Merrill
Engineers and Land Surveyors

May 9, 2022

Stormwater Management Report

Submittal To:

Pembroke Planning Board

The Pembroke Community Center – 128 Center Street
Community Center Redevelopment Project

PEMBROKE COMMUNITY CENTER

Definitive Site Plan

128 Center Street
Pembroke, Massachusetts
May 9, 2022

STORMWATER MANAGEMENT REPORT AND HYDROLOGIC-HYDRAULIC ANALYSIS

Project Summary

The subject property is located on the easterly side of Center Street across from the intersection of Curve Street. The site is located within the Residential A and Pembroke Center Historical Districts and consists of a total of 34.2± acres. The re-development will be concentrated in a 4.6± acre "project area" along Center Street in the easterly or front portion of the parcel where the existing community center building is located. The entirety of the project area is comprised of upland area and is outside of any of the buffer zones associated with the bordering vegetated wetlands (BVW) to the west of the project area.

Currently the project area is developed with an older existing elementary school that has been converted to the Pembroke Community Center. The existing building faces Washington Street (State Route 14) and is set back from the street, behind the Town Green which also contains a gazebo/bandstand. There is an existing driveway that runs through the property from Center Street to the north of the existing building along with a driveway connection from the Pembroke Library driveway to the south of the building. Two baseball fields, basketball courts and two playgrounds are currently located to the east or rear of the building.

The proposed Community Center building will face Center Street and will have a narrower, smaller footprint than the existing structure and will be set in the same general location, behind the Town Green. The site design will include a new parking layout and improved circulation with a drop off area for both the Community Center's after school program as well as the Senior Center. Also proposed are new utility connections, landscaping, a stormwater management system and associated site grading improvements.

Methodology

Drainage computations were performed using the Natural Resources Conservation Services (NRCS) TR-20 method and HydroCAD® Drainage Calculation Software. Sketches of the existing and proposed watershed areas, HydroCAD® Report, and copies of the calculation sheets are included as appendices to this report.

Existing Conditions

From the existing conditions plan and site visits, the project area is relative flat with the building set below the street and somewhat level with the Town Green. Stormwater runoff from the

Town Green area and in front of the Hatch Building flows towards a catch basin within the green itself which directs runoff to a subsurface infiltration system below the green itself. The actual location of the existing system is unknown as no information is available from MassDOT, the Pembroke DPW or any other Town offices due to a fire in the Town hall in the early 1980's. To avoid costly ground penetrating radar survey, the green area has been generally left at the same elevation or slightly higher and the contributing area has been reduced to ensure that the infiltration system will still function as it currently does.

Runoff from the remainder of the project area is directed to either a catch basin in the northeasterly portion of the parking lot that directs runoff to the baseball field or a catch basin to the east of the existing building near the larger playground area which directs runoff to the east of the site. There is an old roof drain system the collects water from downspouts along the front and sides of the building that appears to have been clogged for many years. Downspouts in the rear of the building generally discharge onto the pavement and flow to the drainage system connected to the above referenced catch basin. Site inspections during rain events revealed that all downspouts were over flowing out of the roof drain system onto the ground with the roof runoff flowing overland towards existing catch basins or lower areas on site. The roof drain system appears to likely have been connected to the parking area drainage system that directs runoff to the baseball fields. Unfortunately, with the fire in the Town Hall in the early 1980's, no records remain of any of the construction or subsurface utilities on site.

Much of the existing cover in the project area, outside of the building, would be classified as grass, woods, pavement or landscape areas, in good condition. Soil types were obtained from NRCS mapping and were mapped entirely as HSG B soils in the area where the redevelopment is proposed. Specifically, the soils are listed as map unit symbol 626B, Merrimac - Urban Land Complex, 0 to 8 percent slopes. In order to confirm the soil class and groundwater depth characteristics of these soils, test pits were be performed by Merrill Engineers and Land Surveyors in December of 2021. Soil textures encountered at the time of the testing were entirely loamy sand in the A and B horizons and good permeable sand in the C Layer, which is more consistent with Hydrologic Soil Group A soils. It was also noted that any exposed soil encountered throughout the site is also consistent with a permeable sand. Additionally. the underlying material in the "C" Layer was predominantly found to be an extremely permeable sand which resulted in a percolation rate that defaulted to < 2 min/in, as none of the test holes could be saturated to run an actual percolation test. Based on this information from the on-site soil testing it was determined that the area is characteristic of Hydrologic Soil Group A soils and an exfiltration rate of 8.27in/hr was used in the stormwater infiltration system calculations. There was no sign of mottling or seasonal high ground water in any of the test pits. For the purposes of design, it was assumed that the estimated season high groundwater elevation was consistent with wetlands to the east of the baseball fields (approx. 15'-20' below the field elevation). The wetland flag elevations were unknown but to keep things simple, the elevation of the baseball field was used as a conservative reference.

Ultimately, the runoff from the project area is directed towards the catch basin in the Town Green, the baseball fields or the catch basin near the playground to the rear of the site. These tributary areas are described below:

Watershed Designation		
Existing	*Proposed*	Discharges to
1S	1P	Tributary to Town Green
2S	SUM	Tributary to Baseball Fields
3S	3P	Tributary to CB by Playground

Proposed Conditions/Stormwater Management

Under proposed conditions, the tributary area to the catch basin in the Town Green will be reduced in size and thus the flow to the existing infiltration system will also be reduced. Stormwater runoff from the proposed parking area and driveway will be directed towards a new closed drainage system in the parking area which will route the stormwater to a First Defense FD-3HC Unit which will treat all of the parking and driveway area runoff prior to discharging to the existing catch basin and outfall pipe to the baseball fields. The proposed roof area has been broken out separately and the clean roof (non-metal) runoff will be directed to a subsurface infiltration system in the easterly portion of the parking lot via an HDPE roof drain system which will collect flow from the roof leaders. The infiltration system will capture and infiltrate the runoff from smaller, more frequent storm events (2-yr through 25-yr storms) entirely. Overflow from the 100-yr storm event will be directed via 12" HDPE pipe to the existing catch basin and ultimately to the baseball fields where the flow is currently directed. By removing the roof runoff, and reducing the impervious area directing water towards this tributary area, the peak rates of runoff to this catch basin will be reduced below the existing conditions.

Runoff from the southerly portion of the parking area where existing runoff is directed towards the playground area, will continue to flow in that direction. The impervious area will be greatly reduced in this sub catchment area and thus the peak rates of runoff and volume of runoff will be reduced by more than 50% for all storms. Currently the playground area acts as a qualifying pervious area for some of the parking area while the remainder of this area flows to an existing catch basin along the access road to the baseball field which discharges to an existing 12" pipe located downgradient and an earthen channel which shows signs of past erosion downgradient.

Under proposed conditions, with the reduced pavement area and increased landscape area by the playground, along with the Town's need to keep construction costs down, this area is proposed to be a qualifying pervious area (QPA) for this portion of the parking area. Although the proposed parking lot is technically greater than 75' in length, the existing parking area far exceeds the 75' in length and the existing QPA appears to be functioning well due to the pervious nature of the underlying material. Since this is a redevelopment project for the Town of Pembroke, allowing this area to continue to discharge to the QPA will help the Town take advantage of a Low Impact Development Site Design Credit which will also alleviate much of the erosion in the side of the hill from the existing catch basin due to the decrease in contributing impervious area. Additionally, this approach will assist in keeping the construction costs down while maintaining existing drainage patterns on the site.

Compliance with Stormwater Management Standards

Standard 1 – No New Untreated Discharges

No new stormwater conveyances will discharge untreated pavement runoff into, or cause erosion to downgradient areas. Under existing conditions, the majority of the project area flows either towards an existing catch basin that discharges towards the baseball fields or a catch basin near the existing playground that discharges to an existing earthen channel. The proposed peak rates of runoff and volumes to both of these analysis points will be reduced for all design storms and will be an improvement from the existing conditions. The utilization of a QPA and subsequent reduction in impervious area and contributing to the catch basin by the playground will reduce some of the erosion at the outfall from the catch basin.

Standard 2 – Peak Rate Attenuation

Peak rates of runoff were calculated using the TR-20 methodology developed by the NRCS (refer to Appendices). There will actually be a decrease in runoff rates due to the reduction in overall impervious area proposed within the project area. In order to reduce flows towards the baseball field and provide recharge for the site, the roof runoff will be attenuated by the proposed infiltration system by providing infiltration, storage volume and discharge controls. These measures will both detain and infiltrate runoff, reducing peak rates and volumes of runoff for the 2, 10, 25 and 100-year storms events. See table below for summary of pre and post development runoff rates.

The following is a summary of runoff flow rates for proposed and existing conditions:

RETURN PERIOD	EXISTING CONDITIONS (CFS, CF)			PROPOSED CONDITIONS (CFS, CF)		
	1S TRIB. TO TOWN GREEN	**2S** TRIB. TO BASEBALL FIELDS	**3S** TRIB. TO CB BY PLAY-GROUND	**1P** TRIB. TO TOWN GREEN	**2P** SUM TO BASEBALL FIELDS	**3P** TRIB. TO CB BY PLAY-GROUND
2YR	0.01 (226)	5.92 (18,032)	2.02 (7,059)	0.00 (99)	3.14 (11,072)	0.38 (1,791)
10YR	0.16 (1,542)	10.08 (31,370)	3.55 (12,585)	0.07 (788)	6.78 (22,978)	1.10 (4,396)
25YR	0.60 (3,179)	13.31 (42,099)	4.75 (17,073	0.32 (1,674)	9.85 (33,287)	1.76 (6,815)
100YR	1.93 (7,622)	19.77 (64,127)	7.17 (26,342)	1.09 (4,116)	17.53 (57,372)	3.22 (12,297)

Standard 3 – Groundwater Recharge

Runoff will be infiltrated by the subsurface infiltration system which has been designed a well above the minimum of two feet above seasonal high groundwater. The hydraulic conductivity was based on soil conditions found on the site via soil testing and DEP SMR Table 2.3.3 1982 Rawls Rates - values developed from Rawls, Brakensiek and Saxton, 1982. The total proposed impervious area on the site is reduced from the existing conditions at the site. This is an immediate improvement over the current conditions on the site where there are no structural BMP's which provide infiltration outside of the subsurface infiltration system in the Town Green. In order to provide further improvement, the minimum recharge requirements for the proposed roof area are provided by the proposed infiltration system. The required groundwater recharge volume for the proposed building was calculated to be 923± cubic feet. The proposed infiltration system will provide 3,502± cubic feet of recharge below the outlet, which exceeds the requisite recharge volume for the proposed building. Refer to Appendix B for infiltration system calculations and Appendix C for recharge volume calculations and soil testing results.

As detailed above, no evidence of mottling or groundwater were encountered during soils testing. The estimated seasonal high groundwater elevation is assumed to be below the baseball field elevation (likely 15'-20' below based on BVW). The proposed infiltration system has been set so the bottom is at Elev=69.50 and the baseball field is at approximately Elev=55.0±. Based on this information, the system is well over 4' above the estimated seasonal high groundwater elevation.

Standard 4 – Water Quality

A Long-Term Source Control/Pollution Prevention Plan has been incorporated into the Operation and Maintenance Plan. Refer to Appendix E & F for BMP Operation and Maintenance Plans. The water quality volume was calculated using the 1-inch rule as the site is within an area of rapid infiltration as defined by the Massachusetts Stormwater Handbook. The total required water quality treatment volume was calculated to be 7,091± cubic feet. The infiltration system provides 3,502± c.f. of water quality volume below the outlet and the First Defense Unit provides 5,857± c.f. of water quality volume for a total of 9,359± c.f. of water quality volume. Refer to Appendix C for water quality calculations.

In accordance with the guidelines of the Stormwater Management Policy, the Total Suspended Solids (TSS) Removal was calculated to be 80% or greater for the new treatment trains with the First Defense FD-3HC Unit of the Qualifying Pervious Area (QPA). The tributary area to the subsurface infiltration system is comprised entirely or roof area which is considered clean (non-metal) and as such, meets the pretreatment requirement of 44% TSS removal prior to the infiltration system in areas of rapid infiltration. TSS removal calculations are included in Appendix C.

Standard 5 – Land Use with Higher Potential Pollutants Loads (LUHPPL)

The proposed project is not considered a LUHPPL. Not Applicable.

Standard 6 – Critical Areas

The proposed project does not discharge to any critical areas. Not Applicable.

Standard 7 – Redevelopment and Other Projects Subject to the Standards only to the maximum extent practicable

The project site is currently developed and as such the project would be considered a "Re-Development" project, consisting of the razing of the existing Community Center and removing the existing driveway and parking areas. The proposed project includes the construction of a new 18,450± s.f. Community Center Building along with a new parking area, access driveway, landscaping along with associated site grading and utility connections. For the purpose of stormwater design, the project will provide the requisite recharge volume for the new building area and provide the required water quality volume and TSS removal which exceeds the minimum 80% removal rate required for new construction for the entire site.

Standard 8 – Construction Period Pollutions Prevention and Erosion and Sedimentation Control

Silt socks will be placed at the limit of work as erosion control barriers prior to commencement of any construction activity. A Construction Operation and Maintenance Plan and Construction Pollution Prevention Plan have been provided. Refer to the construction detail plan for erosion control details and the BMP Operation and Maintenance Plans in Appendix E.

Standard 9 – Operation and Maintenance Plan

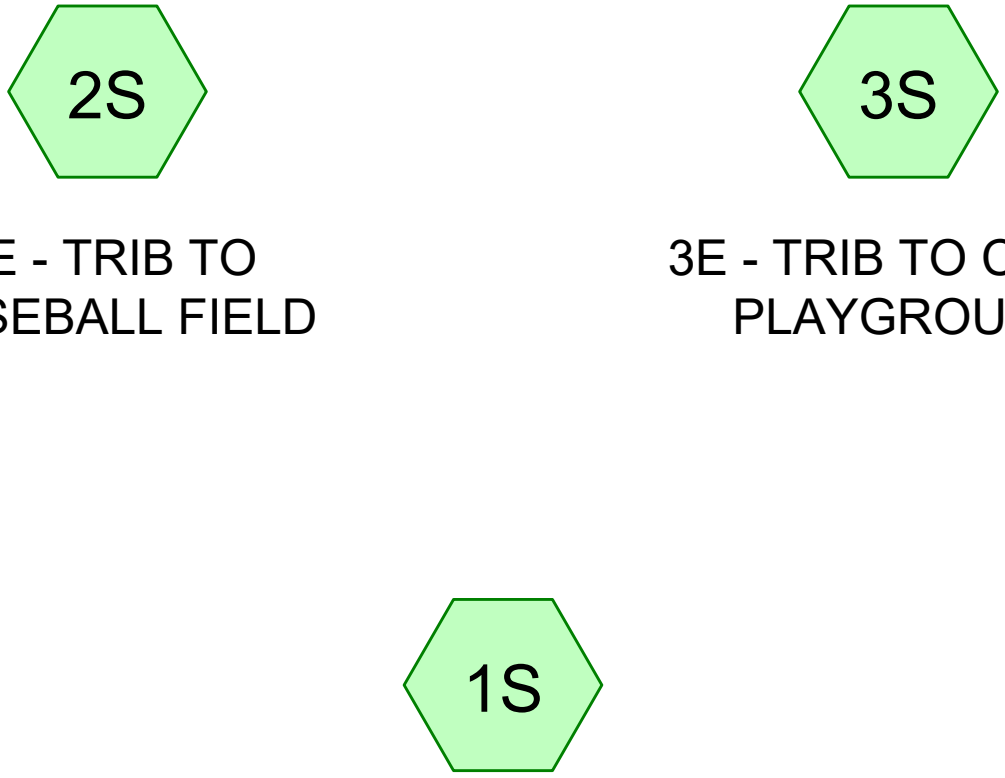
The Long-Term Source Control/Pollution Prevention Plan and Operation and Maintenance Plan is also provided within Appendix F.

Standard 10 – Prohibition of Illicit Discharges

No illicit discharges are anticipated on site. Measures to prevent illicit discharges will be included in the Long-Term Source Control/Pollution Prevention Plan.

APPENDIX A

Existing Conditions
2 (3.35”), 10 (4.95”), 25 (6.19”) and 100 (8.68”) year return storms



Subcat Reach Pond Link

Routing Diagram for 17-199.2 EWS_HSG A

Prepared by MERRILL ENGINEERS AND LAND SURVEYORS, Printed 5/6/2022

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
72,592	39	>75% Grass cover, Good, HSG A (1S, 2S, 3S)
127,716	98	Paved parking, HSG B (1S, 2S, 3S)
200,308	**77**	**TOTAL AREA**

Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB Runoff Area=43,418 sf 9.73% Impervious Runoff Depth=0.06"
Flow Length=347' Tc=11.3 min CN=45 Runoff=0.01 cfs 226 cf

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD Runoff Area=110,058 sf 79.70% Impervious Runoff Depth=1.97"
Flow Length=367' Tc=6.9 min CN=86 Runoff=5.92 cfs 18,032 cf

Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND Runoff Area=46,832 sf 76.38% Impervious Runoff Depth=1.81"
Flow Length=297' Tc=10.6 min CN=84 Runoff=2.02 cfs 7,059 cf

Total Runoff Area = 200,308 sf Runoff Volume = 25,317 cf Average Runoff Depth = 1.52"
36.24% Pervious = 72,592 sf 63.76% Impervious = 127,716 sf

Summary for Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB

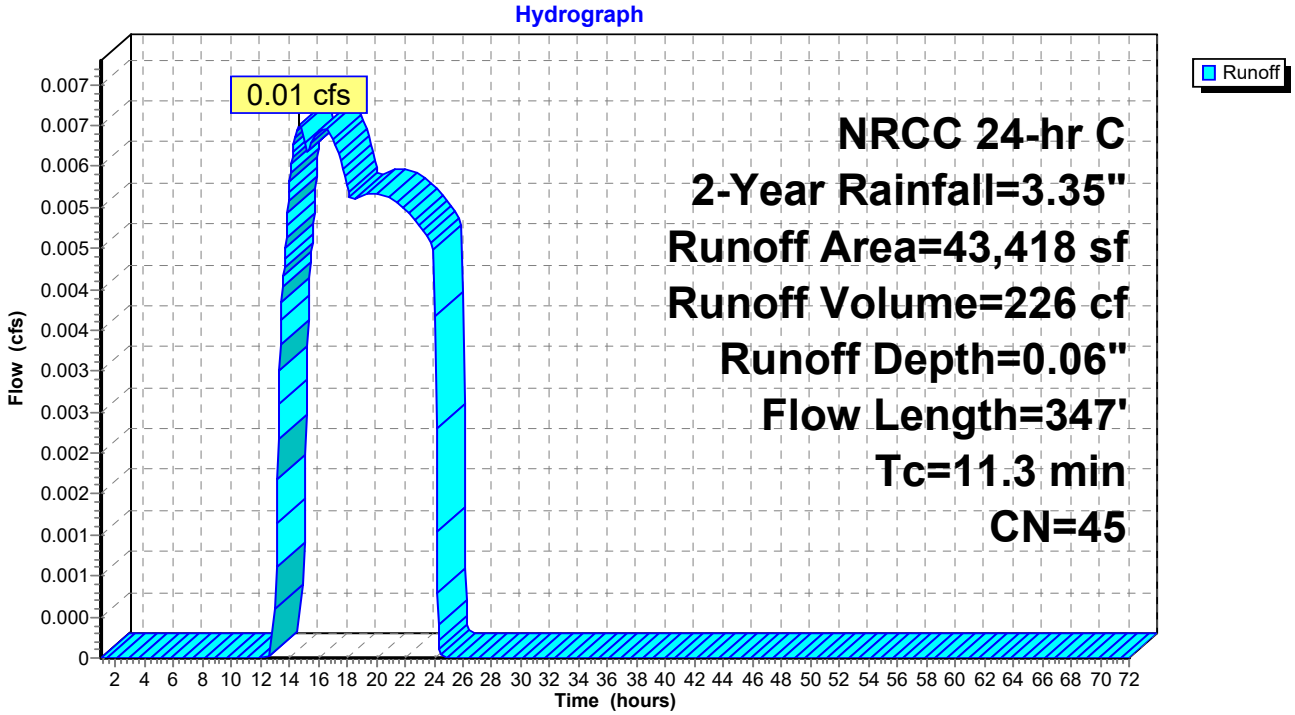
Runoff = 0.01 cfs @ 14.70 hrs, Volume= 226 cf, Depth= 0.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
4,225	98	Paved parking, HSG B
39,193	39	>75% Grass cover, Good, HSG A
43,418	45	Weighted Average
39,193		90.27% Pervious Area
4,225		9.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, lawn** Grass: Dense n= 0.240 P2= 3.16"
1.5	210	0.0200	2.28		**Shallow Concentrated Flow, lawn** Unpaved Kv= 16.1 fps
1.6	87	0.0030	0.88		**Shallow Concentrated Flow, Courts** Unpaved Kv= 16.1 fps
11.3	347	Total			

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB



Summary for Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD

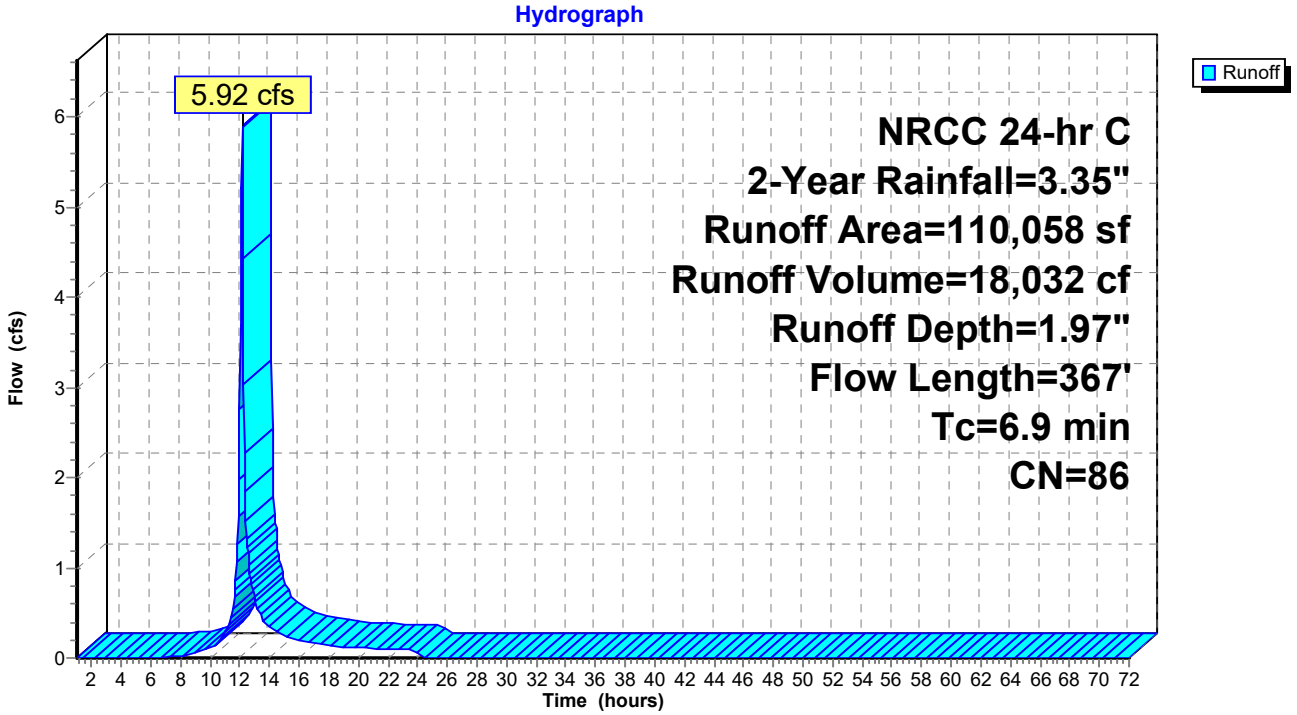
Runoff = 5.92 cfs @ 12.14 hrs, Volume= 18,032 cf, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
87,720	98	Paved parking, HSG B
22,338	39	>75% Grass cover, Good, HSG A
110,058	86	Weighted Average
22,338		20.30% Pervious Area
87,720		79.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0560	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.5	110	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	207	0.0367	3.89		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
6.9	367	Total			

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD



Summary for Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND

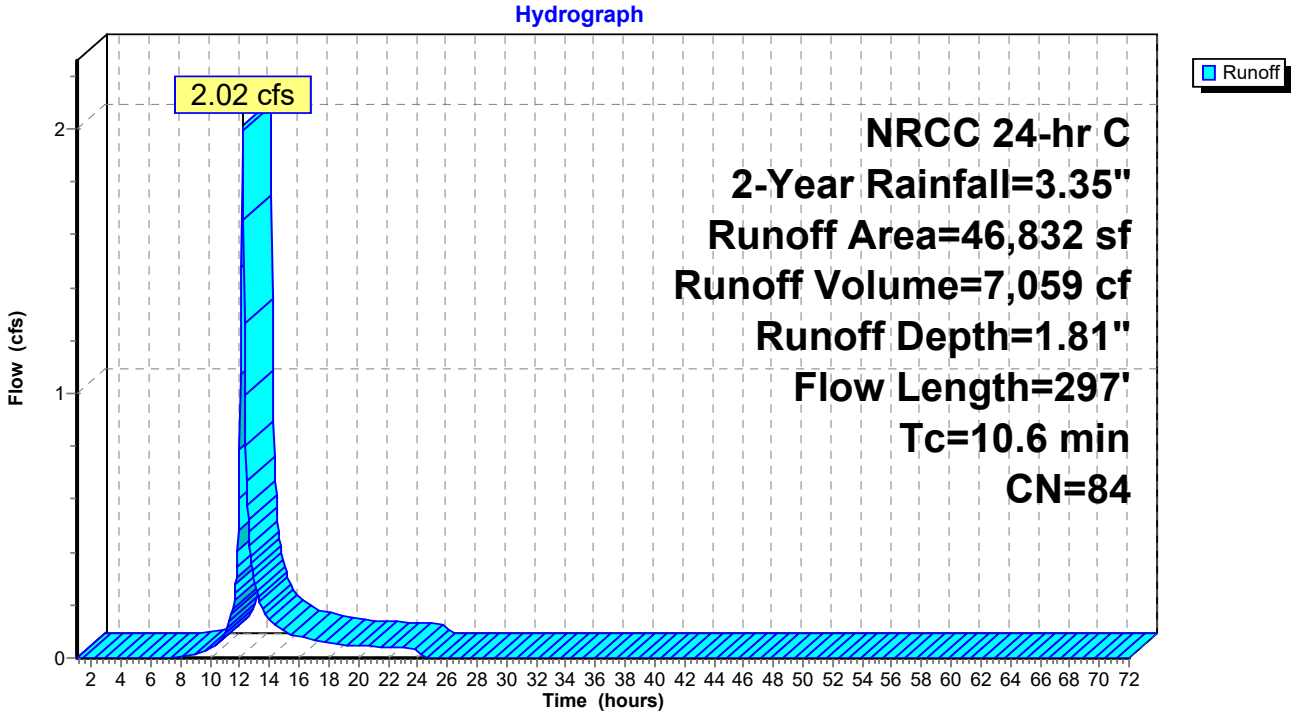
Runoff = 2.02 cfs @ 12.18 hrs, Volume= 7,059 cf, Depth= 1.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
35,771	98	Paved parking, HSG B
11,061	39	>75% Grass cover, Good, HSG A
46,832	84	Weighted Average
11,061		23.62% Pervious Area
35,771		76.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.2	30	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	217	0.0264	3.30		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	297	Total			

Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND



Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB Runoff Area=43,418 sf 9.73% Impervious Runoff Depth=0.43"
Flow Length=347' Tc=11.3 min CN=45 Runoff=0.16 cfs 1,542 cf

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD Runoff Area=110,058 sf 79.70% Impervious Runoff Depth=3.42"
Flow Length=367' Tc=6.9 min CN=86 Runoff=10.08 cfs 31,370 cf

Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND Runoff Area=46,832 sf 76.38% Impervious Runoff Depth=3.22"
Flow Length=297' Tc=10.6 min CN=84 Runoff=3.55 cfs 12,585 cf

Total Runoff Area = 200,308 sf Runoff Volume = 45,497 cf Average Runoff Depth = 2.73"
36.24% Pervious = 72,592 sf 63.76% Impervious = 127,716 sf

Summary for Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB

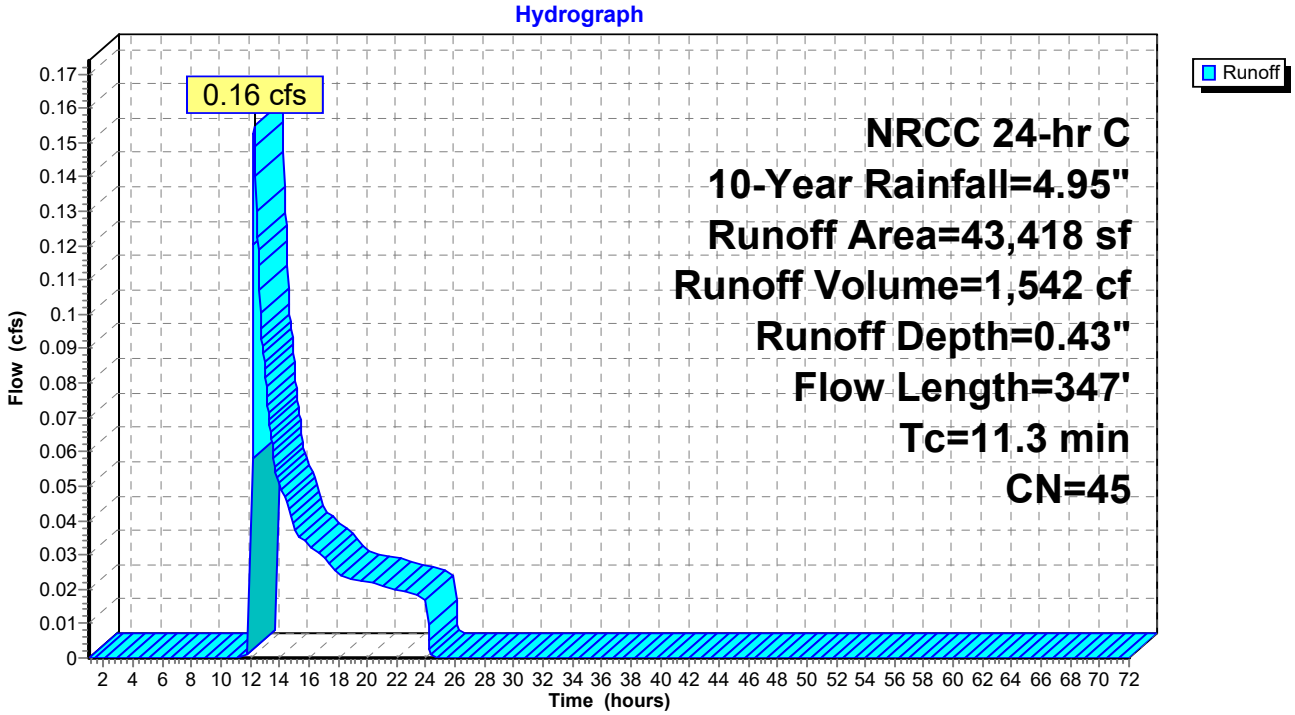
Runoff = 0.16 cfs @ 12.29 hrs, Volume= 1,542 cf, Depth= 0.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
4,225	98	Paved parking, HSG B
39,193	39	>75% Grass cover, Good, HSG A
43,418	45	Weighted Average
39,193		90.27% Pervious Area
4,225		9.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, lawn** Grass: Dense n= 0.240 P2= 3.16"
1.5	210	0.0200	2.28		**Shallow Concentrated Flow, lawn** Unpaved Kv= 16.1 fps
1.6	87	0.0030	0.88		**Shallow Concentrated Flow, Courts** Unpaved Kv= 16.1 fps
11.3	347	Total			

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB



Summary for Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD

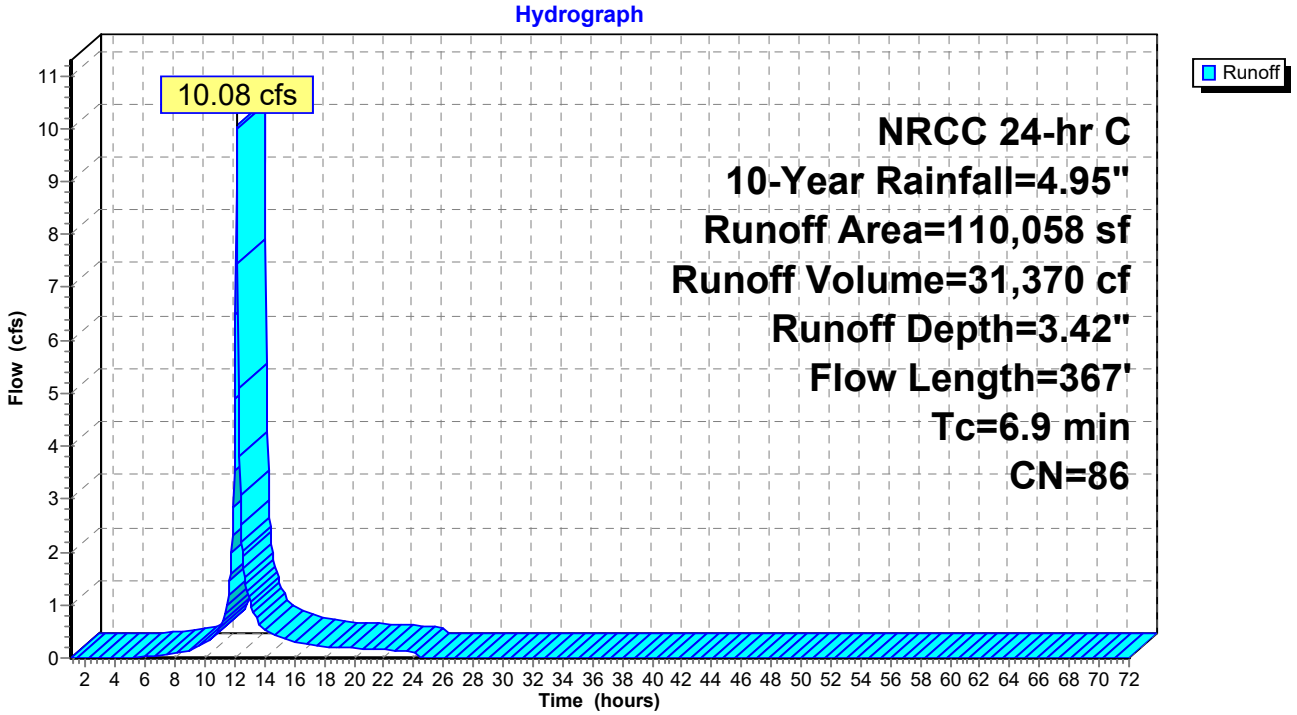
Runoff = 10.08 cfs @ 12.14 hrs, Volume= 31,370 cf, Depth= 3.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
87,720	98	Paved parking, HSG B
22,338	39	>75% Grass cover, Good, HSG A
110,058	86	Weighted Average
22,338		20.30% Pervious Area
87,720		79.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0560	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.5	110	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	207	0.0367	3.89		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
6.9	367	Total			

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD



Summary for Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND

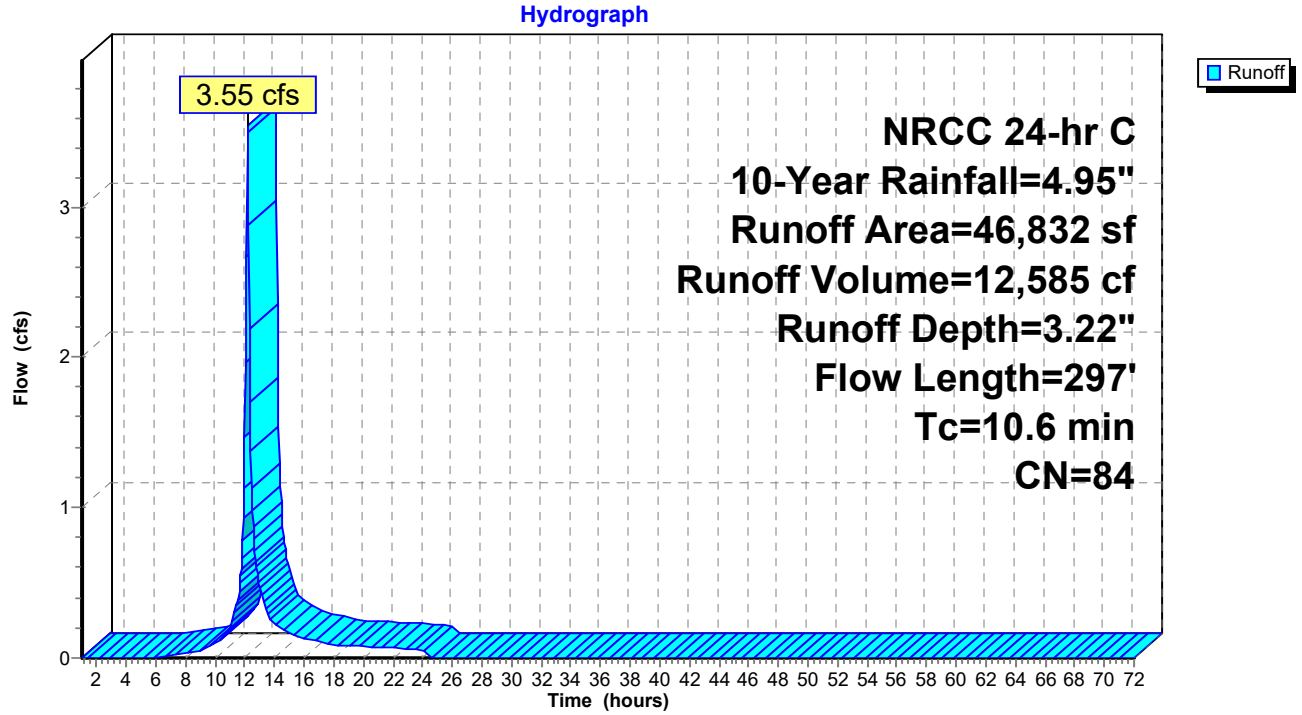
Runoff = 3.55 cfs @ 12.18 hrs, Volume= 12,585 cf, Depth= 3.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
35,771	98	Paved parking, HSG B
11,061	39	>75% Grass cover, Good, HSG A
46,832	84	Weighted Average
11,061		23.62% Pervious Area
35,771		76.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.2	30	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	217	0.0264	3.30		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	297	Total			

Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND



Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB Runoff Area=43,418 sf 9.73% Impervious Runoff Depth=0.88"
Flow Length=347' Tc=11.3 min CN=45 Runoff=0.60 cfs 3,179 cf

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD Runoff Area=110,058 sf 79.70% Impervious Runoff Depth=4.59"
Flow Length=367' Tc=6.9 min CN=86 Runoff=13.31 cfs 42,099 cf

Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND Runoff Area=46,832 sf 76.38% Impervious Runoff Depth=4.37"
Flow Length=297' Tc=10.6 min CN=84 Runoff=4.75 cfs 17,073 cf

Total Runoff Area = 200,308 sf Runoff Volume = 62,351 cf Average Runoff Depth = 3.74"
36.24% Pervious = 72,592 sf 63.76% Impervious = 127,716 sf

Summary for Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB

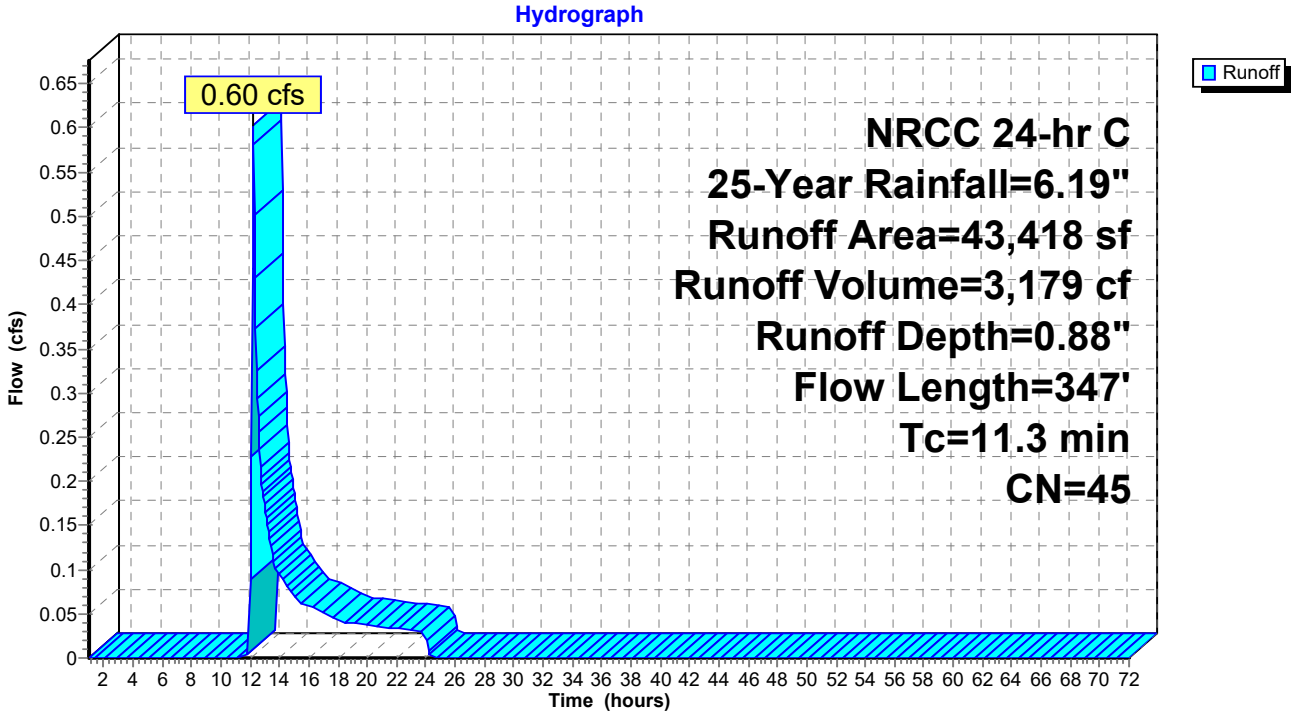
Runoff = 0.60 cfs @ 12.22 hrs, Volume= 3,179 cf, Depth= 0.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
4,225	98	Paved parking, HSG B
39,193	39	>75% Grass cover, Good, HSG A
43,418	45	Weighted Average
39,193		90.27% Pervious Area
4,225		9.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, lawn** Grass: Dense n= 0.240 P2= 3.16"
1.5	210	0.0200	2.28		**Shallow Concentrated Flow, lawn** Unpaved Kv= 16.1 fps
1.6	87	0.0030	0.88		**Shallow Concentrated Flow, Courts** Unpaved Kv= 16.1 fps
11.3	347	Total			

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB



Summary for Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD

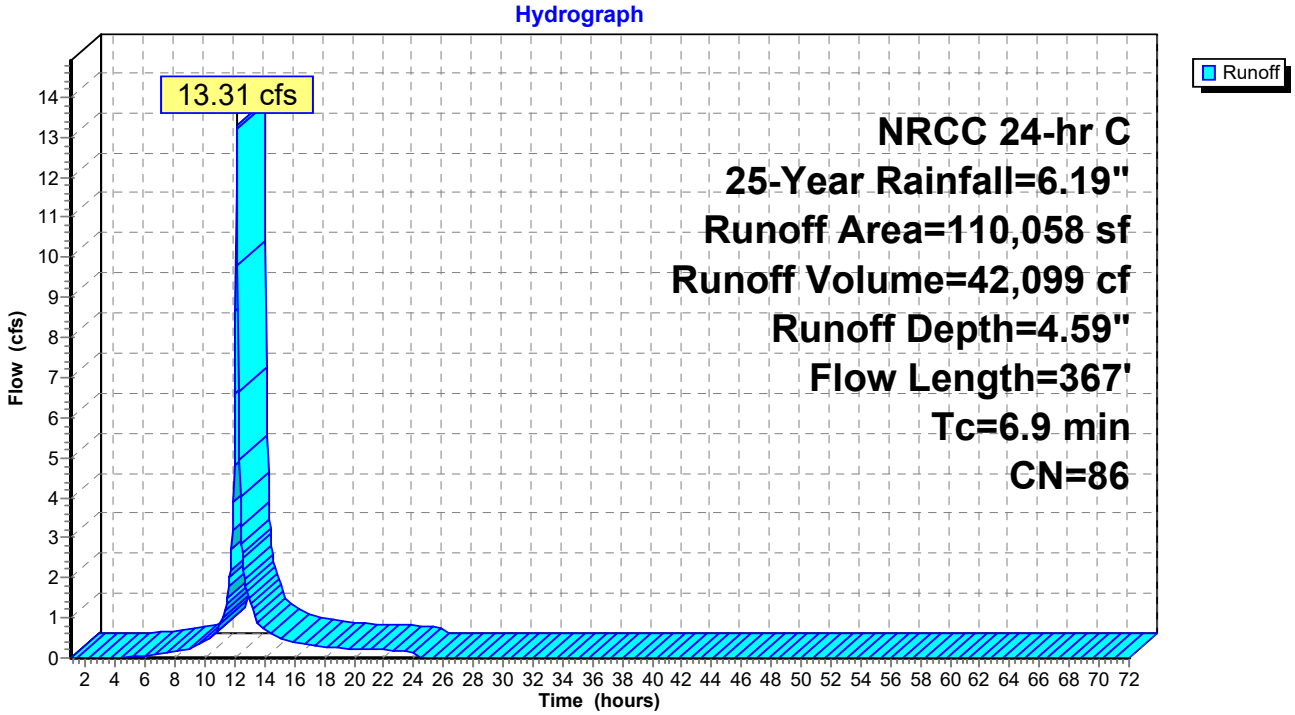
Runoff = 13.31 cfs @ 12.14 hrs, Volume= 42,099 cf, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
87,720	98	Paved parking, HSG B
22,338	39	>75% Grass cover, Good, HSG A
110,058	86	Weighted Average
22,338		20.30% Pervious Area
87,720		79.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0560	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.5	110	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	207	0.0367	3.89		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
6.9	367	Total			

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD



Summary for Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND

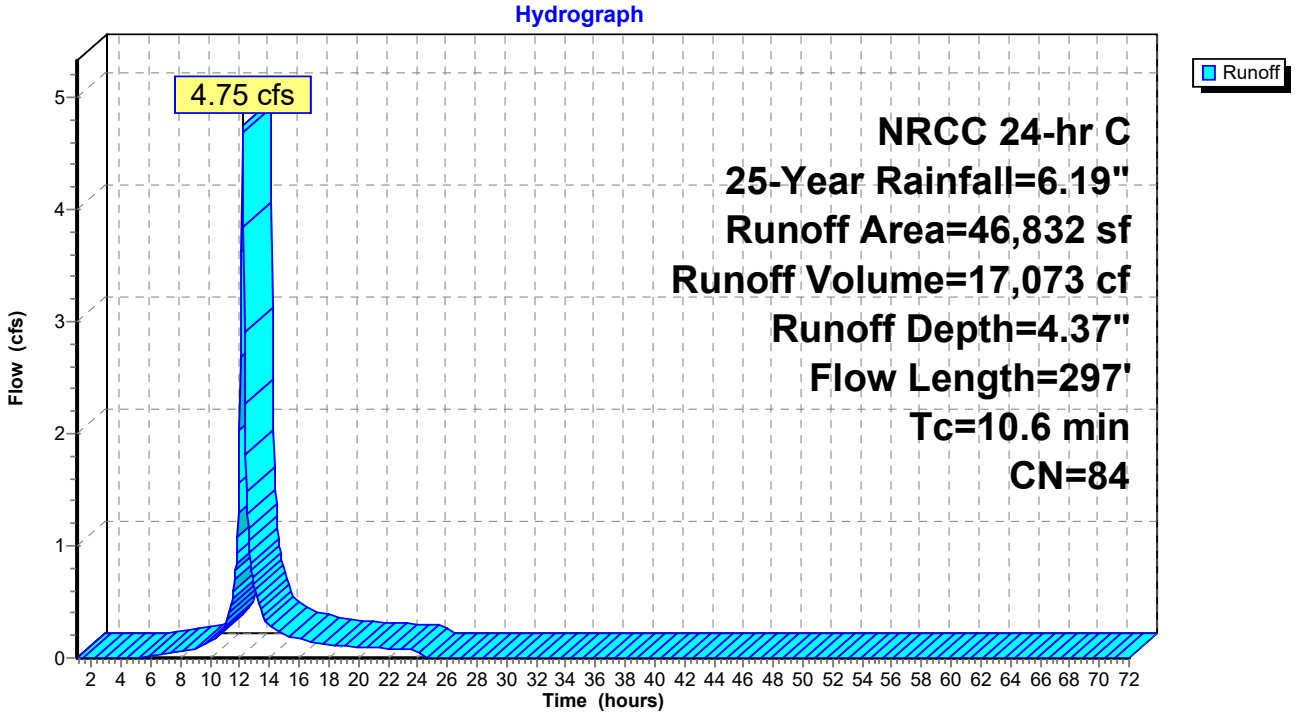
Runoff = 4.75 cfs @ 12.18 hrs, Volume= 17,073 cf, Depth= 4.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
35,771	98	Paved parking, HSG B
11,061	39	>75% Grass cover, Good, HSG A
46,832	84	Weighted Average
11,061		23.62% Pervious Area
35,771		76.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.2	30	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	217	0.0264	3.30		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	297	Total			

Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND



Time span=1.00-72.00 hrs, dt=0.05 hrs, 1421 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB Runoff Area=43,418 sf 9.73% Impervious Runoff Depth=2.11"
Flow Length=347' Tc=11.3 min CN=45 Runoff=1.93 cfs 7,622 cf

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD Runoff Area=110,058 sf 79.70% Impervious Runoff Depth=6.99"
Flow Length=367' Tc=6.9 min CN=86 Runoff=19.77 cfs 64,127 cf

Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND Runoff Area=46,832 sf 76.38% Impervious Runoff Depth=6.75"
Flow Length=297' Tc=10.6 min CN=84 Runoff=7.17 cfs 26,342 cf

Total Runoff Area = 200,308 sf Runoff Volume = 98,091 cf Average Runoff Depth = 5.88"
36.24% Pervious = 72,592 sf 63.76% Impervious = 127,716 sf

Summary for Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB

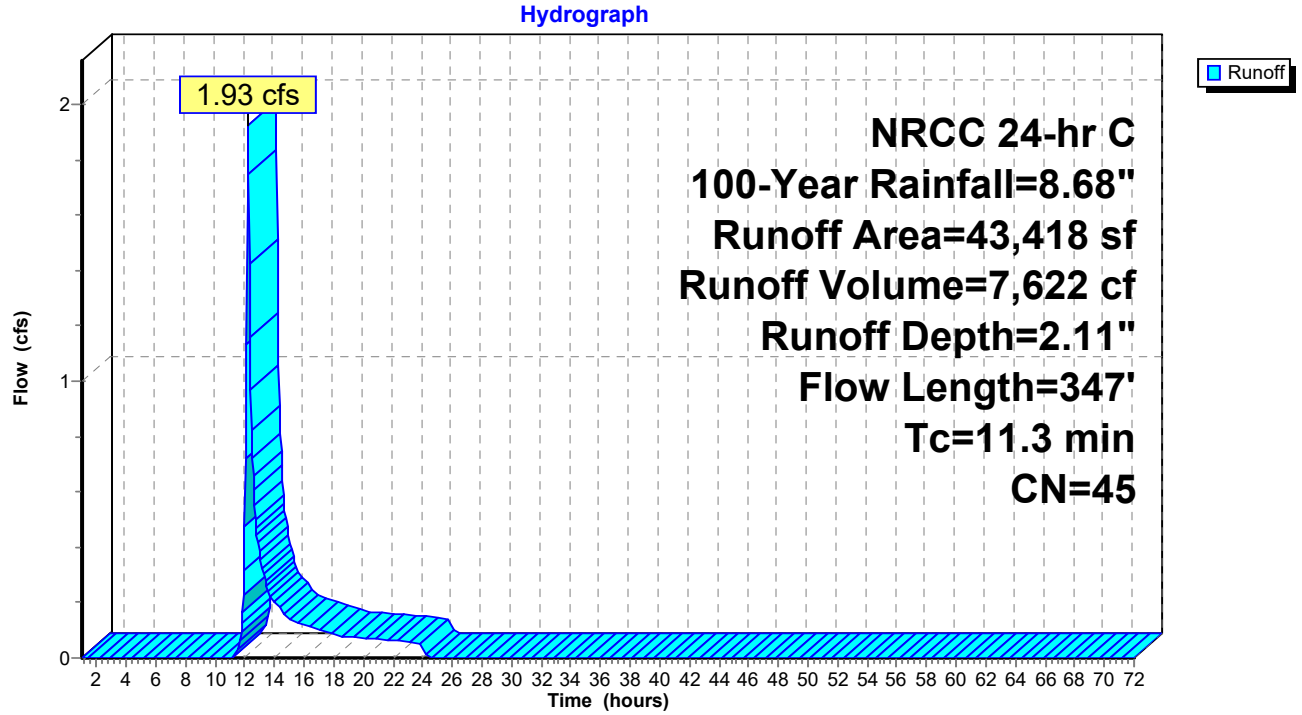
Runoff = 1.93 cfs @ 12.21 hrs, Volume= 7,622 cf, Depth= 2.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
4,225	98	Paved parking, HSG B
39,193	39	>75% Grass cover, Good, HSG A
43,418	45	Weighted Average
39,193		90.27% Pervious Area
4,225		9.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.2	50	0.0200	0.10		**Sheet Flow, lawn** Grass: Dense n= 0.240 P2= 3.16"
1.5	210	0.0200	2.28		**Shallow Concentrated Flow, lawn** Unpaved Kv= 16.1 fps
1.6	87	0.0030	0.88		**Shallow Concentrated Flow, Courts** Unpaved Kv= 16.1 fps
11.3	347	Total			

Subcatchment 1S: 1E - TRIB TO TOWN GREEN CB



Summary for Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD

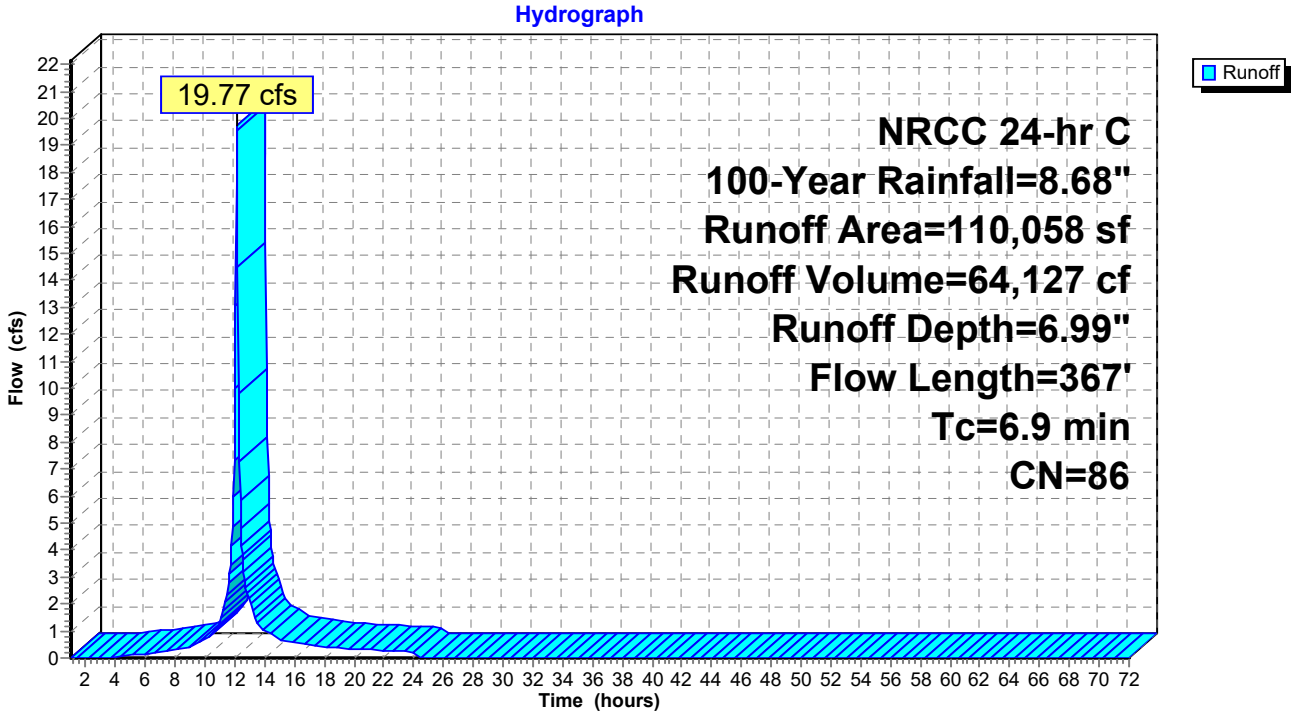
Runoff = 19.77 cfs @ 12.14 hrs, Volume= 64,127 cf, Depth= 6.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
87,720	98	Paved parking, HSG B
22,338	39	>75% Grass cover, Good, HSG A
110,058	86	Weighted Average
22,338		20.30% Pervious Area
87,720		79.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.5	50	0.0560	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.5	110	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	207	0.0367	3.89		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
6.9	367	Total			

Subcatchment 2S: 2E - TRIB TO BASEBALL FIELD



Summary for Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND

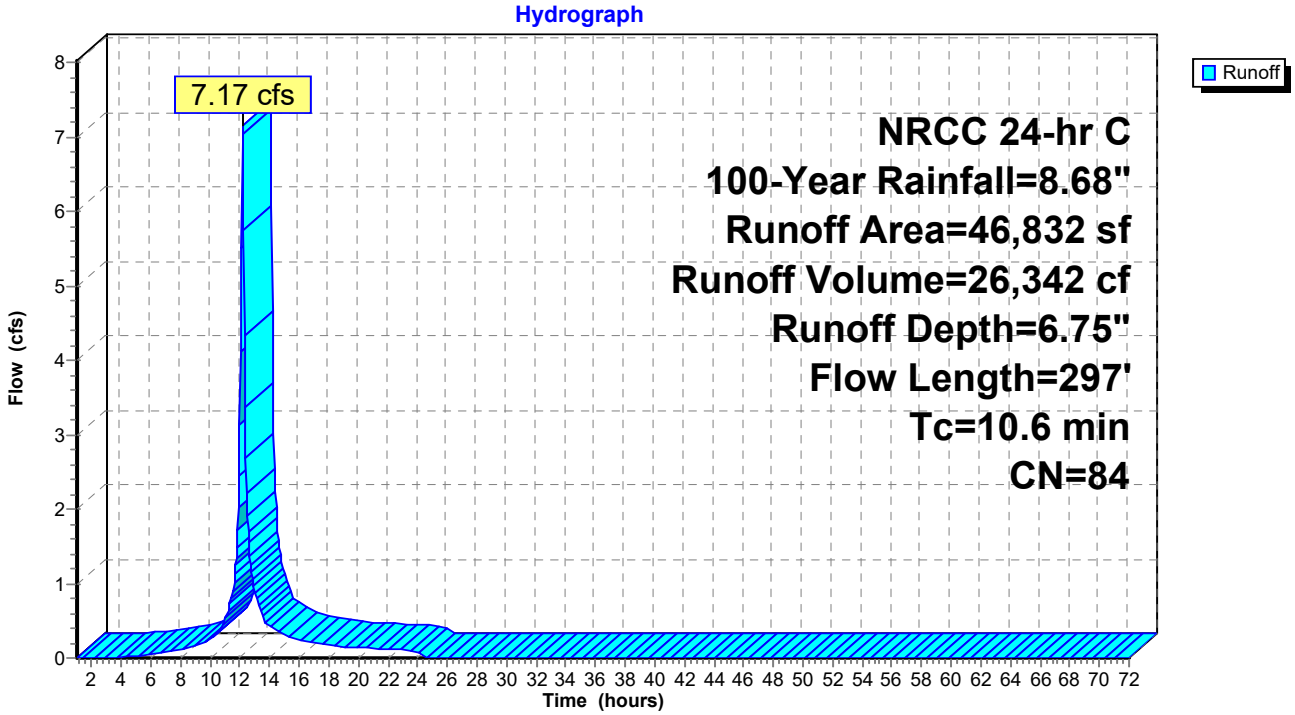
Runoff = 7.17 cfs @ 12.18 hrs, Volume= 26,342 cf, Depth= 6.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-72.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
35,771	98	Paved parking, HSG B
11,061	39	>75% Grass cover, Good, HSG A
46,832	84	Weighted Average
11,061		23.62% Pervious Area
35,771		76.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.16"
0.2	30	0.0230	2.44		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.1	217	0.0264	3.30		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
10.6	297	Total			

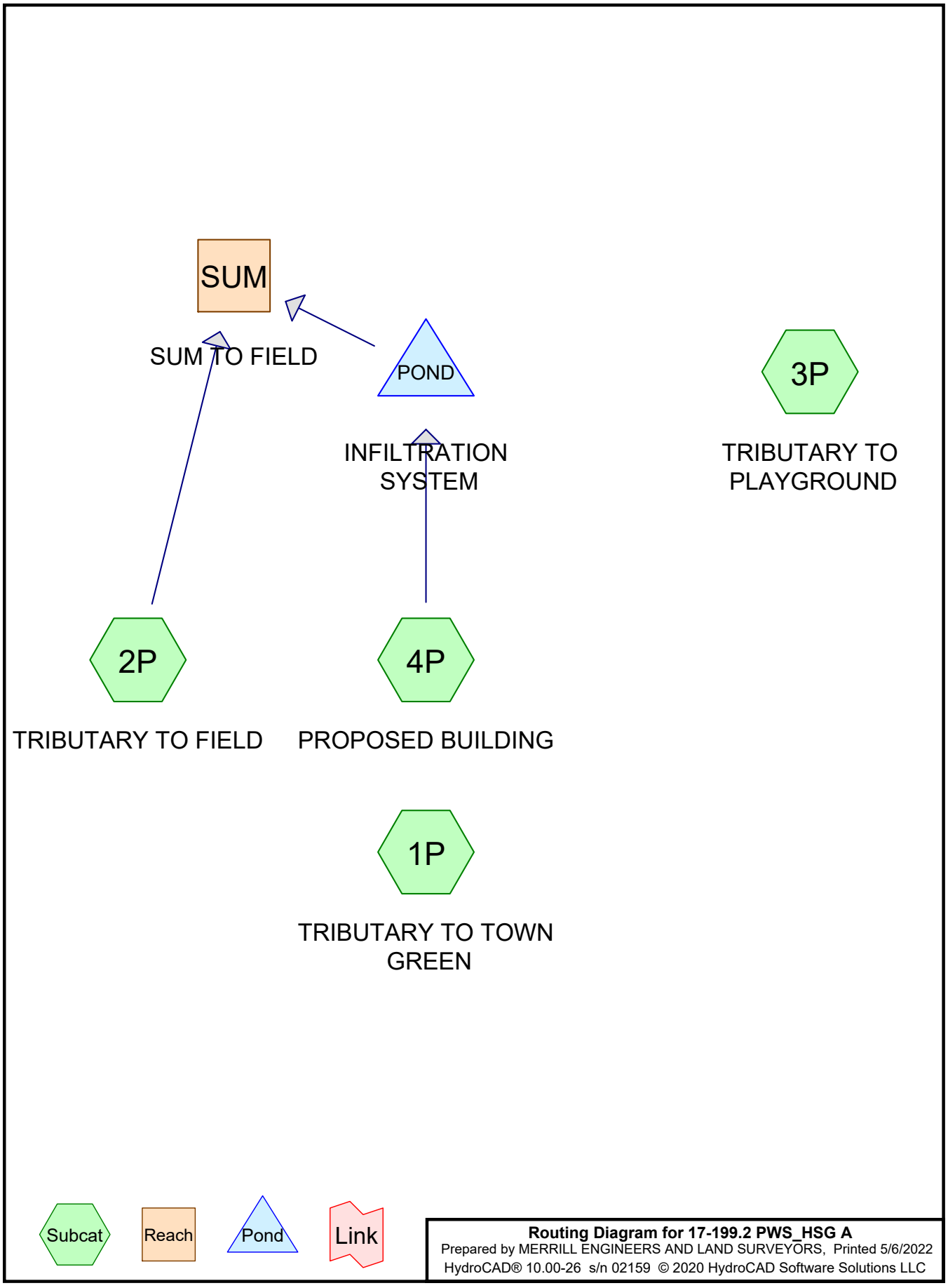
Subcatchment 3S: 3E - TRIB TO CB BY PLAYGROUND



APPENDIX B

Proposed Conditions

2 (3.35”), 10 (4.95”), 25 (6.19”) and 100 (8.68”) year return storms



Routing Diagram for 17-199.2 PWS_HSG A

Prepared by MERRILL ENGINEERS AND LAND SURVEYORS, Printed 5/6/2022

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
95,080	39	>75% Grass cover, Good, HSG A (1P, 2P, 3P)
86,778	98	Paved parking, HSG B (1P, 2P, 3P)
18,450	98	Unconnected roofs, HSG A (4P)
200,308	**70**	**TOTAL AREA**

Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1P: TRIBUTARY TO TOWN GREEN Runoff Area=24,758 sf 8.42% Impervious Runoff Depth=0.05"
Flow Length=212' Tc=9.1 min CN=44 Runoff=0.00 cfs 99 cf

Subcatchment 2P: TRIBUTARY TO FIELD Runoff Area=123,025 sf 57.13% Impervious Runoff Depth=1.08"
Flow Length=436' Tc=9.6 min CN=73 Runoff=3.14 cfs 11,072 cf

Subcatchment 3P: TRIBUTARY TO PLAYGROUND Runoff Area=34,075 sf 42.28% Impervious Runoff Depth=0.63"
Flow Length=567' Tc=13.4 min CN=64 Runoff=0.38 cfs 1,791 cf

Subcatchment 4P: PROPOSED BUILDING Runoff Area=18,450 sf 100.00% Impervious Runoff Depth=3.12"
Tc=6.0 min CN=98 Runoff=1.40 cfs 4,792 cf

Reach SUM: SUM TO FIELD Inflow=3.14 cfs 11,072 cf
Outflow=3.14 cfs 11,072 cf

Pond POND: INFILTRATION SYSTEM Peak Elev=72.65' Storage=1,232 cf Inflow=1.40 cfs 4,792 cf
Discarded=0.19 cfs 4,791 cf Primary=0.00 cfs 0 cf Outflow=0.19 cfs 4,791 cf

Total Runoff Area = 200,308 sf Runoff Volume = 17,754 cf Average Runoff Depth = 1.06"
47.47% Pervious = 95,080 sf 52.53% Impervious = 105,228 sf

Summary for Subcatchment 1P: TRIBUTARY TO TOWN GREEN

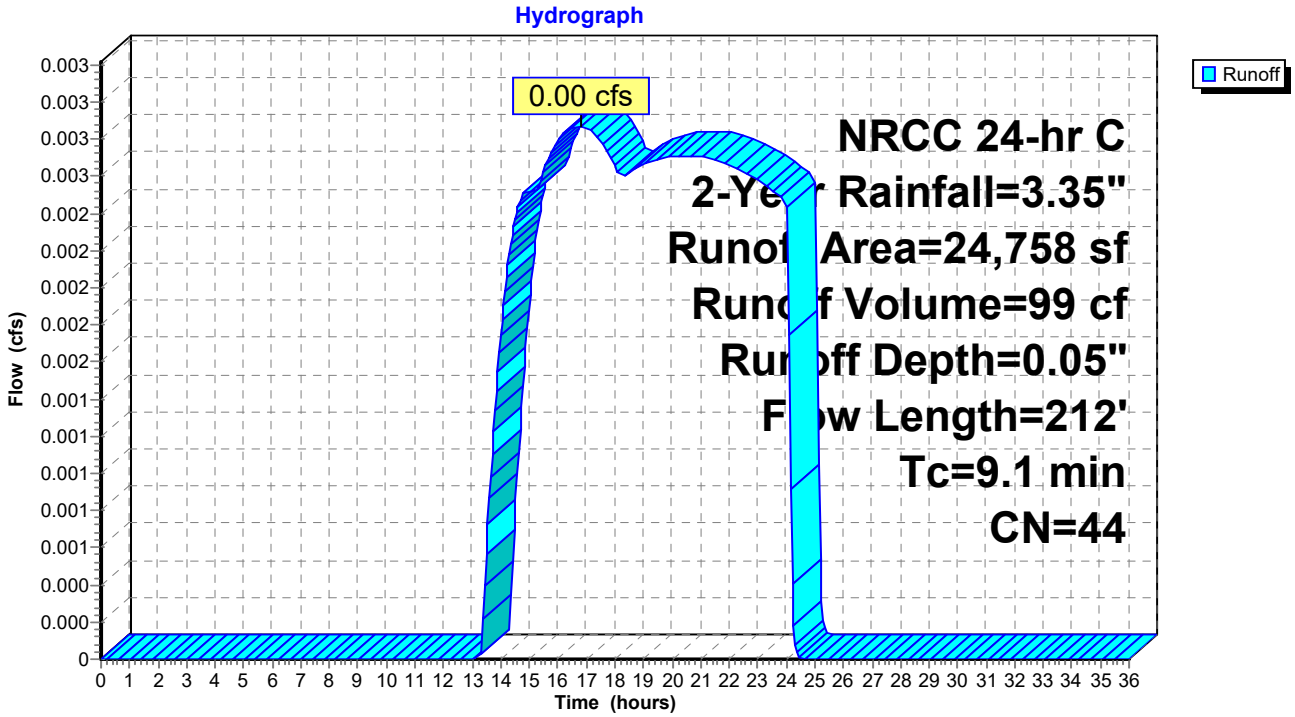
Runoff = 0.00 cfs @ 16.83 hrs, Volume= 99 cf, Depth= 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
2,084	98	Paved parking, HSG B
22,674	39	>75% Grass cover, Good, HSG A
24,758	44	Weighted Average
22,674		91.58% Pervious Area
2,084		8.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
1.1	162	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	212	Total			

Subcatchment 1P: TRIBUTARY TO TOWN GREEN



Summary for Subcatchment 2P: TRIBUTARY TO FIELD

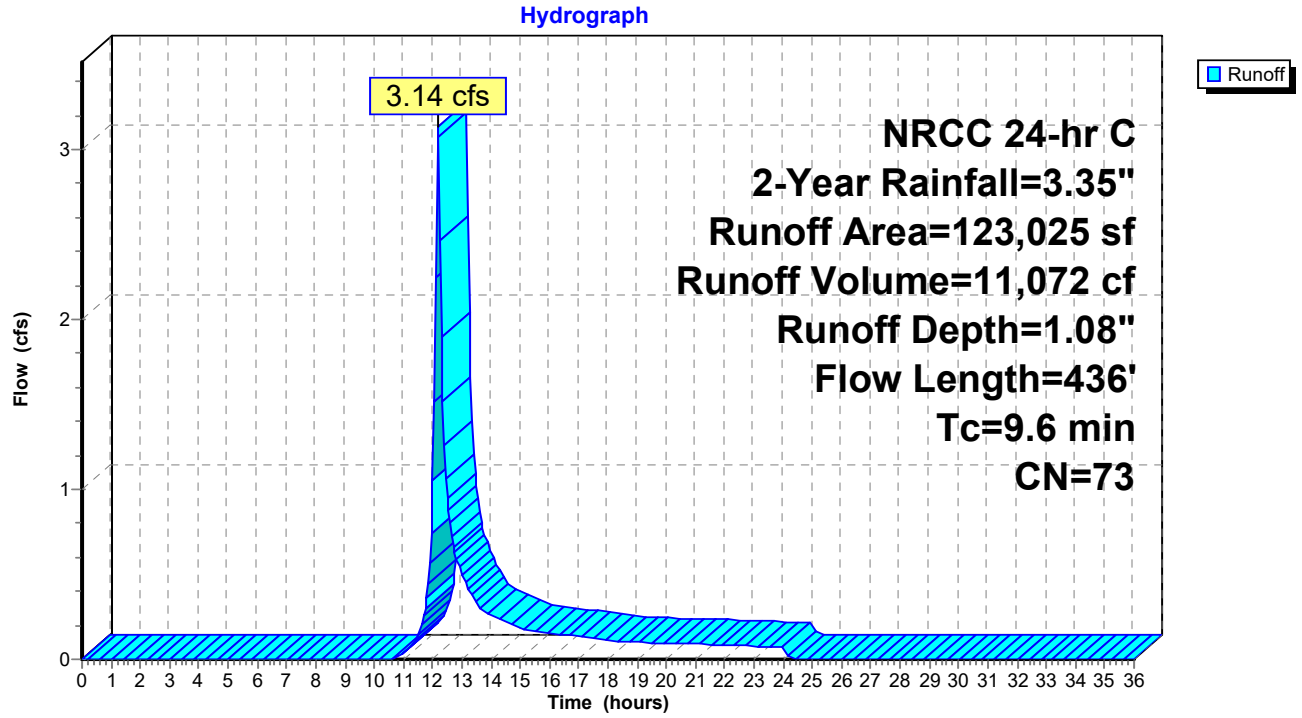
Runoff = 3.14 cfs @ 12.18 hrs, Volume= 11,072 cf, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
70,287	98	Paved parking, HSG B
52,738	39	>75% Grass cover, Good, HSG A
123,025	73	Weighted Average
52,738		42.87% Pervious Area
70,287		57.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	21	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	275	0.0160	5.74	4.51	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
9.6	436	Total			

Subcatchment 2P: TRIBUTARY TO FIELD



Summary for Subcatchment 3P: TRIBUTARY TO PLAYGROUND

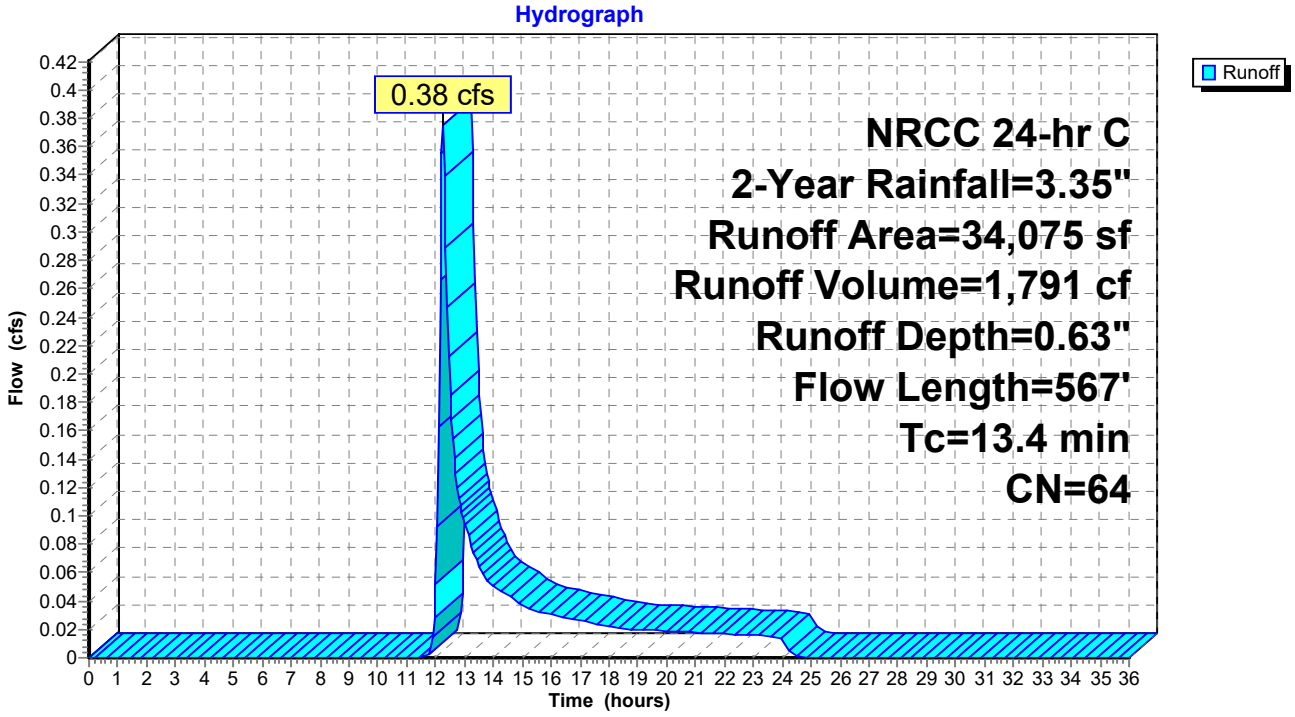
Runoff = 0.38 cfs @ 12.24 hrs, Volume= 1,791 cf, Depth= 0.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
14,407	98	Paved parking, HSG B
19,668	39	>75% Grass cover, Good, HSG A
34,075	64	Weighted Average
19,668		57.72% Pervious Area
14,407		42.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.4	47	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	408	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.3	62	0.0530	3.71		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.4	567	Total			

Subcatchment 3P: TRIBUTARY TO PLAYGROUND



Summary for Subcatchment 4P: PROPOSED BUILDING

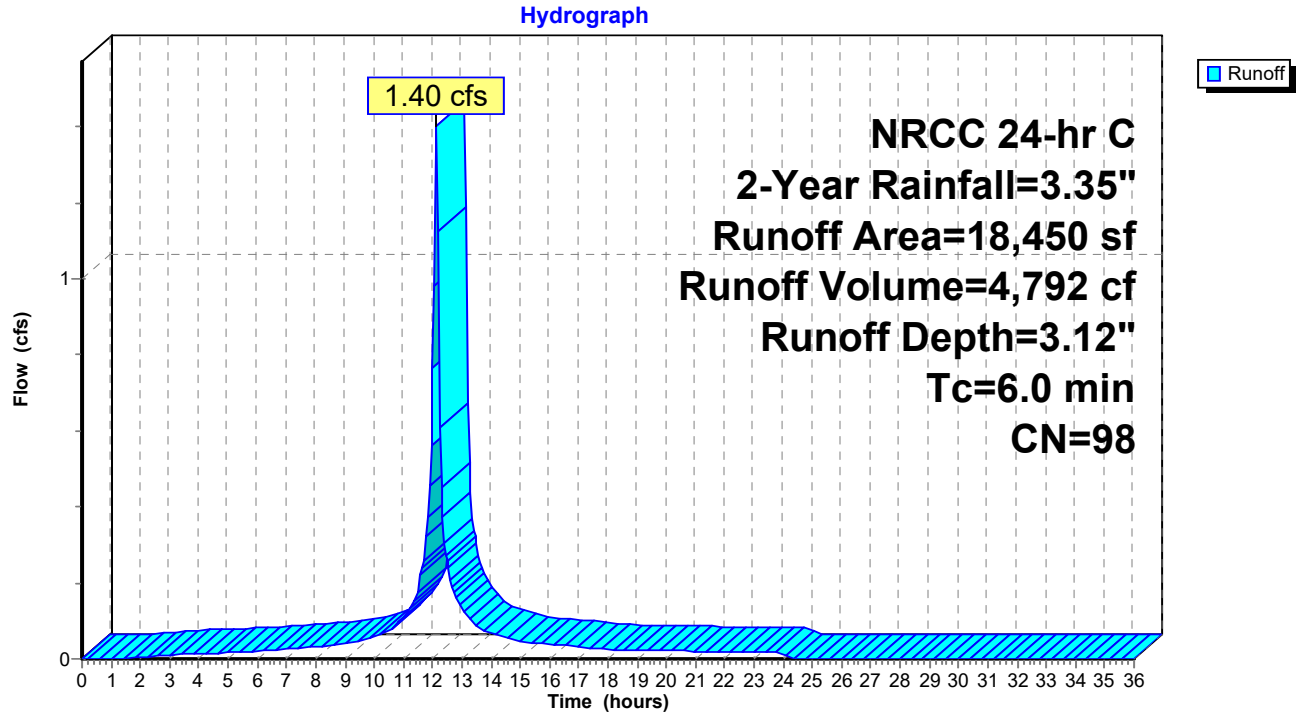
Runoff = 1.40 cfs @ 12.13 hrs, Volume= 4,792 cf, Depth= 3.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 2-Year Rainfall=3.35"

Area (sf)	CN	Description
18,450	98	Unconnected roofs, HSG A
18,450		100.00% Impervious Area
18,450		100.00% Unconnected

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

Subcatchment 4P: PROPOSED BUILDING

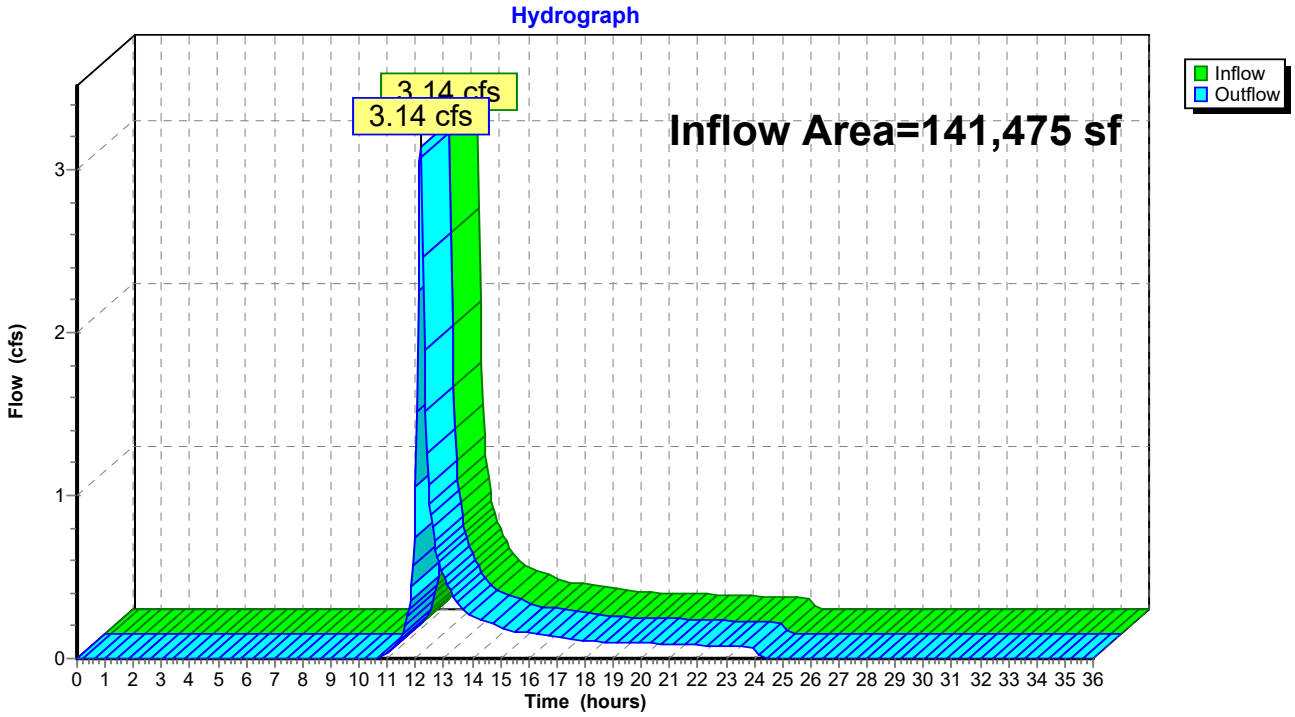


Summary for Reach SUM: SUM TO FIELD

Inflow Area = 141,475 sf, 62.72% Impervious, Inflow Depth = 0.94" for 2-Year event
Inflow = 3.14 cfs @ 12.18 hrs, Volume= 11,072 cf
Outflow = 3.14 cfs @ 12.18 hrs, Volume= 11,072 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Reach SUM: SUM TO FIELD



Summary for Pond POND: INFILTRATION SYSTEM

Inflow Area = 18,450 sf,100.00% Impervious, Inflow Depth = 3.12" for 2-Year event
Inflow = 1.40 cfs @ 12.13 hrs, Volume= 4,792 cf
Outflow = 0.19 cfs @ 11.60 hrs, Volume= 4,791 cf, Atten= 86%, Lag= 0.0 min
Discarded = 0.19 cfs @ 11.60 hrs, Volume= 4,791 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 72.65' @ 12.65 hrs Surf.Area= 997 sf Storage= 1,232 cf

Plug-Flow detention time= 37.0 min calculated for 4,791 cf (100% of inflow)
Center-of-Mass det. time= 36.8 min (794.2 - 757.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.75'	1,433 cf	**23.00'W x 43.37'L x 5.75'H Field A** 5,735 cf Overall - 2,153 cf Embedded = 3,582 cf x 40.0% Voids
#2A	71.50'	2,153 cf	**Cultec R-902HD** x 33 Inside #1 Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap 33 Chambers in 3 Rows Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf
		3,586 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	74.50'	**12.0" Round Culvert** L= 150.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 74.50' / 70.00' S= 0.0300 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	76.30'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height
#3	Discarded	70.75'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.19 cfs @ 11.60 hrs HW=70.82' (Free Discharge)
↑└**3=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=70.75' (Free Discharge)
↑└**1=Culvert** (Controls 0.00 cfs)
↑└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond POND: INFILTRATION SYSTEM - Chamber Wizard Field A

Chamber Model = Cultec R-902HD (Cultec Recharger® 902HD)
Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf
Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap
Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf

78.0" Wide + 9.0" Spacing = 87.0" C-C Row Spacing

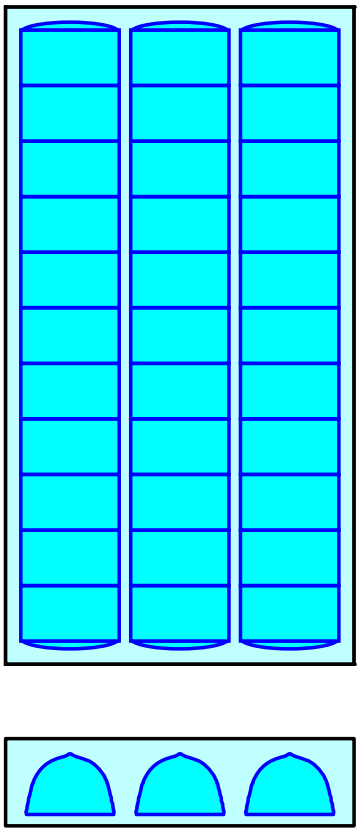
11 Chambers/Row x 3.67' Long +0.52' Cap Length x 2 = 41.37' Row Length +12.0" End Stone x 2 = 43.37' Base Length
3 Rows x 78.0" Wide + 9.0" Spacing x 2 + 12.0" Side Stone x 2 = 23.00' Base Width
9.0" Base + 48.0" Chamber Height + 12.0" Cover = 5.75' Field Height

33 Chambers x 64.7 cf + 2.8 cf Cap Volume x 2 x 3 Rows = 2,152.8 cf Chamber Storage

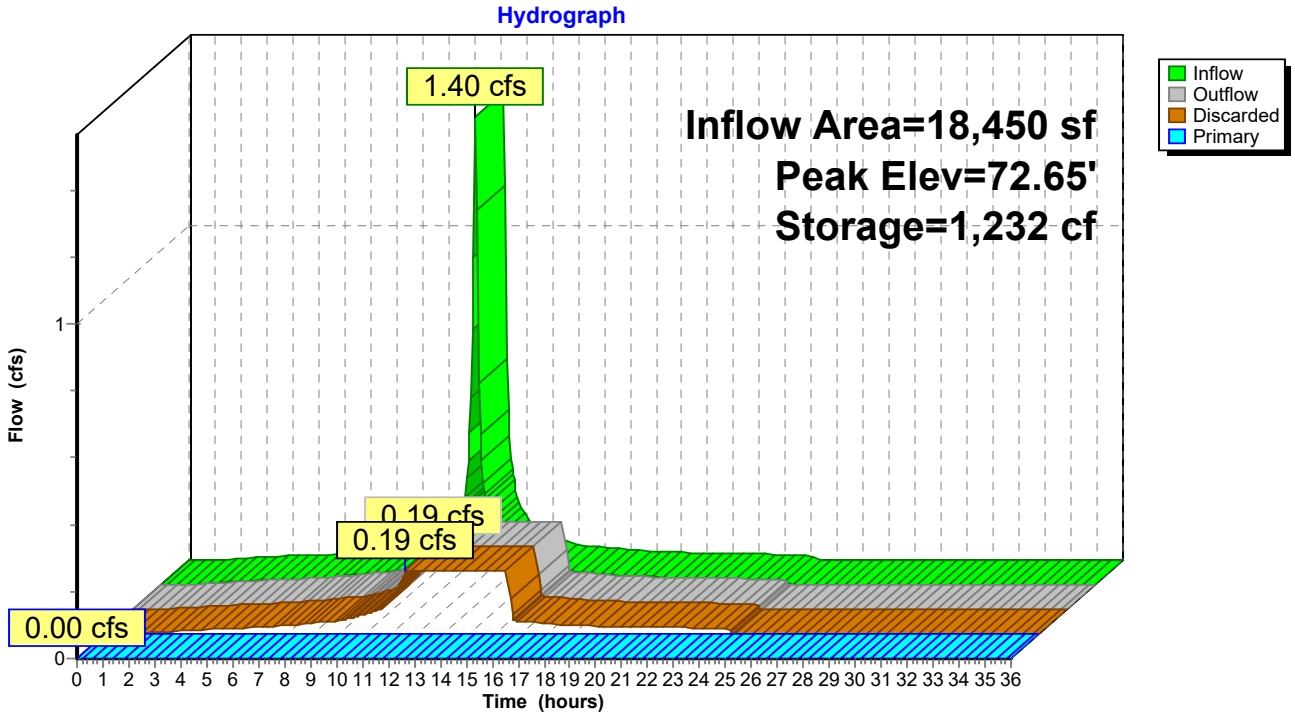
5,735.2 cf Field - 2,152.8 cf Chambers = 3,582.4 cf Stone x 40.0% Voids = 1,433.0 cf Stone Storage

Chamber Storage + Stone Storage = 3,585.8 cf = 0.082 af
Overall Storage Efficiency = 62.5%
Overall System Size = 43.37' x 23.00' x 5.75'

33 Chambers
212.4 cy Field
132.7 cy Stone



Pond POND: INFILTRATION SYSTEM



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1P: TRIBUTARY TO TOWN GREEN Runoff Area=24,758 sf 8.42% Impervious Runoff Depth=0.38"
Flow Length=212' Tc=9.1 min CN=44 Runoff=0.07 cfs 788 cf

Subcatchment 2P: TRIBUTARY TO FIELD Runoff Area=123,025 sf 57.13% Impervious Runoff Depth=2.24"
Flow Length=436' Tc=9.6 min CN=73 Runoff=6.78 cfs 22,978 cf

Subcatchment 3P: TRIBUTARY TO PLAYGROUND Runoff Area=34,075 sf 42.28% Impervious Runoff Depth=1.55"
Flow Length=567' Tc=13.4 min CN=64 Runoff=1.10 cfs 4,396 cf

Subcatchment 4P: PROPOSED BUILDING Runoff Area=18,450 sf 100.00% Impervious Runoff Depth=4.71"
Tc=6.0 min CN=98 Runoff=2.08 cfs 7,247 cf

Reach SUM: SUM TO FIELD Inflow=6.78 cfs 22,978 cf
Outflow=6.78 cfs 22,978 cf

Pond POND: INFILTRATION SYSTEM Peak Elev=74.06' Storage=2,308 cf Inflow=2.08 cfs 7,247 cf
Discarded=0.19 cfs 7,246 cf Primary=0.00 cfs 0 cf Outflow=0.19 cfs 7,246 cf

Total Runoff Area = 200,308 sf Runoff Volume = 35,409 cf Average Runoff Depth = 2.12"
47.47% Pervious = 95,080 sf 52.53% Impervious = 105,228 sf

Summary for Subcatchment 1P: TRIBUTARY TO TOWN GREEN

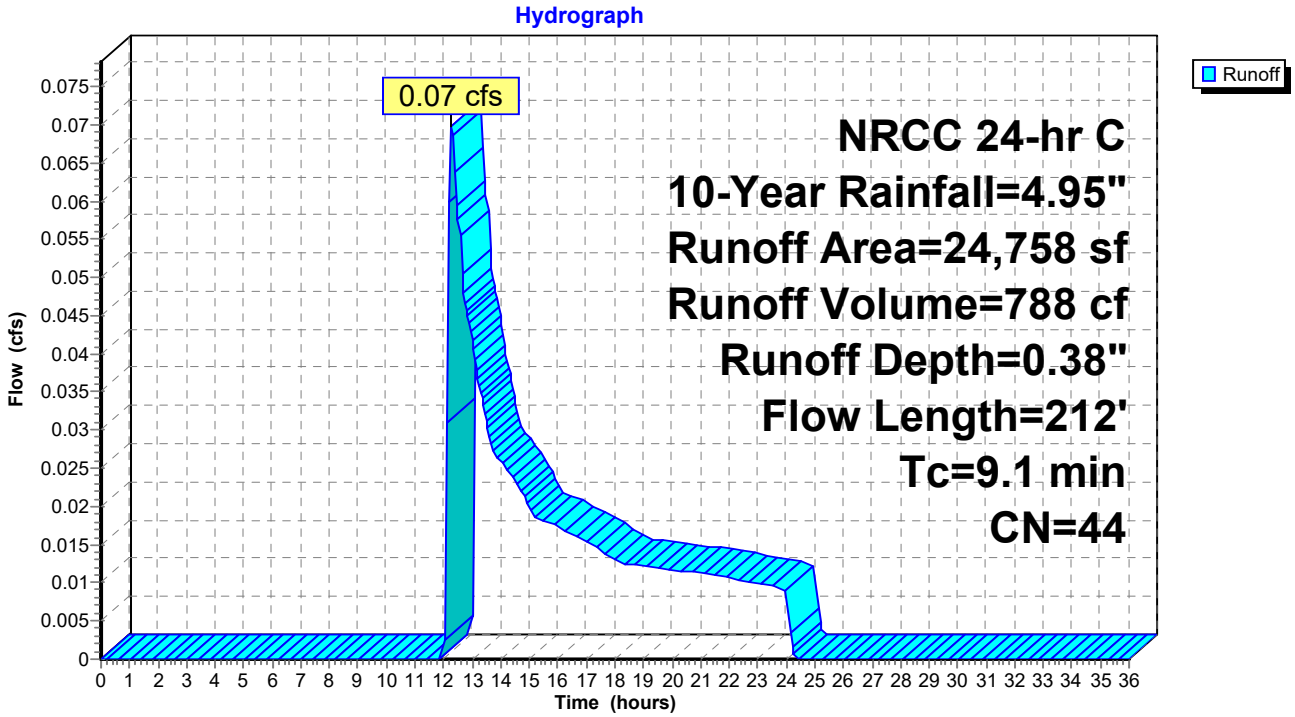
Runoff = 0.07 cfs @ 12.28 hrs, Volume= 788 cf, Depth= 0.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
2,084	98	Paved parking, HSG B
22,674	39	>75% Grass cover, Good, HSG A
24,758	44	Weighted Average
22,674		91.58% Pervious Area
2,084		8.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
1.1	162	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	212	Total			

Subcatchment 1P: TRIBUTARY TO TOWN GREEN



Summary for Subcatchment 2P: TRIBUTARY TO FIELD

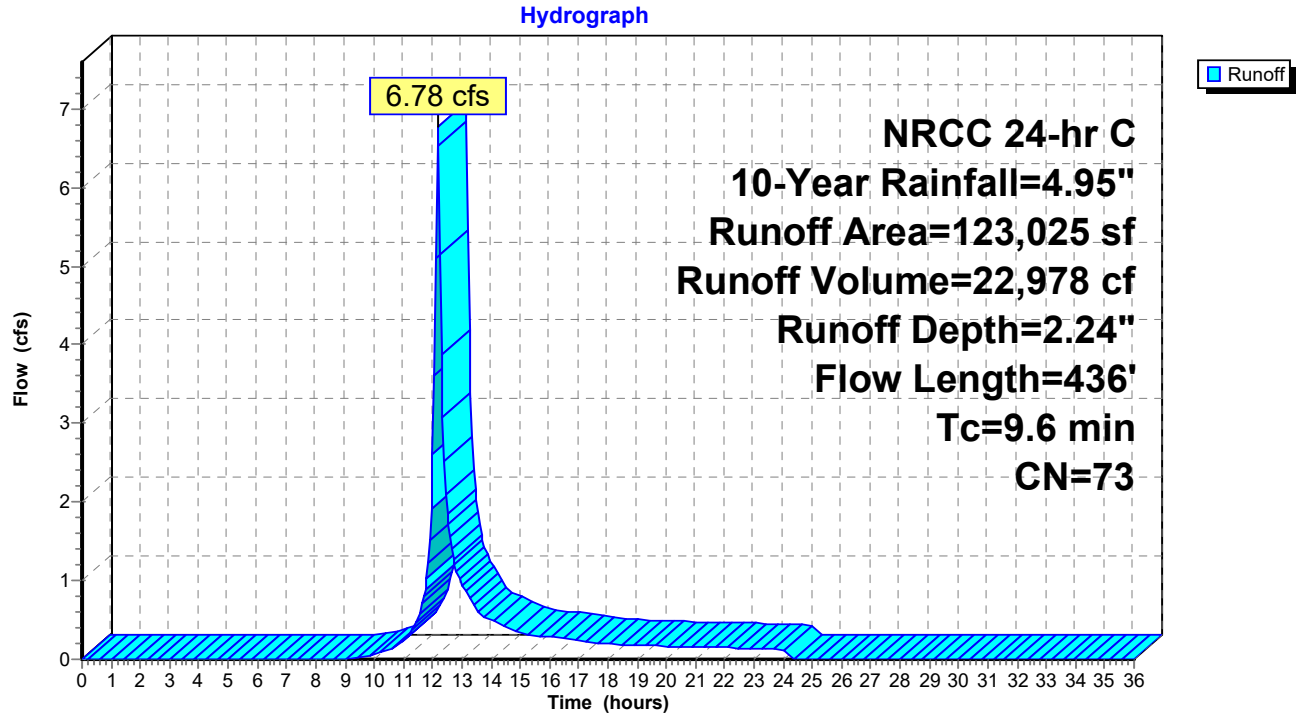
Runoff = 6.78 cfs @ 12.17 hrs, Volume= 22,978 cf, Depth= 2.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
70,287	98	Paved parking, HSG B
52,738	39	>75% Grass cover, Good, HSG A
123,025	73	Weighted Average
52,738		42.87% Pervious Area
70,287		57.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	21	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	275	0.0160	5.74	4.51	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
9.6	436	Total			

Subcatchment 2P: TRIBUTARY TO FIELD



Summary for Subcatchment 3P: TRIBUTARY TO PLAYGROUND

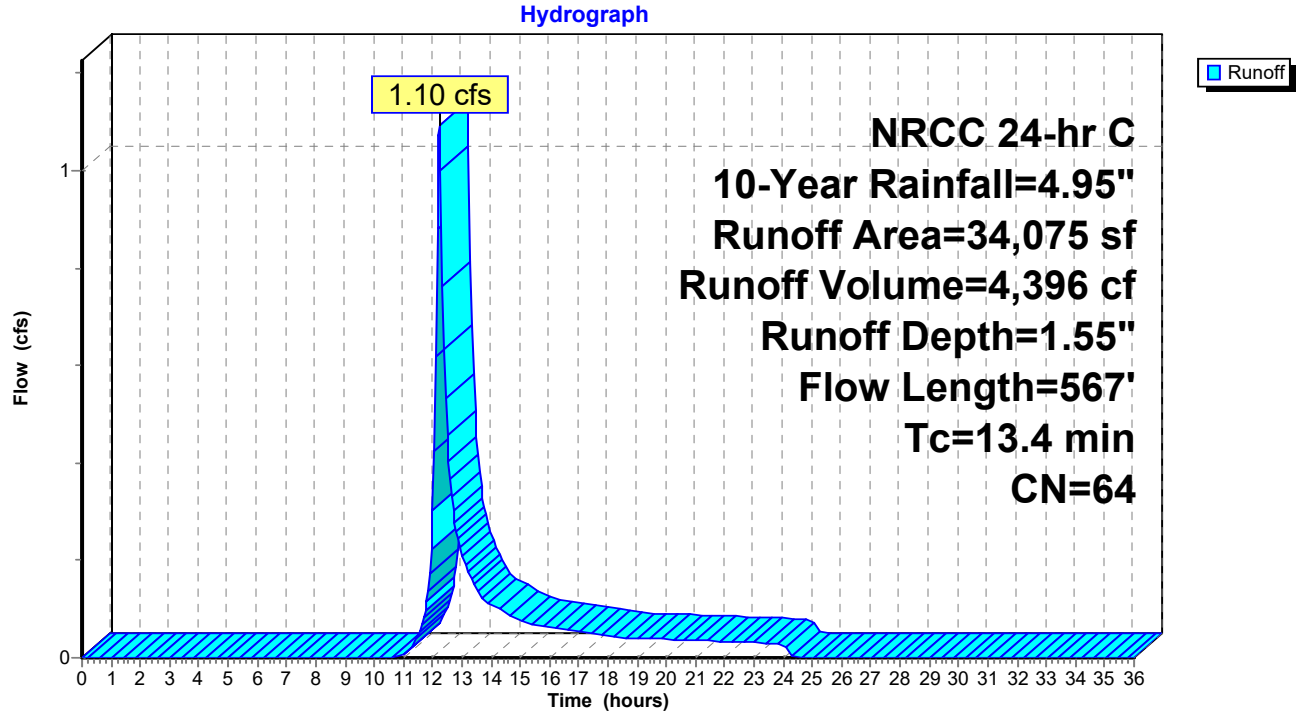
Runoff = 1.10 cfs @ 12.22 hrs, Volume= 4,396 cf, Depth= 1.55"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
14,407	98	Paved parking, HSG B
19,668	39	>75% Grass cover, Good, HSG A
34,075	64	Weighted Average
19,668		57.72% Pervious Area
14,407		42.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.4	47	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	408	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.3	62	0.0530	3.71		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.4	567	Total			

Subcatchment 3P: TRIBUTARY TO PLAYGROUND



Summary for Subcatchment 4P: PROPOSED BUILDING

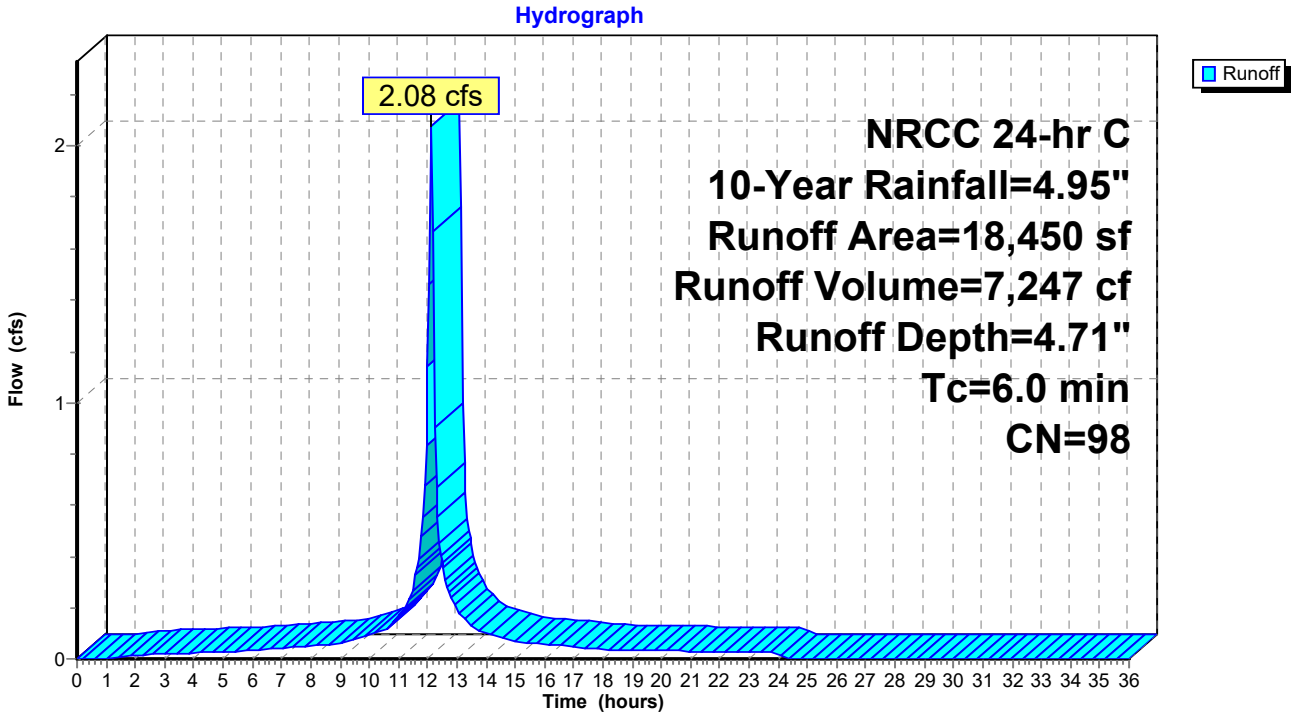
Runoff = 2.08 cfs @ 12.13 hrs, Volume= 7,247 cf, Depth= 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 10-Year Rainfall=4.95"

Area (sf)	CN	Description
18,450	98	Unconnected roofs, HSG A
18,450		100.00% Impervious Area
18,450		100.00% Unconnected

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

Subcatchment 4P: PROPOSED BUILDING

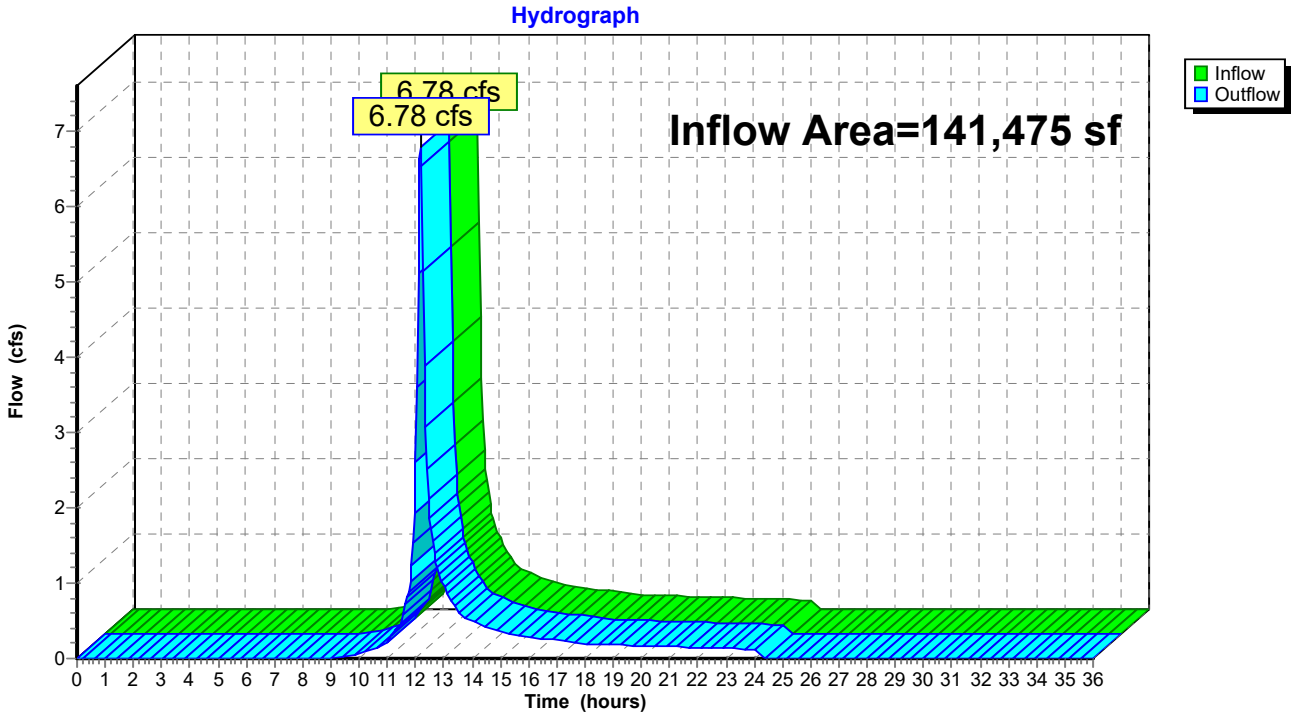


Summary for Reach SUM: SUM TO FIELD

Inflow Area = 141,475 sf, 62.72% Impervious, Inflow Depth = 1.95" for 10-Year event
Inflow = 6.78 cfs @ 12.17 hrs, Volume= 22,978 cf
Outflow = 6.78 cfs @ 12.17 hrs, Volume= 22,978 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Reach SUM: SUM TO FIELD



Summary for Pond POND: INFILTRATION SYSTEM

Inflow Area = 18,450 sf,100.00% Impervious, Inflow Depth = 4.71" for 10-Year event
Inflow = 2.08 cfs @ 12.13 hrs, Volume= 7,247 cf
Outflow = 0.19 cfs @ 11.20 hrs, Volume= 7,246 cf, Atten= 91%, Lag= 0.0 min
Discarded = 0.19 cfs @ 11.20 hrs, Volume= 7,246 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 74.06' @ 13.05 hrs Surf.Area= 997 sf Storage= 2,308 cf

Plug-Flow detention time= 78.1 min calculated for 7,236 cf (100% of inflow)
Center-of-Mass det. time= 77.9 min (827.4 - 749.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.75'	1,433 cf	**23.00'W x 43.37'L x 5.75'H Field A** 5,735 cf Overall - 2,153 cf Embedded = 3,582 cf x 40.0% Voids
#2A	71.50'	2,153 cf	**Cultec R-902HD** x 33 Inside #1 Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap 33 Chambers in 3 Rows Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf
		3,586 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	74.50'	**12.0" Round Culvert** L= 150.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 74.50' / 70.00' S= 0.0300 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	76.30'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height
#3	Discarded	70.75'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.19 cfs @ 11.20 hrs HW=70.82' (Free Discharge)
↑└**3=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=70.75' (Free Discharge)
↑└**1=Culvert** (Controls 0.00 cfs)
↑└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond POND: INFILTRATION SYSTEM - Chamber Wizard Field A

Chamber Model = Cultec R-902HD (Cultec Recharger® 902HD)
Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf
Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap
Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf

78.0" Wide + 9.0" Spacing = 87.0" C-C Row Spacing

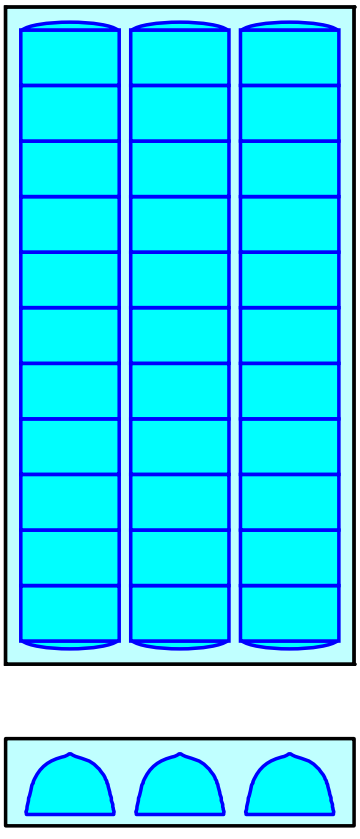
11 Chambers/Row x 3.67' Long +0.52' Cap Length x 2 = 41.37' Row Length +12.0" End Stone x 2 = 43.37' Base Length
3 Rows x 78.0" Wide + 9.0" Spacing x 2 + 12.0" Side Stone x 2 = 23.00' Base Width
9.0" Base + 48.0" Chamber Height + 12.0" Cover = 5.75' Field Height

33 Chambers x 64.7 cf + 2.8 cf Cap Volume x 2 x 3 Rows = 2,152.8 cf Chamber Storage

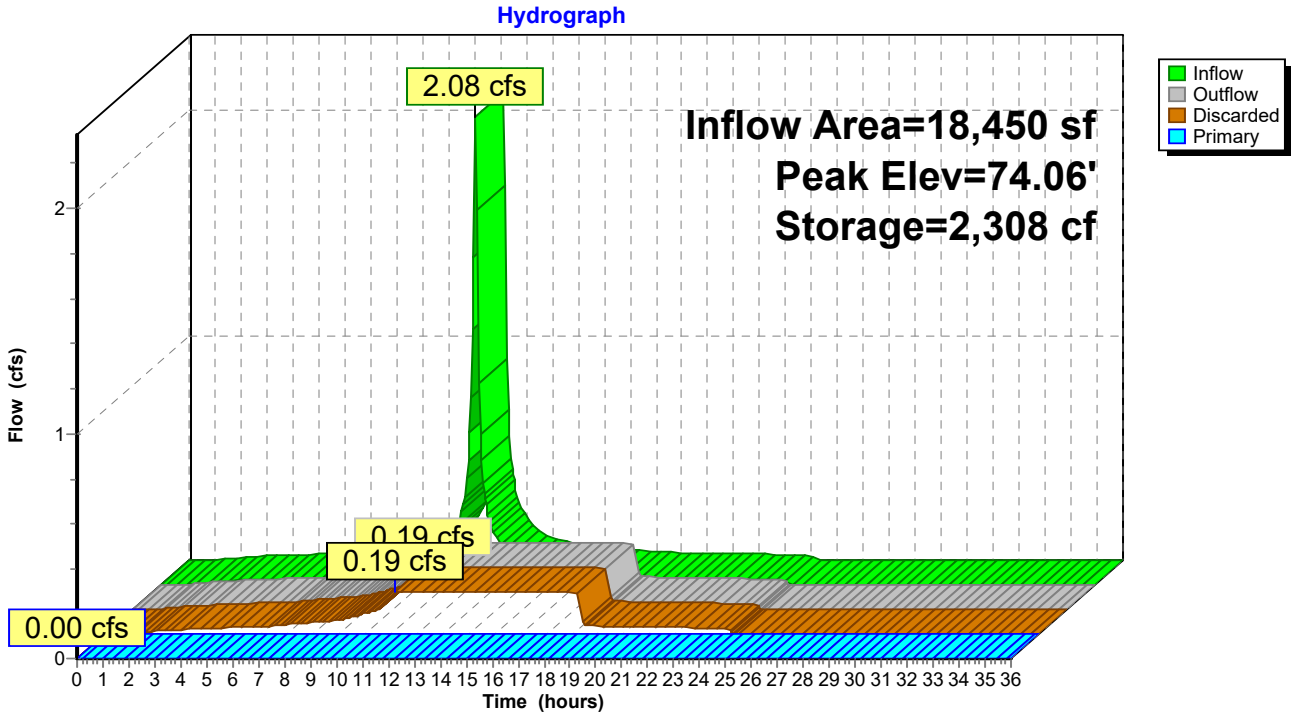
5,735.2 cf Field - 2,152.8 cf Chambers = 3,582.4 cf Stone x 40.0% Voids = 1,433.0 cf Stone Storage

Chamber Storage + Stone Storage = 3,585.8 cf = 0.082 af
Overall Storage Efficiency = 62.5%
Overall System Size = 43.37' x 23.00' x 5.75'

33 Chambers
212.4 cy Field
132.7 cy Stone



Pond POND: INFILTRATION SYSTEM



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1P: TRIBUTARY TO TOWN GREEN Runoff Area=24,758 sf 8.42% Impervious Runoff Depth=0.81"
Flow Length=212' Tc=9.1 min CN=44 Runoff=0.32 cfs 1,674 cf

Subcatchment 2P: TRIBUTARY TO FIELD Runoff Area=123,025 sf 57.13% Impervious Runoff Depth=3.25"
Flow Length=436' Tc=9.6 min CN=73 Runoff=9.85 cfs 33,287 cf

Subcatchment 3P: TRIBUTARY TO PLAYGROUND Runoff Area=34,075 sf 42.28% Impervious Runoff Depth=2.40"
Flow Length=567' Tc=13.4 min CN=64 Runoff=1.76 cfs 6,815 cf

Subcatchment 4P: PROPOSED BUILDING Runoff Area=18,450 sf 100.00% Impervious Runoff Depth=5.95"
Tc=6.0 min CN=98 Runoff=2.61 cfs 9,151 cf

Reach SUM: SUM TO FIELD Inflow=9.85 cfs 33,287 cf
Outflow=9.85 cfs 33,287 cf

Pond POND: INFILTRATION SYSTEM Peak Elev=75.68' Storage=3,257 cf Inflow=2.61 cfs 9,151 cf
Discarded=0.19 cfs 9,152 cf Primary=0.00 cfs 0 cf Outflow=0.19 cfs 9,152 cf

Total Runoff Area = 200,308 sf Runoff Volume = 50,926 cf Average Runoff Depth = 3.05"
47.47% Pervious = 95,080 sf 52.53% Impervious = 105,228 sf

Summary for Subcatchment 1P: TRIBUTARY TO TOWN GREEN

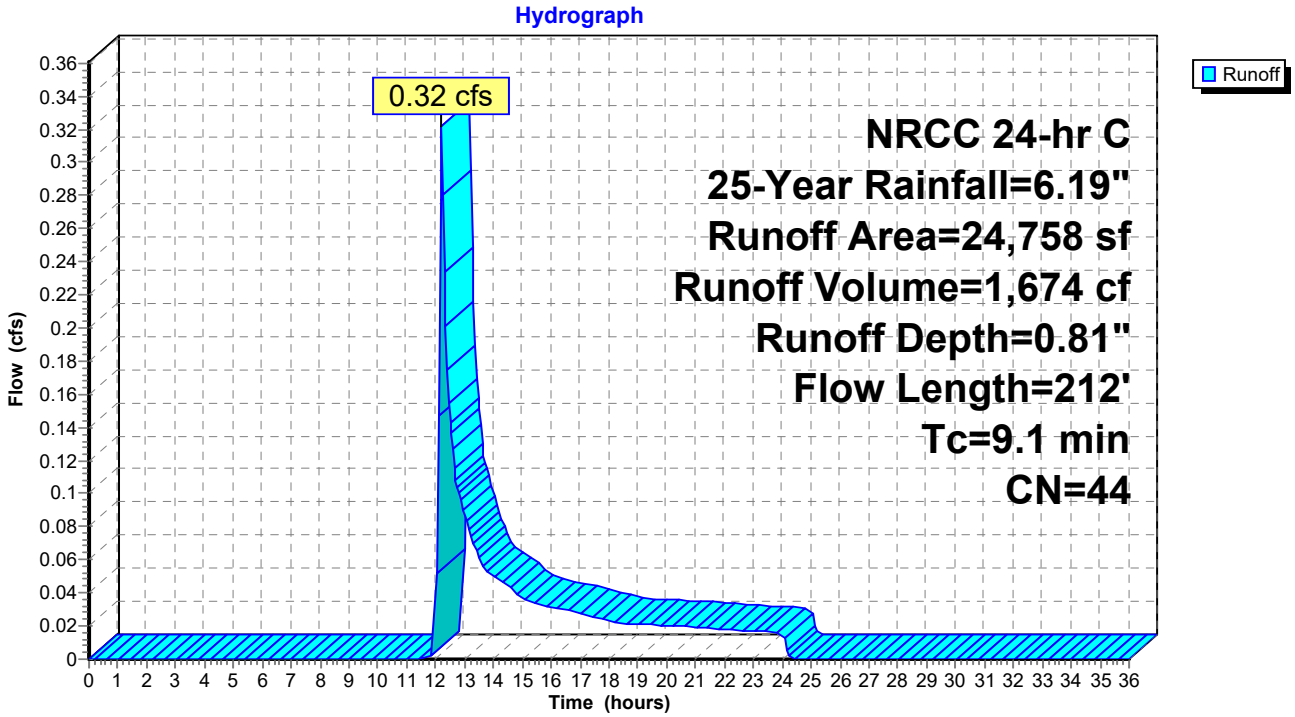
Runoff = 0.32 cfs @ 12.20 hrs, Volume= 1,674 cf, Depth= 0.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
2,084	98	Paved parking, HSG B
22,674	39	>75% Grass cover, Good, HSG A
24,758	44	Weighted Average
22,674		91.58% Pervious Area
2,084		8.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
1.1	162	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	212	Total			

Subcatchment 1P: TRIBUTARY TO TOWN GREEN



Summary for Subcatchment 2P: TRIBUTARY TO FIELD

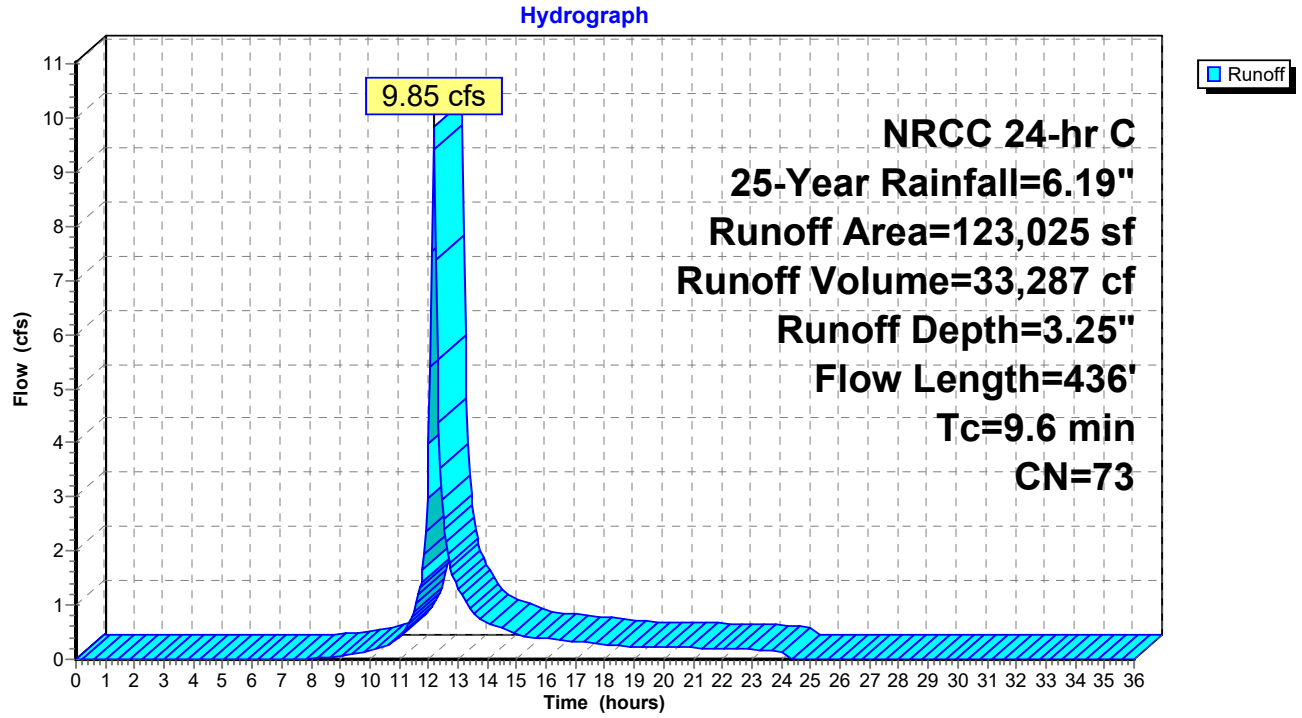
Runoff = 9.85 cfs @ 12.17 hrs, Volume= 33,287 cf, Depth= 3.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
70,287	98	Paved parking, HSG B
52,738	39	>75% Grass cover, Good, HSG A
123,025	73	Weighted Average
52,738		42.87% Pervious Area
70,287		57.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	21	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	275	0.0160	5.74	4.51	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
9.6	436	Total			

Subcatchment 2P: TRIBUTARY TO FIELD



Summary for Subcatchment 3P: TRIBUTARY TO PLAYGROUND

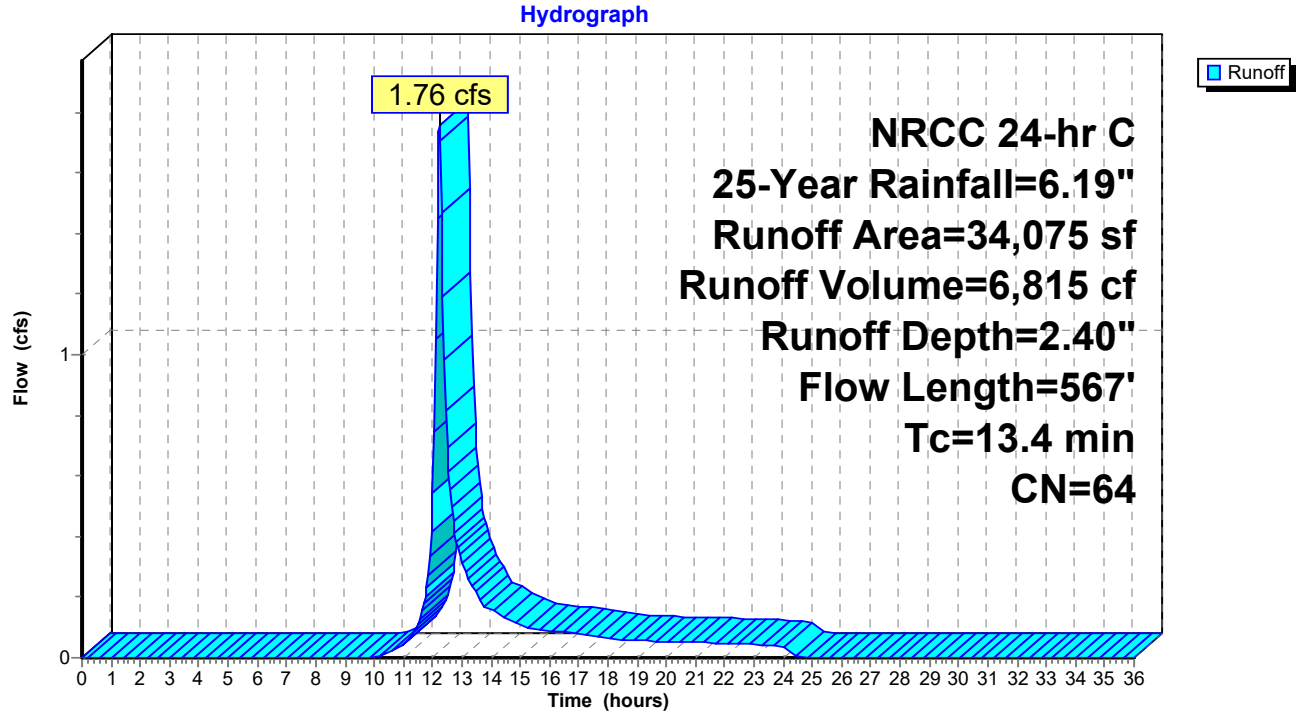
Runoff = 1.76 cfs @ 12.22 hrs, Volume= 6,815 cf, Depth= 2.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
14,407	98	Paved parking, HSG B
19,668	39	>75% Grass cover, Good, HSG A
34,075	64	Weighted Average
19,668		57.72% Pervious Area
14,407		42.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.4	47	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	408	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.3	62	0.0530	3.71		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.4	567	Total			

Subcatchment 3P: TRIBUTARY TO PLAYGROUND



Summary for Subcatchment 4P: PROPOSED BUILDING

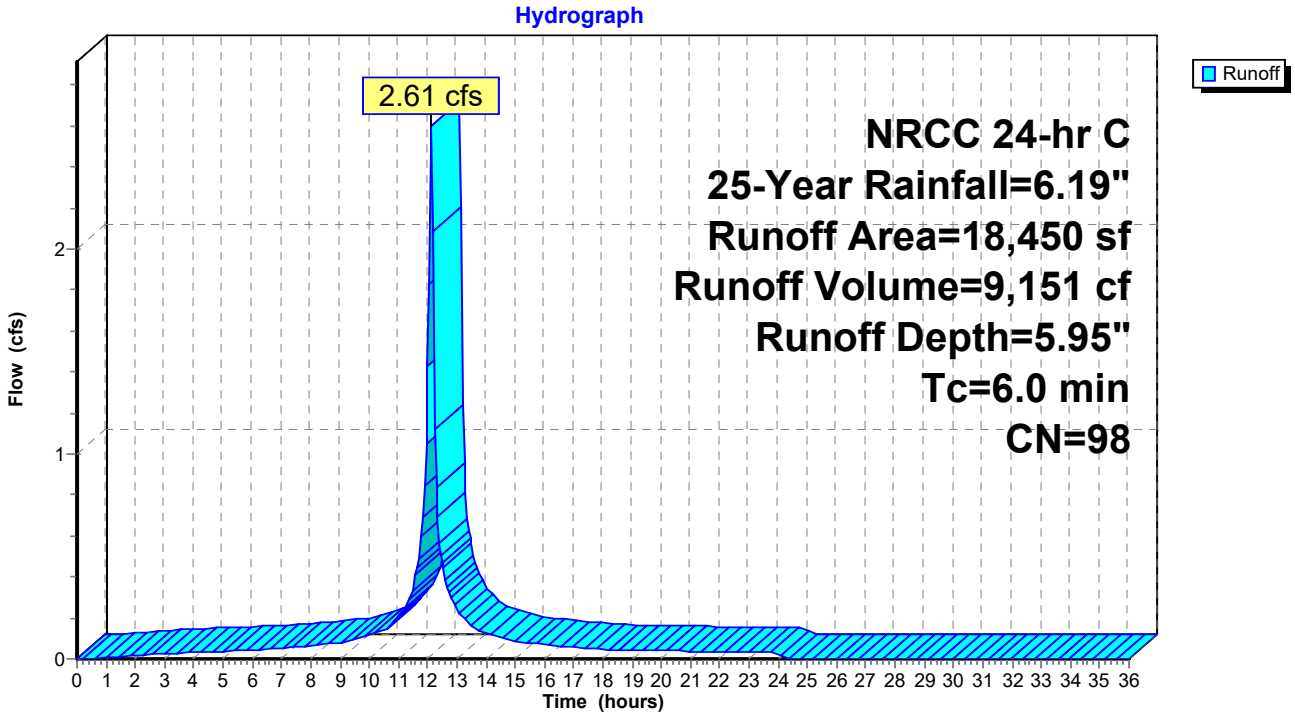
Runoff = 2.61 cfs @ 12.13 hrs, Volume= 9,151 cf, Depth= 5.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 25-Year Rainfall=6.19"

Area (sf)	CN	Description
18,450	98	Unconnected roofs, HSG A
18,450		100.00% Impervious Area
18,450		100.00% Unconnected

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

Subcatchment 4P: PROPOSED BUILDING

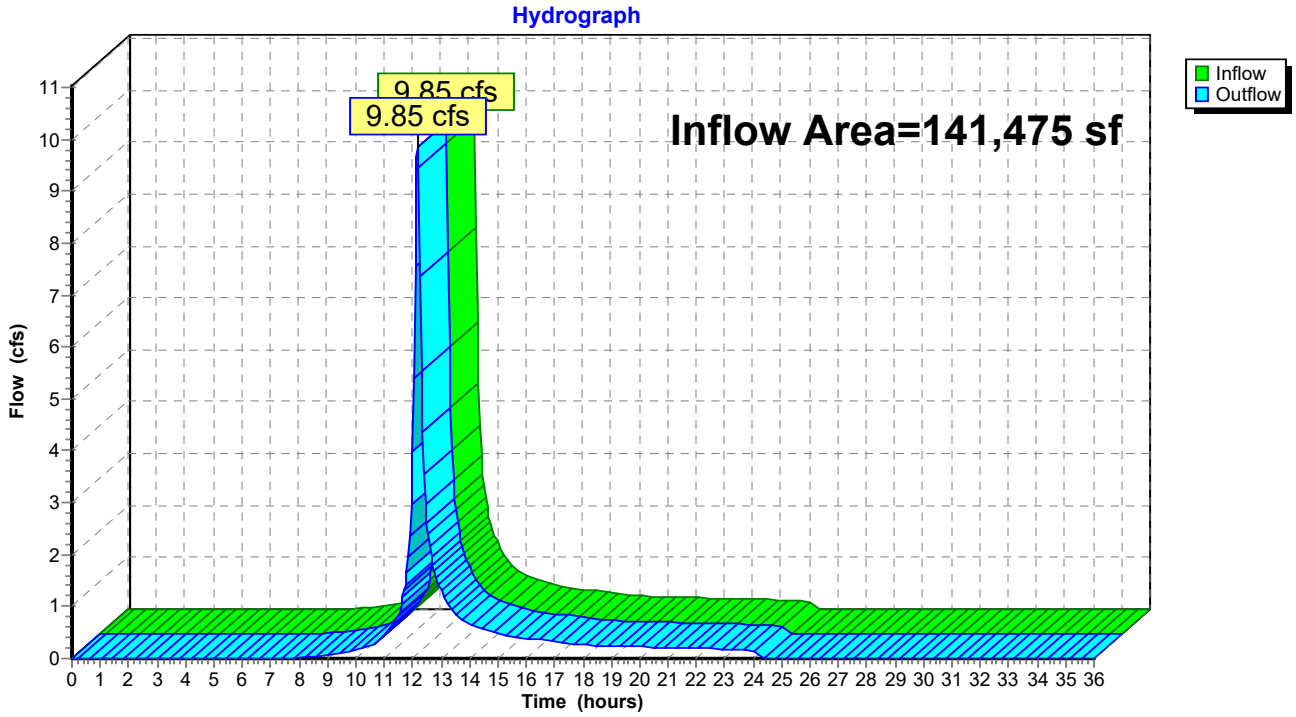


Summary for Reach SUM: SUM TO FIELD

Inflow Area = 141,475 sf, 62.72% Impervious, Inflow Depth = 2.82" for 25-Year event
Inflow = 9.85 cfs @ 12.17 hrs, Volume= 33,287 cf
Outflow = 9.85 cfs @ 12.17 hrs, Volume= 33,287 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Reach SUM: SUM TO FIELD



Summary for Pond POND: INFILTRATION SYSTEM

Inflow Area = 18,450 sf,100.00% Impervious, Inflow Depth = 5.95" for 25-Year event
Inflow = 2.61 cfs @ 12.13 hrs, Volume= 9,151 cf
Outflow = 0.19 cfs @ 10.95 hrs, Volume= 9,152 cf, Atten= 93%, Lag= 0.0 min
Discarded = 0.19 cfs @ 10.95 hrs, Volume= 9,152 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 75.68' @ 13.30 hrs Surf.Area= 997 sf Storage= 3,257 cf

Plug-Flow detention time= 118.1 min calculated for 9,140 cf (100% of inflow)
Center-of-Mass det. time= 118.1 min (863.9 - 745.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.75'	1,433 cf	**23.00'W x 43.37'L x 5.75'H Field A** 5,735 cf Overall - 2,153 cf Embedded = 3,582 cf x 40.0% Voids
#2A	71.50'	2,153 cf	**Cultec R-902HD** x 33 Inside #1 Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap 33 Chambers in 3 Rows Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf
		3,586 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	74.50'	**12.0" Round Culvert** L= 150.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 74.50' / 70.00' S= 0.0300 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	76.30'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height
#3	Discarded	70.75'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.19 cfs @ 10.95 hrs HW=70.82' (Free Discharge)
↑└**3=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=70.75' (Free Discharge)
↑└**1=Culvert** (Controls 0.00 cfs)
↑└**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond POND: INFILTRATION SYSTEM - Chamber Wizard Field A

Chamber Model = Cultec R-902HD (Cultec Recharger® 902HD)
Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf
Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap
Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf

78.0" Wide + 9.0" Spacing = 87.0" C-C Row Spacing

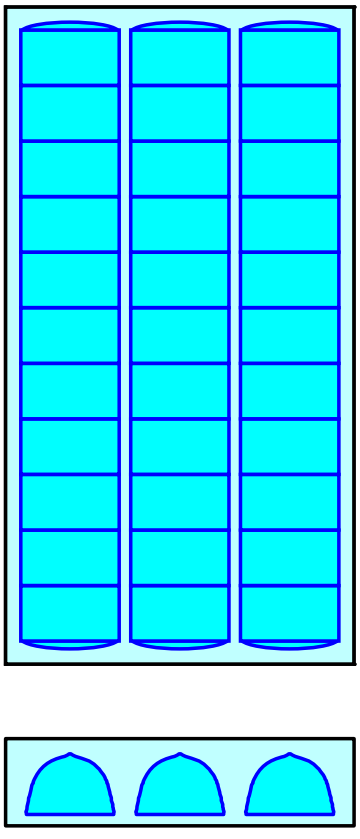
11 Chambers/Row x 3.67' Long +0.52' Cap Length x 2 = 41.37' Row Length +12.0" End Stone x 2 = 43.37' Base Length
3 Rows x 78.0" Wide + 9.0" Spacing x 2 + 12.0" Side Stone x 2 = 23.00' Base Width
9.0" Base + 48.0" Chamber Height + 12.0" Cover = 5.75' Field Height

33 Chambers x 64.7 cf + 2.8 cf Cap Volume x 2 x 3 Rows = 2,152.8 cf Chamber Storage

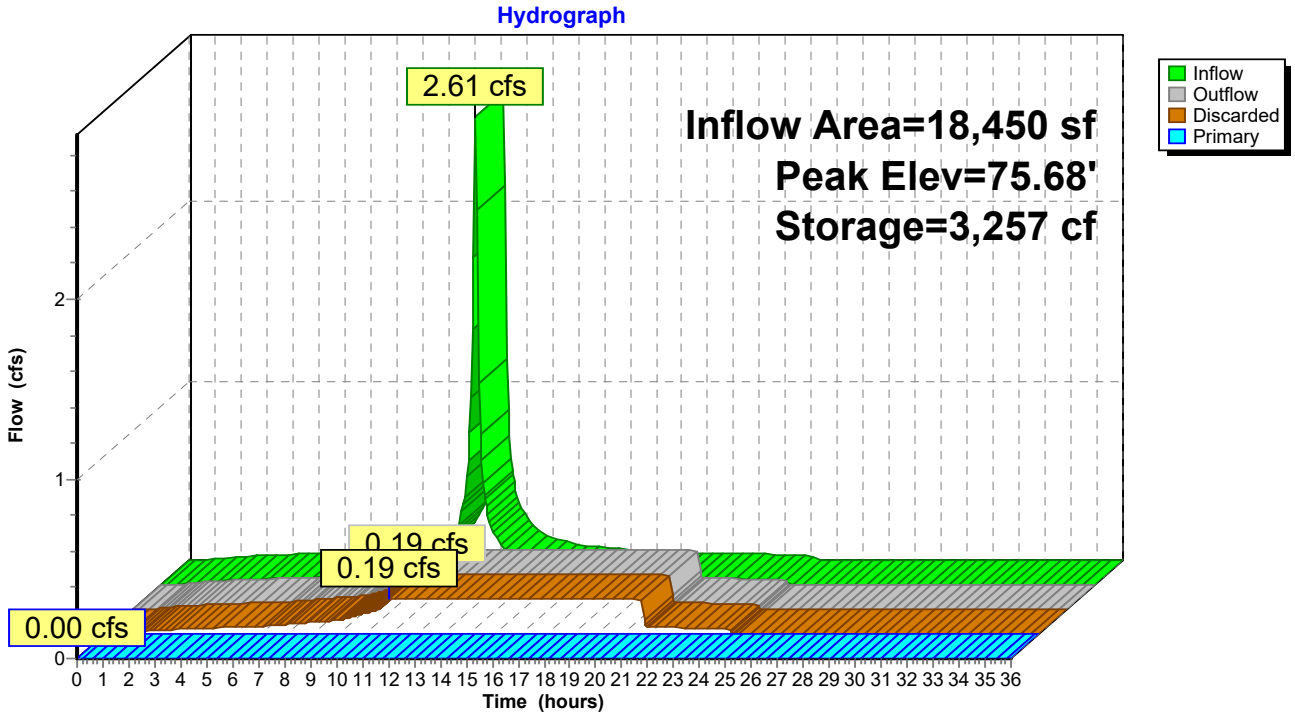
5,735.2 cf Field - 2,152.8 cf Chambers = 3,582.4 cf Stone x 40.0% Voids = 1,433.0 cf Stone Storage

Chamber Storage + Stone Storage = 3,585.8 cf = 0.082 af
Overall Storage Efficiency = 62.5%
Overall System Size = 43.37' x 23.00' x 5.75'

33 Chambers
212.4 cy Field
132.7 cy Stone



Pond POND: INFILTRATION SYSTEM



Time span=0.00-36.00 hrs, dt=0.05 hrs, 721 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1P: TRIBUTARY TO TOWN GREEN Runoff Area=24,758 sf 8.42% Impervious Runoff Depth=2.00"
Flow Length=212' Tc=9.1 min CN=44 Runoff=1.09 cfs 4,116 cf

Subcatchment 2P: TRIBUTARY TO FIELD Runoff Area=123,025 sf 57.13% Impervious Runoff Depth=5.42"
Flow Length=436' Tc=9.6 min CN=73 Runoff=16.31 cfs 55,536 cf

Subcatchment 3P: TRIBUTARY TO PLAYGROUND Runoff Area=34,075 sf 42.28% Impervious Runoff Depth=4.33"
Flow Length=567' Tc=13.4 min CN=64 Runoff=3.22 cfs 12,297 cf

Subcatchment 4P: PROPOSED BUILDING Runoff Area=18,450 sf 100.00% Impervious Runoff Depth=8.44"
Tc=6.0 min CN=98 Runoff=3.66 cfs 12,976 cf

Reach SUM: SUM TO FIELD Inflow=17.53 cfs 57,372 cf
Outflow=17.53 cfs 57,372 cf

Pond POND: INFILTRATION SYSTEM Peak Elev=76.57' Storage=3,586 cf Inflow=3.66 cfs 12,976 cf
Discarded=0.19 cfs 11,135 cf Primary=1.89 cfs 1,836 cf Outflow=2.08 cfs 12,971 cf

Total Runoff Area = 200,308 sf Runoff Volume = 84,925 cf Average Runoff Depth = 5.09"
47.47% Pervious = 95,080 sf 52.53% Impervious = 105,228 sf

Summary for Subcatchment 1P: TRIBUTARY TO TOWN GREEN

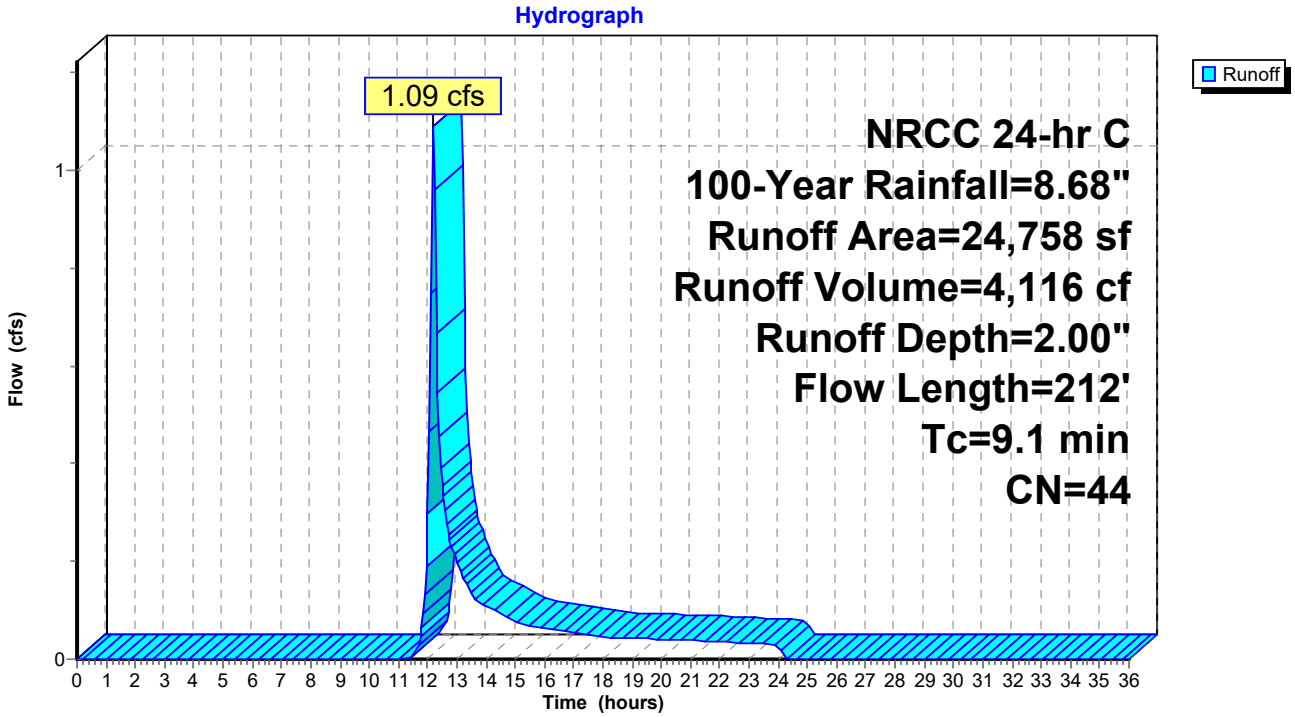
Runoff = 1.09 cfs @ 12.18 hrs, Volume= 4,116 cf, Depth= 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
2,084	98	Paved parking, HSG B
22,674	39	>75% Grass cover, Good, HSG A
24,758	44	Weighted Average
22,674		91.58% Pervious Area
2,084		8.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
1.1	162	0.0240	2.49		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.1	212	Total			

Subcatchment 1P: TRIBUTARY TO TOWN GREEN



Summary for Subcatchment 2P: TRIBUTARY TO FIELD

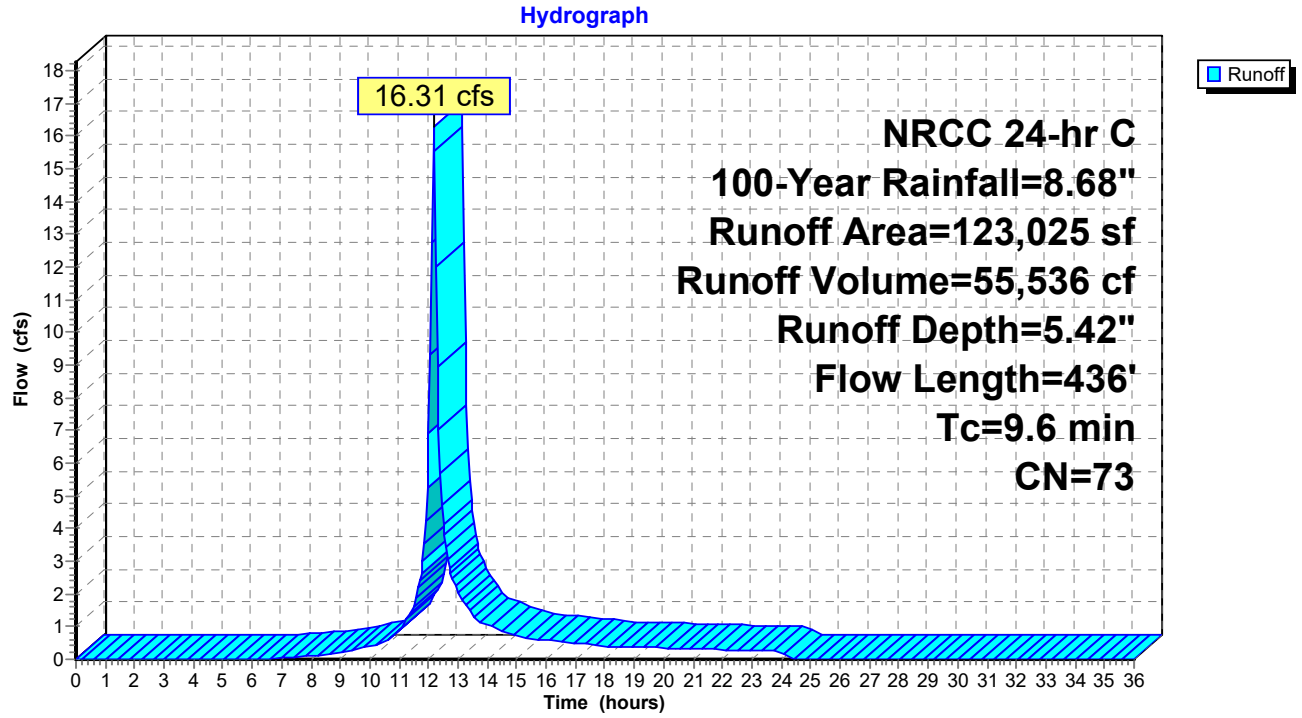
Runoff = 16.31 cfs @ 12.17 hrs, Volume= 55,536 cf, Depth= 5.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
70,287	98	Paved parking, HSG B
52,738	39	>75% Grass cover, Good, HSG A
123,025	73	Weighted Average
52,738		42.87% Pervious Area
70,287		57.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	50	0.0200	0.10		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.7	90	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	21	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.8	275	0.0160	5.74	4.51	**Pipe Channel,** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013
9.6	436	Total			

Subcatchment 2P: TRIBUTARY TO FIELD



Summary for Subcatchment 3P: TRIBUTARY TO PLAYGROUND

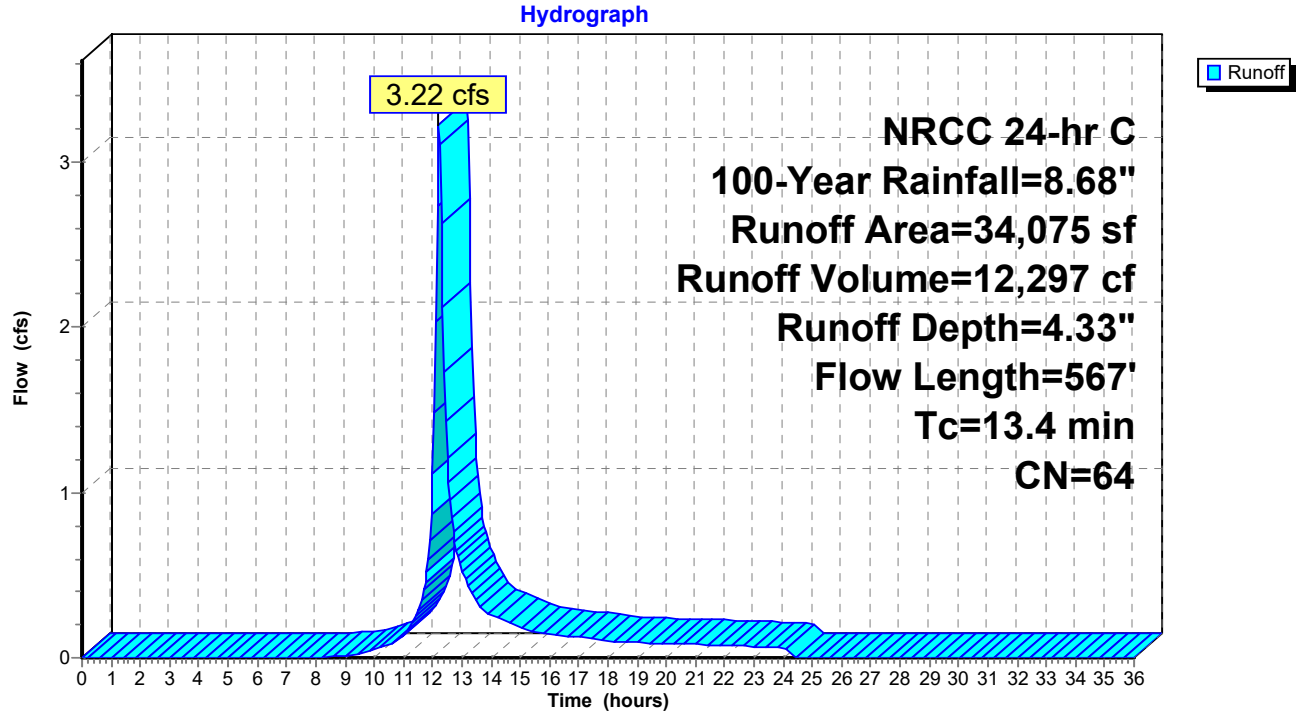
Runoff = 3.22 cfs @ 12.22 hrs, Volume= 12,297 cf, Depth= 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
14,407	98	Paved parking, HSG B
19,668	39	>75% Grass cover, Good, HSG A
34,075	64	Weighted Average
19,668		57.72% Pervious Area
14,407		42.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.0	50	0.0150	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.35"
0.4	47	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	408	0.0130	1.84		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.3	62	0.0530	3.71		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.4	567	Total			

Subcatchment 3P: TRIBUTARY TO PLAYGROUND



Summary for Subcatchment 4P: PROPOSED BUILDING

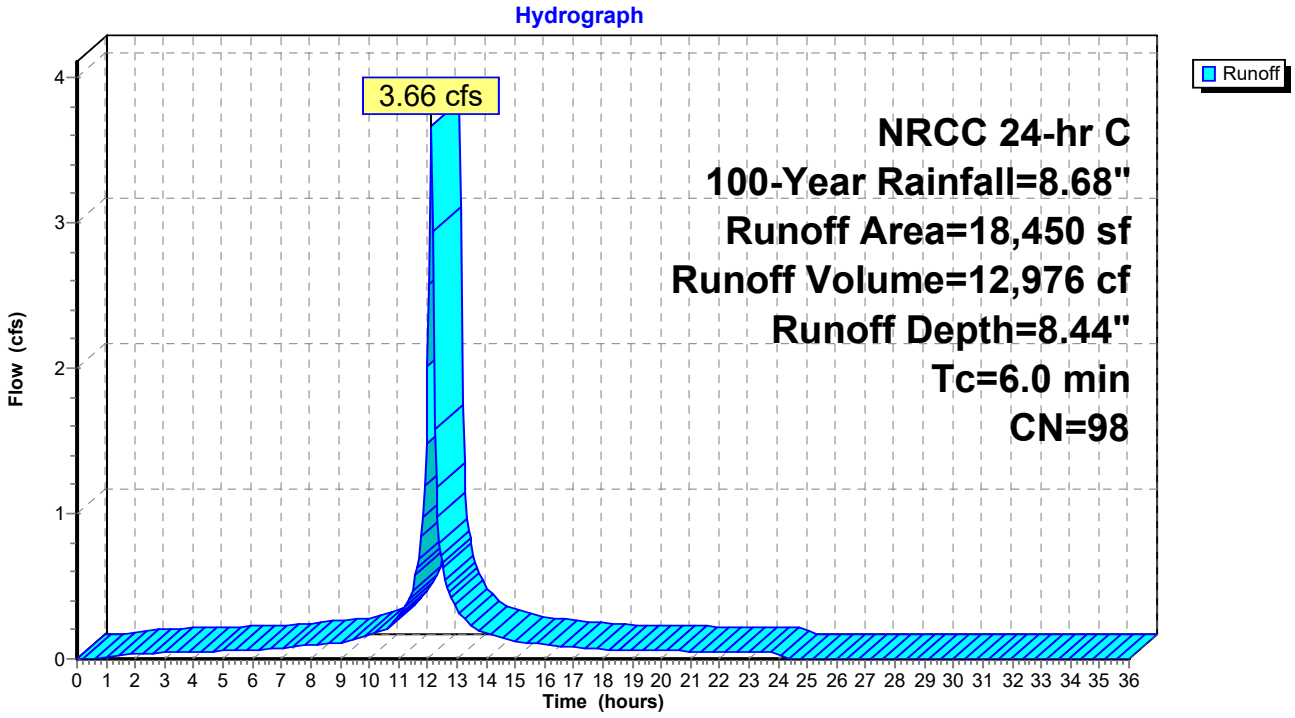
Runoff = 3.66 cfs @ 12.13 hrs, Volume= 12,976 cf, Depth= 8.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs
NRCC 24-hr C 100-Year Rainfall=8.68"

Area (sf)	CN	Description
18,450	98	Unconnected roofs, HSG A
18,450		100.00% Impervious Area
18,450		100.00% Unconnected

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

Subcatchment 4P: PROPOSED BUILDING

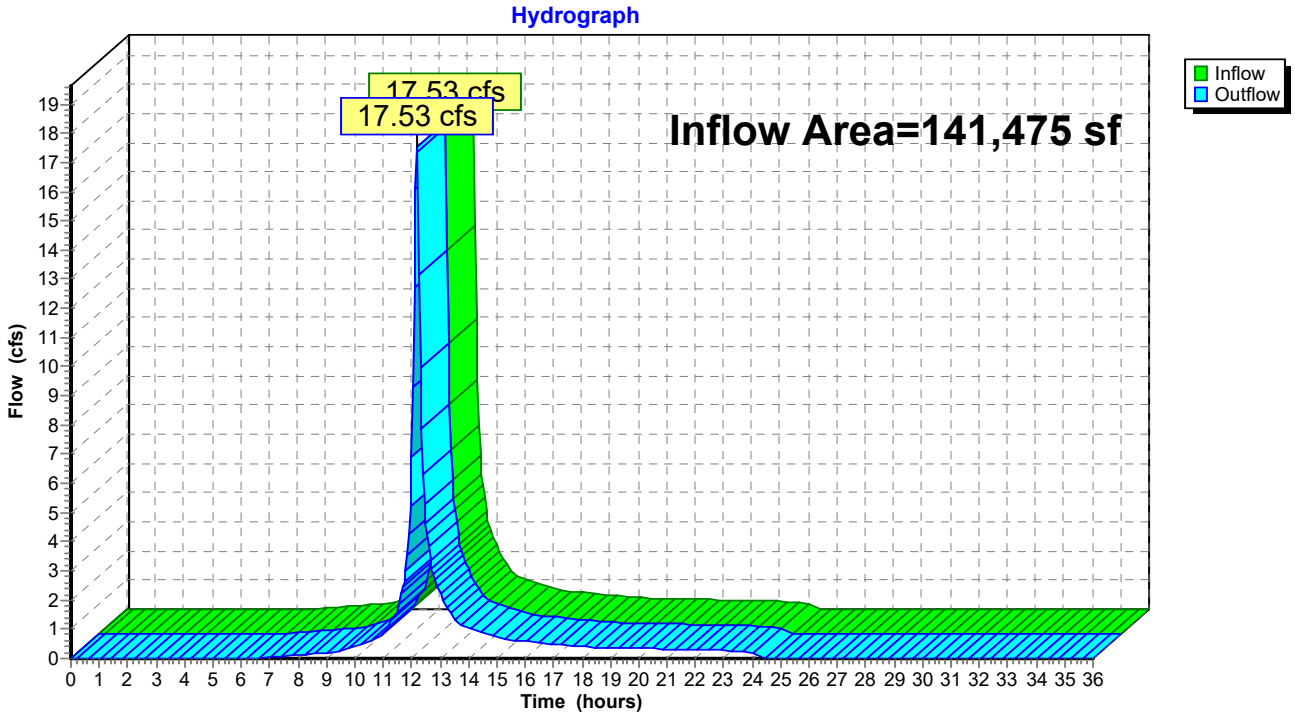


Summary for Reach SUM: SUM TO FIELD

Inflow Area = 141,475 sf, 62.72% Impervious, Inflow Depth = 4.87" for 100-Year event
Inflow = 17.53 cfs @ 12.19 hrs, Volume= 57,372 cf
Outflow = 17.53 cfs @ 12.19 hrs, Volume= 57,372 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs

Reach SUM: SUM TO FIELD



Summary for Pond POND: INFILTRATION SYSTEM

Inflow Area = 18,450 sf,100.00% Impervious, Inflow Depth = 8.44" for 100-Year event
Inflow = 3.66 cfs @ 12.13 hrs, Volume= 12,976 cf
Outflow = 2.08 cfs @ 12.21 hrs, Volume= 12,971 cf, Atten= 43%, Lag= 5.1 min
Discarded = 0.19 cfs @ 10.50 hrs, Volume= 11,135 cf
Primary = 1.89 cfs @ 12.21 hrs, Volume= 1,836 cf

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 76.57' @ 12.20 hrs Surf.Area= 997 sf Storage= 3,586 cf

Plug-Flow detention time= 116.2 min calculated for 12,971 cf (100% of inflow)
Center-of-Mass det. time= 115.9 min (856.9 - 741.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	70.75'	1,433 cf	**23.00'W x 43.37'L x 5.75'H Field A** 5,735 cf Overall - 2,153 cf Embedded = 3,582 cf x 40.0% Voids
#2A	71.50'	2,153 cf	**Cultec R-902HD** x 33 Inside #1 Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap 33 Chambers in 3 Rows Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf
		3,586 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	74.50'	**12.0" Round Culvert** L= 150.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 74.50' / 70.00' S= 0.0300 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	76.30'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height
#3	Discarded	70.75'	**8.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.19 cfs @ 10.50 hrs HW=70.82' (Free Discharge)
↑└**3=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=1.65 cfs @ 12.21 hrs HW=76.55' (Free Discharge)
↑└**1=Culvert** (Passes 1.65 cfs of 4.16 cfs potential flow)
↑└**2=Sharp-Crested Rectangular Weir** (Weir Controls 1.65 cfs @ 1.67 fps)

Pond POND: INFILTRATION SYSTEM - Chamber Wizard Field A

Chamber Model = Cultec R-902HD (Cultec Recharger® 902HD)
Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf
Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap
Cap Storage= +2.8 cf x 2 x 3 rows = 16.6 cf

78.0" Wide + 9.0" Spacing = 87.0" C-C Row Spacing

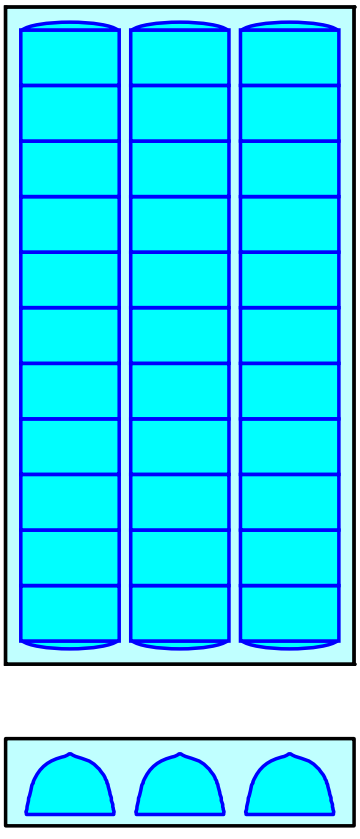
11 Chambers/Row x 3.67' Long +0.52' Cap Length x 2 = 41.37' Row Length +12.0" End Stone x 2 = 43.37' Base Length
3 Rows x 78.0" Wide + 9.0" Spacing x 2 + 12.0" Side Stone x 2 = 23.00' Base Width
9.0" Base + 48.0" Chamber Height + 12.0" Cover = 5.75' Field Height

33 Chambers x 64.7 cf + 2.8 cf Cap Volume x 2 x 3 Rows = 2,152.8 cf Chamber Storage

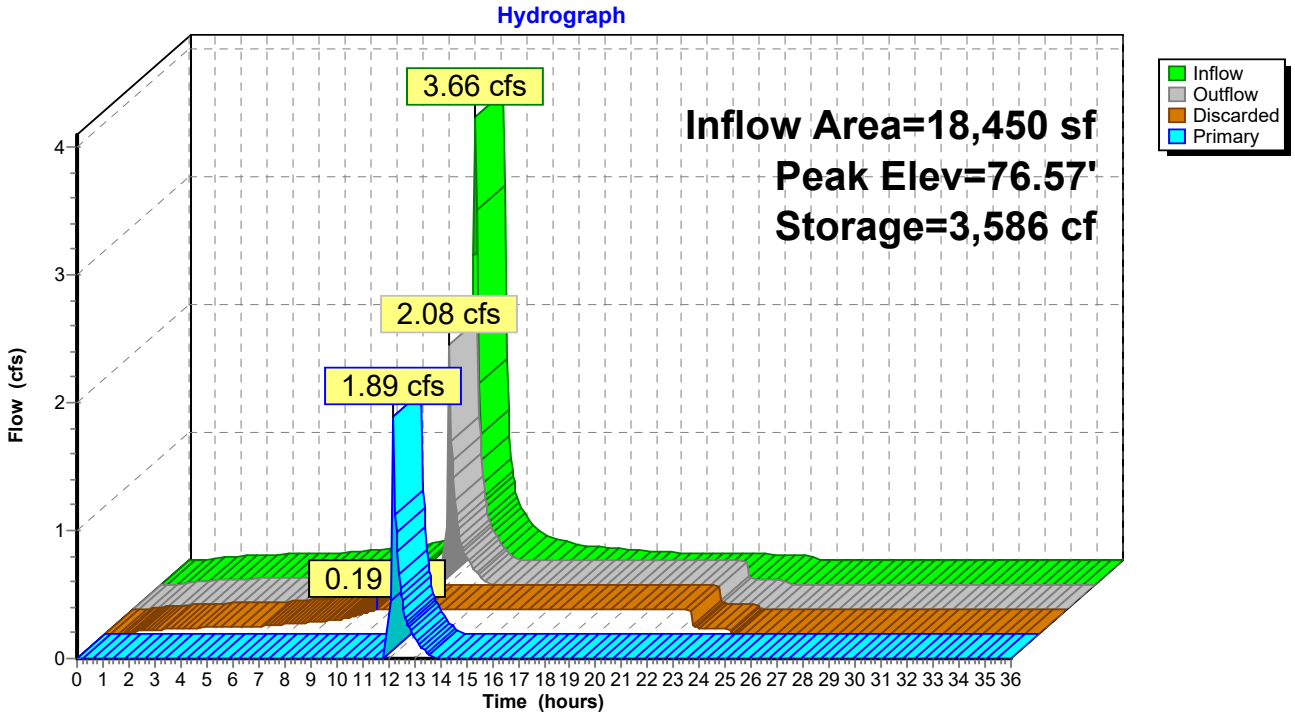
5,735.2 cf Field - 2,152.8 cf Chambers = 3,582.4 cf Stone x 40.0% Voids = 1,433.0 cf Stone Storage

Chamber Storage + Stone Storage = 3,585.8 cf = 0.082 af
Overall Storage Efficiency = 62.5%
Overall System Size = 43.37' x 23.00' x 5.75'

33 Chambers
212.4 cy Field
132.7 cy Stone



Pond POND: INFILTRATION SYSTEM



APPENDIX C

Additional Calculations:

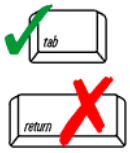
1. **Stormwater Management Form and Checklist**
2. **Recharge Volumes Calculation (Standard #3)**
3. **Water Quality Volume (Standard #4)**
4. **TSS Removal Calculations (Standard #4)**
5. **Calculation showing Infiltration System Drains in 72hrs**
6. **Operations and Maintenance Log**
7. **Inspection Schedule and Evaluation Checklists for Construction Phase and Post Development**
8. **Soil Suitability Assessment**

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☒ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☒ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☒ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

☒ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☒ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☒ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☒ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☒ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☒ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☒ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

MERRILL ENGINEERS AND LAND SURVEYORS
427 COLUMBIA ROAD, HANOVER, MA. 02339
TEL. (781) 826-9200

JOB 17-199.2
SHEET N0. 1 of 1
CALCULATED BY DA
CHECKED BY DK 5/9/2022 5/9/22
REV'D:

Location: **128 Center St, Pembroke**

Recharge Volumes (Standard #3): Re-Development - New Building Only

Total Area (Ac.)=	34.19	1,489,316 S.F.	
Total Impervious Area A Soil (Ac.)=	0.42	18,450	(Building Area only)
Total Impervious Area B Soil (Ac.)=	0.00		
Total Impervious Area C Soil (Ac.)=	0.00		

	Vol. To Recharge (inches per Imp. Acre)	Volume (Imp. Area x inches per Acre)	
Recharge Volume (A soil)	0.6	0.25	
Recharge Volume (B soil)	0.35	0.00	
Recharge Volume (C soil)	0.25	0.00	
		0.25	AC-IN
Total Required Recharge Volume:		0.02	AC-FT
		923	C.F.
Volume Provided (below outlet):		**3,502**	C.F.

MERRILL ENGINEERS AND LAND SURVEYORS
427 COLUMBIA ROAD, HANOVER, MA. 02339
TEL. (781) 826-9200

JOB 17-199.2
SHEET N0. 1 of 2
CALCULATED BY DA
CHECKED BY DK 5/9/2022

WATER QUALITY VOLUME (STANDARD #4)

ew Building Only **Pembroke Community Center - 128 Center St, Pembroke, MA**

Rear Parking Area

First Defense Unit :

Impervious area to be treated: 70,287 s.f.

Proprietary Treatment Unit: Q=(qu)(A)(WQV)

qu for Tc of 6 min.	774	(csm/in)	
Impervious Area: AC*0.0015625mi^2/AC	0.0025	mi^2	1.61 AC
WQV Treated:	1.00	in	
Q (Peak flow rate for 1" WQV):	**1.95**	cfs	
Proposed FD-5HC Max. Treated Flow Rate:	**2.34**	cfs	

Max flow rate = 20 cfs

Volume using: 0.5 or 1.0 inch x Imp. Area (per S.W. Mgmt Policy)
1 inch x Imp. Area **5,857** CF (min)

Total Walter Quality Volume Provided = **5,857** CF (Proposed)

Subsurface Infiltration System

(Pond)

WQ Treatment within Infiltration Chamber System &

Recharge Volume below outlet = **3,502**

Total Walter Quality Volume Provided = **3,502** CF (Proposed)

Water Quality Volume - Total Site Improvements

Total Impervious Area:

Proposed Roof	0.34	
Proposed Pavement/Sidewalk	1.61	
Total Area:	1.95	AC

Water Quality
Volume using: 0.5 or 1.0 inch x Imp. Area (per S.W. Mgmt Policy)
1 inch x Imp. Area **7,091** CF (min)

Total Walter Quality Volume Provided = **9,359** CF (min)

First Defense® High Capacity

A Simple Solution for your Trickiest Sites

Product Profile

The First Defense® High Capacity is an enhanced vortex separator that combines an effective stormwater treatment chamber with an integral peak flow bypass. It efficiently removes sediment total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® High Capacity is available in several model configurations to accommodate a wide range of pipe sizes, peak flows and depth constraints (**Table 1**, next page).

Applications

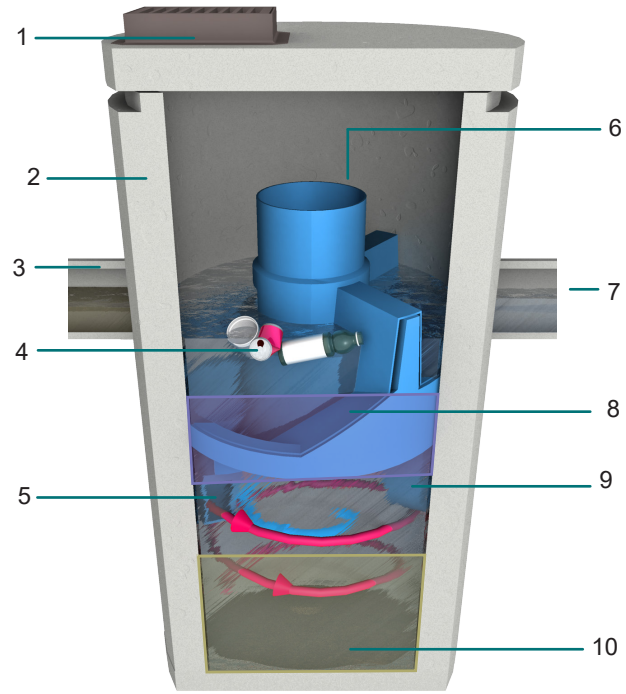
- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for "offline" arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 450% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

Verified by NJCAT and NJDEP

Fig.1 The First Defense® High Capacity has internal components designed to efficiently capture pollutants and prevent washout at peak flows.



Components

1. Inlet Grate (optional)
2. Precast chamber
3. Inlet Pipe (optional)
4. Floatables Draw Off Slot (not pictured)
5. Inlet Chute
6. Internal Bypass
7. Outlet pipe
8. Oil and Floatables Storage
9. Outlet chute
10. Sediment Storage Sump

How it Works

The First Defense® High Capacity has internal components designed to remove and retain gross debris, total suspended solids (TSS) and hydrocarbons (**Fig.1**).

Contaminated stormwater runoff enters the inlet chute from a surface grate and/or inlet pipe. The inlet chute introduces flow into the chamber tangentially to create a low energy vortex flow regime (magenta arrow) that directs sediment into the sump while oils, floating trash and debris rise to the surface.

Treated stormwater exits through a submerged outlet chute located opposite to the direction of the rotating flow (blue arrow). Enhanced vortex separation is provided by forcing the rotating flow within the vessel to follow the longest path possible rather than directly from inlet to outlet.

Higher flows bypass the treatment chamber to prevent turbulence and washout of captured pollutants. An internal bypass conveys infrequent peak flows directly to the outlet eliminating the need for, and expense of, external bypass control structures. A floatables draw off slot functions to convey floatables into the treatment chamber prior to bypass.

Hydro International, 94 Hutchins Drive, Portland, ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212
Email: stormwaterinquiry@hydro-int.com Web: www.hydro-int.com

First Defense® High Capacity

Sizing & Design

This adaptable online treatment system works easily with large pipes, multiple inlet pipes, inlet grates and now, contains a high capacity bypass for the conveyance of large peak flows. Designed with site flexibility in mind, the First Defense® High Capacity allows engineers to maximize available site space without compromising treatment level.

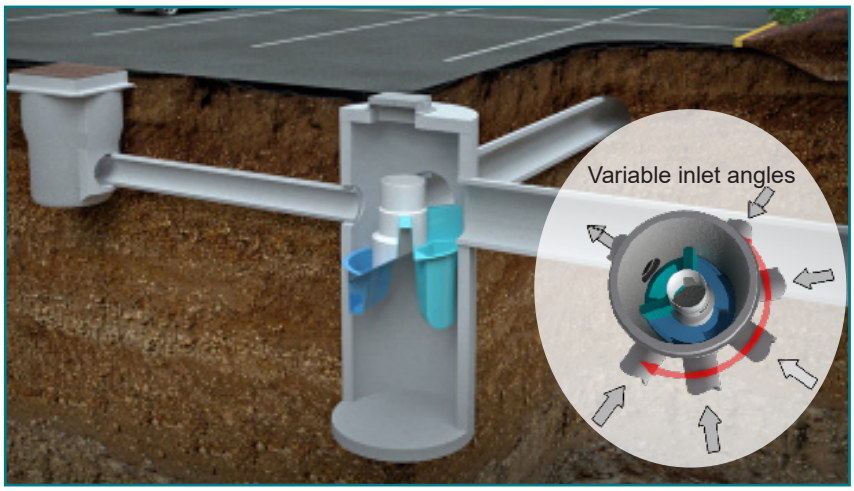


Fig 2. Works with multiple inlet pipes and grates

Inspection and Maintenance

Nobody maintains our systems better than we do. To ensure optimal, ongoing device performance, be sure to recommend Hydro International as a preferred service and maintenance provider to your clients.

Call **1 (800) 848-2706** to schedule an inspection and cleanout or learn more at **hydro-int.com/service**

Sizing Calculator for Engineers

This simple online tool will recommend the best separatror, model size and online/offline arrangement based on site-specific data entered by the user.

Go to hydro-int.com/sizing to access the tool.

Fig 3. Maintenance is done with a vactor truck

Table 1. First Defense® High Capacity Design Criteria.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates		Peak Online Flow Rate	Maximum Pipe Diameter[1]	Oil Storage Capacity	Typical Sediment Storage Capacity[2]	Minimum Distance from Outlet Invert to Top of Rim[3]	Standard Distance from Outlet Invert to Sump Floor
		NJDEP Certified	110µm						
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd^3 / m^3)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.84 / 23.7	1.06 / 30.0	15 / 424	18 / 457	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.71 / 1.13
FD-4HC	4 / 1.2	1.50 / 42.4	1.88 / 53.2	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	4.97 / 1.5
FD-5HC*	5 / 1.5	2.34 / 66.2	2.94 / 83.2	20 / 566	24 / 600	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.19 / 1.5
FD-6HC	6 / 1.8	3.38 / 95.7	4.23 / 119.8	32 / 906	30 / 750	496 / 1,878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	5.97 / 1.8
FD-8HC	8 / 2.4	6.00 / 169.9	7.52 / 212.9	50 / 1,415	48 / 1219	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	7.40 / 2.2

***Coming soon**
[1]Contact Hydro International when larger pipe sizes are required.
[2]Contact Hydro International when custom sediment storage capacity is required.
[3]Minimum distance for models depends on pipe diameter.

Hydro International, 94 Hutchins Drive, Portland, ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212
Email: stormwaterinquiry@hydro-int.com Web: www.hydro-int.com

Stormwater Solutions
hydro-int.com/firstdefensehc

Center for Environmental Systems
Stevens Institute of Technology
One Castle Point
Hoboken, NJ 07030-0000

January 9, 2016

Titus Magnanao
NJDEP
Division of Water Quality
Bureau of Non-Point Pollution Control
401-02B
PO Box 420
Trenton, NJ 08625-0420

Dear Mr. Magnanao,

Based on my review, evaluation and assessment of the testing conducted on the First Defense® HC (FDHC) Stormwater Treatment Device by Hydro International and observed by FB Environmental Associates, the test protocol requirements contained in the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" (NJDEP HDS Protocol) were met or exceeded. Specifically:

Test Sediment Feed

The mean PSD of Hydro Internationals test sediments comply with the PSD criteria established by the NJDEP HDS protocol. The Hydro International removal efficiency test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification. The test sediment was shown to be slightly finer than the sediment blend specified by the protocol. The Hydro International scour test sediment PSD analysis was plotted against the NJDEP removal efficiency test PSD specification and shown to be much finer than specified by the protocol.

Removal Efficiency Testing

In accordance with the NJDEP HDS Protocol, removal efficiency testing was executed on the 4-ft. laboratory unit in order to establish the ability of the FDHC to remove the specified test sediment at 25%, 50%, 75%, 100% and 125% of the target MTFR. Prior to the start of testing Hydro International reviewed existing data and decided to utilize a target MTFR of 675 gpm (1.50 cfs). This target was chosen based on the ultimate goal of demonstrating greater than 50% annualized weighted solids removal as defined in the NJDEP HDS Protocol. The flow rates, feed rates and influent concentration all met the NJDEP HDS test protocol's coefficient of variance requirements and the background concentration for all five test runs never exceeded 20 mg/L.

Scour Testing

In order to demonstrate the ability of the FDHC to be used as an online treatment device scour testing was conducted at greater than 200% of MTFR in accordance with the NJDEP HDS Protocol. The average flow rate during the online scour test was 3.24 cfs, which represents 216% of the MTFR (MTFR = 1.50 cfs). Background concentrations were 2 mg/L throughout the scour testing, which complies with the 20 mg/L maximum background concentration specified by the test protocol. Unadjusted effluent concentrations ranged from 2 mg/L to 4 mg/L with a mean of 2.1 mg/L. When adjusted for background concentrations, the effluent concentrations range from 0 to 2 mg/L with a mean of 0.1 mg/L. These results confirm that the 4-ft. FDHC did not scour at 216% MTFR and meets the criteria for online use.

Maintenance Frequency

The predicted maintenance frequency for all models is 44 months.

Sincerely,

Richard S. Magee, Sc.D., P.E., BCEE

Stormwater Solutions

Hydro International

Turning Water Around...®

December 21, 2015

Dr. Richard Magee, Sc.D., P.E., BCEE
Technical Director
New Jersey Corporation for Advanced Technology
c/o Center for Environmental Systems
Stevens Institute of Technology
One Castle Point on Hudson
Hoboken, NJ 07030

Re: Verification of First Defense® HC to NJDEP HDS Laboratory Testing Protocol

Dear Dr. Magee:

Hydro International's First Defense® HC (FDHC) vortex separator for stormwater treatment recently underwent verification testing according to the NJDEP HDS Laboratory Testing Protocol. As required by the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology", this letter serves as Hydro International's statement that all procedures and requirements identified in the aforementioned protocol and process document were met or exceeded. The 4-ft FDHC removal efficiency and scour tests conducted at Hydro International's laboratory facility in Portland, Maine were done so under the direct supervision of FB Environmental Associates. All water quality samples were analyzed by the independent analytical lab, Maine Environmental Laboratory. The removal efficiency particle size distribution was analyzed by the independent analytical laboratory, GeoTesting Express. The scour test particle size distribution was analyzed at Hydro International's facility under the supervision of FB Environmental Associates. Additionally, the preparation of the verification report and the documentation contained therein fulfill the submission requirements of the process document and protocol.

If you have any questions or comments regarding the verification of the FDHC, please do not hesitate to contact us.

Sincerely,

Lisa Lemont, CPSWQ
Business Development Manager

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Statement of Third Party Observer

STATEMENT OF THIRD PARTY OBSERVER

To: Lisa Lemont, Hydro International, Portland, Maine

From: Forrest Bell, FB Environmental Associates

Subject: Third Party Review under *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]

Date: December 31, 2015

cc: Andrew Anastasio, Hydro International; Jeremy Fink, Hydro International
Margaret Burns, FB Environmental Associates

Statement of Third Party Observer

FB Environmental has served as the third-party observer for tests performed by Hydro International in October through December 2015. The tests assessed the First Defense HC Stormwater Treatment Device as a 50% Total Suspended Solids (TSS) removal device under the New Jersey Department of Environmental Protection certification. Tests were performed by Hydro International staff at their laboratory located at 94 Hutchinson Drive in Portland, Maine, to meet the standards described in *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]. On May 10, 2014, we also submitted a statement of qualifications, as required by NJCAT MTD process.

A member of our staff verified compliance with the laboratory test protocol above, and our staff member was physically present to observe the full duration of all laboratory testing. We have also reviewed the data, calculations, and conclusions associated with the removal efficiency testing in the *Verification Testing Report for the First Defense® HC Stormwater Treatment Device* by Hydro International, dated December 29, 2015, and state that they conform to what we saw during our supervision as third-party observer.

Forrest Bell — December 31, 2015

Signed: Date:

[1] Available at http://www.nj.gov/dep/stormwater/treatment.html

Statement of Disclosure

STATEMENT OF DISCLOSURE – THIRD PARTY OBSERVER

To: Lisa Lemont, Hydro International, Portland, Maine

From: Forrest Bell, FB Environmental Associates

Subject: Third Party Observer Statement of Disclosure under *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP, January 25 2013)[1]

Date: December 31, 2015

cc: Andrew Anastasio, Hydro International
Margaret Burns, FB Environmental Associates

Statement of Disclosure – Third Party Observer

FB Environmental has no financial conflict of interest regarding the test results of the stormwater device testing outlined in the *Verification Testing Report for the First Defense ® HC Stormwater Treatment Device* by Hydro International, dated December 29, 2015.

Disclosure Record

FB Environmental has provided the service of third party observer for tests performed by Hydro International in October through December of 2015. The tests assessed the First Defense HC Stormwater Treatment Device as a 50% Total Suspended Solids (TSS) removal device under the New Jersey Department of Environmental Protection certification as outlined in the *Verification Testing Report for the First Defense ® HC Stormwater Treatment Device* by Hydro International, dated December 29, 2015. Beyond this, FB Environmental and Hydro International have no relationships that would constitute a conflict of interest, as outlined in *Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advanced Technology* (NJDEP 2013). For example, we have no ownership stake, do not receive commissions, do not have licensing agreements, and do not receive funds or grants beyond those associated with the testing program.

Fort Bell — December 31, 2015

Signed: Date:

[1] Available at http://www.nj.gov/dep/stormwater/treatment.html

1 of 1

Hydrograph for Pond POND: INFILTRATION SYSTEM

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)	
0.00	0.00	0	70.75	0.00	0.00	0.00	
1.00	0.02	2	70.76	0.01	0.01	0.00	
2.00	0.03	4	70.76	0.03	0.03	0.00	
3.00	0.04	6	70.76	0.04	0.04	0.00	
4.00	0.05	7	70.77	0.05	0.05	0.00	
5.00	0.06	8	70.77	0.06	0.06	0.00	
6.00	0.06	8	70.77	0.06	0.06	0.00	
7.00	0.08	11	70.78	0.08	0.08	0.00	
8.00	0.09	13	70.78	0.09	0.09	0.00	
9.00	0.11	15	70.79	0.11	0.11	0.00	
10.00	0.17	22	70.81	0.16	**0.16**	0.00	
11.00	0.29	114	71.04	0.19	**0.19**	0.00	
12.00	**2.01**	**1,687**	**73.23**	**0.19**	0.19	**0.00**	
13.00	**0.35**	**3,526**	**76.35**	**0.36**	0.19	**0.17**	
14.00	0.18	3,501	76.29	0.19	0.19	0.00	
15.00	0.12	3,352	75.91	0.19	0.19	0.00	
16.00	0.10	3,053	75.20	0.19	0.19	0.00	
17.00	0.08	2,695	74.61	0.19	0.19	0.00	
18.00	0.07	2,278	74.02	0.19	0.19	0.00	
19.00	0.06	1,819	73.40	0.19	0.19	0.00	
20.00	0.06	1,346	72.79	0.19	0.19	0.00	
21.00	0.05	858	72.18	0.19	0.19	0.00	
22.00	0.05	355	71.57	0.19	0.19	0.00	
23.00	0.05	6	70.77	0.05	0.05	0.00	
24.00	0.04	6	70.76	0.04	0.04	0.00	
25.00	0.00	0	70.75	0.00	0.00	0.00	SYSTEM EMPTY AT 25hrs
26.00	0.00	0	70.75	0.00	0.00	0.00	
27.00	0.00	0	70.75	0.00	0.00	0.00	
28.00	0.00	0	70.75	0.00	0.00	0.00	
29.00	0.00	0	70.75	0.00	0.00	0.00	
30.00	0.00	0	70.75	0.00	0.00	0.00	
31.00	0.00	0	70.75	0.00	0.00	0.00	
32.00	0.00	0	70.75	0.00	0.00	0.00	
33.00	0.00	0	70.75	0.00	0.00	0.00	
34.00	0.00	0	70.75	0.00	0.00	0.00	
35.00	0.00	0	70.75	0.00	0.00	0.00	
36.00	0.00	0	70.75	0.00	0.00	0.00	

Operation and Maintenance Log

Project Name: **PEMBROKE COMMUNITY CENTER**

Project Location: **128 Center Street, Pembroke, Massachusetts 02359**

Inspection Log: *(attach additional pages as necessary)*

No.	Date	Name of Inspector	Signature
1			
2			
3			
4			
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6			
7			
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9			
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STORMWATER MANAGEMENT
BEST MANAGEMENT PRACTICES
INSPECTION SCHEDULE AND EVALUATION CHECKLIST – CONSTRUCTION PHASE

PROJECT LOCATION: 128 Center St, Pembroke, MA Latest Revision: _____

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/ Repair Needed yes/no List items	Date of Cleaning/Repair	Performed By	Water Level in Infiltration System
Silt fence	After every major storm event			Check sediment levels and remove when reaches ¼ to ½ the height of fence				
Catch basins (Existing)	Weekly or after major storm event.			Check silt sack sediment levels				
Stockpiles	After every major storm event			Ensure surrounding erosion control measure are intact				

(1) Refer to the Massachusetts Stormwater Management, Volume Two: Stormwater Technical Handbook (March 1997) for recommendations regarding frequency for inspection and maintenance of specific BMPs.

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended. Slow release fertilizer recommended.
Other notes:(Include deviations from: Con Com Order of Conditions, PB Approval, Construction Sequence and Approved Plan)

Stormwater Control Manager: _____ **Stamp**

H:\17-199.2\Documents\Drainage\17-199.2 ISEC-CONST PHASE.doc

STORMWATER MANAGEMENT
BEST MANAGEMENT PRACTICES
INSPECTION SCHEDULE AND EVALUATION CHECKLIST – POST CONSTRUCTION PHASE

PROJECT LOCATION: **128 Center St, Pembroke, MA** Latest Revision:_____

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/ Repair Needed yes/no List items	Date of Cleaning/Repair	Performed By	Water Level in Detention System
Drain Lines	Yearly			-Sediment build-up -Trash and debris				
Deep Sump Hooded Catch Basins	Quarterly			-Sediment level exceeds 8” -Trach and debris - Floatable oils or hydrocarbon - Grate or outlet blockage				
Pre-Treatment Structure (First Defense Units)	Quarterly			-Sediment not to exceed 18” -Floating contaminates shall be removed by vacuum pump prior to sediment removal -Outlet blockages				
Subsurface Infiltration Chamber Systems	Twice a Year			-Sediment buildup -Standing water greater than 48 hours				
Roadway Pavement Maintenance	Quarterly							

(1) Refer to the Massachusetts Stormwater Management, Volume Two: Stormwater Technical Handbook (2008) for recommendations regarding frequency for inspection and maintenance of specific BMPs.

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended. Slow release fertilizer recommended.
Other notes:(Include deviations from: Con Com Order of Conditions, PB Approval, Construction Sequence and Approved Plan)

Stormwater Control Manager: _____ **Stamp**

Soil Map—Plymouth County, Massachusetts
(128 Center St New Community Center)

Map Scale: 1:3,260 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 45 90 180 270

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N 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 1:12,000.

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: Plymouth County, Massachusetts
Survey Area Data: Version 14, Sep 2, 2021

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

Date(s) aerial images were photographed: Jul 31, 2019—Sep 1, 2019

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
37A	Massasoit - Mashpee complex, 0 to 3 percent slopes	1.4	4.4%
52A	Freetown muck, 0 to 1 percent slopes	1.7	5.2%
53A	Freetown muck, ponded, 0 to 1 percent slopes	7.3	22.5%
221A	Eldridge fine sandy loam, 0 to 3 percent slopes	3.3	10.2%
221B	Eldridge fine sandy loam, 3 to 8 percent slopes	0.0	0.0%
226B	Hinesburg fine sandy loam, 3 to 8 percent slopes	0.2	0.6%
480C	Plymouth - Carver complex, 8 to 15 percent slopes	0.5	1.6%
480E	Plymouth - Carver complex, 15 to 35 percent slopes	5.2	16.1%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	10.4	32.2%
659B	Udorthents, 0 to 8 percent slopes, gravelly	2.3	7.1%
Totals for Area of Interest		**32.3**	**100.0%**

Plymouth County, Massachusetts

626B—Merrimac-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyr9
Elevation: 0 to 820 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Merrimac and similar soils: 45 percent
Urban land: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Merrimac

Setting

Landform: Outwash plains, outwash terraces, moraines, eskers, kames
Landform position (two-dimensional): Backslope, footslope, summit, shoulder
Landform position (three-dimensional): Crest, side slope, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Maximum salinity: Nonsaline (0.0 to 1.4 mmhos/cm)

Sodium adsorption ratio, maximum: 1.0
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Description of Urban Land

Typical profile
M - 0 to 10 inches: cemented material

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: 0 inches to manufactured layer
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low (0.00 to 0.00 in/hr)
Available water supply, 0 to 60 inches: Very low (about 0.0 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: Unranked

Minor Components

Hinckley
Percent of map unit: 5 percent
Landform: Deltas, kames, eskers, outwash plains
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, crest, head slope, side slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear
Hydric soil rating: No

Sudbury
Percent of map unit: 5 percent
Landform: Deltas, terraces, outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Windsor
Percent of map unit: 5 percent
Landform: Outwash terraces, dunes, outwash plains, deltas
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, convex

Across-slope shape: Linear, convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 14, Sep 2, 2021

APPENDIX D

Existing and Proposed Watersheds Plan
(Insert)

PRE-DEVELOPMENT WATERSHEDS

SUBCATCHMENT 1E – TRIB. TO TOWN GREEN

DESCRIPTION	AREA (S.F.)	
IMPERVIOUS AREA	4,225	S.F.
GRASS HSG B	39,193	S.F.
SUBTOTAL	43,418	S.F.

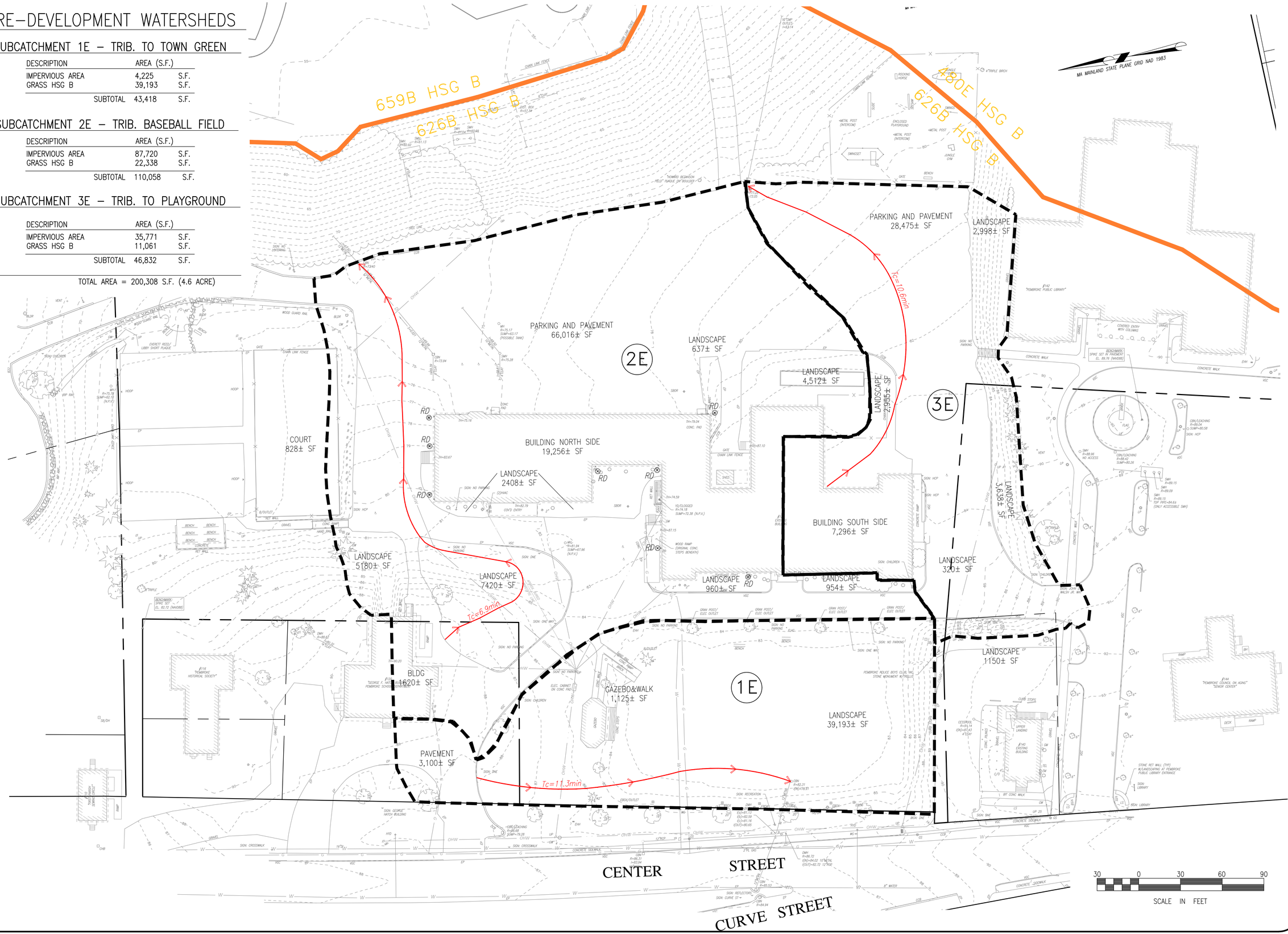
SUBCATCHMENT 2E – TRIB. BASEBALL FIELD

DESCRIPTION	AREA (S.F.)	
IMPERVIOUS AREA	87,720	S.F.
GRASS HSG B	22,338	S.F.
SUBTOTAL	110,058	S.F.

SUBCATCHMENT 3E – TRIB. TO PLAYGROUND

DESCRIPTION	AREA (S.F.)	
IMPERVIOUS AREA	35,771	S.F.
GRASS HSG B	11,061	S.F.
SUBTOTAL	46,832	S.F.

TOTAL AREA = 200,308 S.F. (4.6 ACRE)



REVISIONS

DRAWN BY:	PAL
DESIGNED BY:	PAL/DA
CHECKED BY:	DA

Merrill
Engineers and Land Surveyors
427 COLUMBIA ROAD, HANOVER, MA 02339 / T: (781) 826-9200
26 UNION STREET, PLYMOUTH MA 02360 / T: (508) 746-6060
WWW.MERRILLINC.COM

EXISTING WATERSHED PLAN

#128 CENTER STREET
PEMBROKE, MASSACHUSETTS

PREPARED FOR
BARGMANN HENDRIE + ARCHETYPE, INC.
9 CHANNEL CENTER STREET, SUITE 300
BOSTON, MASSACHUSETTS 02210

MAY 6, 2022

SCALE: AS NOTED

JOB NO. 17-199.2

LATEST REVISION:

SHEET 1 OF 1

POST–DEVELOPMENT WATERSHEDS

SUBCATCHMENT 1P – TRIB. TO END OF DRIVE

DESCRIPTION	AREA (S.F.)	
IMPERVIOUS AREA	2,084	S.F.
GRASS HSG B	22,674	S.F.
SUBTOTAL	24,758	S.F.

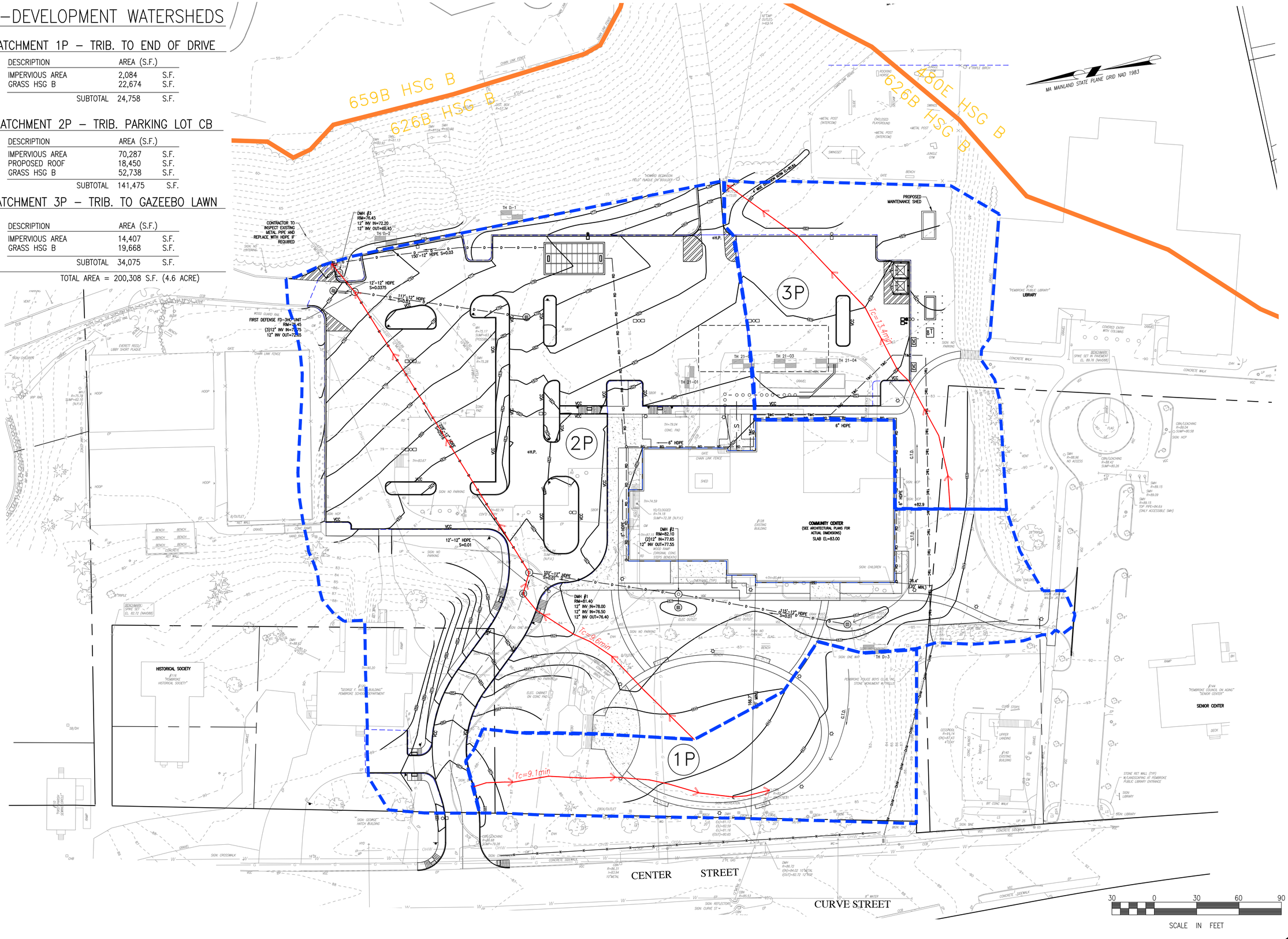
SUBCATCHMENT 2P – TRIB. PARKING LOT CB

DESCRIPTION	AREA (S.F.)	
IMPERVIOUS AREA	70,287	S.F.
PROPOSED ROOF	18,450	S.F.
GRASS HSG B	52,738	S.F.
SUBTOTAL	141,475	S.F.

SUBCATCHMENT 3P – TRIB. TO GAZEEBO LAWN

DESCRIPTION	AREA (S.F.)	
IMPERVIOUS AREA	14,407	S.F.
GRASS HSG B	19,668	S.F.
SUBTOTAL	34,075	S.F.

TOTAL AREA = 200,308 S.F. (4.6 ACRE)



REVISIONS

DRAWN BY: PAL

DESIGNED BY: PAL/DA

CHECKED BY: DA

Merrill
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PROPOSED WATERSHED PLAN

#128 CENTER STREET
PEMBROKE, MASSACHUSETTS

PREPARED FOR

BARGMANN HENDRIE + ARCHETYPE, INC.
9 CHANNEL CENTER STREET, SUITE 300
BOSTON, MASSACHUSETTS 02210

MAY 6, 2022

SCALE: AS NOTED

JOB NO. 17–199.2

LATEST REVISION:

SHEET 1 OF 1

APPENDIX E

Operations and Maintenance Plan

OPERATION AND MAINTENANCE PLAN

PROPOSED DRAINAGE SYSTEM – DURING CONSTRUCTION
May 9, 2022

128 Center Street
Pembroke, MA 02339

Owner: Town of Pembroke
128Center Street
Pembroke, MA 02339

Party Responsible for Operation and Maintenance:
Town of Pembroke DPW
Attn: Eugene Fulmine
100 Center Street
Pembroke, MA 02339

Source of Funding:
Operation and Maintenance of this stormwater management system will be the responsibility of the property owner to include its successor and/or assigns, as the same may appear on record with the appropriate register of deeds.

During Construction:
Construction activities shall follow the Construction Sequence shown on the approved plan. During periods of active construction, the stormwater management system shall be inspected on a weekly basis and within 24 hours of a storm event of greater than 1/2". Maintenance tasks shall be performed monthly or after significant rainfall events of 1" of rain or greater. During construction, silt laden runoff shall be prevented from entering the existing street drainage system(s) and off-site properties.

All erosion and sedimentation control measures shall be in place prior to the commencement of any site work or earthwork operations, shall be maintained during construction, and shall remain in place until all site work is complete and ground cover is established. All erosion and sedimentation control measures shall be constructed in accordance with the Massachusetts erosion and sediment control guidelines for urban and suburban areas dated March 1997 and all municipal regulations. The location of erosion control measures shall be field verified during site preparation operation by the design engineer. The contractor shall keep on site at all time additional erosion control measures for installation at the

direction of the engineer or town officials to mitigate any emergency conditions. The contractor shall anticipate and modify erosion control measures based on past and current weather conditions, season and expected future construction activities.

Sediment at the silt sock erosion control barriers shall be removed once the volume reaches ¼ to ½ the height of the silt sock and shall be maintained throughout the project. Disposal of sediment shall be the responsibility of the contractor in accordance with applicable local, state, and federal guidelines and regulations.

The stabilized construction entrance shall be placed at the project street entrance and shall consist of ¾" to 1 1/2" stone and be constructed as shown on the approved plans. The stabilized construction entrance shall be maintained in a condition that will prevent tracking or flowing of sediment outside the construction area. All sediment dropped, washed or tracked onto the public right-of-way must be removed immediately. Dust shall be controlled on site.

During dewatering operations (if necessary), all water pumped shall be directed to a "dirt bag" pumped sediment removal system (or approved equal) as manufactured by ACF Environmental. The unit shall be placed on a crushed stone blanket. Disposal of such "dirt bag" shall occur when the device is full and can no longer effectively filter sediment or allow water to pass at a reasonable flow rate. Disposal of this unit shall be the responsibility of the contractor in accordance with applicable local, state, and federal guidelines and regulations.

All stockpiles shall be surrounded by erosion controls. The tops of stockpiles shall be covered in such a manner so that stormwater does not infiltrate the materials and thereby render the same unsuitable for fill use. All areas disturbed by construction and not to be paved or otherwise treated as noted on the plan shall be treated with 6" loam, seeded with and straw mulched for erosion control. Where construction activities have permanently ceased or have temporarily been suspended for more than seven days, or when final grades are reached in any portion of the site, stabilization practices shall be implemented within three days.

Earthwork activity on the site shall be done in a manner such that runoff is directed to the line of erosion control measures. Disturbed areas remaining idle for more than 10 days shall be stabilized.

The stormwater infiltration system(s) shall be inspected after every major storm event during construction and cleaned to ensure proper function. The pre-treatment structures shall be inspected after every major storm event during construction and cleaned when sediment exceeds 6” of depth.

Once each structure is in place, it shall be maintained in accordance with the procedures described in the post-construction Operations and Maintenance Plan.

Inspections

The owner shall be responsible to secure the services of a Professional Engineer or similar professional (inspector) on an on-going basis. The inspector shall review the project with respect to the following:

- Proper installation and performance of the Stormwater Management System.
- Review of the controls to determine any damaged or ineffective controls.
- Corrective actions.

The inspector shall prepare and submit a report documenting the findings and should request the required maintenance or repair for the pollution prevention controls when the inspector finds that it is necessary for the control to be effective. The inspector shall notify the Owner to make the changes.

APPENDIX F

Long Term Pollution Prevention Plan

LONG TERM SOURCE CONTROL/POLLUTION PREVENTION PLAN AND OPERATION AND MAINTENANCE PLAN

PROPOSED DRAINAGE SYSTEM – POST CONSTRUCTION
May 9, 2022

128 Center Street
Pembroke, MA 02339

Owner: Town of Pembroke
128Center Street
Pembroke, MA 02339

Party Responsible for Operation and Maintenance:
Town of Pembroke DPW
Attn: Eugene Fulmine
100 Center Street
Pembroke, MA 02339

Note: Inspection records shall be maintained for a period of three years, on an ongoing basis.

Source of Funding:
Operation and Maintenance of this stormwater management system will be the responsibility of the property owner to include its successor and/or assigns, as the same may appear on record with the appropriate register of deeds.

1.0 Vehicle Washing Controls

There will be no vehicle washing operations on the site

2.0 Requirements for Routine Inspections and Maintenance of Stormwater Best Management Practices

Note: The Town shall be notified immediately if a change in ownership or maintenance responsibility occurs at the site.

Street Sweeping

Streets and parking areas shall be swept at least twice per year. Sweeping shall be completed during the early spring, no later than May 1st, before sediment from winter sanding operations is washed into the drainage system and in the fall after November 1st. Disposal of the accumulated sediment shall be in accordance with applicable local, state, and federal guidelines and regulations.

Drain lines

After construction, the drain lines shall be inspected after every major storm for the first few months to ensure proper functions. Presence of accumulated sand and silt would indicate more frequent maintenance of the pre-treatment devices is required. Thereafter, the drain lines shall be inspected at least once per year.

Deep sump and hooded Catch Basins

Catch basin grates shall be checked quarterly and following heavy rainfalls to verify that the inlet openings are not clogged by debris. Debris shall be removed from the grates and disposed of properly. Deep sump catch basins shall be inspected and cleaned bi-annually of all accumulated sediments. Catch basins with hoods shall be inspected annually to check oil build-up and outlet obstructions. Material shall be removed from catch basins and disposed of in accordance with all applicable regulations.

Pre-treatment Structures – First Defense FD-3HC

The proprietary pretreatment unit shall be inspected and maintained from the surface, without entry into the unit biannually and following heavy rain events defined as a storm event exceeding one inch of rainfall within a twenty-four hour period to verify that the inlet opening is not clogged by debris.

During the first year of installation, perform inspection regularly, so an accurate maintenance schedule can be established. Perform oil and floatables removal once per year and immediately in the event of a spill. Oil shall be removed by using a small portable pump and disposed of properly. Perform sediment removal once per year or as needed and following a spill event. Sediment shall be removed from the unit using a vacuum truck. The requirements for the disposal from the unit should be in compliance with all local, state and federal regulations.

Please refer to the attached manufacturer's maintenance manual for additional detail on proper inspection and maintenance of the First Defense unit.

Subsurface Infiltration Chamber System

Proper maintenance of the subsurface infiltration system is essential to the long-term effectiveness of the infiltration function. After construction, the subsurface infiltration chamber systems shall be inspected for proper function after every major storm event until the site is completely developed and stabilized. After the site has been stabilized, the subsurface infiltration chamber system shall be inspected at least twice per year or if lack of performance is observed and perform necessary corrective measures to maintain infiltration capacity; as required by the Stormwater Management Policy.

The system shall have inspection ports for proper inspections. Inspections shall include checking the water level in the system after a major storm event, and performing necessary corrective action if water is observed 72 hours following the storm. The owner shall retain a qualified stormwater professional to assess the cause of this condition and develop a corrective action plan for restoring the infiltration function. The owner shall immediately implement the corrective action to restore the infiltration function. Documentation of these actions shall be maintained in the inspection and maintenance records.

Inspection and Maintenance Options

A. The CULTEC system may be equipped with an inspection port located on the inlet row. The inspection port is a circular cast box placed in a rectangular concrete collar. When the lid is removed, a 6-inch (150 mm) pipe with a screw-in plug will be exposed. Remove the plug. This will provide access to the CULTEC Chamber row below. From the surface, through this access, the sediment may be measured at this location. A stadia rod may be used to measure the depth of sediment if any in this row. If the depth of sediment is in excess of 3 inches (76 mm), then this row should be cleaned with high pressure water through a culvert cleaning nozzle. This would be carried out through an upstream manhole or through the CULTEC StormFilter Unit (or other pretreatment device). CCTV inspection of this row can be deployed through this access port to deter mine if any sediment has accumulated in the inlet row.

B. If the CULTEC bed is not equipped with an inspection port, then access to the inlet row will be through an upstream manhole or the CULTEC StormFilter.

1. Manhole Access This inspection should only be carried out by persons trained in confined space entry and sewer inspection services. After the manhole cover has been removed a gas detector must be lowered into the manhole to ensure that there are not high concentrations of toxic gases present. The inspector should be lowered into the manhole with the proper safety equipment as per OSHA requirements. The inspector may be able to observe sediment from this location. If this is not possible, the inspector will need to deploy a CCTV robot to permit viewing of the sediment. 4 OPERATIONS AND MAINTENANCE GUIDELINES For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com. © CULTEC, Inc. CLT057 01-20

2. StormFilter Access Remove the manhole cover to allow access to the unit. Typically a 30-inch (750 mm) pipe is used as a riser from the StormFilter to the surface. As in the case with manhole access, this access point requires a technician trained in confined space entry with proper gas detection equipment. This individual must be equipped with the proper safety equipment for entry into the StormFilter. The technician will be lowered onto the StormFilter unit. The hatch on the unit must be

removed. Inside the unit are two filters which may be removed according to StormFilter maintenance guidelines. Once these filters are removed the inspector can enter the StormFilter unit to launch the CCTV camera robot.

C. The inlet row of the CULTEC system is placed on a polyethylene liner to prevent scouring of the washed stone beneath this row. This also facilitates the flushing of this row with high pressure water through a culvert cleaning nozzle. The nozzle is deployed through a manhole or the StormFilter and extended to the end of the row. The water is turned on and the inlet row is back-flushed into the manhole or StormFilter. This water is to be removed from the manhole or StormFilter using a vacuum truck.

Maintenance Guidelines

The following guidelines shall be adhered to for the operation and maintenance of the CULTEC stormwater management system:

A. The owner shall keep a maintenance log which shall include details of any events which would have an effect on the system's operational capacity.

B. The operation and maintenance procedure shall be reviewed periodically and changed to meet site conditions.

C. Maintenance of the stormwater management system shall be performed by qualified workers and shall follow applicable occupational health and safety requirements.

D. Debris removed from the stormwater management system shall be disposed of in accordance with applicable laws and regulations.

Suggested Maintenance Schedules

A. Minor Maintenance The following suggested schedule shall be followed for routine maintenance during the regular operation of the stormwater system:

Frequency	Action
Monthly in first year	Check inlets and outlets for clogging and remove any debris, as required.
Spring and Fall	Check inlets and outlets for clogging and remove any debris, as required.
One year after commissioning and every third year following	Check inlets and outlets for clogging and remove any debris, as required.

Inspection & Maintenance Steps
Accumulated sediment must be removed from the bottom of the chambers. Material removed from the systems shall be disposed of in accordance with all applicable local, state, and federal regulations.

3.0 Snow Disposal and Plowing Plans

1. Site Selection

Snow disposal is to be located adjacent to or on pervious surfaces. At these locations, the snow meltwater can filter in to the soil, leaving behind sand and debris which can be removed in the springtime.

2. Site Preparation and Maintenance

It is important to prepare and maintain these sites to maximize their effectiveness. The following maintenance measures should be undertaken for all snow disposal sites:

- Some form of a barrier should be placed securely on any down gradient side of the snow disposal site, to prevent snow from migrating beyond the designated disposal area, or over property lines.
- Debris should be cleared from the site prior to using the site for snow disposal.
- Debris should be cleared from the site and properly disposed of at the end of the snow season and no later than May 15.

Any snow that cannot be properly disposed of as outlined above, shall be removed from the site and disposed of in accordance with State, Federal, and Local Regulations.

4.0 Provisions for Solid Waste Management

Waste disposal dumpsters and trailers will be used for the disposal of construction debris, which will be removed from site according to state, local and federal guidelines. Construction debris will include pavement, utility, earth and building materials, which cannot be reused. The dumpsters will be located on-site, covered, and placed well away from the wetland resource areas and catch basins as possible. All machinery will be operated and maintained so as to limit impacts to drainage systems by avoiding leakage of fuel. If stockpiles of debris materials are necessary, perimeter controls or plastic sheeting/covering will be used if deemed

necessary during regular site inspections. A concrete washout area will be established as necessary and utilized.

Portable sanitary units will be placed on-site during construction and will be serviced regularly. They will be placed over 100 feet from resource areas wherever possible.

5.0 Spill Prevention

The Owner shall be aware of, educate occupants of, and enforce the following spill prevention measures:

Material Management Practices
The following are the material management practices that will be used to reduce the risk of spills or other accidental exposure of materials and substances to storm water runoff.

Good Housekeeping:
The following good housekeeping practices will be followed onsite during the construction project:

- An effort will be made to store only enough product required to do the job.
- All materials stored onsite will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof or other enclosure.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, all of a product will be used up before disposing of the container
- Manufacturer's recommendations for proper use and disposal will be followed

Hazardous Products
These practices are used to reduce the risks associated with hazardous materials.

- Exterior storage of deicing chemicals, fertilizers, herbicides, pesticides, or other hazardous materials shall be prohibited.
- Products will be kept in original containers unless they are not resalable.
- Original labels and material safety data will be retained; they contain important product information.

- If surplus product must be disposed of, manufacturers or local State recommended methods for proper disposal will be followed.

Product Specific Practices
The following product specific practices will be followed onsite:

Petroleum Products
All onsite vehicles will be monitored for leaks and receive regular preventative maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers which are clearly labeled. Any asphalt substances used onsite will be applied according to the manufacturer's recommendations.

Fertilizers
If used, fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to storm water. Storage will be in a covered shed; exterior storage shall be prohibited. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.

Paints
All containers will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to manufacturers' instructions or State and local regulations.

Spill Control Practices
In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup:

- Manufacturers' recommended methods for spill cleanup will be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area onsite. Equipment and materials will include but not be limited to brooms, dustpans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose.
- All spills will be cleaned up immediately after discovery.

- The spill area will be kept well ventilated and personnel will wear appropriate State or local government agency, protective clothing, regardless of the size.
- The spill prevention plan will be adjusted to include measures to prevent this type of spill from reoccurring and how to clean up the spill if there is another one. A description of the spill, what cause it, and the cleanup measures will also be included.

6.0 Solid Waste

Solid Waste shall be picked up by a private firm, and solid waste disposed of in accordance with State, Federal, and Local regulations.

7.0 Street Sweeping

The parking area shall be swept at least four times per year. Sweeping shall be completed during the early spring, no later than May 1st, before sediment from winter sanding operations is washed into the drainage system. Disposal of the accumulated sediment shall be in accordance with applicable local, state, and federal guidelines and regulations.

8. Illicit Discharge Statement

To the best of our knowledge, there are no current illicit discharges present on the site. No new illicit discharges from the site are proposed. **The site operator is specifically notified that Illicit Discharges are prohibited.** Below is a list of those non-stormwater discharges allowed by MassDEP.

Dana M. Altobello, P.E.

Allowable Non-Stormwater Discharges

The following non-storm water discharges are authorized provided it has been determined by the permittee that they are not significant contributors of pollutants to the MS4. If these discharges are identified as significant contributors to the MS4, they must be addressed in the Illicit Discharge Detection and Elimination minimum control measure described in Parts II, III, IV and V.

1. water line flushing,
2. landscape irrigation,
3. diverted stream flows,
4. rising ground waters,
5. uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)),
6. uncontaminated pumped ground water,
7. discharge from potable water sources,
8. foundation drains,
9. air conditioning condensation,
10. irrigation water, springs,
11. water from crawl space pumps,
12. footing drains,
13. lawn watering,
14. flows from riparian habitats and wetlands,
15. dechlorinated swimming pool discharges,
16. street wash water, and
17. Residential building wash waters, without detergents.

Discharges or flows from firefighting activities occur during emergency situations. The permittee is not expected to evaluate firefighting discharges with regard to pollutant contributions. Therefore, these discharges are authorized as allowable non-storm water discharges, unless identified, by EPA, as significant sources of pollutants to Waters of the U.S..

For additional information, refer to Performance, Standards and Guidelines for Stormwater Management in Massachusetts, published by the Department of Environmental Protection.

Maintenance Cost

The maintenance cost shall include BMP inspections, maintenance of subsurface drainage infiltration chambers, cleaning sediment forebays, outlet control structures, street sweeping and minor maintenance repairs. The anticipated maintenance cost $750 per year.