

Appendix I

Drainage Analysis



DRAINAGE ANALYSIS

GREENBARK 30 BATTERY ENERGY
STORAGE PROJECT

PREPARED FOR
Greenbark 30 BESS, LLC

DATE
27 June 2024

REFERENCE
0600327



DRAINAGE ANALYSIS

GREENBARK 30 BATTERY ENERGY STORAGE PROJECT

0600327



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CLIENT: Greenbark 30 BESS, LLC

PROJECT NO: 0600327

DATE: 27 June 2024

VERSION: 01

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ACRONYMS AND ABBREVIATIONS

Acronym	Description
CA	California
DMA	Drainage Management Area
EGS	GenOn's Ellwood Generating Station
GPA	General Plan Amendment
HSG	Hydrologic soil groups
LID	Low Impact Development

Acronym	Description
NRCS	Natural Resource Conservation Service
SCM	stormwater control measure
SSURGO	USDA Soil Survey Geographic Database
UPRR	Union Pacific Railroad
USDA	United States Department of Agriculture

1. PURPOSE

The objective of this report is to demonstrate that the Greenbark 30 Battery Energy Storage Project is designed in compliance with the City of Goleta Low Impact Development LID requirements. Analysis of the existing and proposed drainage patterns and storm water peak flows for the project site are evaluated to mitigate the impacts of the proposed development.

2. PROJECT DESCRIPTION

The project parcel is identified as an unaddressed parcel (assessor parcel #079-210-053) located at the terminus of Via Jero, Goleta, California. The Project site parcel is comprised of 2.1 acres of undeveloped area. Project improvements will occupy the central portion of the parcel.

Surrounding uses include Union Pacific Railroad (UPRR) rail line right-of-way and an associated earthen berm along the northern perimeter of the Project site parcel; U.S. Interstate Highway 101 (US 101) and residential neighborhoods north of UPRR; a commercial parking lot and Ellwood Elementary School to the east; GenOn's Ellwood Generating Station (EGS), Las Armas Road, and the Hideaway residential neighborhood (accessed from Las Armas Road at Sanderling Lane) to the west; the Mariposa at Ellwood Shores elder care facility to the southeast (accessed from the east side of Via Jero); and a vacant commercial parking lot and Hollister Avenue to the south.

A 64-foot-wide undeveloped private road easement, referred to as Campesino Drive, runs east-west between Las Armas Road and the northern terminus of Via Jero. This easement is on the adjacent parcel to the south (vacant commercial parking lot), and it abuts the Project site parcel's southern border.

Land uses south of Hollister Avenue include Sandpiper Golf Course, The Bluffs residential neighborhood, Ellwood Mesa Open Space and Sperling Reserve, and the Pacific Ocean.

The Project site parcel and adjacent parcels to the east, south, and southeast are zoned General Commercial (CG). The adjacent EGS parcel to the west and the Ellwood Elementary School to the east are zoned Public/Quasi Public. The Hideaway residential neighborhood west of Las Armas Road is zoned Planned Residential.

Figure 1 in Appendix A shows the location of the Site and the vicinity area.

The site is undeveloped, and no current or historical uses of the Project site parcel have been identified. An informal dirt footpath has been established along the eastern portion of the Project site parcel, entering from Via Jero.

The proposed project is comprised of a new battery energy storage system (BESS) facility. Associated site features include development of a new internal access driveway, landscape areas, drainage conveyance and a new stormwater control measure (SCM) consisting of a bioretention basin at the south perimeter of the operational area. A 20-foot-wide internal perimeter road will encompass the BESS equipment and provide dual access from Viajero in the southeast corner and from the adjacent EGS property in the southwest corner.

3. BASIS FOR INPUT DATA

3.1 SOILS

Hydrologic soil groups (HSG) were identified based on the United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) and incorporated into the infiltration rate and curve number (CN) data set. Soils present at the Site consist of MeC-Milpitas-Positas fine sandy loams soil. The hydrologic group is reported to be group D. The soil is identified as moderately well drained. Soil data were sourced from the following: <https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcseprd1464625>.

The Soil Map and Hydrologic Soil Group descriptions are represented in Appendix B.

3.2 DRAINAGE AREA

3.2.1 EXISTING DRAINAGE AREA

The existing, Pre-Development Drainage area is shown on Figure 2 in Appendix A and summarized in Table 1. As shown on Figure 2, the site is generally flat and slopes gently from north to south. The existing site is 2.1 acres, all of which is dirt, pervious area covered by vegetation. Site vegetation consists primarily of sparse weeds, shrubs, and grasses, with a few trees along the western perimeter.

Stormwater runoff analyses and basin delineation used the topographic map provided by Monument Land Surveying, Inc. for the Site. The Project site parcel is generally flat lying, and slopes gently from north to south. The majority of stormwater runoff flows to the south and drains to an existing wetland at the south edge of the site. The majority of the wetland feature is located on the adjacent parcel to the south.

TABLE 1: PRE-DEVELOPMENT DRAINAGE AREA

Pervious Area		Impervious Area		Total Area
acre	%	acre	%	acre
2.1	100%	0	0%	2.1

3.2.2 PROPOSED DRAINAGE AREA

The post-development conditions drainage area is shown on Figure 3 in Appendix A. The proposed battery energy storage facility will include several battery modules set on concrete pads that will be surrounded by permeable gravel. The associated site features include development of a new access driveway constructed of permeable gravel base, landscape areas, drainage conveyance, and a new SCM consisting of a bioretention basin at the south perimeter of the operational area. A 20-foot-wide internal perimeter permeable gravel road will encompass the BESS equipment and provide dual access from Via Jero in the southeast corner and the adjacent EGS property in the southwest corner.

The proposed project area includes three sub-drainage areas. Drainage area I (DMA-I) and Drainage area III (DMA-III) slope gently from north to south. Drainage area II (DMA-II) slopes gently from north to southeast.

The post-development drainage area will include a total of 1.6 acres (76%) pervious area and 0.5 acres (24%) of impervious area. However, BMPs are predicted to improve the permeability of the pervious areas within the site.

TABLE 2: POST-CONSTRUCTION DRAINAGE AREA

Drainage Area	Pervious Area		Impervious Area		Total Area
	acre	%	acre	%	acre
DMA-I	1.4	74%	0.5	26%	1.9
DMA-II	0.1	100%	0	0%	0.1
DMA-III	0.1	100%	0	0%	0.1
Total	1.6	76%	0.5	24%	2.1

3.2.3 STORMWATER RUNOFF ESTIMATION

Hydrologic peak flow calculations were made for the existing (pre-project) and proposed (post project) conditions for the 2-yr, 5-yr, 10-yr, 25-year, 50-year, and 100-year storm events using HydroCAD hydrologic modeling software.

Runoff was calculated for the existing and proposed drainage areas using topographic information and land cover and hydrologic soil group data obtained from Web Soil Survey Website. Using this information a composite CN was generated for the pre- and post-development drainage areas. These areas were input into HydroCAD to calculate peak flow runoff rate and runoff volume. In HydroCAD, the storm events utilized to run calculations were the 24-hour, 2-, 5-, 10-, 25-, 50- and 100- year storms based on rainfall data from NOAA (Atlas 14, Volume 6, Version 2) for the area. The model was run using the storm type I, 24 hour, which is applied to the area. Details of the hydrologic computational methods are provided in Appendix C.

The pre- and post-development hydrologic peak and volume flows generated on the project area are summarized in Table 3 through Table 5.

TABLE 3: PRE-DEVELOPMENT PEAK FLOW (CFS)

Condition	Drainage Area Name	Total Area	Precipitation (in)					
			2-year	5-year	10-year	25-year	50-year	100-year
			acres	3.53	4.54	5.33	6.36	7.12
Pre-construction Runoff Peak Flow Rate (cfs)	DMA	2.10	4.00	5.59	6.83	8.44	9.65	10.78

TABLE 4: POST-DEVELOPMENT PEAK FLOW (CFS)

Condition	Drainage Area Name	Total Area	Precipitation (in)					
			2-year	5-year	10-year	25-year	50-year	100-year
			acres	3.53	4.54	5.33	6.36	7.12
Post-construction Runoff Peak Flow Rate (cfs)	DMAI	1.9	2.99	4.50	5.73	7.35	8.57	9.73
	DMAII	0.1	0.07	0.11	0.15	0.19	0.23	0.26
	DMAIII	0.1	0.28	0.39	0.48	0.59	0.67	0.75

TABLE 5: PRE- AND POST-DEVELOPMENT RUNOFF VOLUME (ACRE-FT)

Condition	Drainage Area Name	2-year	5-year	10-year	25-year	50-year	100-year
Pre-construction Runoff Volume (acre-ft)	DMA	0.42	0.58	0.72	0.89	1.02	1.15
Post-construction Runoff Volume (acre-ft)	DMAI	0.29	0.43	0.54	0.69	0.80	0.91
	DMAII	0.01	0.01	0.01	0.02	0.02	0.02
	DMAIII	0.03	0.04	0.05	0.06	0.06	0.07
<i>Total Post construction Runoff Volume (acre-ft)</i>		0.32	0.47	0.60	0.76	0.89	1.01
<i>Increased Post-construction Runoff Volume (acre-ft)</i>		-0.10	-0.11	-0.12	-0.13	-0.13	-0.14

4. CONCLUSION

This analysis calculated the pre-project (existing) and post-project (developed) site stormwater peak flow using the 2, 5, 10-, 25-, 50- and 100-year design storm events.

BMPs are predicted to improve the permeability of the pervious areas within the site. The post construction land cover includes the battery modules set on concrete pads, landscape area, permeable gravel roads, open space areas covered by permeable gravel and a bioretention basin. DMA-III is not included within the development plan and disturbance area. Results of this analysis show that the stormwater runoff resulting from development of the project site is decreased for all design storm events and that the proposed development will result in stormwater peak flow discharging from the project area at less than pre-project levels.



APPENDIX A FIGURES

FIGURE 1: SITE LOCATION AND VICINITY

FIGURE 2: PRE-DEVELOPMENT CONDITION

FIGURE 3: POST-DEVELOPMENT CONDITION

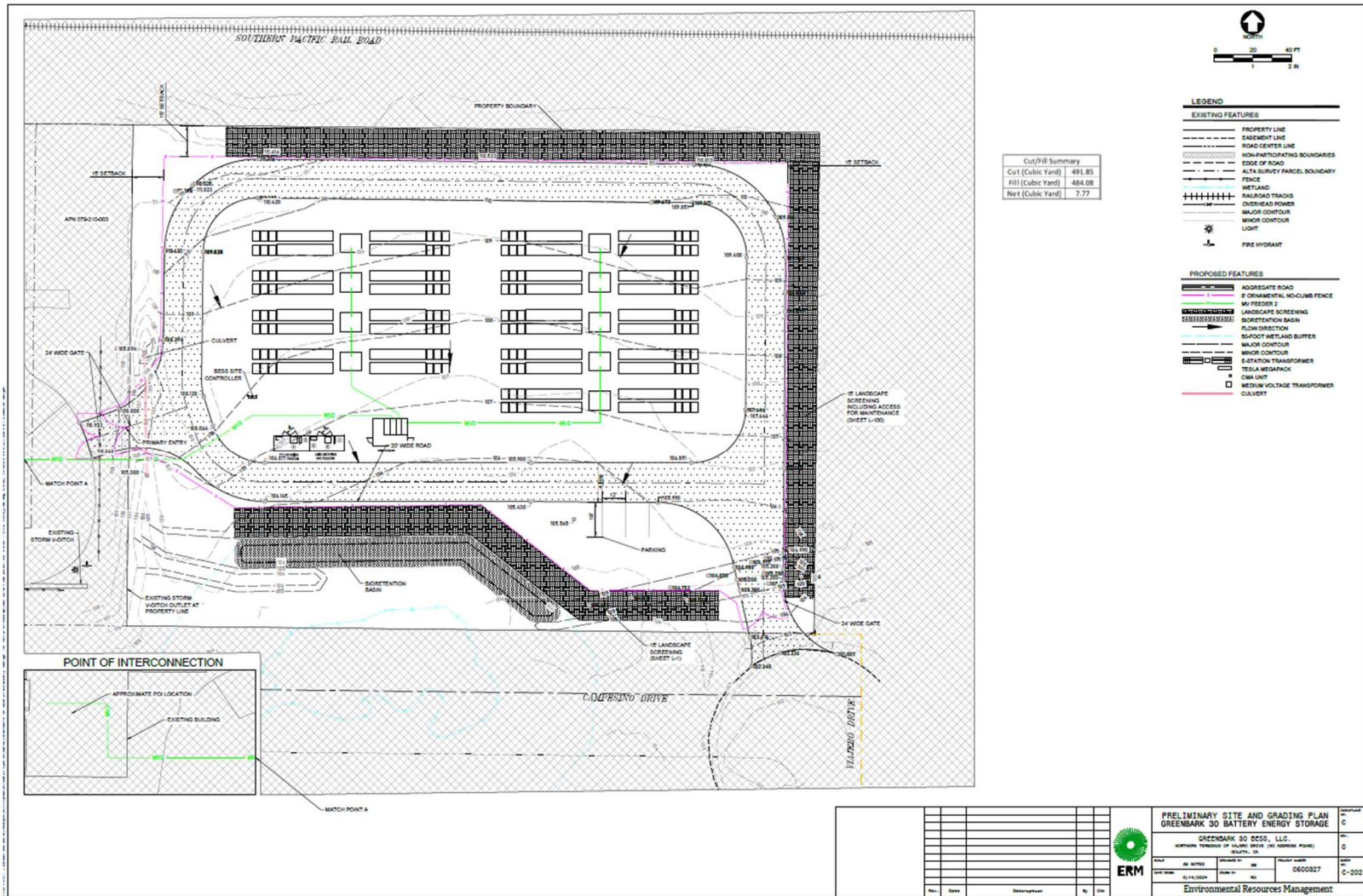


FIGURE 1: SITE LOCATION AND VICINITY





FIGURE 3: POST-DEVELOPMENT SITE CONDITIONS





APPENDIX B

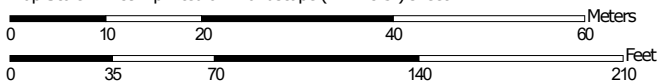
SOIL CHARACTERISTICS

Soil Map—Santa Barbara County, California, South Coastal Part
(S_i)



Soil Map may not be valid at this scale.

Map Scale: 1:789 if printed on A landscape (11" x 8.5") sheet.




Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Santa Barbara County, California, South Coastal Part
Survey Area Data: Version 16, Sep 12, 2023

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

Date(s) aerial images were photographed: Apr 12, 2022—Apr 29, 2022

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
MeC	Milpitas-Positas fine sandy loams, 2 to 9 percent slopes	2.8	100.0%
Totals for Area of Interest		2.8	100.0%

Santa Barbara County, California, South Coastal Part

MeC—Milpitas-Positas fine sandy loams, 2 to 9 percent slopes

Map Unit Setting

National map unit symbol: hc63

Elevation: 20 to 520 feet

Mean annual precipitation: 20 to 23 inches

Mean annual air temperature: 59 to 62 degrees F

Frost-free period: 360 to 365 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Milpitas and similar soils: 45 percent

Positas and similar soils: 35 percent

Minor components: 20 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Milpitas

Setting

Landform: Terraces

Landform position (two-dimensional): Footslope

Landform position (three-dimensional): Tread

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Mixed alluvium

Typical profile

H1 - 0 to 25 inches: fine sandy loam

H2 - 25 to 54 inches: gravelly clay

H3 - 54 to 68 inches: very gravelly sandy loam

Properties and qualities

Slope: 2 to 9 percent

Depth to restrictive feature: 20 to 28 inches to abrupt textural change

Drainage class: Moderately well drained

Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water supply, 0 to 60 inches: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: D

Ecological site: R015XD115CA - CLAYPAN
Hydric soil rating: No

Description of Positas

Setting

Landform: Terraces
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Mixed alluvium

Typical profile

H1 - 0 to 19 inches: fine sandy loam
H2 - 19 to 41 inches: clay
H3 - 41 to 68 inches: clay loam

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: 14 to 26 inches to abrupt textural change
Drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: R015XD115CA - CLAYPAN
Hydric soil rating: No

Minor Components

Botella

Percent of map unit: 7 percent
Landform: Valleys
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Ballard

Percent of map unit: 7 percent
Landform: Alluvial fans

Landform position (two-dimensional): Foothlope

Landform position (three-dimensional): Talf

Down-slope shape: Linear

Across-slope shape: Convex

Hydric soil rating: No

Eroded soils

Percent of map unit: 6 percent

Hydric soil rating: No

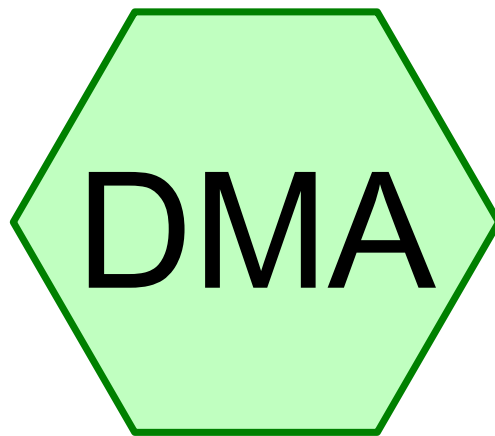
Data Source Information

Soil Survey Area: Santa Barbara County, California, South Coastal Part

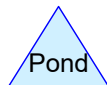
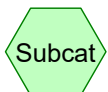
Survey Area Data: Version 16, Sep 12, 2023



APPENDIX C HYDROCAD MODELING



GREENBARK 30 BATTERY ENERGY_Pre Development



PreConstructionRunoffn

Prepared by ERM

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Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.100	89	<50% Grass cover, Poor, HSG D (DMA)

PreConstructionRunoffn

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Type I 24-hr 2-year Rainfall=3.53"

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Page 3

Summary for Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Runoff = 4.00 cfs @ 9.98 hrs, Volume= 0.417 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 2-year Rainfall=3.53"

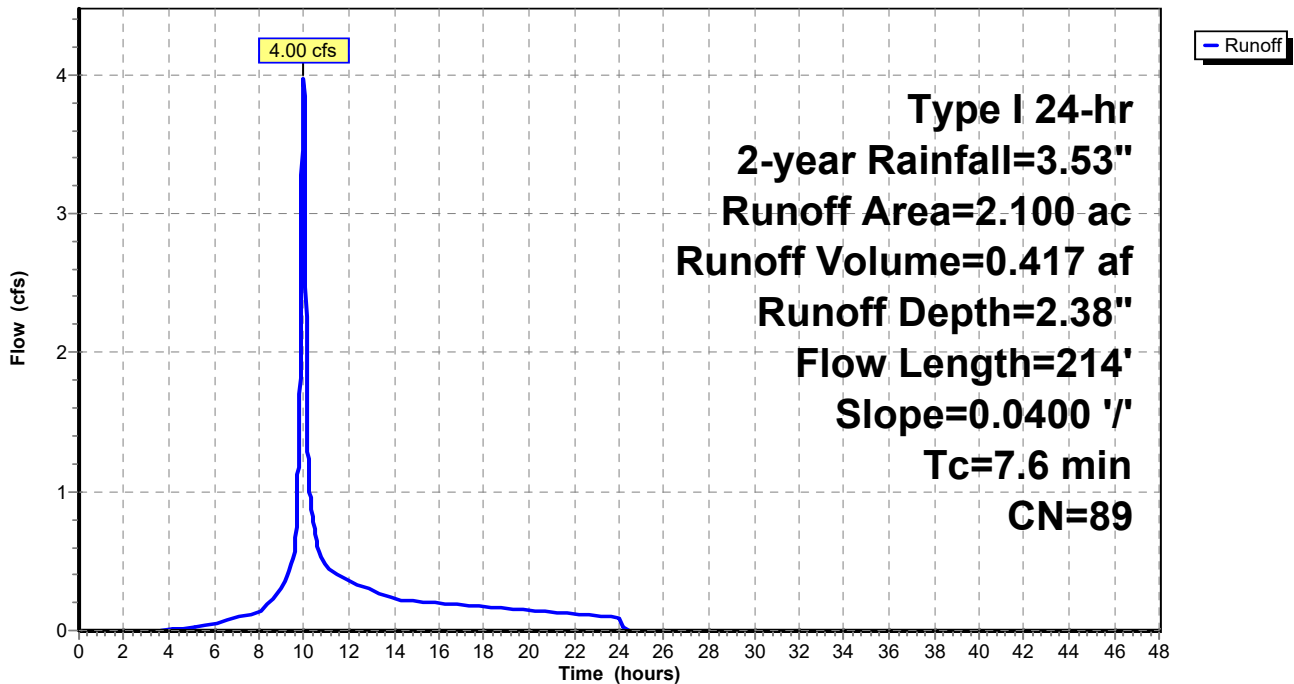
Area (ac)	CN	Description
2.100	89	<50% Grass cover, Poor, HSG D
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	214	0.0400	0.47		Sheet Flow, Flow to Biofiltration Systems

Cultivated: Residue<=20% n= 0.060 P2= 2.40"

Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Hydrograph



PreConstructionRunoffn

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Type I 24-hr 5-year Rainfall=4.54"

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Page 4

Summary for Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Runoff = 5.59 cfs @ 9.98 hrs, Volume= 0.583 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 5-year Rainfall=4.54"

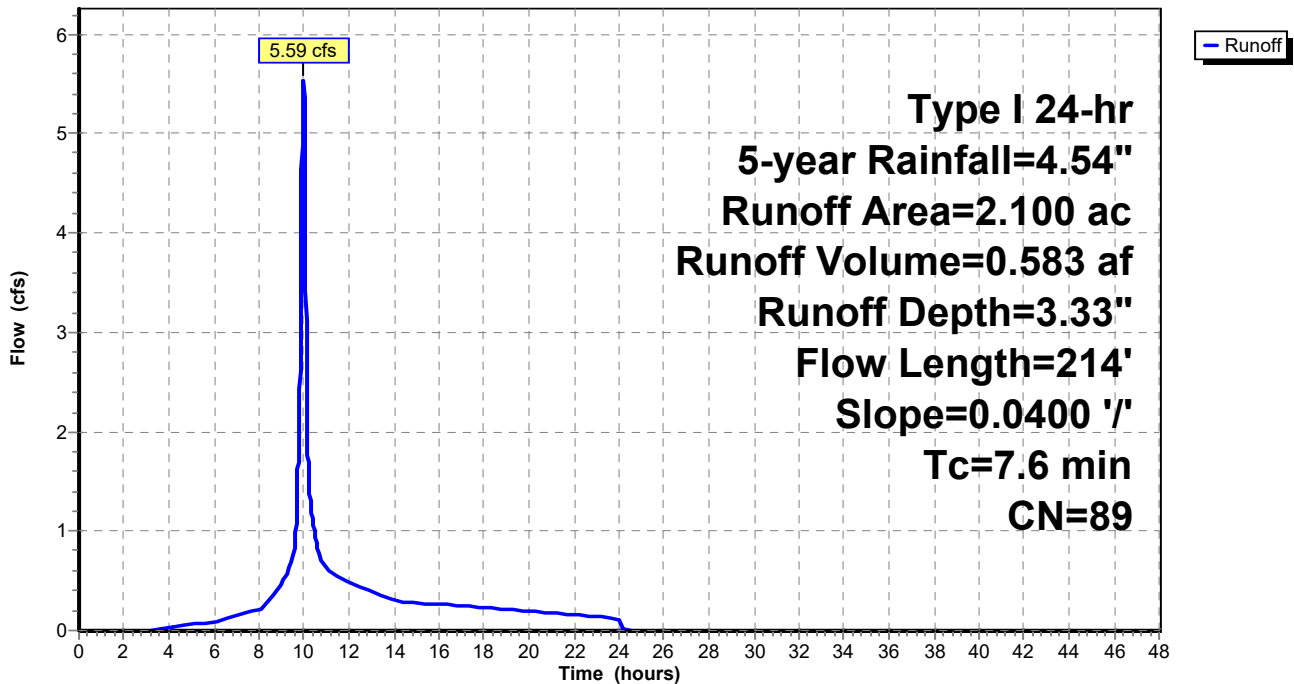
Area (ac)	CN	Description
2.100	89	<50% Grass cover, Poor, HSG D
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	214	0.0400	0.47		Sheet Flow, Flow to Biofiltration Systems

Cultivated: Residue<=20% n= 0.060 P2= 2.40"

Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Hydrograph



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Type I 24-hr 10-year Rainfall=5.33"

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Page 5

Summary for Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Runoff = 6.83 cfs @ 9.98 hrs, Volume= 0.716 af, Depth= 4.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 10-year Rainfall=5.33"

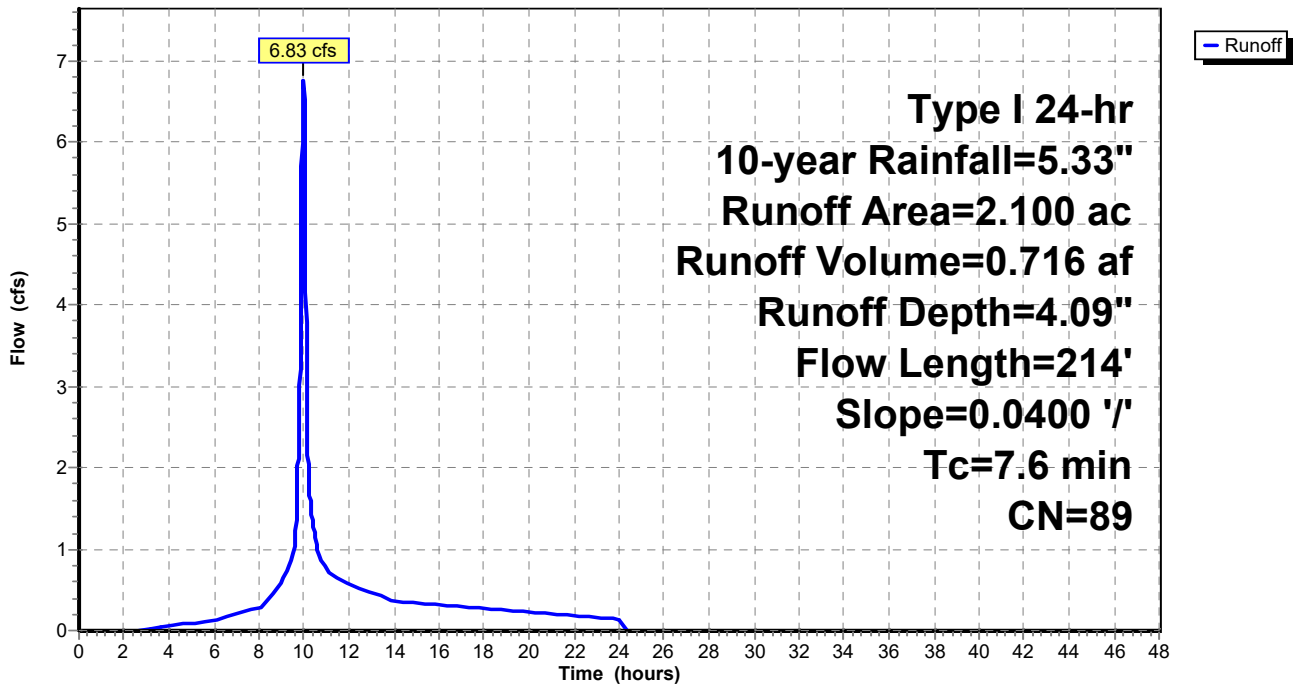
Area (ac)	CN	Description
2.100	89	<50% Grass cover, Poor, HSG D
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	214	0.0400	0.47		Sheet Flow, Flow to Biofiltration Systems

Cultivated: Residue<=20% n= 0.060 P2= 2.40"

Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Hydrograph



PreConstructionRunoffn

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Type I 24-hr 25-year Rainfall=6.36"

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Summary for Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Runoff = 8.44 cfs @ 9.98 hrs, Volume= 0.890 af, Depth= 5.08"

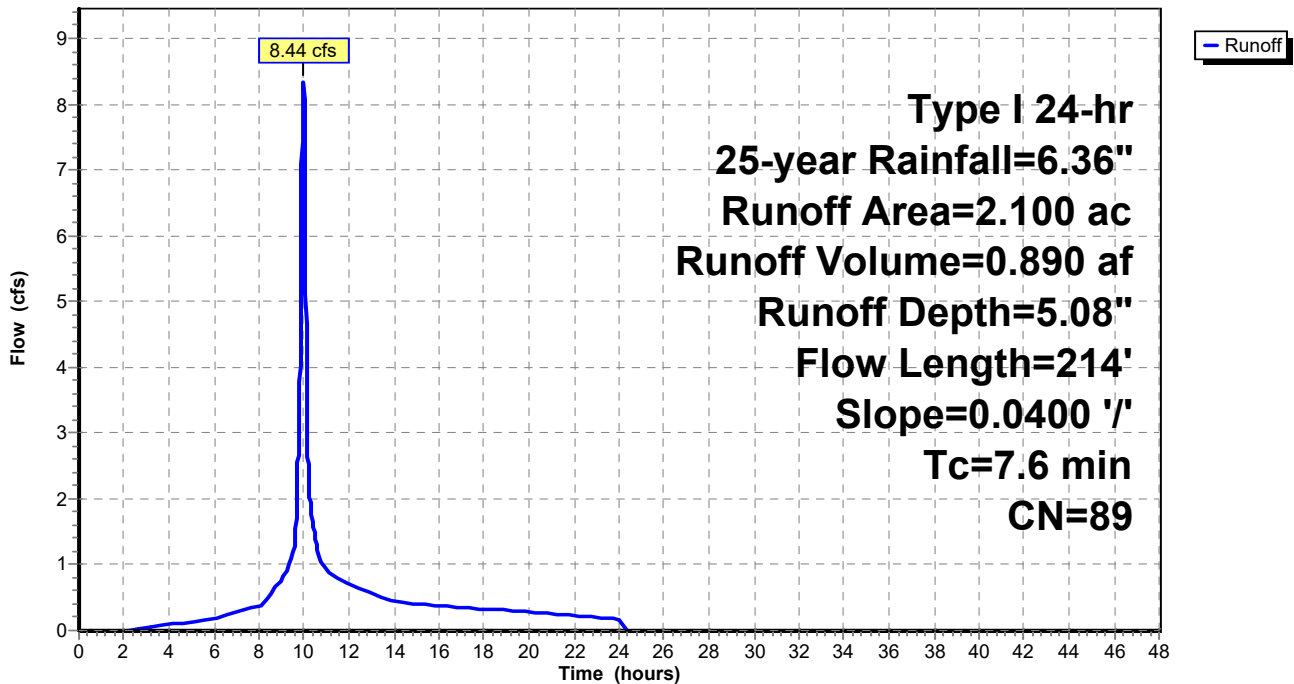
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 25-year Rainfall=6.36"

Area (ac)	CN	Description
2.100	89	<50% Grass cover, Poor, HSG D
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	214	0.0400	0.47		Sheet Flow, Flow to Biofiltration Systems Cultivated: Residue<=20% n= 0.060 P2= 2.40"

Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Hydrograph



PreConstructionRunoffn

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Type I 24-hr 50-year Rainfall=7.13"

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Summary for Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Runoff = 9.65 cfs @ 9.98 hrs, Volume= 1.021 af, Depth= 5.84"

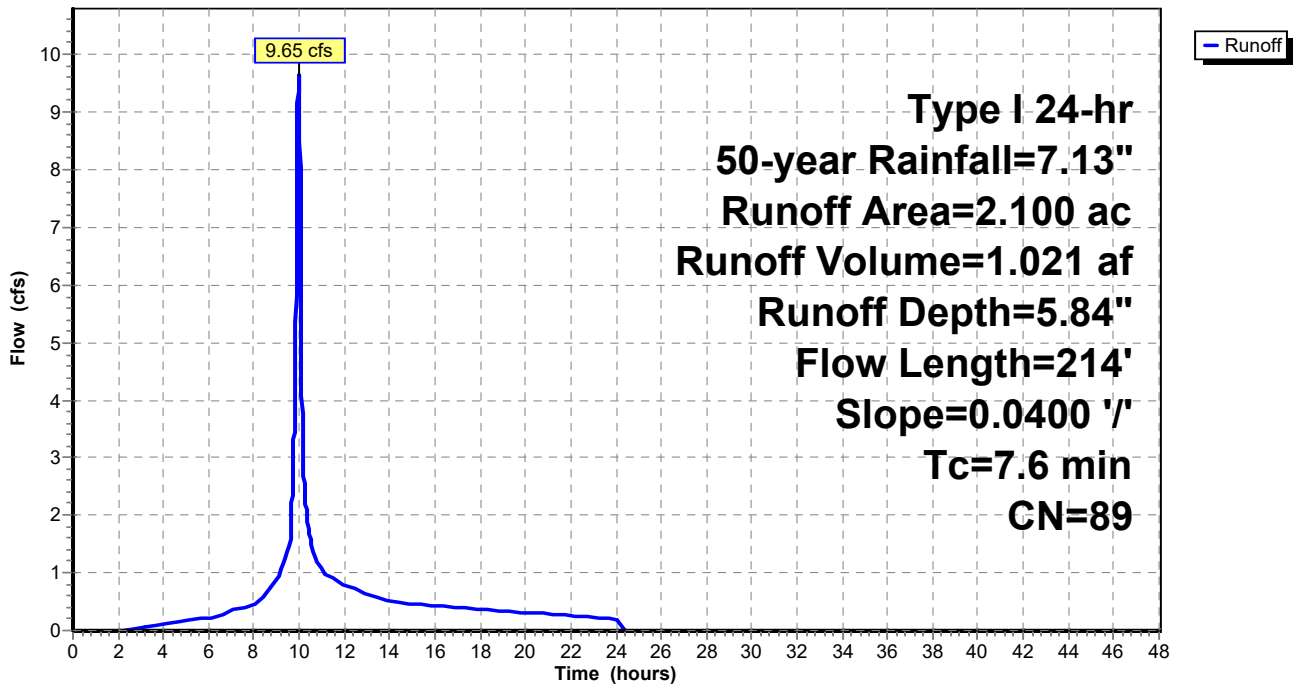
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 50-year Rainfall=7.13"

Area (ac)	CN	Description
2.100	89	<50% Grass cover, Poor, HSG D
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	214	0.0400	0.47		Sheet Flow, Flow to Biofiltration Systems Cultivated: Residue<=20% n= 0.060 P2= 2.40"

Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Hydrograph



PreConstructionRunoffn

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Type I 24-hr 100-year Rainfall=7.86"

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Summary for Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Runoff = 10.78 cfs @ 9.98 hrs, Volume= 1.146 af, Depth= 6.55"

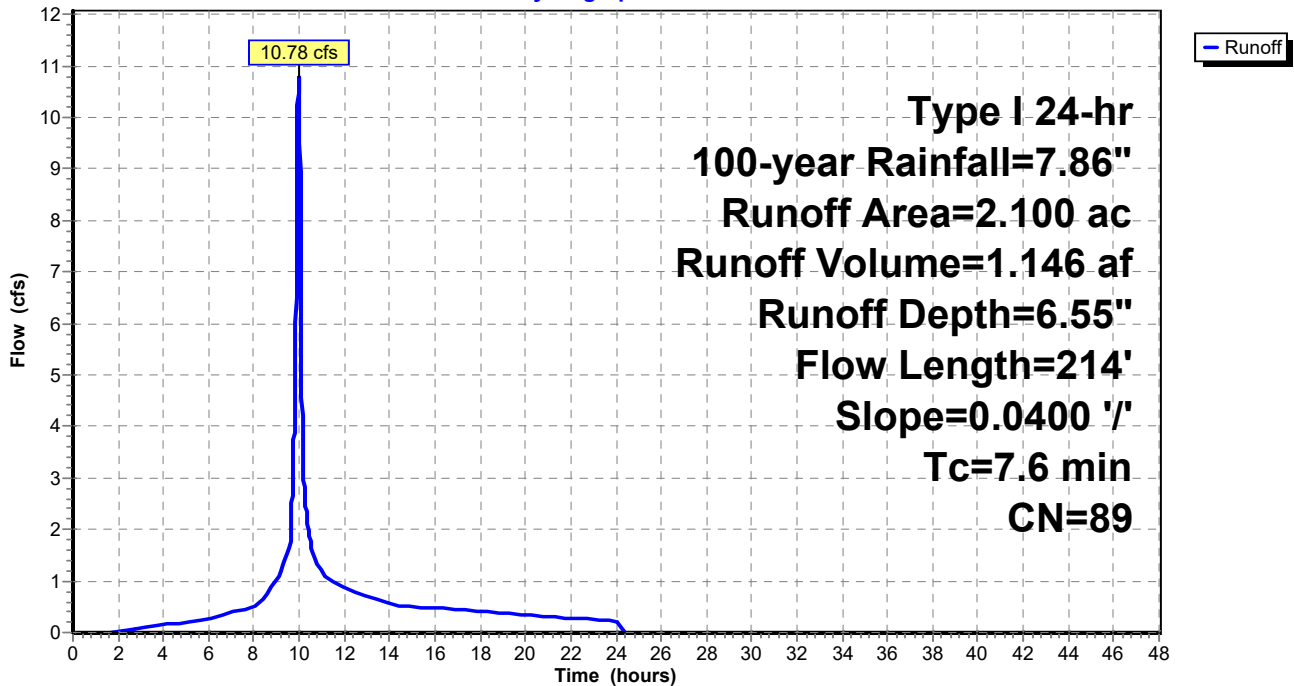
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type I 24-hr 100-year Rainfall=7.86"

Area (ac)	CN	Description
2.100	89	<50% Grass cover, Poor, HSG D
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.6	214	0.0400	0.47		Sheet Flow, Flow to Biofiltration Systems Cultivated: Residue<=20% n= 0.060 P2= 2.40"

Subcatchment DMA: GREENBARK 30 BATTERY ENERGY_Pre Development

Hydrograph

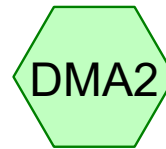




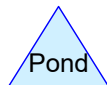
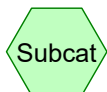
GREENBARK 30
BATTERY
ENERGY_Post
Development



GREENBARK 30
BATTERY
ENERGY_Post
Development



GREENBARK 30
BATTERY
ENERGY_Post
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Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.395	89	<50% Grass cover, Poor, HSG D (DMA1, DMA2, DMA3)
0.272	75	Landscape (DMA1, DMA2)
0.431	98	Paved parking, HSG D (DMA1)
0.462	76	Permeable Gravel Roads (DMA1, DMA2)
0.484	76	Permeable Gravel surface (DMA1)
0.060	98	Water Surface, 0% imp, HSG D (DMA1)

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Type I 24-hr 2-year Rainfall=3.53"

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Summary for Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 3.13 cfs @ 9.91 hrs, Volume= 0.301 af, Depth= 1.88"

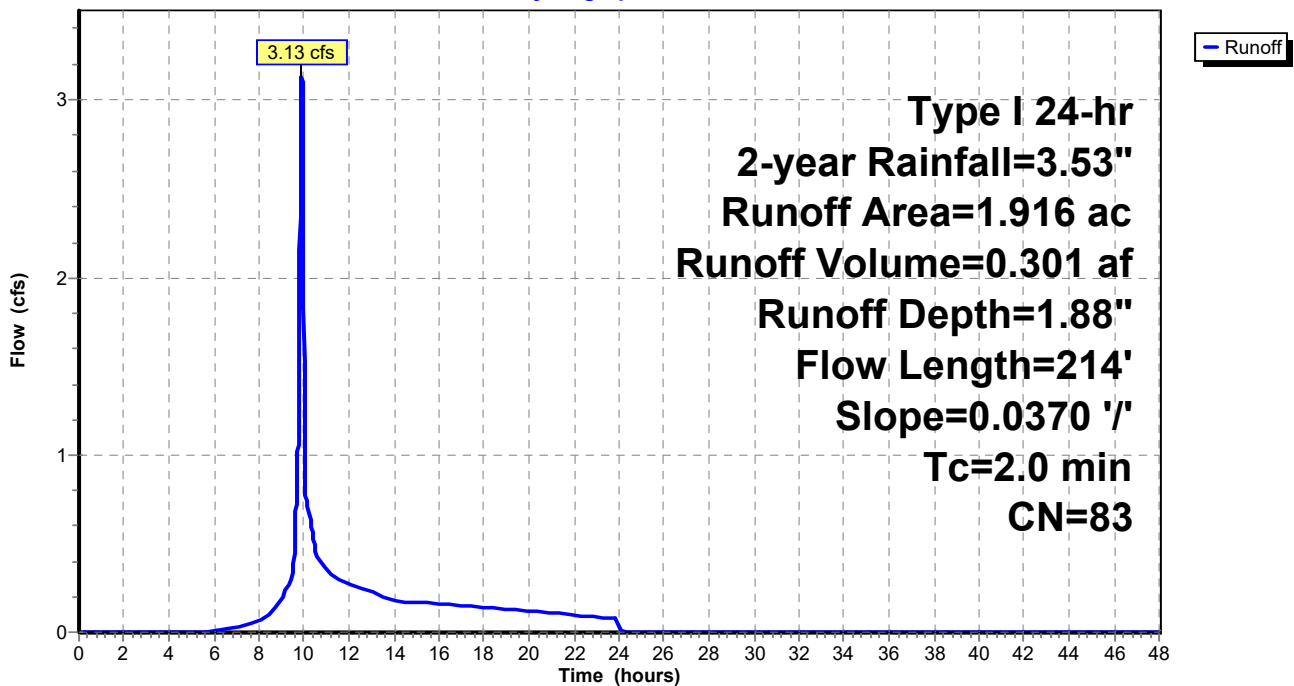
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 2-year Rainfall=3.53"

Area (ac)	CN	Description
* 0.445	76	Permeable Gravel Roads
0.431	98	Paved parking, HSG D
* 0.253	75	Landscape
0.060	98	Water Surface, 0% imp, HSG D
* 0.484	76	Permeable Gravel surface
0.243	89	<50% Grass cover, Poor, HSG D
1.916	83	Weighted Average
1.485		77.51% Pervious Area
0.431		22.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	214	0.0370	1.77		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 2-year Rainfall=3.53"

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Summary for Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.08 cfs @ 9.89 hrs, Volume= 0.008 af, Depth= 1.66"

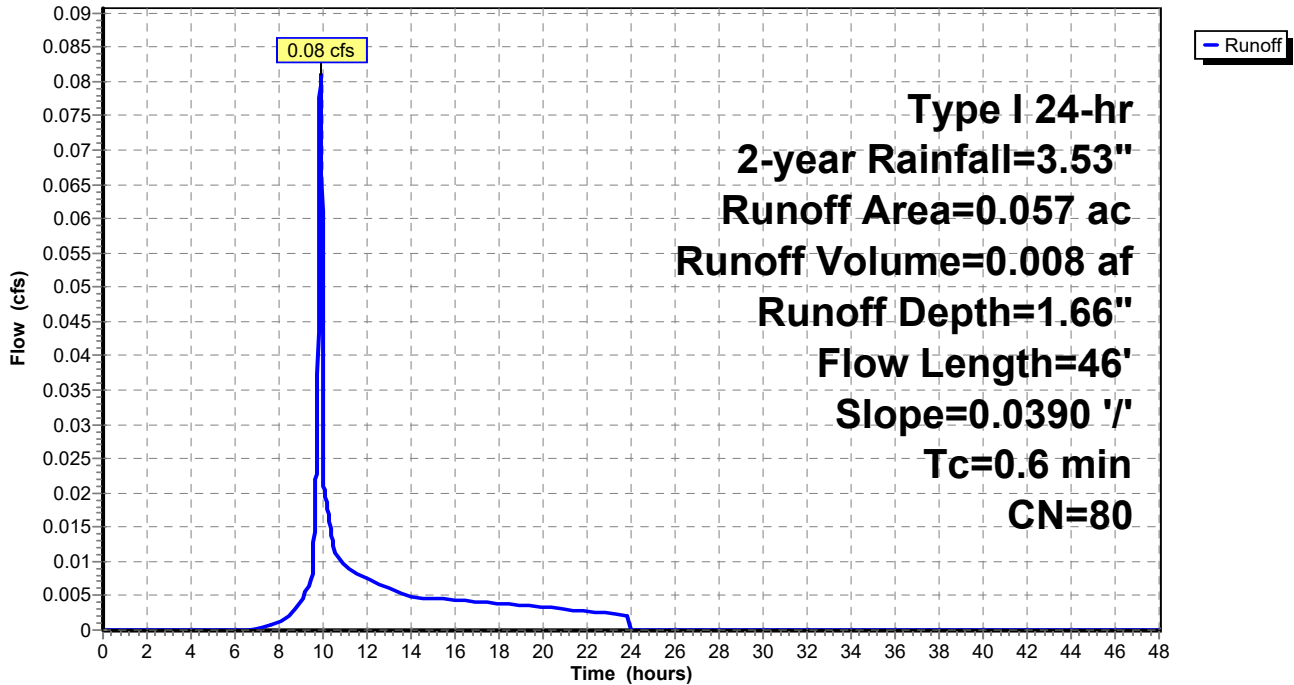
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 2-year Rainfall=3.53"

Area (ac)	CN	Description
0.021	89	<50% Grass cover, Poor, HSG D
* 0.017	76	Permeable Gravel Roads
* 0.019	75	Landscape
0.057	80	Weighted Average
0.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	46	0.0390	1.33		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 2-year Rainfall=3.53"

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Summary for Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.28 cfs @ 9.88 hrs, Volume= 0.026 af, Depth= 2.38"

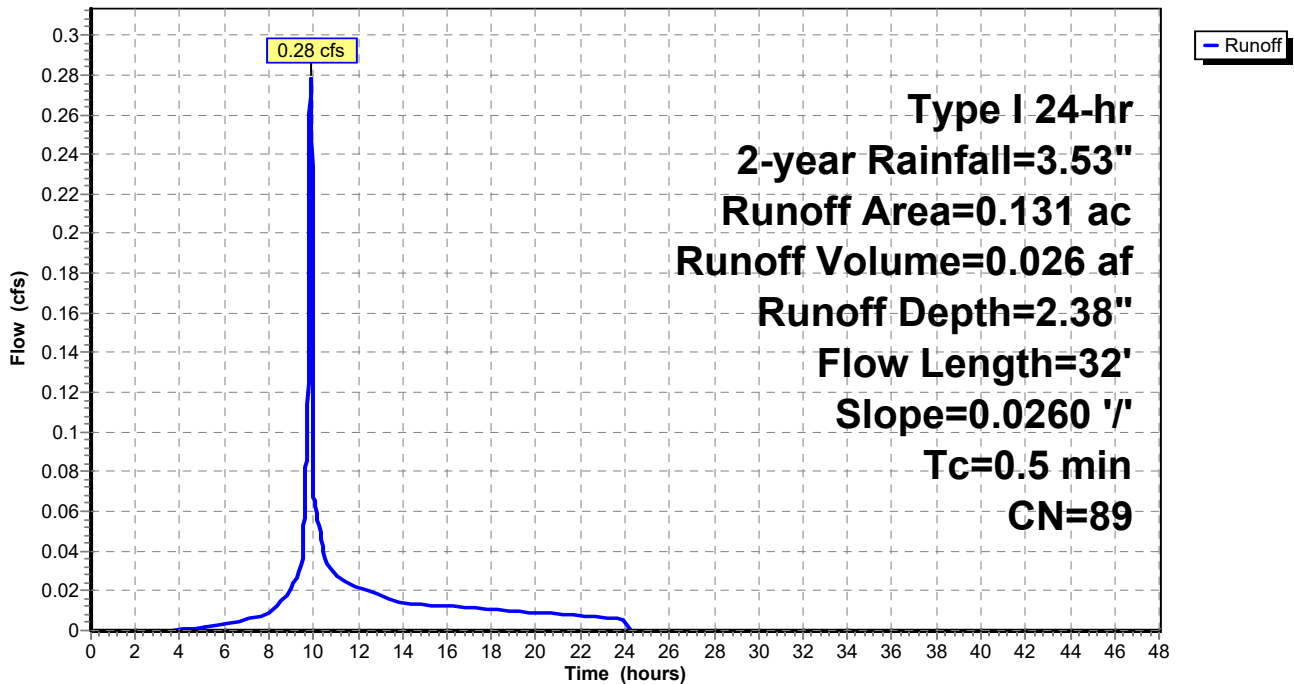
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 2-year Rainfall=3.53"

Area (ac)	CN	Description
0.131	89	<50% Grass cover, Poor, HSG D
0.131		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	32	0.0260	1.05		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 5-year Rainfall=4.54"

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Summary for Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 4.67 cfs @ 9.91 hrs, Volume= 0.441 af, Depth= 2.76"

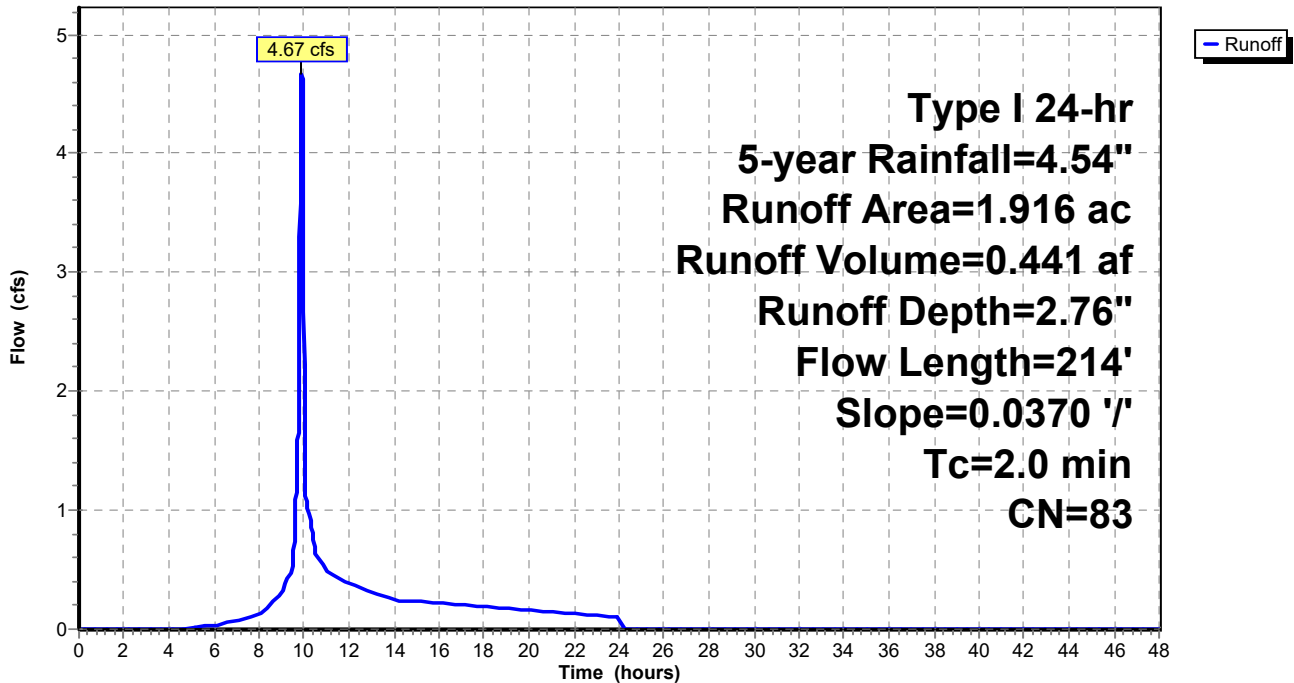
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 5-year Rainfall=4.54"

Area (ac)	CN	Description
* 0.445	76	Permeable Gravel Roads
0.431	98	Paved parking, HSG D
* 0.253	75	Landscape
0.060	98	Water Surface, 0% imp, HSG D
* 0.484	76	Permeable Gravel surface
0.243	89	<50% Grass cover, Poor, HSG D
1.916	83	Weighted Average
1.485		77.51% Pervious Area
0.431		22.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	214	0.0370	1.77		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 5-year Rainfall=4.54"

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Summary for Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

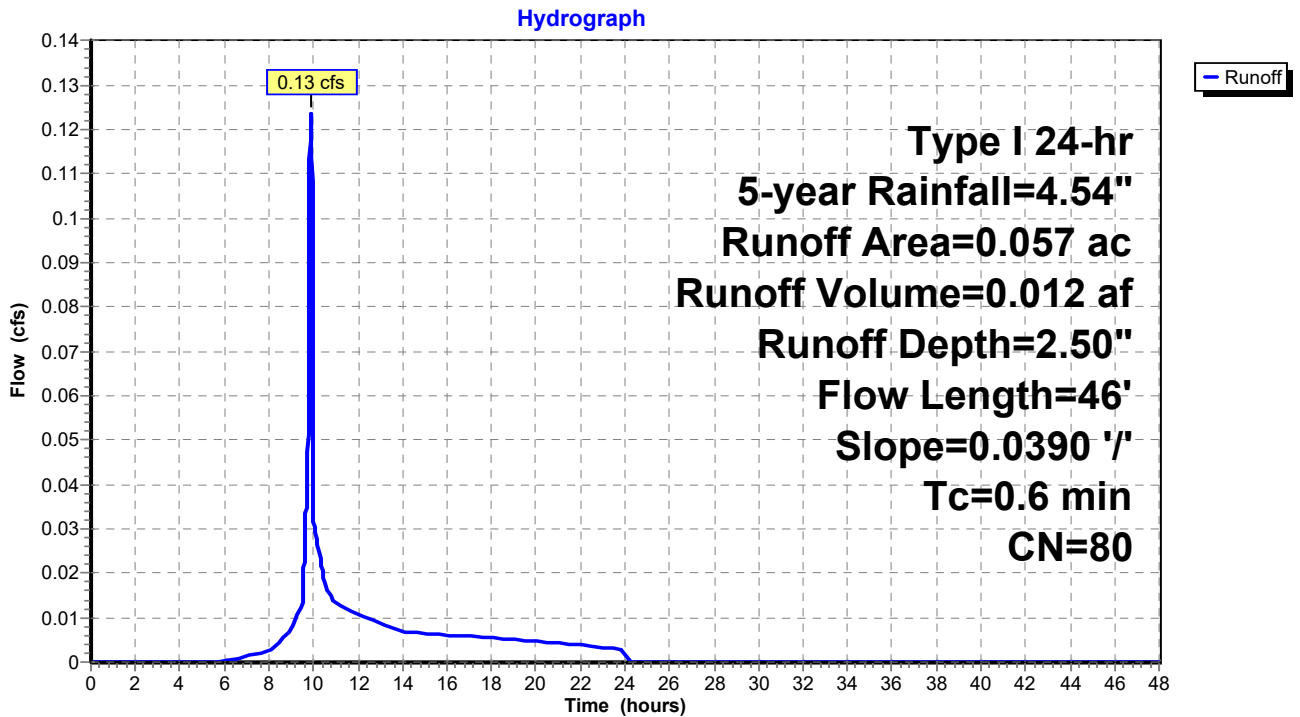
Runoff = 0.13 cfs @ 9.89 hrs, Volume= 0.012 af, Depth= 2.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 5-year Rainfall=4.54"

Area (ac)	CN	Description
0.021	89	<50% Grass cover, Poor, HSG D
* 0.017	76	Permeable Gravel Roads
* 0.019	75	Landscape
0.057	80	Weighted Average
0.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	46	0.0390	1.33		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development



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Type I 24-hr 5-year Rainfall=4.54"

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Summary for Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.39 cfs @ 9.88 hrs, Volume= 0.036 af, Depth= 3.33"

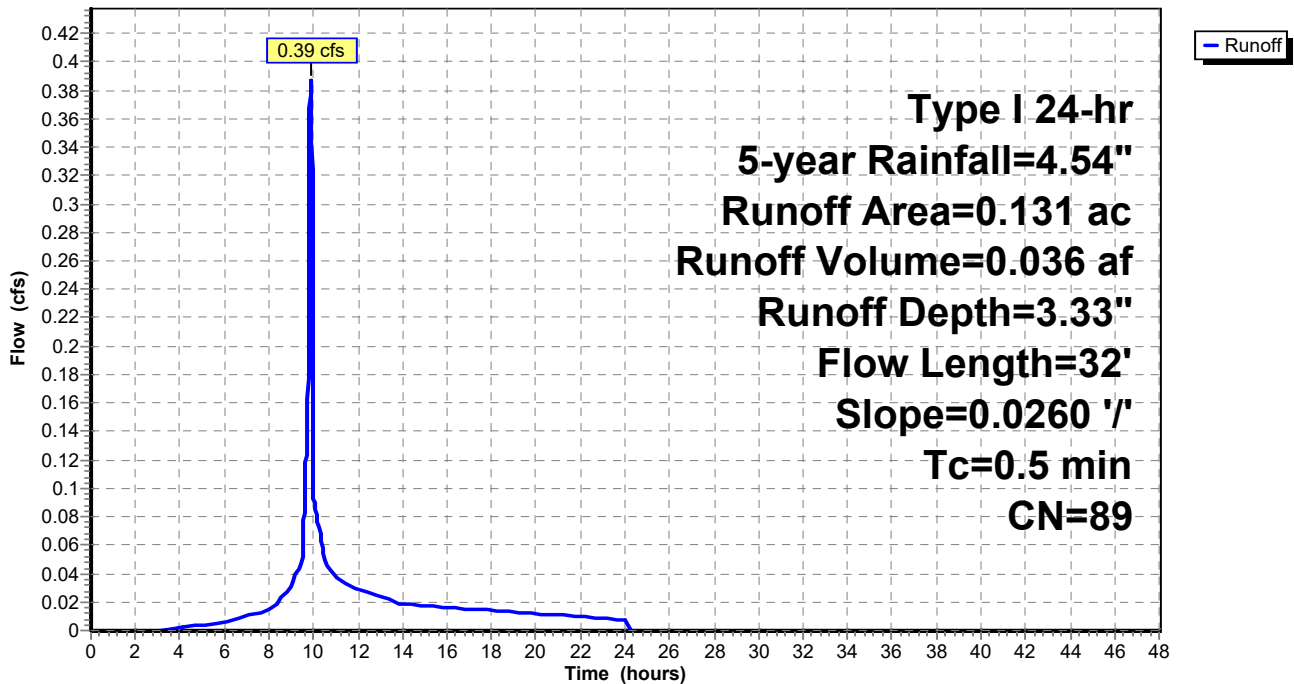
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 5-year Rainfall=4.54"

Area (ac)	CN	Description
0.131	89	<50% Grass cover, Poor, HSG D
0.131		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	32	0.0260	1.05		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 10-year Rainfall=5.33"

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Summary for Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 5.90 cfs @ 9.90 hrs, Volume= 0.555 af, Depth= 3.47"

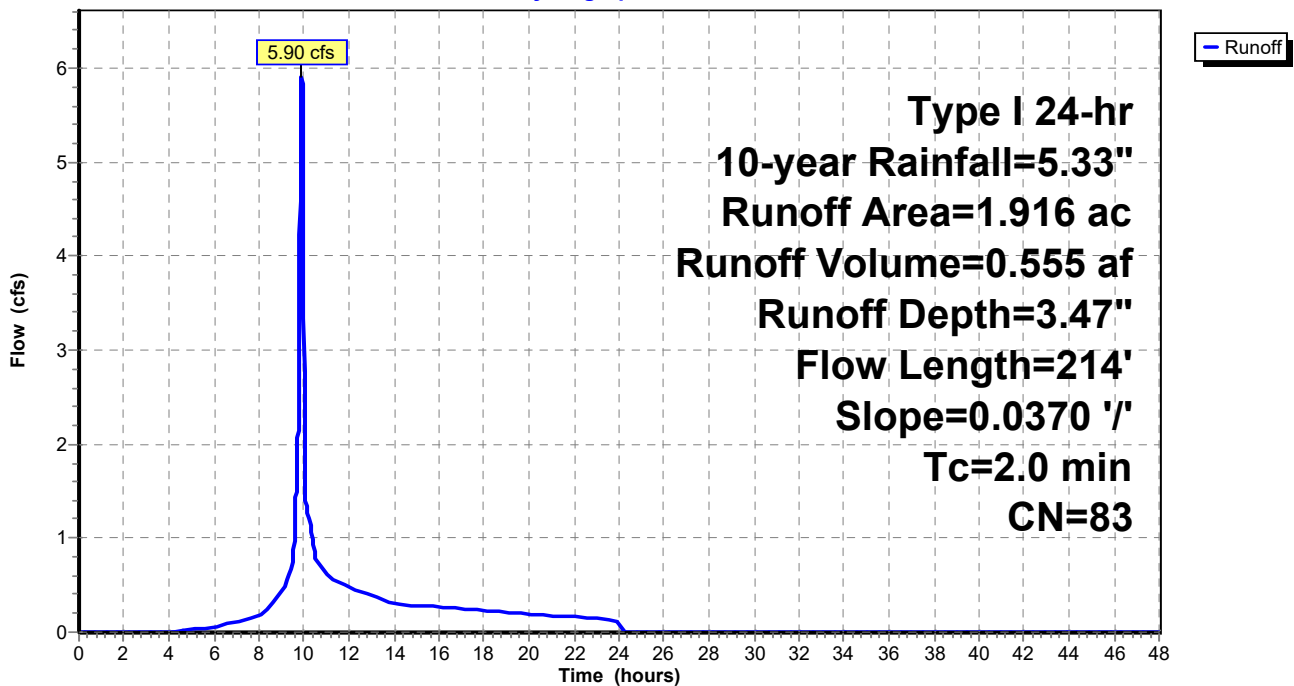
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 10-year Rainfall=5.33"

Area (ac)	CN	Description
* 0.445	76	Permeable Gravel Roads
0.431	98	Paved parking, HSG D
* 0.253	75	Landscape
0.060	98	Water Surface, 0% imp, HSG D
* 0.484	76	Permeable Gravel surface
0.243	89	<50% Grass cover, Poor, HSG D
1.916	83	Weighted Average
1.485		77.51% Pervious Area
0.431		22.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	214	0.0370	1.77		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 10-year Rainfall=5.33"

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Summary for Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.16 cfs @ 9.88 hrs, Volume= 0.015 af, Depth= 3.18"

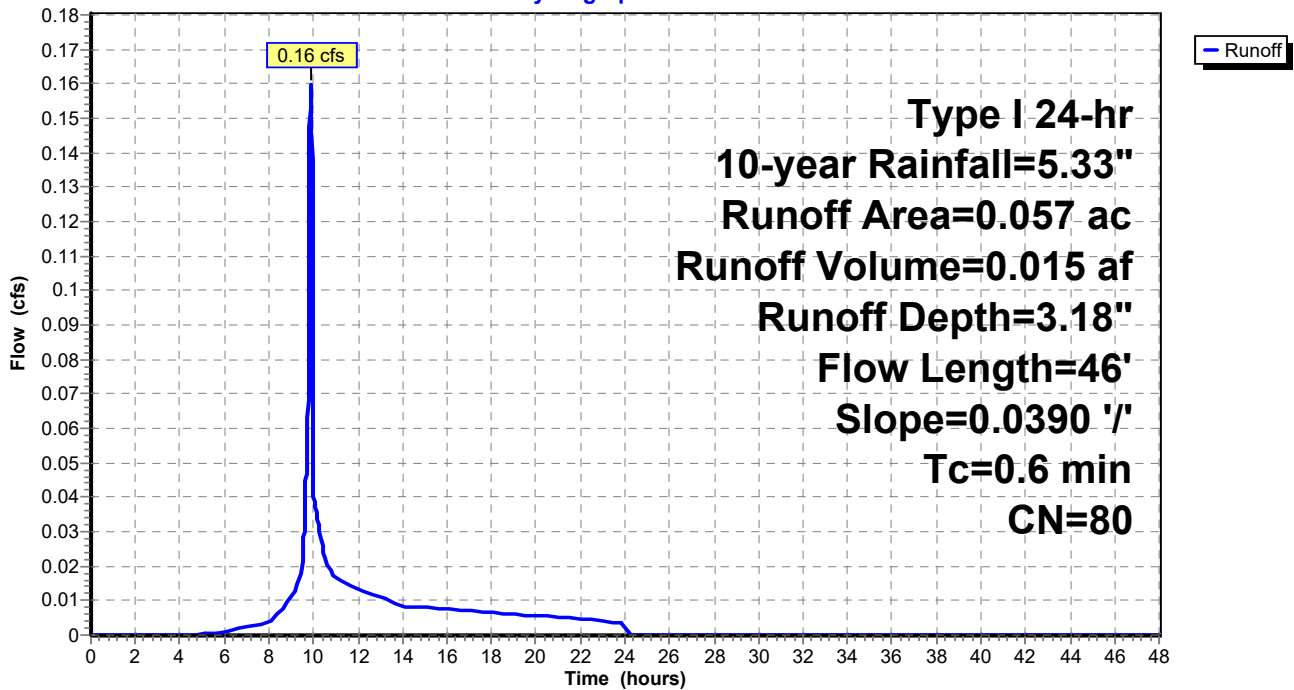
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 10-year Rainfall=5.33"

Area (ac)	CN	Description
0.021	89	<50% Grass cover, Poor, HSG D
* 0.017	76	Permeable Gravel Roads
* 0.019	75	Landscape
0.057	80	Weighted Average
0.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	46	0.0390	1.33		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 10-year Rainfall=5.33"

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Summary for Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.48 cfs @ 9.88 hrs, Volume= 0.045 af, Depth= 4.09"

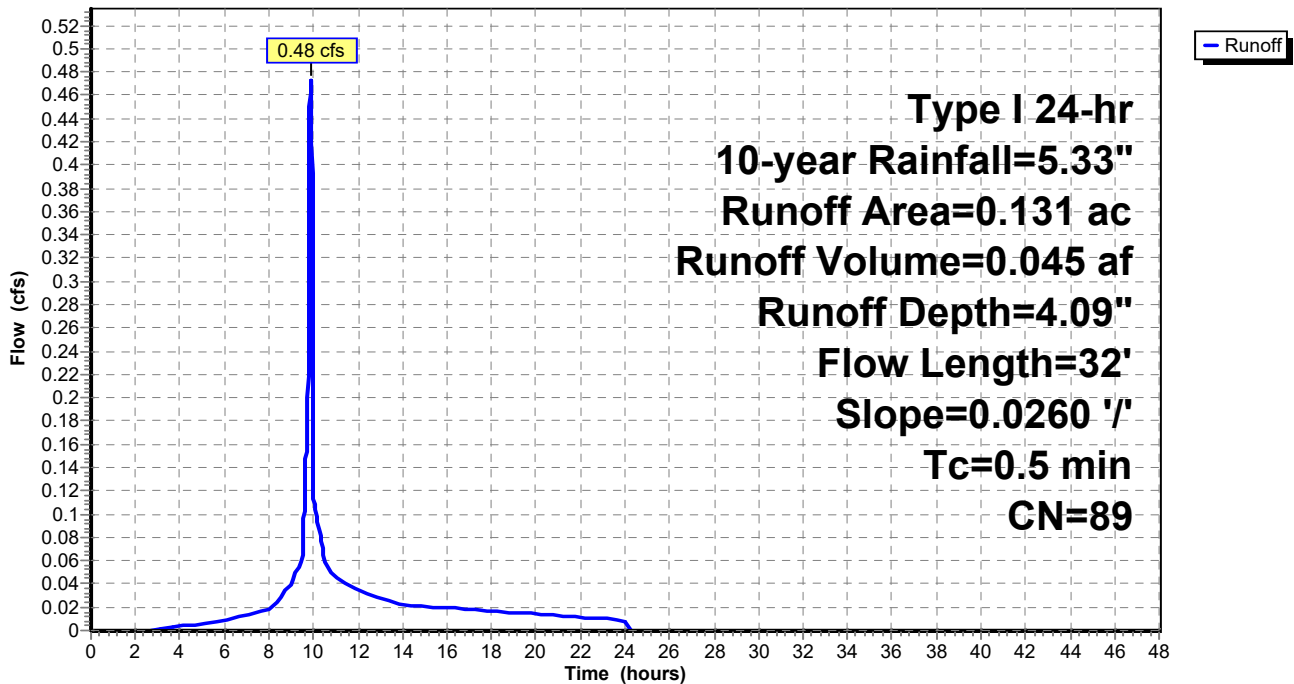
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 10-year Rainfall=5.33"

Area (ac)	CN	Description
0.131	89	<50% Grass cover, Poor, HSG D
0.131		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	32	0.0260	1.05		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 25-year Rainfall=6.36"

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Summary for Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 7.53 cfs @ 9.90 hrs, Volume= 0.707 af, Depth= 4.43"

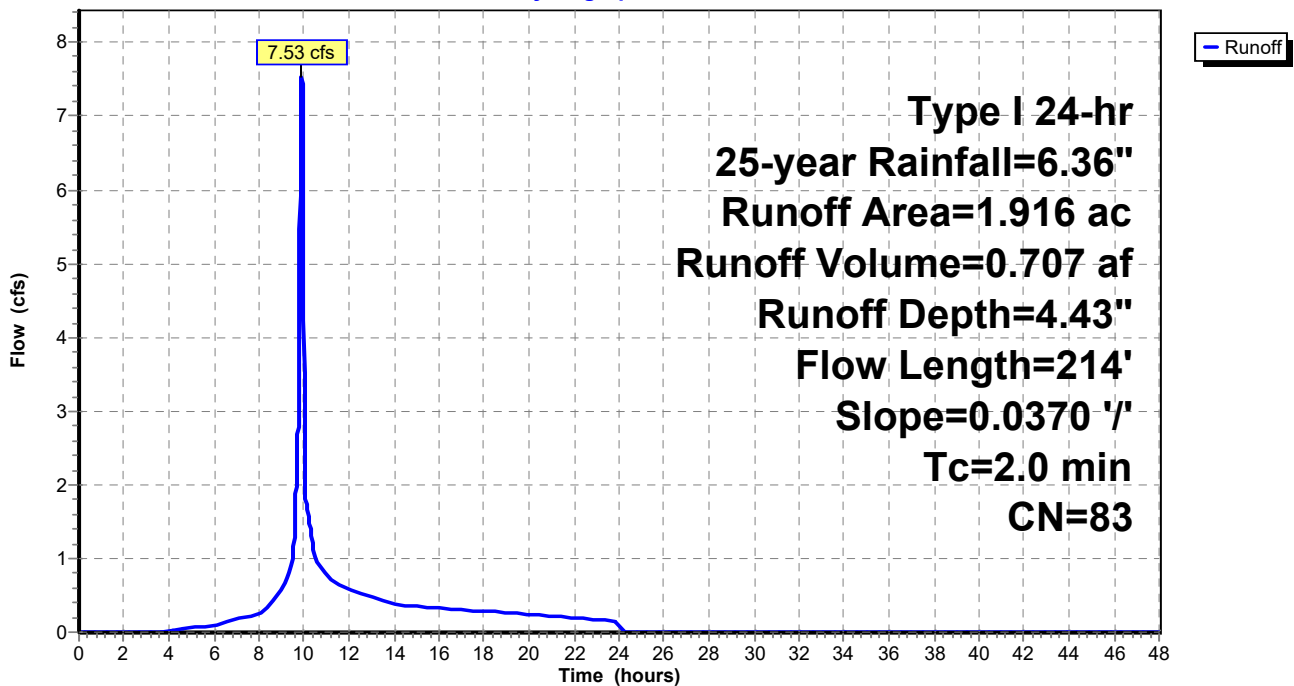
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 25-year Rainfall=6.36"

Area (ac)	CN	Description
* 0.445	76	Permeable Gravel Roads
0.431	98	Paved parking, HSG D
* 0.253	75	Landscape
0.060	98	Water Surface, 0% imp, HSG D
* 0.484	76	Permeable Gravel surface
0.243	89	<50% Grass cover, Poor, HSG D
1.916	83	Weighted Average
1.485		77.51% Pervious Area
0.431		22.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	214	0.0370	1.77		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 25-year Rainfall=6.36"

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Summary for Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.21 cfs @ 9.88 hrs, Volume= 0.020 af, Depth= 4.11"

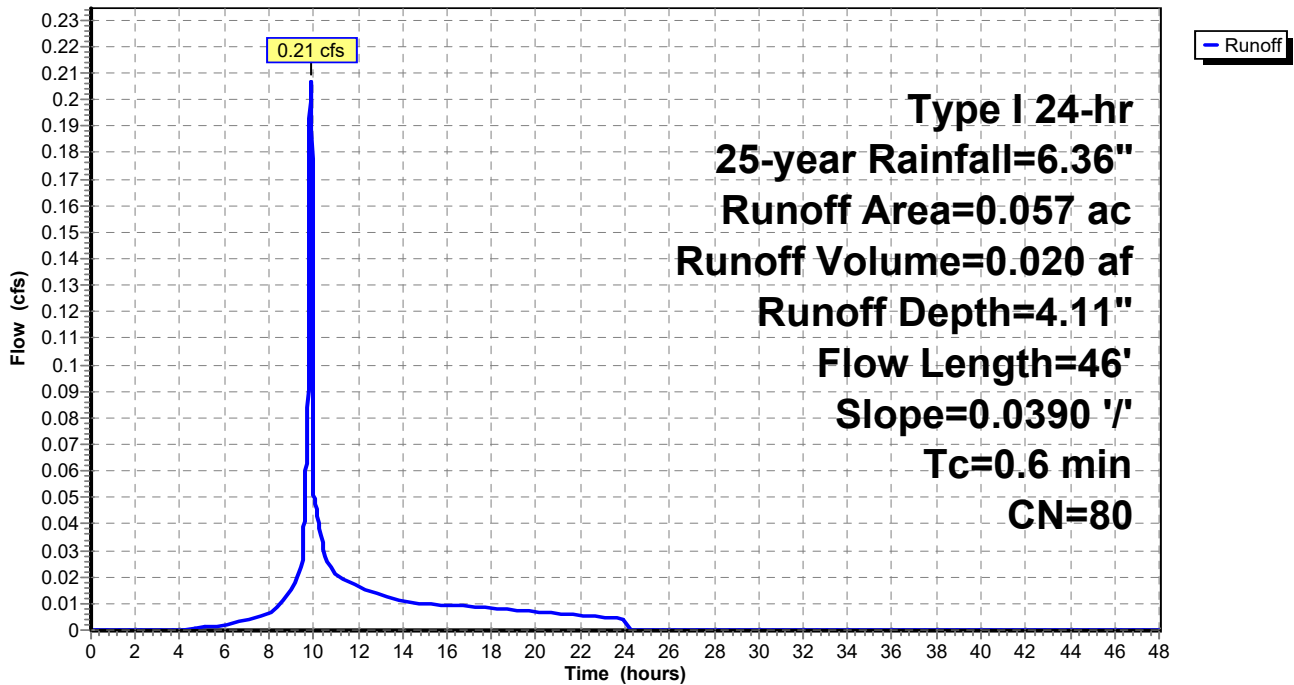
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type I 24-hr 25-year Rainfall=6.36"

Area (ac)	CN	Description
0.021	89	<50% Grass cover, Poor, HSG D
* 0.017	76	Permeable Gravel Roads
* 0.019	75	Landscape
0.057	80	Weighted Average
0.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	46	0.0390	1.33		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 25-year Rainfall=6.36"

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Summary for Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.59 cfs @ 9.88 hrs, Volume= 0.056 af, Depth= 5.08"

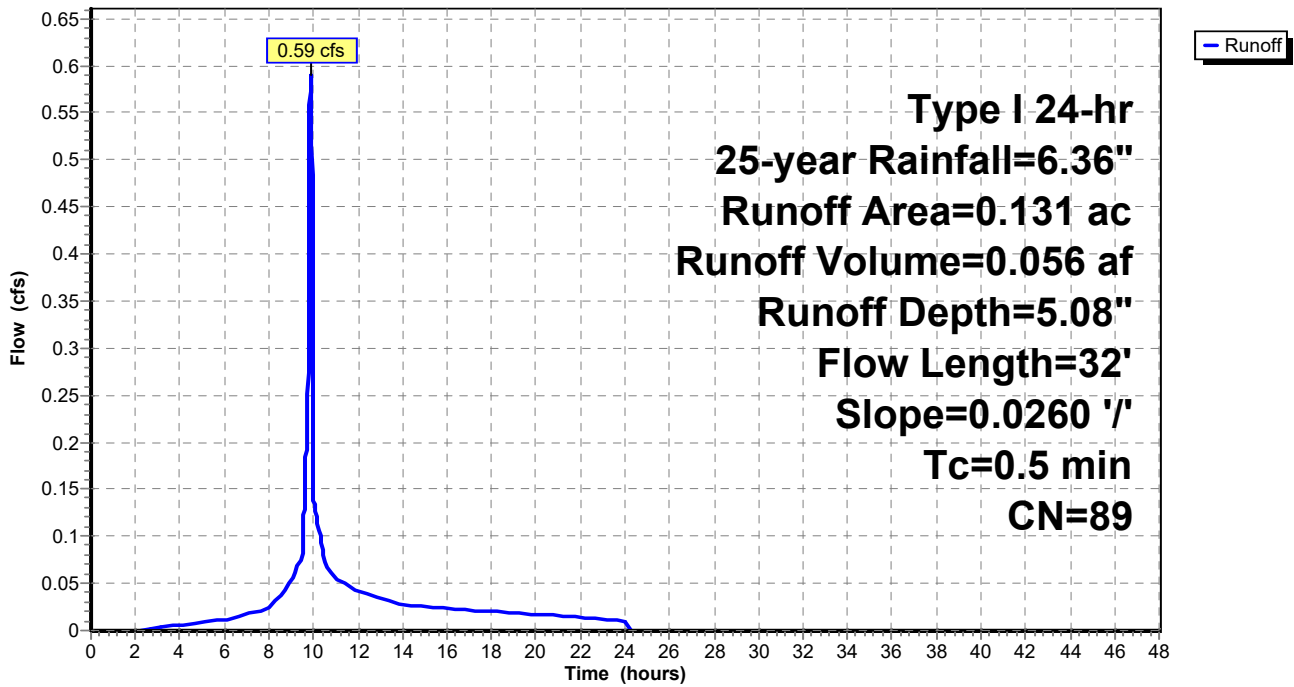
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 25-year Rainfall=6.36"

Area (ac)	CN	Description
0.131	89	<50% Grass cover, Poor, HSG D
0.131		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	32	0.0260	1.05		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 50-year Rainfall=7.13"

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Summary for Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 8.76 cfs @ 9.90 hrs, Volume= 0.822 af, Depth= 5.15"

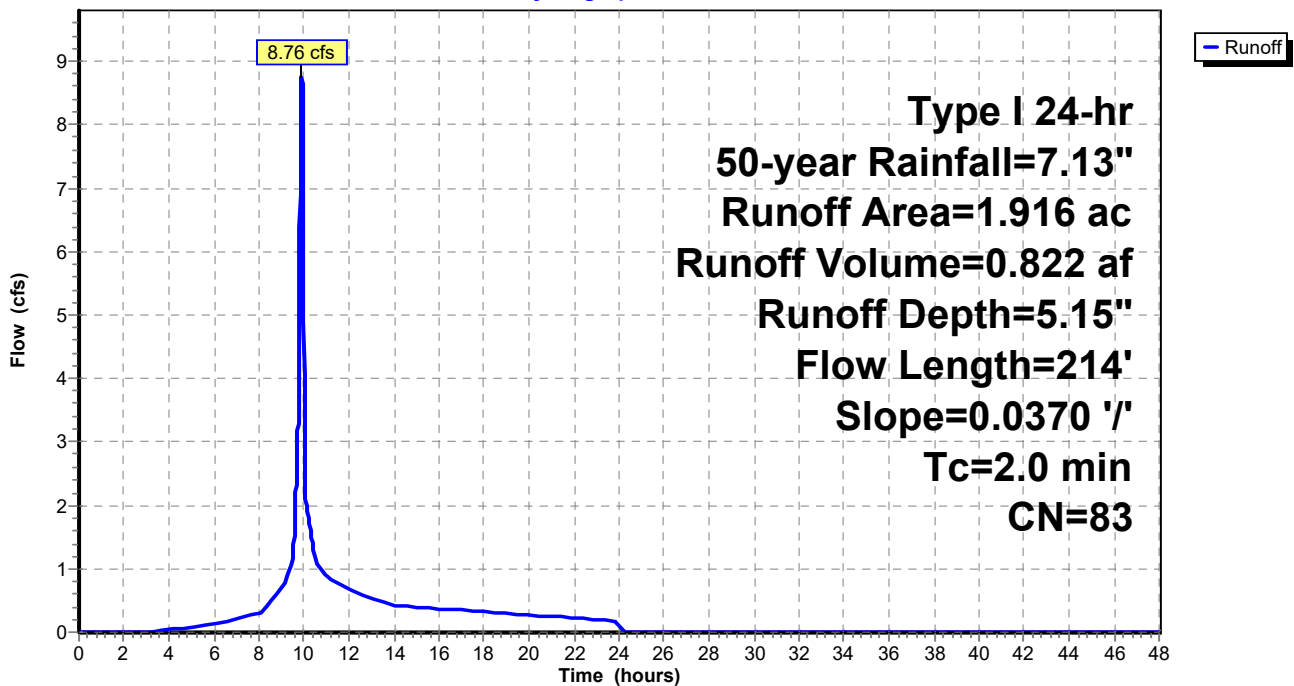
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 50-year Rainfall=7.13"

Area (ac)	CN	Description
* 0.445	76	Permeable Gravel Roads
0.431	98	Paved parking, HSG D
* 0.253	75	Landscape
0.060	98	Water Surface, 0% imp, HSG D
* 0.484	76	Permeable Gravel surface
0.243	89	<50% Grass cover, Poor, HSG D
1.916	83	Weighted Average
1.485		77.51% Pervious Area
0.431		22.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	214	0.0370	1.77		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 50-year Rainfall=7.13"

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Summary for Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.25 cfs @ 9.88 hrs, Volume= 0.023 af, Depth= 4.81"

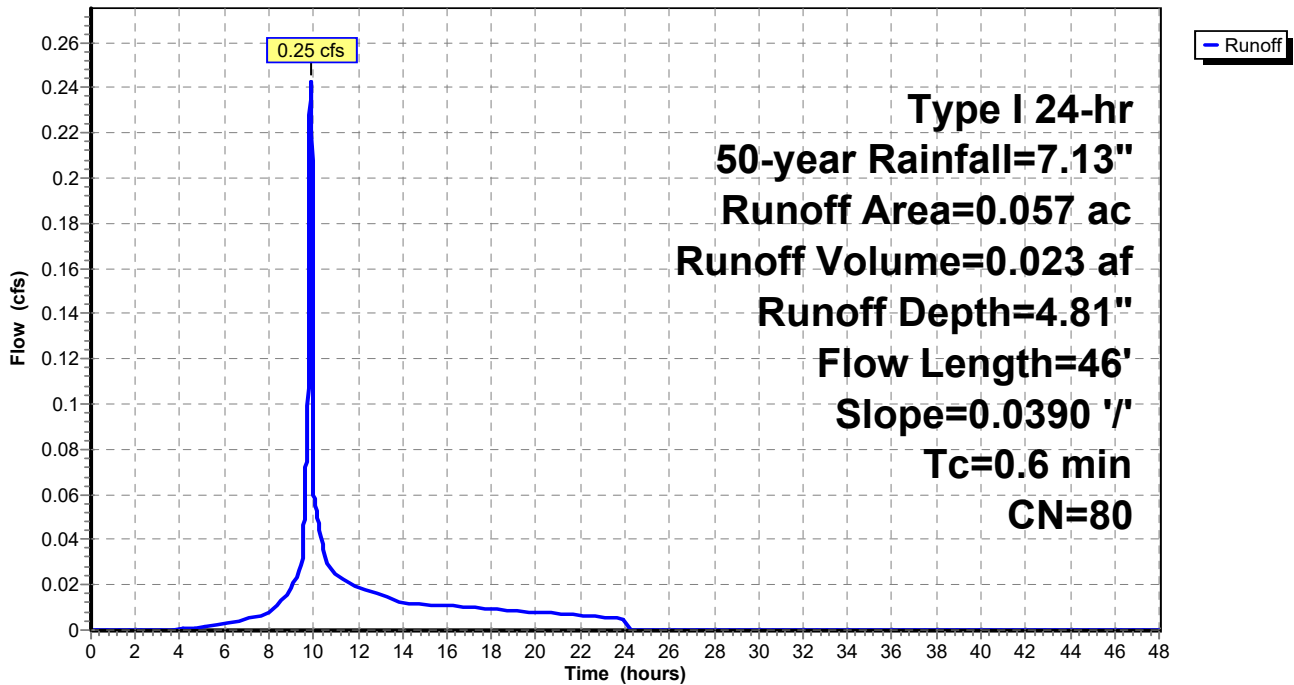
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type I 24-hr 50-year Rainfall=7.13"

Area (ac)	CN	Description
0.021	89	<50% Grass cover, Poor, HSG D
* 0.017	76	Permeable Gravel Roads
* 0.019	75	Landscape
0.057	80	Weighted Average
0.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	46	0.0390	1.33		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 50-year Rainfall=7.13"

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Summary for Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.67 cfs @ 9.88 hrs, Volume= 0.064 af, Depth= 5.84"

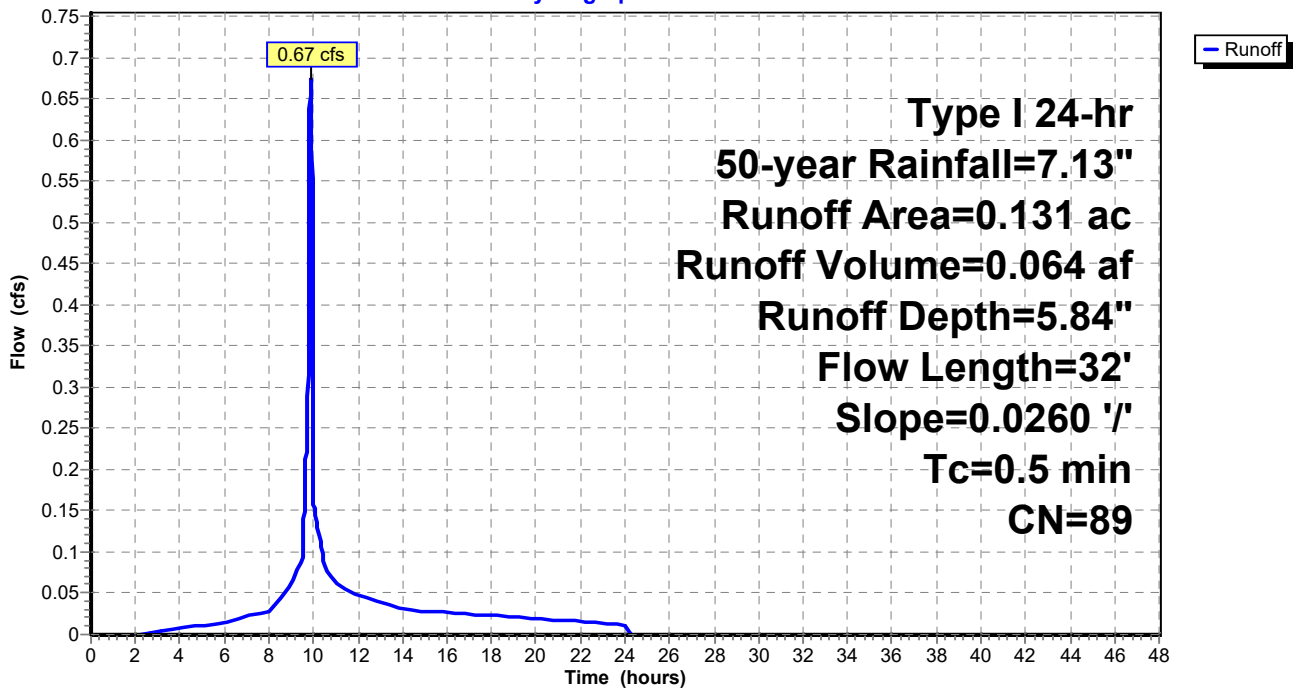
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 50-year Rainfall=7.13"

Area (ac)	CN	Description
0.131	89	<50% Grass cover, Poor, HSG D
0.131		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	32	0.0260	1.05		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 100-year Rainfall=7.86"

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Summary for Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 9.92 cfs @ 9.90 hrs, Volume= 0.933 af, Depth= 5.84"

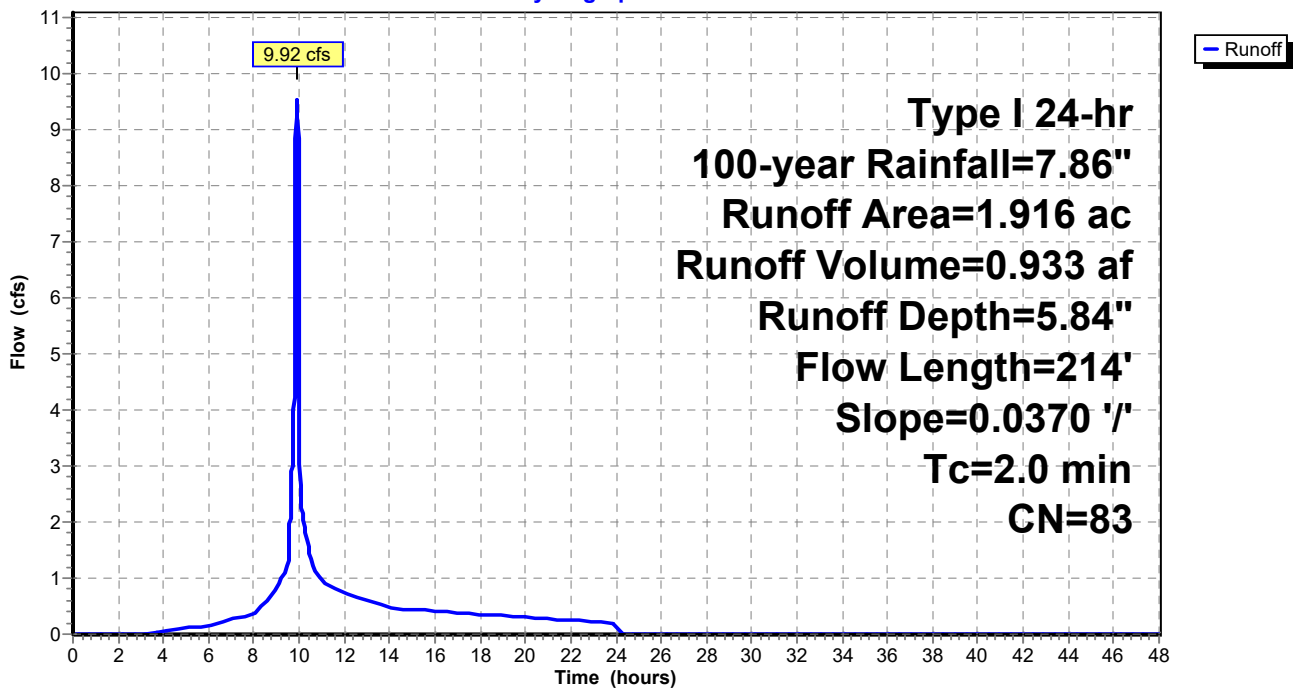
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 100-year Rainfall=7.86"

Area (ac)	CN	Description
* 0.445	76	Permeable Gravel Roads
0.431	98	Paved parking, HSG D
* 0.253	75	Landscape
0.060	98	Water Surface, 0% imp, HSG D
* 0.484	76	Permeable Gravel surface
0.243	89	<50% Grass cover, Poor, HSG D
1.916	83	Weighted Average
1.485		77.51% Pervious Area
0.431		22.49% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.0	214	0.0370	1.77		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA1: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



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Type I 24-hr 100-year Rainfall=7.86"

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Summary for Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.28 cfs @ 9.88 hrs, Volume= 0.026 af, Depth= 5.49"

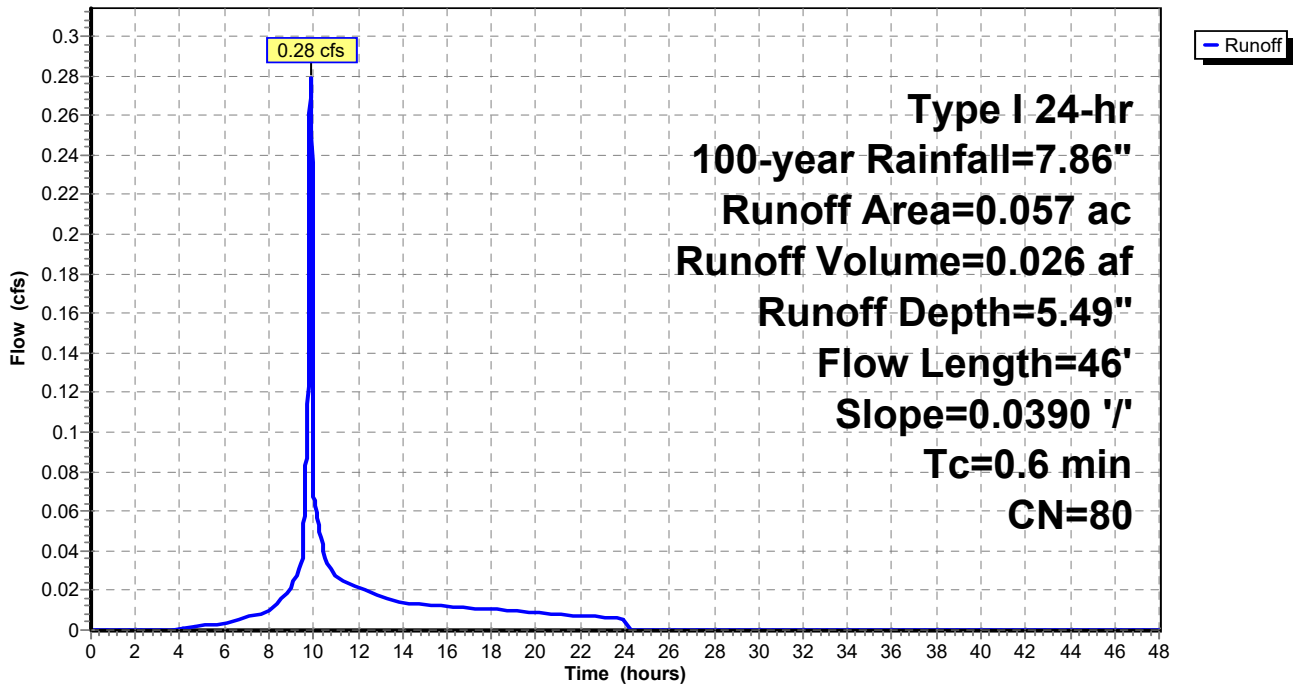
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
 Type I 24-hr 100-year Rainfall=7.86"

Area (ac)	CN	Description
0.021	89	<50% Grass cover, Poor, HSG D
* 0.017	76	Permeable Gravel Roads
* 0.019	75	Landscape
0.057	80	Weighted Average
0.057		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	46	0.0390	1.33		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA2: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph



PostConstructionRunoffn

Prepared by ERM

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Type I 24-hr 100-year Rainfall=7.86"

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Summary for Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Runoff = 0.75 cfs @ 9.87 hrs, Volume= 0.071 af, Depth= 6.55"

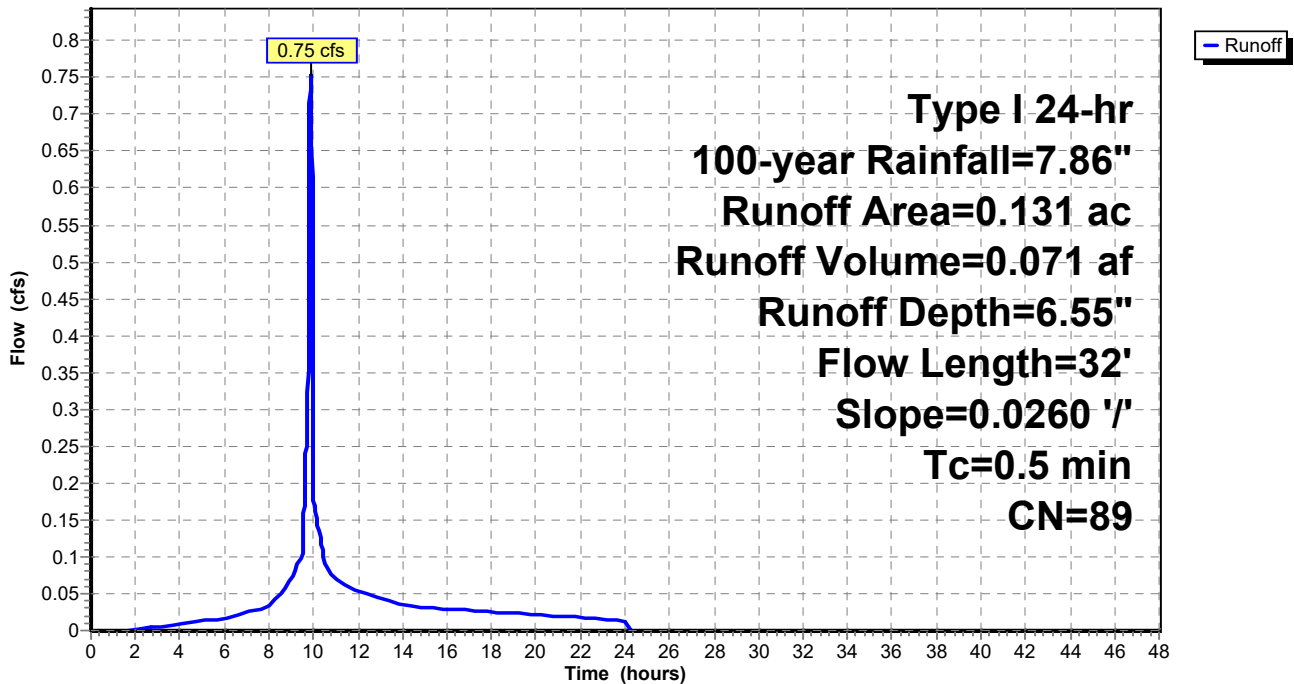
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type I 24-hr 100-year Rainfall=7.86"

Area (ac)	CN	Description
0.131	89	<50% Grass cover, Poor, HSG D
0.131		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	32	0.0260	1.05		Sheet Flow, Flow to Biofiltration Systems Smooth surfaces n= 0.011 P2= 2.40"

Subcatchment DMA3: GREENBARK 30 BATTERY ENERGY_Post Development

Hydrograph





CN Estimation¹

For some conditions, such as a layer of sand over an impervious surface, you may be able to estimate the CN value by using the SCS equation for the potential maximum retention, as listed above:

$$S = \frac{1000}{CN} - 10$$

where S is in inches

If we calculate S as the available voids in the sand, we can estimate the CN value by rearranging the equation as:

$$CN = \frac{1000}{S + 10}$$

where S is in inches

It is assumed that the permeable gravel includes 12 inches of sand with 30% voids and would have a maximum retention of 3 inches, corresponding to a CN value of 73.5.

¹ HydroCAD® Stormwater Modeling



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