/31/69
Start of Winter Season:  12/06                 End of Winter Season:  03/28
Model Run Start Date:  01/05/69    Model Run End Date:  12/31/69
Date of run:  02-21-2020    Time of run:  09:34:18
Total Area Modeled (acres):  1.046
Years in Model Run:  0.99

                                             Runoff       Percent      Particulate    Particulate    Percent
                                             Volume       Runoff       Solids         Solids         Particulate
                                             (cu ft)      Volume       Conc.          Yield          Solids
                                                          Reduction    (mg/L)         (lbs)          Reduction

Total of all Land Uses without Controls:     69757          -           123.6          538.1           -
Outfall Total with Controls:                 69826        -0.10%        60.32          262.9         51.14%
Annualized Total After Outfall Controls:     70796                                     266.6
```

Appendix E – Hydrology Exhibits



Know what's **below.**
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DATE	DESCRIPTION

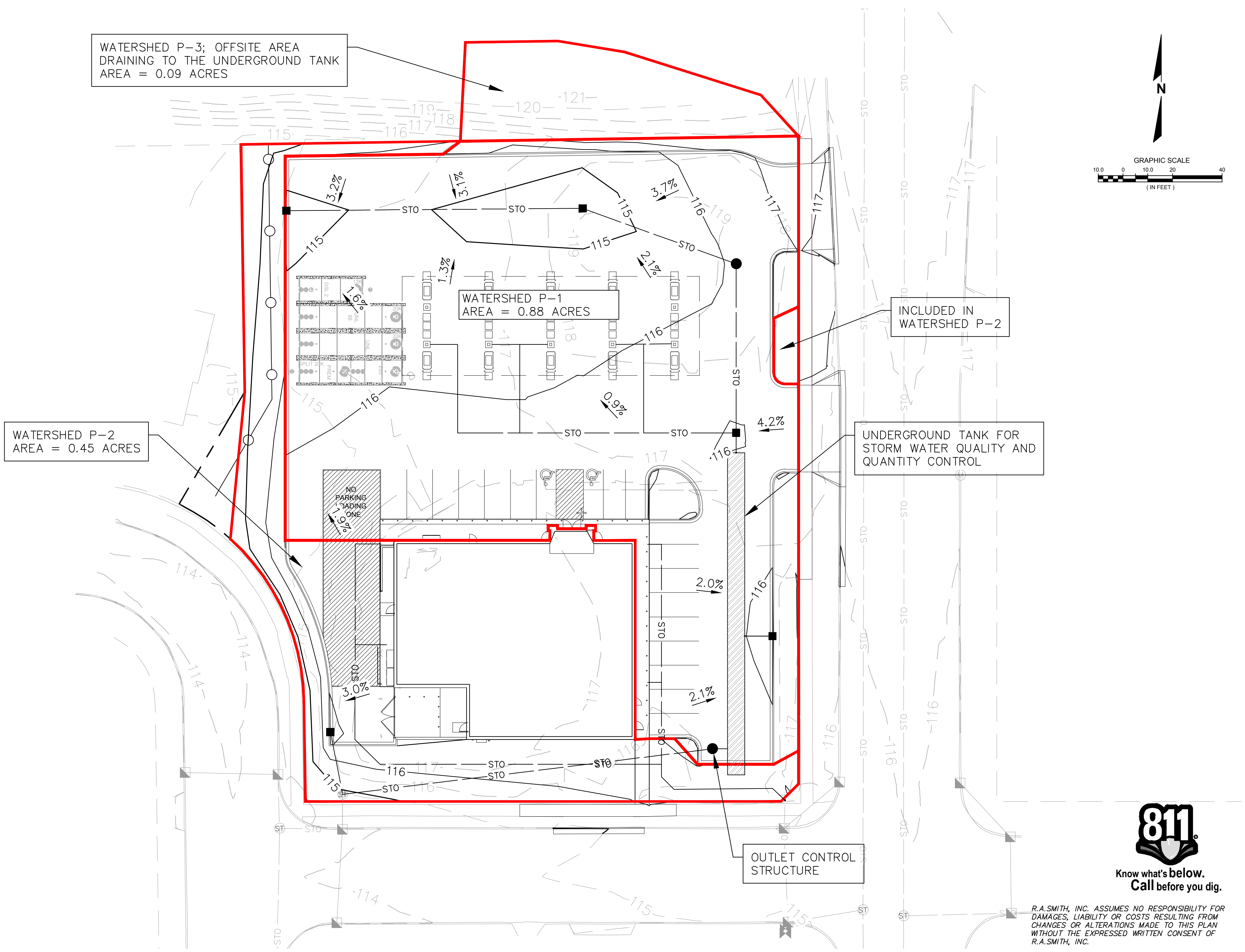
raSmith
CREATIVITY BEYOND ENGINEERING
16745 W. Bluemound Road
Brookfield, WI 53005-5938
(262) 781-1000
rasmith.com
Brookfield, WI | Milwaukee, WI | Appleton, WI | Madison, WI | Cedarburg, WI
Mount Pleasant, WI | Naperville, IL | Irvine, CA

KWIK TRIP #527
WAUKESHA, WI

EXISTING HYDROLOGY EXHIBIT

DATE: 02/21/2020
SCALE: 1" = 40'
JOB NO. 3190494
PROJECT MANAGER:
ROBERT J. HARLEY, P.E.
DESIGNED BY: CBW
CHECKED BY: RJH

SHEET NUMBER
HX100



WATERSHED P–3; OFFSITE AREA DRAINING TO THE UNDERGROUND TANK
AREA = 0.09 ACRES

WATERSHED P–1
AREA = 0.88 ACRES

WATERSHED P–2
AREA = 0.45 ACRES

INCLUDED IN WATERSHED P–2

UNDERGROUND TANK FOR STORM WATER QUALITY AND QUANTITY CONTROL

OUTLET CONTROL STRUCTURE

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DATE	DESCRIPTION

raSmith
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Brookfield, WI 53005-5938
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Brookfield, WI | Milwaukee, WI | Appleton, WI | Madison, WI | Cedarburg, WI
Mount Pleasant, WI | Naperville, IL | Irvine, CA

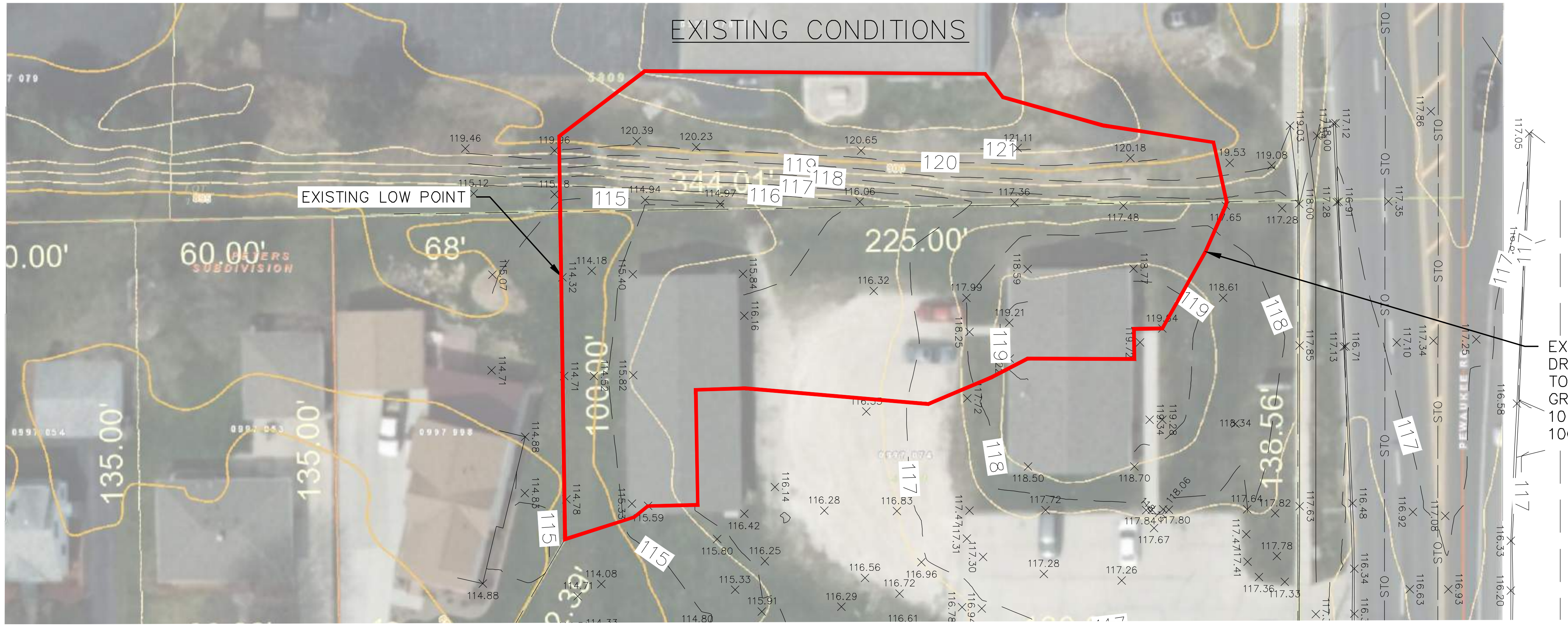
KWIK TRIP #527
WAUKESHA, WI

PROPOSED HYDROLOGY EXHIBIT

DATE: 2/21/2020
SCALE: 1" = 40'
JOB NO. 3190494
PROJECT MANAGER:
ROBERT J. HARLEY, P.E.
DESIGNED BY: CBW
CHECKED BY: RJH

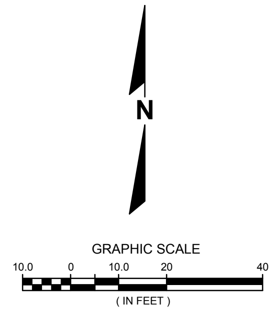
SHEET NUMBER
HX101

EXISTING CONDITIONS



EXISTING LOW POINT

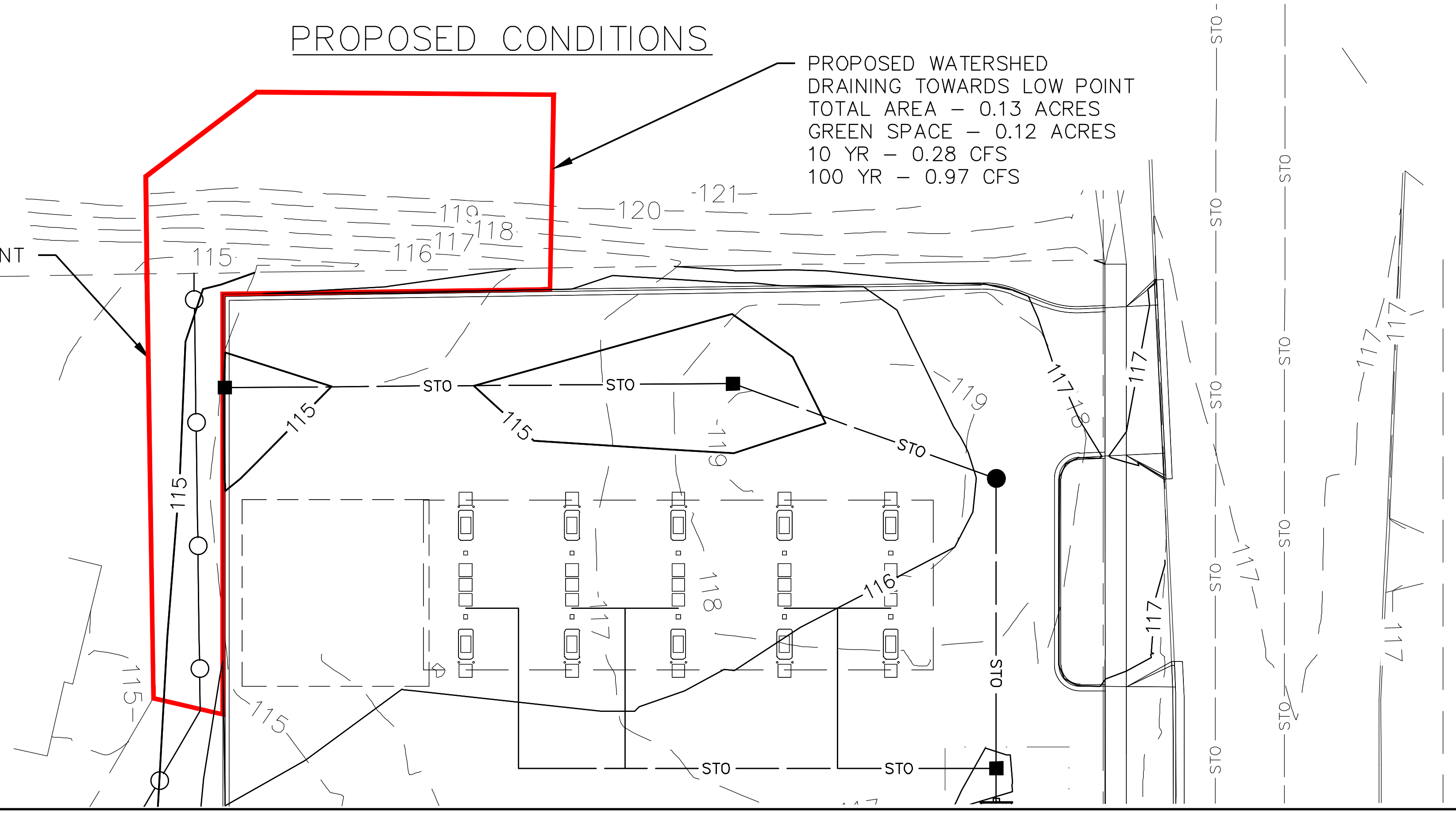
EXISTING WATERSHED
DRAINING TOWARDS LOW POINT
TOTAL AREA – 0.43 ACRES
GREEN SPACE – 0.31 ACRES
10 YR – 1.03 CFS
100 YR – 3.28 CFS



PROPOSED CONDITIONS

PROPOSED WATERSHED
DRAINING TOWARDS LOW POINT
TOTAL AREA – 0.13 ACRES
GREEN SPACE – 0.12 ACRES
10 YR – 0.28 CFS
100 YR – 0.97 CFS

LOW POINT



811
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DATE	DESCRIPTION

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Mount Pleasant, WI | Naperville, IL | Irvine, CA

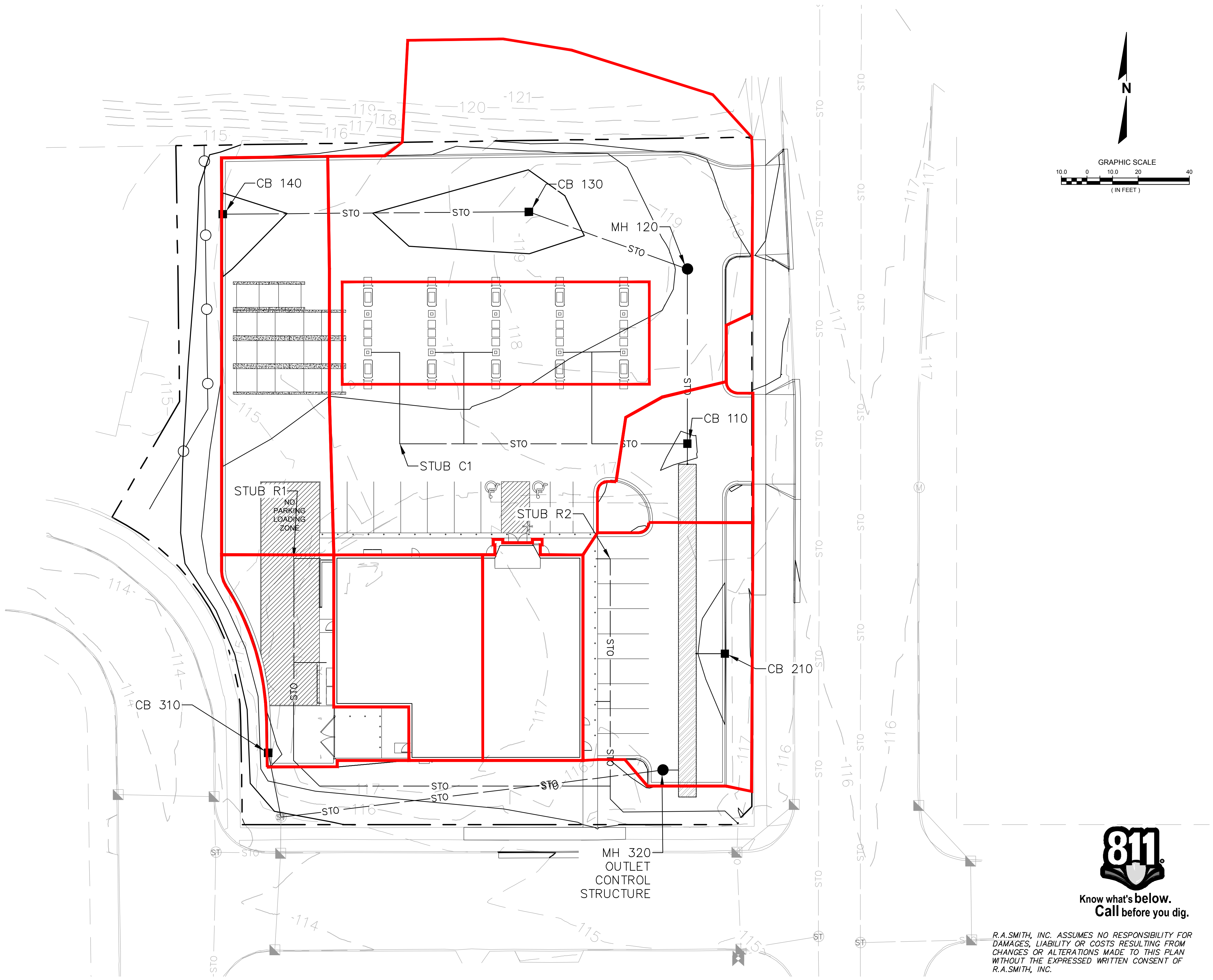
KWIK TRIP #527
WAUKESHA, WI

LOW POINT HYDROLOGY EXHIBIT

DATE: 4/14/2020
SCALE: 1" = 40'
JOB NO. 3190494
PROJECT MANAGER:
ROBERT J. HARLEY, P.E.
DESIGNED BY: CBW
CHECKED BY: RJH

SHEET NUMBER
HX300

Appendix F – Storm Sewer Design



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DATE	DESCRIPTION

raSmith
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rasmith.com

Brookfield, WI | Milwaukee, WI | Appleton, WI | Madison, WI | Cedarburg, WI
Mount Pleasant, WI | Naperville, IL | Irvine, CA

KWIK TRIP #527
WAUKESHA, WI

STORM SEWER CATCHMENT AREAS

DATE: 02/21/2020
SCALE: 1" = 40'
JOB NO. 3190494
PROJECT MANAGER:
ROBERT J. HARLEY, P.E.
DESIGNED BY: CBW
CHECKED BY: RJH

SHEET NUMBER
HX200

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	8.000	0.06	0.83	0.79	0.05	0.67	6.0	8.9	5.6	3.77	7.43	4.22	18	0.50	109.75	109.79	110.51	110.55	116.03	115.85	110-Tank
2	1	68.214	0.00	0.66	0.00	0.00	0.52	6.0	8.3	5.8	3.04	7.41	2.45	18	0.50	109.79	110.13	110.96	111.00	115.85	116.18	120-110
3	2	65.867	0.51	0.66	0.76	0.39	0.52	6.0	7.7	6.0	3.13	7.43	3.10	18	0.50	110.13	110.46	111.12	111.19	116.18	114.42	130-120
4	3	119.545	0.15	0.15	0.90	0.14	0.14	6.0	6.0	6.7	0.90	2.52	1.98	12	0.50	110.46	111.06	111.32	111.50	114.42	114.75	140-130
5	1	112.358	0.11	0.11	0.90	0.10	0.10	6.0	6.0	6.7	0.66	2.37	2.44	10	1.00	110.46	111.58	110.96	111.94	115.85	116.24	C1-110

Project File: New.stm

Number of lines: 5

Run Date: 2/21/2020

NOTES:Intensity = 33.54 / (Inlet time + 4.60) ^ 0.68; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	8.000	0.06	0.83	0.79	0.05	0.67	6.0	8.0	8.7	5.83	7.43	4.90	18	0.50	109.75	109.79	110.68	110.78	116.03	115.85	110-Tank
2	1	68.214	0.00	0.66	0.00	0.00	0.52	6.0	7.6	8.9	4.66	7.41	2.78	18	0.50	109.79	110.13	111.30	111.40	115.85	116.18	120-110
3	2	65.867	0.51	0.66	0.76	0.39	0.52	6.0	7.2	9.1	4.78	7.43	3.02	18	0.50	110.13	110.46	111.53	111.62	116.18	114.42	130-120
4	3	119.545	0.15	0.15	0.90	0.14	0.14	6.0	6.0	9.9	1.33	2.52	1.82	12	0.50	110.46	111.06	111.72	111.87	114.42	114.75	140-130
5	1	112.358	0.11	0.11	0.90	0.10	0.10	6.0	6.0	9.9	0.98	2.37	2.58	10	1.00	110.46	111.58	111.30	112.02	115.85	116.24	C1-110

Project File: New.stm

Number of lines: 5

Run Date: 2/21/2020

NOTES:Intensity = 34.00 / (Inlet time + 2.20) ^ 0.59; Return period =Yrs. 100 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	11.142	0.15	0.15	0.80	0.12	0.12	6.0	6.0	6.7	0.80	3.54	3.31	12	0.99	109.75	109.86	110.07	110.23	0.00	115.79	210-Tank

Project File: New.stm

Number of lines: 1

Run Date: 2/20/2020

NOTES:Intensity = 33.54 / (Inlet time + 4.60) ^ 0.68; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	11.142	0.15	0.15	0.80	0.12	0.12	6.0	6.0	9.9	1.19	3.54	3.37	12	0.99	109.75	109.86	110.21	110.32	0.00	115.79	210-Tank

Project File: New.stm

Number of lines: 1

Run Date: 2/20/2020

NOTES:Intensity = 34.00 / (Inlet time + 2.20) ^ 0.59; Return period =Yrs. 100 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	14.110	0.00	0.08	0.00	0.00	0.07	6.0	6.7	6.4	3.72	0.00	4.74	12	0.00	108.86	108.86	109.86	110.01	113.13	114.74	300-Out
2	1	25.628	0.08	0.08	0.90	0.07	0.07	6.0	6.0	6.7	0.48	5.02	2.50	12	1.99	110.06	110.57	110.36	110.86	114.74	115.87	310-300
3	1	150.294	0.00	0.00	0.00	0.00	0.00	6.0	6.0	0.0	3.26	2.74	4.15	12	0.59	108.86	109.75	110.36	111.62	114.74	116.55	320-300
4	3	6.115	0.00	0.00	0.00	0.00	0.00	6.0	6.0	0.0	3.26	0.00	4.15	12	0.00	109.75	109.75	111.66	111.68	116.55	116.46	TANK-320

Project File: New.stm

Number of lines: 4

Run Date: 2/21/2020

NOTES:Intensity = 33.54 / (Inlet time + 4.60) ^ 0.68; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	14.110	0.00	0.08	0.00	0.00	0.07	6.0	6.5	9.6	6.59	0.00	8.43	12	0.00	108.86	108.86	109.83	110.30	113.13	114.74	300-Out
2	1	25.628	0.08	0.08	0.90	0.07	0.07	6.0	6.0	9.9	0.71	5.02	0.97	12	1.99	110.06	110.57	111.39	111.39	114.74	115.87	310-300
3	1	150.294	0.00	0.00	0.00	0.00	0.00	6.0	6.0	0.0	5.90	2.74	7.51	12	0.59	108.86	109.75	111.39	115.51	114.74	116.55	320-300
4	3	6.115	0.00	0.00	0.00	0.00	0.00	6.0	6.0	0.0	5.90	0.00	7.51	12	0.00	109.75	109.75	115.64	115.73	116.55	116.46	TANK-320

Project File: New.stm

Number of lines: 4

Run Date: 2/21/2020

NOTES:Intensity = 34.00 / (Inlet time + 2.20) ^ 0.59; Return period =Yrs. 100 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	6.975	0.00	0.16	0.00	0.00	0.14	0.0	8.6	5.7	0.82	0.86	2.80	8	0.43	112.33	112.36	112.85	112.88	112.79	116.46	B5-Out
2	1	39.807	0.00	0.16	0.00	0.00	0.14	0.0	8.4	5.8	0.84	0.93	2.60	8	0.50	112.36	112.56	112.98	113.11	116.46	116.22	B4-B5
3	2	7.114	0.00	0.16	0.00	0.00	0.14	0.0	8.3	5.8	0.84	0.98	2.46	8	0.56	112.56	112.60	113.19	113.22	116.22	116.32	B3-B4
4	3	5.001	0.00	0.16	0.00	0.00	0.14	0.0	8.3	5.8	0.84	1.01	2.40	8	0.60	112.60	112.63	113.29	113.30	116.32	116.55	T1-B3
5	4	113.686	0.00	0.09	0.00	0.00	0.08	0.0	7.0	6.3	0.51	0.93	1.86	8	0.50	112.63	113.20	113.39	113.61	116.55	116.21	B2-T1
6	5	14.142	0.00	0.09	0.00	0.00	0.08	0.0	6.9	6.3	0.51	0.92	2.10	8	0.49	113.20	113.27	113.67	113.69	116.21	116.15	B1-B2
7	6	78.929	0.09	0.09	0.90	0.08	0.08	6.0	6.0	6.7	0.54	0.92	2.49	8	0.49	113.27	113.66	113.74	114.01	116.15	116.79	R1-B1
8	4	88.754	0.07	0.07	0.90	0.06	0.06	6.0	6.0	6.7	0.42	0.92	1.50	8	0.50	112.63	113.07	113.39	113.49	116.55	116.71	R2-T1

Project File: New.stm

Number of lines: 8

Run Date: 2/20/2020

NOTES:Intensity = 33.54 / (Inlet time + 4.60) ^ 0.68; Return period =Yrs. 10 ; c = cir e = ellip b = box

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	6.975	0.00	0.16	0.00	0.00	0.14	0.0	7.8	8.8	1.27	0.86	3.98	8	0.43	112.33	112.36	112.86	112.99	112.79	116.46	B5-Out
2	1	39.807	0.00	0.16	0.00	0.00	0.14	0.0	7.6	8.9	1.28	0.93	3.68	8	0.50	112.36	112.56	113.15	113.54	116.46	116.22	B4-B5
3	2	7.114	0.00	0.16	0.00	0.00	0.14	0.0	7.6	8.9	1.29	0.98	3.68	8	0.56	112.56	112.60	113.70	113.76	116.22	116.32	B3-B4
4	3	5.001	0.00	0.16	0.00	0.00	0.14	0.0	7.5	8.9	1.29	1.01	3.69	8	0.60	112.60	112.63	113.92	113.97	116.32	116.55	T1-B3
5	4	113.686	0.00	0.09	0.00	0.00	0.08	0.0	6.7	9.4	0.76	0.93	2.19	8	0.50	112.63	113.20	114.18	114.57	116.55	116.21	B2-T1
6	5	14.142	0.00	0.09	0.00	0.00	0.08	0.0	6.6	9.5	0.77	0.92	2.21	8	0.49	113.20	113.27	114.63	114.68	116.21	116.15	B1-B2
7	6	78.929	0.09	0.09	0.90	0.08	0.08	6.0	6.0	9.9	0.80	0.92	2.29	8	0.49	113.27	113.66	114.73	115.03	116.15	116.79	R1-B1
8	4	88.754	0.07	0.07	0.90	0.06	0.06	6.0	6.0	9.9	0.62	0.92	1.78	8	0.50	112.63	113.07	114.18	114.38	116.55	116.71	R2-T1

Project File: New.stm

Number of lines: 8

Run Date: 2/20/2020

NOTES:Intensity = 34.00 / (Inlet time + 2.20) ^ 0.59; Return period =Yrs. 100 ; c = cir e = ellip b = box