Preliminary Drainage Report

Dollar Street Middle School

Prepared for: IBI
Prepared by: Nathan Patterson, PE
Project Engineer: Danielle Pruett, PE

January 2021 | KPFF Project #2000067

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Project Overview

Purpose of this Report

This report describes the stormwater management design strategies for the proposed development. The basis for this report is the City of West Linn Public Works Design Standards and the 2020 City of Portland Stormwater Management Manual (SWMM) and requirements outlined therein. The purpose of the proposed stormwater management facilities is to protect existing public stormwater infrastructure and to improve the overall health of the watershed.

Project Location and Zoning

The project property is located between Dollar Street and Willamette Falls Drive in West Linn, Oregon. The site extends from approximately the western end of Dollar Street to the edge of private property along Epperly Way. The predevelopment site zoning designation is R-10.

FIGURE 1: Site Vicinity Map

Type of Development and Proposed Improvements

The project includes development of a new West Linn-Wilsonville School District Middle School which will include new parking areas, play areas, a track and field, and site circulation improvements. The development will include half-street improvements along Dollar Street to the north of the project, and reconstruction of

Willamette Falls Drive to the south. An extension of Brandon Place will cross through the site and connect to Willamette Falls Drive.

Watershed Description

The site is located within the Tualatin River and Dollar Creek Drainage Basins as identified by the City of West Linn GIS.

Existing vs. Post Construction Conditions

The project is adjacent to the following existing stormwater infrastructure:

Tualatin River Drainage Basin:

- 24-inch storm sewer main along north side of Willamette Falls Drive.
- 12-inch public stormwater outfall to the Tualatin River at the end of Dollar Street.
- 12-inch public stormwater outfall to the Tualatin River via overland through Fields Bridge Park.
- 12-inch storm sewer along north side of Dollar Street (west of eastern intersection with River Heights Circle).
- Public stormwater pond north of the Willamette Falls Drive at Tualatin River Bridge.

Dollar Creek Drainage Basin:

- 18-inch public stormwater outfall to the Tualatin River via property west of Epperly Way.
- 12-inch storm sewer along north side of Dollar Street (east of eastern intersection with River Heights Circle).
- Surface conveyance ditch on eastern property line from Dollar Street toward Willamette Falls Drive.

The table below describes the outfall location for major onsite and offsite drainage basins. See Basin Maps and subsequent report sections for a more detailed subbasin analysis.

TABLE 1: Proposed Drainage Basin Summary

Proposed Major Basin	Outfall Location	Drainage Basin
Onsite Development (impervious, mixed)	12-inch Tualatin River north of bridge	Tualatin River
Onsite Eastern Slopes (non-impervious)	East Surface Conveyance Ditch	Dollar Creek
Onsite Southern Slopes (non-impervious)	24-inch Willamette Falls Drive Storm Main	Tualatin River
Willamette Falls Drive (northwest)	12-inch Tualatin River north of bridge	Tualatin River
Willamette Falls Drive (central)	12-inch Fields Bridge Park	Tualatin River
Willamette Falls Drive (southeast)	18-inch Main opposite Epperly Way	Dollar Creek
Brandon Place Extension	Public Storm Pond	Tualatin River
Dollar Street (west)	12-inch Dollar Street Storm Main	Tualatin River
Dollar Street (east)	East Surface Conveyance Ditch	Dollar Creek

Geotechnical Engineer Recommendations

GeoDesign, Inc. has provided the geotechnical report titled “Report of Geotechnical Engineering Services” for the project, dated October 20, 2020. The proposed design includes the engineer’s recommended foundation drainage, hard piped roof drainage, and slope drainage improvements for cement treated fill. Specifically, the methodology used to construct and provide drainage for the fill slopes facing Willamette

Falls Drive are unique for this project. An excerpt from the report's conclusions and recommendations are included in Appendix D.

Methodology

Proposed Stormwater Management Narrative

All surface stormwater generated by impervious areas will be collected and treated as described below. Although not required, the majority of developed pervious areas are also captured and treated due to the layout of the proposed improvements. Untreated areas include the fill slopes along the south and southwest sides of the development where slope drainage infrastructure is implemented as recommended by the geotechnical engineer. These collection systems will be connected to the public storm drain system in Willamette Falls Drive due to their lower elevations.

Detention and Flow Control

Both major basins identified in Table 1 drain to the Tualatin River, therefore no stormwater detention shall be required if adequate capacity to convey the 10-year storm is shown to exist or is provided with the development (Public Works Design Standard 2.0040.C.) Stormwater generated from the onsite improvements will utilize an existing outfall location north of the Tualatin River bridge. This line will be reconstructed in-place as needed to provide the additional capacity for the new development. Subsequent submittals will demonstrate the available capacity at each proposed point of connection for the public road improvements, as required.

Water Quality (Onsite)

The majority of stormwater generated by the proposed onsite improvements will be captured in a piped system and routed to a grassy swale parallel to the major driveway access off the Brandon Street Extension. By implementing a downstream treatment system, it is infeasible to hydraulically separate pervious areas from impervious areas, therefore the swale will be sized to treat all flows that enter it rather than for the required treatment of impervious flows only. This grassy swale is configured to meet the City of Portland BES geometric requirements using the Performance Approach and will provide a minimum of nine minutes of residence time. Check dams will be spaced at maximum 50-feet on center and will double as both steps in grade to follow the adjacent roadway and as flow spreaders to ensure the facility functions as designed. The access aisle parallel to the grassy swale will be treated by a small stormwater basin sized using the Portland BES PAC Calculator with a 25% increase in size per West Linn's standards.

Water Quality (Dollar Street)

Surface runoff from the southern half-street improvements is collected at flow through planter basins (FTP). Basins are sized using the Portland BES Presumptive Approach Calculator (PAC) with a 25% increase in size per West Linn's standards.

Water Quality (Brandon Place Extension)

Surface water collection is provided with curb inlets. These curb inlets daylight at a new outfall to an enlarged existing public storm basin north of the proposed roundabout. The enlargement of the existing storm basin will consider the tributary basin from the existing bridge and new roundabout and will be sized using the Portland BES PAC Calculator with a 25% increase in size per West Linn's standards.

Water Quality (Willamette Falls Drive)

Flow through planters are proposed in locations where the road cross section and grading allows for a planter strip. Flow through planters are sized using the Portland BES PAC Calculator with a 25% increase in size per West Linn's standards. In locations where vegetated facilities are infeasible, Contech Stormfilter gutter inlets (SFCB) are proposed. The northern separated bike lane and sidewalk will, pending final selection of paving materials, either be mitigated by using pervious asphalt with underdrain in the bike lane or will shed to the roadway treatment facilities. The southern separated bike lane and sidewalk will shed surface runoff toward each other that will be collected at curb inlets located in the bike lane. This will create an informal gutter along the curb line separating the facilities. Treatment will be provided via a combination of either pervious asphalt, Stormfilter curb inlets, or by routing to another treatment facility. The final treatment design for these areas will be refined in subsequent submittals.

Analysis

Basin Summary

Individual basin maps for each public street frontage and for the onsite development are included in Appendix A. Summaries for onsite (Table 2) and public (Table 3) are below. Hydrographs for the onsite basins are also included in Appendix C along with design assumptions including time of concentration, curve numbers, and design storm rainfall data. Note that all onsite basins flow to the Tualatin River via the reconstructed outfall north of the Tualatin River bridge. The ultimate outfall or connection point for public basins are as shown below in Table 3.

TABLE 2: Onsite Basin Area Breakdown

Basin	Basin Area (sf)	% Impervious	WQ Peak Flow (cfs)	Receiving Facility
A	14,120	100	0.093	FTP-Onsite
B	77,000	100	0.506	Swale
C	50,915	100	0.335	Swale
D	32,675	100	0.215	Swale
E	98,990	100	0.651	Swale
F	42,620	100	0.280	Swale
G	100,645	0	0.030	Swale
H	22,030	0	0.006	Swale
I	101,140	0	0.030	Swale
J	49,600	0	0.015	Swale
K	5,120	0	0.002	Swale
Total	**601,435**		**1.99***	

**Swale peak inflow is not a direct sum of peak flows due to peaks occurring at different times. See hydrographs in Appendix C.*

TABLE 3: Offsite Basin Area and Routing Summary

Basin	Basin Area (sf)	Receiving Facility	Ultimate Outfall or Connection Point
DOL-A	7,190	FTP-A	Brandon Place 12" Storm Main
DOL-B	10,360	FTP-B	Brandon Place 12" Storm Main
DOL-C	10,280	FTP-C	Brandon Place 12" Storm Main
DOL-D1	5,320	FTP-D1	WFD East 18" Outfall
DOL-D2	5,710	FTP-D2	WFD East 18" Outfall
DOL-E	8,485	FTP-E	WFD East 18" Outfall
BRA-A1	25,713	BASIN-A	Tualatin River North of Bridge Outfall
BRA-A2	21,675	BASIN-A	Tualatin River North of Bridge Outfall
WFD-N1	7,950	FTP-N1	Fields Bridge Park East Entry Outfall
WFD-S1	6,060	FTP-S1	Fields Bridge Park East Entry Outfall
WFD-N2A	4,000	FTP-N2A	Fields Bridge Park East Entry Outfall
WFD-S2A	4,150	FTP-S2A	Fields Bridge Park East Entry Outfall
WFD-N2B	4,610	FTP-N2B	Fields Bridge Park East Entry Outfall
WFD-S2B	4,005	FTP-S2B	Fields Bridge Park East Entry Outfall
WFD-N3	3,690	SFCB-N3	Fields Bridge Park East Entry Outfall
WFD-S3	3,590	SFCB-S3	Fields Bridge Park East Entry Outfall
WFD-N4	3,690	SFCB-N4	Fields Bridge Park East Entry Outfall
WFD-S4	4,450	FTP-S4	Fields Bridge Park East Entry Outfall
WFD-N5	1,585	FTP-N5	WFD East 18" Outfall
WFD-S5	2,605	FTP-S5	WFD East 18" Outfall
WFD-PED+BIKE NORTH	17,560	STORMFILTER CURB INLET/PERVIOUS PAVEMENT	Fields Bridge Park East Entry Outfall
WFD-PED+BIKE-SW	5,760	STORMFILTER CURB INLET/PERVIOUS PAVEMENT	Fields Bridge Park East Entry Outfall
WFD-PED+BIKE-SE	12,020	STORMFILTER CURB INLET/PERVIOUS PAVEMENT	Fields Bridge Park East Entry Outfall

Facility Sizing for Water Quality

Grassy Swale

Using the 1.99 cubic feet per second input as shown in Table 2, the swale bottom, longitudinal slope, and treatment flow depth is then adjusted to provide minimum 9-minute residence time for the peak flow of the water quality storm. See Appendix C for the grassy swale sizing calculations.

Flow Through Planters and Basins

To establish a conservative sizing factor, several basins ranging in size were ran through the City of Portland PAC Calculator. 25% basin vegetated area was then added to the City of Portland's minimum size per West Linn's standards. This demonstrated that using a 2% sizing factor (vegetated treatment area / total tributary area) provides the required pollutant removal. All Basin and FTP facilities are sized using this minimum 2% sizing factor. Individual reports for each of the fifteen planters and two basins will be provided in subsequent submittals to demonstrate all necessary requirements are met.

Stormfilter Catch Basin Inlets

Stormfilter cartridges are approved to treat specific peak flows or tributary areas. The 18-inch standard cartridge heights are proposed. ZPG media is proposed as it is the most cost-effective media and it allows single cartridge configurations for the project's basin areas. However, PSORB media is an alternate that may

be implemented if further design revisions increase basin areas to the point that multiple cartridge structures would be required. The following figures show the approved tributary basin areas for each media type. The preliminary design indicates single cartridge concrete gutter inlets are adequate to treat each basin assigned a Stormfilter Catch Basin (SFCB). Dual cartridge units may be required pending the final material selection of sidewalks and bike lanes.

Table 1. Contech StormFilter with ZPG Sizing to Meet City of Portland Pollution Reduction Requirements			
Cartridge Size/Stack Configuration	Cartridge Design Flow Rate (gpm/ cartridge stack)	Maximum Drainage Area (acres/ cartridge stack)	Maximum Drainage Area (square feet/ cartridge stack
12	5	0.065	2838
18	7.5	0.098	4257
27	11.3	0.147	6413

FIGURE 2: City of Portland Stormfilter ZPG Approvals

Table 1. Contech StormFilter with PhosphoSorb Sizing to Meet City of Portland Pollution Reduction Requirements			
Cartridge Size/Stack Configuration	Cartridge Design Flow Rate (gpm/ cartridge stack)	Maximum Drainage Area (acres/ cartridge stack)	Maximum Drainage Area (square feet/ cartridge stack
12	8.35	0.109	4739
18	12.53	0.163	7112
27	18.79	0.245	10665

FIGURE 3: City of Portland Stormfilter PSORB Approvals

Conveyance

The storm drainage for both the private and public improvements will be sized per West Linn Public Works Design Standards section 2.0013.C. Manning's Equation will be used to verify pipe sizes, slopes, and velocities are within specification. The design storm shall be a minimum of the 10-year, 24-hour event as modeled using AutoCAD Storm and Sanitary Analysis 2020 using model inputs as required by the standards and outlined in this report. A time of concentration of 5-minutes will be used for all developed areas. Further analysis and modeling will be provided in subsequent versions of this report.

Engineering Conclusions

The stormwater system will be designed in accordance with the City of West Linn Public Works standards. The proposed stormwater facilities will meet the water quality requirements for the project site. The existing and new facilities and components will be shown to have adequate capacity to handle the required storm events. Therefore, the preliminary stormwater system design meets the intent of the City of West Linn requirements and should be approved as designed.

Operations and Maintenance

The Operations and Maintenance Plan will be included in the final version of this document.

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Appendix A

Basin Maps

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SHEET NOTES

1. STORMWATER BASINS SHOWN ARE PRELIMINARY. FURTHER CONSIDERATION OF SITE PAVING AND COMPONENTS WILL BE TAKEN IN FINAL DESIGN. PRELIMINARY CALCULATIONS RESULT IN CONSERVATIVELY LARGE WATER QUALITY AND CONVEYANCE FLOWS. THESE FLOWS ARE LIKELY TO DECREASE AS THE DESIGN IS REFINED.

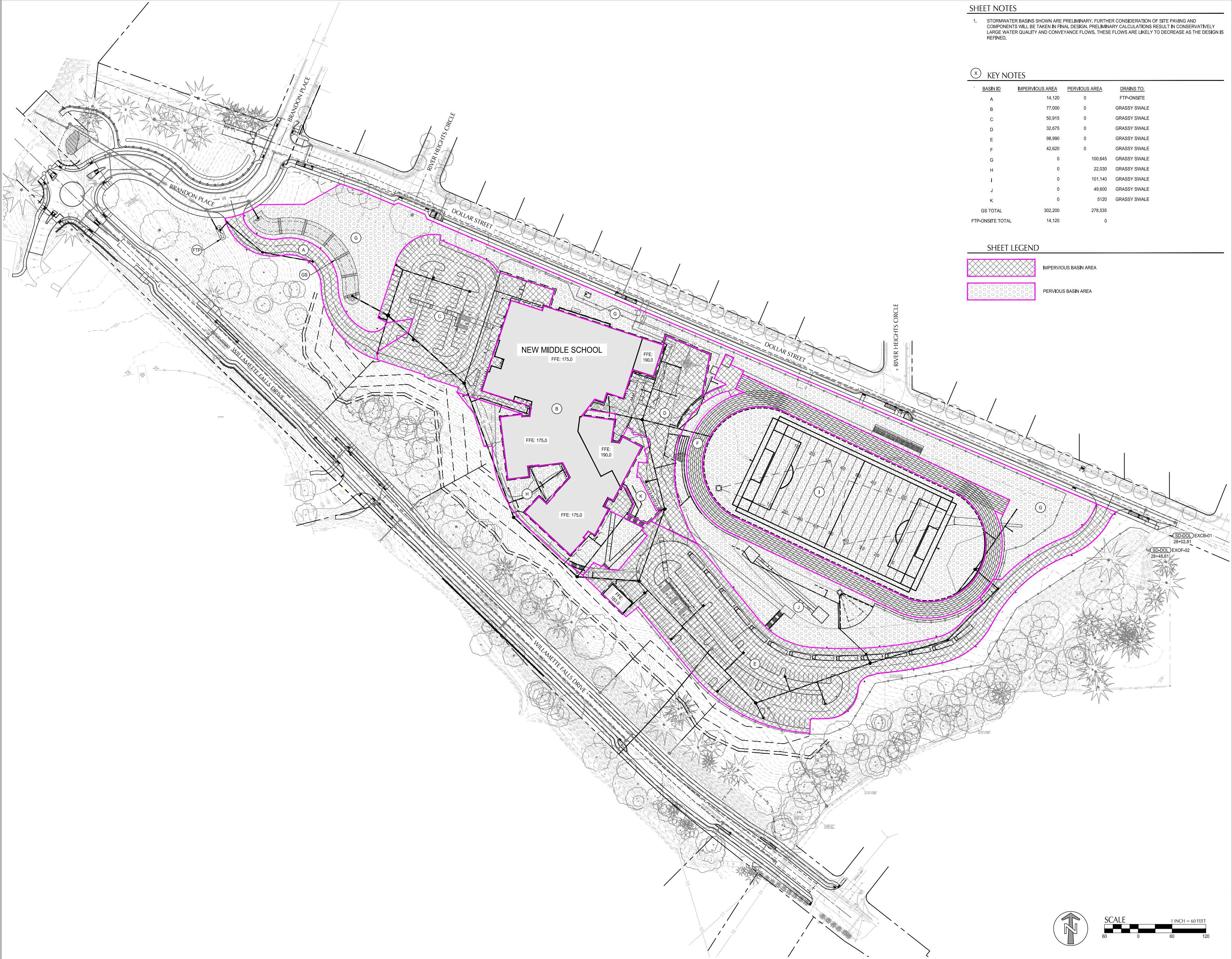
(X) KEY NOTES

BASIN ID	IMPERVIOUS AREA	PERVIOUS AREA	DRAINS TO:
A	14,120	0	FTP-ONSITE
B	77,000	0	GRASSY SWALE
C	50,915	0	GRASSY SWALE
D	32,675	0	GRASSY SWALE
E	98,990	0	GRASSY SWALE
F	42,620	0	GRASSY SWALE
G	0	100,645	GRASSY SWALE
H	0	22,030	GRASSY SWALE
I	0	101,140	GRASSY SWALE
J	0	49,600	GRASSY SWALE
K	0	5120	GRASSY SWALE
GS TOTAL	302,200	278,535	
FTP-ONSITE TOTAL	14,120	0	

SHEET LEGEND

IMPERVIOUS BASIN AREA

PERVIOUS BASIN AREA



CLIENT

West Linn-Wilsonville School District

22210 SW Stafford Rd, Tualatin, OR 97062

ISSUES

No.	DESCRIPTION	DATE
A	100% SCHEMATIC DESIGN	2020-07-31
B	100% DESIGN DEVELOPMENT	2021-01-29

NOT FOR CONSTRUCTION

KEYPLAN

CONSULTANTS

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SEAL

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PROJECT
New Athey Creek Middle School

945 Dollar Street
West Linn, OR 97068

PROJECT NO:
124738

DRAWN BY: **XX**	CHECKED BY: **DP, MW**
PROJECT MGR: **DP**	APPROVED BY: **DP**

SHEET TITLE
PRELIMINARY BASIN MAP

SHEET NUMBER EXH | ISSUE A

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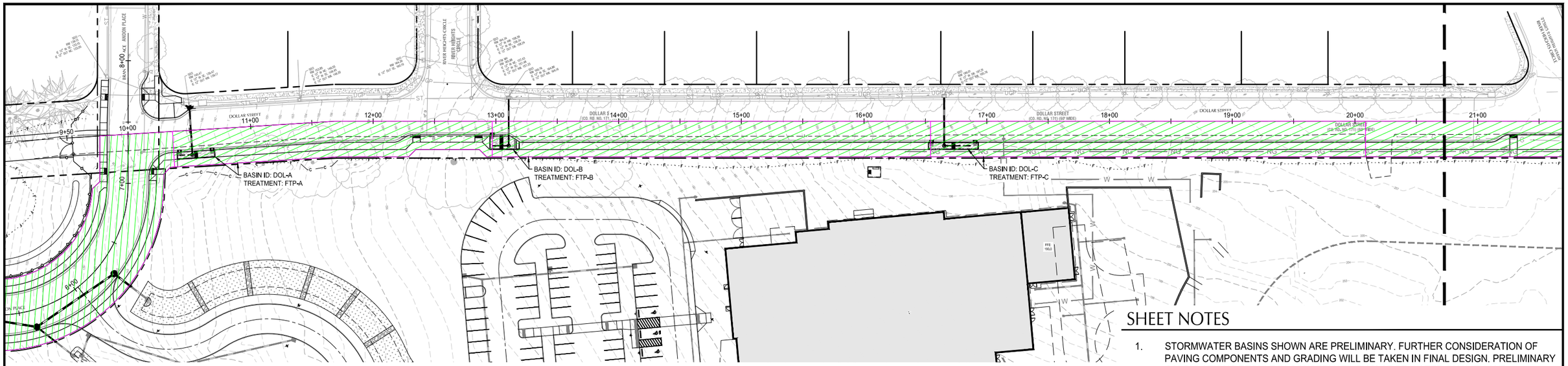

PRELIMINARY BASIN MAP - DOLLAR STREET

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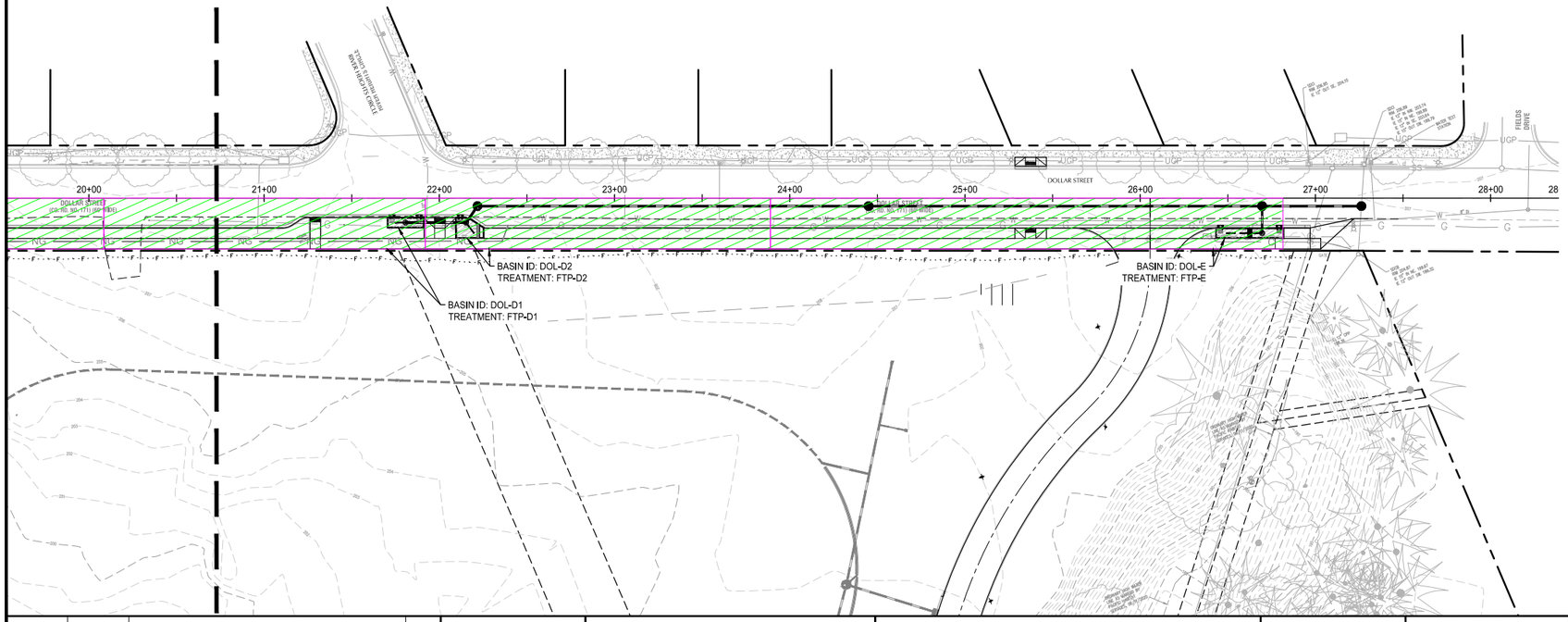

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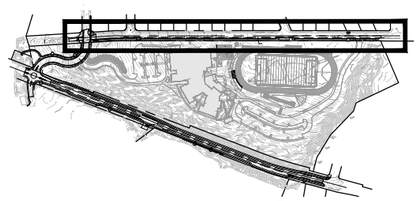
BASIN SUMMARY

BASIN ID	IMPERVIOUS AREA	TREATED (Y/N)	DRAINS TO:
DOL-A	7,190	Y	FTP-A
DOL-B	10,360	Y	FTP-B
DOL-C	10,280	Y	FTP-C
DOL-D1	5,320	Y	FTP-D1
DOL-D2	5,710	Y	FTP-D2
DOL-E	8,485	Y	FTP-E

SHEET LEGEND

TREATED BASIN AREA

UNTREATED BASIN AREA



KEY MAP

REVISION	DATE	DESCRIPTION	BY

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NEW MIDDLE SCHOOL AT DOLLAR STREET
PUBLIC IMPROVEMENT PLANS

DOLLAR STREET DRIVE - PRELIMINARY BASIN MAP

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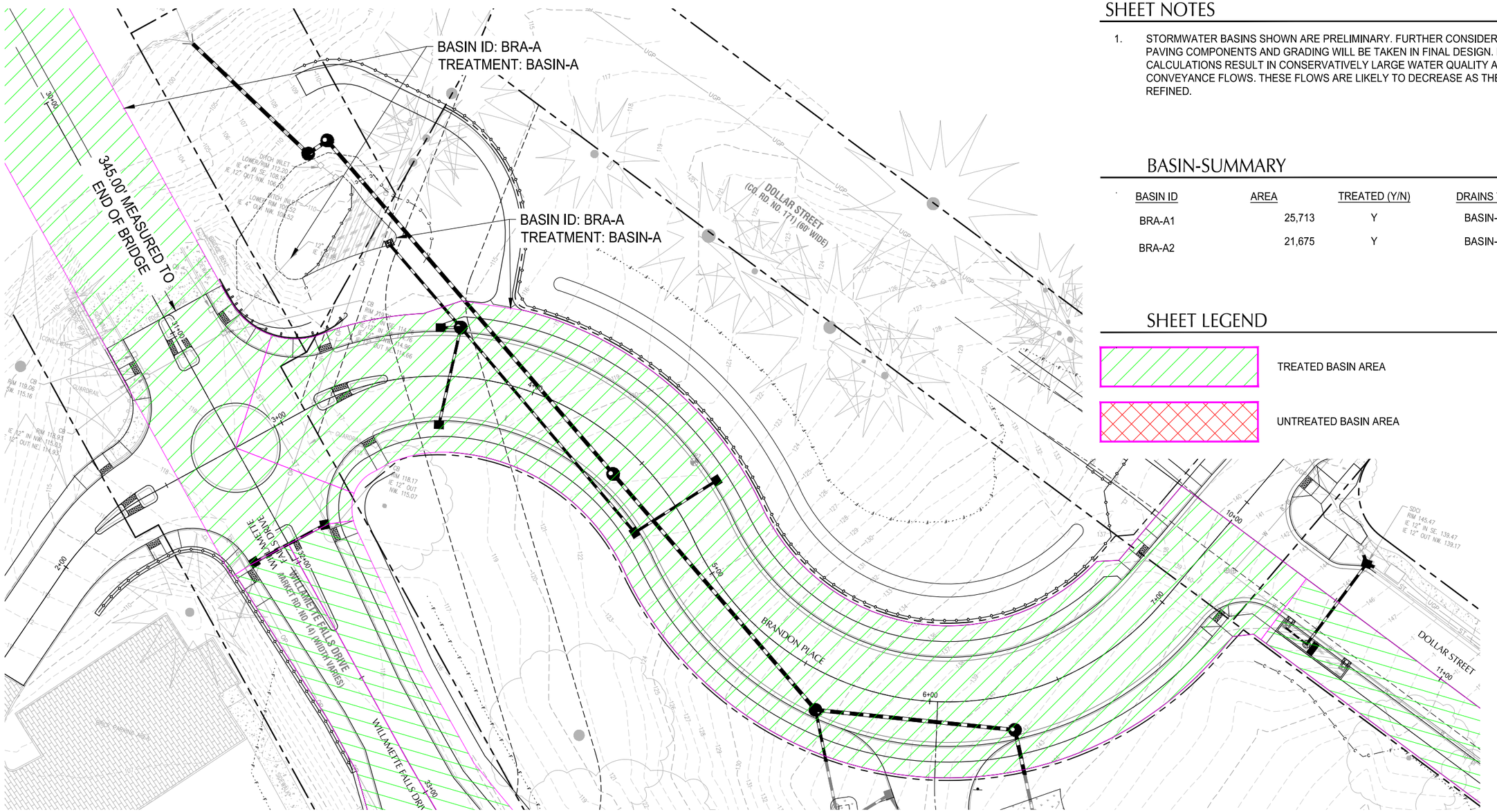

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BASIN-SUMMARY

BASIN ID	AREA	TREATED (Y/N)	DRAINS TO:
BRA-A1	25,713	Y	BASIN-A
BRA-A2	21,675	Y	BASIN-A

SHEET LEGEND

TREATED BASIN AREA

UNTREATED BASIN AREA

PRELIMINARY BASIN MAP - BRANDON STREET EXTENSION

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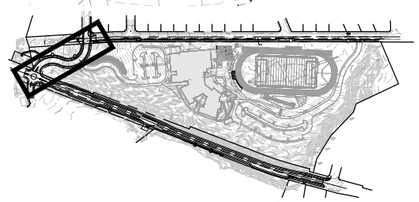

KEY MAP

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NEW MIDDLE SCHOOL AT DOLLAR STREET
PUBLIC IMPROVEMENT PLANS

WILLAMETTE FALLS DRIVE - PRELIMINARY BASIN MAP

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SHEET 1 OF XX
RECORD NO.
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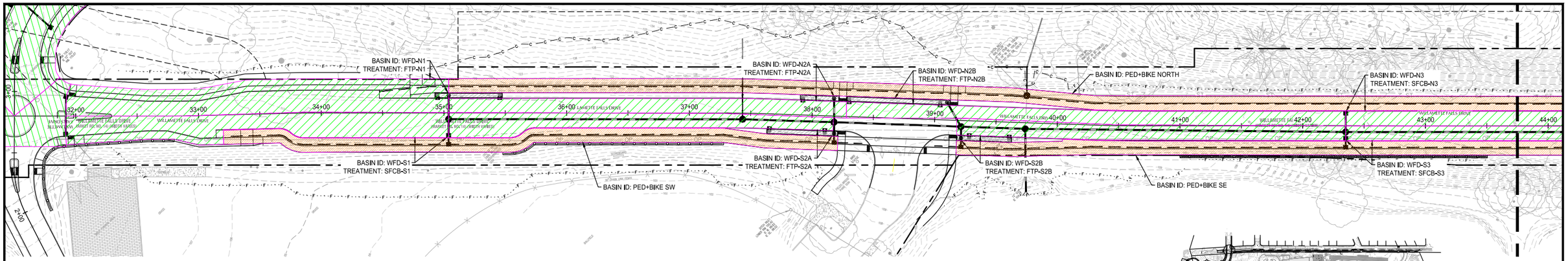
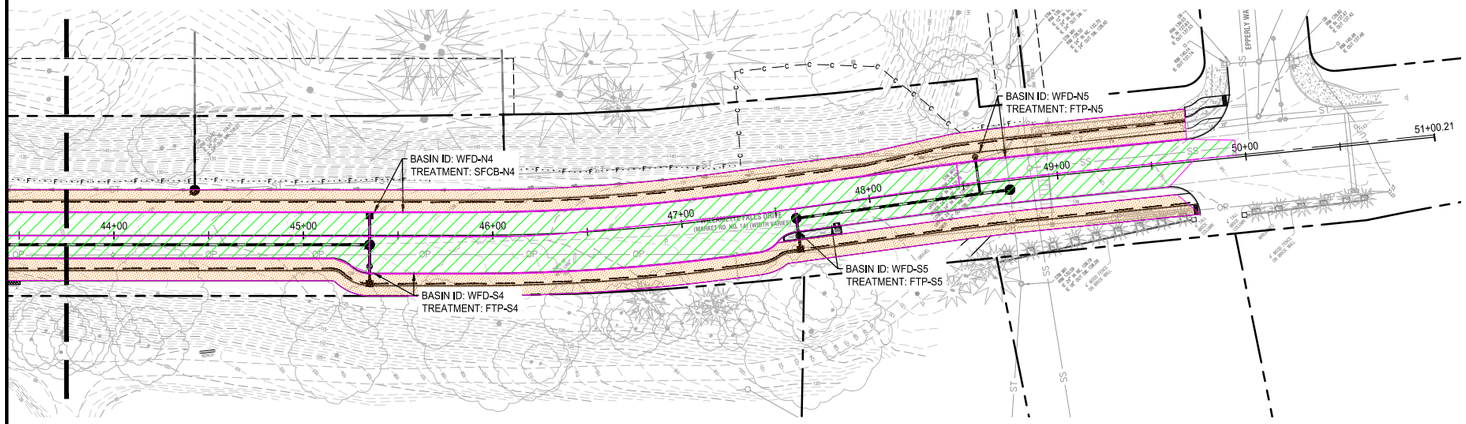
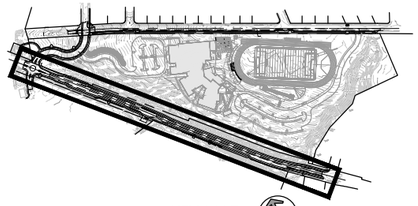


PRELIMINARY BASIN MAP - WILLAMETTE FALLS DRIVE

SCALE: 1" = 40'





KEY MAP

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2. SEE ROADWAY TYPICAL SECTION FOR BIKE AND PED FACILITY DRAINAGE AND PERVIOUS PAVEMENT APPLICATIONS. PERVIOUS AREAS ARE CONSIDERED UNMANAGED. SOUTHERN SIDEWALK DRAINAGE IS COLLECTED AT CURB INLETS LOCATED IN THE BIKE LANE. TREATMENT TO BE PROVIDED VIA CURB INLETS AS FURTHER DEFINED IN SUBSEQUENT DESIGN SUBMITTALS.

BASIN SUMMARY

BASIN ID	IMPERVIOUS AREA	TREATED (Y/N)	DRAINS TO:
WFD-N1	7,950	Y	FTP-N1
WFD-S1	6,060	Y	SFCB-S1
WFD-N2A	4,000	Y	FTP-N2A
WFD-S2A	4,150	Y	FTP-S2A
WFD-N2B	4,610	Y	FTP-N2B
WFD-S2B	4,005	Y	FTP-S2B
WFD-N3	3,690	Y	SFCB-N3
WFD-S3	3,590	Y	SFCB-S3
WFD-N4	3,690	Y	SFCB-N4
WFD-S4	4,450	Y	FTP-S4
WFD-N5	1,585	Y	FTP-N5
WFD-S5	2,605	Y	FTP-S5
PED+BIKE NORTH	17,560		SEE NOTE 2
PED+BIKE SW	5,760		SEE NOTE 2
PED+BIKE SE	12,020		SEE NOTE 2

SHEET LEGEND

TREATED BASIN AREA

UNTREATED BASIN AREA

BIKE AND PEDESTRIAN FACILITY
SEE SHEET NOTE 2

REVISION	DATE	DESCRIPTION	BY

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WILLAMETTE FALLS DRIVE - PRELIMINARY BASIN MAP

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Appendix B

Preliminary Stormwater Details

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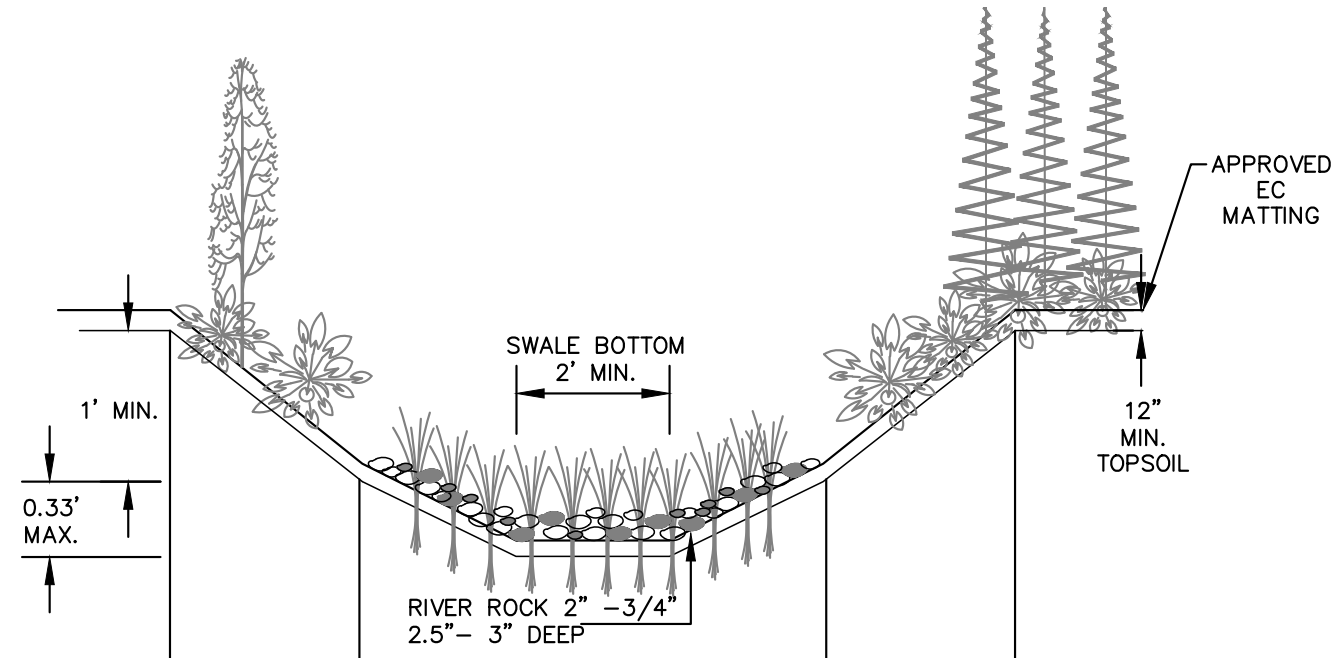
PRELIMINARY GRASSY SWALE DETAIL



SWALE AREA	FREEBOARD AREA	TREATMENT AREA 6' MINIMUM WIDTH			FREEBOARD AREA	BUFFER/MITIGATION AREA
EC MATTING	ECONOJUTE*	COCONUT FIBER OR GEOJUTE PLUS*			ECONOJUTE*	ECONOJUTE* (S> 20%)
SEED MIX	LOW GROW MIX SEE NOTE #5	NONE			LOW GROW MIX SEE NOTE #5	AS APPROVED BY DISTRICT OR CITY
MAX. SLOPE	2.5:1	4:1	FLAT BOTTOM	4:1	2.5:1	NA

* OR AS APPROVED

NOTES:
1. REFER TO BES DESIGN & CONSTRUCTION STANDARDS, FOR LANDSCAPING REQUIREMENTS INCLUDING TREE PLACEMENT, TOPSOIL AND PLANTING SPECIFICATIONS.
2. JUTE MATTING– GEOJUTE PLUS IN TREATMENT AREA, ECONOJUTE FOR ALL OTHER AREAS, OR SIMILIAR FABRICS. COCONUT FIBER IS ALSO ACCEPTABLE.
3. 12–INCHES OF TOPSOIL SHALL BE PLACED THROUGHOUT THE WATER QUALITY TRACT.
4. FREEBOARD AREA SEED MIX, DWARF TALL FESCUE 40%, DWARF PERENIAL RYE 30%, CREEPING RED FESCUE 25%, COLONIAL BENT GRASS 5%. APPLY AT A RATE OF 120# / ACRE.

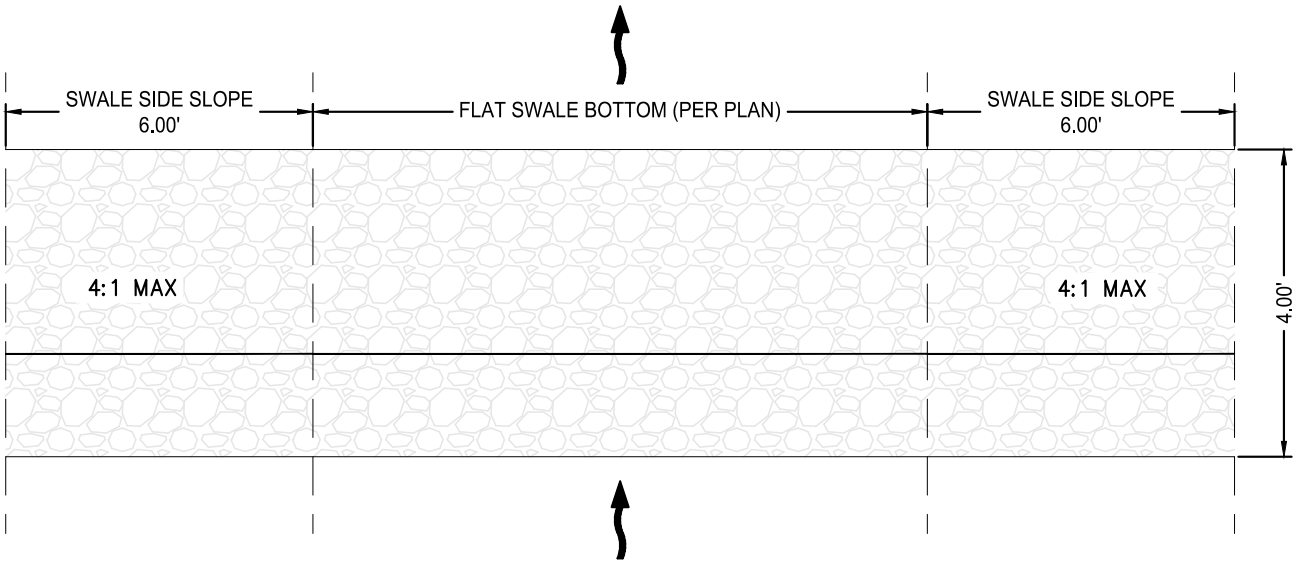
CONSTRUCTION

1. Water Quality Swale shall be over-excavated and filled to final grade with 12-inch amended topsoil. Topsoil amendments shall be garden compost, not conventional fertilizer amendments.
2. A biodegradable Erosion Control Matting shall be placed over the topsoil throughout the swale cross section, fabric shall be held in place in accordance with the manufacturer's installation requirements. Anchor spacing shall be based on 3 fps flow over the fabric.
    a. Treatment area - high-density jute matting (Geojute Plus or other approved equal)
    b. All other areas - low-density jute matting (Econojute or other approved equal)
3. 2.5-3 inches of 2"-$\frac{3}{4}$" river run rock shall be placed over the matting evenly throughout the length and width of the swale.
4. Plant materials shall be placed in accordance with the plan and plant table as shown on approved plans.
5. The water quality swale treatment area plantings can be deemed "substantially complete" once active green growth has occurred to an average growth of 3" and plant density is an average of approx. 6 plants (minimum 1-inch plugs or equivalent) per square foot.

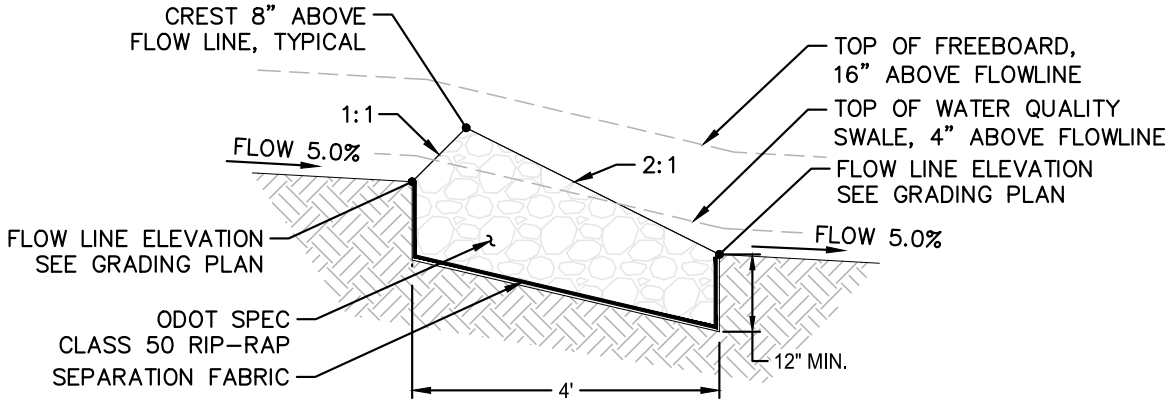
2 GRASSY SWALE

SCALE: NTS

PRELIMINARY GRASSY SWALE FLOW SPREADER DETAIL



TOP VIEW



SECTION A

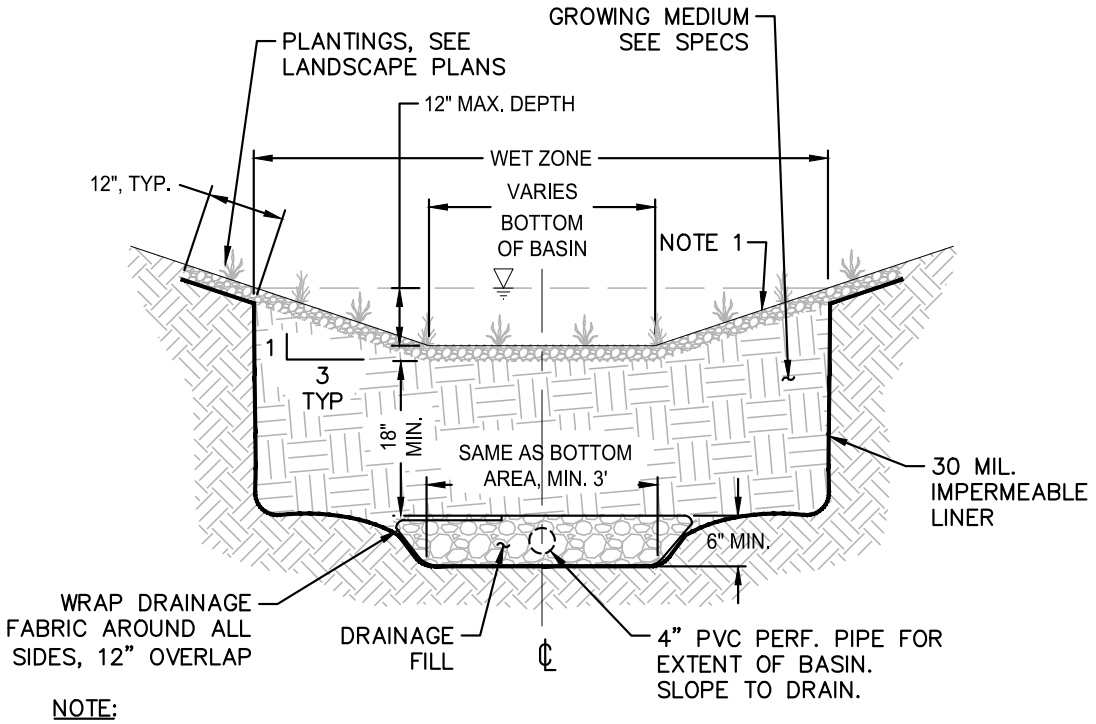
NOTES

1. INSTALL RIP-RAP SPREADER ACROSS FULL WATER QUALITY SEGMENT OF SWALE
2. CREST OF BERM SHALL BE LEVEL AND UNIFORM ACROSS ENTIRE SECTION.
3. SEE GRADING PLAN FOR ELEVATION DROP ACROSS RIP RAP

4 RIP-RAP FLOW SPREADER AND CHECK DAM

SCALE: NTS

PRELIMINARY TREATMENT
BASIN DETAIL



NOTE:
1. INSTALL GEOJUTE PLUS OR COCONUT FIBER MATTING, OR 2" THICK LAYER OF PEA GRAVEL OR OTHER NON-FLOATING MULCH AS APPROVED BY LANDSCAPE ARCHITECT.

1 TYP. VEGETATED FILTRATION BASIN (VFB)

SCALE: NTS

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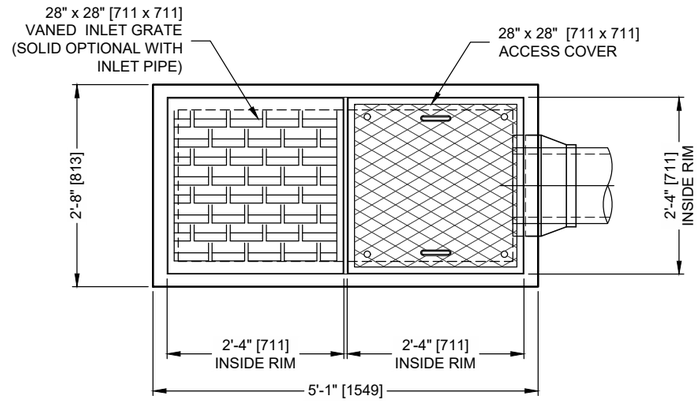
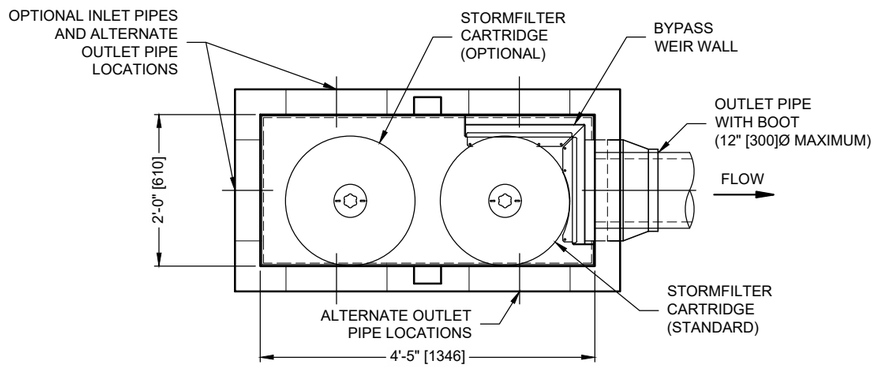
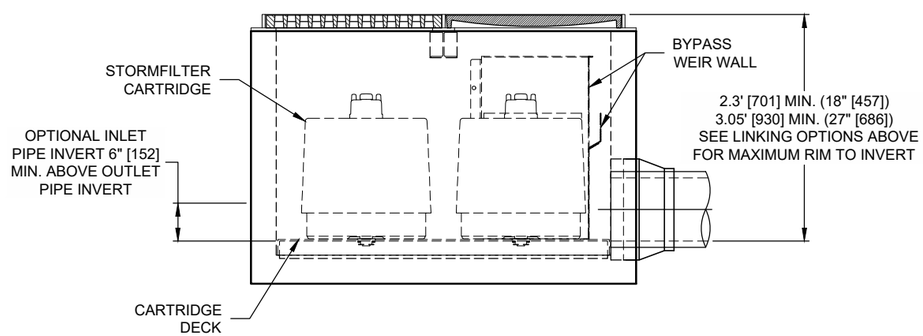


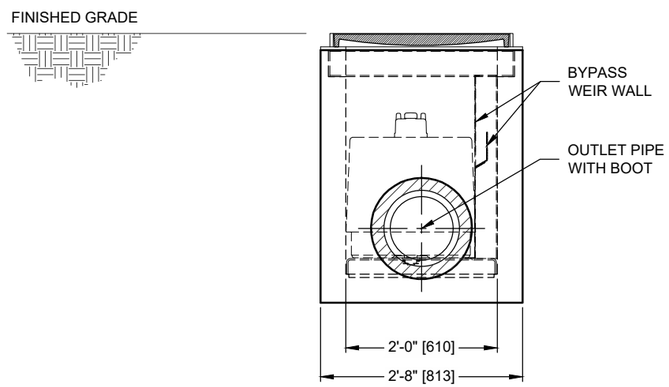
PLAN VIEW



PLAN VIEW
CASTINGS NOT SHOWN



ELEVATION VIEW



RIGHT SIDE VIEW

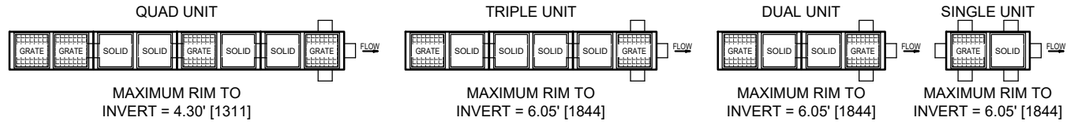
STORMFILTER DESIGN NOTES

- CONCRETE CATCHBASIN STORMFILTER TREATMENT CAPACITY VARIES BY CARTRIDGE COUNT AND LOCAL APPROVALS
- PEAK CONVEYANCE CAPACITY IS 1.3 CFS
- CONCRETE CATCHBASIN STORMFILTER IS AVAILABLE WITH UP TO TWO (2), 18" [457] OR 27" [686] TALL CARTRIDGES
- UP TO 4 INDIVIDUAL UNITS MAY BE LINKED FOR AN ULTIMATE CAPACITY OF EIGHT (8) CARTRIDGES

CARTRIDGE SIZE (in. [mm])	27 [686]			18 [457]		
ACTIVATION HEAD (ft. [mm])	3.05 [930]			2.3 [701]		
SPECIFIC FLOW RATE (gpm/sf [L/s/m^2])	2 [1.36]	1.67* [1.13]*	1 [0.68]	2 [1.36]	1.67* [1.13]*	1 [0.68]
CARTRIDGE FLOW RATE (gpm [L/s])	22.5 [1.4]	18.79 [1.19]	11.25 [0.71]	15 [0.95]	12.53 [0.79]	7.5 [0.47]

* 1.67 gpm/sf [1.13 L/s/m^2] SPECIFIC FLOW RATE IS APPROVED WITH PHOSPHOSORB® (PSORB) MEDIA ONLY

LINKING OPTIONS SHOWN BELOW. FLEXIBLE INLET PIPE, GRATED AND SOLID COVER PLACEMENT. MAXIMUM HEIGHT FOR LINKED UNITS VARIES. CONTACT YOUR CONTECH REPRESENTATIVE FOR MORE INFORMATION



GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. ALTERNATE DIMENSIONS ARE MILLIMETERS [mm] UNLESS NOTED OTHERWISE.
4. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
5. 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.
6. FILTER CARTRIDGES SHALL BE MEDIA-FILLED, PASSIVE, SIPHON ACTUATED, RADIAL FLOW, AND SELF CLEANING. RADIAL MEDIA DEPTH SHALL BE 7-INCHES [178]. FILTER MEDIA CONTACT TIME SHALL BE AT LEAST 38 SECONDS.
7. SPECIFIC FLOW RATE IS THE MEASURE OF THE FLOW (GPM [L/S]) DIVIDED BY THE MEDIA SURFACE CONTACT AREA (SF [m^2]).
8. STRUCTURE SHALL MEET AASHTO HS20 LOAD RATING, ASSUMING EARTH COVER OF 0' - 0'-2" [51] 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

1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STORMFILTER STRUCTURE.
3. CONTRACTOR TO PROVIDE AND INSTALL PIPES. MATCH PIPE INVERTS SHOWN ON PROJECT SPECIFIC DRAWINGS.
4. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT CARTRIDGES FROM CONSTRUCTION-RELATED EROSION RUNOFF.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (cfs [L/s])	
PEAK FLOW RATE (cfs [L/s])	
RETURN PERIOD OF PEAK FLOW (yrs)	
CARTRIDGE SIZE (27, 18)	
CARTRIDGE FLOW RATE	
MEDIA TYPE (PERLITE, ZPG, PSORB)	
NUMBER OF CARTRIDGES REQUIRED	
RIM ELEVATION	

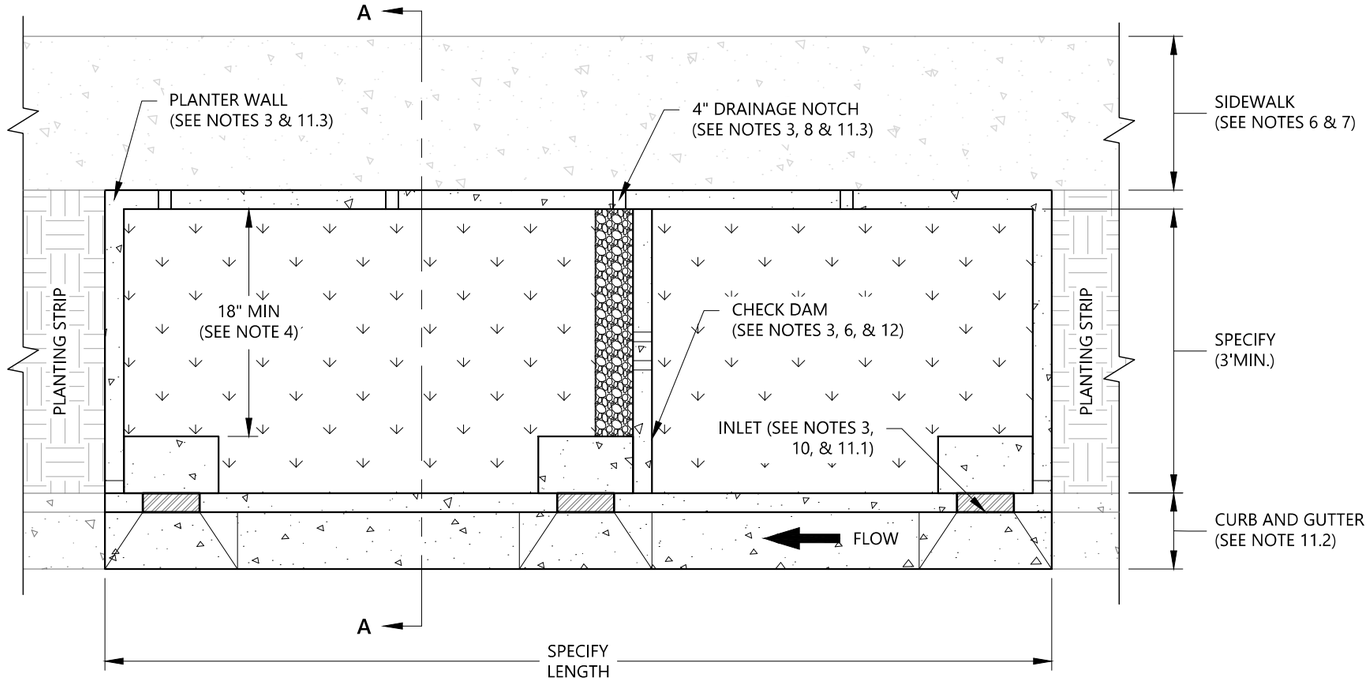
PIPE DATA:	INVERT	MATERIAL	DIAMETER
INLET PIPE 1			
INLET PIPE 2			
OUTLET PIPE			

NOTES/SPECIAL REQUIREMENTS:

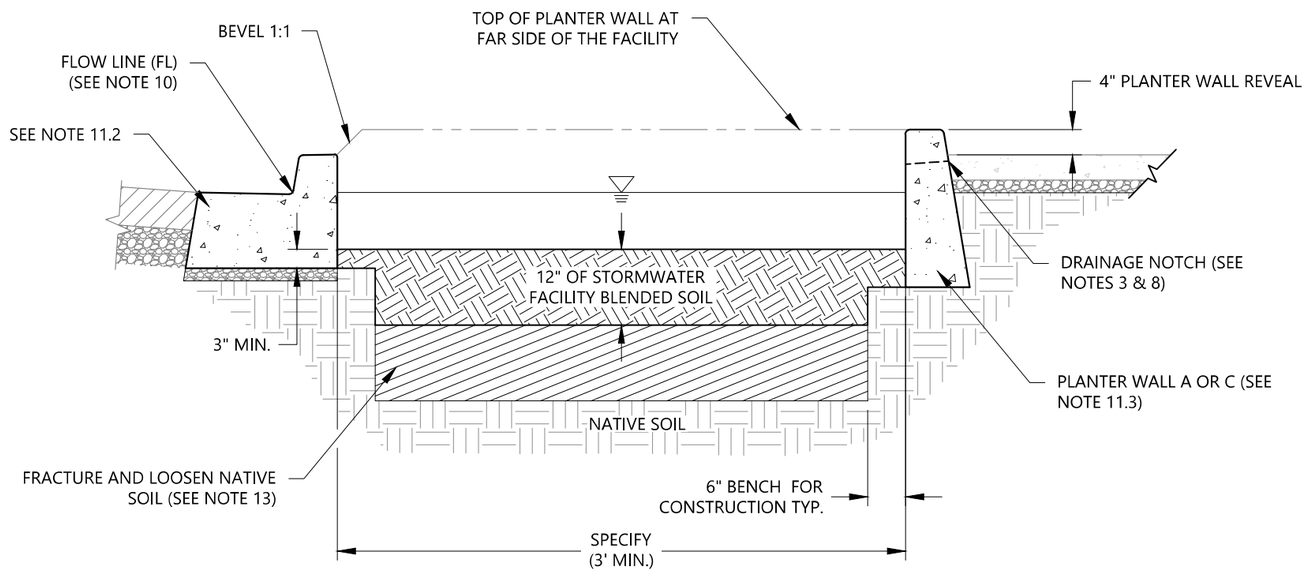
The Stormwater Management StormFilter®

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
11815 NE Glenn Widing Drive, Portland, OR 97220
800-548-4667 503-240-3393 800-561-1271 FAX

CONCRETE CATCHBASIN STORMFILTER STANDARD DETAIL



PLAN VIEW
(PLANTER WITHOUT PARKING)



SECTION A-A
(PLANTER WITHOUT PARKING)

DESIGNER INFORMATION:

1. Adapt this plan and section view example to your engineered design. Maximize surface storage.
2. Area and depth of facility are based upon engineering calculations and right-of-way constraints.
3. Provide beginning and ending stations for each facility. Provide stationing and/or dimensions and elevations at each inlet, outlet, check dam, notch, and wall corner
4. If less than 18-in between splash pad and planter wall, then extend pad to wall.
5. Show liner, slotted pipe, 24" depth stormwater facility blended soil, and aggregate in section when used. Refer to SWMM detail SW-316: Stormwater Configuration Sections.
6. Sidewalk elevation must be set above check dam and inlet elevations to allow overflow to drain to street before sidewalk.
7. Detail assumes top-of-curb and top-of-sidewalk at approximately the same elevation. Modify detail if site conditions are different
8. Place drainage notch at low point in sidewalk. Space additional notches 6-ft apart.
9. Proposed utility lines to be located out of facility, or per details P-331, P-332, and P-333.
10. Depress gutter pan Flow Line (FL) 2-in to Bottom of Inlet (BI).

RELATED DETAILS AND RESOURCES:

11. City of Portland Standard Drawings:
    - 11.1. P-300: Concrete Inlet, Type Metal.
    - 11.2. P-540: Curbs, 18" Thickened Curb and Gutter typ. When adjacent to a bike lane use 12" Thickened Curb and Gutter.
    - 11.3. P-307: Planter Walls.
    - 11.4. P-332: Utility Coordination Water Service Line Sleeving.
    - 11.5. P-333: Utility Coordination Water Asset Clearances.
12. Stormwater Management Details:
    - 12.1. SW-312: Check Dam - Infiltration Facility.
    - 12.2. SW-313: Check Dam - Infiltration Facility with Rock.
    - 12.3. SW-314: Check Dam - Partial Infiltration Facility with Weep Holes.
    - 12.4. SW-315: Check Dam - Lined Facility with Weep Holes.

CONSTRUCTION NOTES:

13. In facilities that are unlined, fracture and loosen soil - DO NOT TILL - to a depth of 12" below stormwater facility blended soil excavation before installing aggregates or blended soil.

IMPORTANT: Utility conflicts and existing conditions can create major design variables. Locate utilities and survey existing conditions prior to beginning design work and include information on design drawings.

The Portland Bureau of Transportation (PBOT), Portland Water Bureau (PWB), and Bureau of Environmental Services (BES) are responsible for the review and approval of Stormwater Swales in the public right of way. Stormwater facilities in Wellhead Protection Areas may require special containment measures as required by City Code 21.35.

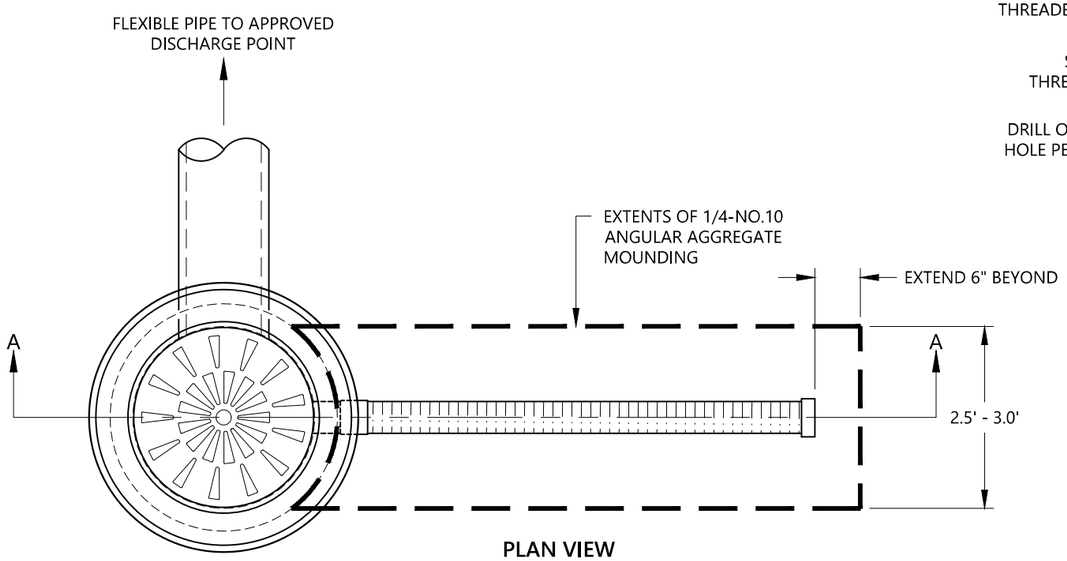
For more information contact:
PBOT (503) 823-7884
BES (503) 823-7761
PWB (503) 823-7368
Urban Forestry (503) 823-8733

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

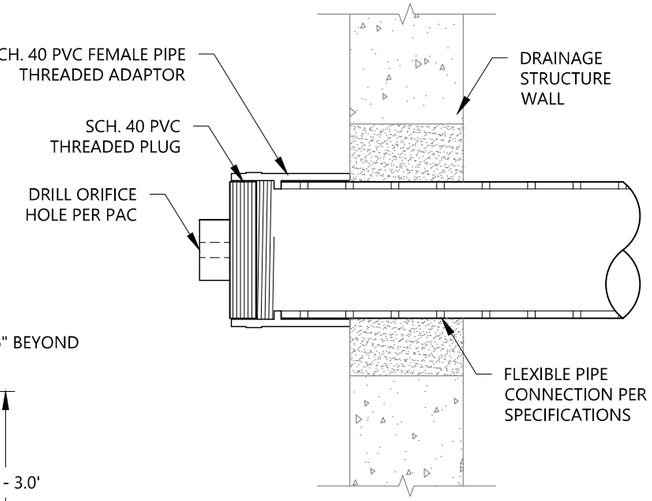
SWMM Detail Title

PLANTER - NO PARKING PLAN AND SECTION VIEWS

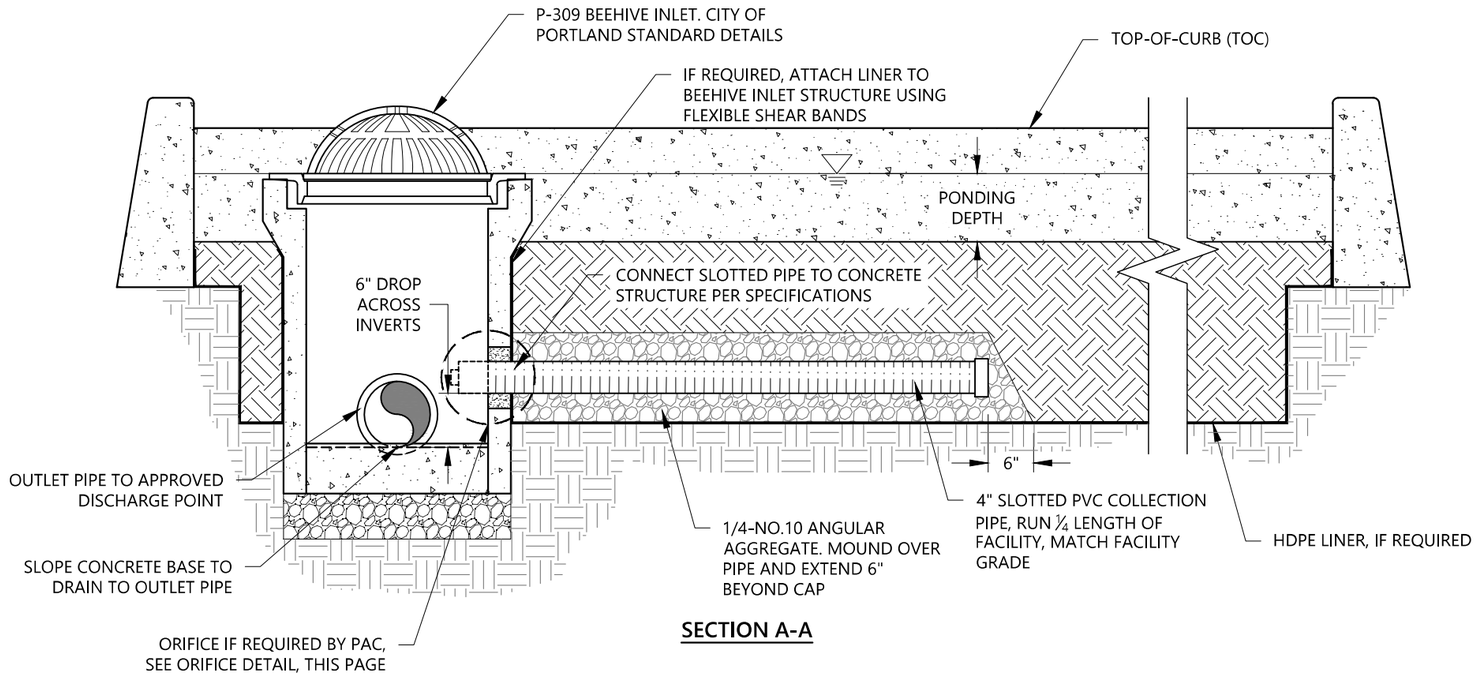
Effective Date: 12-14-2020	SWMM Detail No. SW-301
Calc. Book No.: N/A	
Baseline Report Date: N/A	



PLAN VIEW



ORIFICE DETAIL



SECTION A-A

DESIGNER INFORMATION:

1. EXAMPLE SHOWN IS FOR A LINED FACILITY. MODIFY DETAIL FOR UNLINED FACILITY.
2. IF CONNECTING TO A COMBINATION SEWER MAINTENANCE HOLE INSTALLTION OF A SWING-CHECK BACKWATER VALVE OR APPROVED EQUAL IS REQUIRED TO PREVENT ODOR EMISSIONS.
3. PRE-DRILL ORIFICE BEFORE INSTALLATION. SMOOTH AND/OR SAND ORIFICE REMOVING ROUGH EDGES. CLEAR PIPE OF ALL DEBRIS BEFORE INSTALLING ORIFICE CAP.

Bureau of Environmental Services
CITY OF PORTLAND, OREGON
2020 STORMWATER MANAGEMENT MANUAL

SWMM Detail Title

OVERFLOW CONFIGURATION BEEHIVE OVERFLOW STRUCTURE

Effective Date: 12-14-2020	SWMM Detail No. SW-317
Calc. Book No.: N/A	
Baseline Report Date: N/A	

3.2.5.5 Grassy Swales

Grassy swales are grass channels designed primarily for conveying and treating stormwater runoff. Water quality treatment is provided as water moves horizontally through the swale and is filtered through the grass. Grassy swales can be designed to manage flow rates and volume if infiltration rates are adequate. They can be lined if infiltration is prohibited.

Design

Grassy swales must be designed under the Performance Approach.

Site Suitability: Grassy swales are appropriate for all soil types.

Setbacks: See Section 2.2.4 for setback requirements.

Access: See access requirements in Section 3.2.2.1.

Pollution Prevention: See pollution prevention requirements in Section 3.2.2.1.

Sizing: The swale must be designed to treat runoff from the pollution reduction design storm intensity, using the following criteria:

- Maximum design velocity: 0.9 ft/s

- Minimum hydraulic residence time: 9 minutes (i.e., time for the design flow to pass through the swale)
- Manning n value: 0.25
- Maximum ponding depth: 4 inches unless otherwise approved (This is to maximize contact with the grass.)

It is recommended to allow high flows exceeding the pollution reduction design storm to bypass the grassy swale.

Swales without high-flow diversion devices must be sized to safely convey the 25-year storm event (peak 25-year, 5-minute intensity = 3.32 inches per hour), analyzed using the Rational Method. They must also meet the following criteria:

- Have a minimum of 4 inches of freeboard above the water surface.
- Maintain a maximum velocity through the facility of 3 ft/s.

The figures below provide minimum required dimensions (swale length and bottom width) given peak flow rates. The values are derived from the City's Sewer and Drainage Facilities Design Manual.

Figure 3-3. Swale Length at 1.5% Longitudinal Slope

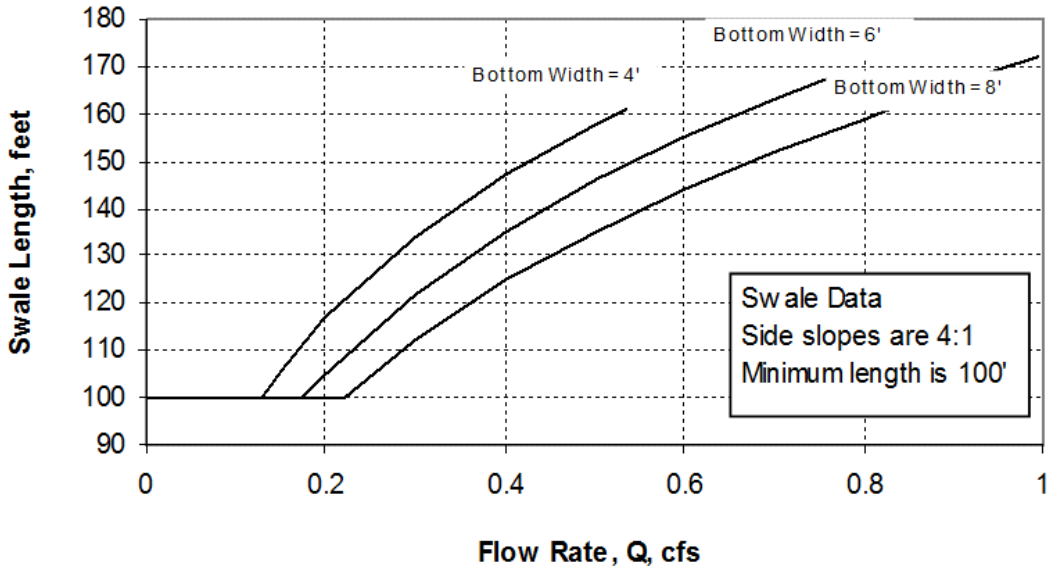


Figure 3-4. Swale Length at 3.0% Longitudinal Slope

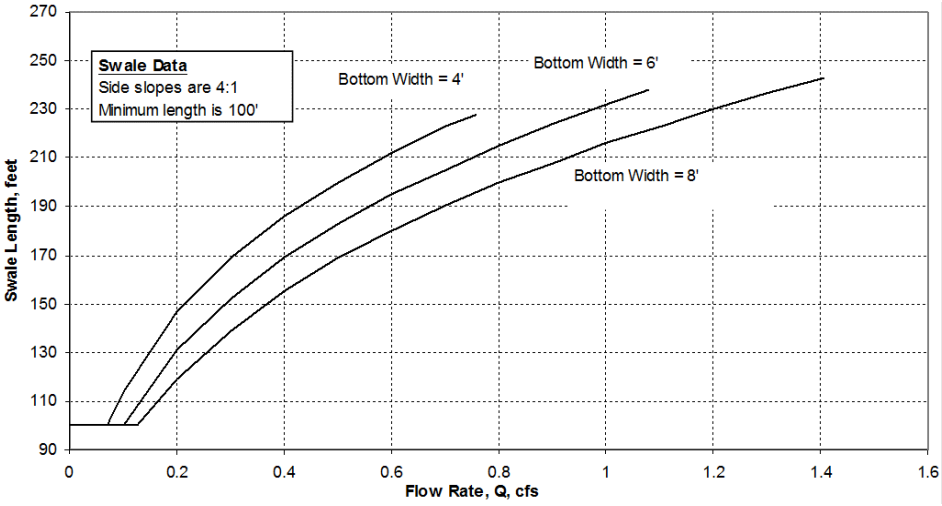
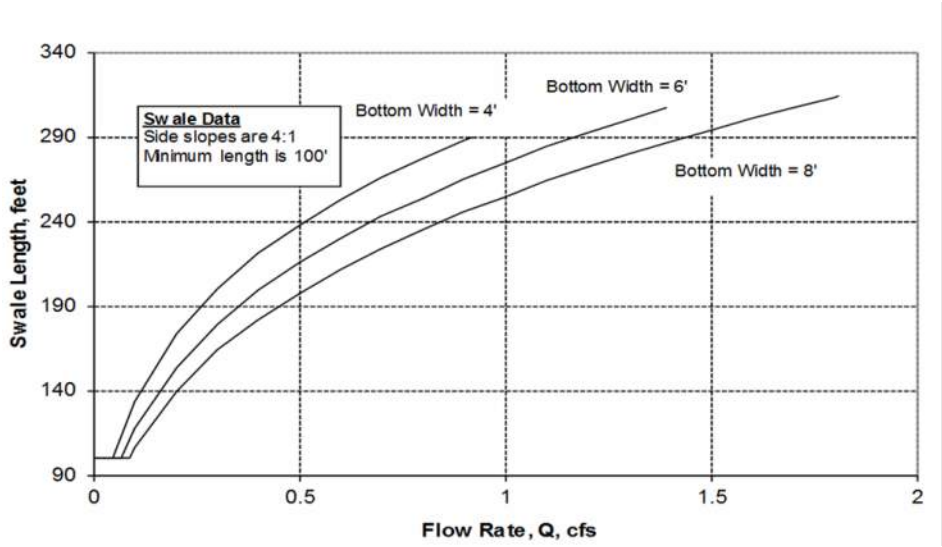


Figure 3-5. Swale Length at 5.0% Longitudinal Slope



Dimensions and Slopes: Minimize the depth of the swale and the steepness of the side slopes to avoid safety risks and prevent erosion within the facility. The bottom of the grassy swale must be smooth with a uniform longitudinal slope to minimize flow channelization. Grassy swales must also meet the following criteria:

All grassy swales:

- Minimum length: 100 ft
- Maximum side slopes: 4 horizontal to 1 vertical (4:1)

Grassy swales on private property:

- Minimum top width: 10 ft
- Minimum bottom width: 2 ft (must be flat)

Grassy swales on public property:

- Minimum top width: 12 ft
- Minimum bottom width: 4 ft (must be flat)

Flow Spreader: Install a flow-spreading device at the inlet to distribute flows evenly across the bottom of the swale. In swales with a bottom width greater than 6 ft, install a flow spreader at least every 50 ft.

Soil: Amend the native soils per the requirements for rain gardens if needed to support plant growth (see Section 3.2.2.2).

Vegetation: Plant the entire surface area of the grassy swale with native grass or swale seed mix to provide 100% coverage of both the swale bottom and the side slopes. For BES-maintained facilities, select native wildflowers and grasses that require minimal mowing (i.e., no more than once or twice annually). BES does not allow lawn-type areas in BES-maintained facilities and exceptions require BES approval. Grassy swales in environmental zones must meet requirements established by PCC Title 33 for grass species in Environmental Zones.

BES may allow trees and shrubs in the flow path if the swale exceeds the length and widths specified. See Section 3.5 for information about trees.

Construction Requirements

See standard construction requirements for bioretention facilities in Section 3.2.2.2.

Seed native grass mixes in the swale flow path. Apply seed at the rates specified by the supplier. Plants must be established by the time the facility is completed and at least 3 months after seeding. Establish grasses as soon as possible after the swale is completed and before water is allowed to enter the facility. Do not allow entry of concentrated stormwater flows until the vegetation is fully established.

Unless vegetation is established prior to completion of construction, install biodegradable erosion control matting that is appropriate for low-velocity flows (approximately 1 ft/s) in the flow path before allowing water into the facility.

Appendix C

Stormwater Calculations and Model Hydrographs

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Water Quality Grassy Swale Sizing

Dollar Street Middle School
KPFF Job No 2000067
Designer: NP
Check Engineer: DP/MW
Preliminary Drainage Report, January 2021

Design Storm
1.33 inches (SCS Type IA 24-hr storm distribution - 1/2 2-year)

Water Quality Grassy Swale

Tributary Basin Area:	580735	sf	(Impervious+Pervious)
Convert to Acres:	13.332	ac	

Portland BES SWMM: 2.3.4.11 Grassy Swale Criteria:

Minimum Residence Time "T":	9.00	min	
Maximum Water Depth "y":	0.33	feet	
Minimum Freeboard:	1.00	feet	
Maximum Velocity "V":	0.90	ft/s	(for WQ event)
Minimum Length "L":	100.00	feet	
Minimum Slope "s":	0.0050	ft/ft	
Minimum Bottom Width "b":	2.00	feet	
Side Slope in Treatment Area "z":	4.00	zH:1V	
Manning's coefficient "n":	0.25		

Find Water Quality Flow Rate "Q" in cfs:
Q = 1.9900 cfs *(see model hydrographs for peak inflow)*

Assume y=0.33, s=5.0%, Find b: b=(Qn)/(1.49*y^1.67*s^0.5)
Required minimum b = 9.50 ft

Assume b=16', Determine velocity V: V=Q/A(wetted) A(wetted) = by + zy^2 A(wetted)= 1.10 sf
V = 0.35 fps

Find Required Length for 9 minute Residence: L=9(min)*60(s) * V (fps)
L= 188.00 ft

Assume L=250', time of concentration t: t = L / (V*60)
t = 11.90 min

Facility Proposed Design

Bottom width (ft)	16.00	ft	
Design flow depth (ft)	0.33	ft	
Slope (%)	5.00	%	
WQ side slope (H:V)	4:1	H:V	
Length (ft)	250.00	ft	*(includes a 4-ft energy dissipater and (4) 2-ft slope reducing riprap flow spreaders,*
Time of Concentration (min)	11.90	min	
Design velocity	0.35	fps	*(flow splitter MH negates need to meet max 2.0 fps for 25-yr storm)*
Freeboard	1.00	ft	*(not required, as facility is protected from high flows)*
Freeboard area side slope	3:1	H:V, max	*(2.5:1 allowable)*

25-year High Flow Conveyance Check

Max V=	3.00	fps	
Q(25-yr)=	9.11	cfs	*(see model hydrographs for peak inflow)*
y(observed) =	0.60	ft	*(below top of freeboard of 1.33-ft)*
V(observed) =	0.83	fps	

Conclusion
The proposed grassy swale fully treats all water quality flows as specified by the City of Portland Stormwater Management Manual. All minimum and maximum criteria for the VGrassy Swale are met or surpassed. There is no high-flow bypass system for this swale, therefore the swale is shown to be designed to safely pass the 25-year storm event.

Project Description

File Name ..... SSA-DD-LU.SPF

Project Options

Flow Units ..... CFS
Elevation Type ..... Elevation
Hydrology Method ..... Santa Barbara UH
Time of Concentration (TOC) Method ..... SCS TR-55
Link Routing Method ..... Kinematic Wave
Enable Overflow Ponding at Nodes ..... YES
Skip Steady State Analysis Time Periods ..... YES

Analysis Options

Start Analysis On ..... Jun 18, 2020 00:00:00
End Analysis On ..... Jun 19, 2020 00:00:00
Start Reporting On ..... Jun 18, 2020 00:00:00
Antecedent Dry Days ..... 0 days
Runoff (Dry Weather) Time Step ..... 0 01:00:00 days hh:mm:ss
Runoff (Wet Weather) Time Step ..... 0 00:05:00 days hh:mm:ss
Reporting Time Step ..... 0 00:05:00 days hh:mm:ss
Routing Time Step ..... 30 seconds

Rainfall Details

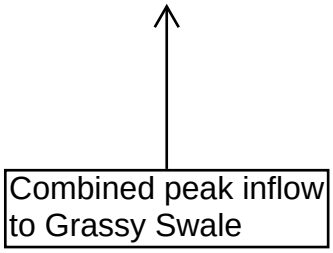
SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	1/2-2YR	Cumulative	inches	Oregon	Clackamas	2	1.33	SCS Type IA 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ft²)	Impervious Area (%)	Impervious Area Curve Number	Pervious Area Curve Number	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	BASIN-A	14120.02	100.00	98.00	79.00	1.33	1.11	0.36	0.09	0 00:05:00
2	BASIN-B	77000.01	100.00	98.00	79.00	1.33	1.11	1.96	0.51	0 00:05:00
3	BASIN-C	50915.02	100.00	98.00	79.00	1.33	1.11	1.30	0.34	0 00:05:00
4	BASIN-D	32675.01	100.00	98.00	79.00	1.33	1.11	0.83	0.22	0 00:05:00
5	BASIN-E	98990.01	100.00	98.00	79.00	1.33	1.11	2.52	0.65	0 00:05:00
6	BASIN-F	42620.02	100.00	98.00	79.00	1.33	1.11	1.09	0.28	0 00:05:00
7	BASIN-G	100644.99	0.00	98.00	79.00	1.33	0.18	0.42	0.03	0 00:10:00
8	BASIN-H	22029.99	0.00	98.00	79.00	1.33	0.18	0.09	0.01	0 00:10:00
9	BASIN-I	101140.00	0.00	98.00	79.00	1.33	0.18	0.42	0.03	0 00:10:00
10	BASIN-J	49599.99	0.00	98.00	79.00	1.33	0.18	0.21	0.02	0 00:10:00
11	BASIN-K	5122.00	0.00	98.00	79.00	1.33	0.18	0.02	0.00	0 00:10:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	FTP-ONSITE	Junction	106.00	120.00	0.00	0.00	0.00	0.09	106.00	0.00	14.00	0 00:00	0.00	0.00
2	GRASSY-SWALE	Junction	106.00	120.00	0.00	0.00	0.00	1.99	106.00	0.00	14.00	0 00:00	0.00	0.00



Subbasin Hydrology

Subbasin : BASIN-A

Input Data

Area (ft²) 14120.02
Impervious Area (%) 100.00
Impervious Area Curve Number 98.00
Pervious Area Curve Number 79.00
Rain Gage ID ..... Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	14120.02		98

Time of Concentration

TOC Method : SCS TR-55

Sheet Flow Equation :

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

Where :

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

Shallow Concentrated Flow Equation :

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

Where:

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

Channel Flow Equation :

V = (1.49 * (R^(2/3)) * (Sf^0.5)) / n
R = Aq / Wp
Tc = (Lf / V) / (3600 sec/hr)

Where :

Tc = Time of Concentration (hr)
Lf = Flow Length (ft)
R = Hydraulic Radius (ft)
Aq = Flow Area (ft²)
Wp = Wetted Perimeter (ft)
V = Velocity (ft/sec)
Sf = Slope (ft/ft)
n = Manning's roughness

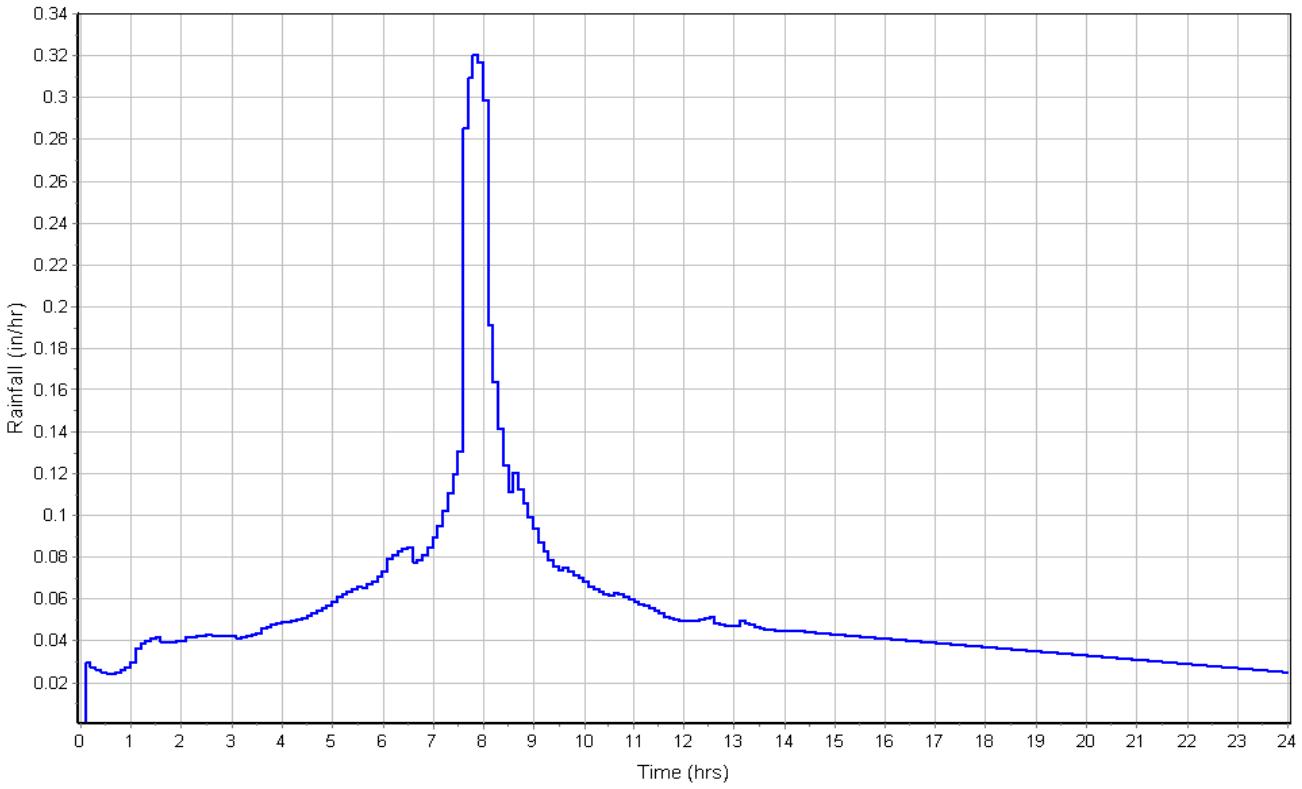
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

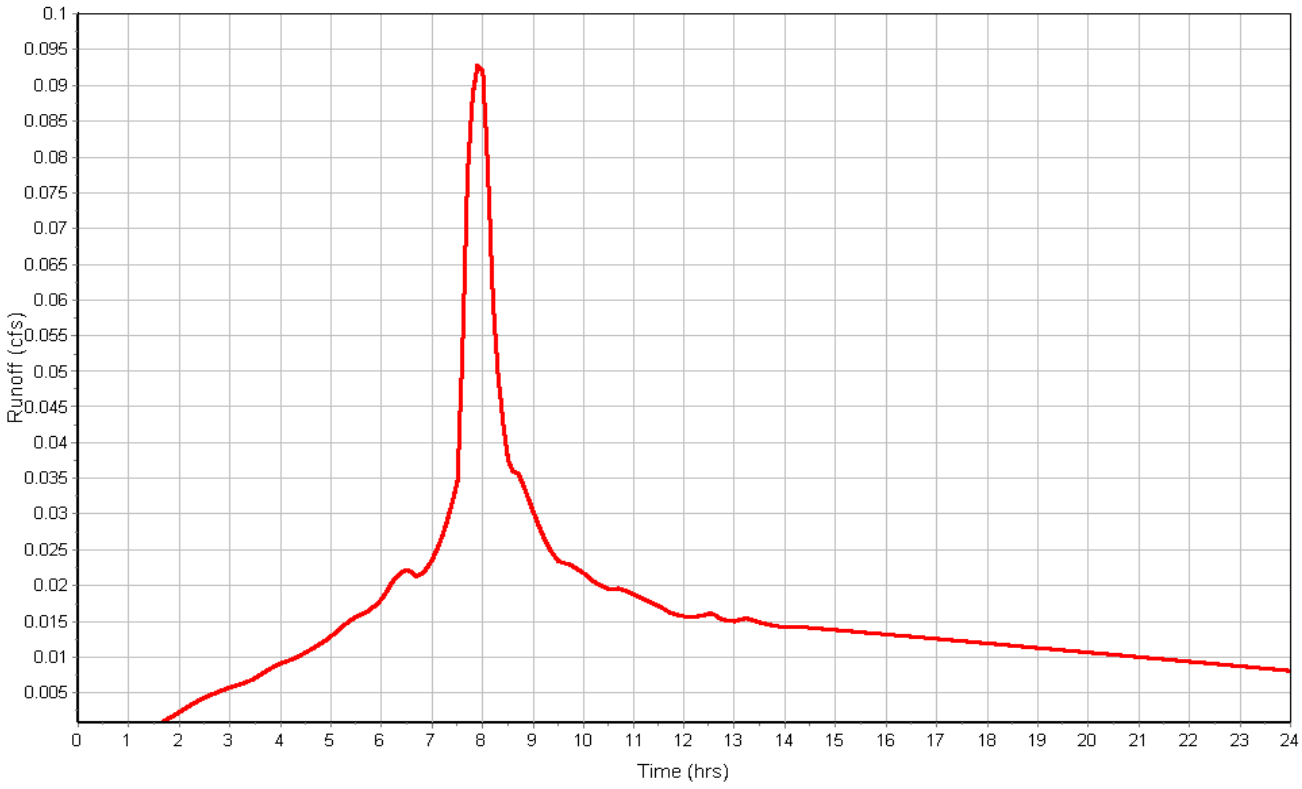
Total Rainfall (in) 1.33
Total Runoff (in) 1.11
Peak Runoff (cfs) 0.09
Weighted Curve Number 98.00
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASIN-A

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-B

Input Data

Area (ft²)	77000.01
Impervious Area (%)	100.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	77000.01		98

Time of Concentration

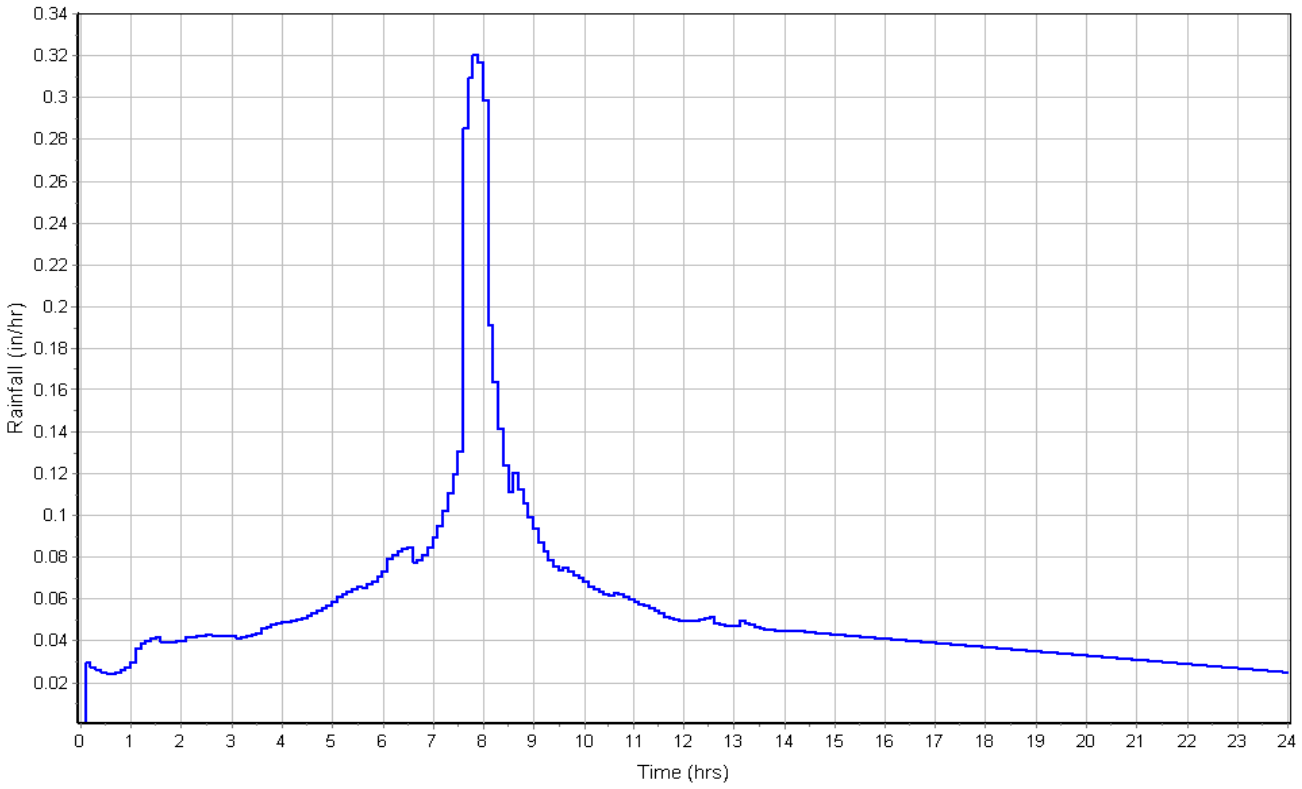
User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

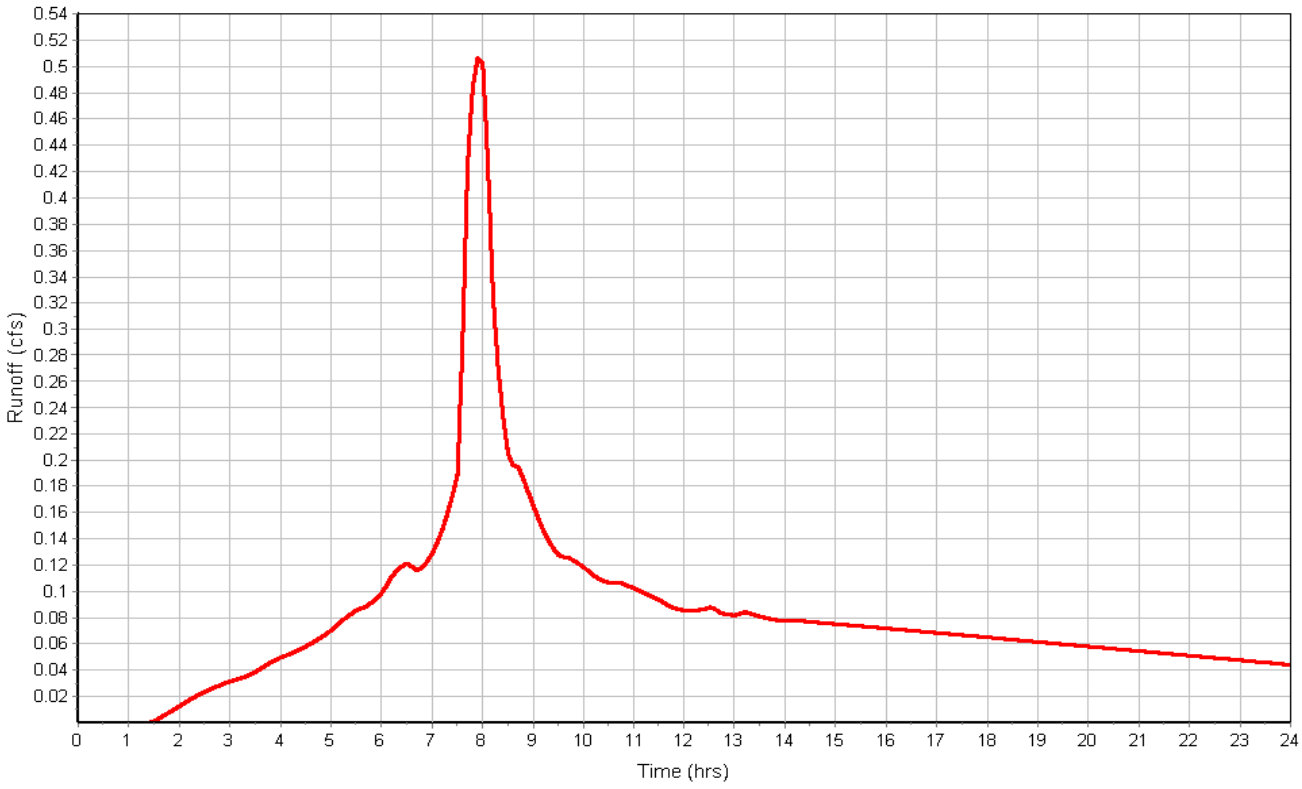
Total Rainfall (in)	1.33
Total Runoff (in)	1.11
Peak Runoff (cfs)	0.51
Weighted Curve Number	98.00
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : BASIN-B

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-C

Input Data

Area (ft²)	50915.02
Impervious Area (%)	100.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	50915.02		98

Time of Concentration

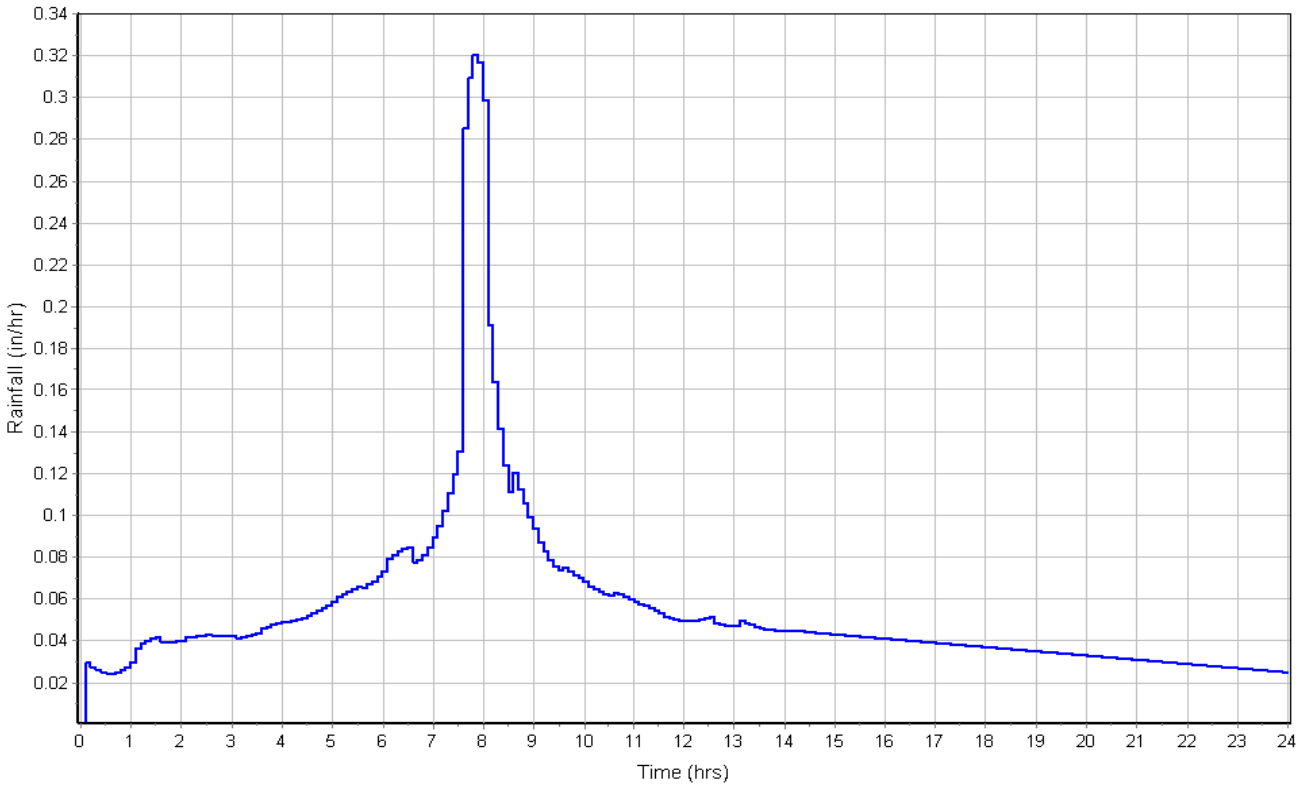
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

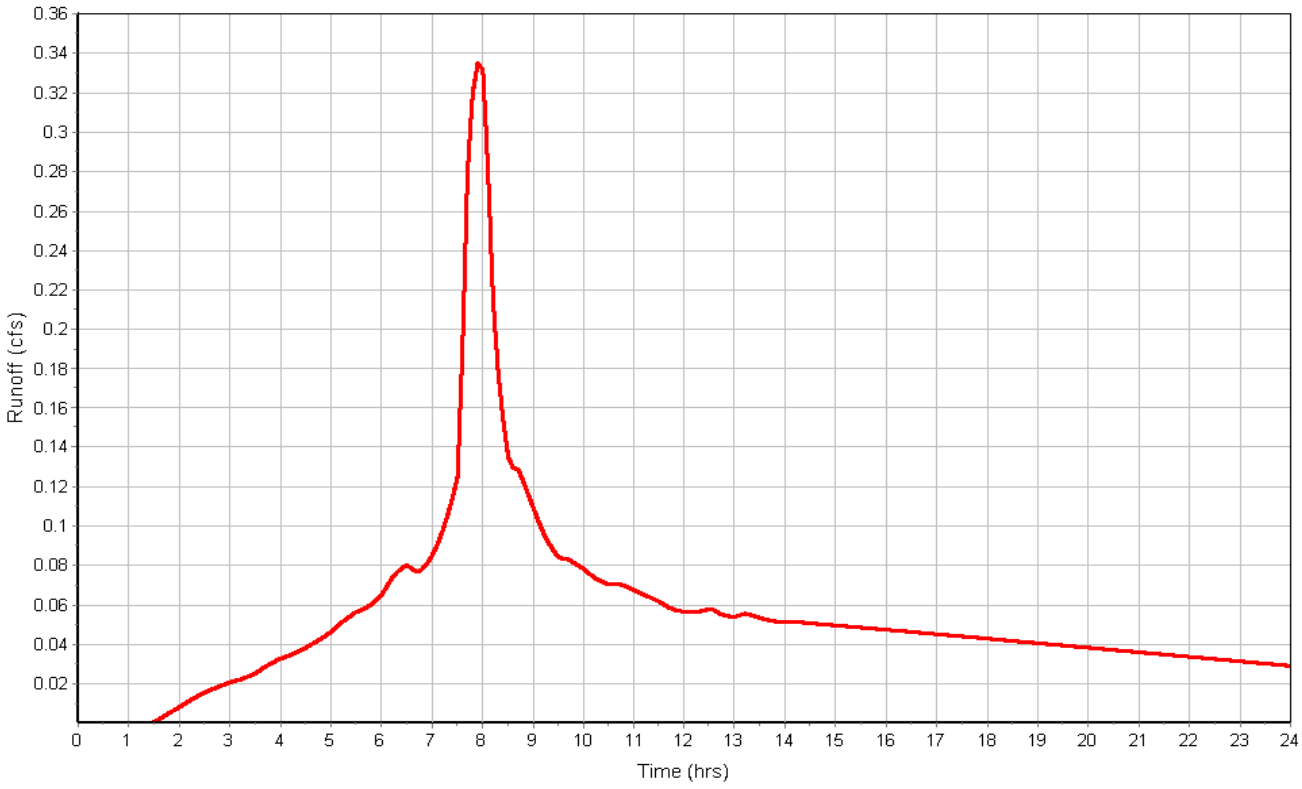
Total Rainfall (in)	1.33
Total Runoff (in)	1.11
Peak Runoff (cfs)	0.34
Weighted Curve Number	98.00
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : BASIN-C

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-D

Input Data

Area (ft²)	32675.01
Impervious Area (%)	100.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	32675.01		98

Time of Concentration

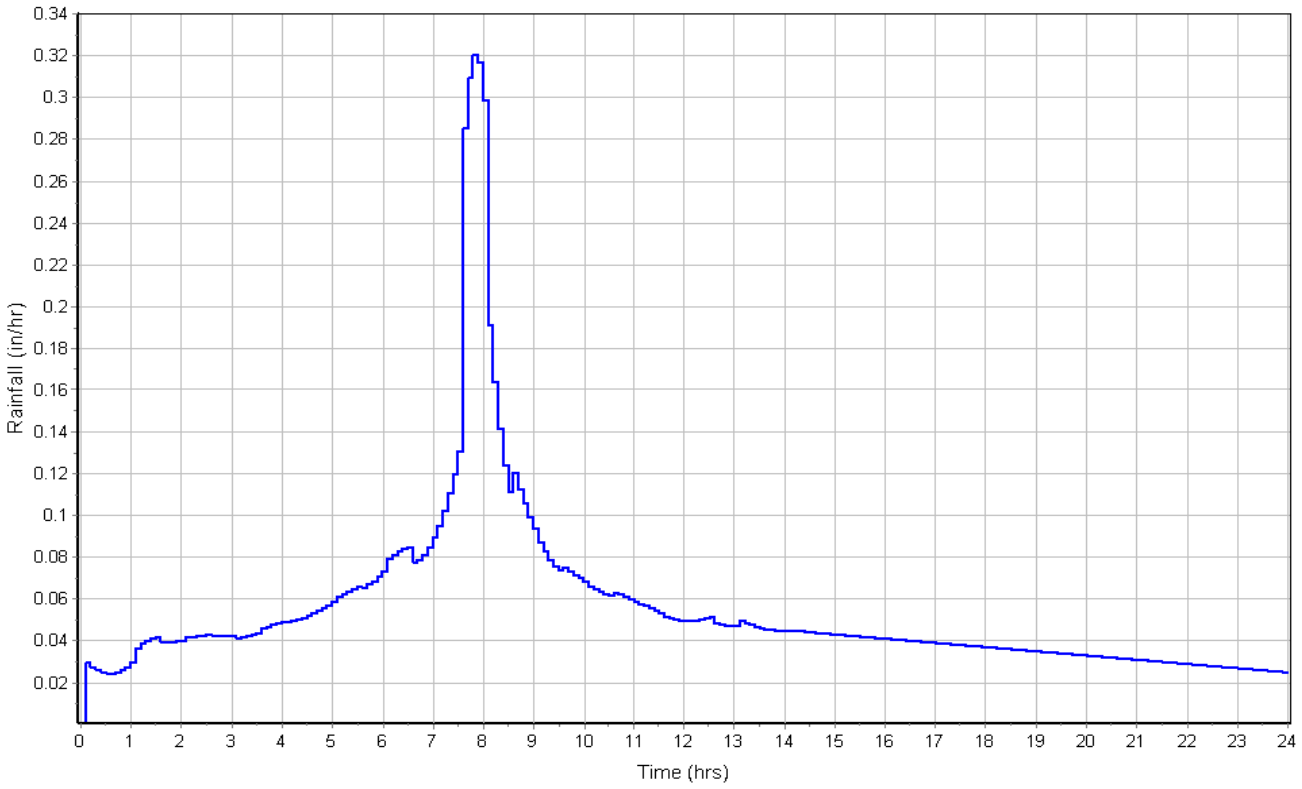
User-Defined TOC override (minutes): 5.00

Subbasin Runoff Results

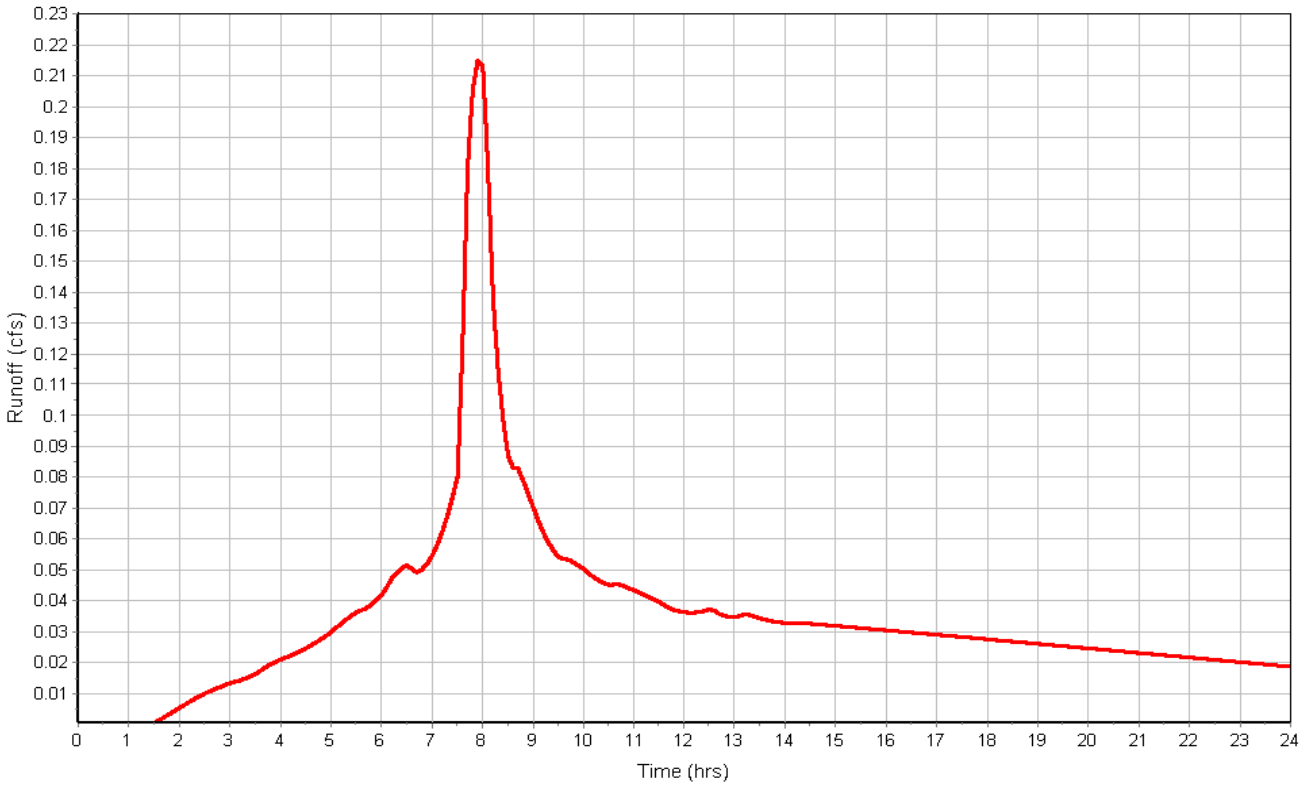
Total Rainfall (in)	1.33
Total Runoff (in)	1.11
Peak Runoff (cfs)	0.22
Weighted Curve Number	98.00
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : BASIN-D

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-E

Input Data

Area (ft²)	98990.01
Impervious Area (%)	100.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	98990.01		98

Time of Concentration

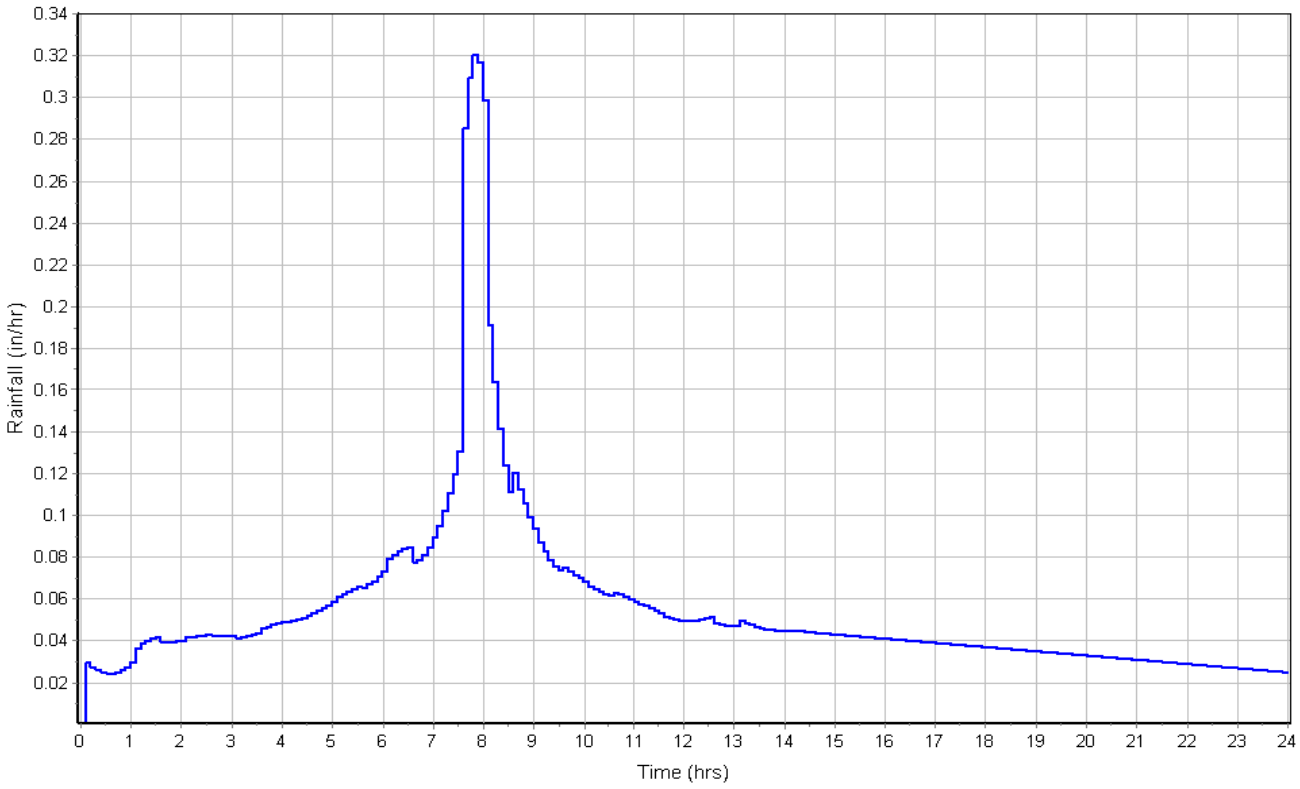
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

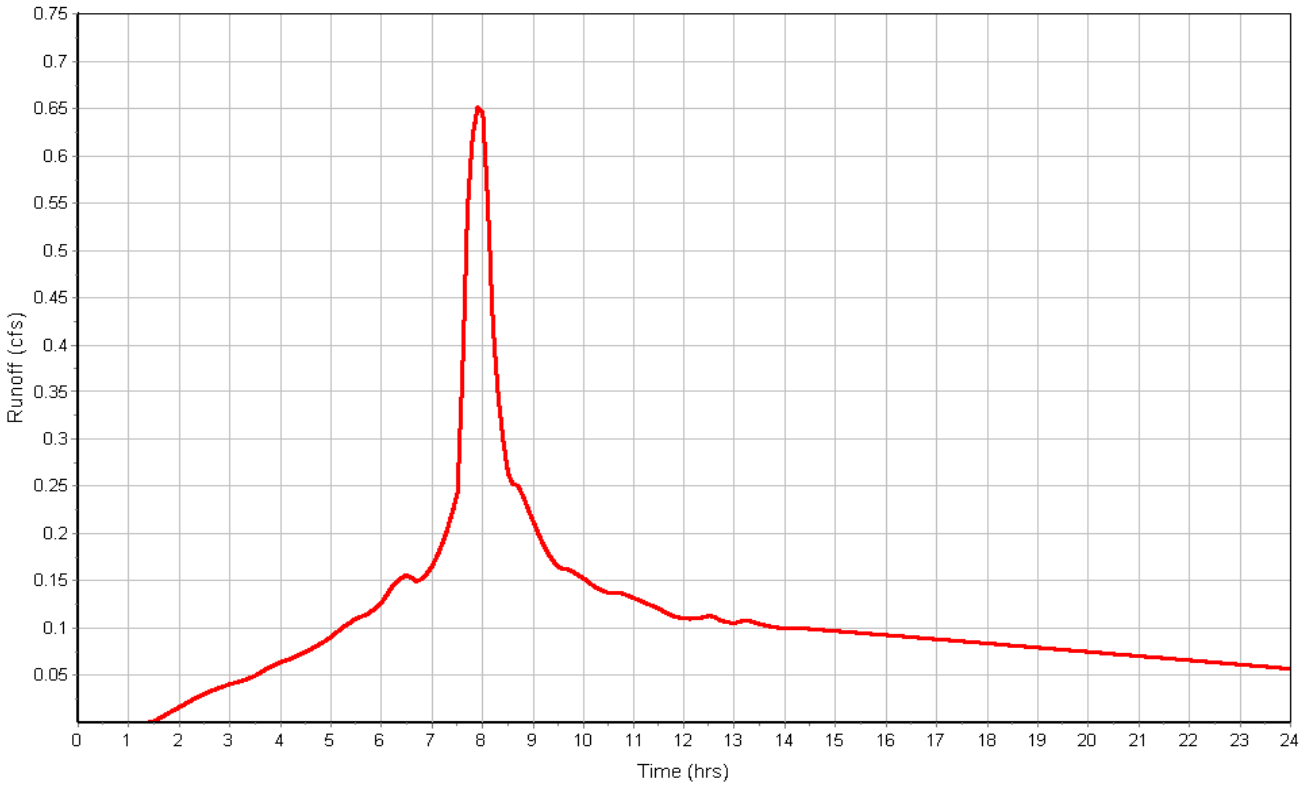
Total Rainfall (in)	1.33
Total Runoff (in)	1.11
Peak Runoff (cfs)	0.65
Weighted Curve Number	98.00
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : BASIN-E

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-F

Input Data

Area (ft²)	42620.02
Impervious Area (%)	100.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	42620.02		98

Time of Concentration

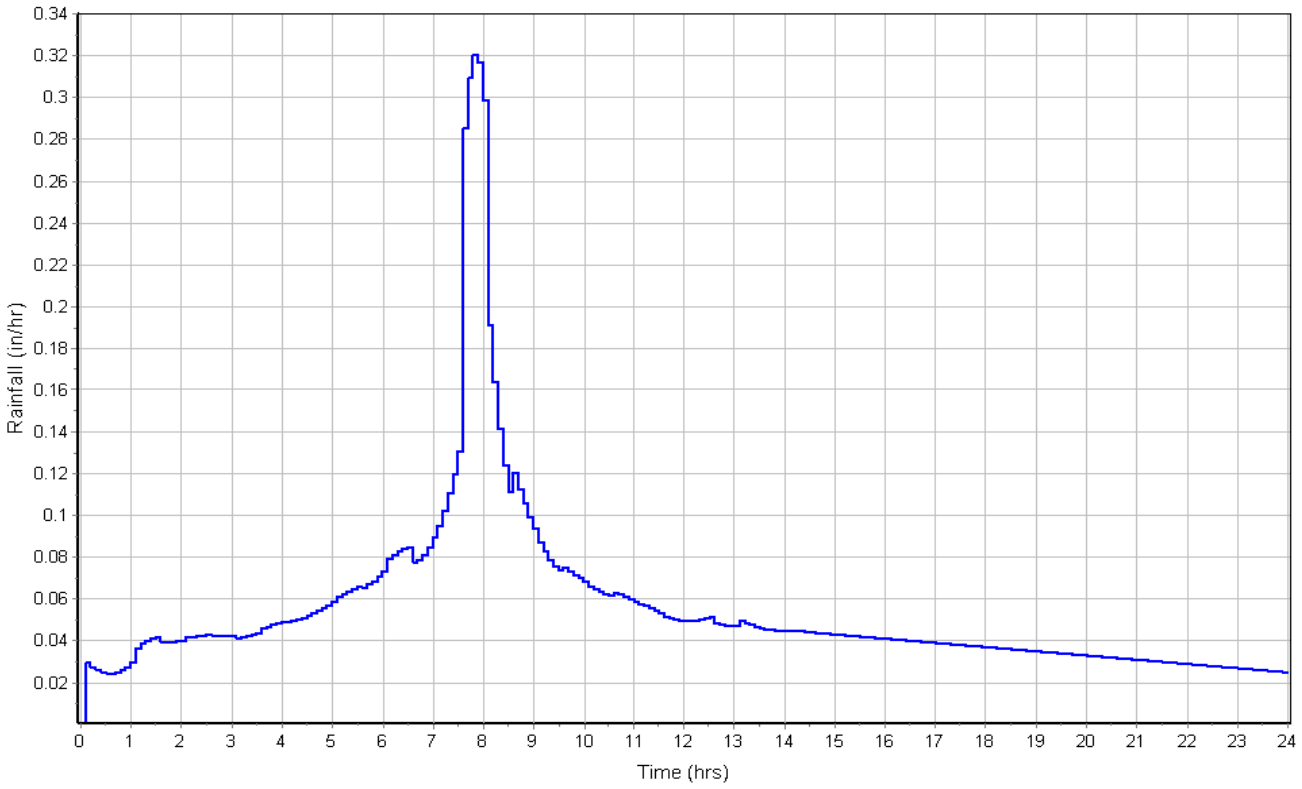
User-Defined TOC override (minutes): 5

Subbasin Runoff Results

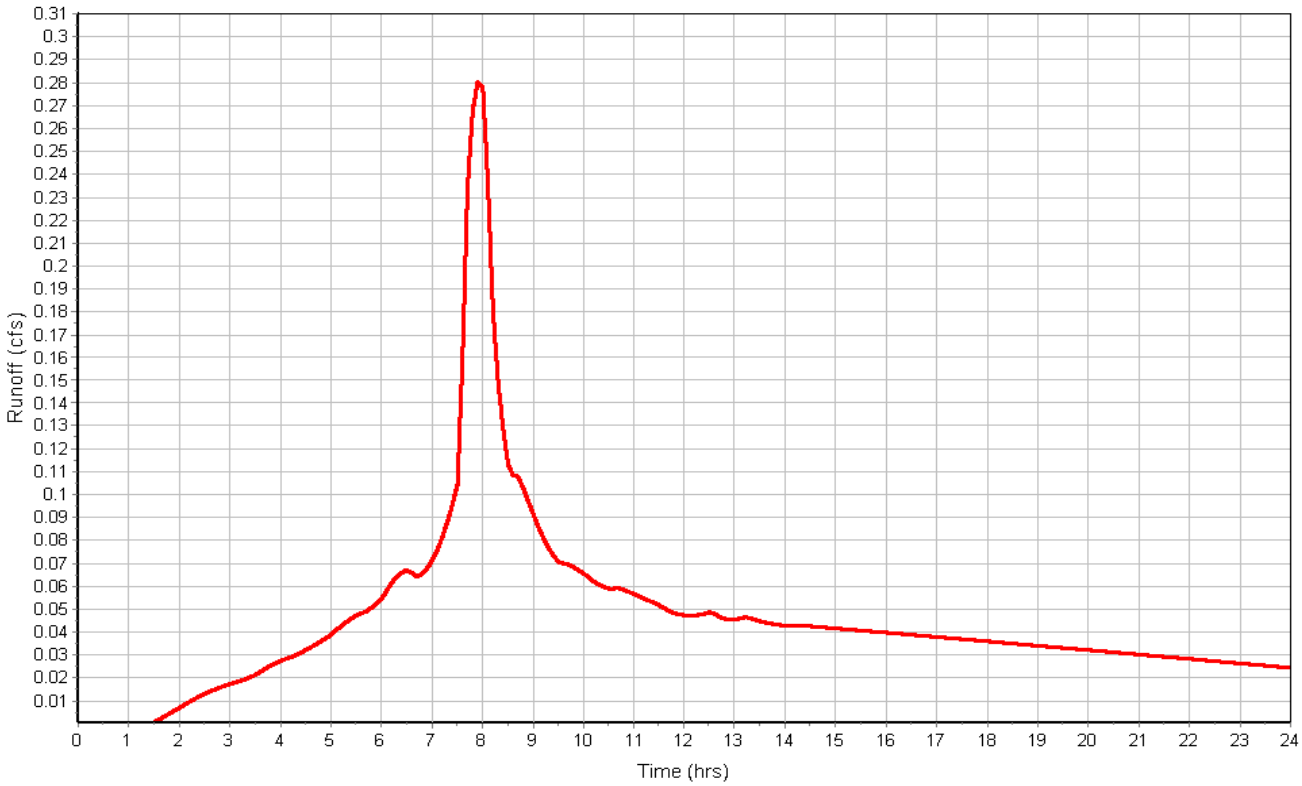
Total Rainfall (in)	1.33
Total Runoff (in)	1.11
Peak Runoff (cfs)	0.28
Weighted Curve Number	98.00
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : BASIN-F

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-G

Input Data

Area (ft²)	100644.99
Impervious Area (%)	0.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	100644.99		79

Time of Concentration

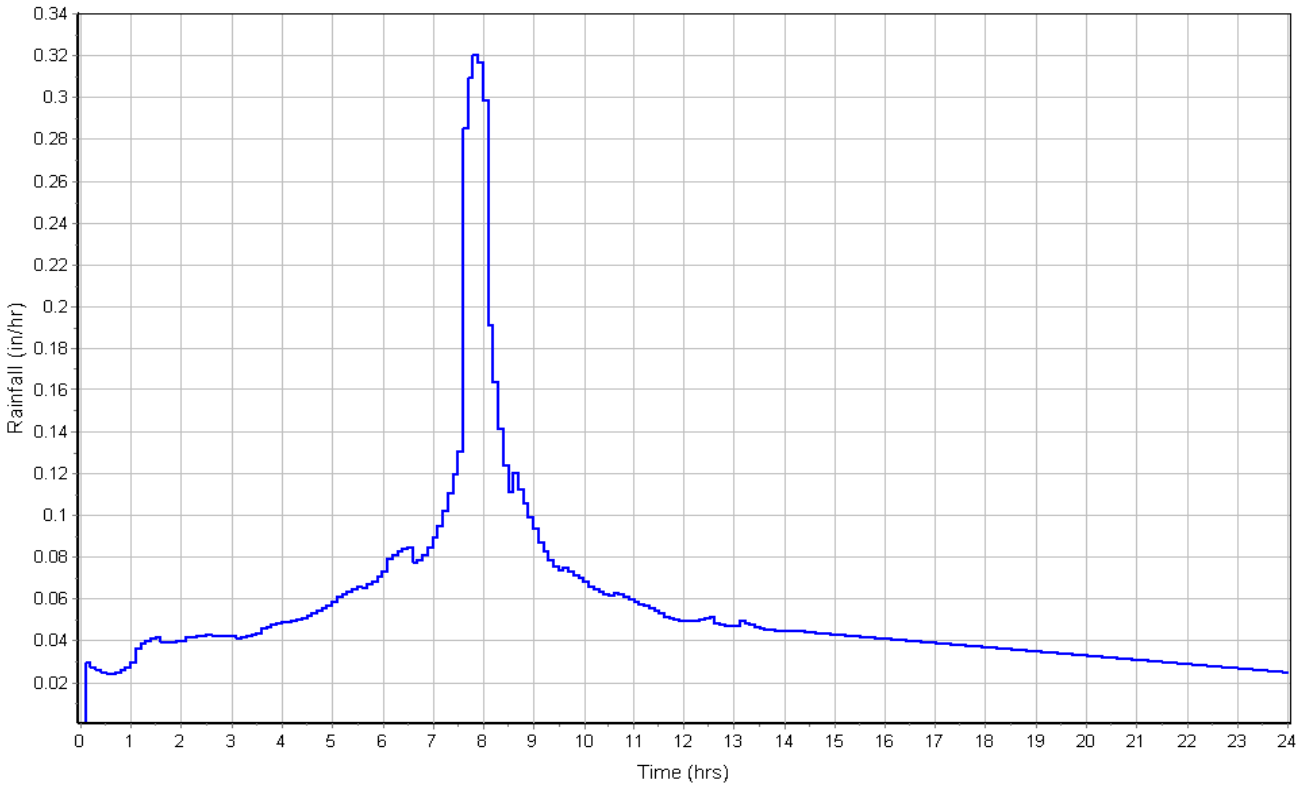
User-Defined TOC override (minutes): 10

Subbasin Runoff Results

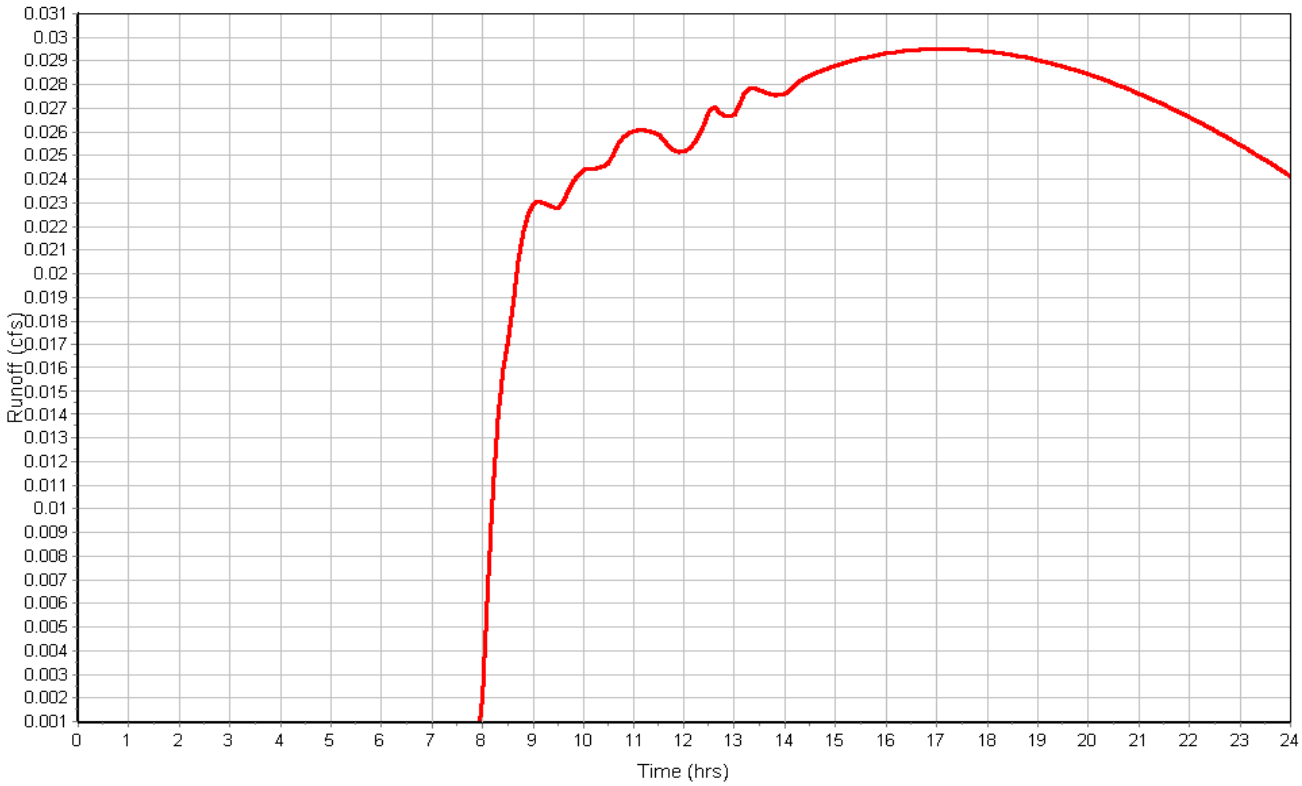
Total Rainfall (in)	1.33
Total Runoff (in)	0.18
Peak Runoff (cfs)	0.03
Weighted Curve Number	79.00
Time of Concentration (days hh:mm:ss)	0 00:10:00

Subbasin : BASIN-G

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-H

Input Data

Area (ft²)	22029.99
Impervious Area (%)	0.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	22029.99		79

Time of Concentration

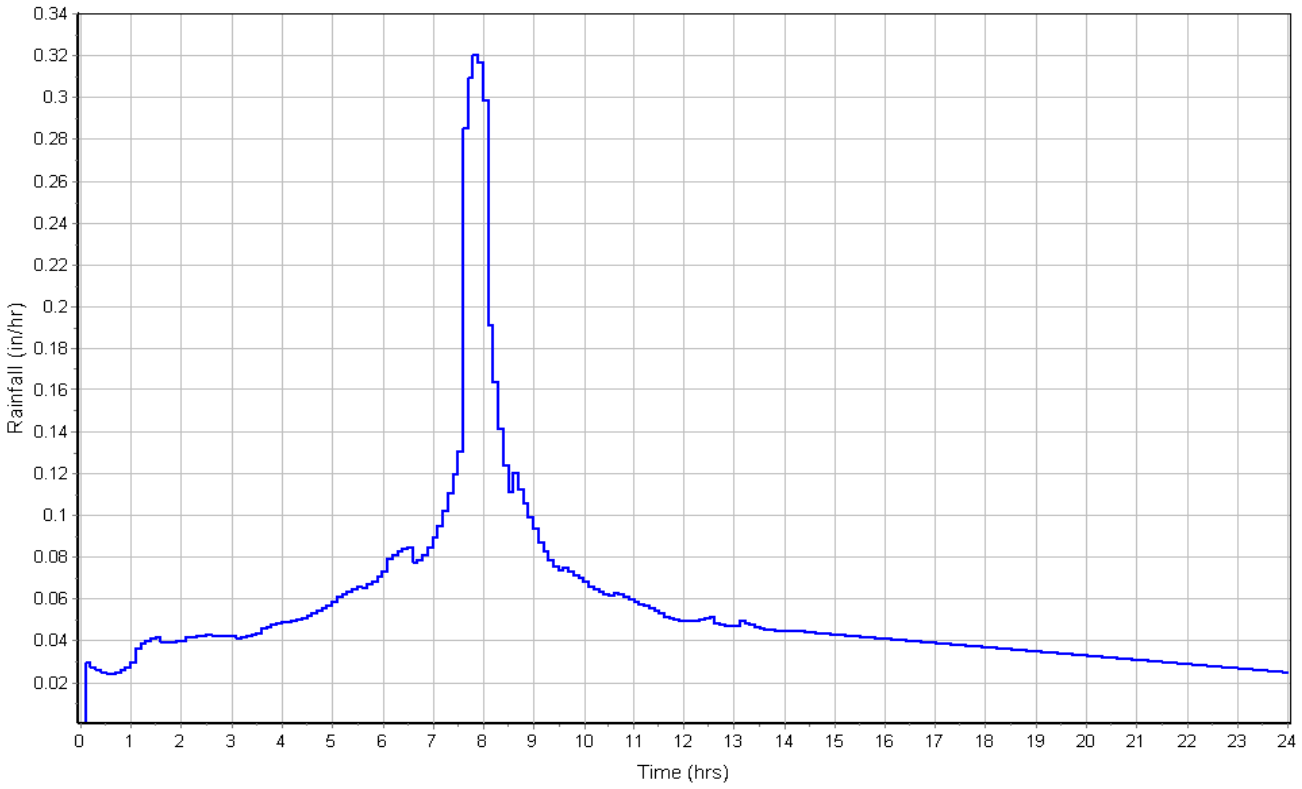
User-Defined TOC override (minutes): 10

Subbasin Runoff Results

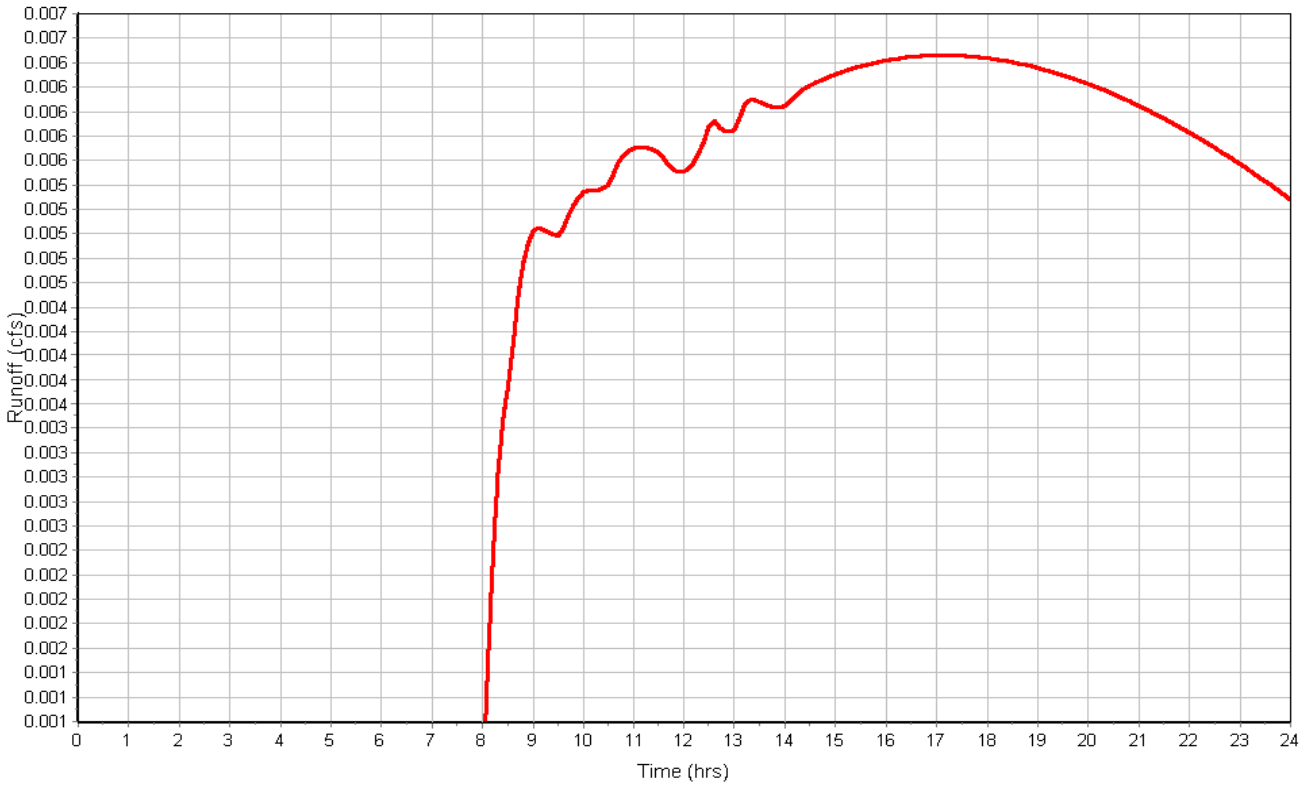
Total Rainfall (in)	1.33
Total Runoff (in)	0.18
Peak Runoff (cfs)	0.01
Weighted Curve Number	79.00
Time of Concentration (days hh:mm:ss)	0 00:10:00

Subbasin : BASIN-H

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-I

Input Data

Area (ft²)	101140.00
Impervious Area (%)	0.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	101140.00		79

Time of Concentration

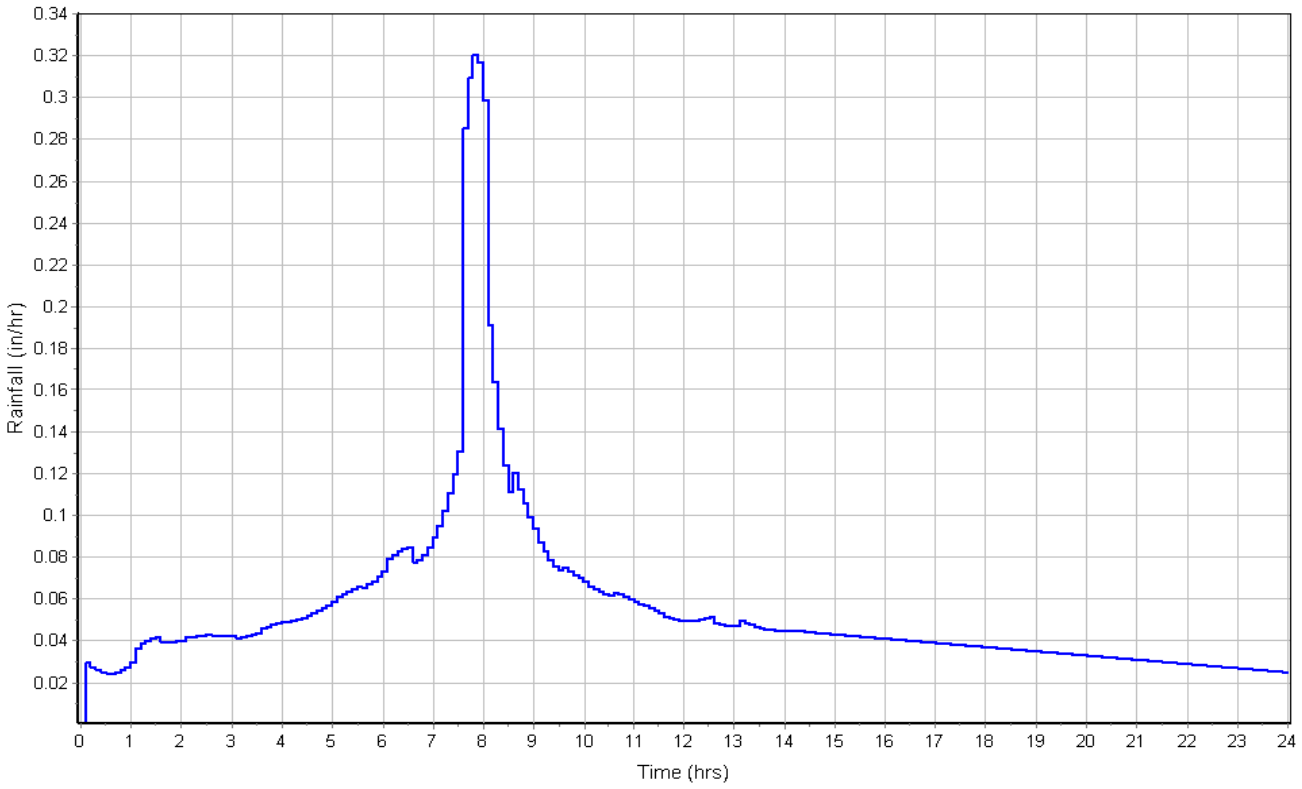
User-Defined TOC override (minutes): 10

Subbasin Runoff Results

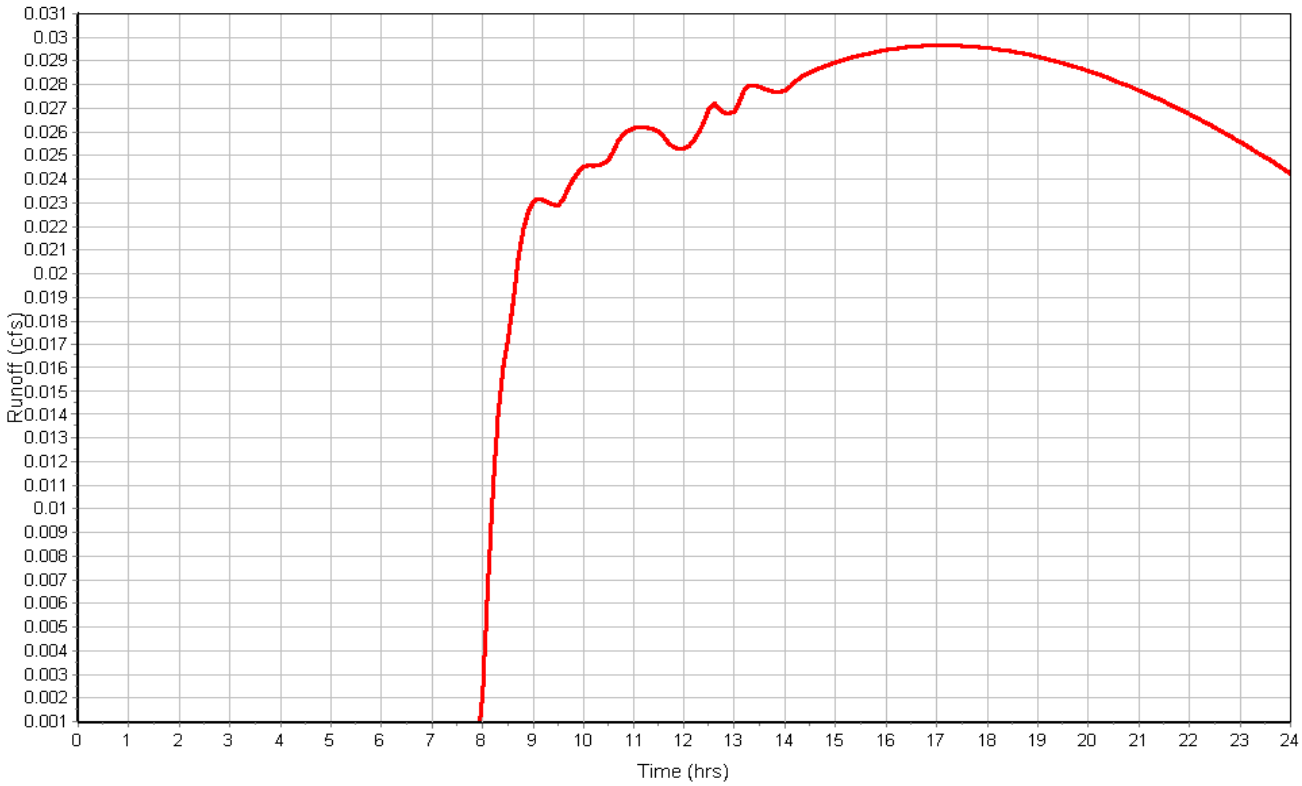
Total Rainfall (in)	1.33
Total Runoff (in)	0.18
Peak Runoff (cfs)	0.03
Weighted Curve Number	79.00
Time of Concentration (days hh:mm:ss)	0 00:10:00

Subbasin : BASIN-I

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-J

Input Data

Area (ft²)	49599.99
Impervious Area (%)	0.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	49599.99		79

Time of Concentration

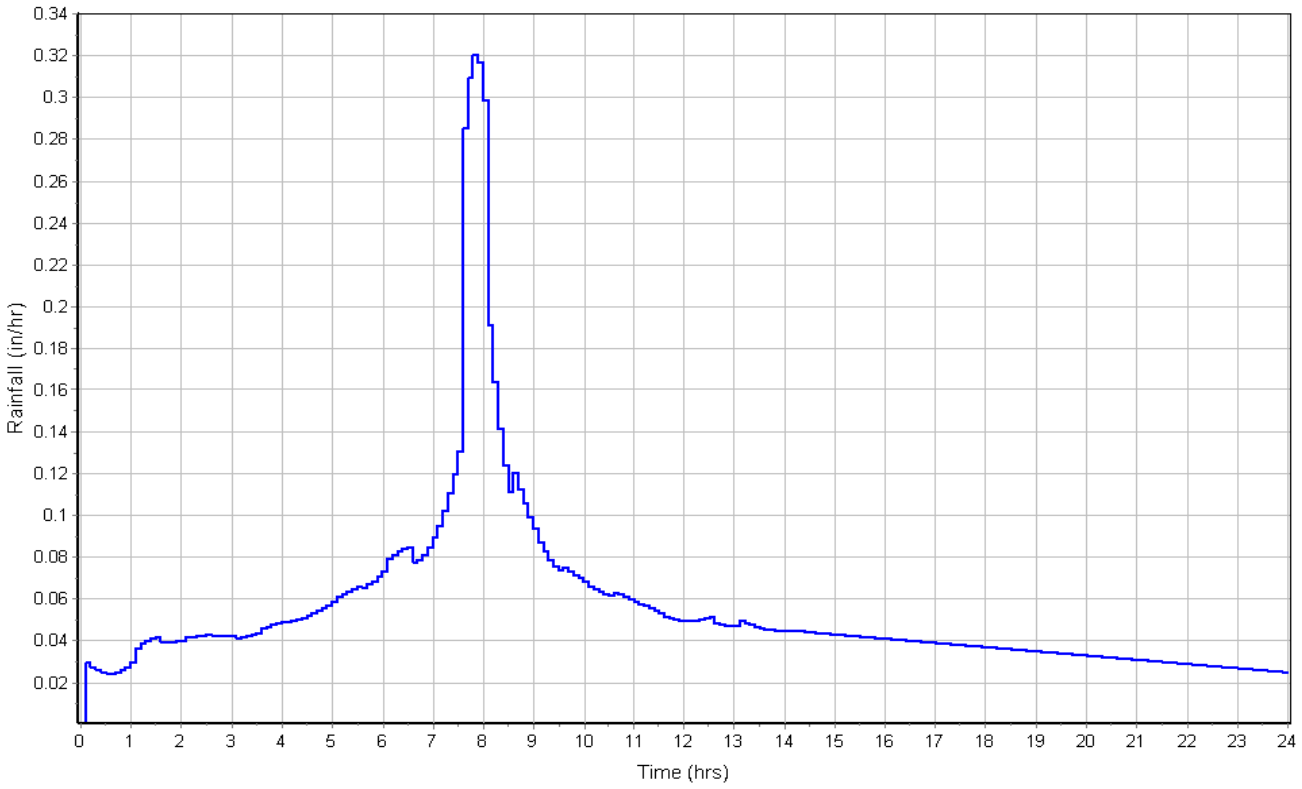
User-Defined TOC override (minutes): 10

Subbasin Runoff Results

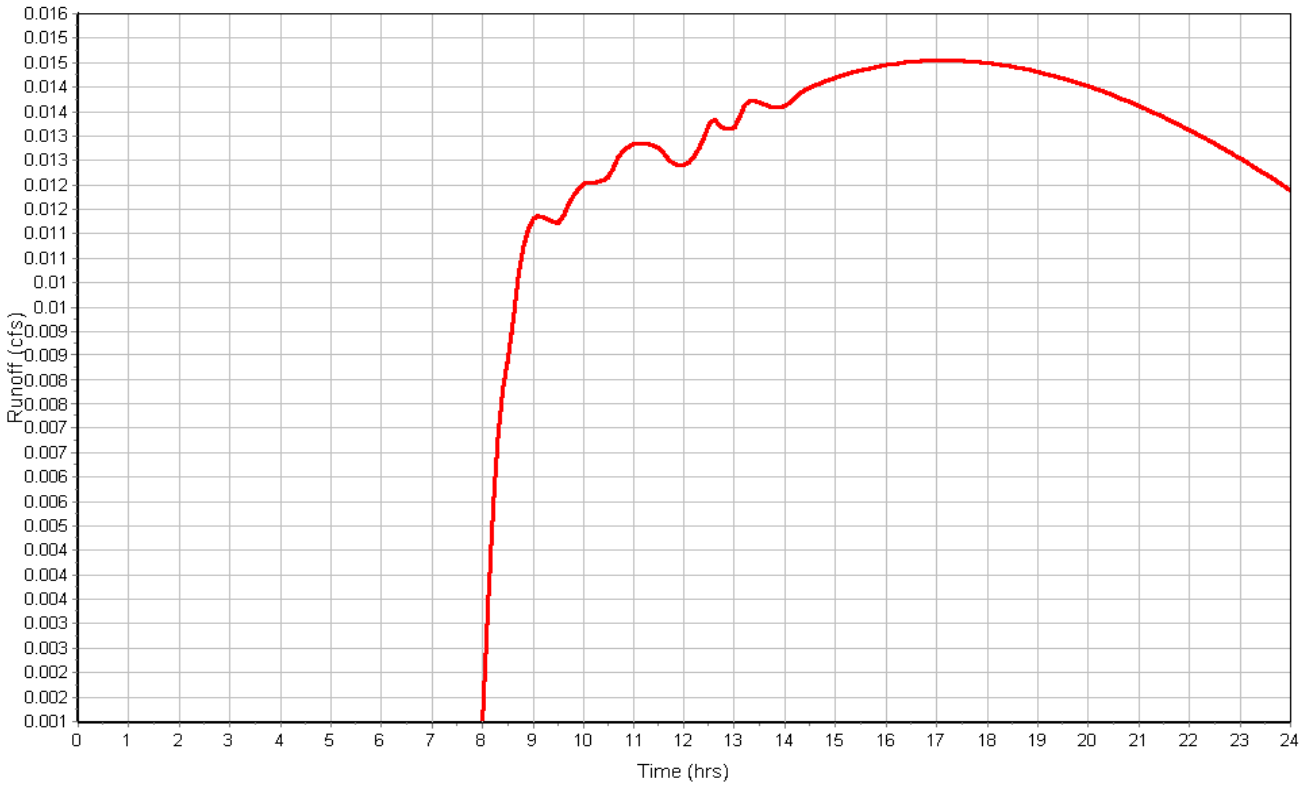
Total Rainfall (in)	1.33
Total Runoff (in)	0.18
Peak Runoff (cfs)	0.02
Weighted Curve Number	79.00
Time of Concentration (days hh:mm:ss)	0 00:10:00

Subbasin : BASIN-J

Rainfall Intensity Graph



Runoff Hydrograph



Subbasin : BASIN-K

Input Data

Area (ft²)	5122.00
Impervious Area (%)	0.00
Impervious Area Curve Number	98.00
Pervious Area Curve Number	79.00
Rain Gage ID	Rain Gage-01

Composite Curve Number

Soil/Surface Description	Area (ft²)	Soil Group	Curve Number
Composite Area & Weighted CN	5122.00		79

Time of Concentration

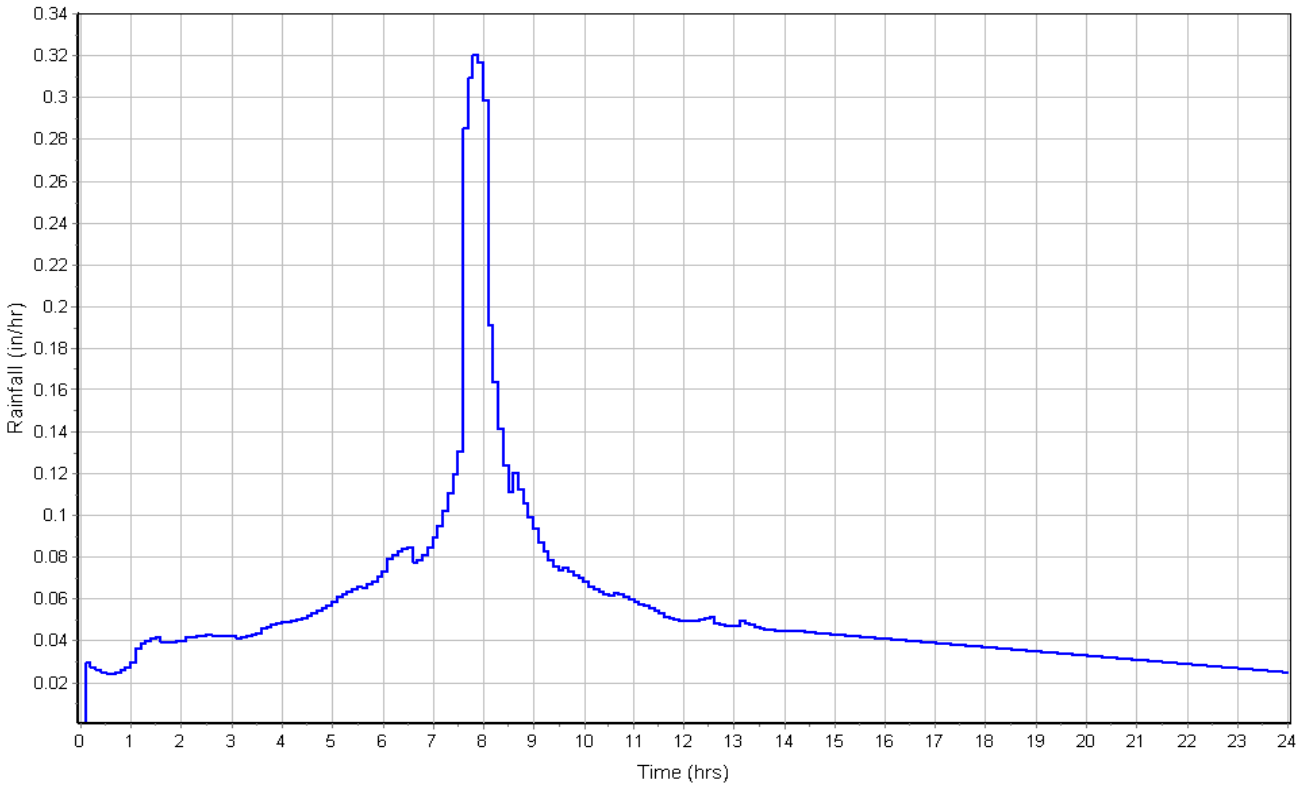
User-Defined TOC override (minutes): 10

Subbasin Runoff Results

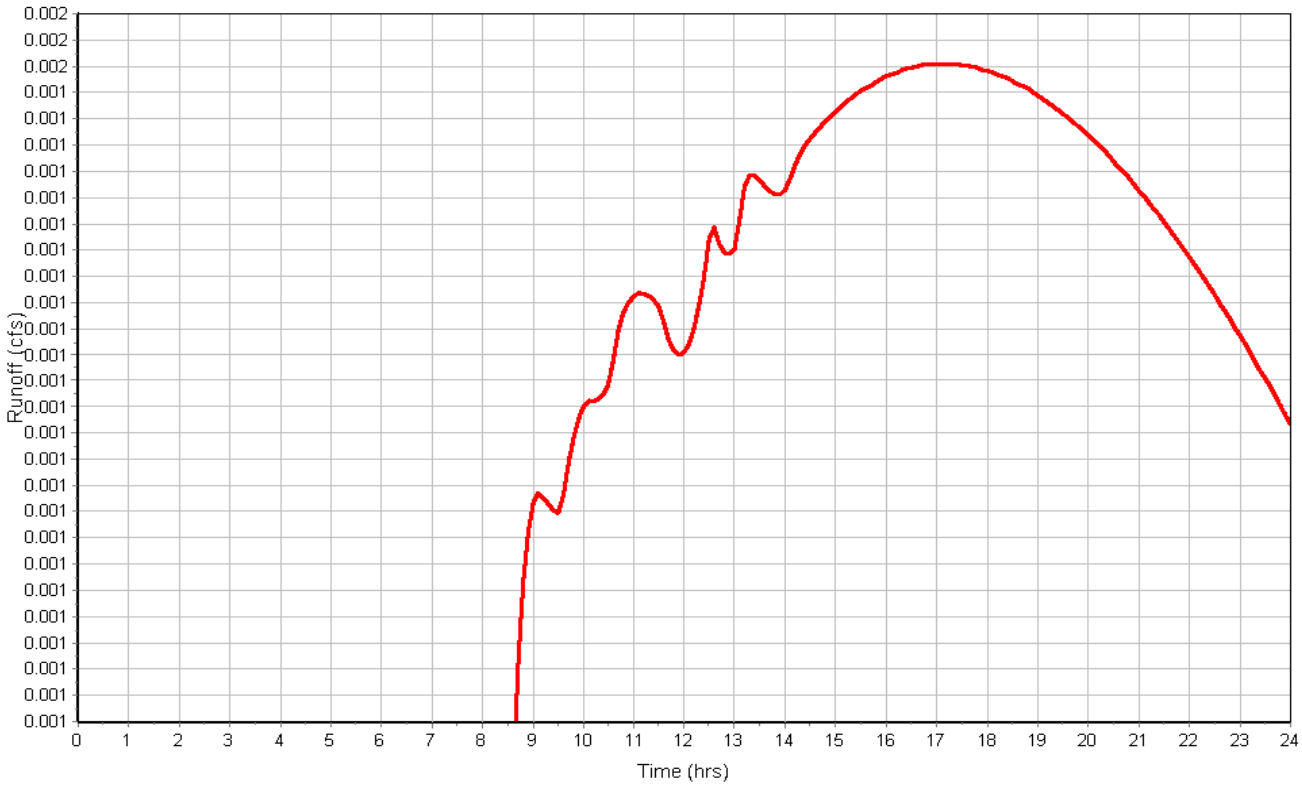
Total Rainfall (in)	1.33
Total Runoff (in)	0.18
Peak Runoff (cfs)	0.00
Weighted Curve Number	79.00
Time of Concentration (days hh:mm:ss)	0 00:10:00

Subbasin : BASIN-K

Rainfall Intensity Graph



Runoff Hydrograph



Appendix D

Supplemental Documents and Information

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Search

Properties and Qualities Ratings

Open All | Close All

Soil Chemical Properties
- Calcium Carbonate (CaCO3)
- Cation-Exchange Capacity (CEC-7)
- Effective Cation-Exchange Capacity (ECEC)
- Electrical Conductivity (EC)
- Gypsum
- pH (1 to 1 Water)
- Sodium Adsorption Ratio (SAR)

Soil Erosion Factors
- K Factor, Rock Free
- K Factor, Whole Soil
- T Factor
- Wind Erodibility Group
- Wind Erodibility Index

Soil Health Properties
- Soil Health - Available Water Capacity
- Soil Health - Bulk Density, One-Third Bar
- Soil Health - Organic Matter
- Soil Health - Sodium Adsorption Ratio (SAR)
- Soil Health - Soil Reaction (pH)
- Soil Health - Surface Texture

Soil Physical Properties
- Available Water Capacity
- Available Water Storage
- Available Water Supply, 0 to 100 cm
- Available Water Supply, 0 to 150 cm
- Available Water Supply, 0 to 25 cm
- Available Water Supply, 0 to 50 cm
- Bulk Density, One-Third Bar
- Linear Extensibility
- Liquid Limit
- Organic Matter
- Percent Clay
- Percent Sand
- Percent Silt
- Plasticity Index
- Saturated Hydraulic Conductivity (Ksat)
- Saturated Hydraulic Conductivity (Ksat), Standard Classes
- Surface Texture
- Water Content, 15 Bar
- Water Content, One-Third Bar

Soil Qualities and Features
- AASHTO Group Classification (Surface)
- AASHTO Group Index
- Depth to a Selected Soil Restrictive Layer
- Depth to Any Soil Restrictive Layer
- Drainage Class
- Frost Action
- Frost-Free Days
- **Hydrologic Soil Group**

View Description | View Rating

View Options

Map ☑
Table ☑
Description of Rating ☑
Rating Options ☑
Detailed Description ☐

Advanced Options

Aggregation Method: Dominant Condition
Component Percent Cutoff:
Tie-break Rule: Lower / Higher

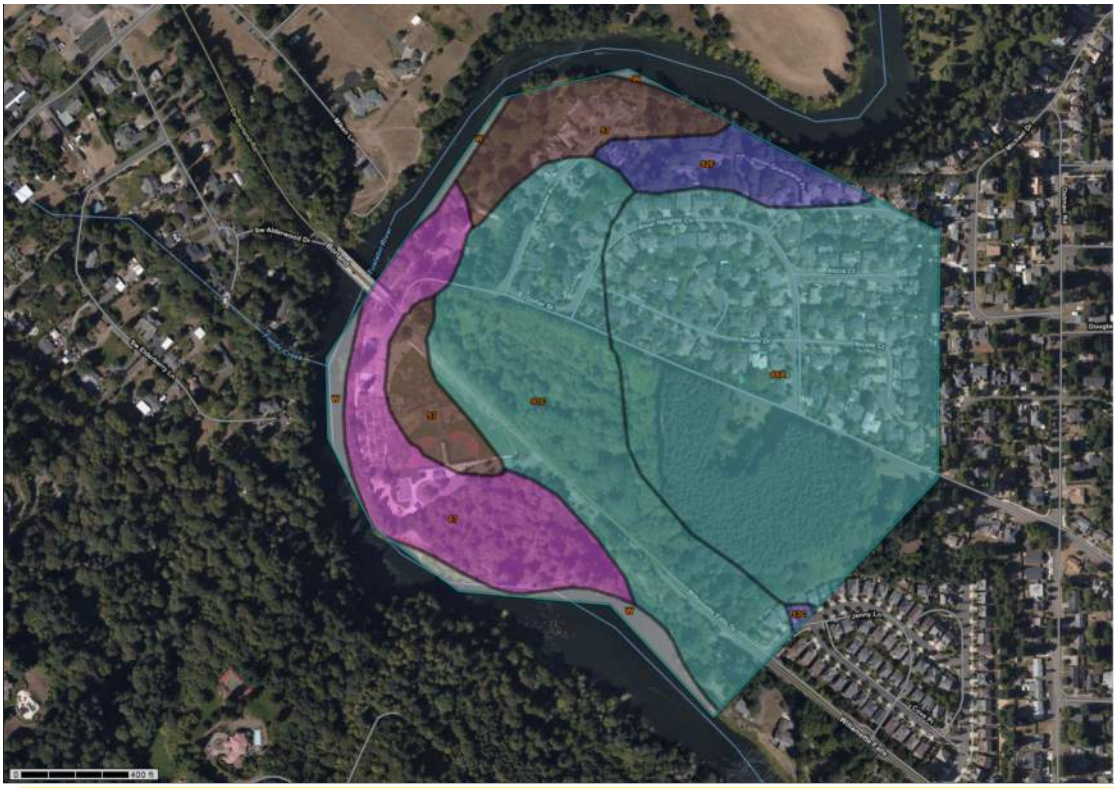
View Description | View Rating

- Map Unit Name
- Parent Material Name
- Representative Slope
- Soil Slippage Potential
- Unified Soil Classification (Surface)

Water Features
- Depth to Water Table
- Flooding Frequency Class
- Ponding Frequency Class

Map — Hydrologic Soil Group

Scale (not to scale)



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

You have zoomed in beyond the scale at which the soil map for this area is intended to be used. Mapping of soils is done at a particular scale. The soil surveys that comprise your AOI were ma design of map units and the level of detail shown in the resulting soil map are dependent on that map 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 contrast been shown at a more detailed scale.

Tables — Hydrologic Soil Group — Summary By Map Unit

Summary by Map Unit — Clackamas County Area, Oregon (OR610)

Summary by Map Unit — Clackamas County Area, Oregon (OR610)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
53C	Latourell loam, 8 to 15 percent slopes	B	0.1	0.2%
57	McBee variant loam	B/D	8.2	9.6%
67	Newberg fine sandy loam	A	11.8	13.9%
88A	Willamette silt loam, wet, 0 to 3 percent slopes	C	35.2	41.5%
91C	Woodburn silt loam, 8 to 15 percent slopes	C	22.6	26.6%
92F	Xerochrepts and Haploxerolls, very steep	B	4.1	4.8%
W	Water		2.9	3.4%
Totals for Area of Interest			**84.8**	**100.0%**

Description — 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.

Rating Options — Hydrologic Soil Group

Aggregation Method: Dominant Condition
Component Percent Cutoff: *None Specified*
Tie-break Rule: Higher

1DWLRQDO)ORRG+D]DUG/D\HU)50HWWH

FEMA

/HJHQG

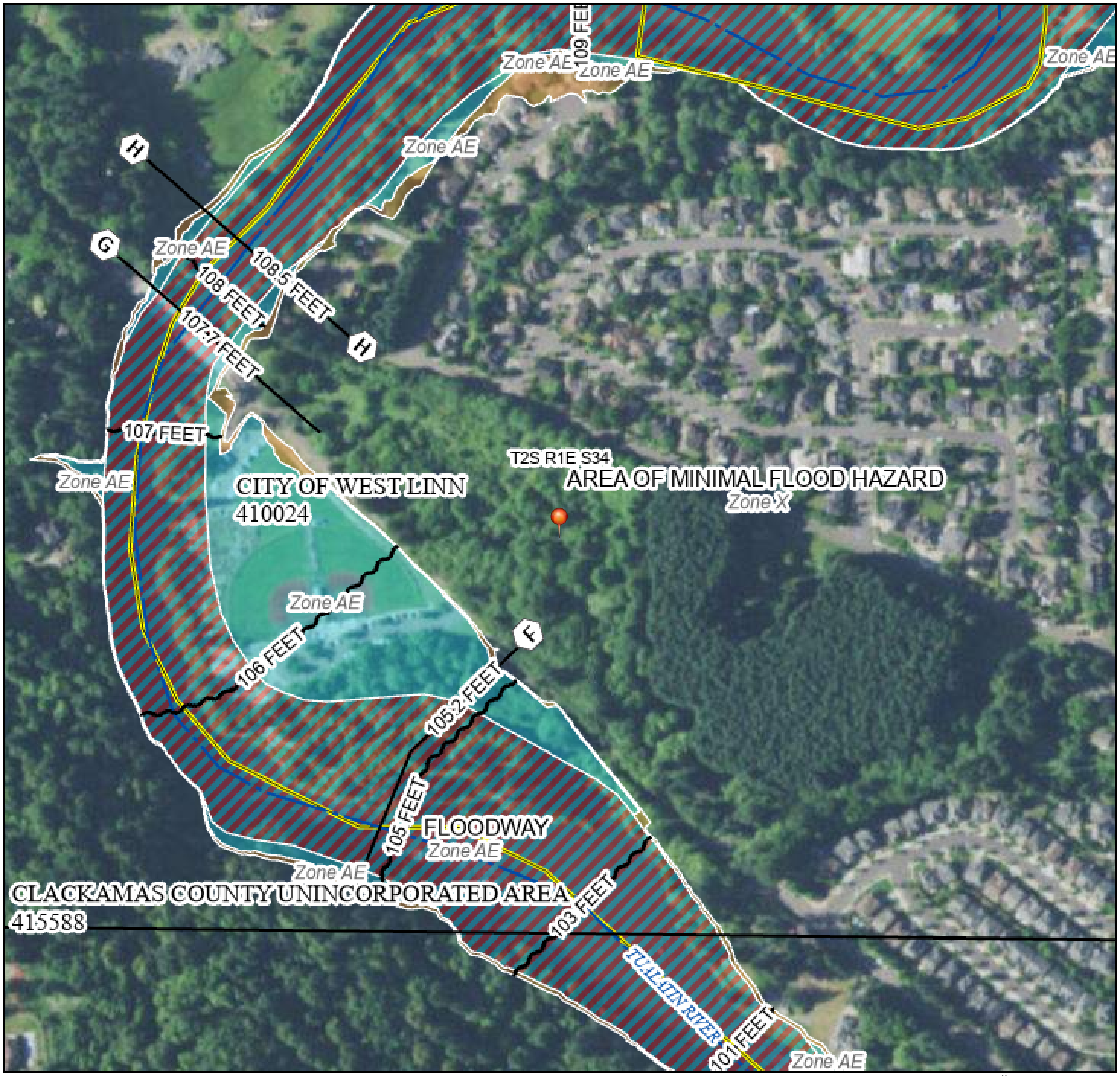


Table 4. Results of Global Stability Analyses (continued)

Cross Section	Condition	FOS
Section D-D'	Existing Slope Conditions – Static	1.6
	Existing Slope Conditions – Seismic	1.1
	Proposed Slope Conditions – Static	1.6
	Proposed Slope Conditions – Seismic	1.2

Our analyses indicate the computed FOS's for existing and proposed slope conditions under static and seismic analyses satisfy the minimum FOS's for global stability. The FOS's for slope stability are greater than 1.5 and 1.1 for static and seismic conditions, respectively. However, localized areas of potential shallow instability (e.g., FOS less than 1.5 or 1.1 for static and seismic conditions, respectively) are present on the steep slopes located immediately above Willamette Falls Drive.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our subsurface explorations and engineering analyses, it is our opinion that the site can be developed as proposed. The primary geotechnical considerations for the project are summarized in the "Executive Summary." Our specific recommendations are provided in the following sections.

7.0 DESIGN

7.1 PERMANENT SLOPES

Permanent cut or fill slopes on the site should not exceed a gradient of 2H:1V, unless specifically evaluated for stability. Slopes that will be maintained by mowing should not be constructed steeper than 3H:1V. Footings, buildings, access rods, and pavement should be located at least 5 feet horizontally from the face of slopes. Slopes should be planted with appropriate vegetation to provide protection against erosion as soon as possible after grading. Surface water runoff should be collected and directed away from slopes to prevent water from running down the face of the slope.

7.2 DRAINAGE

7.2.1 Temporary Drainage

During grading at the site, the contractor should be made responsible for temporary drainage of surface water as necessary to prevent standing water and/or erosion at the working surface and drainage onto slopes. During rough and finished grading of the building site, the contractor should keep all footing excavations and building pads free of water.

7.2.2 Surface Drainage

We recommend connecting all roof drains to a tightline leading to storm drain facilities. Pavement surfaces and open space areas should be sloped such that surface water runoff is collected and routed to suitable discharge points. We also recommend sloping ground surfaces adjacent to the building away to facilitate drainage away from the building.

7.2.3 Keyway Drains

We recommend installing a subsurface drain to collect any perched water at the inside of the keyway cut for the fill slopes above Willamette Falls Drive. The drain should consist of a perforated drainpipe covered with a minimum 2-foot-wide and 2-foot-tall zone of drain rock wrapped in a drainage geotextile. Collected water should be routed in non-perforated line(s) to the stormwater system or to a suitable discharge at the base of the slope.

7.2.4 Cement-Amended Slope Drainage

We recommend installing drainage at the contact of relatively impervious cement-amended fill slopes and overlying topsoil to limit runoff onto the slopes below. Drainage should consist of angled strip drains pinned to the cement-amended slope on maximum spacings of 30 feet on-center and connected to minimum 2-foot-wide and 2-foot-deep zones of drain rock with perforated collector pipes. The surface of the cement-amended slopes should be roughened prior to placing the overlying topsoil. Water collected from the top of the cement-amended slopes should be routed in non-perforated line(s) to the stormwater system or a suitable discharge at the base of the slope. The collected water should not be connected to the perforated pipe for the subsurface keyway drain at the base of the fill.

7.2.5 Stormwater Infiltration Systems

We recommend locating any infiltration facilities below a 5H:1V projection from the base of any slopes and/or walls to limit the potential influence of groundwater on the stability of the slopes and walls. Any stormwater detention facilities within the 5H:1V projection from the base of slopes and/or walls should be lined to prevent infiltration near walls and slopes.

Infiltration testing was completed in explorations to evaluate the feasibility of shallow infiltration systems. The infiltration rate will depend on the fines content and consistency of the soil. Tested rates ranged from negligible to 1.5 inches per hour. The unfactored field rates in Table 1 can be used for design. It is the responsibility of the designer to include the appropriate FOS's for the systems.

We recommend that GeoDesign observe the soil conditions and complete confirmation testing during construction to verify the field rates meet the design rates. Due to the presence of variable fines content, it may be necessary to enlarge or deepen systems during construction. Furthermore, we recommend including a contingency to deepen infiltration systems or add additional infiltration systems in other portions of the site during construction if tested rates at the time of construction are unsuitable.

7.2.6 Foundation Drains

Where drains are not already required for embedded building walls, we recommend installing a perimeter foundation drain around the planned new building. The foundation drains should be constructed at a minimum slope of approximately ½ percent and drained by gravity to a suitable discharge. The perforated drainpipe should not be tied to a stormwater drainage system without backflow provisions. The foundation drains should consist of 4-inch-diameter, perforated drainpipe embedded in a minimum 2-foot-wide zone of crushed drain rock that extends up to 6 inches BGS and is wrapped in a drainage geotextile. The invert elevation of the drainpipe

should be installed below the base of imported granular fill and base rock for the building and at least 18 inches below the finish floor elevation. The drain rock and drainage geotextile should meet the requirements specified in the "Materials" section.

7.3 SEISMIC DESIGN CRITERIA

7.3.1 ASCE 7-16 Seismic Design Parameters

Since the school is classified as a special occupancy structure, SOSSC requires a site-specific seismic evaluation. Seismic design criteria for this project will be based on the 2019 SOSSC and ASCE 7-16. A site-specific seismic evaluation was completed, the results of which are presented in Appendix F.

7.3.2 Liquefaction and Lateral Spreading

Liquefaction is caused by a rapid increase in pore water pressure that reduces the effective stress between soil particles to near zero. Granular soil, which relies on interparticle friction for strength, is susceptible to liquefaction until the excess pore pressures can dissipate. In general, loose, saturated sand soil with low silt and clay content is the most susceptible to liquefaction. Saturated silty soil with low plasticity is moderately susceptible to liquefaction or cyclic failure under relatively higher levels of ground shaking. We did not encounter any significant amount of soil considered to be susceptible to liquefaction or cyclic failure at the site. Since the site is not near an open face with saturated conditions and has low susceptibility to liquefaction, lateral spreading is expected to be negligible at this site.

7.4 SHALLOW FOUNDATION RECOMMENDATIONS

7.4.1 General

Based on the results of our explorations and analysis, the proposed school building and other associated structures can be supported by conventional spread footings bearing on a minimum 3-inch-thick layer of crushed rock underlain by undisturbed native soil or structural fill overlying firm native soil. Foundations should not be established on undocumented fill, soft soil, or soil containing deleterious material. If present, this material should be removed and replaced with granular pads.

We recommend placing a minimum 3-inch-thick granular pad over the footing subgrades to protect from disturbance since the silt and silty subgrades will be prone to disturbance during wet weather and the sand or sandy subgrades will be prone to disturbance when dry. If granular pads greater than 6 inches thick are required for the removal of unsuitable materials below footings, the granular pads should extend 6 inches beyond the margins of the footings for every foot excavated below the base grade of the footing. The granular pads should consist of imported granular material, as defined in the "Structural Fill" section. The imported granular material for granular pads 1 foot thick or greater should be compacted to not less than 95 percent of the maximum dry density, as determined by ASTM D1557, or until well-keyed, as determined by one of our geotechnical staff. We recommend that a member of our geotechnical staff observe prepared footing subgrades and granular pads.

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Appendix E

Operations and Maintenance Plan

The operations and maintenance plan will be included in the final version of this document.

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