

**PRELIMINARY DRAINAGE REPORT
FOR**

**Devon Estates
Salem, Oregon**

**Prepared For:
HSF Development, LLC
3245 Boone Road SE
Salem, Oregon 97317**

July 1, 2019



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INTRODUCTION

The Devon Estates development is a proposed 86 lot subdivision located south of Sahalee Court SE and west of Devon Avenue SE. The parcel of land to be developed is Tax Lot 300 of Marion County Assessor's Map 08 3W 22C. A vicinity map and supporting maps are in Appendix A of this report.



Project Site

Green Stormwater Infrastructure (GSI) to the Maximum Extent Feasible (MEF) is being used for the new developed areas along the easterly side of the development per City of Salem Administrative Rules, Chapter 109, Division 004, Stormwater System, Appendix 4E (Standards). Because of natural steep slopes at approximately 10 percent, stormwater quality will be proposed as Manufactured Treatment Technologies; Contech Stormwater Solutions Inc. stormfilters using ZPG media devices for the westerly side of the development. Stormwater flow control facilities will be constructed to meet the City of Salem standards.



EXISTING CONDITIONS

The 19.7-acre site is generally rectangular in the shape. Surface conditions consists of grass, brush and minimal trees. There are no identified wetlands, streams or sensitive areas located on the property. A topographical high point is located on the southerly side of the site. Drainage from this high point flows westerly and easterly. The maximum relief is approximately 112-feet with a high point elevation of 651. The abutting properties are zoned single family residential with nearby public improvements that include minimal storm water conveyance systems. Infrastructure will be designed and constructed to connect to these systems. Appendix A contains multiple maps of the site.

Soils

The Natural Resources Conservation Service (NRCS) Soil Resource Report for Marion County was used to determine a Hydrological Soil Group classification for runoff calculations. The report identifies the site soils to be Jory, Nekia and Salkum soils. The predominate soils are in the hydrologic soil group C. The report is in Appendix B.

Infiltration

Infiltration testing was performed at the site to determine percolation rate of the soil. Test results recommend design infiltration rates between 0.3 and 0.4 inches per hour. Appendix B contains an excerpt from the geotechnical report with recommended infiltration rates.

WATER QUALITY METHODOLOGY

Because of the poor percolation rates of the soils and natural steep slopes located on the site, green stormwater facilities will be designed as volume control facilities with off-site water quality swales for the easterly side. Volume control facilities with Manufactured Treatment Technology devices for the westerly side.

WATER QUALITY ANALYSIS

Water quality flow rates will be calculated with HydroCAD 10.00. The Santa Barbara Unit Hydrograph method will be used to generate the hydrographs. A Type 1A storm and a 24-hour rainfall depth of 1.38 inches per hour will be used to determine the water quality flow rate.

WATER QUALITY SWALE DESIGN

The proposed water quality swale will provide water quality treatment by slowing the stormwater down, allowing for the removal of pollutants through sedimentation, adsorption onto surrounding

vegetation, filtration and biological uptake. The swale will be designed per the City of Salem design standards.

MANUFACTURED TREATMENT TECHNOLOGY DESIGN

The proposed manufactured treatment device will be CONTECH Stormwater Solutions storm filters using ZPG media. The system will be designed in accordance to the manufacturer's recommendations per City of Salem design standards.

STORMWATER QUANTITY ANALYSIS

Stormwater quantity (Flow Control) is proposed to be handled by on-site detention. Runoff from the developed basins will be routed to the facilities that ultimately controls runoff to pre-developed flow rates. It should be noted that the site currently has three independent drainage basins and were analyzed independently.

Per Subsection 4.2(p)(3)(A) of the standards, one-half of the post development peak runoff rate of the two-year storm must be equal to or less than one-half of the peak runoff rate of the pre-developed two-year, 24-hour storm. This also applies to the 10-year, 24-hour storm event. Because the facility will be a volume based, the system will retain the 100-year event for post-developed conditions and control the flow to pre-developed conditions.

The pre-developed flow rates were calculated using HydroCAD 10.00. Table 1 below lists the 24-hour rainfall depths used for the analysis of each storm event. Please note that the 2-year event was halved and then analyzed.

Table 1

Storm Event (year)	24-hour Rainfall Depth (in)
Half of 2	1.1
10	3.2
100	4.4
WQ	1.38

For the pre-developed conditions, a time of concentration of 22.2 minutes was calculated for Basin 1, 21.6 minutes for Basin 2A and 18.6 minutes for Basin 2B. The time of concentration data is in Appendix C. The calculations are incorporated in the HydroCAD output located in Appendix D. The entire area was

classified as "City of Salem Pre-Development, HSG C" with a Curve Number (CN) of 72. A pre-developed basin map is in Appendix A. Because portions of Devon Avenue will drain into the Basin 2 systems, the areas were included in the pre-developed areas. The portion of the right-of-way was assumed to be impervious and a CN value of 98 was used in the analysis.

The Santa Barbara Unit Hydrograph method was used to generate the hydrographs. A Type 1A rainfall distribution was used with the above rainfall depths. Table 2 below identifies the allowable pre-developed release rates for each storm event.

Table 2

Storm Event	Basin #1 Allowable Release Rate (cfs)	Basin #2A Allowable Release Rate (cfs)	Basin #2B Allowable Release Rate (cfs)
1/2 of 2-year	0.09	0.05	0.02
10-year	2.61	1.25	0.61
100-year	5.04	2.37	1.12

The post-developed flow rates were calculated using HydroCAD 10.00. A time of concentration of 10 minutes was assumed for all basins. The calculations are incorporated in the HydroCAD output located in Appendix D. Each on-site basin was classified as 60 percent "Impervious, HSG C" with a CN of 98 and 40 percent "> 75% Grass cover, HSG C" with a CN of 74. This was based on code setback requirements and City street section standards. Off-site areas contributing to the development's drainage system were classified as "City of Salem Pre-Development, HSG C" with a Curve Number (CN) of 72 or "Impervious, HSG C" with a CN of 98. Table 3 below lists the CN values for the developed areas that will contribute storm water runoff to the detention systems. A developed basin map is in Appendix A.

Table 3

Basin	Impervious Area (Ac) CN = 98	Landscape Area (Ac) CN = 74	Exist. Impervious Area (AC) CN = 98	TOTAL Area (Ac)	Composite CN
Basin 1A	6.25	4.16	0	10.41	88
Basin 1B	0.64	0.43	0	1.07	88
Basin 2A	0.84	0.57	0.15	1.56	89
Basin 2B	4.11	2.74	0.18	7.03	89

Table 4 below identifies the calculated detention volume requirements for each storm event. The required detention was determined by taking the differential runoff volume from each hydrograph between the pre-developed and post-developed conditions for the three storm events and multiplying by 0.80. Multiplying by 0.80 gives the best approximation for facility sizing and reduces design iterations.

Table 4

Storm Event	Basin #1A Detention Volume (cf)	Basin #2A Detention Volume (cf)	Basin #2B Detention Volume (cf)
1/2 of 2-year	15,000	750	10,400
10-year	26,400	0	35,300
100-year	28,300	0	50,200

A 1.07-acre portion of Basin 1, developed Basin 1B, will not drain into the detention pond that will serve the westerly side of the development. To compensate for this uncontrolled release, a portion of the off-site runoff flowing through the system will be metered. In other words, off-site flow rates will be reduced to mirror uncontrolled release rates from Basin 1B.

It should be noted that the existing 5.39-acre Basin 2A historically drained to a County system along Devon Avenue SE just north of the site near the intersection with Elkins Way SE. The outlet of this system drains to an undefined system. Table 2 above identifies the flow rates. The developed Basin 2A will be reduced to 1.41-acres with flow rates at or below pre-developed conditions.

The proposed detention systems will be pond facilities located near the lowest point in each basin to maximize the capture of runoff. A basin map has been provided in Appendix A showing the locations of the detention ponds.

STORMWATER QUALITY ANALYSIS

Water quality flow rates were calculated using HydroCAD 10.00. The Santa Barbara Unit Hydrograph method was used to generate the hydrographs. A Type 1A rainfall distribution was used with a 1.38 rainfall depth. Appendix E contains the analysis.

Because of natural slopes that exceed 10 percent for Basin 1, a design exception for implementing green stormwater infrastructure to the maximum extent feasible is being requested to allow for a manufactured stormwater treatment facility to treat runoff from Basin 1A. A copy of the design exception request is in Appendix E.

The proposed facility is a Contech StormFilter system using ZPG media. The filters will be in a vault with a high flow bypass to convey larger storm events. The media filters will be the 27-inch height type that have the capacity to treat 22.5 gpm per filter. Because a 1.07-acres portion will not drain into the detention and water quality facility, the system will be sized as if the basin was draining into it. This will allow the future upstream development to be treated by the facility. Table 5 below identifies flow rates and required treatment filters. Appendix E contains the analysis and a generic plan of the Contech system.

Table 5

Storm Event	Basin 1A & 1B WQ Flow Rate (cfs)	Basin 1A & 1B WQ Flow Rate (gpm)	Required Filters	System Capacity (Filters)
WQ	2.0	898	40	48

Because of natural slopes that exceed 7 percent for Basin 2, a water quality swale is being proposed downstream to the south and adjacent to the east of Devon Avenue. A post-development basin map is in Appendix A. Because Basin 2A is not capable of being served by a water quality facility, the entire length of Devon Avenue will be treated by the facility as a suitable exchange. Both basins drain to Powell Creek. Table 6 below contains the water quality flow rates as well as the 100-year flow rate for conveyance. Note that Basin 2A are being included in the table. This is being provided to demonstrate that off-site flows will be equal or greater than that basin.

Table 6

Storm Event	Basin 2A WQ Flow Rate (cfs)	Basin 2B WQ Flow Rate (cfs)	Basin OS1 WQ Flow Rate (cfs)	Basin OS2 WQ Flow Rate (cfs)
WQ	0.08 *	0.04	0.14	0.07
100-year		1.12	0.47	2.11

* Will not enter the WQ facility

The program Hydraulic Toolbox 4.2 from the Federal Highway Administration (FHWA) was used to analysis the swale. The calculated WQ flow rate for the swale is 0.25 cfs. A design flow rate of 2.0 cfs was used in the analysis. The swale will have a width of 10-feet with side slopes at 3:1 and a longitudinal slope of 6.0 percent. The analysis yields an average velocity of 0.613 feet per second. With a length of 550-feet, the average hydraulic residence time is calculated to be 897 seconds or 15 minutes, which exceeds the required 9 minutes residence time. The maximum depth is 0.299 feet or 3.6 inches. Below is the computer output of the analysis.

The screenshot shows the 'WQ Analysis' window with the following settings and results:

- Type:** Trapezoidal
- Side Slope 1 (Z1):** 3.0 (H : 1V)
- Side Slope 2 (Z2):** 3.0 (H : 1V)
- Channel Width (B):** 10.0 (ft)
- Pipe Diameter (D):** 0.0 (ft)
- Longitudinal Slope:** 0.06 (ft/ft)
- ☐ Override Default
- Manning's Roughness:** 0.2500
- ☐ Use Lining
- Lining Type:** Woven Paper Net
- ☒ Enter Flow: 2.000 (cfs)
- ☐ Enter Depth: 0.299 (ft)
- Calculate** button
- Plot...** and **Compute Curves...** buttons
- OK** and **Cancel** buttons

Parameter	Value	Unit
Flow	2.000	cfs
Depth	0.299	ft
Area of Flow	3.260	sq ft
Wetted Perimeter	11.892	ft
Hydraulic Radius	0.274	ft
Average Velocity	0.613	fps
Top Width (T)	11.795	ft
Froude Number	0.206	
Critical Depth	0.106	ft
Critical Velocity	1.822	fps
Critical Slope	1.94853	ft/ft
Critical Top Width	10.638	ft
Max Shear Stress	1.120	lb/ft ²
Avg Shear Stress	1.026	lb/ft ²

The calculated 100-year flow rate of 3.70 cfs was used in the analysis. The analysis yields an average velocity of 2.92 feet per second. The maximum depth is 0.122 feet or 1.5 inches. Below is the computer output of the analysis.

Conveyance Analysis

Type: Trapezoidal Define...

Side Slope 1 (Z1): 3.0 H : 1V

Side Slope 2 (Z2): 3.0 H : 1V

Channel Width (B): 10.0 (ft)

Pipe Diameter (D): 0.0 (ft)

Longitudinal Slope: 0.06 (ft/ft)

☐ Override Default

Manning's Roughness: 0.0300

☐ Use Lining

Lining Type: Woven Paper Net

☒ Enter Flow: 3.700 (cfs)

☐ Enter Depth: 0.122 (ft)

Calculate

Plot... Compute Curves...

OK Cancel

Parameter	Value	Unit
Flow	3.700	cfs
Depth	0.122	ft
Area of Flow	1.267	sq ft
Wetted Perimeter	10.773	ft
Hydraulic Radius	0.118	ft
Average Velocity	2.920	fps
Top Width (T)	10.733	ft
Froude Number	1.498	
Critical Depth	0.159	ft
Critical Velocity	2.215	fps
Critical Slope	0.02471	ft/ft
Critical Top Width	10.957	ft
Max Shear Stress	0.458	lb/ft ²
Avg Shear Stress	0.440	lb/ft ²

CONCLUSION

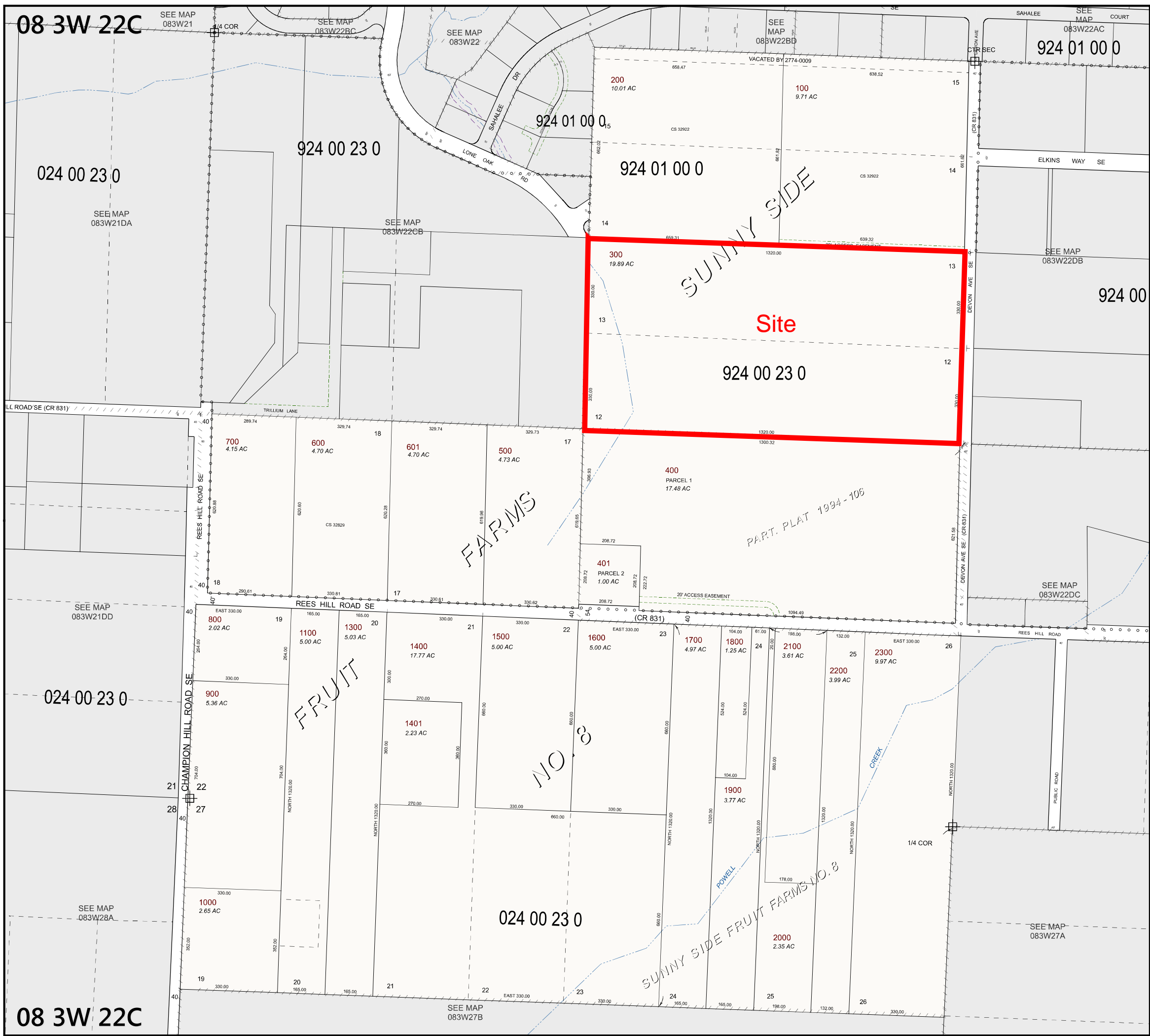
Based on the presented information, the preliminary design can meet the City of Salem water quality and quantity standards. If there are any questions regarding this analysis or the design, please contact Matthew Hendrick at Multi/Tech Engineering by phone at (503) 363-9227 or via e-mail at mhendrick@mtengineering.net.



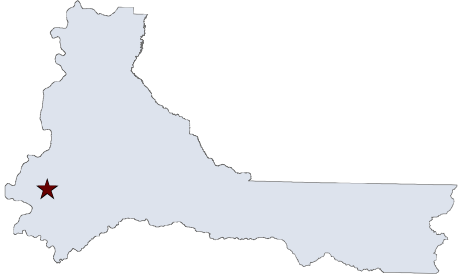
Appendix A

08 3W 22C

08 3W 22C



08 3W 22C
SALEM



MARION COUNTY, OREGON
SW1/4 SEC22 T8S R3W W.M.
SCALE 1" = 200'

LEGEND

- LINE TYPES
- Taxlot Boundary
 - Road Right-of-Way
 - Railroad Right-of-Way
 - Private Road ROW
 - Subdivision/Plat Bndry
 - Waterline - Taxlot Bndry
 - Historical Boundary
 - Easement
 - Railroad Centerline
 - Taxcode Line
 - Map Boundary
 - Waterline - Non Bndry

CORNER TYPES

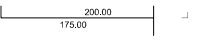
- + 1/16TH Section Cor.
- ⊙ DLC Corner
- ⊕ 1/4 Section Cor.
- ⊕ 16, 15 Section Corner
- ⊕ 21, 22

NUMBERS

- Tax Code Number
- 000 00 00 0
- Acreage 0.25 AC
- All acres listed are Net Acres, excluding any portions of the taxlot within public ROWs

NOTES

Tick Marks: A tick mark in the road indicates that the labeled dimension extends into the public ROW



CANCELLED NUMBERS

1200			
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DISCLAIMER: THIS MAP WAS PREPARED FOR ASSESSMENT PURPOSES ONLY



Assessors Office
Cartography Dept

FOR ADDITIONAL MAPS VISIT OUR WEBSITE AT
www.co.marion.or.us

PLOT DATE: 1/24/2018

SALEM
08 3W 22C

DEVON ESTATES

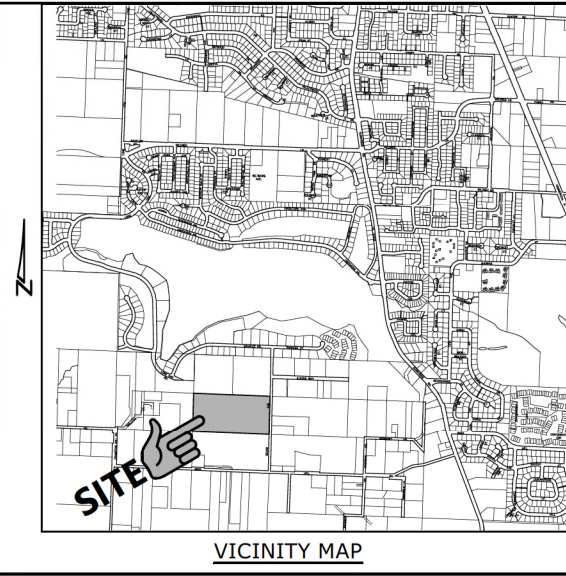
SEC. 22, T. 8 S., R. 3 W., W.M.
CITY OF SALEM
MARION COUNTY, OREGON

Owner / Developer:

HSF Development, LLC

3245 BOONE ROAD SE
SALEM, OREGON 97317

T.B.M. 487.21 NGVD 29
ALUMINUM CAP CENTERLINE MONUMENT
AT THE INTERSECTION OF SAHALEE DR.
AND LONE OAK ROAD



VICINITY MAP



Drawing is Not to Scale

UTILITIES:
CABLE _____ COMCAST
POWER _____ P.G.E.
PHONE _____ CENTURY LINK
GAS _____ N.W. NATURAL
STORM DRAIN, _____
SANITARY SEWER, _____
WATER _____ CITY OF SALEM

PARCEL SIZE:
DEVELOPABLE AREA _____ 19.745 Ac.

NUMBER OF UNITS _____ 85
DENSITY _____ 4.30 UNITS/AC.
LARGEST _____ 10,727 S.F.
SMALLEST _____ 5,933 S.F.
AVERAGE _____ 6,884 S.F.

EXISTING ZONE _____ RA

PRELIMINARY SHEET INDEX

SHEET P101 COVER SHEET
SHEET P102 EXISTING CONDITIONS PLAN — ONSITE
SHEET P103 EXISTING CONDITIONS PLAN — OFFSITE
SHEET P104 TREE CONSERVATION PLAN
SHEET P201 SITE PLAN
SHEET P301 UTILITY PLAN
SHEET P302 GRADING & DRAINAGE PLAN — ONSITE
SHEET P303 GRADING & DRAINAGE PLAN — OFFSITE
SHEET P401 STREET PLAN & PROFILE — LONE OAK RD.
SHEET P402 STREET PLAN & PROFILE — ONE AVE.
SHEET P403 STREET PLAN & PROFILE — TWO AVE.
SHEET P404 STREET PLAN & PROFILE — THREE ST.
SHEET P405 STREET PLAN & PROFILE — FOUR ST.
SHEET P406 STREET PLAN & PROFILE — FIVE ST.

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COVER SHEET

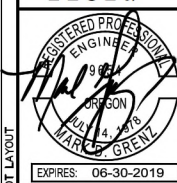
DEVON ESTATES

NO CHANGES, MODIFICATIONS
OR REPRODUCTIONS TO BE
MADE TO THESE DRAWINGS
WITHOUT WRITTEN
AUTHORIZATION FROM THE
DESIGN ENGINEER.

DIMENSIONS & NOTES TAKE
PRECEDENCE OVER
GRAPHICAL REPRESENTATION.

P.H.S. 06/25/2019

Design: M.D.G.
Drawn: P.H.S.
Checked: B.M.G.
Date: NOV. 2017
Scale: AS SHOWN



JOB # 6502

P101



EXISTING CONDITIONS PLAN

DEVON ESTATES

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OR REPRODUCTIONS TO BE
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DESIGN ENGINEER.

Design: M.D.G.
 Drawn: P.H.S.
 Checked: B.M.G.
 Date: NOV. 2017
 Scale: AS SHOWN



JOB # 650

P102



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PREDEVELOPED
BASIN MAP



NOT TO SCALE

#2A-(OFFSITE)
1.115 Ac.*

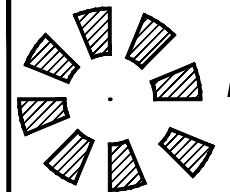
#2B-(OFFSITE)
0.122 Ac.*

BASIN #1
12.06 Acres**

BASIN #2A
5.39 Acres**

BASIN #2B
2.30 Acres**

* IMPERVIOUS SURFACE HSG C CN = 98
** CITY OF SALEM PREDEVELOPED HSG C CN=79

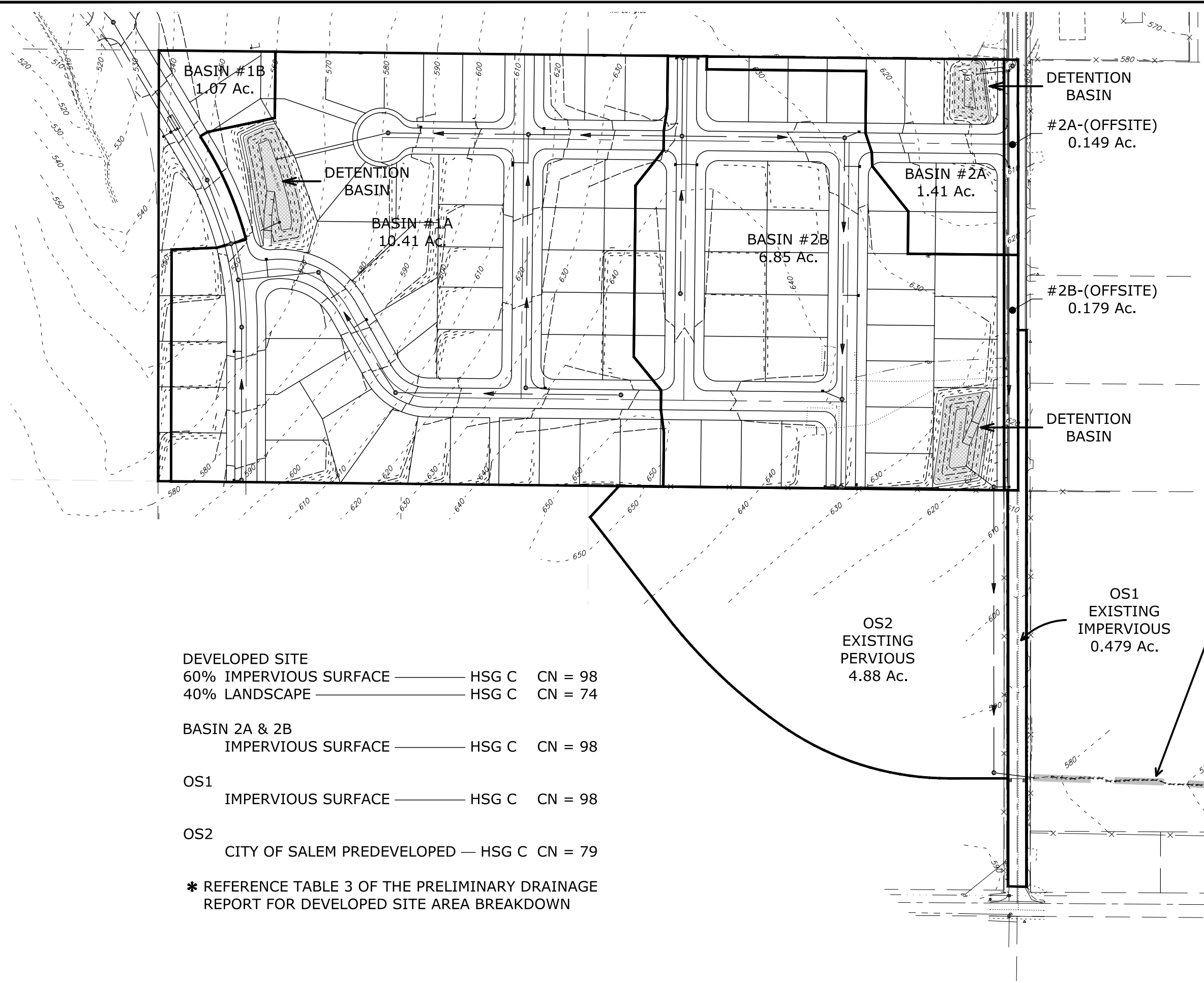
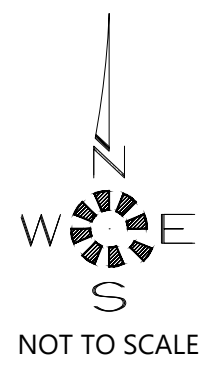


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POST-DEVELOPED
BASIN MAP



- DEVELOPED SITE

60% IMPERVIOUS SURFACE ——— HSG C CN = 98

40% LANDSCAPE ——— HSG C CN = 74
- BASIN 2A & 2B

IMPERVIOUS SURFACE ——— HSG C CN = 98
- OS1

IMPERVIOUS SURFACE ——— HSG C CN = 98
- OS2

CITY OF SALEM PREDEVELOPED — HSG C CN = 79
- * REFERENCE TABLE 3 OF THE PRELIMINARY DRAINAGE REPORT FOR DEVELOPED SITE AREA BREAKDOWN

PROPOSED W.Q. SWALE
 LENGTH = 550'
 WIDTH = 10'
 SLOPE = 6%
 DEPTH = 12"

J:\6500-6599\6502-DevonAvenueSubdivision\Draw\6502p.dwg, BASIN2, 7/1/2019 11:34:23 AM, P Saunders



Appendix B



United States
Department of
Agriculture

NRCS

Natural
Resources
Conservation
Service

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

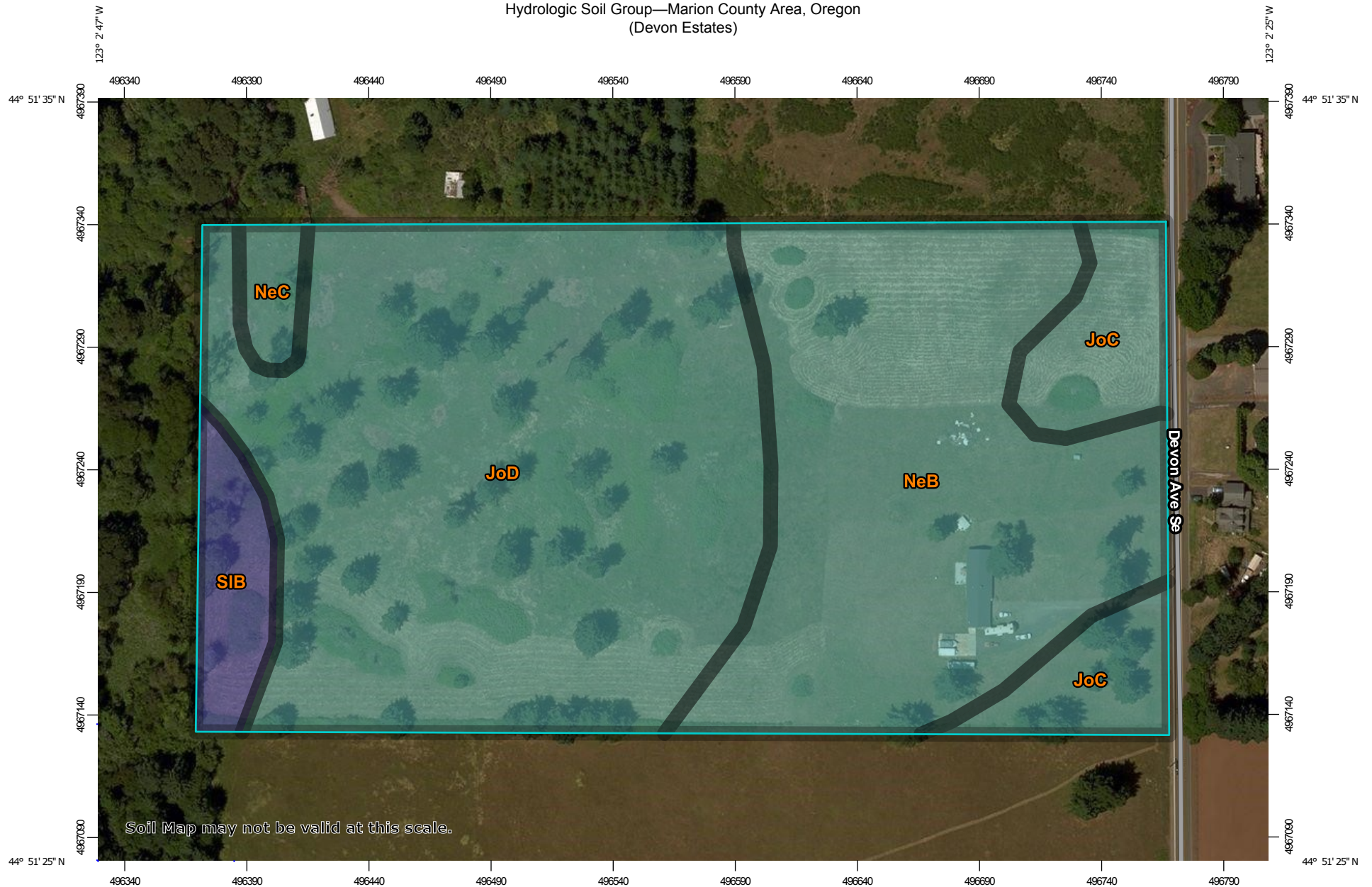
Custom Soil Resource Report for **Marion County Area, Oregon**

Devon Estates

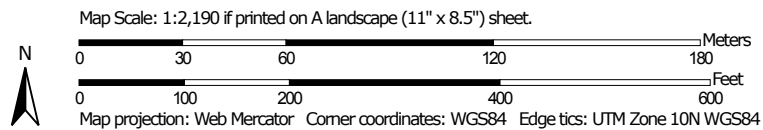


October 11, 2018

Hydrologic Soil Group—Marion County Area, Oregon (Devon Estates)




Soil Map may not be valid at this scale.



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 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Marion County Area, Oregon
 Survey Area Data: Version 15, Sep 18, 2018

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

Date(s) aerial images were photographed: Jun 15, 2015—Jun 23, 2015

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
JoC	Jory silty clay loam, 7 to 12 percent slopes	C	1.8	8.8%
JoD	Jory silty clay loam, 12 to 20 percent slopes	C	10.3	50.5%
NeB	Nekia silty clay loam, 2 to 7 percent slopes	C	7.1	34.7%
NeC	Nekia silty clay loam, 7 to 12 percent slopes	C	0.4	1.8%
SIB	Salkum silty clay loam, basin, 0 to 6 percent slopes	B	0.8	4.1%
Totals for Area of Interest			20.5	100.0%

Description

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.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

All roof drainage should be directed into conduits that carry runoff water away from the residential structures to a suitable outfall. Roof downspouts should not be connected to foundation drains. A minimum ground slope of about 2 percent is generally recommended in unpaved areas around the proposed new residential structures.

Groundwater was not encountered at the site in any of the exploratory test pits (TH-#1 through TH-#8) at the time of excavation to depths of at least 7 feet beneath existing site grades. Additionally, surface water ponding was not observed at the site during our field exploration work. However, the northeasterly portion of the site contains an existing seasonal drainage basin feature. Further, groundwater elevations in the area and/or across the subject property may fluctuate seasonally and may temporarily pond/perch near the ground surface during periods of prolonged rainfall.

As such, based on our current understand of the possible site grading required to bring the subject site and/or residential lots to finish design grade(s), we are of the opinion that an underslab drainage system is not required for the proposed single-family residential structures. However, a perimeter foundation drain is recommended for any perimeter footings and/or below grade retaining walls. A typical recommended perimeter footing/retaining wall drain detail is shown on Figure No. 4. Further, due to our understanding that various surface infiltration ditches and/or swales may be utilized for the project as well as the relatively low infiltration rates of the near surface sandy, clayey silt subgrade soils anticipated within and/or near to the foundation bearing level of the proposed residential structures, we are generally of the opinion that storm water detention and/or disposal systems should not be utilized within the residential lots and/or around the proposed residential structures unless approved by the Geotechnical Engineer.

Design Infiltration Rates

Based on the results of our field infiltration testing, we recommend using the following infiltration rate to design any on-site near surface storm water infiltration and/or disposal systems for the project:

Subgrade Soil Type	Recommended Infiltration Rate
sandy, clayey SILT (ML)	0.3 to 0.4 inches per hour (in/hr)

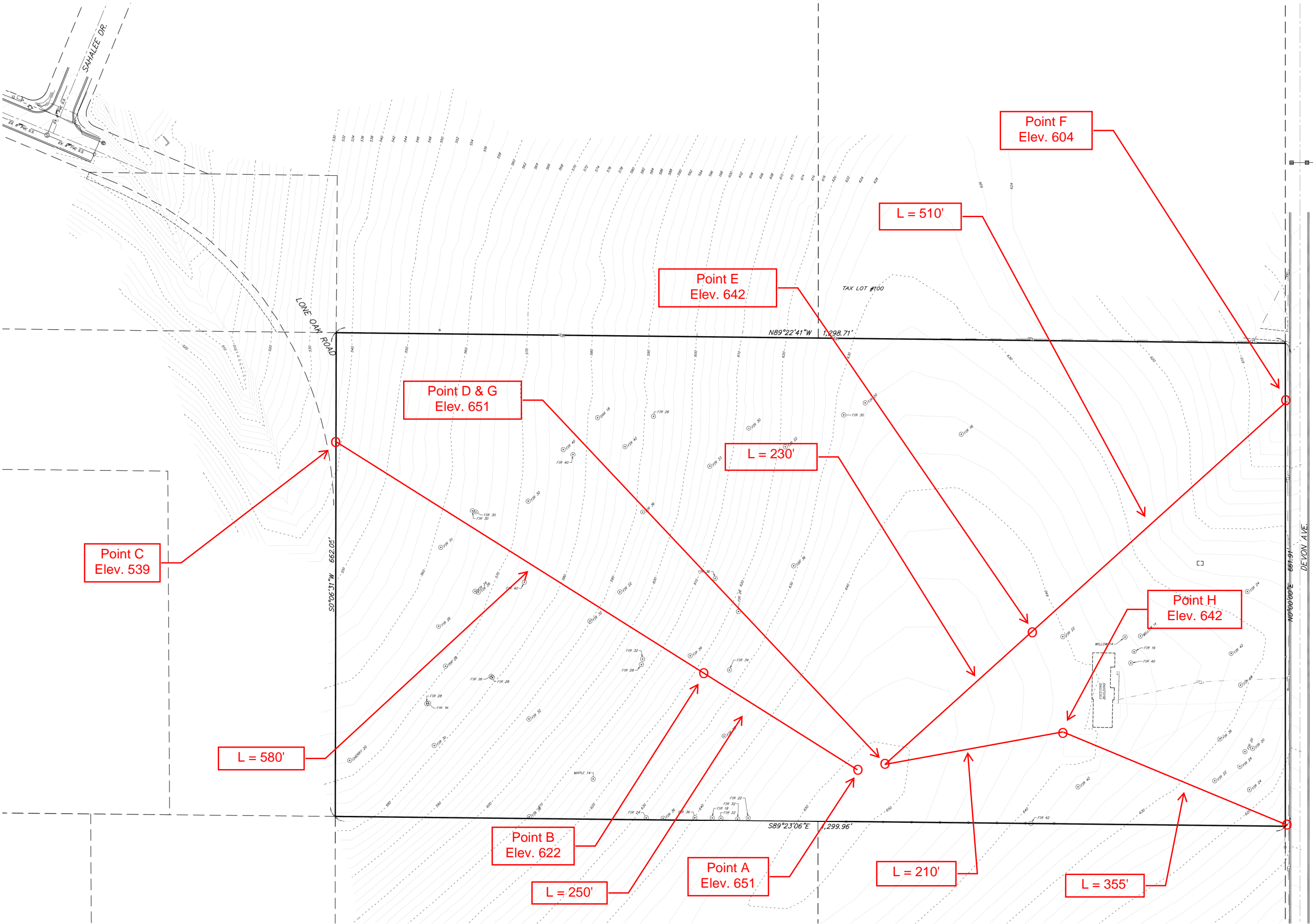
Note: A safety factor of two (2) was used to calculate the above recommended design infiltration rate. Additionally, given the gradational variability of the on-site sandy, clayey sit subgrade soils beneath the site as well as the anticipation of some site grading for the project, it is generally recommended that field testing be performed during and/or following construction of any on-site storm water infiltration system(s) in order to confirm that the above recommended design infiltration rates are appropriate.



Appendix C

Time of Concentration

Drawing is NOT to Scale



MULTI/TECH

ENGINEERING SERVICES, INC.

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www.mtengineering.net office@mtengineering.net

EXISTING
CONDITIONS
PLAN

DEVON ESTATES

NO CHANGES, MODIFICATIONS
OR REPRODUCTIONS TO BE
MADE TO THESE DRAWINGS
WITHOUT WRITTEN
AUTHORIZATION FROM THE
DESIGN ENGINEER.
DIMENSIONS & NOTES TAKE
PRECEDENCE OVER
GRAPHICAL REPRESENTATION.

Design: M.D.G.
Drawn: P.H.S.
Checked: B.M.G.
Date: NOV. 2017
Scale: AS SHOWN

REGISTERED PROFESSIONAL
ENGINEER
6554
JUN 14 2017
MARK D. GREIN

EXPIRES: 06-30-2019

JOB # 6502

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project Devon Estates (Basin #1)	By M. Hendrick	Date 10/2018
Location Salem, Oregon	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Segment ID	A-B	
1. Surface description (Table 4D-4)	Meadow/Pasture/Farm	
2. Manning's roughness coefficient, n (Table 4D-4)	0.15	
3. Flow length, L (total L + 300 ft) ft	250	
4. Two-year 24-hour rainfall, P ₂ in	2.2	
5. Land slope, s ft/ft	0.116	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr	0.20	+
		= 0.20

Shallow concentrated flow

Segment ID	B-C	
7. Surface description (paved or unpaved)	Forest & Meadow	
8. Flow length, Lft	580	
9. Watercourse slope, s ft/ft	0.143	
10. Average velocity, V (figure 3-1) ft/s	0.95	
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr	0.17	+
		= 0.17

Channel flow

Segment ID		
12. Cross sectional flow area, a ft ²		
13. Wetted perimeter, p _w ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15. Channel slope, s ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute Vft/s		
18. Flow length, L ft		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr		+
20. Watershed or subarea T _c or T _t (add T _t in steps 6, 11, and 19) Hr		= 0.37

0.37 Hrs = 22.2 Minutes

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project Devon Estates (Basin #2)	By M. Hendrick	Date 10/2018
Location Salem, Oregon	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

	Segment ID	D-E	
1. Surface description (Table 4D-4)		Meadow/Pasture/Farm	
2. Manning's roughness coefficient, n (Table 4D-4)		0.15	
3. Flow length, L (total L \geq 300 ft) ft		230	
4. Two-year 24-hour rainfall, P_2 in		2.2	
5. Land slope, s ft/ft		0.039	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T_t hr		0.29	+
			= 0.29

Shallow concentrated flow

	Segment ID	E-F	
7. Surface description (paved or unpaved)		Pasture	
8. Flow length, L ft		510	
9. Watercourse slope, s ft/ft		0.075	
10. Average velocity, V (figure 3-1) ft/s		2.0	
11. $T_t = \frac{L}{3600 V}$ Compute T_t hr		0.07	+
			= 0.07

Channel flow

	Segment ID		
12. Cross sectional flow area, a ft ²			
13. Wetted perimeter, p_w ft			
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft			
15. Channel slope, s ft/ft			
16. Manning's roughness coefficient, n			
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute V ft/s			
18. Flow length, L ft			
19. $T_t = \frac{L}{3600 V}$ Compute T_t hr			+
20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) Hr			= 0.36

0.36 Hrs = 21.6 Minutes

Worksheet 3: Time of Concentration (T_c) or travel time (T_t)

Project Devon Estates (Basin #3)	By M. Hendrick	Date 5/2019
Location Salem, Oregon	Checked	Date

Check one: ☐ Present ☐ Developed

Check one: ☐ T_c ☐ T_t through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)

Segment ID	G-H	
1. Surface description (Table 4D-4)	Meadow/Pasture/Farm	
2. Manning's roughness coefficient, n (Table 4D-4)	0.15	
3. Flow length, L (total L + 300 ft) ft	210	
4. Two-year 24-hour rainfall, P ₂ in	2.2	
5. Land slope, s ft/ft	0.043	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} s^{0.4}}$ Compute T _t hr	0.26	+ = 0.26

Shallow concentrated flow

Segment ID	H-I	
7. Surface description (paved or unpaved)	Pasture	
8. Flow length, Lft	355	
9. Watercourse slope, s ft/ft	0.079	
10. Average velocity, V (figure 3-1) ft/s	2.0	
11. $T_t = \frac{L}{3600 V}$ Compute T _t hr	0.05	+ = 0.05

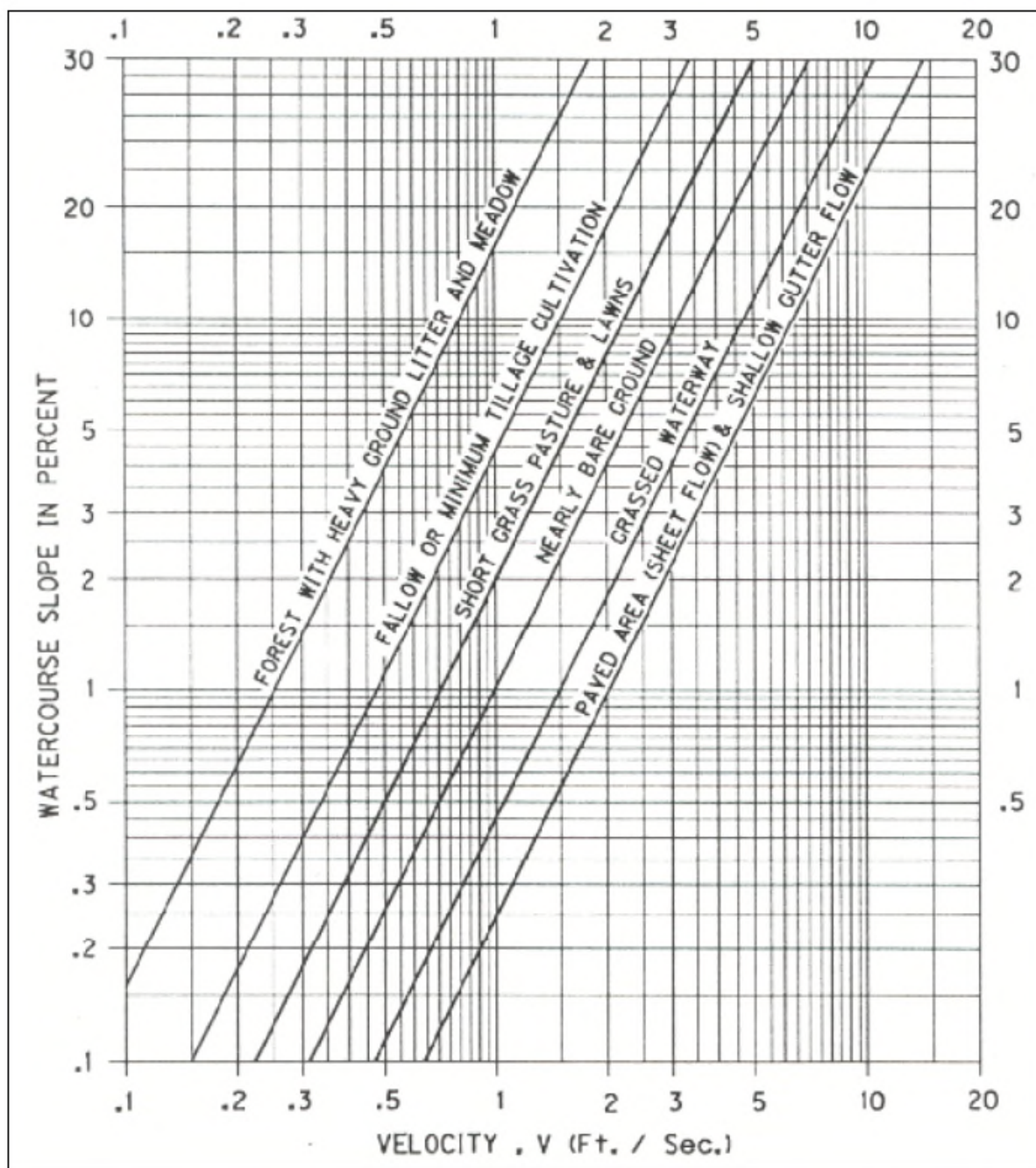
Channel flow

Segment ID		
12. Cross sectional flow area, a ft ²		
13. Wetted perimeter, p _w ft		
14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ft		
15. Channel slope, s ft/ft		
16. Manning's roughness coefficient, n		
17. $V = \frac{1.49 r^{2/3} s^{1/2}}{n}$ Compute Vft/s		
18. Flow length, L ft		
19. $T_t = \frac{L}{3600 V}$ Compute T _t hr		+ =
20. Watershed or subarea T _c or T _t (add T _t in steps 6, 11, and 19) Hr		0.31

0.31 Hrs = 18.6 Minutes

Manning's Roughness Coefficients for Overland Sheet Flow	
Surface Types:	n
Impervious Areas	0.014
Gravel Pavement	0.02
Developed: Landscape Areas (Except Lawns)	0.08
Undeveloped: Meadow, Pasture, or Farm	0.15
Developed: Lawns	0.24
Pre-developed: Mixed	0.30
Pre-developed: Woodland and Forest	0.40
Development Types:	n
Commercial Development	0.015
Industrial Development, Heavy	0.04
Industrial Development, Light	0.05
Dense Residential (over 6 units/acre)	0.08
Normal Residential (3 to 6 units/acre)	0.20
Light Residential (1 to 3 units/acre)	0.30
Parks	0.40

Table 4D-4. Manning's Roughness Coefficients for Overland Sheet Flow





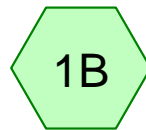
Appendix D



Developed Conditions
Basin #1A



Existing Conditions
Basin #1



Developed Conditions
Basin #1B



Existing Conditions
Basin #2A



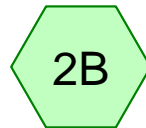
Developed Conditions
Basin #2A



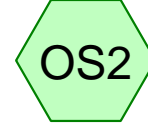
Devon Ave Impervious



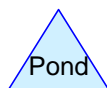
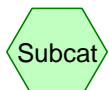
Existing Conditions
Basin #2B



Developed Conditions
Basin #2B



Existing Conditions
South



Routing Diagram for Devon Estates Hydrology

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Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr Half of 2-year Rainfall=1.10"

Printed 5/1/2019

Summary for Subcatchment Ex1: Existing Conditions Basin #1

Runoff = 0.09 cfs @ 18.85 hrs, Volume= 4,383 cf, Depth= 0.10"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

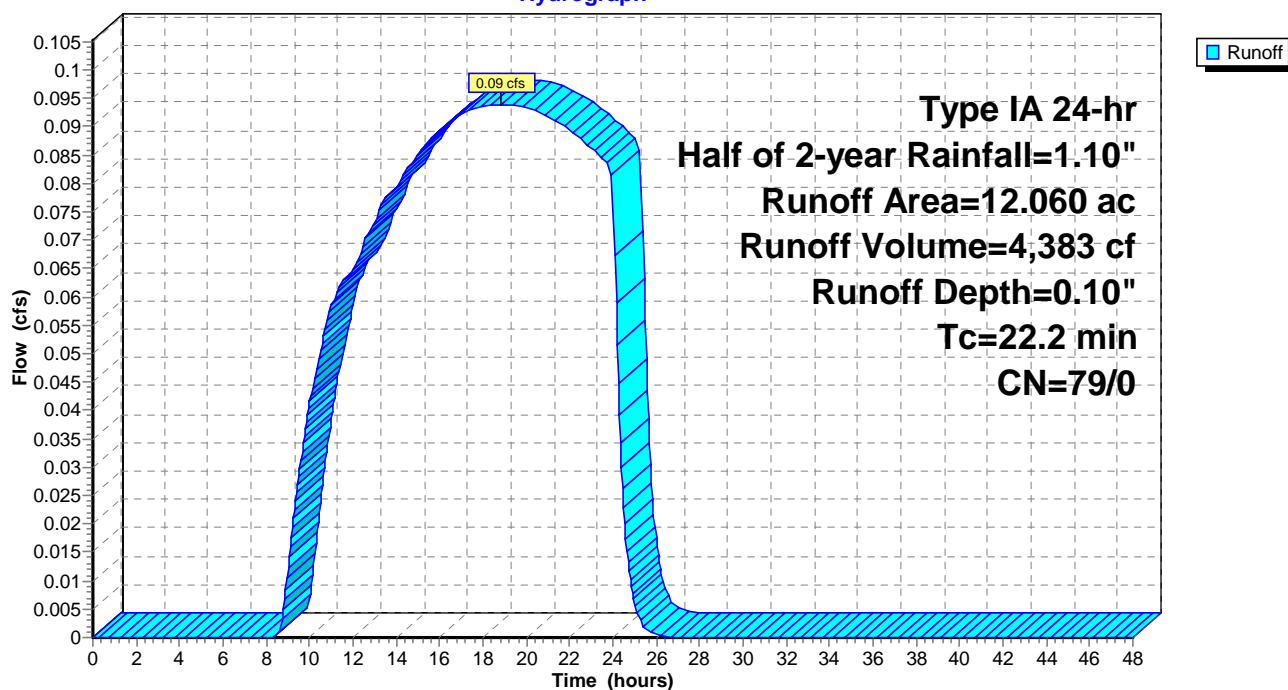
Type IA 24-hr Half of 2-year Rainfall=1.10"

Area (ac)	CN	Description
* 12.060	79	City of Salem Pre-developed, HSG C
12.060	79	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.2					Direct Entry, TR-55 Worksheet

Subcatchment Ex1: Existing Conditions Basin #1

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr Half of 2-year Rainfall=1.10"

Printed 5/1/2019

Summary for Subcatchment Ex2A: Existing Conditions Basin #2A

Runoff = 0.05 cfs @ 18.46 hrs, Volume= 2,330 cf, Depth= 0.12"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

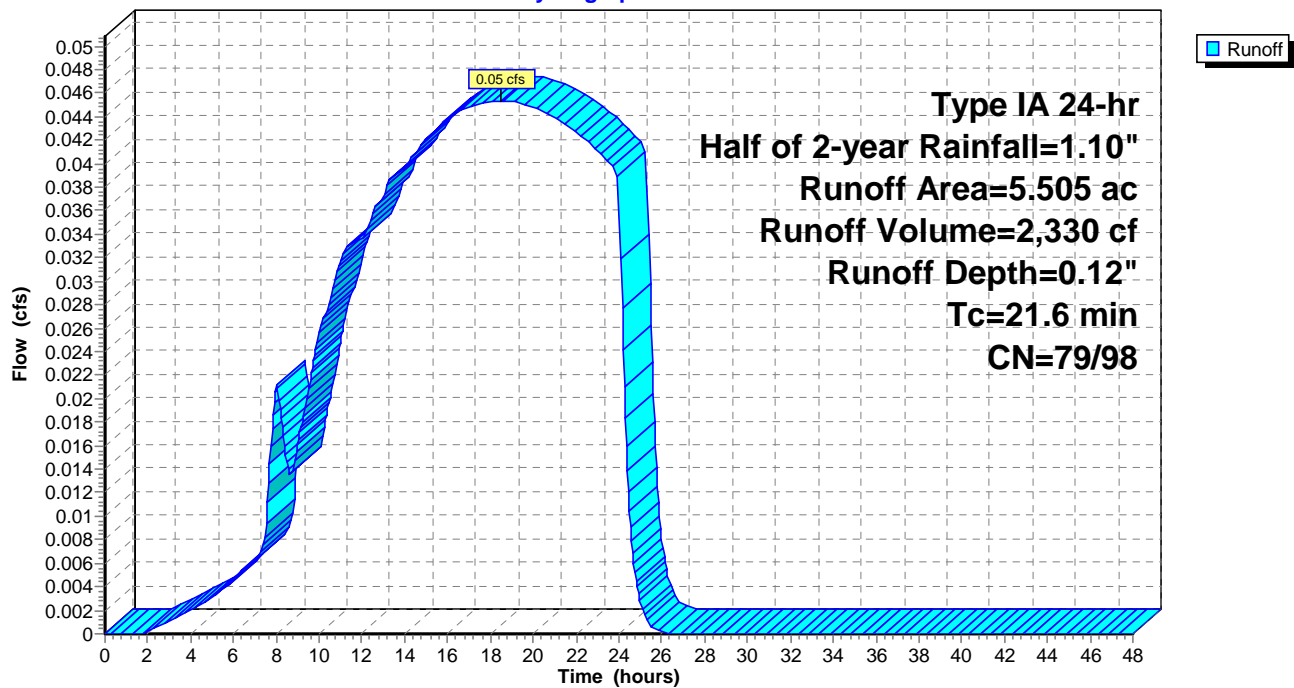
Type IA 24-hr Half of 2-year Rainfall=1.10"

Area (ac)	CN	Description
* 5.390	79	City of Salem Pre-developed, HSG C
0.115	98	Paved roads w/curbs & sewers, HSG C
5.505	79	Weighted Average
5.390	79	97.91% Pervious Area
0.115	98	2.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2A: Existing Conditions Basin #2A

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr Half of 2-year Rainfall=1.10"

Printed 5/1/2019

Summary for Subcatchment Ex2B: Existing Conditions Basin #2B

Runoff = 0.02 cfs @ 8.01 hrs, Volume= 1,229 cf, Depth= 0.14"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

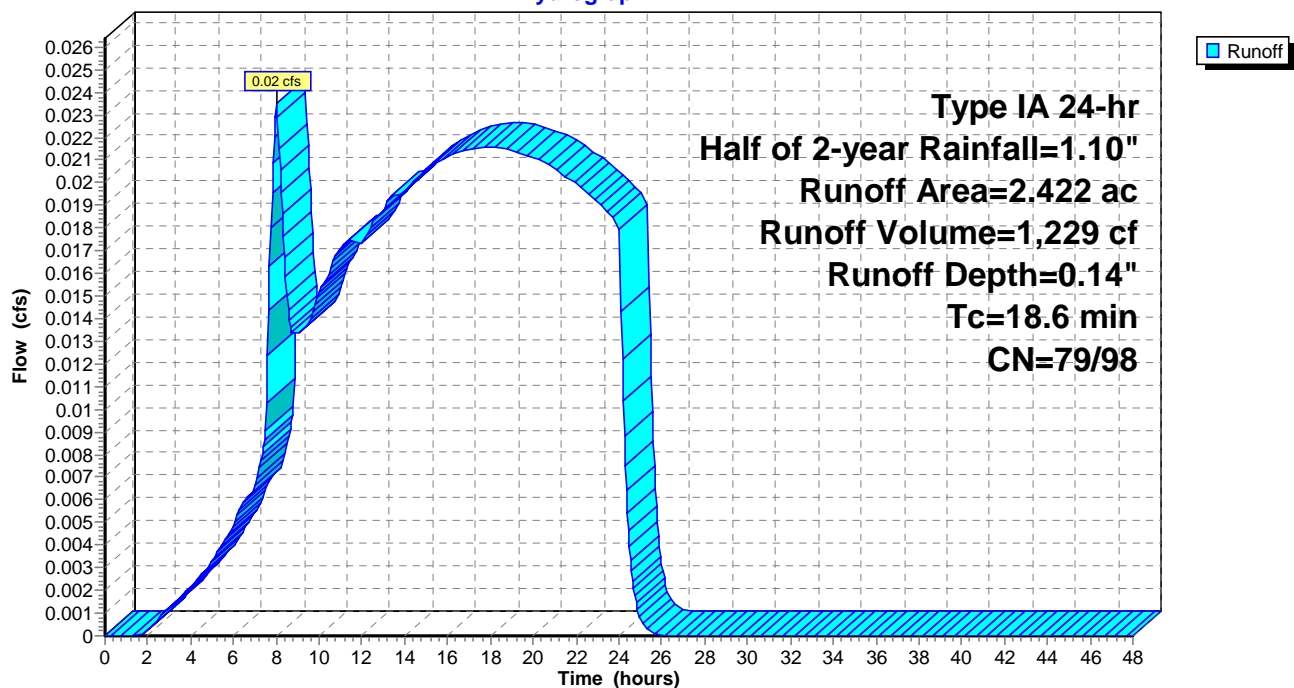
Type IA 24-hr Half of 2-year Rainfall=1.10"

Area (ac)	CN	Description
* 2.300	79	City of Salem Pre-developed, HSG C
0.122	98	Paved roads w/curbs & sewers, HSG C
2.422	80	Weighted Average
2.300	79	94.96% Pervious Area
0.122	98	5.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2B: Existing Conditions Basin #2B

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr Half of 2-year Rainfall=1.10"

Printed 5/1/2019

Summary for Subcatchment 1A: Developed Conditions Basin #1A

Runoff = 1.37 cfs @ 7.98 hrs, Volume= 20,758 cf, Depth= 0.55"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

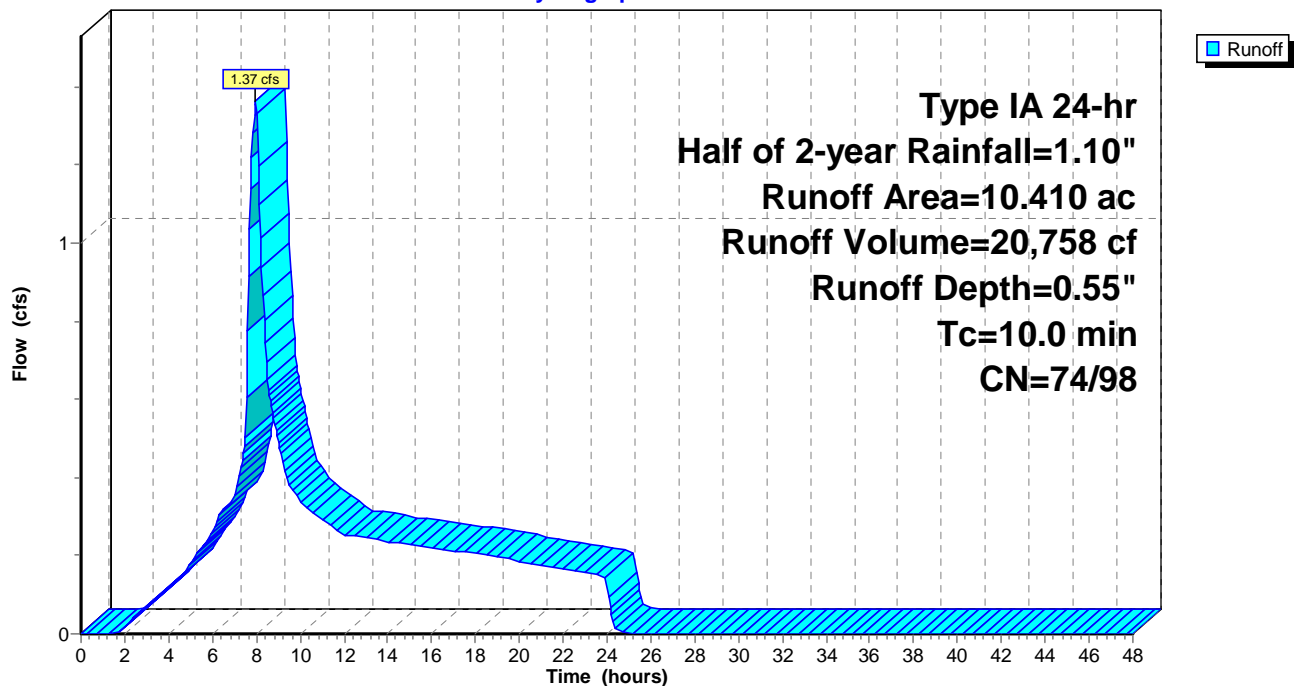
Type IA 24-hr Half of 2-year Rainfall=1.10"

Area (ac)	CN	Description
4.160	74	>75% Grass cover, Good, HSG C
* 6.250	98	Impervious surface, HSG C
10.410	88	Weighted Average
4.160	74	39.96% Pervious Area
6.250	98	60.04% Impervious Area

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

Subcatchment 1A: Developed Conditions Basin #1A

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr Half of 2-year Rainfall=1.10"

Printed 5/1/2019

Summary for Subcatchment 1B: Developed Conditions Basin #1B

Runoff = 0.14 cfs @ 7.98 hrs, Volume= 2,126 cf, Depth= 0.55"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

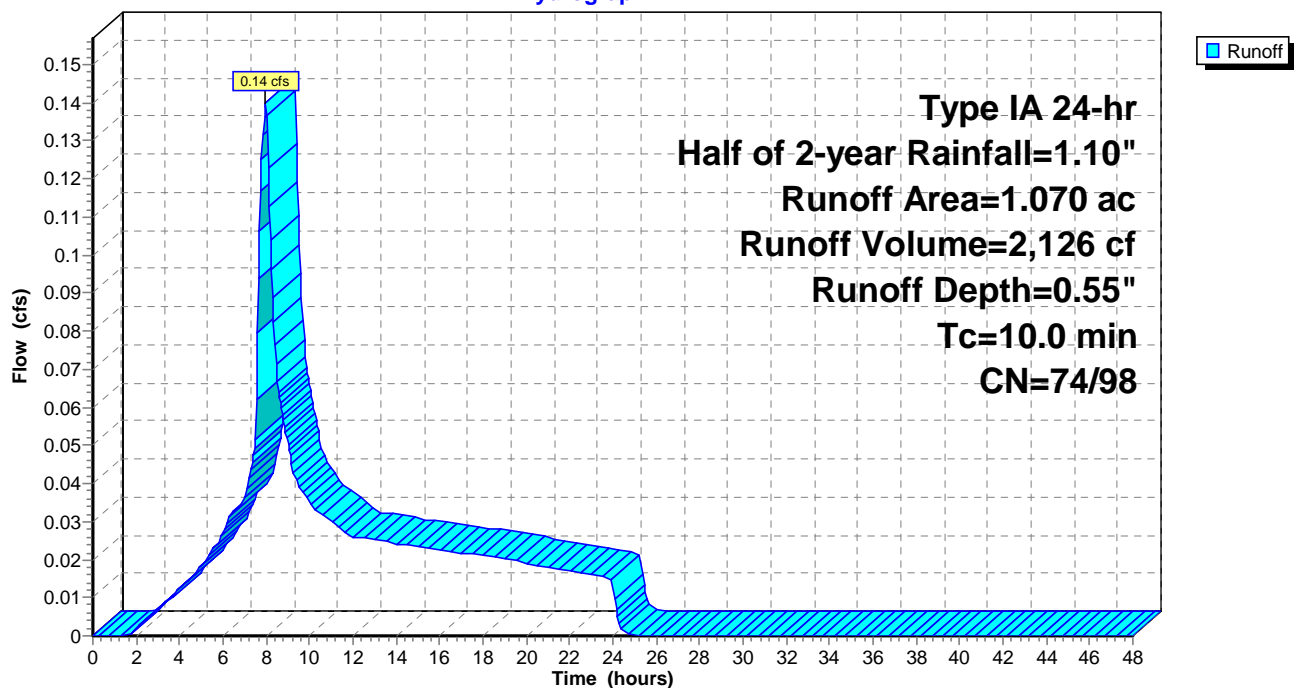
Type IA 24-hr Half of 2-year Rainfall=1.10"

Area (ac)	CN	Description
0.430	74	>75% Grass cover, Good, HSG C
* 0.640	98	Impervious surface, HSG C
1.070	88	Weighted Average
0.430	74	40.19% Pervious Area
0.640	98	59.81% Impervious Area

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

Subcatchment 1B: Developed Conditions Basin #1B

Hydrograph



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Type IA 24-hr Half of 2-year Rainfall=1.10"

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Summary for Subcatchment 2A: Developed Conditions Basin #2A

Runoff = 0.22 cfs @ 7.98 hrs, Volume= 3,272 cf, Depth= 0.58"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

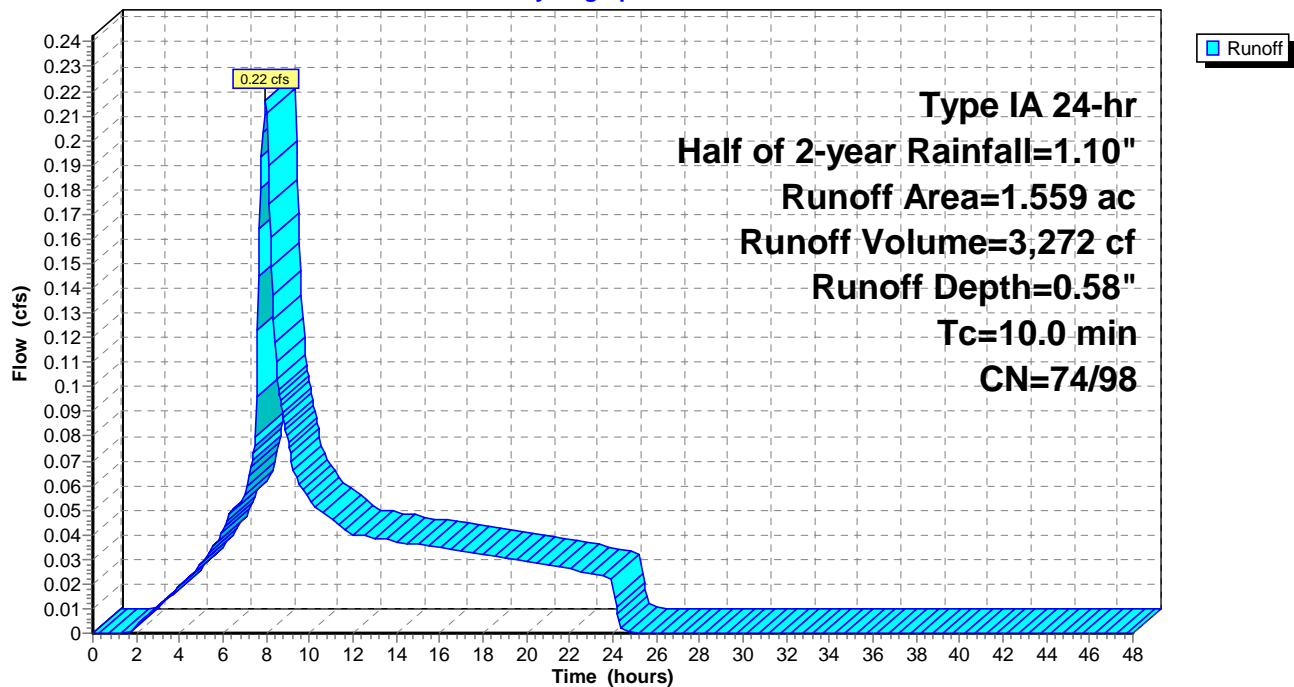
Type IA 24-hr Half of 2-year Rainfall=1.10"

Area (ac)	CN	Description
0.570	74	>75% Grass cover, Good, HSG C
* 0.840	98	Impervious surface, HSG C
0.149	98	Paved roads w/curbs & sewers, HSG C
1.559	89	Weighted Average
0.570	74	36.56% Pervious Area
0.989	98	63.44% Impervious Area

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

Subcatchment 2A: Developed Conditions Basin #2A

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr Half of 2-year Rainfall=1.10"

Printed 5/1/2019

Summary for Subcatchment 2B: Developed Conditions Basin #2B

Runoff = 0.94 cfs @ 7.98 hrs, Volume= 14,228 cf, Depth= 0.56"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

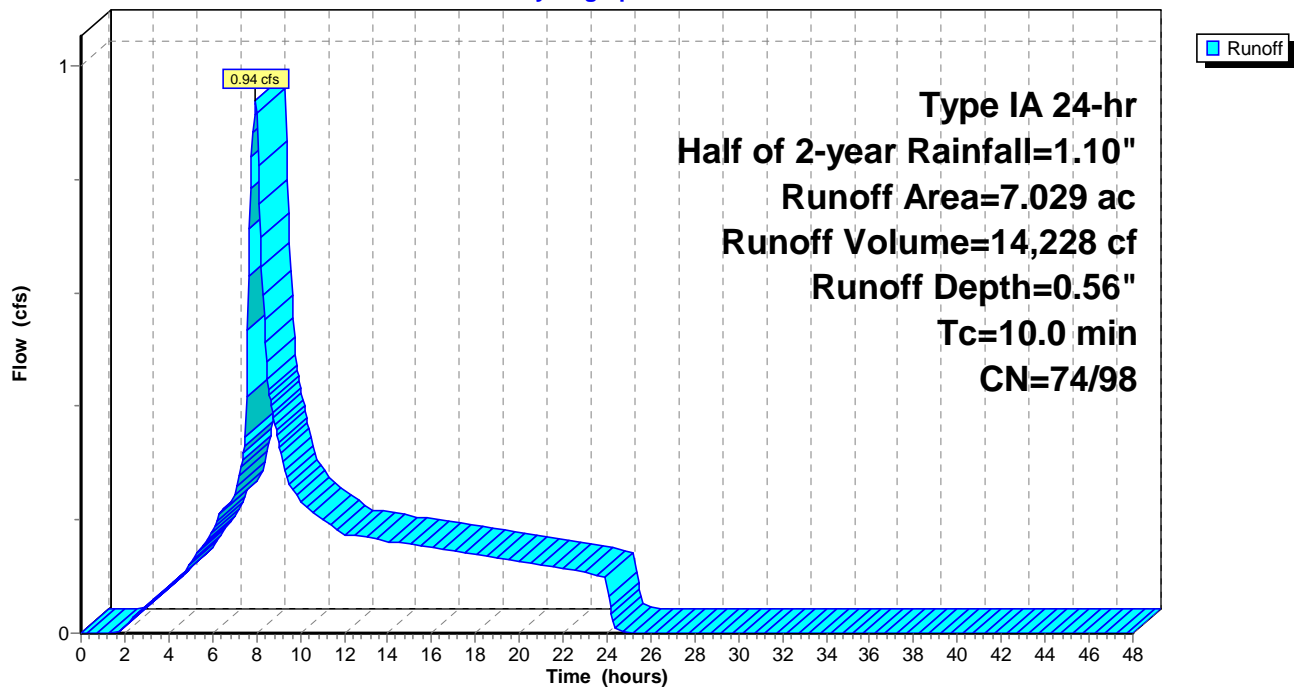
Type IA 24-hr Half of 2-year Rainfall=1.10"

Area (ac)	CN	Description
2.740	74	>75% Grass cover, Good, HSG C
* 4.110	98	Impervious surface, HSG C
0.179	98	Paved roads w/curbs & sewers, HSG C
7.029	89	Weighted Average
2.740	74	38.98% Pervious Area
4.289	98	61.02% Impervious Area

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

Subcatchment 2B: Developed Conditions Basin #2B

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr 10-year Rainfall=3.20"

Printed 5/1/2019

Summary for Subcatchment Ex1: Existing Conditions Basin #1

Runoff = 2.61 cfs @ 8.06 hrs, Volume= 58,518 cf, Depth= 1.34"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

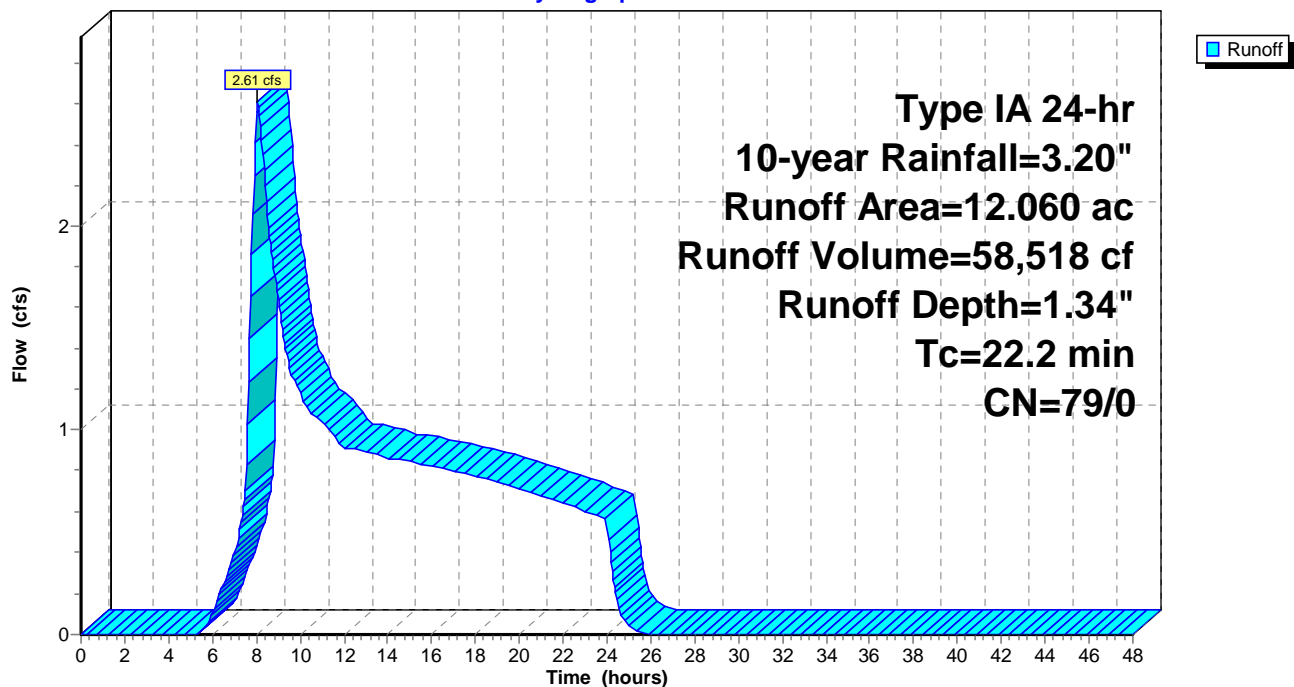
Type IA 24-hr 10-year Rainfall=3.20"

Area (ac)	CN	Description
* 12.060	79	City of Salem Pre-developed, HSG C
12.060	79	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.2					Direct Entry, TR-55 Worksheet

Subcatchment Ex1: Existing Conditions Basin #1

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr 10-year Rainfall=3.20"

Printed 5/1/2019

Summary for Subcatchment Ex2A: Existing Conditions Basin #2A

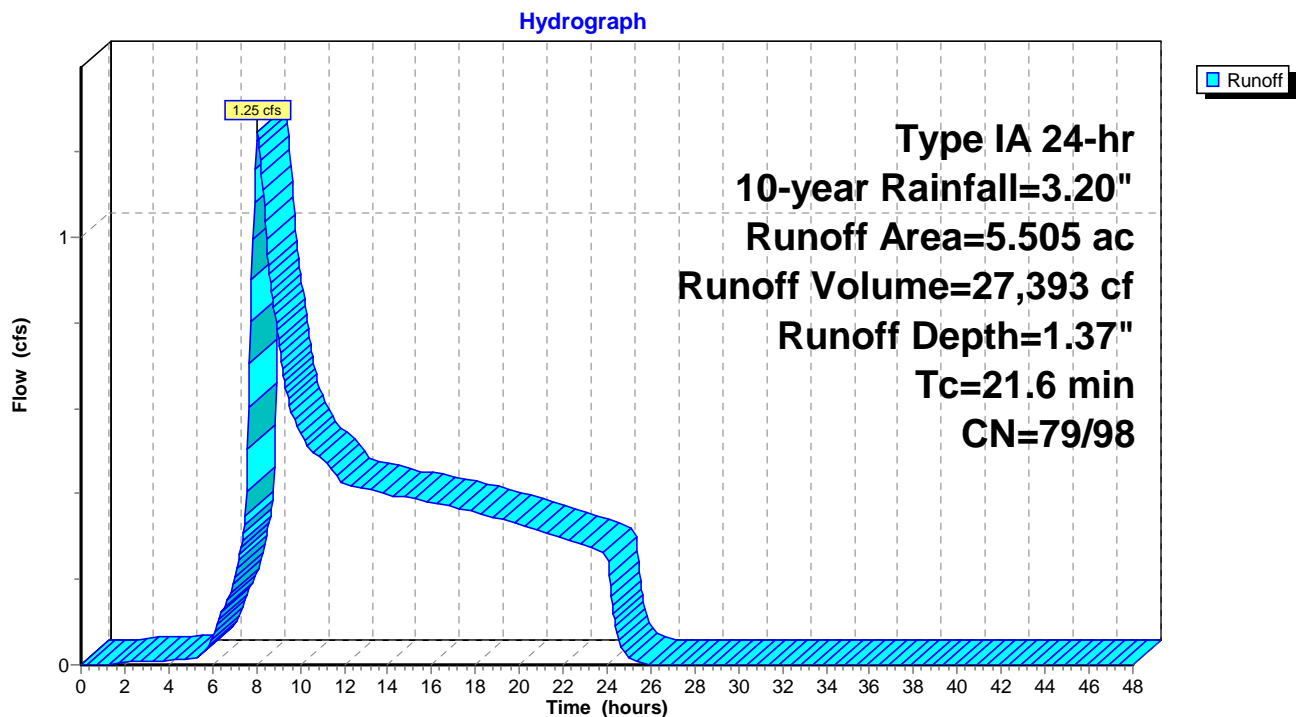
Runoff = 1.25 cfs @ 8.05 hrs, Volume= 27,393 cf, Depth= 1.37"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=3.20"

Area (ac)	CN	Description
* 5.390	79	City of Salem Pre-developed, HSG C
0.115	98	Paved roads w/curbs & sewers, HSG C
5.505	79	Weighted Average
5.390	79	97.91% Pervious Area
0.115	98	2.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2A: Existing Conditions Basin #2A



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Type IA 24-hr 10-year Rainfall=3.20"

Printed 5/1/2019

Summary for Subcatchment Ex2B: Existing Conditions Basin #2B

Runoff = 0.61 cfs @ 8.04 hrs, Volume= 12,474 cf, Depth= 1.42"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

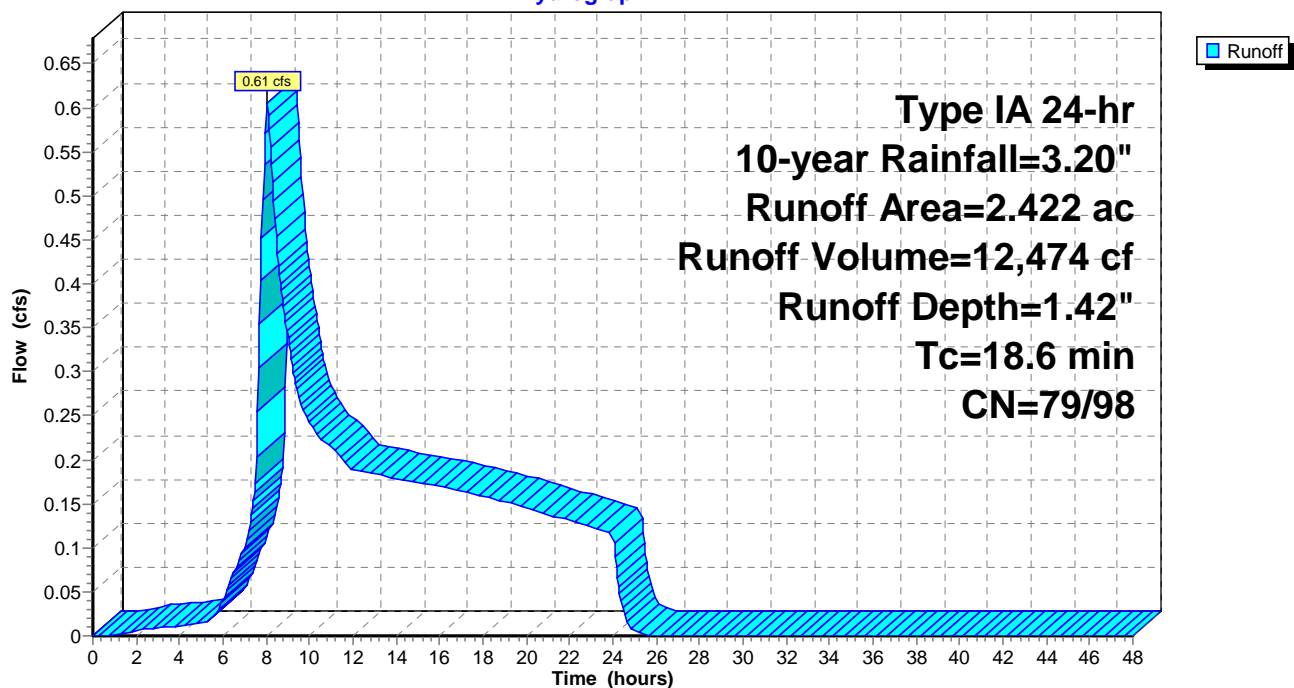
Type IA 24-hr 10-year Rainfall=3.20"

Area (ac)	CN	Description
* 2.300	79	City of Salem Pre-developed, HSG C
0.122	98	Paved roads w/curbs & sewers, HSG C
2.422	80	Weighted Average
2.300	79	94.96% Pervious Area
0.122	98	5.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2B: Existing Conditions Basin #2B

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr 10-year Rainfall=3.20"

Printed 5/1/2019

Summary for Subcatchment 1A: Developed Conditions Basin #1A

Runoff = 5.16 cfs @ 7.98 hrs, Volume= 82,993 cf, Depth= 2.20"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

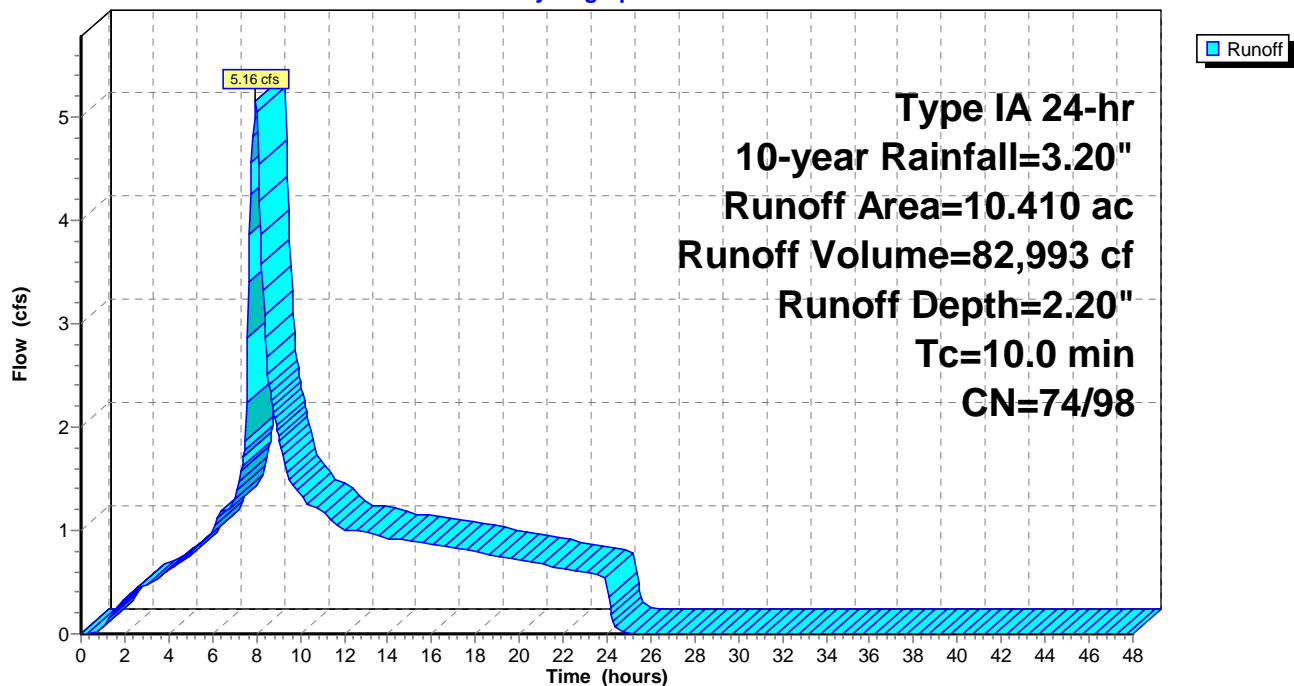
Type IA 24-hr 10-year Rainfall=3.20"

Area (ac)	CN	Description
4.160	74	>75% Grass cover, Good, HSG C
* 6.250	98	Impervious surface, HSG C
10.410	88	Weighted Average
4.160	74	39.96% Pervious Area
6.250	98	60.04% Impervious Area

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

Subcatchment 1A: Developed Conditions Basin #1A

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 10-year Rainfall=3.20"

Printed 5/1/2019

Summary for Subcatchment 1B: Developed Conditions Basin #1B

Runoff = 0.53 cfs @ 7.98 hrs, Volume= 8,514 cf, Depth= 2.19"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

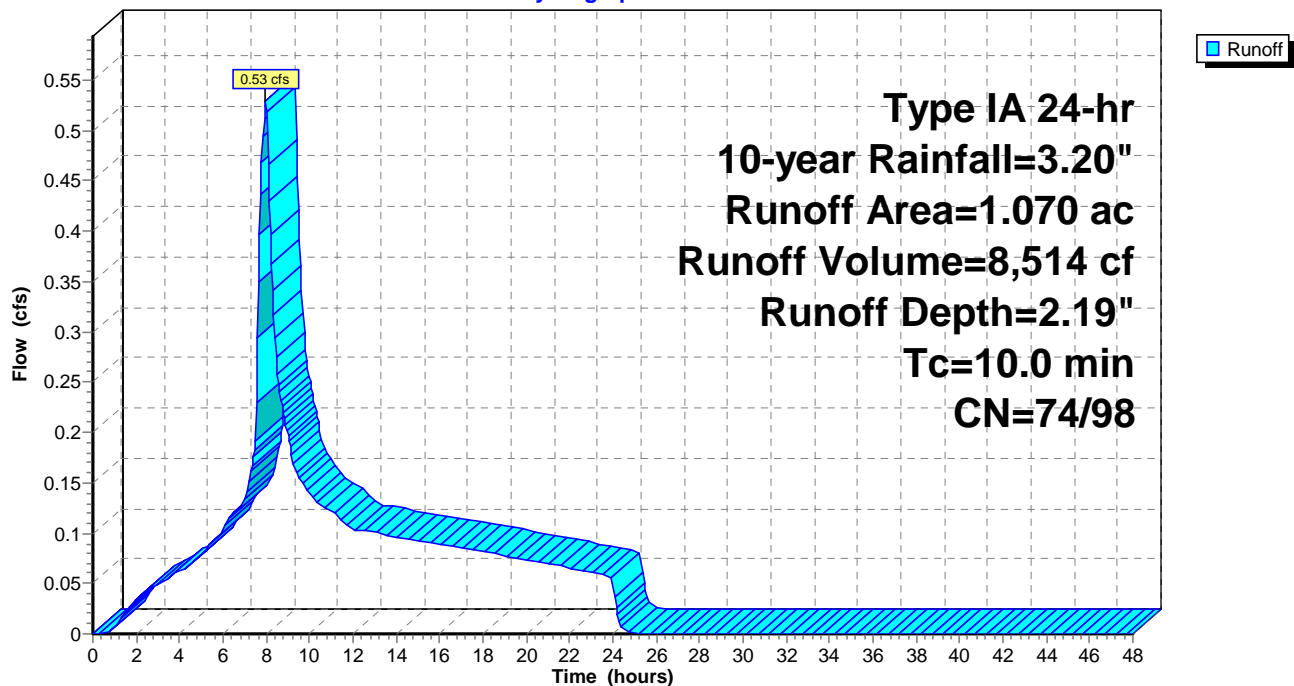
Type IA 24-hr 10-year Rainfall=3.20"

Area (ac)	CN	Description
0.430	74	>75% Grass cover, Good, HSG C
* 0.640	98	Impervious surface, HSG C
1.070	88	Weighted Average
0.430	74	40.19% Pervious Area
0.640	98	59.81% Impervious Area

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

Subcatchment 1B: Developed Conditions Basin #1B

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 10-year Rainfall=3.20"

Printed 5/1/2019

Summary for Subcatchment 2A: Developed Conditions Basin #2A

Runoff = 0.80 cfs @ 7.98 hrs, Volume= 12,800 cf, Depth= 2.26"

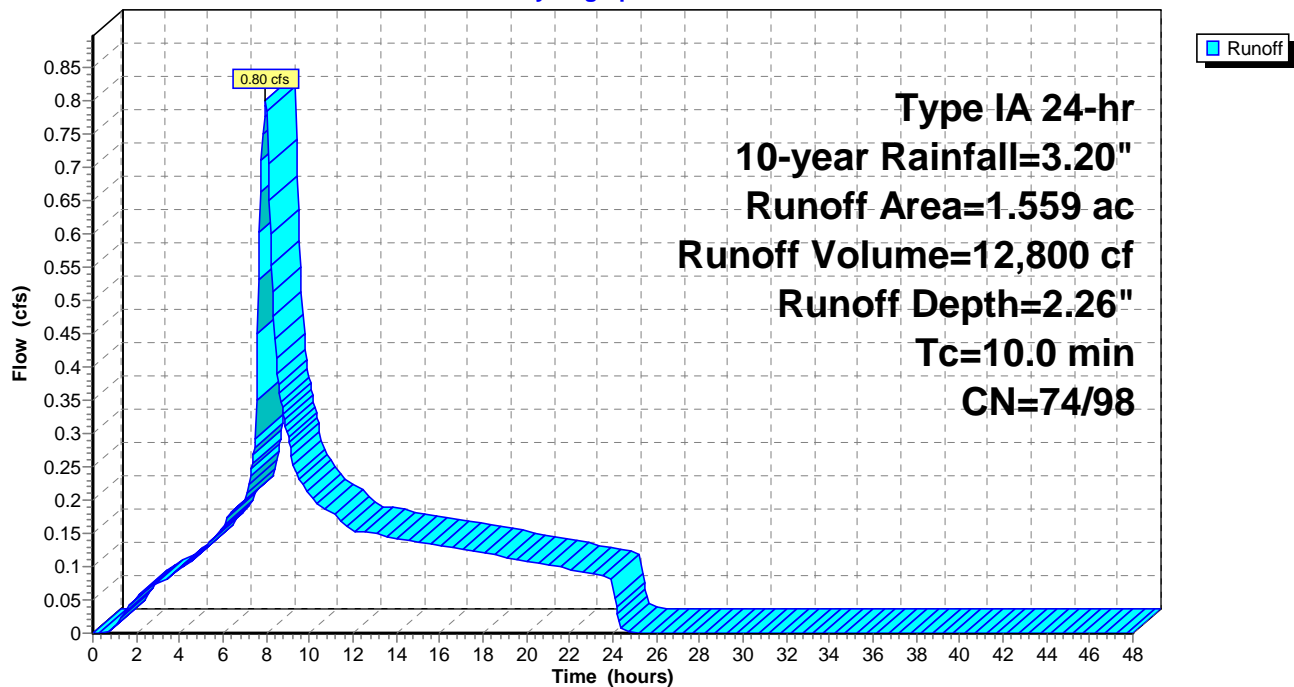
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 10-year Rainfall=3.20"

Area (ac)	CN	Description
0.570	74	>75% Grass cover, Good, HSG C
* 0.840	98	Impervious surface, HSG C
0.149	98	Paved roads w/curbs & sewers, HSG C
1.559	89	Weighted Average
0.570	74	36.56% Pervious Area
0.989	98	63.44% Impervious Area

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

Subcatchment 2A: Developed Conditions Basin #2A

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 10-year Rainfall=3.20"

Printed 5/1/2019

Summary for Subcatchment 2B: Developed Conditions Basin #2B

Runoff = 3.52 cfs @ 7.98 hrs, Volume= 56,521 cf, Depth= 2.22"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

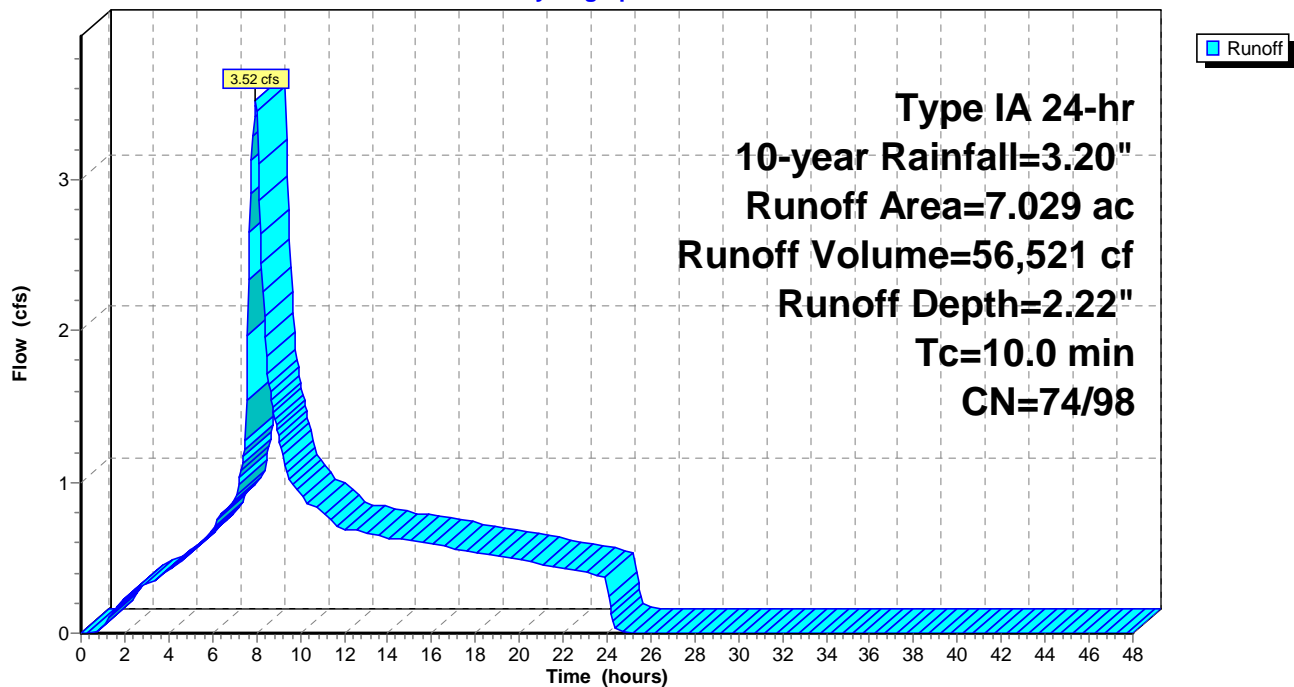
Type IA 24-hr 10-year Rainfall=3.20"

Area (ac)	CN	Description
2.740	74	>75% Grass cover, Good, HSG C
* 4.110	98	Impervious surface, HSG C
0.179	98	Paved roads w/curbs & sewers, HSG C
7.029	89	Weighted Average
2.740	74	38.98% Pervious Area
4.289	98	61.02% Impervious Area

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

Subcatchment 2B: Developed Conditions Basin #2B

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment Ex1: Existing Conditions Basin #1

Runoff = 5.04 cfs @ 8.05 hrs, Volume= 100,374 cf, Depth= 2.29"

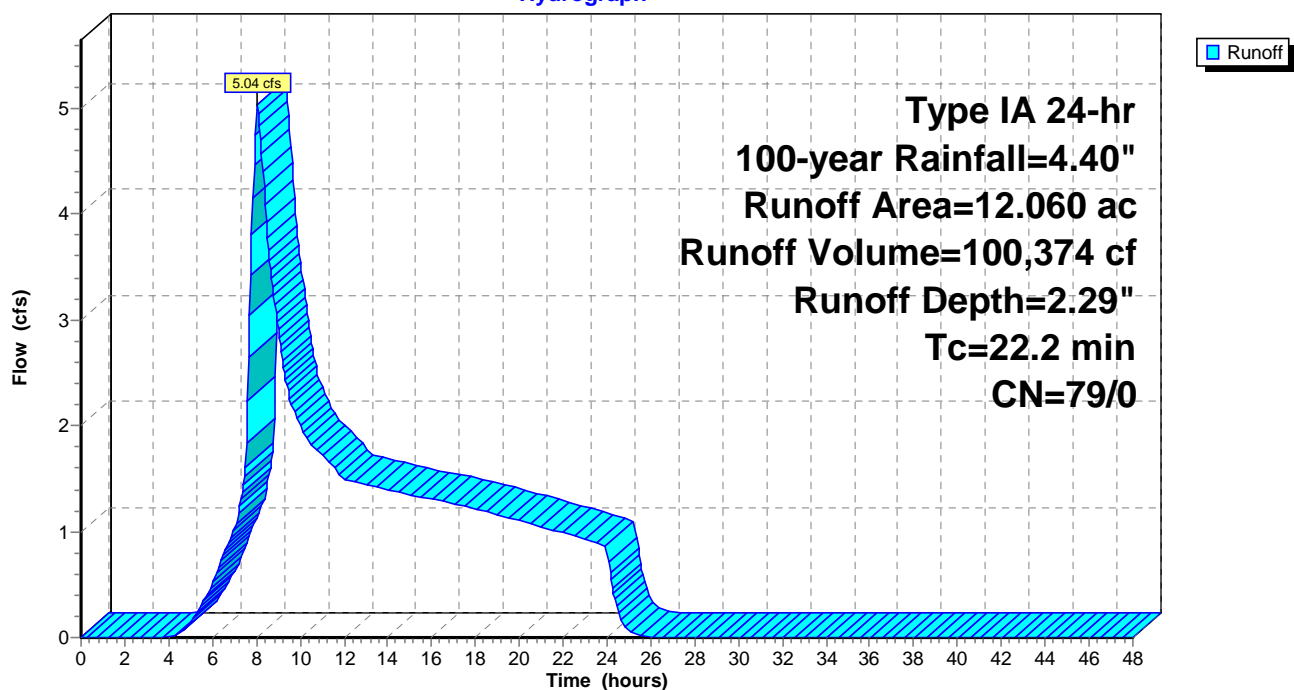
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
* 12.060	79	City of Salem Pre-developed, HSG C
12.060	79	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
22.2					Direct Entry, TR-55 Worksheet

Subcatchment Ex1: Existing Conditions Basin #1

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment Ex2A: Existing Conditions Basin #2A

Runoff = 2.37 cfs @ 8.04 hrs, Volume= 46,599 cf, Depth= 2.33"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

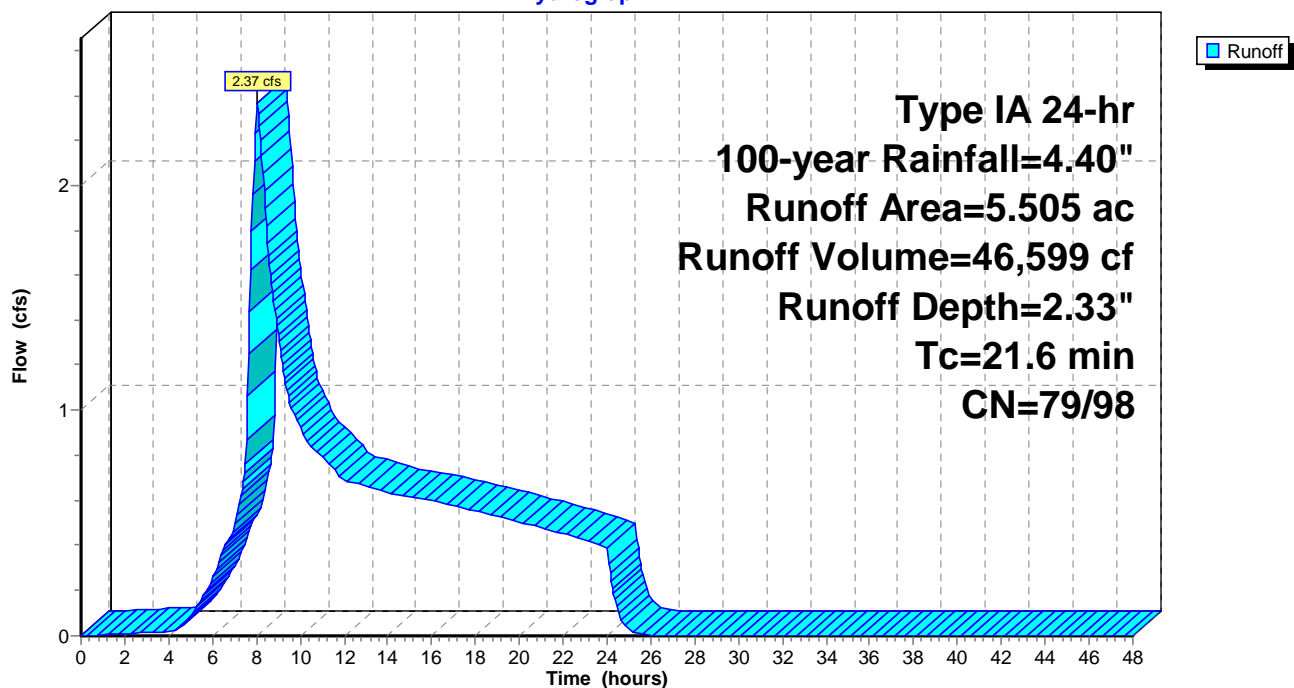
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
* 5.390	79	City of Salem Pre-developed, HSG C
0.115	98	Paved roads w/curbs & sewers, HSG C
5.505	79	Weighted Average
5.390	79	97.91% Pervious Area
0.115	98	2.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2A: Existing Conditions Basin #2A

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment Ex2B: Existing Conditions Basin #2B

Runoff = 1.12 cfs @ 8.03 hrs, Volume= 20,987 cf, Depth= 2.39"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

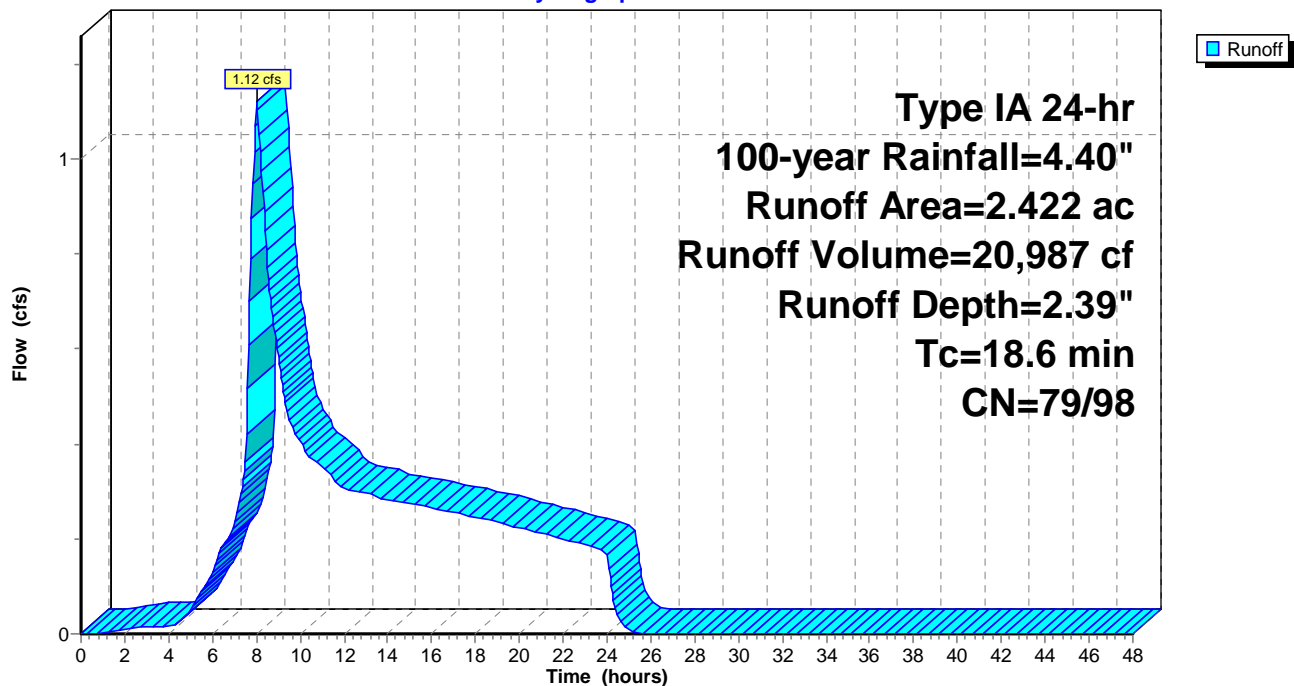
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
* 2.300	79	City of Salem Pre-developed, HSG C
0.122	98	Paved roads w/curbs & sewers, HSG C
2.422	80	Weighted Average
2.300	79	94.96% Pervious Area
0.122	98	5.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2B: Existing Conditions Basin #2B

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment 1A: Developed Conditions Basin #1A

Runoff = 7.77 cfs @ 7.98 hrs, Volume= 123,104 cf, Depth= 3.26"

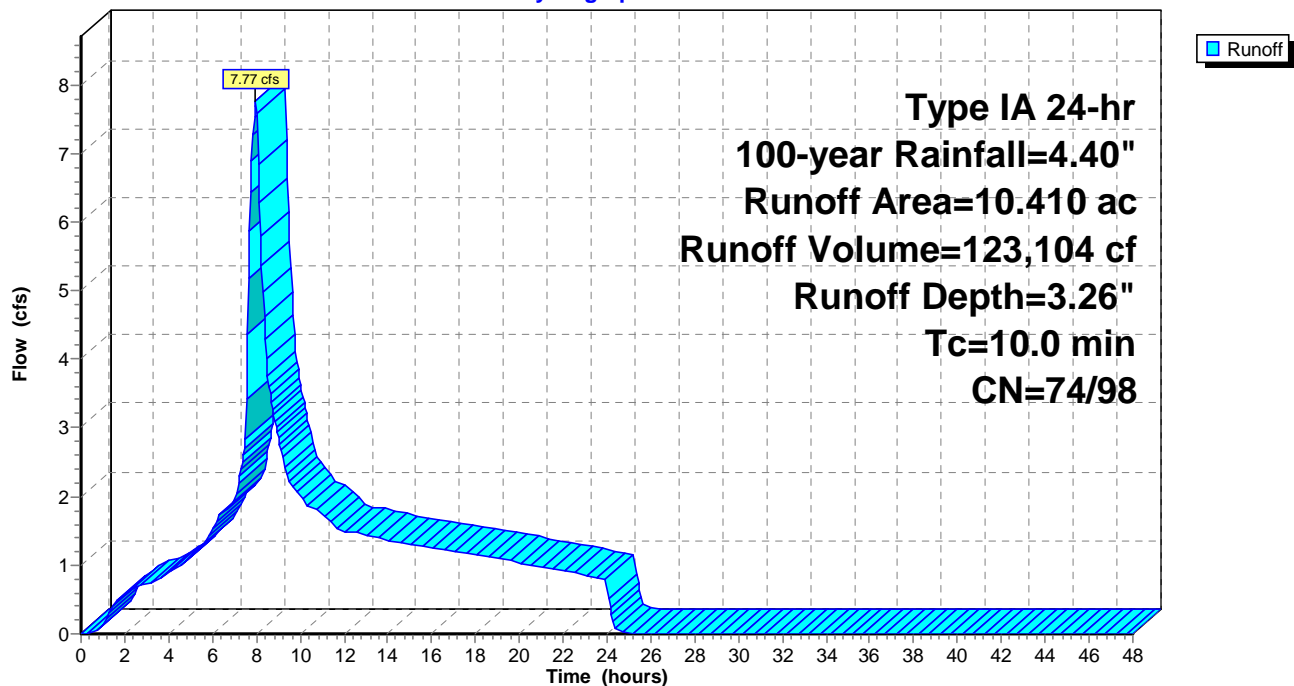
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
4.160	74	>75% Grass cover, Good, HSG C
* 6.250	98	Impervious surface, HSG C
10.410	88	Weighted Average
4.160	74	39.96% Pervious Area
6.250	98	60.04% Impervious Area

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

Subcatchment 1A: Developed Conditions Basin #1A

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment 1B: Developed Conditions Basin #1B

Runoff = 0.80 cfs @ 7.98 hrs, Volume= 12,633 cf, Depth= 3.25"

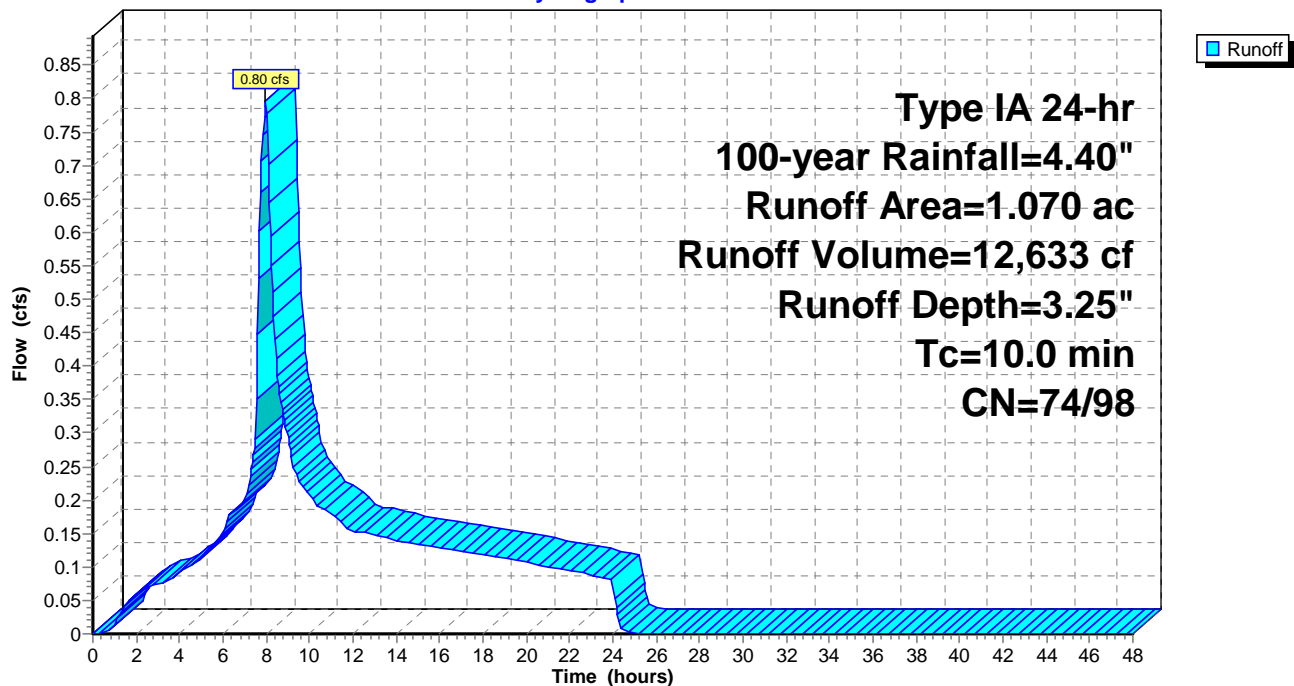
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
0.430	74	>75% Grass cover, Good, HSG C
* 0.640	98	Impervious surface, HSG C
1.070	88	Weighted Average
0.430	74	40.19% Pervious Area
0.640	98	59.81% Impervious Area

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

Subcatchment 1B: Developed Conditions Basin #1B

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment 2A: Developed Conditions Basin #2A

Runoff = 1.20 cfs @ 7.98 hrs, Volume= 18,872 cf, Depth= 3.33"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

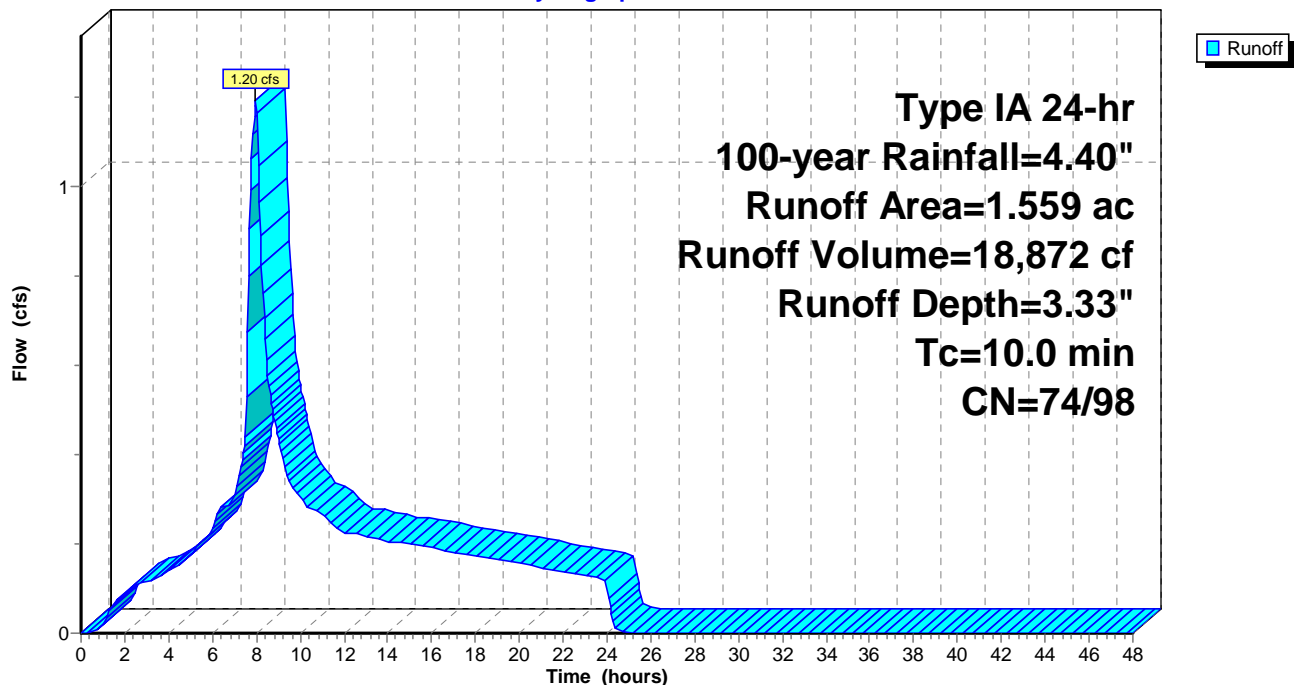
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
0.570	74	>75% Grass cover, Good, HSG C
* 0.840	98	Impervious surface, HSG C
0.149	98	Paved roads w/curbs & sewers, HSG C
1.559	89	Weighted Average
0.570	74	36.56% Pervious Area
0.989	98	63.44% Impervious Area

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

Subcatchment 2A: Developed Conditions Basin #2A

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment 2B: Developed Conditions Basin #2B

Runoff = 5.29 cfs @ 7.98 hrs, Volume= 83,689 cf, Depth= 3.28"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

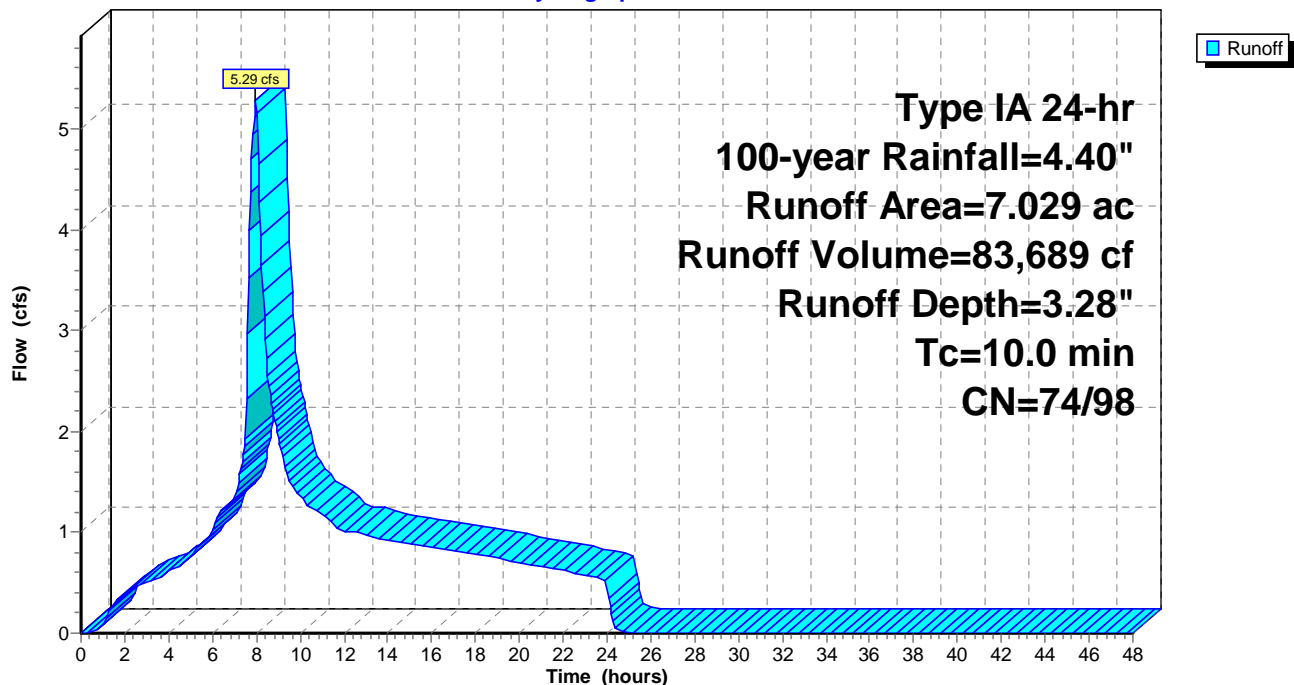
Type IA 24-hr 100-year Rainfall=4.40"


Area (ac)	CN	Description
2.740	74	>75% Grass cover, Good, HSG C
* 4.110	98	Impervious surface, HSG C
0.179	98	Paved roads w/curbs & sewers, HSG C
7.029	89	Weighted Average
2.740	74	38.98% Pervious Area
4.289	98	61.02% Impervious Area

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

Subcatchment 2B: Developed Conditions Basin #2B

Hydrograph





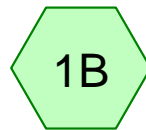
Appendix E



Developed Conditions
Basin #1A



Existing Conditions
Basin #1



Developed Conditions
Basin #1B



Existing Conditions
Basin #2A



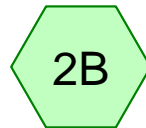
Developed Conditions
Basin #2A



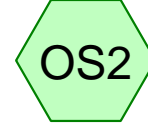
Devon Ave Impervious



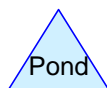
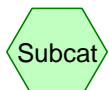
Existing Conditions
Basin #2B



Developed Conditions
Basin #2B



Existing Conditions
South



Routing Diagram for Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc., Printed 5/1/2019
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Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr WQ Rainfall=1.38"

Printed 5/1/2019

Summary for Subcatchment 1A: Developed Conditions Basin #1A

Runoff = 1.78 cfs @ 7.98 hrs, Volume= 28,018 cf, Depth= 0.74"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

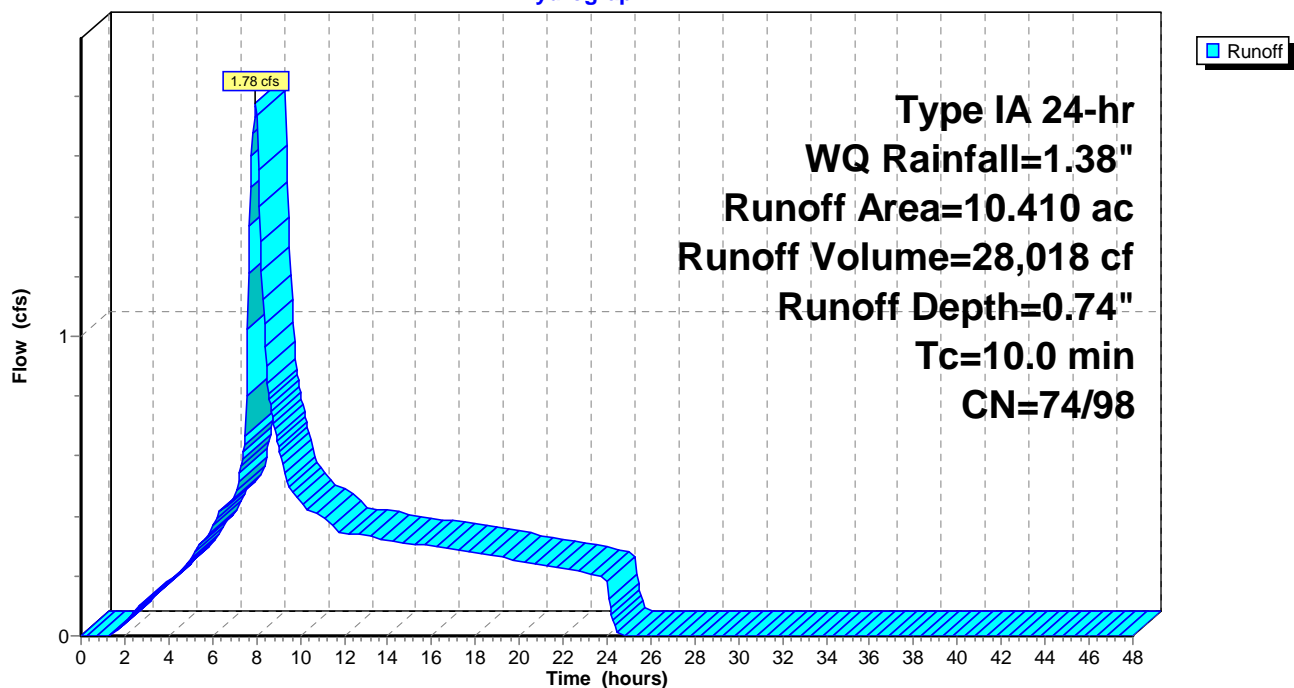
Type IA 24-hr WQ Rainfall=1.38"

Area (ac)	CN	Description
4.160	74	>75% Grass cover, Good, HSG C
* 6.250	98	Impervious surface, HSG C
10.410	88	Weighted Average
4.160	74	39.96% Pervious Area
6.250	98	60.04% Impervious Area

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

Subcatchment 1A: Developed Conditions Basin #1A

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr WQ Rainfall=1.38"

Printed 5/1/2019

Summary for Subcatchment 1B: Developed Conditions Basin #1B

Runoff = 0.18 cfs @ 7.98 hrs, Volume= 2,871 cf, Depth= 0.74"

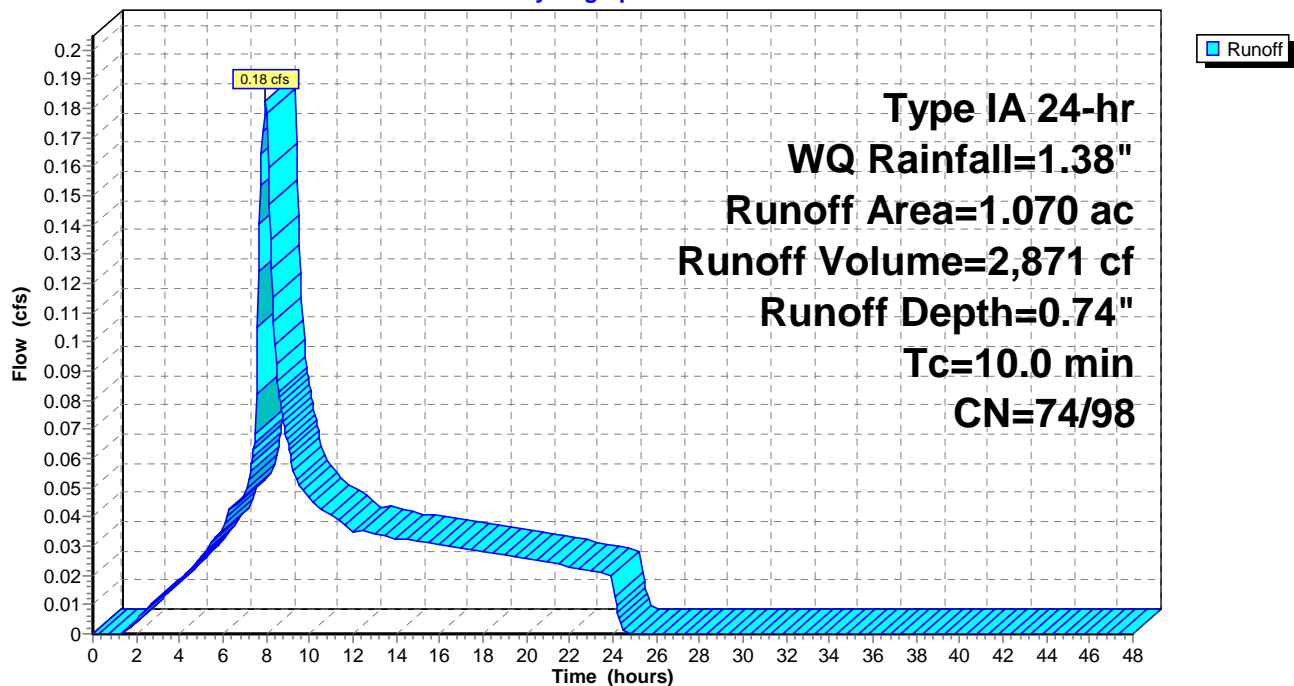
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.38"

Area (ac)	CN	Description
0.430	74	>75% Grass cover, Good, HSG C
* 0.640	98	Impervious surface, HSG C
1.070	88	Weighted Average
0.430	74	40.19% Pervious Area
0.640	98	59.81% Impervious Area

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

Subcatchment 1B: Developed Conditions Basin #1B

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr WQ Rainfall=1.38"

Printed 5/1/2019

Summary for Subcatchment Ex2A: Existing Conditions Basin #2A

Runoff = 0.08 cfs @ 16.70 hrs, Volume= 4,501 cf, Depth= 0.23"

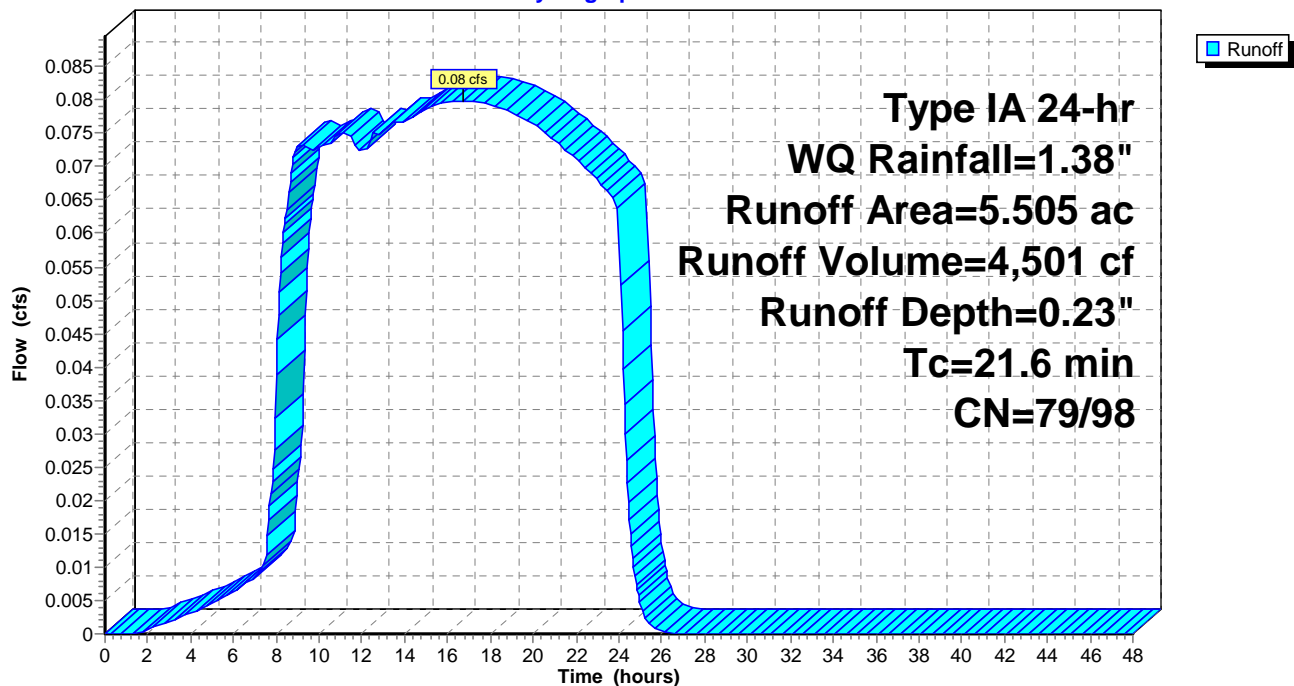
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.38"

Area (ac)	CN	Description
* 5.390	79	City of Salem Pre-developed, HSG C
0.115	98	Paved roads w/curbs & sewers, HSG C
5.505	79	Weighted Average
5.390	79	97.91% Pervious Area
0.115	98	2.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2A: Existing Conditions Basin #2A

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr WQ Rainfall=1.38"

Printed 5/1/2019

Summary for Subcatchment Ex2B: Existing Conditions Basin #2B

Runoff = 0.04 cfs @ 8.28 hrs, Volume= 2,228 cf, Depth= 0.25"

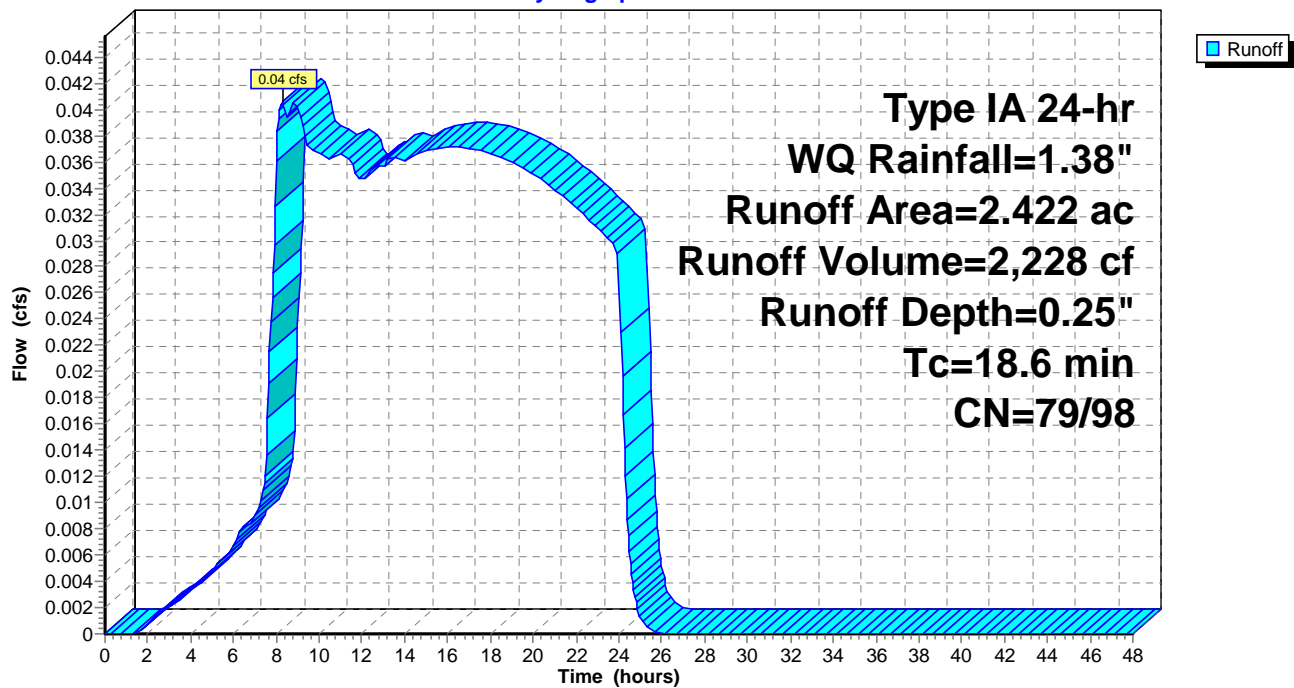
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.38"

Area (ac)	CN	Description
* 2.300	79	City of Salem Pre-developed, HSG C
0.122	98	Paved roads w/curbs & sewers, HSG C
2.422	80	Weighted Average
2.300	79	94.96% Pervious Area
0.122	98	5.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2B: Existing Conditions Basin #2B

Hydrograph



Devon Estates Hydrology

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Type IA 24-hr WQ Rainfall=1.38"

Printed 5/1/2019

Summary for Subcatchment OS1: Devon Ave Impervious

Runoff = 0.14 cfs @ 7.98 hrs, Volume= 2,021 cf, Depth= 1.16"

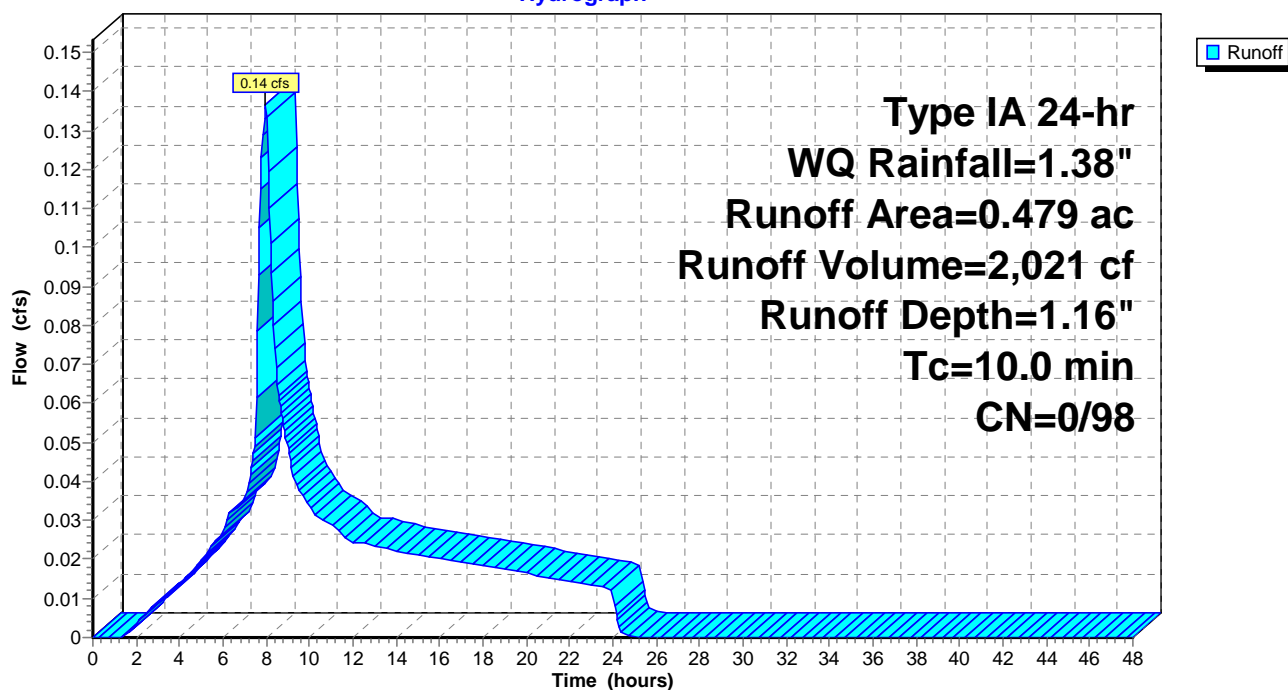
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.38"

Area (ac)	CN	Description
* 0.479	98	Impervious surface, HSG C
0.479	98	100.00% Impervious Area

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

Subcatchment OS1: Devon Ave Impervious

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr WQ Rainfall=1.38"

Printed 5/1/2019

Summary for Subcatchment OS2: Existing Conditions South

Runoff = 0.07 cfs @ 16.99 hrs, Volume= 3,636 cf, Depth= 0.21"

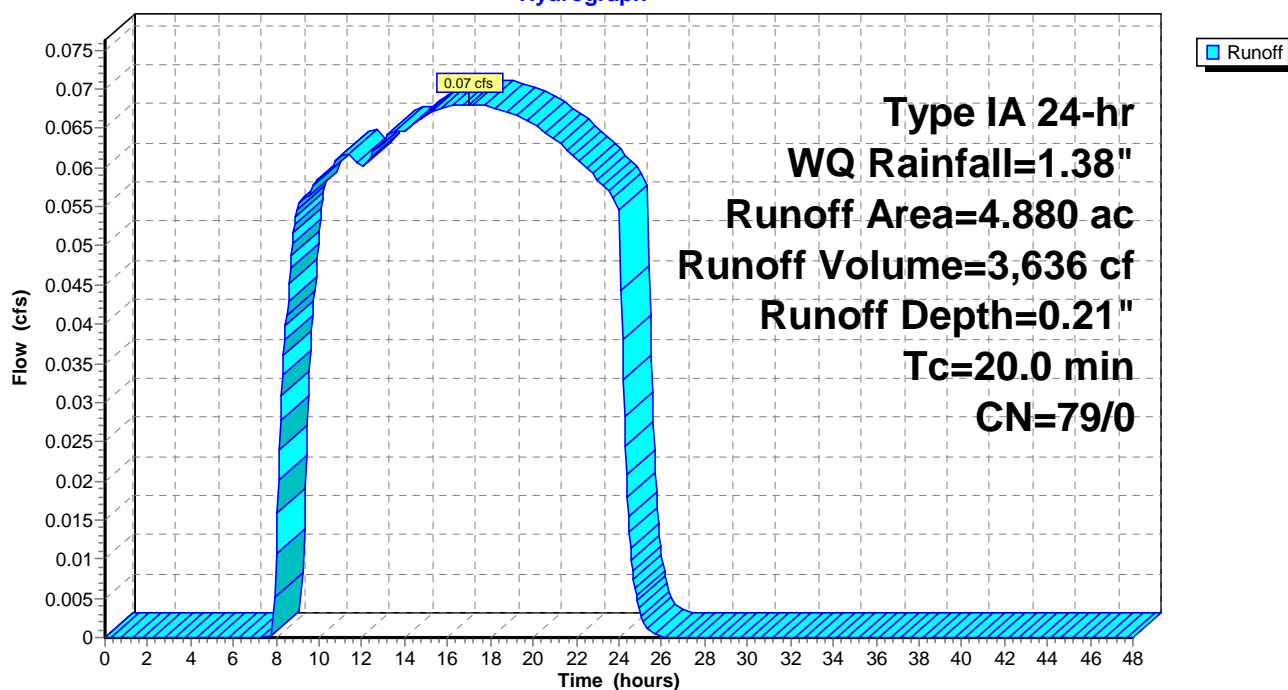
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr WQ Rainfall=1.38"

Area (ac)	CN	Description
* 4.880	79	City of Salem Pre-developed, HSG C
4.880	79	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					Direct Entry, TR-55 Worksheet

Subcatchment OS2: Existing Conditions South

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment Ex2B: Existing Conditions Basin #2B

Runoff = 1.12 cfs @ 8.03 hrs, Volume= 20,987 cf, Depth= 2.39"

Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

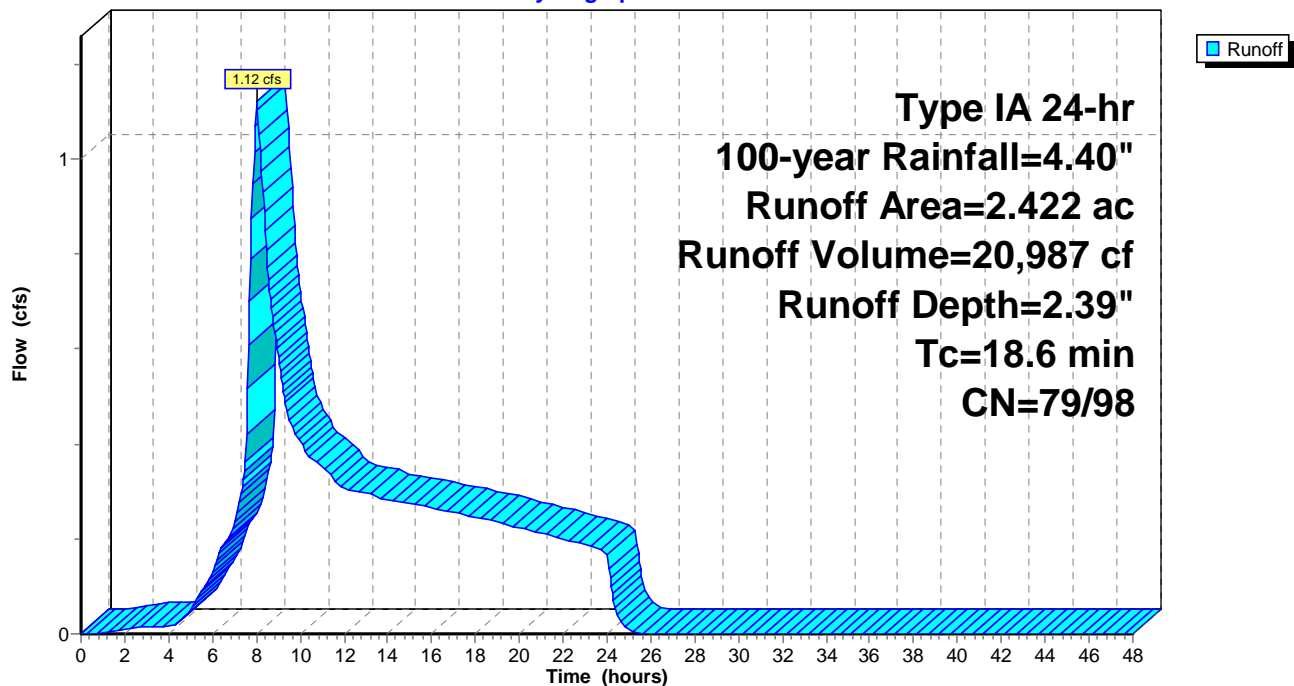
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
* 2.300	79	City of Salem Pre-developed, HSG C
0.122	98	Paved roads w/curbs & sewers, HSG C
2.422	80	Weighted Average
2.300	79	94.96% Pervious Area
0.122	98	5.04% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.6					Direct Entry, TR-55 Worksheet

Subcatchment Ex2B: Existing Conditions Basin #2B

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

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Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment OS1: Devon Ave Impervious

Runoff = 0.47 cfs @ 7.98 hrs, Volume= 7,241 cf, Depth= 4.16"

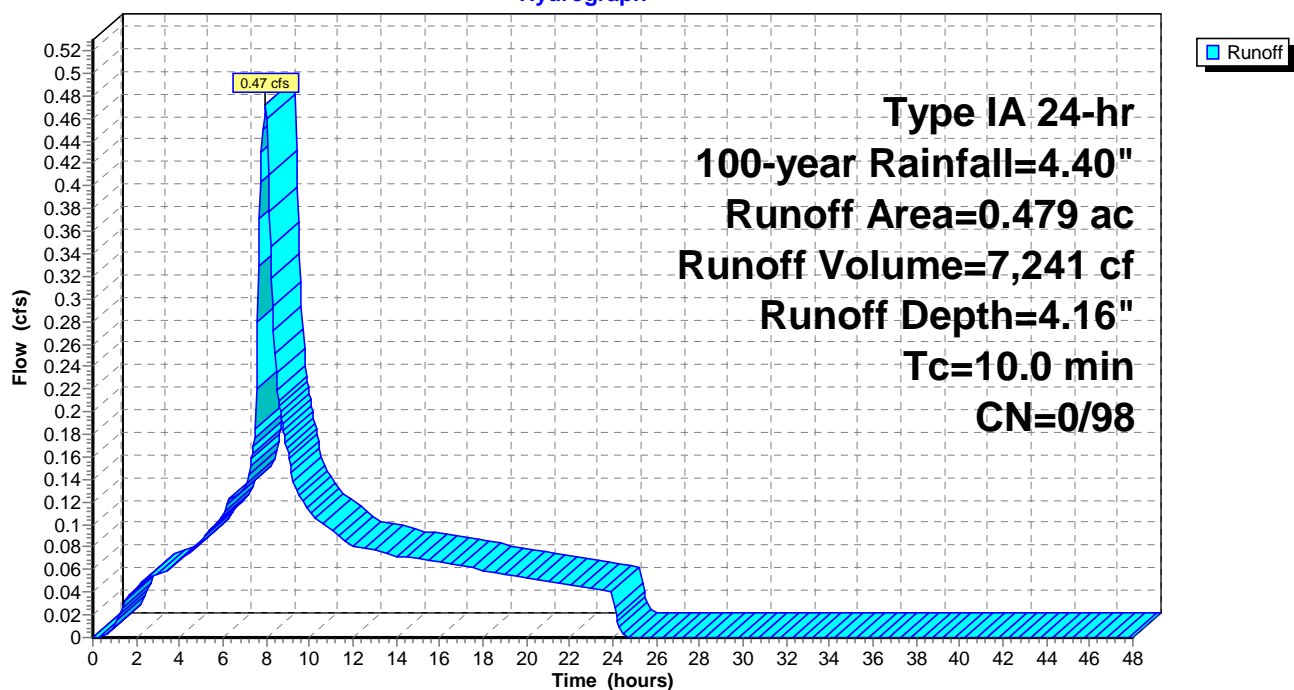
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year Rainfall=4.40"

Area (ac)	CN	Description
* 0.479	98	Impervious surface, HSG C
0.479	98	100.00% Impervious Area

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

Subcatchment OS1: Devon Ave Impervious

Hydrograph



Devon Estates Hydrology

Prepared by Multitech Engineering Services, Inc.

HydroCAD® 10.00-17 s/n 09412 © 2016 HydroCAD Software Solutions LLC

Type IA 24-hr 100-year Rainfall=4.40"

Printed 5/1/2019

Summary for Subcatchment OS2: Existing Conditions South

Runoff = 2.11 cfs @ 8.04 hrs, Volume= 40,616 cf, Depth= 2.29"

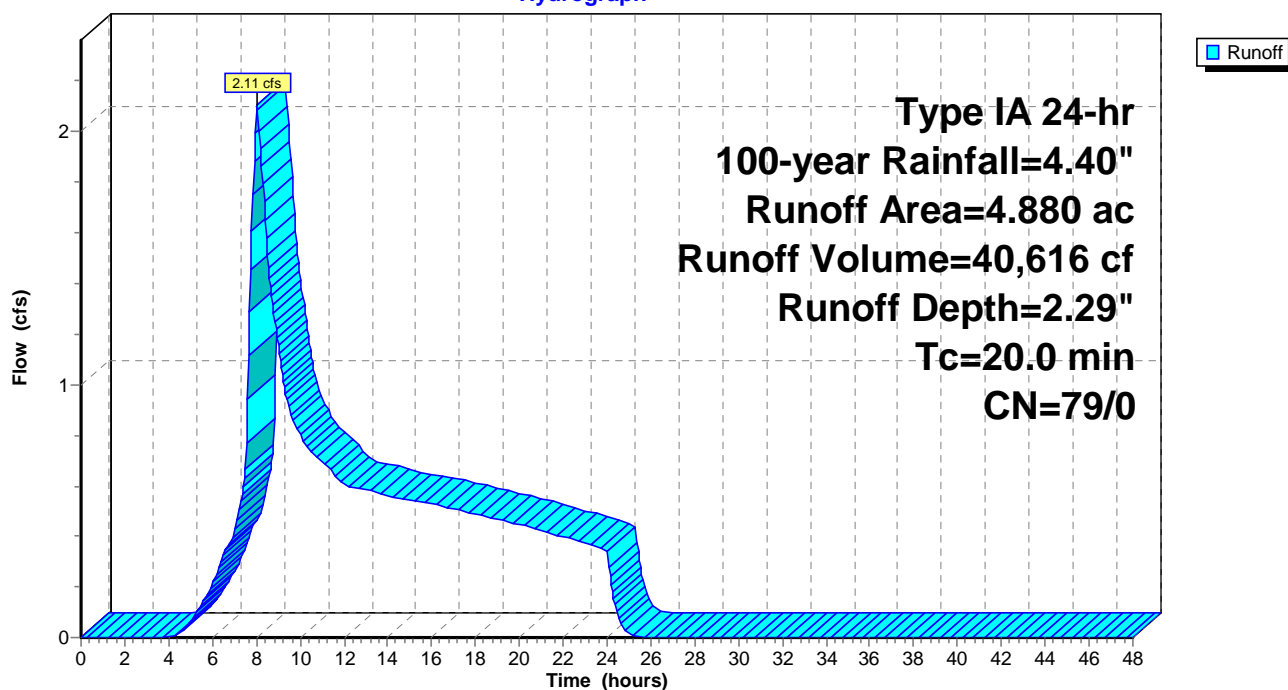
Runoff by SBUH method, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-year Rainfall=4.40"

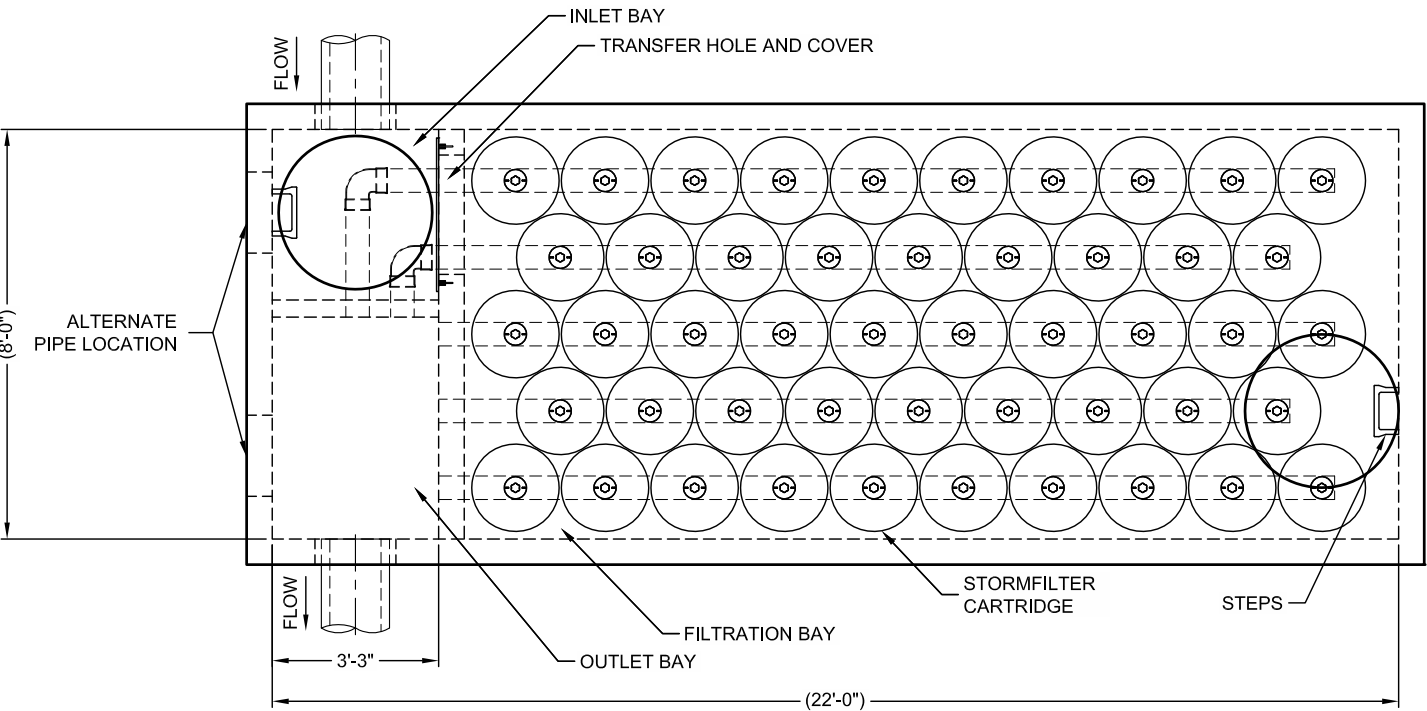
Area (ac)	CN	Description
* 4.880	79	City of Salem Pre-developed, HSG C
4.880	79	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0					Direct Entry, TR-55 Worksheet

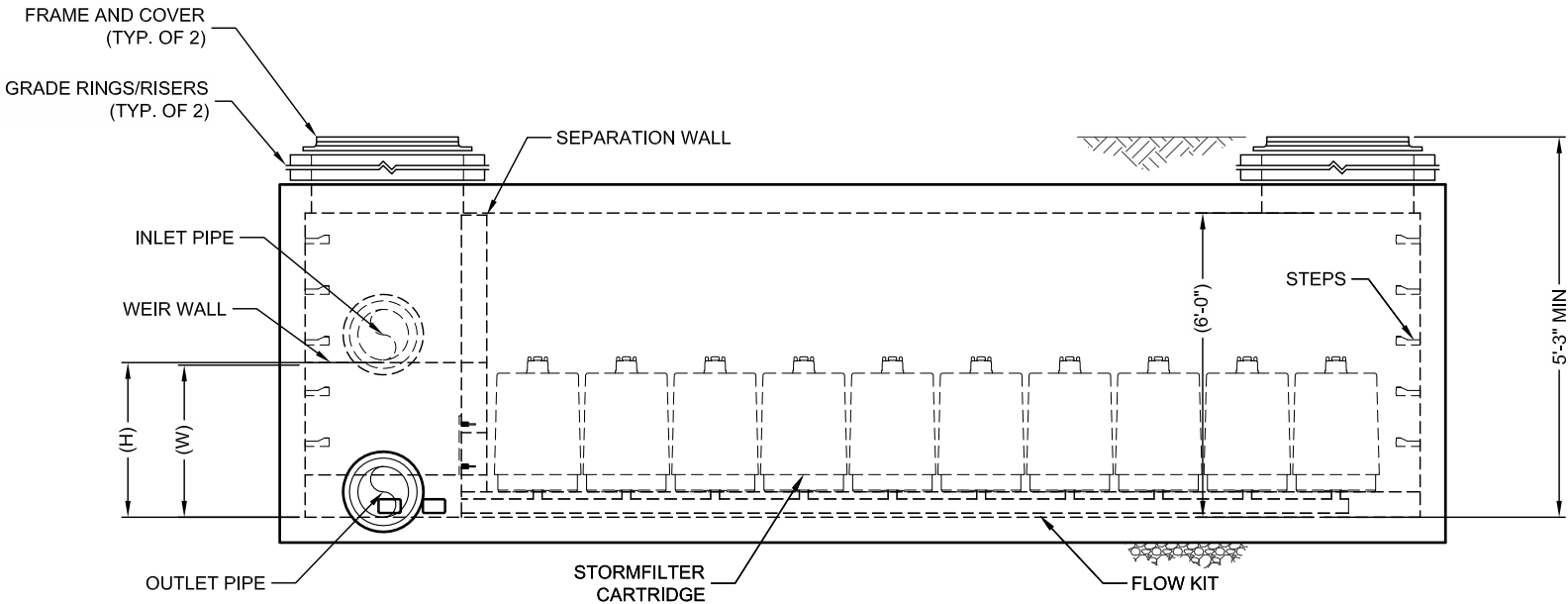
Subcatchment OS2: Existing Conditions South

Hydrograph





PLAN VIEW



ELEVATION



THE PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING:
U.S. PATENTS: 5,322,629; 5,324,492; 5,757,037; 5,846,197; 6,003,439; 6,494,042;
RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

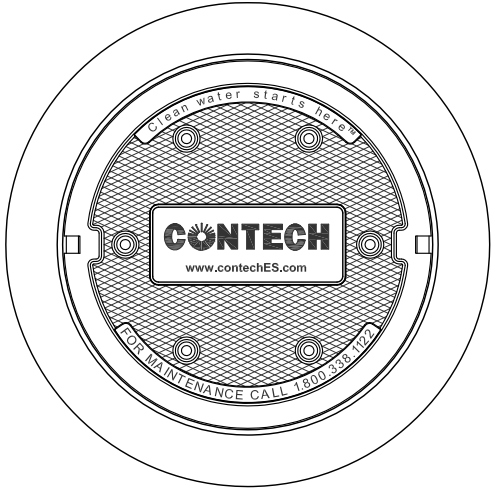
STORMFILTER DESIGN NOTES

- THE 8' x 22' PEAK DIVERSION STORMFILTER TREATMENT CAPACITY VARIES BY CARTRIDGE COUNT AND LOCALLY APPROVED SURFACE AREA SPECIFIC FLOW RATE. PEAK CONVEYANCE CAPACITY TO BE DETERMINED BY ENGINEER OF RECORD.
- THE PEAK DIVERSION STORMFILTER IS AVAILABLE IN A LEFT INLET (AS SHOWN) OR RIGHT INLET CONFIGURATION.
- ALL PARTS AND INTERNAL ASSEMBLY PROVIDED BY CONTECH UNLESS OTHERWISE NOTED.

CARTRIDGE SELECTION

CARTRIDGE HEIGHT	27"			18"			LOW DROP		
RECOMMENDED HYDRAULIC DROP (H)	3.05'			2.3'			1.8'		
HEIGHT OF WEIR (W)	3.00'			2.25'			1.75'		
SPECIFIC FLOW RATE (gpm/sf)	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf	2 gpm/sf	1.67* gpm/sf	1 gpm/sf
CARTRIDGE FLOW RATE (gpm)	22.5	18.79	11.25	15	12.53	7.5	10	8.35	5

* 1.67 gpm/sf SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

PERFORMANCE SPECIFICATION

FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. **RADIAL MEDIA DEPTH SHALL BE 7-INCHES**. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST **38 SECONDS**. SPECIFIC FLOW RATE SHALL BE **2 GPM/SF (MAXIMUM)**. SPECIFIC FLOW RATE IS THE MEASURE OF THE FLOW (GPM) DIVIDED BY THE MEDIA SURFACE CONTACT AREA (SF). MEDIA VOLUMETRIC FLOW RATE SHALL BE **6 GPM/CF OF MEDIA (MAXIMUM)**.

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH () ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH REPRESENTATIVE. www.contechES.com
4. STORMFILTER WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING. CONTRACTOR TO CONFIRM STRUCTURE MEETS REQUIREMENTS OF PROJECT.
5. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 5' AND GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION. CASTINGS SHALL MEET AASHTO M306 AND BE CAST WITH THE CONTECH LOGO.

INSTALLATION NOTES

- A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
- B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE (LIFTING CLUTCHES PROVIDED).
- C. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL SECTIONS AND ASSEMBLE STRUCTURE.
- D. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH OUTLET PIPE INVERT WITH OUTLET BAY FLOOR.
- E. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.
- F. CONTRACTOR TO REMOVE THE TRANSFER HOLE COVER WHEN THE SYSTEM IS BROUGHT ONLINE.

SITE SPECIFIC DATA REQUIREMENTS			
STRUCTURE ID			*
WATER QUALITY FLOW RATE (cfs)			*
PEAK FLOW RATE (cfs)			*
RETURN PERIOD OF PEAK FLOW (yrs)			*
CARTRIDGE HEIGHT (27", 18", LOW DROP(LD))			*
NUMBER OF CARTRIDGES REQUIRED			*
CARTRIDGE FLOW RATE			*
MEDIA TYPE (PERLITE, ZPG, PSORB)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE	*	*	*
OUTLET PIPE	*	*	*
UPSTREAM RIM ELEVATION			*
DOWNSTREAM RIM ELEVATION			*
ANTI-FLOTATION BALLAST	WIDTH		HEIGHT
	*		*
NOTES/SPECIAL REQUIREMENTS:			
* PER ENGINEER OF RECORD			



www.contechES.com

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800-338-1122 513-645-7000 513-645-7993 FAX

THE STORMWATER MANAGEMENT STORMFILTER
8' x 22' PEAK DIVERSION STORMFILTER
STANDARD DETAIL

Design Exception Request

2014 City of Salem's Public Works Administrative Rules Chapter 109, Division 004

Grantham Crest Subdivision (Previously Devon Estates)

Division	Section	Exception	Reason	City Engineer Approval Initials	Date
Stormwater System	4E.7	Allow non-GSI facilities, Manufactured Treatment Technologies, to mitigate the impacts of runoff from 60 percent of the development	The proposed subdivision is located on natural steep slopes that exceed 10 percent for the westerly portion of the development where the proposed Manufactured Treatment Technology will be located. Steep slopes of this nature do not allow GSI facilities to be constructed and are not feasible. The maximum slope for a swale is 6 percent. For planter facilities, concrete check dams would be required every 2-feet.		

