STORMWATER CALCULATIONS & REPORT

Project

50 Mattakeesett Street,
Pembroke, MA 02359
Assessor's Parcel C9-23E
Proposed Warehouse Building

Owner

JPC / Pembroke Realty Trust
137 Washington Street
Norwell, MA 02061

Applicant

Mike Bulman
P.O. Box 20
Scituate, MA 02066

Date: February 7, 2020
Revised: March 2, 2020
Revised: May 28, 2020

Prepared by:

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Registered Professional Engineers,
Project Managers & Environmental Consultants

www.MorseCoInc.com

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Project Narrative
50 Mattakeesett Street
Pembroke, Massachusetts

Project Summary

The project proponent proposes to construct one new warehouse building at 50 Mattakeesett Street, Pembroke, MA. The property is shown as Pembroke Assessor's Parcel C9-23E and is approximately 1.5 acres. The property has frontage on Mattakeesett Street and is abutted by developed residential properties. The property slopes to the southwest, northwest, and northeast towards the abutting residential properties.

The proposed stormwater system is comprised of a stormwater basin and a roof drywell system. The systems will provide groundwater recharge of stormwater roof runoff and control the rates and volumes of runoff.

Pre-Development Condition

The site is currently comprised of an office building, paved parking lot, concrete walkway, woods, lawn and landscaped areas. The property currently has a stormwater system consisting of catch basins and leaching pits located in corners of the parking lot.

Soil information was obtained from the Soils Conservation Services (SCS) Survey of Plymouth County, Massachusetts and on-site soil testing. Based on SCS Soils Mapping the soils are classified as "427B – Newfields fine sandy loam, 3 to 8 percent slopes" (Hydrologic Soil Group B).

Post-Development Condition

In the post-development condition stormwater analysis, the same watershed areas were analyzed for the purpose of analyzing the rates and volumes of runoff from the proposed new storage unit buildings, and driveways. The proposed stormwater system is comprised of a roof drywell system with an overflow to an infiltration basin. The system will provide groundwater recharge, treatment of driveway runoff and control the rates and volumes of runoff. Refer to Watershed Delineation Plan WS-2 for a delineation of post-development drainage subareas. The design points for the post-development design condition correspond to the design points for the pre-development design condition and are shown on Plans WS-1 and WS-2.

The stormwater management system was designed to be in compliance with the DEP Stormwater Management Policy to the extent practicable.

Erosion and Siltation Control

The potential for temporary impacts to downgradient properties and/or wetlands due to erosion and migration of sediments will be mitigated by adherence to basic erosion control practices. These include:

1. Install staked mulch sock and/or silt fence (as directed by Conservation Agent) at the upland edge of the limit of work as shown on the Site Plan. This erosion control barrier shall be installed prior to earthwork at the site. An additional stockpile of siltation fence, and stakes will be stored on site for use in repairing the erosion control barrier as needed. Inspections of the erosion control barrier shall be made weekly and after all significant rainfall events.
2. Clearly define the limits of work in the field in order to minimize the extent of clearing and soil disturbance.
3. Regrade, loam and seed exposed soil areas immediately following construction.

SUMMARY OF STORMWATER STANDARDS 1 – 10
(50 Mattakeesett Street, Pembroke, MA)

Standard #1: ***No new stormwater conveyances (i.e. outfalls)…***

The project complies as it does not propose any new stormwater outfalls. Stormwater in the existing and proposed conditions flows overland in a southwesterly direction towards the abutting properties. It is the intent of the proposed design to follow the natural/existing conditions stormwater flow paths to the extent practicable. Proposed roof runoff will be directed to a roof drywell system and the driveway runoff will be directed to rain garden.

Standard #2: ***Post-Development peak discharge rates do not exceed pre-development rates…***

The project has been designed to mitigate peak rates and volumes of runoff. See below for calculations of the runoff discharges and volumes for the 2, 10 and 100-yr. storm events.

Peak Discharge Rates (cfs):

Design Point #1:

	2-Yr.	10-Yr.	100-Yr.
Pre-Development	0.44	1.39	4.30
Post-Development	0.28	0.79	3.40

Design Point #3:

	2-Yr.	10-Yr.	100-Yr.
Pre-Development	0.08	0.37	1.42
Post-Development	0.08	0.37	1.42

Volume of Runoff (ac-ft.):

Design Point #1:

	2-Yr.	10-Yr.	100-Yr.
Pre-Development	0.046	0.118	0.342
Post-Development	0.027	0.066	0.262

Design Point #3:

	2-Yr.	10-Yr.	100-Yr.
Pre-Development	0.013	0.040	0.130
Post-Development	0.013	0.040	0.130

Standard #3: ***Loss of annual recharge to groundwater shall be eliminated…***

There is no loss of annual recharge to groundwater because the project proposes an infiltration basin and system of roof drywell chambers designed to infiltrate runoff.

Recharge Volume = 0.35 inches of runoff X Increased Impervious Area** (Hydrologic Soil Group B)

The redevelopment results in an increase of 4,000 s.f. of impervious roof area, all of which is directed to an infiltration BMP.

Therefore Minimum Recharge Volume = 0.35 in. x 4,000 s .f. X (1 ft./12 in.) = 117 c.f. (min.)

PROVIDED RECHARGE = 342.4 c.f.
(Provided within 32 ADS Arc-36HC Chambers, at 10.7 c.f./chamber)

Standard #4: *Stormwater management systems...shall remove 80% of the average... TSS....*

Requirement: Provide 80% TSS Removal of the Water Quality Volume.

Water Quality Volume (WQV) = 1 inches of runoff X new driveway impervious areas*

Therefore: Minimum WQV = 1 inches X 0 s.f. X (1 ft./12 in.) = 0 c.f. (min.)

PROVIDED = 3,436 c.f. (Provided within rain garden)
(Additional TSS removal calculation worksheets are included in this report for the proposed rain garden (90% TSS removal) and pretreatment systems (44% TSS removal))

**Total impervious area for Std. 4 Calculation is not required to include roof runoff, as roof runoff is considered clean and free of suspended solids (non-metal roof is proposed).*

Standard #5: Stormwater discharges from Land Uses with Higher Potential Pollutant Loads

Not applicable. An office building is not a land use with higher potential pollutant loads.

Standard #6: Stormwater discharges to critical areas...

Property is located in the Water Resource and Groundwater Protection District Zone III. Additional pretreatment has been utilized though the use of a peastone diaphragm and sediment forebay.

Standard #7: A redevelopment project is required to meet standards....only to the extent practicable

The project is considered to be a partial redevelopment. The project has been designed to comply with all standards.

Standard #8: Erosion & Sedimental Control Plan

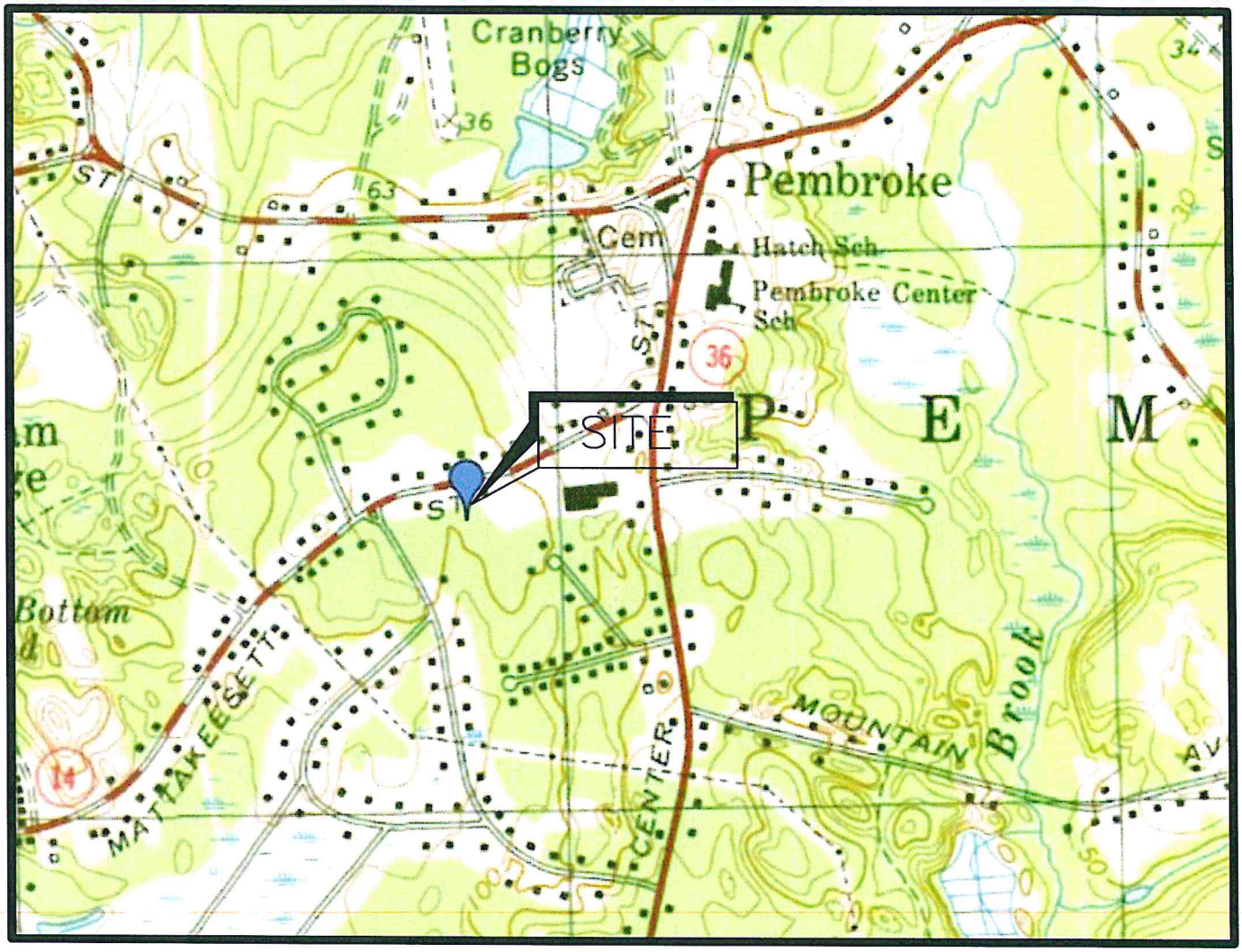
An Erosion & Sedimentation Control plan is submitted in Appendix A of this report.

Standard #9: A Long Term Operation & Maintenance Plan shall be developed...

A Post-Construction Operation & Maintenance Plan is submitted in Appendix A of this report.

Standard #10: All illicit discharges to the stormwater management system are prohibited.

An illicit discharge compliance statement is submitted in Appendix A of this report.



0' 1000' 2000'

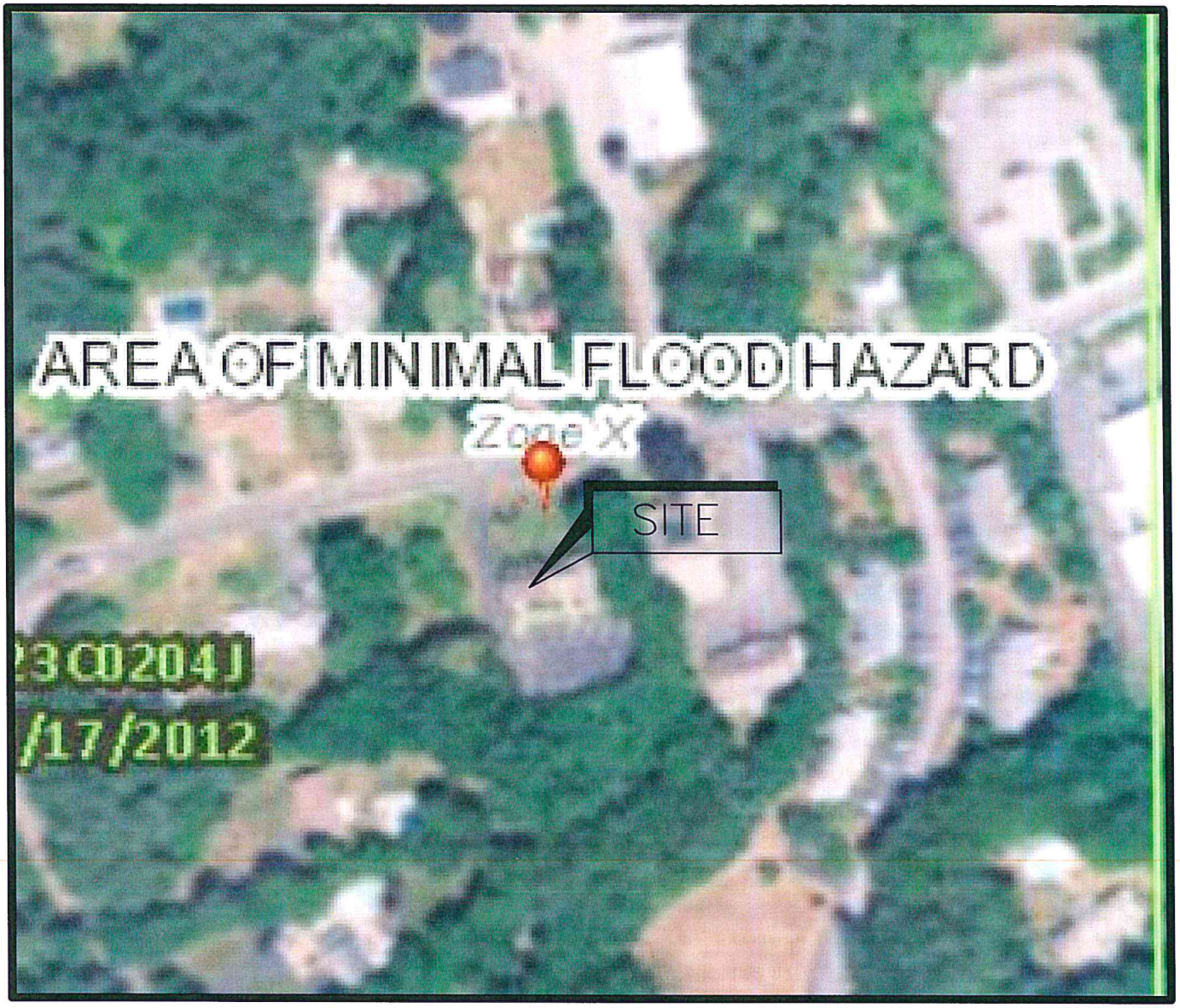
SCALE: 1" = 1000'

U.S. GEOLOGICAL SURVEY
7.5 X 15 MINUTE SERIES

MORSE
ENGINEERING CO., INC.
19 UNION STREET
P.O. BOX 92
SCITUATE, MA 02066
(781) 545-0895

FIGURE – 1

USGS LOCUS MAP
50 MATTAKEESETT STREET
PEMBROKE, MASSACHUSETTS



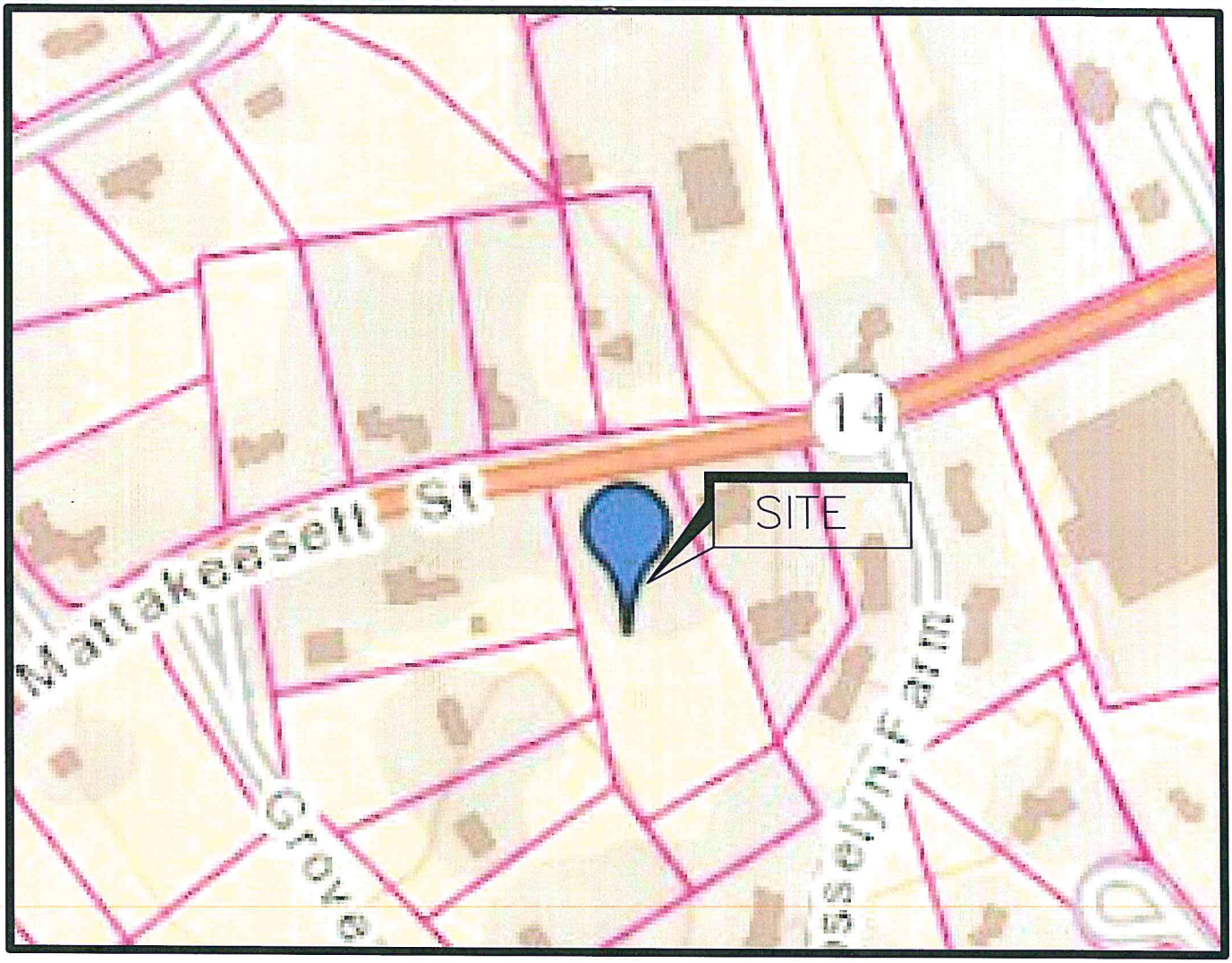
0' 200' 400'

SCALE: 1" = 200'

MORSE
ENGINEERING CO., INC.
19 UNION STREET
P.O. BOX 92
SCITUATE, MA 02066
(781) 545-0895

FIGURE – 2

FEMA FLOOD MAP
50 MATTAKEESETT STREET
PEMBROKE, MASSACHUSETTS



0' 200' 400'

SCALE: 1" = 200'

NATURAL HERITAGE & ENDANGERED SPECIES ATLAS
MASS GIS

MORSE
ENGINEERING CO., INC.
19 UNION STREET
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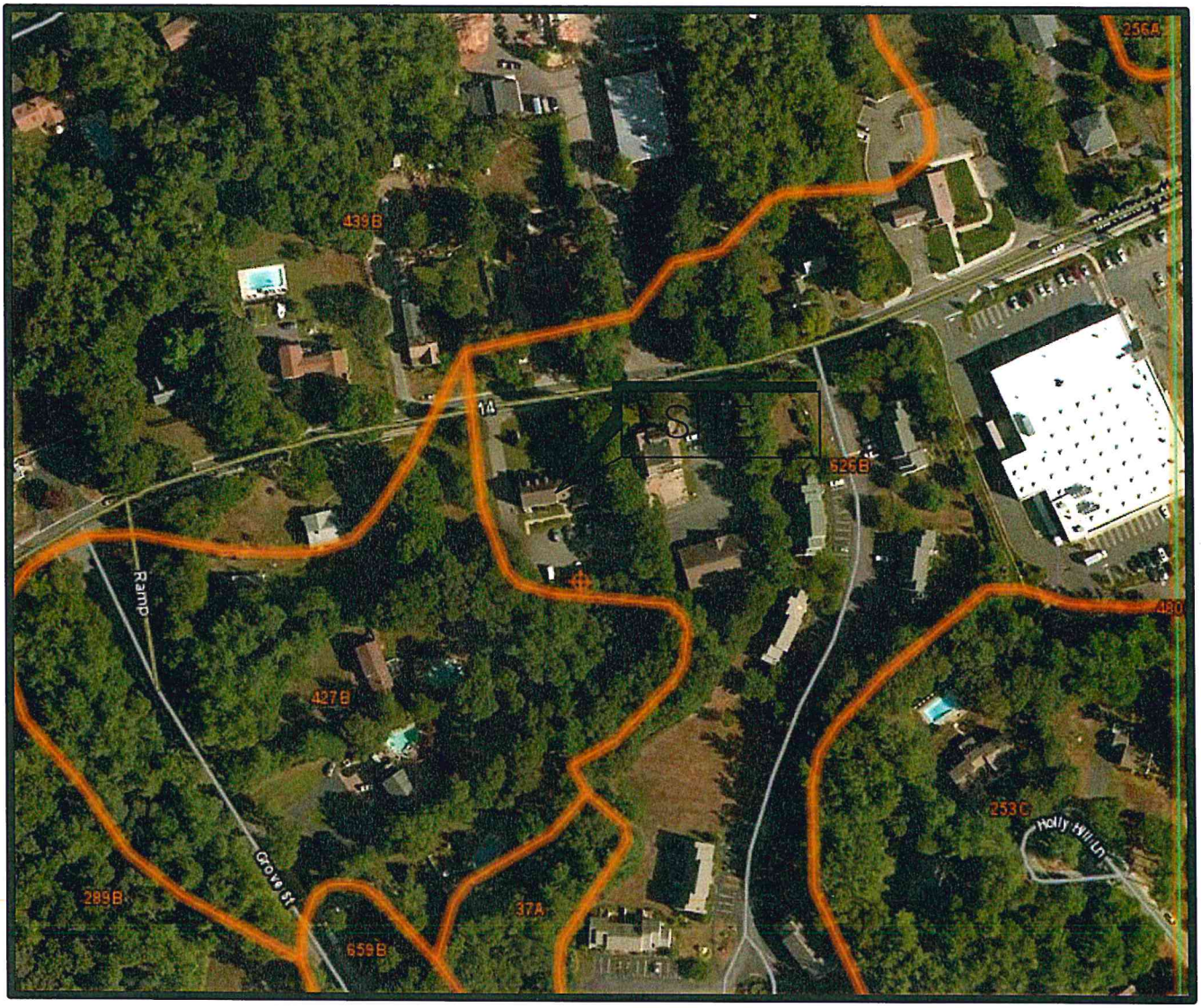
SCITUATE, MA 02066
(781) 545-0895

FIGURE – 3

NHESP MAP
50 MATTAKEESETT STREET
PEMBROKE, MASSACHUSETTS



0' 200' 400'

SCALE: 1" = 200'

SCS SOILS MAP

MORSE
ENGINEERING CO., INC.
42.12N
70.44W
19 UNION STREET
P.O. BOX 92
SCITUATE, MA 02066
(781) 545-0895

FIGURE 4 – 4

SCS SOILS MAP
50 MATTAKEESETT STREET
PEMBROKE, MASSACHUSETTS

APPENDIX A

- Const. Phase Stormwater Management Plan
- Construction Phase Erosion Control Maintenance Schedule & Checklist
- Post-Development Operation & Maintenance Plan & Long-Term Operation & Maintenance
- Illicit Discharge Compliance Statement
- Sediment Forebay Calculation
- TSS Removal Calculation Worksheets
- Mounding Analysis
- MassDEP Stormwater Checklist

Construction Phase Operation & Maintenance Plan
Best Management Practices
50 Mattakeesett Street
Pembroke, MA

Responsible Parties & Contact Information:

Owner:

JPC / Pembroke Realty Trust
137 Washington Street
Norwell, MA 02061
781-659-7273

Contractor:

_____
_____
_____
_____

Inspection & Record Keeping:

The responsible party shall maintain an operation and maintenance log during construction to control construction-related impacts, including erosion, sedimentation and other pollutant sources and land disturbance activities.

The anticipated time to complete this project is twelve months. The responsible party shall inspect the construction site at least once every 14 calendar days and within 24 hours of a storm event of ½ inch or greater. Inspections shall be performed until the site is fully stabilized and the temporary sedimentation controls have been removed. The inspector shall inspect each measure to determine if it was installed/performed correctly. The inspector shall also determine if the measures have been damaged and if so the corrective action.

The log shall kept on-site at all times and shall be made available to MassDEP and the Conservation Commission upon request. Member and agents of MassDEP and the Conservation Commission shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the Operation and Maintenance Plan requirements for each BMP.

Operation & Maintenance:

Land disturbance activities for this project include constructing the proposed storage unit buildings and associated driveways, grading, lawn, landscaping and stormwater systems. During land disturbance and construction activities, project proponents must implement controls that prevent erosion, control sediment movement, and stabilize exposed soils to prevent pollutants from moving offsite. Construction activities increase the potential for erosion and sedimentation at a site which may adversely impact wetland resource areas. To prevent this impact, the following conditions shall be imposed to control erosion and sedimentation:

Stabilization Practices: Disturbed areas shall be stabilized and protected as soon as practicable. Disturbed areas shall be stabilized when construction activity in the area has ceased for more than 14 days unless not feasible due to snow cover or if construction activities will resume within 21 days after construction temporarily ceased. Stabilization measures include the following:

- Temporary seeding
- Geotextiles
- Mulching and Netting
- Permanent seeding

Construction Phase: Erosion Control Maintenance Schedule & Checklist

Construction Practices

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check (1)	Cleaning/Repair Needed: ☐yes ☐no (List Items)	Date of Cleaning/ Repair	Performed by
Construction Site Stabilization	Weekly			1. Construction Site Stabilization Inspection/ Maintenance, temporary seeding, mulching etc. Disturbed areas shall be stabilized when construction activity in the area has ceased for more than 14 days			
Erosion Barrier	Bi-Weekly			1 Remove accumulated silt. 2 Repair rips / bulges.			
Mulching & Netting	Bi-Weekly			1. Mulch Maintenance			
Land Grading	Weekly			1. Check for washouts and/or gullies. 2. Check for accumulated silt.			
Permanent Seeding	Bi-Weekly			1. Permanent Seeding Inspection/ Maintenance			

Stormwater Control Manager _____

Long-Term Operation & Maintenance Plan
Best Management Practices
50 Mattakeesett Street
Pembroke, MA

Responsible Parties & Contact Information:

Owner:

JPC/Pembroke Realty Trust
137 Washington Street
Norwell, MA 02061
781-659-7273

Record Keeping:

The responsible party shall maintain an operation and maintenance log for a minimum of three years prior including inspections, repairs, replacement and disposal. The log shall be kept on-site at all times.

The log shall be made available to MassDEP and the Conservation Commission upon request. Members and agents of MassDEP and the Town shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the Operation and Maintenance Plan requirements for each BMP.

Operation & Maintenance:

In order to maintain the integrity of the stormwater management system, frequent inspections and maintenance shall be performed by the owner. The BMPs require continuous inspections and maintenance in order to function properly. The BMPs should be inspected and maintained as specified and after all major storm events.

Gutter & Downspout Systems shall be inspected quarterly. Material observed within any gutter or downspout shall be removed and disposed of in accordance with all applicable local, state and federal regulations. Inspect for signs of overflow to the surcharge pipe. It is recommended that "gutter guards" be installed on the roof gutter system to prevent leaves and tree debris from entering the subsurface system.

Infiltration Basin shall be checked for infiltrative capacity on a quarterly basis and after any significant rainfall event. Trash, leaves, branches, etc. shall be removed from basin and channel areas. Silt, sand and sediment, if significant accumulation occurs, shall be removed by hand annually, Material shall be removed and disposed of in accordance with all applicable local, states and federal regulations. Care shall be taken to maintain vegetation growth within a basin. Grass shall be cut and weeds and brush removed or trimmed at regular intervals during the growing season. Reseeding and weed control may need to be performed periodically to maintain healthy, dense vegetation and maintain the pollutant removal efficiency of the basin. Any slope erosion within the basins shall be stabilized and repaired as soon as practical. Mowing shall be performed frequently enough to keep the vegetation in vigorous condition and to control encroachment of weeds and woody vegetation, however it should not be mowed too closely so as to reduce the filtering effect. Mowing shall be performed with a bag attachment to prevent the compaction of cut grass and occur at a minimum of two times per year. The basins shall be monitored immediately after each two year storm event to

verify that they fully drain within a 72-hour period. If it is found that the basin is not sufficiently drained, the basin shall be inspected by a Professional Engineer and the underlying gravel layer should be removed and replaced as overseen by a Professional Engineer.

Important items to check during inspection include: signs of differential settlement, cracking, erosion, leakage in the embankments, tree growth on the embankments, condition of riprap, sediment accumulation and the health of the turf.

Roof Drywells shall be checked for infiltrative capacity on a quarterly basis and after any significant rainfall event. Additional inspections should be scheduled during the first few months to make sure that the chambers are exfiltrating within 72 hours of all storms. It is recommended that "gutter guards" be installed on the roof gutter system to prevent leaves and tree debris from entering the subsurface system. Material observed within any roof drywell shall be removed and disposed of in accordance with all applicable local, states and federal regulations.

Anticipated Operation and Maintenance Cost:
The annual anticipated operation and maintenance cost is approximately $1,500.00.

Project Location: 50 Mattakeesett Street, Pembroke, MA

Stormwater Management – Post Construction Phase

Best Management Practices – Inspection Schedule and Evaluation Checklist

Long Term Practices

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check (1)	Cleaning/Repair Needed: ☐yes ☐no (List Items)	Date of Cleaning/ Repair	Performed by
Driveway Sweeping	Monthly			Sweep & Remove any accumulated sediment			
Gutter and Downspout System	Quarterly			Remove material in gutters and downspouts. Install gutter guards. Inspect for signs of overflow to surcharge.			
Infiltration Basin	Quarterly			Check infiltrative capacity. Remove sediment, trash and debris. Repair erosion and scour. Mow Grass			
Roof Drywell System	Quarterly			Inspect for infiltrative capacity Repair erosion or scour			

March 2, 2020

TO: Town of Pembroke
Conservation Commission
100 Center Street, Town Hall
Pembroke, MA 02359

RE: 50 Mattakeesett Street, Pembroke, MA

To Members of the Commission:

This letter is a statement that to the best of my knowledge, no illicit discharges currently exist or are being considered by me to the stormwater management system. An illicit discharge is any discharge that is not composed entirely of stormwater.

Applicant's Representative

MORSE ENGINEERING CO., INC.
10 New Driftway, Suite 303, P.O. Box 92
Scituate, MA 02066
(781) 545-0895

JOB 50 Mattakeesett St.
SHEET NO. _____ OF _____
CALCULATED BY JDG DATE 3/2/2020
CHECKED BY _____ DATE _____
SCALE _____

Sediment Forebay

Required = 0.1 Inch x Impervious Area

$= 0.1 \text{ Inch} \times \frac{1 \text{ Ft.}}{12 \text{ inch}} \times 2{,}058 \text{ S.F.} = 18 \text{ C.F.}$

Provided = 53 C.F. ✓

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: 50 Mattakeesett Street

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Rain Garden	0.90	1.00	0.90	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10
	0.00	0.10	0.00	0.10

Total TSS Removal = 90%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 18-288
Prepared By: JMH
Date: 3/2/2020

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

INSTRUCTIONS:
1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: 50 MATTAKEESETT STREET - PRE-TREATMENT

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
PEASTONE DIAPHRAGM	0.25	1.00	0.25	0.75
SEDIMENT FOREBAY	0.25	0.75	0.19	0.56

Total TSS Removal = 44 %

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 18.288
Prepared By: JMH
Date: 3/2/2020

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

50 Mattakeesett Street
Rain Garden
3/2/2020
JMH

MOUNDING ANALYSIS VARIABLES

R (100 – Year) = Recharge (Infiltration Rate) (Ft/Day)
Infiltration rate was determined to be the quantity of water discarded in a 100-year storm over the drain time of the system.
R=(0.075 ac.ft. x 43,560 s.f./ac.) / 761 s.f. system footprint / (24 hours x 1day/24 hours) = 4.3 ft/day

Sy = Specific Yield
Value per Table for Specific Yield of Various Geologic Materials (From Morris and Johnson 1967).
Sy = 21% = 0.21

K = Horizontal Hydraulic Conductivity
Vertical soil permeability is assumed to be one-tenth of the horizontal hydraulic conductivity.
Vertical soil permeability was determined to be 2.41 in/hour = 4.82 ft/day
Therefore K = 48.2 ft/day

X and Y = ½ Length and Width of Basin

T = Duration of Infiltration Period, Days
The designed system has a drain down time of 20 hours = 0.3 days

hi = Initial Saturated Thickness
Determined from the nearest well per the MassDEP Well Database.
Bedrock was recorded at 110' at #43 Mattakeesett Street

MOUNDING ANALYSIS SUMMARY

A mounding analysis was performed for the rain garden.

The rain garden will fully drain in 8 hours. Refer to Draw Down Calculations.

The rain garden is proposed with 2' of separation from the bottom of the basin to seasonal high groundwater. The mounding analysis reports 0.407' of mounding at the center of the basin. Therefore, the mounding analysis demonstrates that the mound that forms under the rain garden will not break out.

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
4.3000	*R*	Recharge (infiltration) rate (feet/day)
0.210	Sy	Specific yield, Sy (dimensionless, between 0 and 1)
48.20	K	Horizontal hydraulic conductivity, Kh (feet/day)*
20.000	x	1/2 length of basin (x direction, in feet)
17.000	y	1/2 width of basin (y direction, in feet)
0.300	t	duration of infiltration period (days)
110.000	hi(0)	initial thickness of saturated zone (feet)
110.407	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
0.407	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

Conversion Table

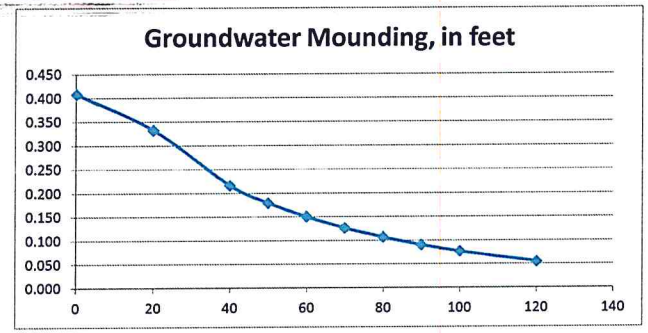
inch/hour	feet/day
0.67	1.33
2.00	4.00

hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.407	0
0.332	20
0.216	40
0.179	50
0.150	60
0.126	70
0.106	80
0.090	90
0.076	100
0.055	120

Re-Calculate Now



Disclaimer

This spreadsheet-solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

50 Mattakeesett Street
Drywell
3/2/2020
JMH

MOUNDING ANALYSIS VARIABLES

R (100 – Year) = Recharge (Infiltration Rate) (Ft/Day)
Infiltration rate was determined to be the quantity of water discarded in a 100-year storm over the drain time of the system.
R=(0.049 ac.ft. x 43,560 s.f./ac.) / 628 s.f. system footprint / (24 hours x 1day/24 hours) = 3.4 ft/day

Sy = Specific Yield
Value per Table for Specific Yield of Various Geologic Materials (From Morris and Johnson 1967).
Sy = 21% = 0.21

K = Horizontal Hydraulic Conductivity
Vertical soil permeability is assumed to be one-tenth of the horizontal hydraulic conductivity.
Vertical soil permeability was determined to be 2.41 in/hour = 4.82 ft/day
Therefore K = 48.2 ft/day

X and Y = ½ Length and Width of Basin

T = Duration of Infiltration Period, Days
The designed system has a drain down time of 20 hours = 0.3 days

hi = Initial Saturated Thickness
Determined from the nearest well per the MassDEP Well Database.
Bedrock was recorded at 110' at #43 Mattakeesett Street

MOUNDING ANALYSIS SUMMARY

A mounding analysis was performed for the drywell.

The drywell will fully drain in 7 hours. Refer to Draw Down Calculations.

The drywell is proposed with 2' of separation from the bottom of the basin to seasonal high groundwater. The mounding analysis reports 0.140' of mounding at the center of the structure. Therefore, the mounding analysis demonstrates that the mound that forms under the drywell will not break out.

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
3.4000	*R*	Recharge (infiltration) rate (feet/day)
0.210	Sy	Specific yield, Sy (dimensionless, between 0 and 1)
48.20	K	Horizontal hydraulic conductivity, Kh (feet/day)*
41.000	x	1/2 length of basin (x direction, in feet)
4.000	y	1/2 width of basin (y direction, in feet)
0.300	t	duration of infiltration period (days)
110.000	hi(0)	initial thickness of saturated zone (feet)
110.140	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
0.140	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)

Conversion Table

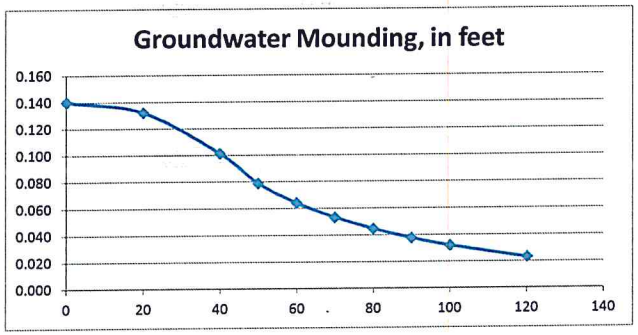
inch/hour	feet/day
0.67	1.33
2.00	4.00

hours	days	
36	1.50	

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.140	0
0.132	20
0.101	40
0.079	50
0.064	60
0.053	70
0.045	80
0.038	90
0.032	100
0.023	120

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

MORSE ENGINEERING CO., INC.
10 New Driftway, Suite 303, P.O. Box 92
Scituate, MA 02066
(781) 545-0895

JOB 50 MATTAKEESETT ST

SHEET NO. _____ OF _____

CALCULATED BY JMH DATE 3/2/2020

CHECKED BY _____ DATE _____

SCALE _____

DRAW DOWN

RAIN GARDEN

$V_{(BOTTOM\ TO\ OUTLET)} = 1200\ CF$

$$TIME = \frac{1200\ CF}{2.41\ \frac{IN}{HR}\left(761\ SF\right)\left(\frac{1\ FT}{12\ IN}\right)} = 7.9\ HRS$$

7.9 HRS < 72 HRS ✓

DRYWELL

$$TIME = \frac{832\ CF}{2.41\ \frac{IN}{HR}\left(628\ SF\right)\left(\frac{1\ FT}{12\ IN}\right)} = 6.6\ HRS$$

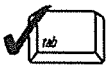
6.6 HRS < 72 HRS ✓

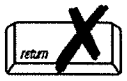
Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

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

☒ Partial 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:

- [x] 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
- [x] 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

- [x] No new untreated discharges
- [x] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [x] 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

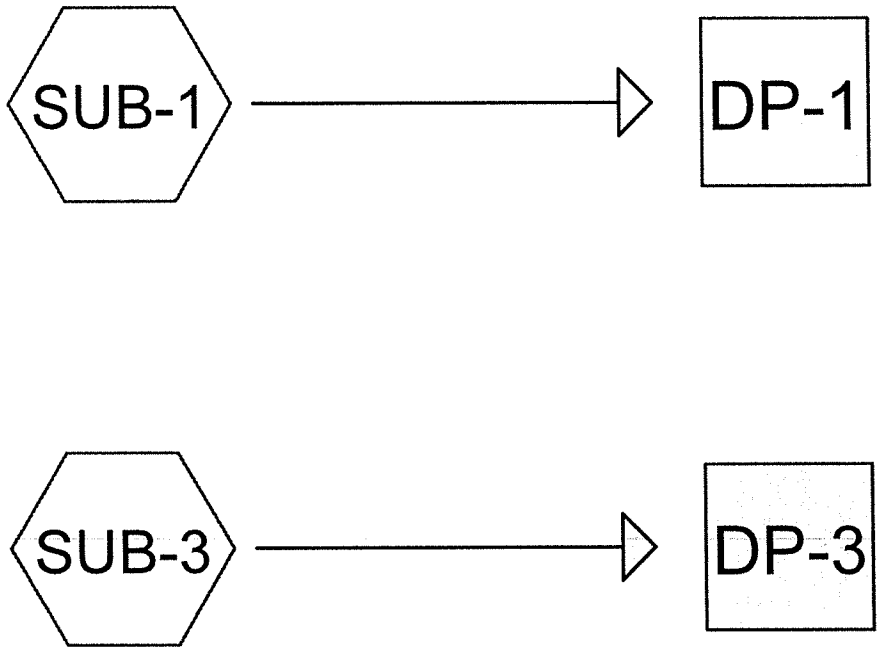
☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ 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.

APPENDIX B

- Pre-Development HydroCAD Analysis
- Post-Development HydroCAD Analysis



Subcat Reach Pond Link

Drainage Diagram for Pre-Cornell rev. 3.2.20
Prepared by Microsoft, Printed 3/3/2020

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.212	36	Woods, Fair, HSG A (SUB-1, SUB-3)
0.207	39	>75% Grass cover, Good, HSG A (SUB-1, SUB-3)
0.613	60	Woods, Fair, HSG B (SUB-1, SUB-3)
0.024	98	Concrete (SUB-1, SUB-3)
0.222	98	Pavement (SUB-1, SUB-3)
0.052	98	Roof (SUB-1, SUB-3)
1.329	61	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.419	HSG A	SUB-1, SUB-3
0.613	HSG B	SUB-1, SUB-3
0.000	HSG C	
0.000	HSG D	
0.297	Other	SUB-1, SUB-3
1.329		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.02 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SUB-1: Runoff Area=39,737 sf 19.43% Impervious Runoff Depth>0.60"
Flow Length=180' Tc=9.2 min CN=63 Runoff=0.44 cfs 0.046 af

Subcatchment SUB-3: Runoff Area=18,134 sf 28.77% Impervious Runoff Depth>0.37"
Flow Length=190' Tc=13.5 min CN=57 Runoff=0.08 cfs 0.013 af

Reach DP-1: Inflow=0.44 cfs 0.046 af
Outflow=0.44 cfs 0.046 af

Reach DP-3: Inflow=0.08 cfs 0.013 af
Outflow=0.08 cfs 0.013 af

Total Runoff Area = 1.329 ac Runoff Volume = 0.059 af Average Runoff Depth = 0.53"
77.65% Pervious = 1.032 ac 22.35% Impervious = 0.297 ac

Summary for Subcatchment SUB-1:

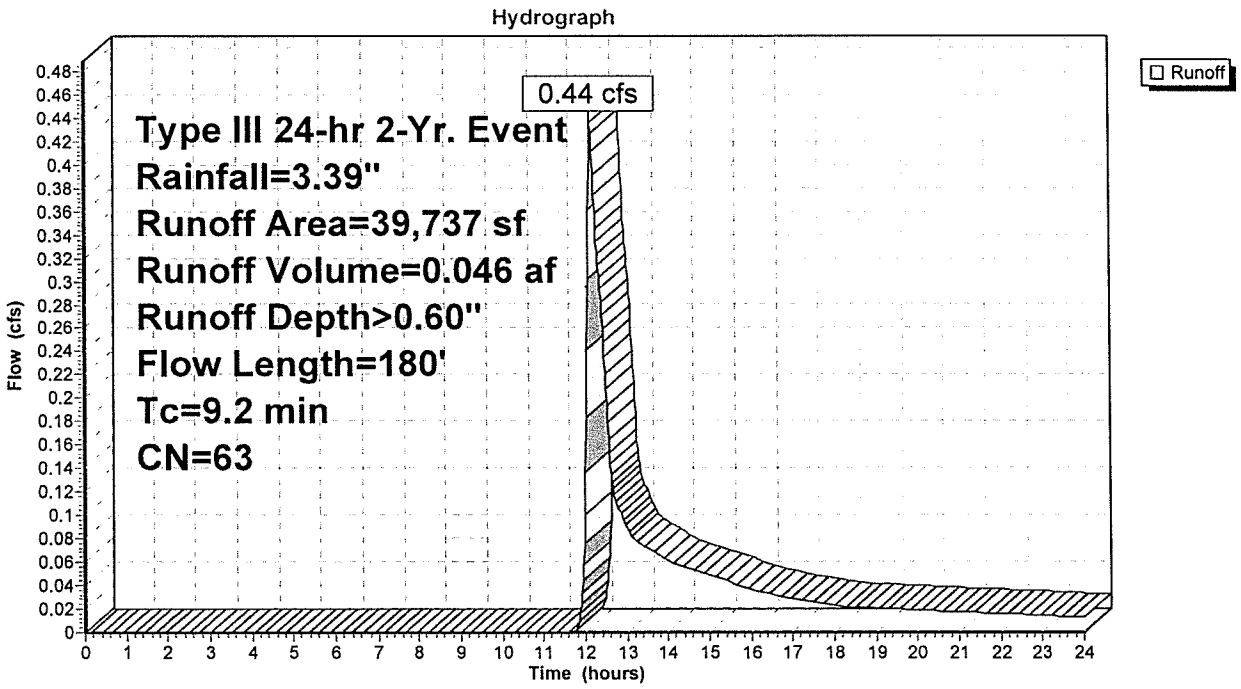
Runoff = 0.44 cfs @ 12.16 hrs, Volume= 0.046 af, Depth> 0.60"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Yr. Event Rainfall=3.39"

	Area (sf)	CN	Description
	25,100	60	Woods, Fair, HSG B
*	6,468	98	Pavement
*	462	98	Concrete
	1,709	39	>75% Grass cover, Good, HSG A
*	789	98	Roof
	5,209	36	Woods, Fair, HSG A
	39,737	63	Weighted Average
	32,018		80.57% Pervious Area
	7,719		19.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.7	130	0.0347	3.00		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.2	180	Total			

Subcatchment SUB-1:



Summary for Subcatchment SUB-3:

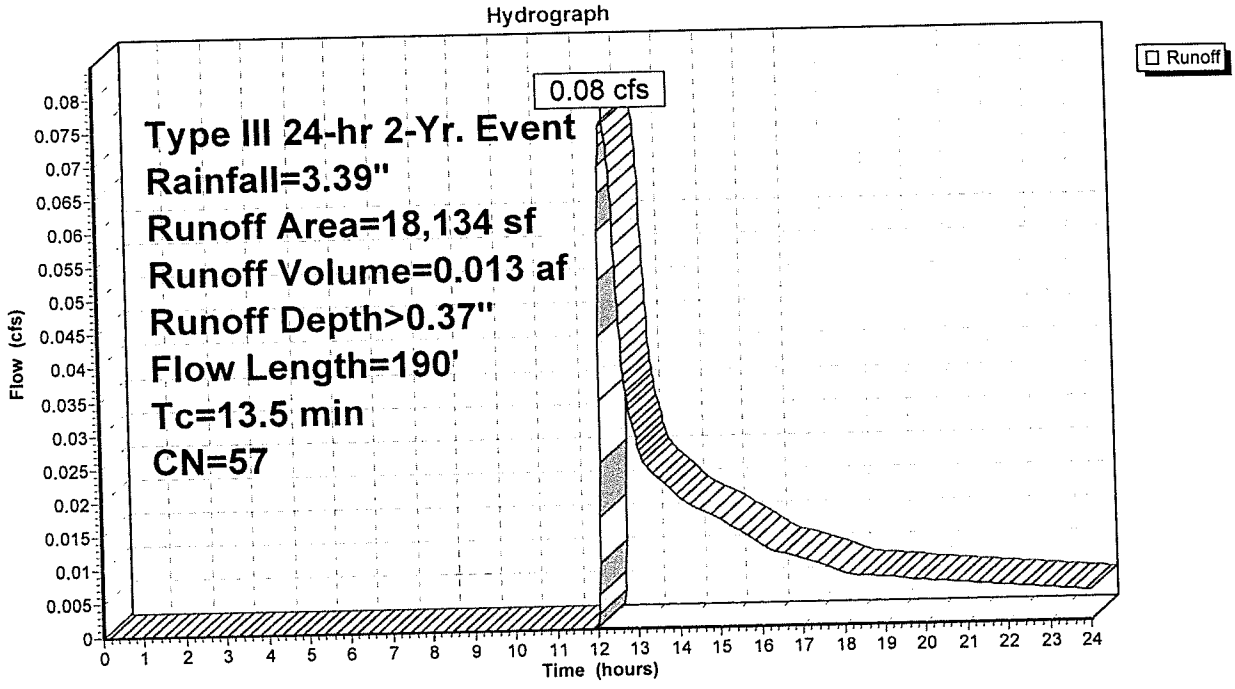
Runoff = 0.08 cfs @ 12.36 hrs, Volume= 0.013 af, Depth> 0.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Yr. Event Rainfall=3.39"

	Area (sf)	CN	Description
	1,600	60	Woods, Fair, HSG B
*	3,184	98	Pavement
*	567	98	Concrete
	7,296	39	>75% Grass cover, Good, HSG A
*	1,466	98	Roof
	4,021	36	Woods, Fair, HSG A
	18,134	57	Weighted Average
	12,917		71.23% Pervious Area
	5,217		28.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	140	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.5	190	Total			

Subcatchment SUB-3:



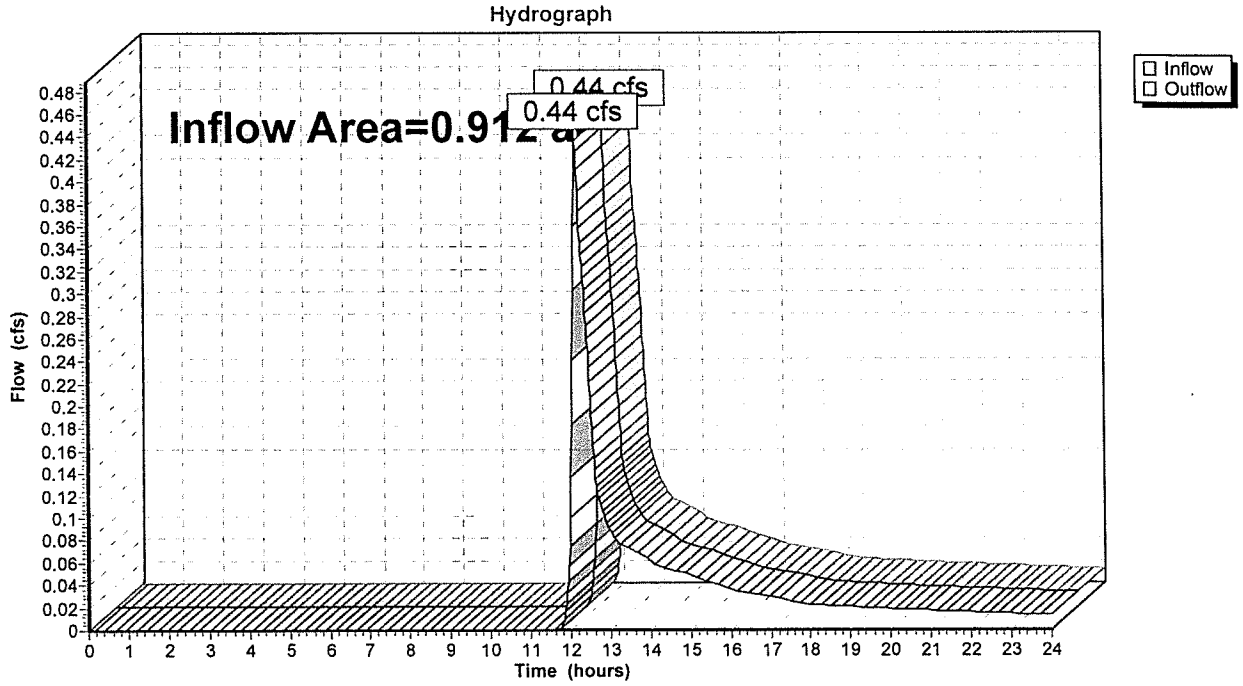
Summary for Reach DP-1:

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

Inflow Area = 0.912 ac, 19.43% Impervious, Inflow Depth > 0.60" for 2-Yr. Event event
Inflow = 0.44 cfs @ 12.16 hrs, Volume= 0.046 af
Outflow = 0.44 cfs @ 12.16 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Reach DP-1:



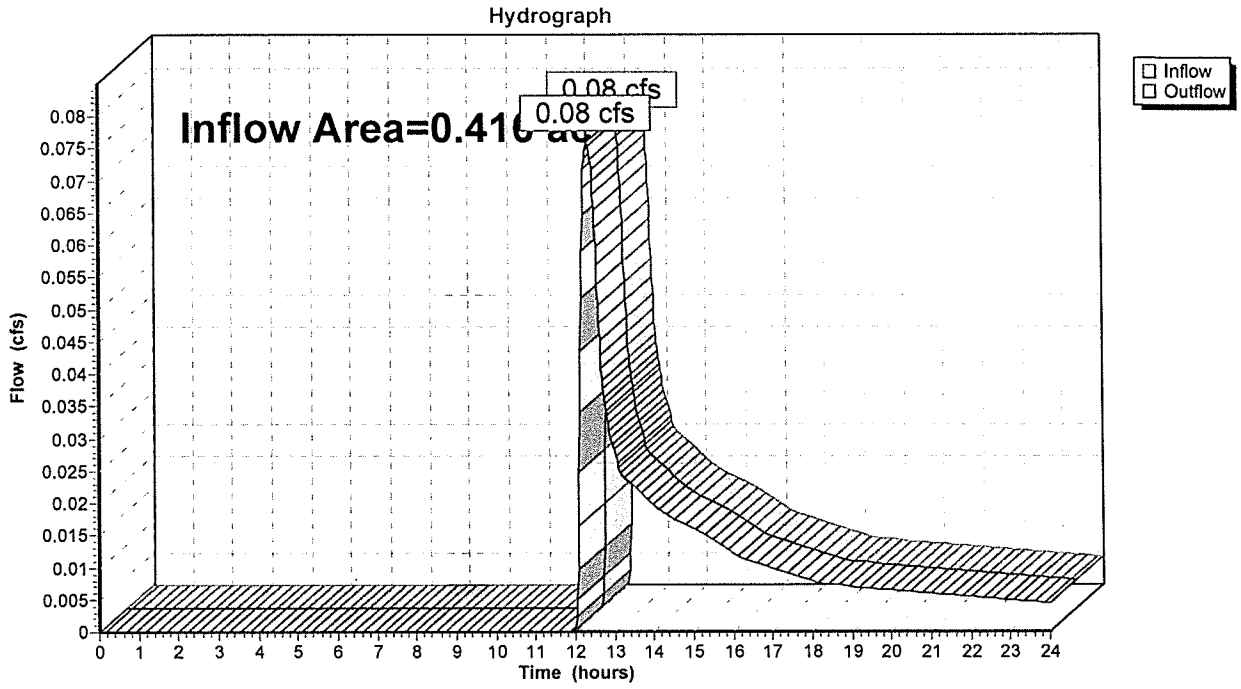
Summary for Reach DP-3:

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

Inflow Area = 0.416 ac, 28.77% Impervious, Inflow Depth > 0.37" for 2-Yr. Event event
Inflow = 0.08 cfs @ 12.36 hrs, Volume= 0.013 af
Outflow = 0.08 cfs @ 12.36 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Reach DP-3:



Time span=0.00-24.00 hrs, dt=0.02 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SUB-1: Runoff Area=39,737 sf 19.43% Impervious Runoff Depth>1.56"
Flow Length=180' Tc=9.2 min CN=63 Runoff=1.39 cfs 0.118 af

Subcatchment SUB-3: Runoff Area=18,134 sf 28.77% Impervious Runoff Depth>1.14"
Flow Length=190' Tc=13.5 min CN=57 Runoff=0.37 cfs 0.040 af

Reach DP-1: Inflow=1.39 cfs 0.118 af
Outflow=1.39 cfs 0.118 af

Reach DP-3: Inflow=0.37 cfs 0.040 af
Outflow=0.37 cfs 0.040 af

Total Runoff Area = 1.329 ac Runoff Volume = 0.158 af Average Runoff Depth = 1.43"
77.65% Pervious = 1.032 ac 22.35% Impervious = 0.297 ac

Summary for Subcatchment SUB-1:

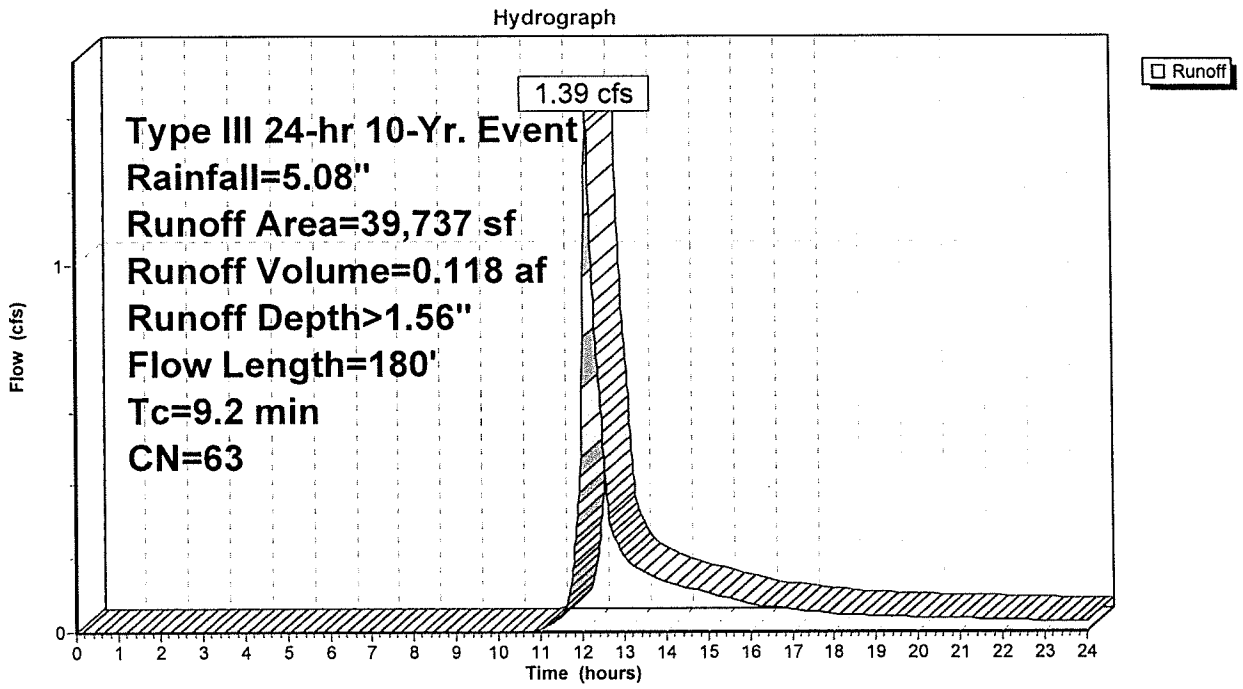
Runoff = 1.39 cfs @ 12.14 hrs, Volume= 0.118 af, Depth> 1.56"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Yr. Event Rainfall=5.08"

	Area (sf)	CN	Description
	25,100	60	Woods, Fair, HSG B
*	6,468	98	Pavement
*	462	98	Concrete
	1,709	39	>75% Grass cover, Good, HSG A
*	789	98	Roof
	5,209	36	Woods, Fair, HSG A
	39,737	63	Weighted Average
	32,018		80.57% Pervious Area
	7,719		19.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.7	130	0.0347	3.00		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.2	180	Total			

Subcatchment SUB-1:



Summary for Subcatchment SUB-3:

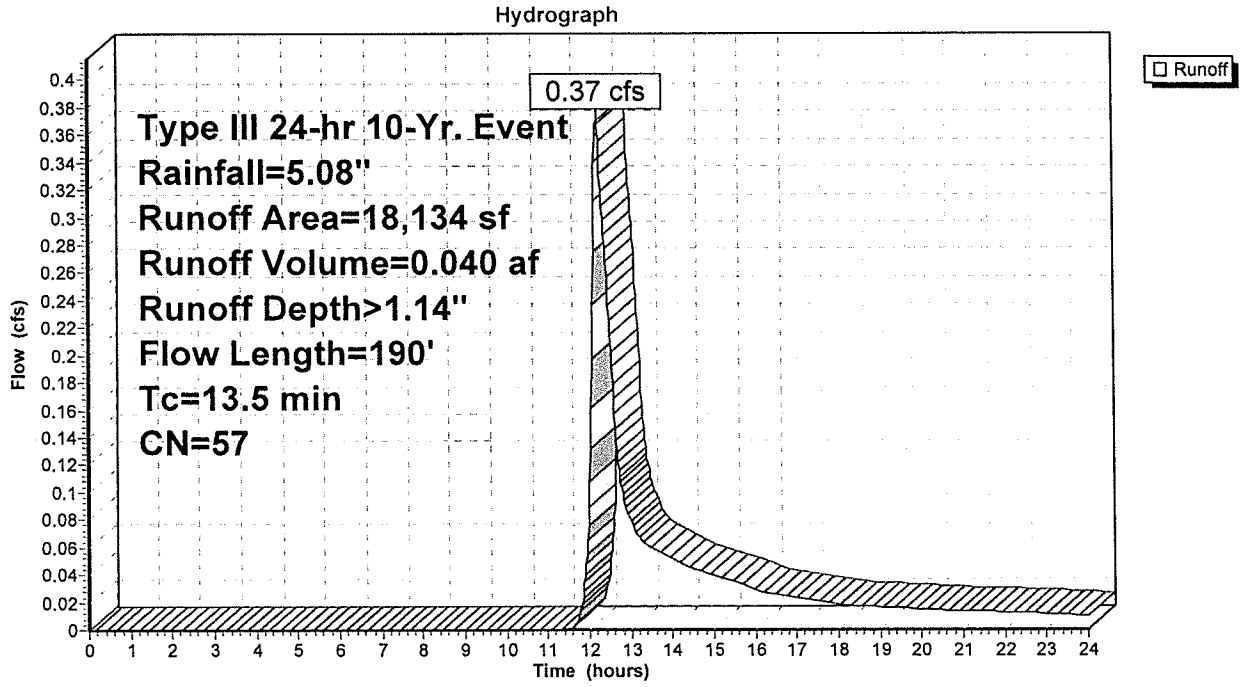
Runoff = 0.37 cfs @ 12.21 hrs, Volume= 0.040 af, Depth> 1.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Yr. Event Rainfall=5.08"

	Area (sf)	CN	Description
	1,600	60	Woods, Fair, HSG B
*	3,184	98	Pavement
*	567	98	Concrete
	7,296	39	>75% Grass cover, Good, HSG A
*	1,466	98	Roof
	4,021	36	Woods, Fair, HSG A
	18,134	57	Weighted Average
	12,917		71.23% Pervious Area
	5,217		28.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	140	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.5	190	Total			

Subcatchment SUB-3:



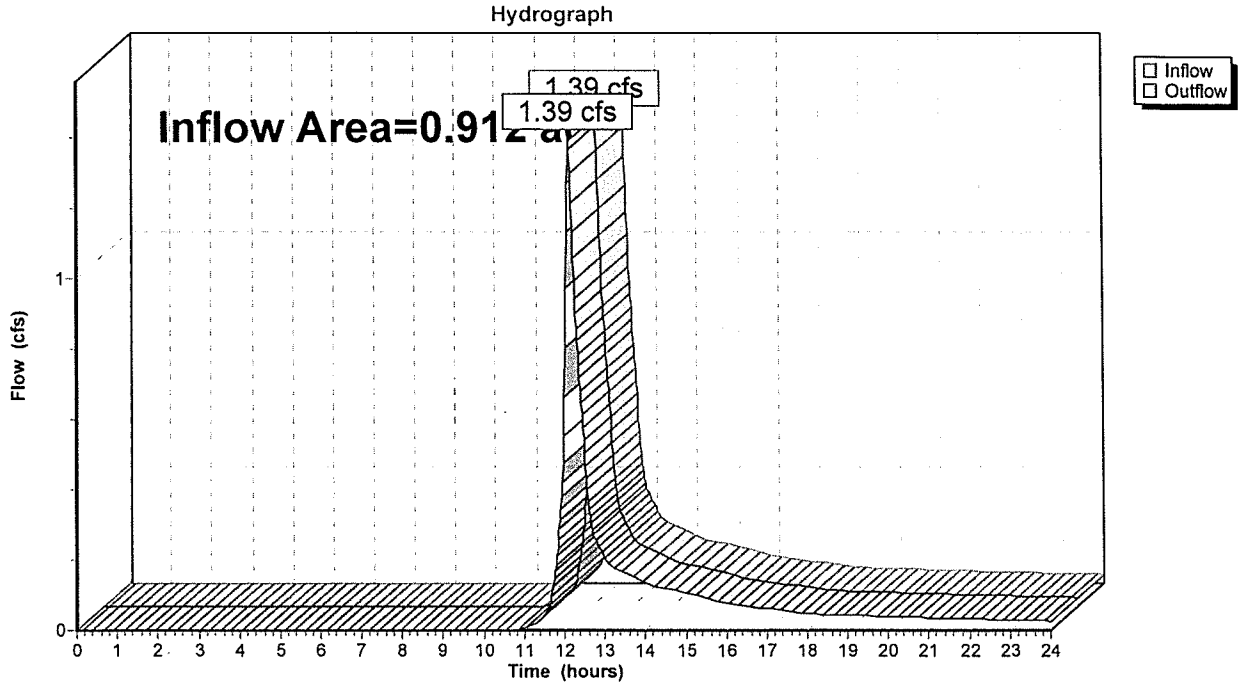
Summary for Reach DP-1:

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

Inflow Area = 0.912 ac, 19.43% Impervious, Inflow Depth > 1.56" for 10-Yr. Event event
Inflow = 1.39 cfs @ 12.14 hrs, Volume= 0.118 af
Outflow = 1.39 cfs @ 12.14 hrs, Volume= 0.118 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Reach DP-1:



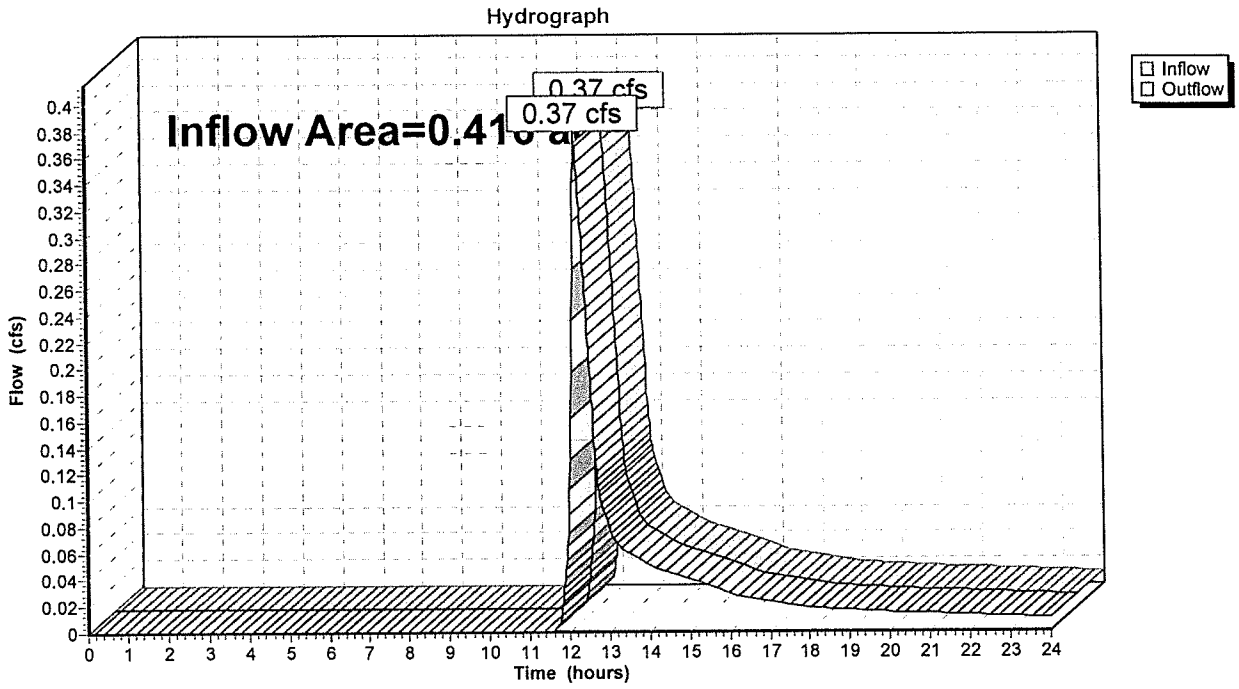
Summary for Reach DP-3:

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

Inflow Area = 0.416 ac, 28.77% Impervious, Inflow Depth > 1.14" for 10-Yr. Event event
Inflow = 0.37 cfs @ 12.21 hrs, Volume= 0.040 af
Outflow = 0.37 cfs @ 12.21 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Reach DP-3:



Time span=0.00-24.00 hrs, dt=0.02 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment SUB-1: Runoff Area=39,737 sf 19.43% Impervious Runoff Depth>4.49"
Flow Length=180' Tc=9.2 min CN=63 Runoff=4.30 cfs 0.342 af

Subcatchment SUB-3: Runoff Area=18,134 sf 28.77% Impervious Runoff Depth>3.75"
Flow Length=190' Tc=13.5 min CN=57 Runoff=1.42 cfs 0.130 af

Reach DP-1: Inflow=4.30 cfs 0.342 af
Outflow=4.30 cfs 0.342 af

Reach DP-3: Inflow=1.42 cfs 0.130 af
Outflow=1.42 cfs 0.130 af

Total Runoff Area = 1.329 ac Runoff Volume = 0.472 af Average Runoff Depth = 4.26"
77.65% Pervious = 1.032 ac 22.35% Impervious = 0.297 ac

Summary for Subcatchment SUB-1:

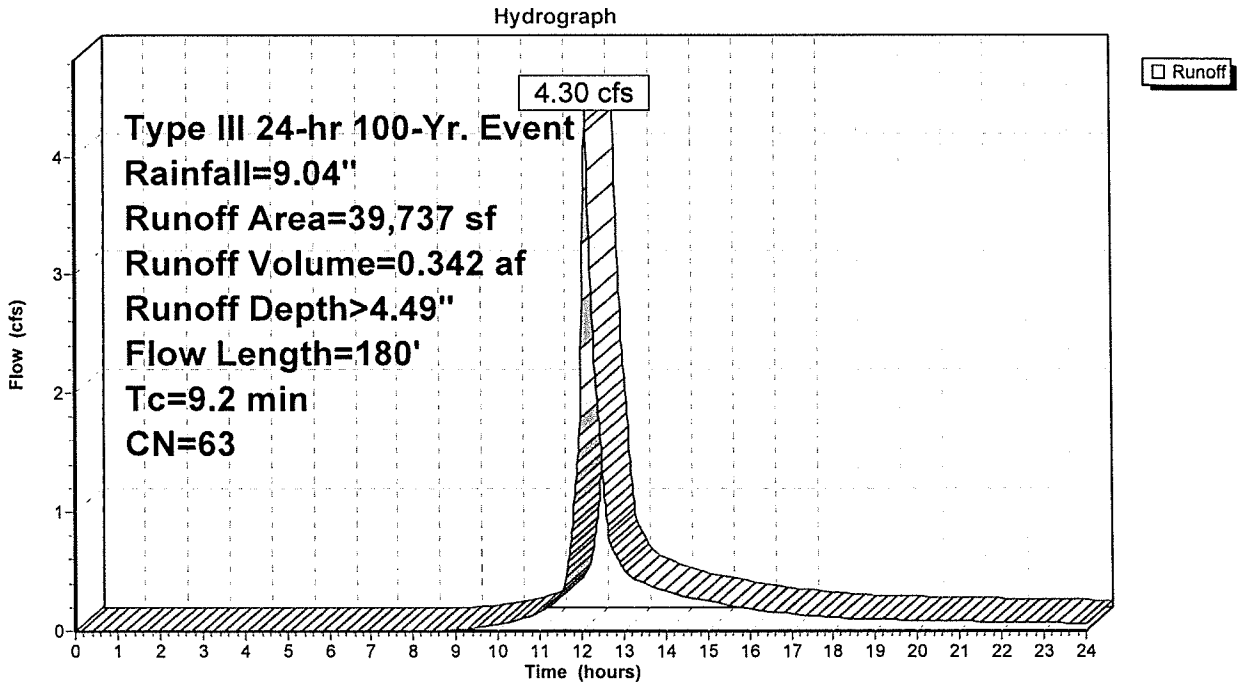
Runoff = 4.30 cfs @ 12.13 hrs, Volume= 0.342 af, Depth> 4.49"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Yr. Event Rainfall=9.04"

	Area (sf)	CN	Description
	25,100	60	Woods, Fair, HSG B
*	6,468	98	Pavement
*	462	98	Concrete
	1,709	39	>75% Grass cover, Good, HSG A
*	789	98	Roof
	5,209	36	Woods, Fair, HSG A
	39,737	63	Weighted Average
	32,018		80.57% Pervious Area
	7,719		19.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.7	130	0.0347	3.00		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.2	180	Total			

Subcatchment SUB-1:



Summary for Subcatchment SUB-3:

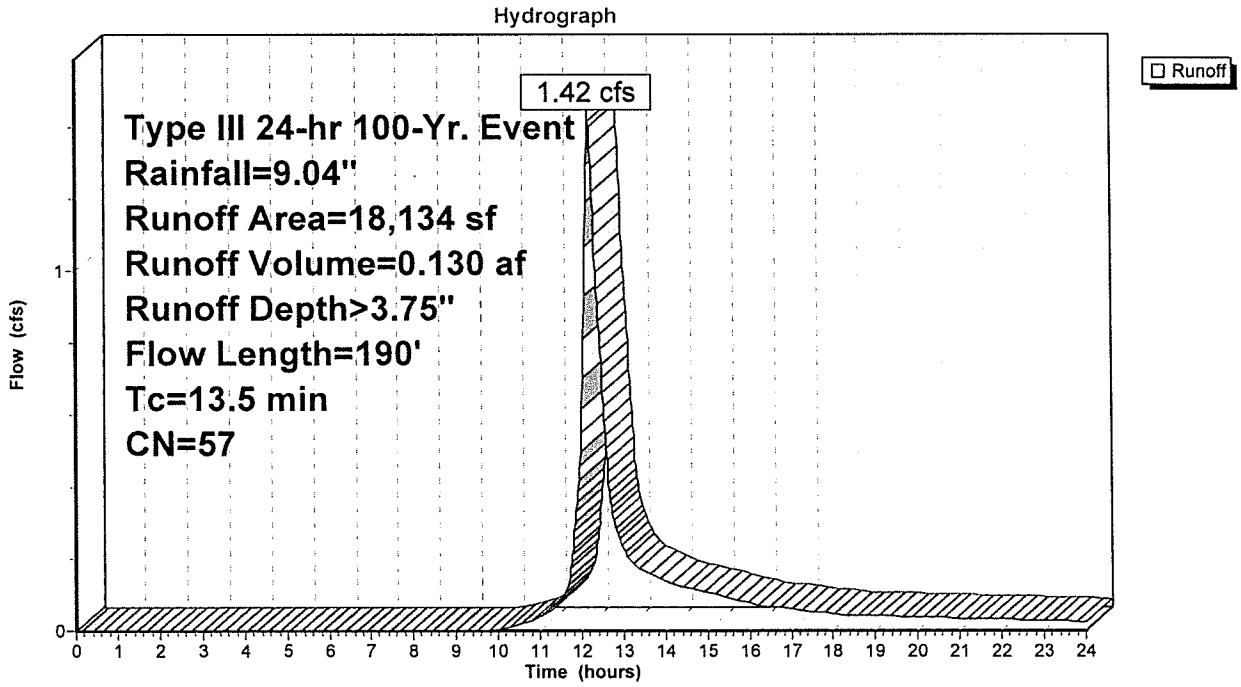
Runoff = 1.42 cfs @ 12.19 hrs, Volume= 0.130 af, Depth> 3.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Yr. Event Rainfall=9.04"

	Area (sf)	CN	Description
	1,600	60	Woods, Fair, HSG B
*	3,184	98	Pavement
*	567	98	Concrete
	7,296	39	>75% Grass cover, Good, HSG A
*	1,466	98	Roof
	4,021	36	Woods, Fair, HSG A
	18,134	57	Weighted Average
	12,917		71.23% Pervious Area
	5,217		28.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	140	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.5	190	Total			

Subcatchment SUB-3:



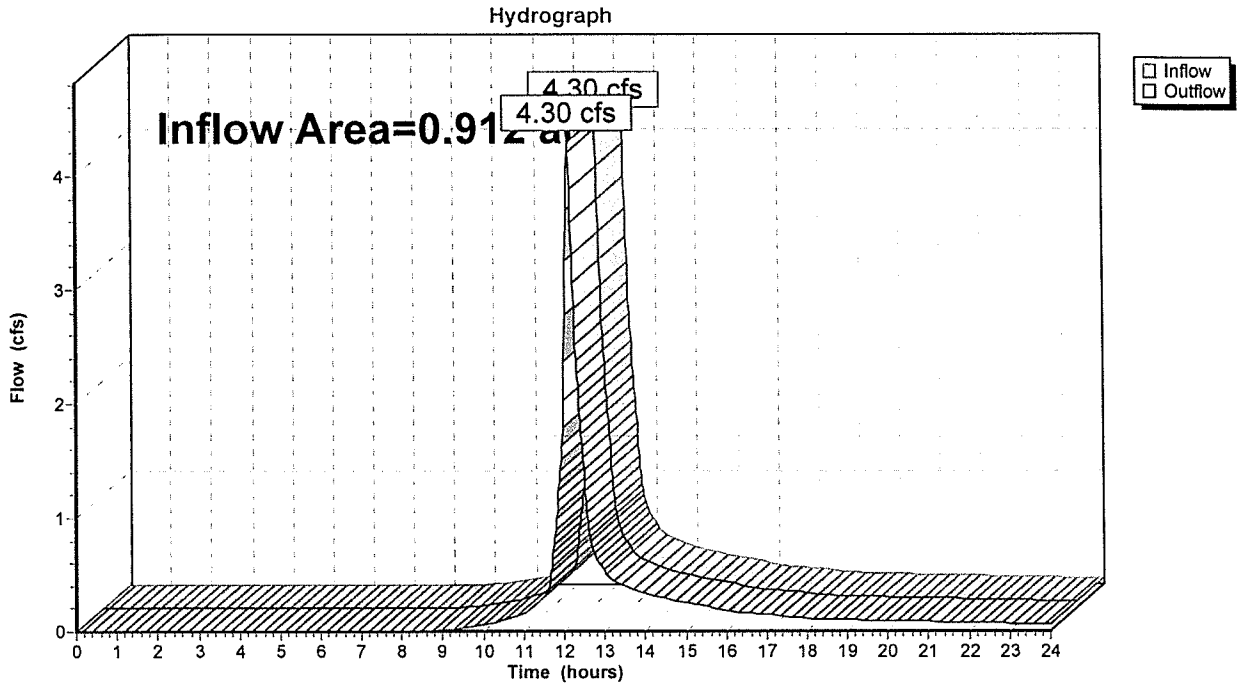
Summary for Reach DP-1:

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

Inflow Area = 0.912 ac, 19.43% Impervious, Inflow Depth > 4.49" for 100-Yr. Event event
Inflow = 4.30 cfs @ 12.13 hrs, Volume= 0.342 af
Outflow = 4.30 cfs @ 12.13 hrs, Volume= 0.342 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Reach DP-1:



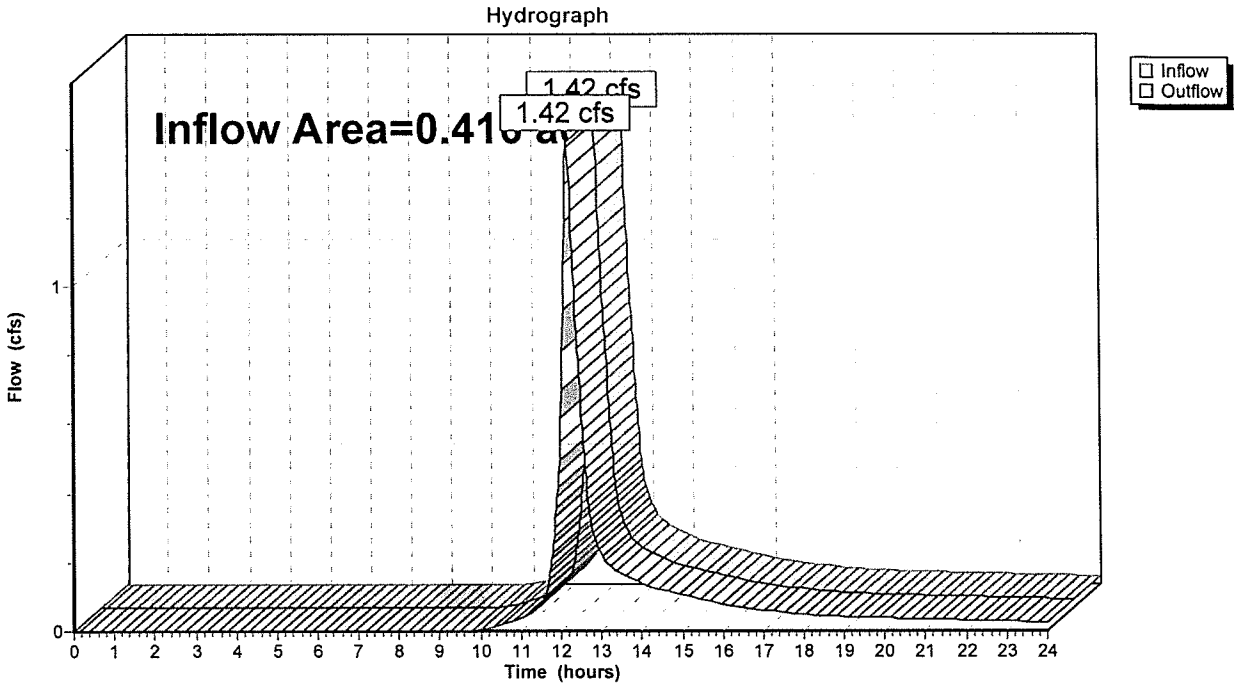
Summary for Reach DP-3:

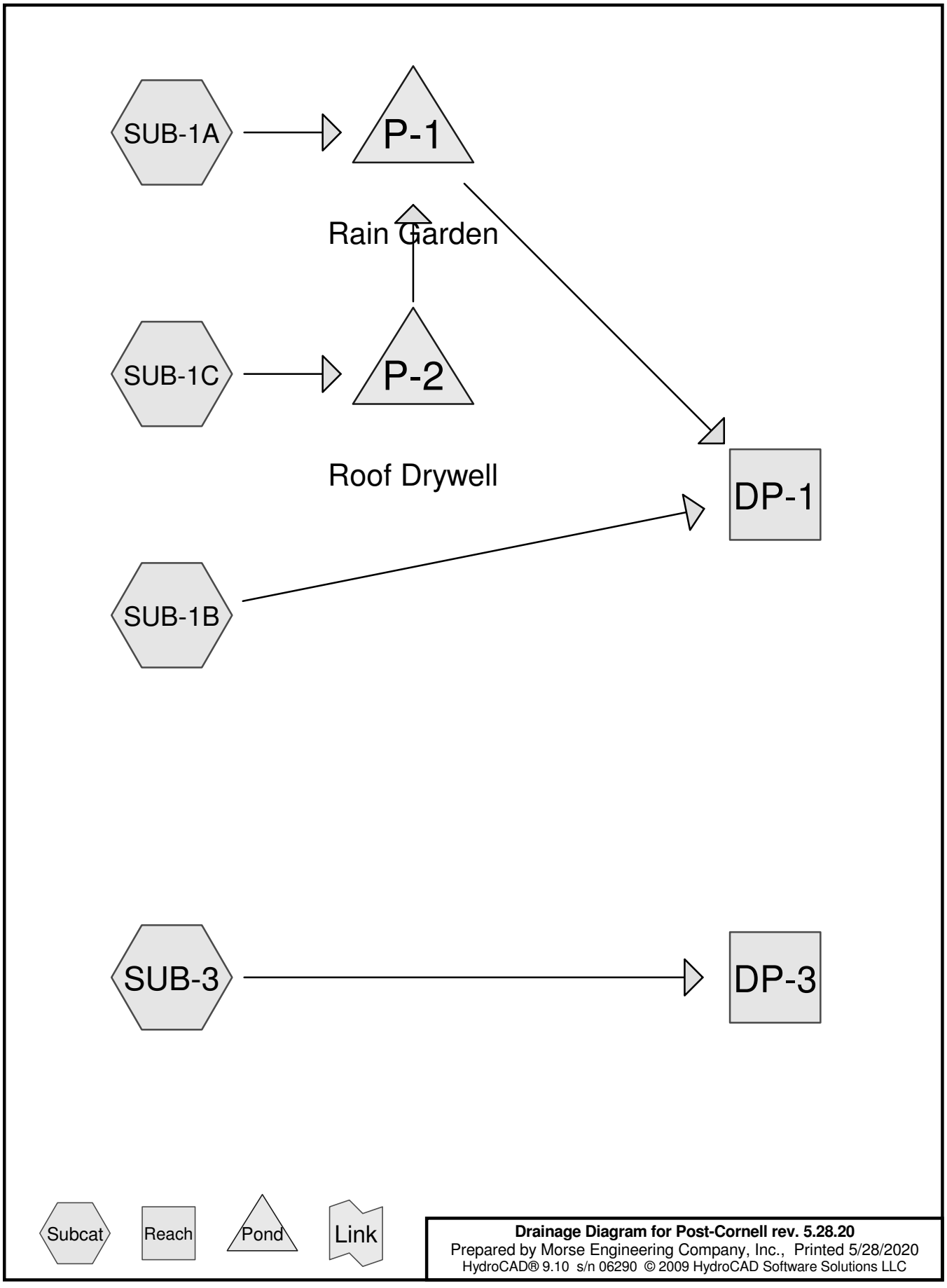
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.416 ac, 28.77% Impervious, Inflow Depth > 3.75" for 100-Yr. Event event
Inflow = 1.42 cfs @ 12.19 hrs, Volume= 0.130 af
Outflow = 1.42 cfs @ 12.19 hrs, Volume= 0.130 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Reach DP-3:





Drainage Diagram for Post-Cornell rev. 5.28.20
Prepared by Morse Engineering Company, Inc., Printed 5/28/2020

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.164	36	Woods, Fair, HSG A (SUB-1A, SUB-1B, SUB-3)
0.227	39	>75% Grass cover, Good, HSG A (SUB-1A, SUB-1B, SUB-3)
0.322	60	Woods, Fair, HSG B (SUB-1A, SUB-1B, SUB-3)
0.157	61	>75% Grass cover, Good, HSG B (SUB-1A, SUB-3)
0.002	82	Gravel (SUB-3)
0.069	92	Reclaimed Asphalt (SUB-1A)
0.024	98	Concrete (SUB-1B, SUB-3)
0.221	98	Pavement (SUB-1A, SUB-1B, SUB-3)
0.144	98	Roof (SUB-1B, SUB-1C, SUB-3)
1.329		**TOTAL AREA**

Summary for Subcatchment SUB-1A:

Runoff = 0.30 cfs @ 12.19 hrs, Volume= 0.029 af, Depth> 0.99"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Yr. Event Rainfall=3.39"

	Area (sf)	CN	Description
*	2,058	98	Pavement
	6,699	61	>75% Grass cover, Good, HSG B
	2,909	60	Woods, Fair, HSG B
*	3,000	92	Reclaimed Asphalt
	290	36	Woods, Fair, HSG A
	473	39	>75% Grass cover, Good, HSG A
	15,429	71	Weighted Average
	13,371		86.66% Pervious Area
	2,058		13.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.4	78	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.7	128	Total			

Summary for Subcatchment SUB-1B:

Runoff = 0.28 cfs @ 12.15 hrs, Volume= 0.027 af, Depth> 0.69"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Yr. Event Rainfall=3.39"

	Area (sf)	CN	Description
*	789	98	Roof
*	4,368	98	Pavement
*	462	98	Concrete
	2,128	39	>75% Grass cover, Good, HSG A
	9,636	60	Woods, Fair, HSG B
	2,925	36	Woods, Fair, HSG A
	20,308	65	Weighted Average
	14,689		72.33% Pervious Area
	5,619		27.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.7	130	0.0347	3.00		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.2	180	Total			

Summary for Subcatchment SUB-1C:

Runoff = 0.30 cfs @ 12.08 hrs, Volume= 0.024 af, Depth> 3.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Yr. Event Rainfall=3.39"

	Area (sf)	CN	Description
*	4,000	98	Roof
	4,000		100.00% Impervious Area

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

Summary for Subcatchment SUB-3:

Runoff = 0.08 cfs @ 12.36 hrs, Volume= 0.013 af, Depth> 0.37"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 2-Yr. Event Rainfall=3.39"

	Area (sf)	CN	Description
	1,463	60	Woods, Fair, HSG B
*	3,184	98	Pavement
*	567	98	Concrete
	7,296	39	>75% Grass cover, Good, HSG A
*	1,466	98	Roof
	3,933	36	Woods, Fair, HSG A
	137	61	>75% Grass cover, Good, HSG B
*	88	82	Gravel
	18,134	57	Weighted Average
	12,917		71.23% Pervious Area
	5,217		28.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	140	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.5	190	Total			

Summary for Reach DP-1:

Inflow Area = 0.912 ac, 29.39% Impervious, Inflow Depth > 0.35" for 2-Yr. Event event
Inflow = 0.28 cfs @ 12.15 hrs, Volume= 0.027 af
Outflow = 0.28 cfs @ 12.15 hrs, Volume= 0.027 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Summary for Reach DP-3:

Inflow Area = 0.416 ac, 28.77% Impervious, Inflow Depth > 0.37" for 2-Yr. Event event
Inflow = 0.08 cfs @ 12.36 hrs, Volume= 0.013 af
Outflow = 0.08 cfs @ 12.36 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Summary for Pond P-1: Rain Garden

Inflow Area = 0.446 ac, 31.18% Impervious, Inflow Depth > 0.79" for 2-Yr. Event event
Inflow = 0.30 cfs @ 12.19 hrs, Volume= 0.029 af
Outflow = 0.05 cfs @ 13.07 hrs, Volume= 0.029 af, Atten= 83%, Lag= 52.8 min
Discarded = 0.05 cfs @ 13.07 hrs, Volume= 0.029 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Peak Elev= 92.07' @ 13.07 hrs Surf.Area= 919 sf Storage= 397 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 67.5 min (939.9 - 872.4)

Volume	Invert	Avail.Storage	Storage Description
#1	91.60'	3,436 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
91.60	761	0	0
92.00	902	333	333
92.80	1,091	797	1,130
94.20	2,203	2,306	3,436

Device	Routing	Invert	Outlet Devices
#1	Discarded	91.60'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	93.20'	**8.0' long x 1.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.62 2.64 2.64 2.68 2.75 2.86 2.92 3.07 3.07 3.03 3.28 3.32

Discarded OutFlow Max=0.05 cfs @ 13.07 hrs HW=92.07' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=91.60' TW=0.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Pond P-2: Roof Drywell

Inflow Area = 0.092 ac,100.00% Impervious, Inflow Depth > 3.15" for 2-Yr. Event event
Inflow = 0.30 cfs @ 12.08 hrs, Volume= 0.024 af
Outflow = 0.03 cfs @ 11.70 hrs, Volume= 0.024 af, Atten= 88%, Lag= 0.0 min
Discarded = 0.03 cfs @ 11.70 hrs, Volume= 0.024 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Peak Elev= 93.90' @ 12.68 hrs Surf.Area= 627 sf Storage= 324 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 57.8 min (812.5 - 754.7)

Volume	Invert	Avail.Storage	Storage Description
#1	93.40'	342 cf	**Chambers** Listed below Inside #2
#2	92.90'	490 cf	**Stone Backfill (Prismatic)** Listed below (Recalc) 1,568 cf Overall - 342 cf Embedded = 1,226 cf x 40.0% Voids
		832 cf	Total Available Storage

Elevation (feet)	Cum.Store (cubic-feet)
93.40	0
94.80	342

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
92.90	627	0	0
93.90	627	627	627
95.40	627	941	1,568

Device	Routing	Invert	Outlet Devices
#1	Discarded	92.90'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	94.50'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.03 cfs @ 11.70 hrs HW=92.93' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=92.90' TW=91.60' (Dynamic Tailwater)
2=Orifice/Grate (Controls 0.00 cfs)

Summary for Subcatchment SUB-1A:

Runoff = 0.72 cfs @ 12.18 hrs, Volume= 0.064 af, Depth> 2.17"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Yr. Event Rainfall=5.08"

	Area (sf)	CN	Description
*	2,058	98	Pavement
	6,699	61	>75% Grass cover, Good, HSG B
	2,909	60	Woods, Fair, HSG B
*	3,000	92	Reclaimed Asphalt
	290	36	Woods, Fair, HSG A
	473	39	>75% Grass cover, Good, HSG A
	15,429	71	Weighted Average
	13,371		86.66% Pervious Area
	2,058		13.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.4	78	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.7	128	Total			

Summary for Subcatchment SUB-1B:

Runoff = 0.79 cfs @ 12.14 hrs, Volume= 0.066 af, Depth> 1.70"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Yr. Event Rainfall=5.08"

	Area (sf)	CN	Description
*	789	98	Roof
*	4,368	98	Pavement
*	462	98	Concrete
	2,128	39	>75% Grass cover, Good, HSG A
	9,636	60	Woods, Fair, HSG B
	2,925	36	Woods, Fair, HSG A
	20,308	65	Weighted Average
	14,689		72.33% Pervious Area
	5,619		27.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.7	130	0.0347	3.00		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.2	180	Total			

Summary for Subcatchment SUB-1C:

Runoff = 0.46 cfs @ 12.08 hrs, Volume= 0.037 af, Depth> 4.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Yr. Event Rainfall=5.08"

	Area (sf)	CN	Description
*	4,000	98	Roof
	4,000		100.00% Impervious Area

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

Summary for Subcatchment SUB-3:

Runoff = 0.37 cfs @ 12.21 hrs, Volume= 0.040 af, Depth> 1.14"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 10-Yr. Event Rainfall=5.08"

	Area (sf)	CN	Description
	1,463	60	Woods, Fair, HSG B
*	3,184	98	Pavement
*	567	98	Concrete
	7,296	39	>75% Grass cover, Good, HSG A
*	1,466	98	Roof
	3,933	36	Woods, Fair, HSG A
	137	61	>75% Grass cover, Good, HSG B
*	88	82	Gravel
	18,134	57	Weighted Average
	12,917		71.23% Pervious Area
	5,217		28.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	140	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.5	190	Total			

Summary for Reach DP-1:

Inflow Area = 0.912 ac, 29.39% Impervious, Inflow Depth > 0.87" for 10-Yr. Event event
Inflow = 0.79 cfs @ 12.14 hrs, Volume= 0.066 af
Outflow = 0.79 cfs @ 12.14 hrs, Volume= 0.066 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Summary for Reach DP-3:

Inflow Area = 0.416 ac, 28.77% Impervious, Inflow Depth > 1.14" for 10-Yr. Event event
Inflow = 0.37 cfs @ 12.21 hrs, Volume= 0.040 af
Outflow = 0.37 cfs @ 12.21 hrs, Volume= 0.040 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Summary for Pond P-1: Rain Garden

Inflow Area = 0.446 ac, 31.18% Impervious, Inflow Depth > 1.74" for 10-Yr. Event event
Inflow = 0.72 cfs @ 12.18 hrs, Volume= 0.065 af
Outflow = 0.07 cfs @ 14.04 hrs, Volume= 0.061 af, Atten= 91%, Lag= 111.8 min
Discarded = 0.07 cfs @ 14.04 hrs, Volume= 0.061 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Peak Elev= 92.92' @ 14.04 hrs Surf.Area= 1,183 sf Storage= 1,261 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 189.9 min (1,038.0 - 848.1)

Volume	Invert	Avail.Storage	Storage Description
#1	91.60'	3,436 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
91.60	761	0	0
92.00	902	333	333
92.80	1,091	797	1,130
94.20	2,203	2,306	3,436

Device	Routing	Invert	Outlet Devices
#1	Discarded	91.60'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	93.20'	**8.0' long x 1.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.62 2.64 2.64 2.68 2.75 2.86 2.92 3.07 3.07 3.03 3.28 3.32

Discarded OutFlow Max=0.07 cfs @ 14.04 hrs HW=92.92' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=91.60' TW=0.00' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P-2: Roof Drywell

Inflow Area = 0.092 ac,100.00% Impervious, Inflow Depth > 4.84" for 10-Yr. Event event
Inflow = 0.46 cfs @ 12.08 hrs, Volume= 0.037 af
Outflow = 0.05 cfs @ 12.75 hrs, Volume= 0.037 af, Atten= 89%, Lag= 39.9 min
Discarded = 0.03 cfs @ 11.42 hrs, Volume= 0.037 af
Primary = 0.01 cfs @ 12.75 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Peak Elev= 94.53' @ 12.75 hrs Surf.Area= 627 sf Storage= 573 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 113.6 min (860.8 - 747.2)

Volume	Invert	Avail.Storage	Storage Description
#1	93.40'	342 cf	**Chambers** Listed below Inside #2
#2	92.90'	490 cf	**Stone Backfill (Prismatic)** Listed below (Recalc) 1,568 cf Overall - 342 cf Embedded = 1,226 cf x 40.0% Voids
		832 cf	Total Available Storage

Elevation (feet)	Cum.Store (cubic-feet)
93.40	0
94.80	342

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
92.90	627	0	0
93.90	627	627	627
95.40	627	941	1,568

Device	Routing	Invert	Outlet Devices
#1	Discarded	92.90'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	94.50'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.03 cfs @ 11.42 hrs HW=92.93' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.01 cfs @ 12.75 hrs HW=94.53' TW=92.80' (Dynamic Tailwater)
└**2=Orifice/Grate** (Weir Controls 0.01 cfs @ 0.53 fps)

Summary for Subcatchment SUB-1A:

Runoff = 1.83 cfs @ 12.17 hrs, Volume= 0.162 af, Depth> 5.48"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Yr. Event Rainfall=9.04"

	Area (sf)	CN	Description
*	2,058	98	Pavement
	6,699	61	>75% Grass cover, Good, HSG B
	2,909	60	Woods, Fair, HSG B
*	3,000	92	Reclaimed Asphalt
	290	36	Woods, Fair, HSG A
	473	39	>75% Grass cover, Good, HSG A
	15,429	71	Weighted Average
	13,371		86.66% Pervious Area
	2,058		13.34% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.4	78	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
12.7	128	Total			

Summary for Subcatchment SUB-1B:

Runoff = 2.32 cfs @ 12.13 hrs, Volume= 0.184 af, Depth> 4.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Yr. Event Rainfall=9.04"

	Area (sf)	CN	Description
*	789	98	Roof
*	4,368	98	Pavement
*	462	98	Concrete
	2,128	39	>75% Grass cover, Good, HSG A
	9,636	60	Woods, Fair, HSG B
	2,925	36	Woods, Fair, HSG A
	20,308	65	Weighted Average
	14,689		72.33% Pervious Area
	5,619		27.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.5	50	0.0500	0.10		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
0.7	130	0.0347	3.00		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.2	180	Total			

Summary for Subcatchment SUB-1C:

Runoff = 0.81 cfs @ 12.08 hrs, Volume= 0.067 af, Depth> 8.79"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Yr. Event Rainfall=9.04"

	Area (sf)	CN	Description
*	4,000	98	Roof
	4,000		100.00% Impervious Area

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

Summary for Subcatchment SUB-3:

Runoff = 1.42 cfs @ 12.19 hrs, Volume= 0.130 af, Depth> 3.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Type III 24-hr 100-Yr. Event Rainfall=9.04"

	Area (sf)	CN	Description
	1,463	60	Woods, Fair, HSG B
*	3,184	98	Pavement
*	567	98	Concrete
	7,296	39	>75% Grass cover, Good, HSG A
*	1,466	98	Roof
	3,933	36	Woods, Fair, HSG A
	137	61	>75% Grass cover, Good, HSG B
*	88	82	Gravel
	18,134	57	Weighted Average
	12,917		71.23% Pervious Area
	5,217		28.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	140	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.5	190	Total			

Summary for Reach DP-1:

Inflow Area = 0.912 ac, 29.39% Impervious, Inflow Depth > 3.44" for 100-Yr. Event event
Inflow = 3.40 cfs @ 12.24 hrs, Volume= 0.262 af
Outflow = 3.40 cfs @ 12.24 hrs, Volume= 0.262 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Summary for Reach DP-3:

Inflow Area = 0.416 ac, 28.77% Impervious, Inflow Depth > 3.75" for 100-Yr. Event event
Inflow = 1.42 cfs @ 12.19 hrs, Volume= 0.130 af
Outflow = 1.42 cfs @ 12.19 hrs, Volume= 0.130 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs

Summary for Pond P-1: Rain Garden

Inflow Area = 0.446 ac, 31.18% Impervious, Inflow Depth > 4.86" for 100-Yr. Event event
Inflow = 2.18 cfs @ 12.18 hrs, Volume= 0.180 af
Outflow = 1.90 cfs @ 12.26 hrs, Volume= 0.160 af, Atten= 13%, Lag= 5.0 min
Discarded = 0.09 cfs @ 12.26 hrs, Volume= 0.083 af
Primary = 1.81 cfs @ 12.26 hrs, Volume= 0.077 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Peak Elev= 93.40' @ 12.26 hrs Surf.Area= 1,564 sf Storage= 1,920 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 71.1 min (886.1 - 815.0)

Volume	Invert	Avail.Storage	Storage Description
#1	91.60'	3,436 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
91.60	761	0	0
92.00	902	333	333
92.80	1,091	797	1,130
94.20	2,203	2,306	3,436

Device	Routing	Invert	Outlet Devices
#1	Discarded	91.60'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	93.20'	**8.0' long x 1.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.62 2.64 2.64 2.68 2.75 2.86 2.92 3.07 3.07 3.03 3.28 3.32

Discarded OutFlow Max=0.09 cfs @ 12.26 hrs HW=93.40' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=1.80 cfs @ 12.26 hrs HW=93.40' TW=0.00' (Dynamic Tailwater)
2=Broad-Crested Rectangular Weir (Weir Controls 1.80 cfs @ 1.16 fps)

Summary for Pond P-2: Roof Drywell

Inflow Area = 0.092 ac,100.00% Impervious, Inflow Depth > 8.79" for 100-Yr. Event event
Inflow = 0.81 cfs @ 12.08 hrs, Volume= 0.067 af
Outflow = 0.39 cfs @ 12.24 hrs, Volume= 0.067 af, Atten= 52%, Lag= 9.1 min
Discarded = 0.03 cfs @ 10.12 hrs, Volume= 0.049 af
Primary = 0.36 cfs @ 12.24 hrs, Volume= 0.019 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.02 hrs
Peak Elev= 95.22' @ 12.24 hrs Surf.Area= 627 sf Storage= 786 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 92.6 min (831.9 - 739.2)

Volume	Invert	Avail.Storage	Storage Description
#1	93.40'	342 cf	**Chambers** Listed below Inside #2
#2	92.90'	490 cf	**Stone Backfill (Prismatic)** Listed below (Recalc) 1,568 cf Overall - 342 cf Embedded = 1,226 cf x 40.0% Voids
		832 cf	Total Available Storage

Elevation (feet)	Cum.Store (cubic-feet)
93.40	0
94.80	342

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
92.90	627	0	0
93.90	627	627	627
95.40	627	941	1,568

Device	Routing	Invert	Outlet Devices
#1	Discarded	92.90'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	94.50'	**4.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.03 cfs @ 10.12 hrs HW=92.93' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.36 cfs @ 12.24 hrs HW=95.22' TW=93.39' (Dynamic Tailwater)
2=Orifice/Grate (Orifice Controls 0.36 cfs @ 4.08 fps)

PLANS

- Watershed Delineation Plan (WS-1 & WS-2)