Appendix A
Site Information

- Site Locus Map
- FEMA Firmette Map
- Existing Drainage Areas
- Proposed Drainage Areas
- Existing/Proposed Floodplain Limit Plan

vhb

Site Locus Plan

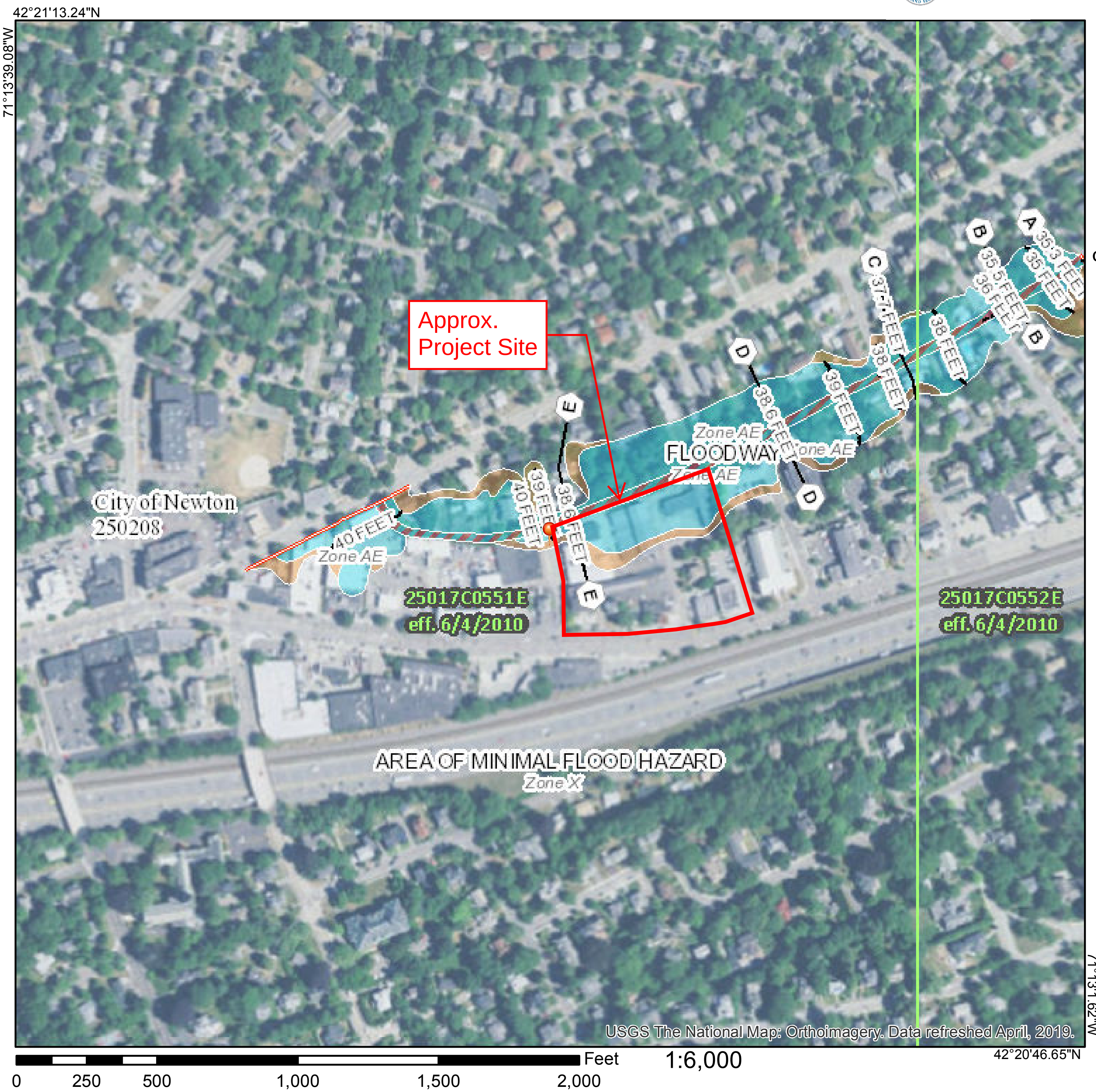
Figure 1

Mark Development
West Newton, MA

May 2021

National Flood Hazard Layer FIRMette

FEMA



Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- (B) 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- (8) Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

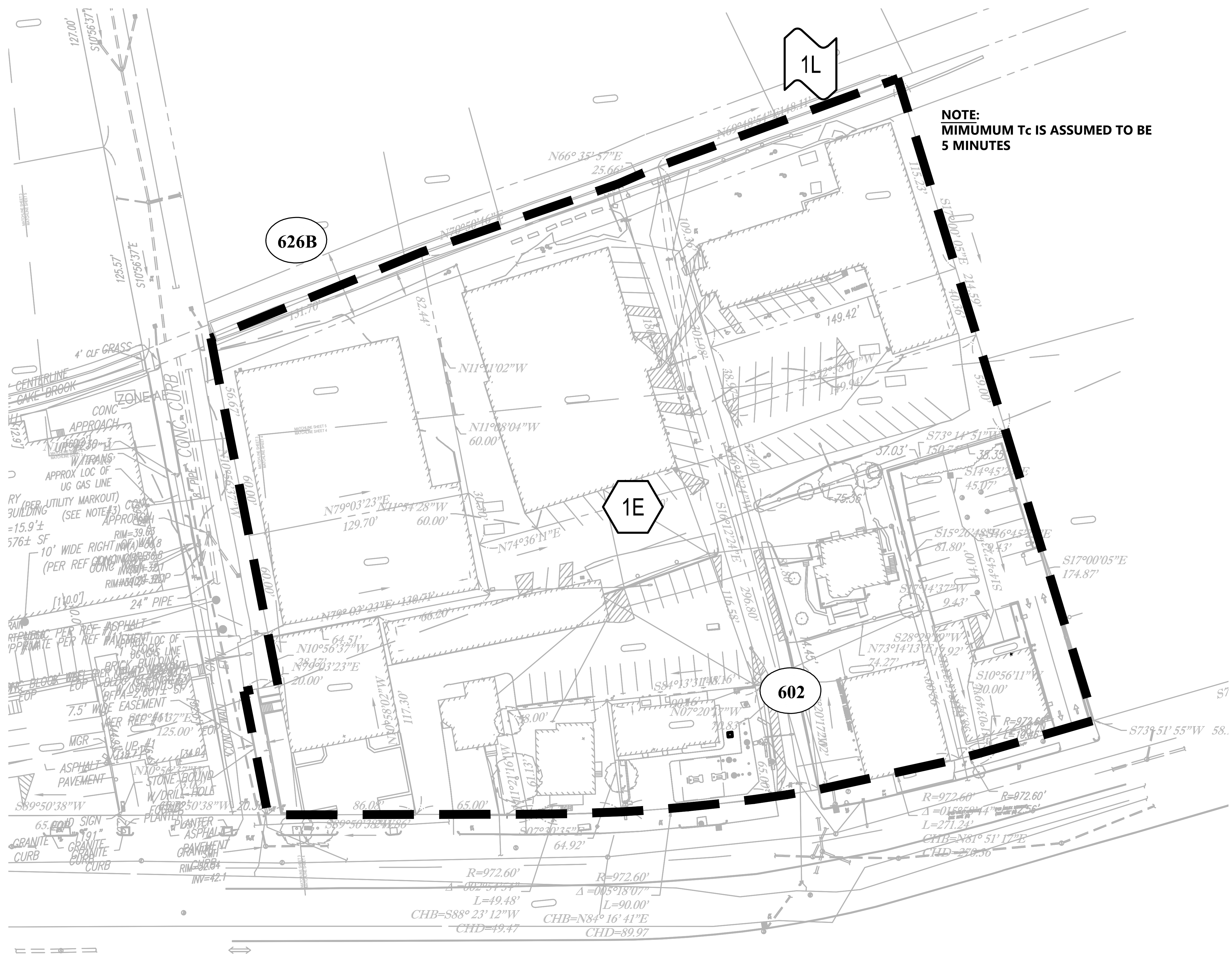
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/14/2019 at 3:01:56 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

\\vhb\gbl\proj\Wat-LD\14517.00\cad\ld\Eng\Stormwater\14517.00-EXWatertshed_5-12-21.dwg



NOTE:
MIMUMUM Tc IS ASSUMED TO BE 5 MINUTES

Legend

SYMBOLS

- X — **DESIGN POINT**
- X — **DRAINAGE AREA DESIGNATION**
- X — **POND**

LINETYPES

- **DRAINAGE AREA BOUNDARY**
- **TIME OF CONCENTRATION FLOW LINE**
- **SOIL TYPE BOUNDARY**
- 100'BZ — **100' BUFFER ZONE**

SCS SOIL CLASSIFICATIONS

- 602 — **CANTON-URBAN LAND COMPLEX, 3 TO 15 PERCENT SLOPES, HSG B**

0 30 60 Feet

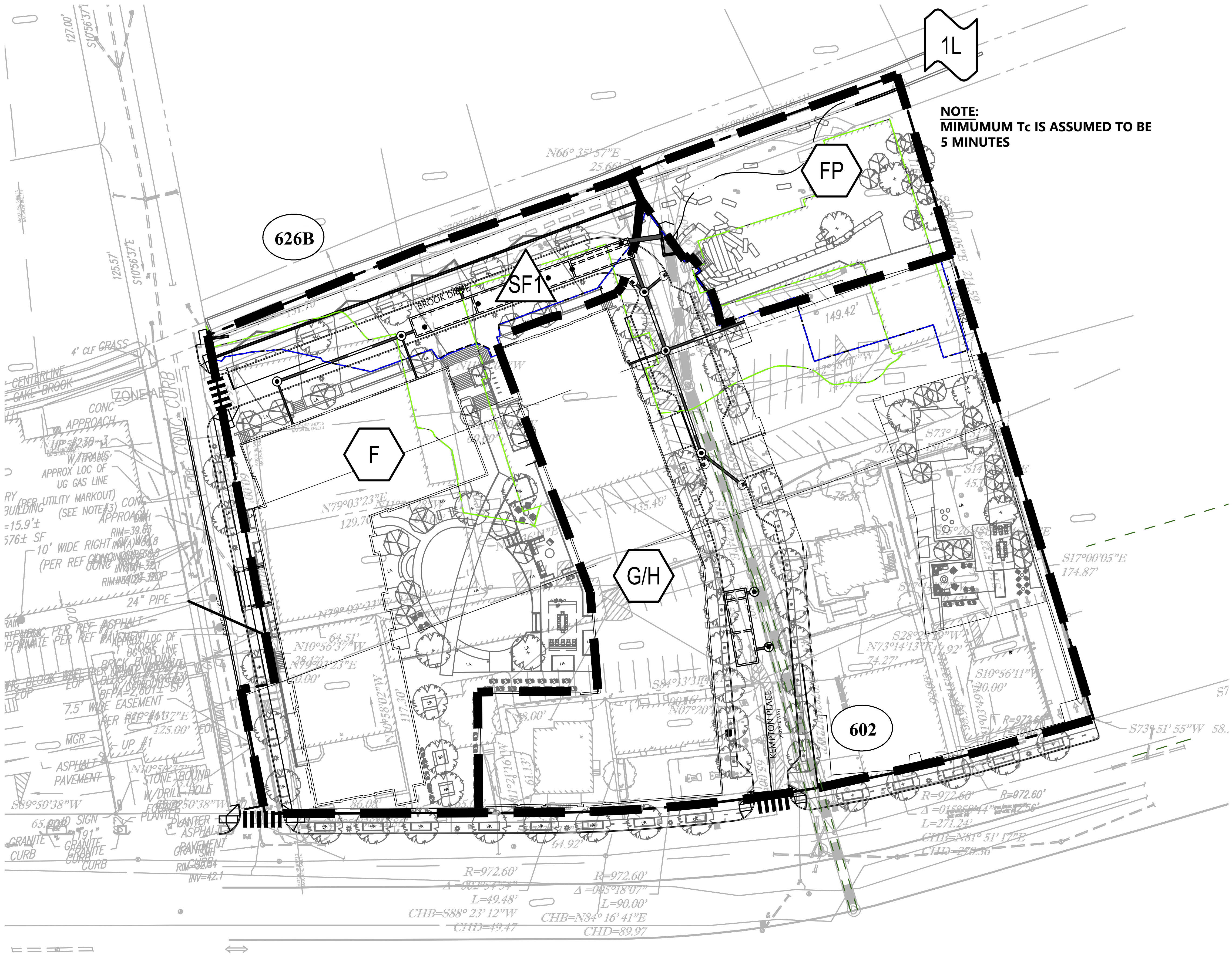
vhb

Existing Drainage Conditions

Figure 3

Mark Development
West Newton, MA

April 2020
Revised May 2021



Legend

SYMBOLS

X (wavy box)	DESIGN POINT
X (hexagon)	DRAINAGE AREA DESIGNATION
X (triangle)	POND

LINETYPES

Heavy dashed line	DRAINAGE AREA BOUNDARY
Light dashed line	TIME OF CONCENTRATION FLOW LINE
Grey line	SOIL TYPE BOUNDARY
——100'BZ——	100' BUFFER ZONE

SCS SOIL CLASSIFICATIONS

602	CANTON-URBAN LAND COMPLEX, 3 TO 15 PERCENT SLOPES, HSG B

0 30 60 Feet

Proposed Drainage Conditions

Figure 4

Mark Development
West Newton, MA

April 2020
Revised May 2021

Legend

LINETYPES

EXISTING FLOODPLAIN LIMIT

PROPOSED FLOODPLAIN LIMIT

Floodplain Storage Volume Calculations

Elevation	Existing Incremental Floodplain Storage (CY)[1]	Existing Cumulative Floodplain Storage (CY)[1]	Proposed Incremental Floodplain Storage (CY)[2]	Proposed Cumulative Floodplain Storage (CY)[2]	Net Incremental Storage Increase (CY)
29-30	0.1	0.1	15.7	15.7	**(+) 15.6**
30-31	18.2	18.3	120.3	136.0	**(+) 102.1**
31-32	27.0	45.3	175.0	311.0	**(+) 148**
32-33	29.8	75.1	219.9	530.9	**(+) 190.1**
33-34	33.4	108.5	257.2	788.1	**(+) 223.8**
34-35	75.7	184.2	297.7	1085.8	**(+) 222**
35-36	299.5	483.7	447.6	1533.4	**(+) 148.1**
36-37	533.6	1017.3	737.9	2271.3	**(+) 204.3**
37-38	776.6	1793.9	798.3	3069.6	**(+) 21.7**
38-38.6	571.6	2365.5	616.7	3686.3	**(+) 45.1**
TOTAL		**2365.5**		**3686.3**	**(+) 1320.8 (+55.8%)**

1. Existing storage calculated from topographic survey by CPA as of May 18, 2019 below floodplain elevation 38.6 ft
2. Proposed storage calculated from proposed grading by VHB as of April 21, 2020 below floodplain elevation 38.6 ft

vhb

Existing/Proposed Floodplain
Limit Plan
Mark Development
West Newton, MA

Figure 5

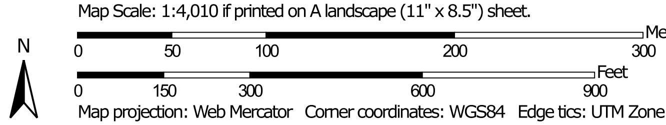
April 2020

Appendix B
Standard 3 Computations and Supporting Information

- NRCS Web Soil Survey

Soil Map—Middlesex County, Massachusetts

Map Scale: 1:4,010 if printed on A landscape (11" x 8.5") sheet.



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 1:25,000.

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: Middlesex County, Massachusetts
Survey Area Data: Version 18, Sep 7, 2018

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

Date(s) aerial images were photographed: Aug 10, 2014—Aug 25, 2014

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
602	Urban land	24.7	51.3%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	23.4	48.7%
Totals for Area of Interest		**48.0**	**100.0%**

Appendix C
Standard 4 & 9 Computations and Supporting Information

- StormCAD Pipe Sizing Report
- Water Quality Volume Calculations
- TSS Removal Worksheets
- Phosphorus Removal Calculations
- Sand Filter System Sizing
- Operation & Maintenance Plan

StormCAD Pipe Sizing Report

Link Summary

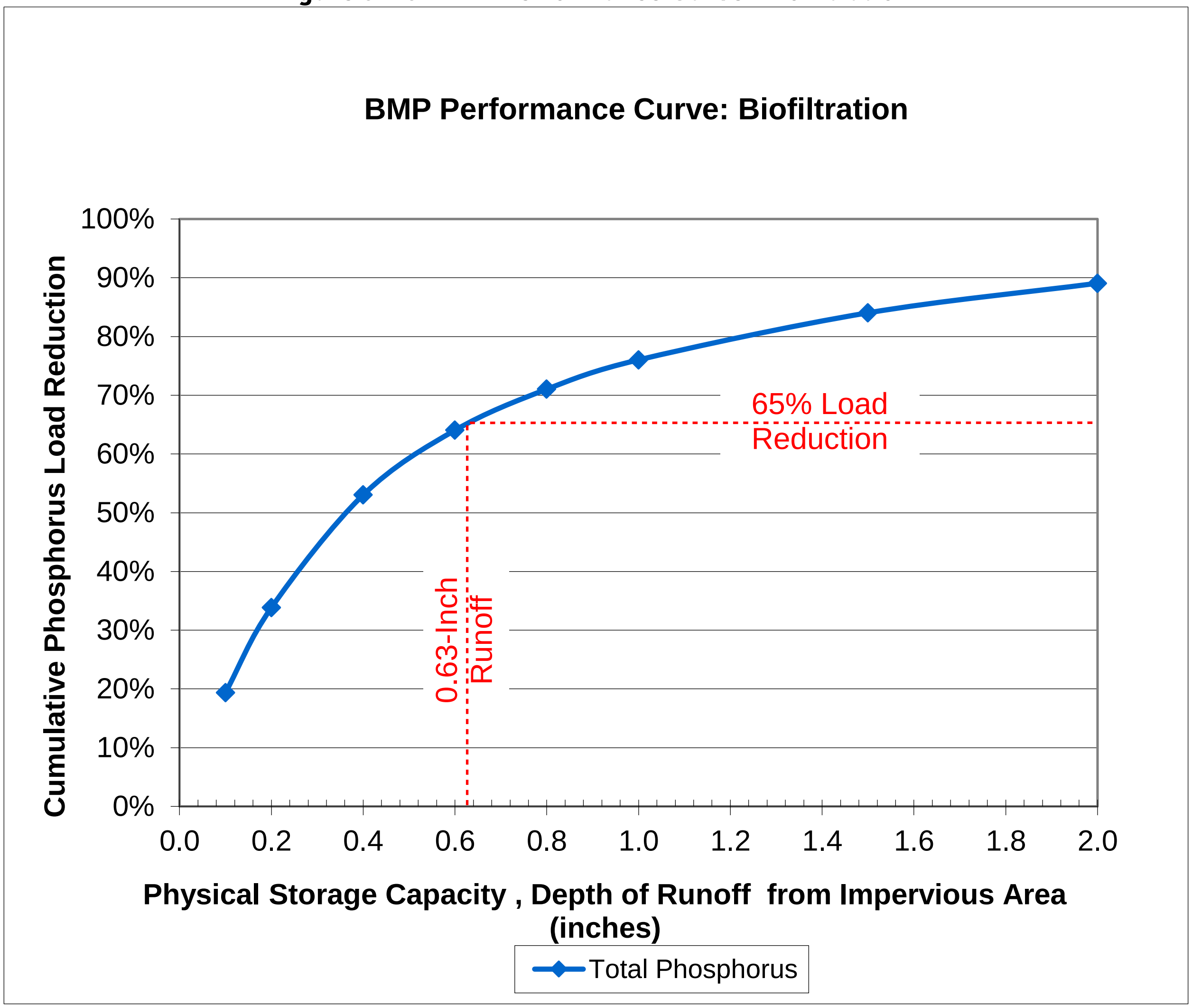
SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Pipe - (11)	Pipe	RD-H1	DMH 8	19.34	37.30	36.92	1.9700	10.000	0.0120	0.00	3.33	0.00	0.00	0.00	0.00	0.00	Calculated
2	Pipe - (11) (1)	Pipe	DMH 8	DMH 7	21.05	36.92	36.50	1.9700	10.000	0.0120	1.20	3.33	0.36	5.61	0.35	0.41	0.00	Calculated
3	Pipe - (15)	Pipe	RD-F1	DMH 3	27.65	36.25	35.70	1.9900	10.000	0.0120	0.00	3.35	0.00	0.00	0.00	0.00	0.00	Calculated
4	Pipe - (16)	Pipe	RD-F2	DMH 4	36.62	36.25	35.75	1.3700	10.000	0.0120	0.00	2.77	0.00	0.00	0.00	0.00	0.00	Calculated
5	Pipe - (17)	Pipe	DMH 7	DMH 6	33.37	36.50	36.27	0.7000	12.000	0.0120	1.55	3.23	0.48	4.08	0.49	0.49	0.00	Calculated
6	Pipe - (18)	Pipe	DMH 6	DMH 5	73.51	36.17	35.66	0.7000	12.000	0.0120	1.54	3.23	0.48	4.10	0.49	0.49	0.00	Calculated
7	Pipe - (19)	Pipe	DMH 5	DMH 4	73.19	35.66	35.15	0.6900	15.000	0.0120	3.40	5.81	0.58	4.95	0.69	0.55	0.00	Calculated
8	Pipe - (20)	Pipe	DMH 4	WQS 1	17.71	35.15	35.00	0.8500	12.000	0.0120	3.40	3.55	0.96	5.16	0.78	0.78	0.00	Calculated
9	Pipe - (20) (1)	Pipe	WQS 1	DMH 3	36.27	34.75	34.60	0.4100	15.000	0.0120	3.40	4.50	0.75	4.04	0.81	0.65	0.00	Calculated
10	Pipe - (21)	Pipe	DMH 2	Out-1Pipe - (21)	45.63	31.90	31.58	0.7000	15.000	0.0120	0.71	11.72	0.06	2.66	0.21	0.17	0.00	Calculated
11	Pipe - (23)	Pipe	CB 3	DMH 7	23.83	36.77	36.60	0.7000	12.000	0.0120	0.37	3.23	0.11	3.13	0.23	0.23	0.00	Calculated
12	Pipe - (24)	Pipe	DMH 9	DMH 8	99.88	38.26	37.02	1.2400	12.000	0.0120	1.20	4.30	0.28	4.73	0.36	0.36	0.00	Calculated
13	Pipe - (25)	Pipe	CB 4	DMH 9	26.62	38.54	38.36	0.7000	12.000	0.0120	0.77	3.23	0.24	3.78	0.33	0.33	0.00	Calculated
14	Pipe - (26)	Pipe	CB 5	DMH 9	6.10	39.07	39.03	0.7000	12.000	0.0120	0.45	3.23	0.14	2.89	0.25	0.25	0.00	Calculated
15	Pipe - (27)	Pipe	CB 1	DMH 5	19.78	36.00	35.75	1.2600	12.000	0.0120	1.05	4.34	0.24	4.55	0.33	0.33	0.00	Calculated
16	Pipe - (29)	Pipe	CB 2	DMH 5	7.99	36.00	35.94	0.7000	12.000	0.0120	0.96	3.23	0.30	3.58	0.37	0.37	0.00	Calculated
17	Pipe - (30)	Pipe	DMH 3	Out-1Pipe - (30)	4.09	34.60	34.50	2.4500	12.000	0.0120	2.68	6.04	0.44	7.46	0.47	0.47	0.00	Calculated
18	Pipe - (31)	Pipe	SF-1	DMH 2	4.10	32.00	31.90	2.4400	12.000	0.0120	0.00	6.03	0.00	0.00	0.00	0.00	0.00	Calculated
19	Pipe - (32)	Pipe	DMH 3	DMH 2	33.01	34.60	33.00	4.8500	15.000	0.0120	0.71	15.41	0.05	6.42	0.18	0.15	0.00	Calculated
20	Pipe - (8)	Pipe	RD-G4	DMH 5	36.60	36.50	35.75	2.0500	10.000	0.0120	0.00	3.40	0.00	0.00	0.00	0.00	0.00	Calculated

Water Quality Volume Calculations

Table 3- 16: Biofiltration BMP Performance Table

Biofiltration BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	19%	34%	53%	64%	71%	76%	84%	89%

Figure 3- 13: BMP Performance Curve: Biofiltration



Impervious Area	57,502	Building F	WQV	3,019	Building F
	82,956	Building G/H		4,355	Building G/H
	15,665	Washington St		822	Washington St

TSS Removal Worksheets

TSS Removal Calculation Worksheet

VHB, Inc..
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name: **Washington Street Mixed-Us**
Project Number: **14517.00**
Location: **Newton, MA**
Discharge Point:
Drainage Area(s):

Sheet: **1 of 1**
Date: **23-Apr-2020**
Computed by: **OMW**
Checked by: **HH**

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**1.00**	**0.25**	**0.75**
Sand Filter	**80%**	**0.75**	**0.60**	**0.15**
	0%	**0.15**	**0.00**	**0.15**
	0%	**0.15**	**0.00**	**0.15**
	0%	**0.15**	**0.00**	**0.15**

Treatment Train TSS Removal = **85%**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).
** Equals remaining load from previous BMP (E)
*** Stormceptor sizing calculation gives a TSS removal rate of 87%. To be conservative, 80% removal is used for this calculation (Change name of device and the claimed removal rate shown on the calc. sheet. Remove this sentence if not applicable.

Phosphorus Removal Calculations

Phosphorus Loading - Existing Conditions

Project Name: Dunstan East Mixed-Use Redevelopment
Project Location: Newton, MA

Proj. No.: 14517.00
Date: May 2021
Calculated by: DBL
Checked by:

Subcatchment Number	Land Cover within Use	Phosphorus Load Export Rate (lbs/ac/year)*	Area** (acre)	Phosphorous Loading to BMP per Area (lb/yr)	Total Phosphorus Loading to BMP (lb/yr)
Commercial (Development)	Directly Connected Impervious	2.32	3.23	7.49	7.54
	Pervious (HGS B)	0.12	0.36	0.04	
Totals =			3.59	---	7.54

* Per MA MS4 General Permit, Table 3-1, Average Annual Disttinct Phosphorus Load (P Load) export rates for use in exstimating phosphorus load reduction credits the MA MS4 Permit.
** Site Area includes only the proposed area of redevelopment and excludes the MBTA Rail Yard

Phosphorus Loading to BMPs - Proposed Conditions

Project Name: Dunstan East Mixed-Use Redevelopment
Project Location: Newton, MA

Proj. No.: 14517.00
Date: May 2021
Calculated by: DBL
Checked by:

Subcatchment Number	Land Cover within Use	Phosphorus Load Export Rate (lbs/ac/year)*	Area (acre)	Phosphorous Loading to BMP per Area (lb/yr)	Total Phosphorus Loading to BMP (lb/yr)	Phosphorous Removal	Total Phosphorus Removal (lb/yr)
1S	Impervious (High-Density Residential)	2.32	3.00	6.96	7.03	65%	4.57
	Pervious (HGS B)	0.12	0.59	0.07			
Totals =			3.59	---	7.03	---	4.57

Existing Phosphorus Load	7.54
Proposed Phosphorus Load	7.03
Total Phosphorus Removed	***4.57***
	65%

* Per MA MS4 General Permit, Table 3-1, Average Annual Distinct Phosphorus Load (P Load) export rates for use in exstimating phosphorus load reduction credits the MA MS4 Permit.

Weighted Phosphorous Removal Calculation

Project Name: Dunstan East Mixed-Use Redevelopment | **Proj. No.:** 14517.00
Project Location: Newton, MA | **Date:** May 2021
Calculated by: DBL
Checked by:

Subcatchment Number	Impervious Area (ac)	Infiltration Rate (in/hr)	Phosphorous Removal	A x PR
1S	3.00	0.00	65%	1.95
Totals =	3.00		---	1.95

Weighted Phosphorous Removal:	**S(AxPR) / SA =**	**65.0%**

Note: Phosphorous removal based on EPA "Stormwater Best Management Practices (BMP) Performance Analysis" assuming commercial and high density land uses. Refer to BMP Sizing Calculations for total phosphorous removal percentages by BMP type.

Sand Filter Sizing Calculations

Computations

Project:	Dunstan East	Project #	14517.00
Location:	Newton, MA	Sheet	1 of 2
Calculated by:	DBL	Date:	5-May-21
Checked by:		Date:	
Title	Sand Filter Sizing Calculations - Revised		

Sedimentation Chamber Sizing (Sand Filter 1)

A_s = -Q/W ln (1-E)

A_s = sedimentation surface area (ft^2)
Q = discharge rate from drainage area (ft^3/s) = WQV/24hr
W = particle settling velocity (0.0004 ft/s recommended for silt)
E = sediment removal efficiency (assume 0.9 or 90%)

(West Side)				***(East Side)***			
WQV =	2,445	ft^3		WQV =	4,287	ft^3	
Q =	0.028	ft^3/s		Q =	0.050	ft^3/s	
W=	0.0004	ft/s		W=	0.0004	ft/s	
E=	0.9			E=	0.9		
A_s=	**162.9**	**ft^2**		**A_s=**	**285.6**	**ft^2**	
A_s Provided =	**390**	**ft^2**	(10' x 39')	**A_s Provided =**	**292.5**	**ft^2**	(7.5' x 39')

Filter Bed Sizing (Sand Filter 1)

(sediment chamber is combined for total flow)

A_f =(WQV x d)/kt(h+d)

A_f = filter bed surface area (ft^2)
WQV = water quality volume (ft^3)
d = filter bed depth (ft)
k = hydraulic conductivity of filter media (ft/day)
t = time of water quality volume to drain from system (24 hours)
h = average height of water above filter bed during water quality design storm

WQV =	6,732	ft^3
d =	1.5	ft
k =	4	ft/day
t =	1	day
h =	2.70	ft
A_f =	**601.1**	**ft^2**
A_f Provided =	**610**	**ft^2**

Water Quality Volume Storage Check

(Following Georgia Stormwater Management Manual)

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system … must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

WQV =	6,732	ft^3
75% WQV =	**5,049**	**ft^3**

V_s = volume within sedimentation chamber below the top of the sand media

V_t = volume within the voids in the filter bed (assume 40% voids)

V_{temp} = temporary volume stored above the filter bed and low flow weir

A_f = provided filter bed surface area (ft^2)

A_s = provided sedimentation surface area (ft^2)

d = filter bed depth (ft)

h_f = average height of water above filter bed during water quality design storm

h_s = height of sedimentation chambers below top of sand media

$V_s = A_s * h_s$

A_s =	682.5	ft^2
h_s =	2	ft
V_s =	**1,365**	**ft^3**

$V_t = A_f * d * 0.4$

A_f =	610	ft^2
d =	1.5	ft^2
V_t =	**366**	**ft^3**

$V_{temp} = (A_f + A_s) * h_f$

A_f =	610	ft^2
A_s =	682.5	ft^2
h_f =	2.70	ft
V_{temp} =	**3,490**	**ft^3**

Total Provided WQV = $V_s + V_t + V_{temp}$

Total WQV =	**5,221**	**ft^3**	**>**	**5,049**	**ft^3**	**Required**

Project:	Dunstan East	Project #	14517.00
Location:	Newton, MA	Sheet	3 of 4
Calculated by:	PTM	Date:	10-Jun-20
Checked by:		Date:	
Title	Sand Filter Sizing Calculations		

Sedimentation Chamber Sizing (Sand Filter 2)

A_s = -Q/W ln (1-E)

A_s = sedimentation surface area (ft^2)
Q = discharge rate from drainage area (ft^3/s) = WQV/24hr
W = particle settling velocity (0.0004 ft/s recommended for silt)
E = sediment removal efficiency (assume 0.9 or 90%)

WQV =	1,137	ft^3
Q =	0.013	ft^3/s
W=	0.0004	ft/s
E=	0.9	
A_s=	**75.8**	**ft^2**
A_s Provided =	**198**	**ft^2**

Filter Bed Sizing (Sand Filter 2)

A_f =(WQV x d)/kt(h+d)

A_f = filter bed surface area (ft^2)
WQV = water quality volume (ft^3)
d = filter bed depth (ft)
k = hydraulic conductivity of filter media (ft/day)
t = time of water quality volume to drain from system (24 hours)
h = average height of water above filter bed during water quality design storm

WQV =	1,137	ft^3
d =	1.5	ft
k =	4	ft/day
t =	1	day
h =	0.90	ft
A_f =	**177.7**	**ft^2**
A_f Provided =	**198**	**ft^2**

Water Quality Volume Storage Check

(Following Georgia Stormwater Management Manual)

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system … must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

WQV =	1,137	ft^3
75% WQV =	**853**	**ft^3**

V_s = volume within sedimentation chamber below the top of the sand media

V_t = volume within the voids in the filter bed (assume 40% voids)

V_{temp} = temporary volume stored above the filter bed and low flow weir

A_f = provided filter bed surface area (ft^2)

A_s = provided sedimentation surface area (ft^2)

d = filter bed depth (ft)

h_f = average height of water above filter bed during water quality design storm

h_s = height of sedimentation chambers below top of sand media

$V_s = A_s * h_s$

A_s =	198.0	ft^2
h_s =	2	ft
V_s =	**396**	**ft^3**

$V_t = A_f * d * 0.4$

A_f =	198	ft^2
d =	1.5	ft^2
V_t =	**118.8**	**ft^3**

$V_{temp} = (A_f + A_s) * h_f$

A_f =	198	ft^2
A_s =	198.0	ft^2
h_f =	0.90	ft
V_{temp} =	**356**	**ft^3**

Total Provided WQV = $V_s + V_t + V_{temp}$

Total WQV =	**871**	**ft^3**	**>**	**853 ft^3 Required**

Operation & Maintenance Plan

Operation & Maintenance Plan

This Operation and Maintenance Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Description of Pollutant Sources

The Project Site consists of three multi-story mixed-use buildings, and subsequent parking along the north side of Washington Street between Dunston Street and Kempton Place in Newton, Massachusetts. The Site lies within the Charles River Watershed, and is bounded by the Cheese Cake Brook to the north.

Pollutant Control Approach

Maintenance of Pavement Systems

Standard Asphalt Pavement

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- Sweep or vacuum asphalt pavement areas semi-annually with a commercial cleaning unit and dispose of removed material.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary.
- Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect planted areas on a semi-annual basis and remove any litter.

- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.
- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should be cut to a height between three and four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.
- Pet waste provision if applicable.

Management of Snow and Ice

Storage and Disposal

Snow shall be removed from the site shortly after snow events. The standard pavement surfaces will be sanded, and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored in wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.
- Do not stockpile snow on permeable pavement surfaces. Sand and grit in snow will clog pavement.
- Plow parking areas paved with permeable asphalt pavement carefully. Plow blades should be set approximately 1” higher than usual to avoid scarring the pavement and loosening material that could potentially clog surface pores.
- Do not apply abrasives such as sand or grit on or adjacent to permeable asphalt pavement.
- Monitor application rates of deicing materials on permeable pavement areas and reduce application rate accordingly. Permeable pavements tend to require less deicer per unit area because the water is not required to remain liquid over the entire parking surface area before discharge.
- Do not apply abrasives such as sand or grit on or adjacent to permeable pavers.
- Avoid plowing of areas with permeable pavers.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- Specific environmentally sensitive areas, including the 100' buffer zone, should be designated as no and/or reduced salt areas.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Spill prevention equipment and training will be provided by the property management company.

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

FACILITY MANAGER

Name:	______________________	Home Phone:	______________________
Phone:	______________________	E-mail:	______________________

CONSTRUCTION MANAGER

Name:	______________________	Home Phone:	______________________
Phone:	______________________	E-mail:	______________________

The supervisor will first contact the Fire Department and then notify the Police Department, the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts Department of Environmental Protection (DEP) and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the main construction/facility office and readily accessible to all employees. A hazardous waste spill report shall be completed as necessary using the attached form.

Emergency Notification Phone Numbers

1. **FACILITY MANAGER**

   Name: ______________ Home Phone: ______________

   Phone: ______________ E-mail: ______________

   ALTERENATE

   Name: ______________ Home Phone: ______________

   Phone: ______________ E-mail: ______________

2. **FIRE DEPARTMENT**

   Emergency: **911**

   Business: (617) 796-2210

   POLICE DEPARTMENT

   Emergency: **911**

   Business: (617) 796-2107

3. **CLEANUP CONTRACTOR:**

   Address: ______________

   Phone: ______________

4. **MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION**

   Emergency: ______________

   Northeast Region – Wilmington Office: (978) 694-3200

5. **NATIONAL RESPONSE CENTER**

   Phone: (800) 424-8802

   ALTERNATE: U.S. ENVIRONMENTAL PROTECTION AGENCY

   Emergency: ______________

   Business: ______________

6. **CONSERVATION COMMISSION**

   Contact: Jennifer Steel

   Phone: (617) 796-1120

   BOARD OF HEALTH

   Contact: Deborah Youngblood, PhD

   Phone: (617) 796-1420

Hazardous Waste / Oil Spill Report

Date ______________________ Time ____________ AM / PM

Exact location (Transformer #) ______________________

Type of equipment ____________ Make ____________ Size ____________

S / N ____________________ Weather Conditions ____________

On or near Water ☐ Yes If Yes, name of body of Water ____________

☐ No

Type of chemical/oil spilled ______________________

Amount of chemical/oil spilled ______________________

Cause of Spill ______________________

Measures taken to contain or clean up spill ______________________

Amount of chemical/oil recovered ____________ Method ____________

Material collected as a result of cleanup:

__________ Drums containing ______________________

__________ Drums containing ______________________

__________ Drums containing ______________________

Location and method of debris disposal

____

Name and address of any person, firm, or corporation suffering damages:

____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring:

____

Spill reported to General Office by ____________ Time __________ AM / PM

Spill reported to DEP / National Response Center by ______________________

DEP Date __________ Time __________ AM / PM Inspector ____________

NRC Date __________ Time __________ AM / PM Inspector ____________

Additional comments: ______________________

Assessment - Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department	911
Municipality Health Department	(617) 796-1420
Municipality Conservation Commission:	(617) 796-1120

Emergency Response Equipment

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

Supplies		***Recommended Suppliers***
SORBENT PILLOWS/"PIGS"	**2**	http://www.newpig.com
SORBENT BOOM/SOCK	**25 FEET**	Item # KIT276 — mobile container with two pigs,
SORBENT PADS	**50**	26 feet of sock, 50 pads, and five pounds of
LITE-DRI® ABSORBENT	**5**	absorbent (or equivalent)
POUNDS		http://www.forestry-suppliers.com
SHOVEL	**1**	Item # 43210 — Manhole cover pick (or
PRY BAR	**1**	equivalent)
GOGGLES	**1 PAIR**	Item # 33934 — Shovel (or equivalent)
GLOVES – HEAVY	**1 PAIR**	Item # 90926 — Gloves (or equivalent)
		Item # 23334 — Goggles (or equivalent)

Stormwater Operation and Maintenance Plan

Project Information

Site

Dunstan East Mixed-Use Redevelopment
Washington Street
Newton, MA

Owner

Mark Development, LLC
275 Grove Street
Suite 2-150
Newton, MA 02466
(617) 614-9149

Site Supervisor

Site Manager Name
Site Manager Address
Site Manager City, State Zip
Site Manager Phone Number

Name: ______________________________________

Telephone: __________________________________

Cell phone: __________________________________

Email: ______________________________________

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long term operation and maintenance of the stormwater management system.

Catch Basins

- All catch basins shall be inspected and as necessary at least four times a year and at the end of the foliage and snow removal seasons.
- Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

Roof Drain Leaders

- Perform routine roof inspections quarterly.
- Keep roofs clean and free of debris.
- Keep roof drainage systems clear.
- Keep roof access limited to authorized personnel.
- Clean inlets draining to the subsurface bed twice per year as necessary.

Sand Filter System

- Eroded or barren spots should be reestablished immediately after inspection to prevent additional erosion and accumulation of sediment.
- Sediment should be removed from the basin as necessary. Removal procedures should not take place until the floor of the basin is thoroughly dry.

Inspections and Cleaning

- Sand Filter Systems should be inspected at least twice a year to ensure proper filtration and function.
- Vacuum trucks shall be used to remove and replace the top few inches of clogged sand as necessary to provide adequate infiltration.

Appendix D
Standard 7 Supporting Information

- Redevelopment Checklist

Chapter 3

Checklist for Redevelopment Projects

Standard 7: A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Redevelopment is defined to include

- Maintenance and improvement of existing roadways, including widening less than a single lane, adding shoulders, correcting substandard intersections, improving existing drainage systems, and repaving;
- Development rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area; and
- Remedial projects specifically designed to provide improved stormwater management, such as projects to separate storm drains and sanitary sewers, and stormwater retrofit projects.

Components of redevelopment projects that include development of previously undeveloped sites do not meet this definition. The portion of the project located in a previously developed area must meet Standard 7, but project components within undeveloped areas must meet all the Standards.

MassDEP recognizes that site constraints often make it difficult to comply with all the Standards at a redevelopment site. These constraints are as follows:

Lack of space. Because of the presence of existing structures, on-site subsurface sewage disposal systems, stormwater best management practices, and water bodies and wetlands, and easements, the space available for the installation of additional stormwater BMPs may be quite limited. On many suites it may be difficult or impossible to use space-intensive BMPs such as wet detention basins.

Soils: The presence of bedrock or clay can limit the effectiveness of infiltration or detention BMPs. Often soils at redevelopment sites have been compacted by buildings and heavy traffic, impairing their ability to infiltrate stormwater into the ground.

Underground utilities. The presence of underground utilities including gas and water mains, sewer pipes and electric cable conduits can greatly reduce the amount of land available for BMPs.

This chapter provides specific guidance and checklists to ensure that the applicant has met his/her obligations under Standard 7. Because it may be difficult for a redevelopment project to comply with all the Stormwater Management Standards, Standard 7 provides that a redevelopment project is required to comply with the following Standards only "to the maximum extent practicable": Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing outfalls shall be brought into compliance with Standard 1 only to the maximum extent practicable.

As set forth in Standard 7, the phrase "to the maximum extent practicable" means that:

(1) Proponents of redevelopment projects have made all reasonable efforts to meet the requirements of Standards 2 and 3 and the pretreatment and structural stormwater best management practices requirements of Standards 4, 5, and 6 and to bring existing outfalls into compliance with Standard 1.

(2) They have made a complete evaluation of possible stormwater management measures, including environmentally sensitive site design that minimizes land disturbance and impervious surfaces, low impact development techniques and structural stormwater BMPs; and

(3) If not in full compliance with Standard 1 for existing outfalls, Standards 2 and 3 and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6, they are implementing the highest practicable level of stormwater management.

Generally, an alternative is practicable if it can be implemented within the site being redeveloped, taking into consideration cost, land area requirements, soils and other site constraints. However, offsite alternatives may also be practicable. Proponents must document the evaluation of practicable alternatives with sufficient information to support the conclusions of the analysis.

At the same time, stormwater runoff from redevelopment projects must be properly managed. To this end, Standard 7 provides that redevelopment projects shall comply with all other requirements of the Stormwater Management Standards, including, without limitation, the pollution prevention requirements of Standards 4, 5, and 6, the erosion and sedimentation control requirements of Standard 8, the operation and maintenance requirements of Standard 9, and the prohibition of illicit discharge set forth in Standard 10. Proponents must also improve existing conditions.

Proponents of redevelopment projects shall document their compliance with these requirements. To assist proponents and reviewers in determining whether a redevelopment project complies with Standard 7, MassDEP has prepared the following redevelopment checklist.

[*Proponents of MassHighway redevelopment projects and Conservation Commissions reviewing such projects may follow the guidelines for redevelopment provided in the MassHighway Stormwater Handbook for Highways and Bridges (May 2004 or latest version) in lieu of the guidance set forth in this chapter.*[1] *The MassHighway Stormwater Handbook was developed by the Massachusetts Highway Department and issued by joint correspondence of May 7, 2004 by MassHighway and MassDEP. It provides detailed guidance on the evaluation and implementation of stormwater management practices for MassHighway road and bridge redevelopment projects, including a methodology for screening and selecting Best Management Practices (BMPs). Proponents and reviewers of other public roadway redevelopment projects may find useful information in the MassHighway Stormwater Handbook*.]

[1] The MassHighway Handbook published in 2004 must be revised to make it consistent with this Handbook.

Redevelopment Checklist

Existing Conditions

- On-site: For all redevelopment projects, proponents should document existing conditions, including a description of extent of impervious surfaces, soil types, existing land uses with higher potential pollutant loads, and current onsite stormwater management practices.
  Existing Conditions are included
- Watershed: Proponents should determine whether the project is located in a watershed or subwatershed, where flooding, low streamflow or poor water quality is an issue.
  Existing and proposed floodplains associated with the Cheese Cake Brook are shown on the plans.

The Project

Is the project a redevelopment project?

- Maintenance and improvement of existing roadways - Yes
- Development of rehabilitation, expansion or phased project on redeveloped site, or - Yes
- Remedial stormwater project – Yes

For non-roadway projects, is any portion of the project outside the definition of redevelopment?

- Development of previously undeveloped area - No
- Increase in impervious surface - No

If a component of the project is not a redevelopment project, the proponent shall use the checklist set forth below to document that at a minimum the proposed stormwater management system fully meets each Standard for that component. The proponent shall also document that the proposed stormwater management system meets the requirements of Standard 7 for the remainder of the project.

The Stormwater Management Standards

The redevelopment checklist reviews compliance with each of the Stormwater Management Standards in order.

Standard 1: (Untreated discharges)
No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.
Same rule applies for new developments and redevelopments.

Full compliance with Standard 1 is required for new outfalls.

- What BMPs are proposed to ensure that all new discharges associated with the discharge are adequately treated? – Deep Sump Catch Basins with Hoods and Subsurface Sand Filters

- What BMPs are proposed to ensure that no new discharges cause erosion in wetlands or waters of the Commonwealth? – Deep Sump Catch Basins with Hoods and Subsurface Sand Filters, with appropriate erosion control measures and stream restoration at proposed headwalls.
- Will the proposed discharge comply with all applicable requirements of the Massachusetts Clean Waters Act and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00? - Yes

Existing outfalls shall be brought into compliance with Standard 1 to the maximum extent practicable.

- Are there any existing discharges associated with the redevelopment project for which new treatment could be provided? – Yes, and sand filters are proposed
- If so, the proponent shall specify the stormwater BMP retrofit measures that have been considered to ensure that the discharges are adequately treated and indicate the reasons for adopting or rejecting those measures. (See Section entitled "Retrofit of Existing BMPs".) - Proposing Sand Filters to treat Kempton Place prior to discharging to the Cheese Cake Brook
- What BMPs have been considered to prevent erosion from existing stormwater discharges? - Erosion control, dissipation pads, new low points, and stream restoration at the proposed headwalls, allowing the flow from the headwalls to spread and prevent erosion to prevent flow directly into the Cheese Cake Brook

Standard 2: (Peak rate control and flood prevention)

Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for land subject to coastal storm flowage.

Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 2, comparing post-development to pre-development conditions? - Yes
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard. (See Menu of Strategies to Reduce Runoff and Peak Flows and/or Increase Recharge Menu included at the end of this chapter.)

Improvement of existing conditions:

- Does the project reduce the volume and/or rate of runoff to less than current estimated conditions? Has the applicant considered all the alternatives for reducing the volume and/or rate of runoff from the site? (See Menu.) - Yes
- Is the project located within a watershed subject to damage by flooding during the 2-year or 10-year 24-hour storm event? If so, does the project design provide for attenuation of the 2-year and 10-year 24-hour storm event to less than current estimated conditions? Have measures been implemented to reduce the volume of runoff from the site resulting from the 2 year or 10 year 24 hour storm event? (See Menu.) - Yes
- Is the project located adjacent to a water body or watercourse subject to adverse impacts from flooding during the 100-year 24-hour storm event? If so, are portions of the site available to increase flood storage adjacent to existing Bordering Land Subject to Flooding (BLSF)? - Yes
- Have measures been implemented to attenuate peak rates of discharge during the 100-year 24-hour storm event to less than the peak rates under current estimated conditions? Have measures

been implemented to reduce the volume of runoff from the site resulting from the 100-year 24-hour storm event? (See Menu.) - Yes

<u>Standard 3: (Recharge to Ground water)</u>
Loss of annual recharge to ground water shall be eliminated or minimized through the use of infiltration measures, including environmentally sensitive site design, low impact development techniques, best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from the pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusettss Stormwater Handbook.
Full compliance for any component that is not a redevelopment

Compliance to the Maximum Extent Practicable:

- Does the redevelopment design meet Standard 3, comparing post-development to pre-development conditions? - No
- If not, the applicant shall document an analysis of alternative approaches for meeting the Standard? – Standard won't be met due to groundwater depth
- What soil types are present on the site? Is the site is comprised solely of C and D soils and bedrock at the land surface?
- Does the project include sites where recharge is proposed at or adjacent to an area classified as contaminated, sites where contamination has been capped in place, sites that have an Activity and Use Limitation (AUL) that precludes inducing runoff to the groundwater, pursuant to MGL Chapter 21E and the Massachusetts Contingency Plan 310 CMR 40.0000; sites that are the location of a solid waste landfill as defined in 310 CMR 19.000; or sites where groundwater from the recharge location flows directly toward a solid waste landfill or 21E site?[2]
- Is the stormwater runoff from a land use with a higher potential pollutant load? - No
- Is the discharge to the ground located within the Zone II or Interim Wellhead Protection Area of a public water supply? – N/A
- Does the site have an infiltration rate greater than 2.4 inches per hour? - No

Improvements to Existing Conditions:

- Does the project increase the required recharge volume over existing (developed) conditions? If so, can the project be redesigned to reduce the required recharge volume by decreasing impervious surfaces (make building higher, put parking under the building, narrower roads, sidewalks on only one side of street, etc.) or using low impact development techniques such as porous pavement? – Yes: more pervious area is proposed, trees and landscaping improvements, no infiltration proposed under existing conditions, proposing sand filter BMPs.
- Is the project located within a basin or sub-basin that has been categorized as under high or medium stress by the Massachusetts Water Resources Commission, or where there is other evidence that there are rivers and streams experiencing low flow problems? If so, have measures been considered to replace the natural recharge lost as a result of the prior development? (See Menu.)
- Has the applicant evaluated measures for reducing site runoff? (See Menu.) - Yes

<u>Standard 4: (80% TSS Removal)</u>
Stormwater management systems must be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This standard is met when:

[2] A mounding analysis is needed if a site falls within this category. See Volume 3.

> ***a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan and thereafter are implemented and maintained;***
> ***b. Stormwater BMPs are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and***
> ***c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.***

Full compliance for any component that is not a redevelopment
Full compliance with the long-term pollution plan requirement for new developments and redevelopments. – Project Complies

- Has the proponent developed a long-term pollution plan that fully meets the requirements of Standard 4? - Yes
- Does the pollution prevention plan include the following source control measures? - Yes
  - Street sweeping
  - Proper management of snow, salt, sand and other deicing chemicals
  - Proper management of fertilizers, herbicides and pesticides
  - Stabilization of existing eroding surfaces

Compliance to the Maximum Extent Practicable for the other requirements:

- Does the redevelopment design provide for treatment of all runoff from existing (as well as new) impervious areas to achieve 80% TSS removal? If 80% TSS removal is not achieved, has the stormwater management system been designed to remove TSS to the maximum extent practicable? - Yes
- Have the proposed stormwater BMPs been properly sized to capture the prescribed runoff volume? – N/A
  - One inch rule applies for discharge
    - within a Zone II or Interim Wellhead Protection Area,
    - near or to another critical area,
    - from a land use with a higher potential pollutant load
    - to the ground where the infiltration rate is greater than 2.4 inches per hour
- Has adequate pretreatment been proposed? - N/A
  - 44% TSS Removal Pretreatment Requirement applies if:
    - Stormwater runoff is from a land use with a higher potential pollutant load
    - Stormwater is discharged
      - To the ground within the Zone II or Interim Wellhead Protection Area of a Public Water Supply
      - To the ground with an infiltration rate greater than 2.4 inches per hour
      - Near or to an Outstanding Resource Water, Special Resource Water, Cold-Water Fishery, Shellfish Growing Area, or Bathing Beach.

- If the stormwater BMPs do not meet all the requirements set forth above, the applicant shall document an analysis of alternative approaches for meeting the these requirements. (See Section on Retrofitting Existing BMPs (the "Retrofit Section"). – N/A

Improvements to Existing Conditions:

- Have measures been provided to achieve at least partial compliance with the TSS removal standard? - Fully Complies
- Have any of the best management practices in the Retrofit Section been considered? – N/A
- Have any of the following pollution prevention measures been considered? - Yes

    - Reduction or elimination of winter sanding, where safe and prudent to do so
    - Tighter controls over the application of fertilizers, herbicides, and pesticides
    - Landscaping that reduces the need for fertilizer, herbicides and pesticides
    - High frequency sweeping of paved surfaces using vacuum sweepers
    - Improved catch basin cleaning
    - Waterfowl control programs
  - Are there any discharges (new or existing) to impaired waters? If so, see TMDL section. – Site has TMDL phosphorous removal requirements, with which Project complies.

Standard 5 (Higher Potential Pollutant Loads (HPPL) - N/A

For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt and stormwater runoff, the proponent shall use the specific stormwater BMPs determined by the Department to be suitable for such use as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53, and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

Full compliance for any component that is not a redevelopment.

Full compliance with pollution prevention requirements for new developments and redevelopments.

Pollution Prevention

- Has the proponent considered any of the following operational source control measures?
    - Formation of a pollution prevention team,
    - Good housekeeping practices,
    - Preventive maintenance procedures,
    - Spill prevention and clean up,
    - Employee training, and
    - Regular inspection of pollutant sources.

- Has the proponent considered implementation of any of the following operational changes to reduce the quantity of pollutants on site?
    - Process changes,
    - Raw material changes,
    - Product changes, or
    - Recycling.

- Has the proponent considered making capital improvements to protect the land uses with higher potential pollutant loads from exposure to rain, snow, snow melt, and stormwater runoff?

    - Enclosing and/or covering pollutant sources (e.g. placing pollutant sources within a building or other enclosure, placing a roof over storage and working areas, placing tarps under pollutant source)

    - Installing a containment system with an emergency shutoff to contain spills?

    - Physically segregating the pollutant source to prevent run-on of uncontaminated stormwater?

Treatment

- If applicable, compliance with the treatment and pretreatment requirements of Standard 5 only to the Maximum Extent Practicable by directing the stormwater runoff from land uses with higher potential pollutant loads to appropriate stormwater BMPs?
    - Are the BMPs selected capable of removing the pollutants associated with the higher potential pollutant load land ("LUHPPL") use?
    - Is the land use likely to generate stormwater with high concentrations of oil and grease? If so has an oil grit separator, sand filter, filtering bioretention area or equivalent been proposed for pretreatment?

Improvement of Existing Conditions.

- If the redevelopment converts a site from a non-LUHPPL use to a LUHPPL use, the applicant shall document how the stormwater BMPs shall be modified or replaced to come into compliance with Standard 5.
- What specific measures have been considered to offset the anticipated impacts of land uses with higher potential pollutant loads?
- If the redevelopment proposal is a brownfield project, the applicant shall demonstrate how the stormwater management measures have been designed to prevent mobilization or remobilization of soil and groundwater contamination. (See Brownfield section)

<u>Other Requirements</u>

- Does the discharge comply with all applicable requirements of the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00?

<u>Standard 6 (Critical Areas)</u> - N/A
Stormwater discharges to a Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or any other critical area require the use of the specific source control and pollution prevention measures and the specific stormwater best management practices determined by the Department to be suitable for managing discharges to such area, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters or Special Resource Waters shall be set back from the receiving water and receive the highest and best practical method of treatment. A "stormwater discharge," as defined in 314 CMR 3.04(2)(a)1. or (b), to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of the public water supply.
Full compliance for component of project that is not a redevelopment
Full compliance with pollution prevention requirements for new developments and redevelopments.

If applicable, compliance to the Maximum Extent Practicable with the pretreatment and treatment requirements of Standard 6:

- Does the redevelopment project utilize the pretreatment, treatment and infiltration BMPs approved for discharges near or to critical areas?

- If the redevelopment project does not comply with Standard 6, the applicant shall document an analysis of alternative measures for meeting Standard 6. (See Section on Specific Redevelopment Projects.)

Improvements to Existing Conditions:
- Have measures to protect critical areas been considered, including additional pollution prevention measures and structural and non-structural BMPs?

Other Requirements
- Does the discharge comply with the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00, and 314 CMR 5.00?

Standard 8: (Erosion, Sediment Control)
A plan to control construction-related impacts, including erosion sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan), must be developed and implemented.

All redevelopment projects shall fully comply with Standard 8.

- Has the proponent submitted a construction period erosion, sedimentation and pollution prevention plan that meets the requirements of Standard 8?

Yes – the project is covered by a National Pollutant Discharge Elimination System Permit, but a Stormwater Pollution Prevention Plan will be submitted before land disturbance.

Standard 9: (Operation and Maintenance)
A long-term operation and maintenance plan must be developed and implemented to ensure that stormwater management systems function as designed.
All redevelopment projects shall fully comply with Standard 9.

- Has the proponent submitted a long-term Operation and Maintenance plan that meets the requirements of Standard 9? – Yes

Standard 10 (Illicit Discharges)
All illicit discharges to the stormwater management system are prohibited.
All redevelopment projects shall fully comply with Standard 10.

- Are there any known or suspected illicit discharges to the stormwater management system at the redevelopment project site? – No
- Has an illicit connection detection program been implemented using visual screening, dye or smoke testing? - No
- Have an Illicit Discharge Compliance Statement and associated site map been submitted verifying that there are no illicit discharges to the stormwater management system at the site? - No

Improvements to Existing Conditions:
- Once all illicit discharges are removed, has the proponent implemented any measures to prevent additional illicit discharges? – Yes, LTPPP & SWPPP

Figure 5-1

Menu of Strategies to Reduce Runoff or Peak Flows and/or Increase Recharge

- Rehabilitate the soils
- Plant trees and other vegetation
- Install a green roof
- Maximize naturally vegetated areas
- Reduce impervious surfaces
- Disconnect roof runoff from direct discharge to the drainage system
- Disconnect other existing paved areas from direct discharge to the drainage system, allowing controlled flow over pervious areas or through BMPs providing at least partial recharge
- Install porous pavement and/or other recharge measures (where sustainable and maintainable for promoting infiltration)
- Apply LID techniques for runoff reduction
- Install additional structural BMPs that are appropriate for redevelopment sites including infiltration trenches, subsurface structures, oil-grit separators, proprietary BMPs
- Retrofit existing BMPs

Retrofitting Existing BMPs

Many BMPs can be effectively retrofitted depending on site conditions and the water quantity or quality objectives trying to be achieved.[3] The objective of stormwater retrofitting is to remedy problems associated with, and improve water quality mitigation functions of, older, poorly designed, or poorly maintained stormwater management systems. Prior to the development of the stormwater standards, site drainage design did not require stormwater detention for controlling post-development peak flows. As a result, drainage, flooding, and erosion problems can be common in many older developed areas of the state. Furthermore, a majority of the dry detention basins throughout the state have been designed to control peak flows, without regard to water quality mitigation. Therefore, many existing dry detention basins provide only minimal water quality benefit. Incorporating stormwater retrofits into existing developed sites or into redevelopment projects can reduce the adverse impacts of uncontrolled stormwater runoff.

Bioretention Area Retrofits - can be used as a stormwater retrofit, by modifying existing landscaped areas, or if a parking lot is being resurfaced. In highly urban watersheds, they are one of the few practical retrofit options.

Catch Basin Retrofits or Reconstruction - Older catch basins without sumps can be replaced with catch basins having four foot-deep sumps. Sumps provide storage volume for coarse sediments, assuming that accumulated sediment is removed on a regular basis. Hooded outlets, which are covers over the catch basin outlets that extend below the standing water line, can also be used to trap litter and other floatable materials. Leaching catch basins can be installed adjacent to deep sump catch basins to achieve 80% TSS removal. Be aware, however, that many products are being touted as catch basin inserts, but the effectiveness of these devices can vary significantly.

Dry Detention Basin Retrofits - Traditional dry detention basins can be modified to become extended dry detention basins, wet basins, or constructed stormwater wetlands for enhanced pollutant removal. This is one of the most commonly and easily implemented retrofits, since it typically requires little or no additional land area, capitalizes on an existing facility for which there is already some resident acceptance of stormwater management, and involves minimal impacts to environmental resources (Claytor, Center for Watershed Protection, 2000).

There are numerous retrofit options that will enhance the removal of pollutants in detention basins:

- Excavate the basin bottom to create more permanent pool storage.
- Raise the basin embankment to obtain additional storage for extended detention.
- Modify the outfall structure to create a two-stage release to better control small storms while not significantly compromising flood control detention for large storms.
- Increase the flow path from inflow to outflow and eliminate short-circuiting by using baffles, earthen berms or micro-pond topography to increase residence time.
- Incorporate stilling basins at inlets and outlets.
- Regrade the basin bottom to create a wetland area near the basin outlet or revegetate parts of the basin bottom with wetland vegetation to enhance pollutant removal, reduce mowing, and improve aesthetics.
- Create a wetland shelf along the perimeter of a wet basin to improve shoreline stabilization, enhance pollutant filtering, and enhance aesthetic and habitat functions.
- Create a low maintenance “no-mow” wildflower ecosystem in the drier portions of the basin.

[3] Additional information on retrofitting stormwater BMPs can be found in the Urban Stormwater Retrofit Practices Manual. See http://www.cwp.org/Downloads/ELC_USRM3app.pdf.

- Provide a high flow bypass to avoid resuspension of captured sediments/pollutants during high flows.
- Eliminate low-flow bypasses.

Drainage Channel Retrofits - Existing channelized streams and drainage conveyances such as drainage channels can be modified to reduce flow velocities and enhance pollutant removal. Weir walls or riprap check dams placed across a channel create opportunities for ponding, infiltration, and establishment of wetland vegetation upstream of the retrofit. In-stream retrofit practices include stream bank stabilization of eroded areas and placement of habitat improvement structures (i.e., flow deflectors, boulders, pools/riffles, and low-flow channels) in natural streams and along stream banks. In-stream retrofits may require an evaluation of potential flooding and floodplain impacts resulting from altered channel conveyance, as well as requirements for local, state, or federal approval for work in wetlands and watercourses.

Parking Lots and Roadways- Parking lots offer ideal opportunities for a wide range of stormwater retrofits:

1. Incorporate bioretention areas into parking lot islands and landscaped areas; tree planter boxes can be converted into functional bioretention areas, rain gardens, or treebox filters to reduce and treat stormwater runoff.
2. Remove curbing and add slotted curb stops. Curbs along the edges of parking lots can sometimes be removed or slotted to re-route runoff to vegetated filter strips, water quality swales, grass channels, or bioretention facilities. The capacity of existing swales may need to be evaluated and expanded as part of this retrofit option.
3. Incorporate new treatment practices such as bioretention areas, sand filters, and constructed stormwater wetlands at the edges of parking lots.
4. In overflow parking or other low-traffic areas, asphalt can be replaced with porous pavement.

Sand Filter Retrofits - are suitable where space is limited, because they consume little surface space and have few site restrictions. Since sand filters cannot treat large drainage areas, retrofitting many small individual sites may be the only option. This option may be expensive.

Storm Drain Outfalls - New stormwater treatment practices can be constructed at the outfalls of existing drainage systems. The new stormwater treatment practices are commonly designed as *off-line devices* to treat the first flush volume and bypass larger storms. Water quality swales, bioretention areas, sand filters, constructed stormwater wetlands, and wet basins are commonly used for this type of retrofit. Other stormwater treatment practices may also be used if there is enough space for construction and maintenance.

Specific Redevelopment Projects

Redevelopment projects present unique challenges for controlling stormwater. It is possible that site constraints may prevent a redevelopment project from complying with one or more of the Stormwater Management Standards. Even if a redevelopment project cannot meet all of the Standards, there may be ample opportunity to improve existing site conditions depending on the other water quality or quantity issues in the watershed. The following special considerations provide unique opportunities for identifying how existing conditions may be improved:

A. Groundwater Recharge Areas - Redevelopment projects located within these areas (Zone II, Interim Wellhead Protection Areas (IWPA), aquifer protection districts, etc.) should place a high priority on ground water recharge BMPs.
   1) Disconnecting Rooftop Runoff – In some instances, building roof drains connected to the stormwater drainage system can be disconnected and re-directed to vegetated filter strips, bioretention facilities, or infiltration structures (dry wells or infiltration trenches).
   2) Use of Porous Paving Materials - Existing impermeable pavement in overflow parking or other low-traffic areas can sometimes be replaced with alternative permeable materials such as modular concrete paving blocks, modular concrete or plastic lattice, or cast-in-place concrete grids. Site-specific factors including traffic volumes, soil permeability, maintenance, sediment loads, and land use must be carefully considered prior to selection.

B. Cold-Water Fisheries - Redevelopment projects adjacent to these areas should place a high priority on mitigating potential thermal impacts. Techniques to consider include:

   1) Maintain Time of Concentration **-** Time of concentration (Tc) is based on the flow path and length, ground cover, slope and channel shape. When development occurs, Tc is often shortened due to the impervious area, causing greater flows to occur over a shorter period of time. Increasing the Tc will help to reduce the thermal impact of stormwater runoff from warm surface areas. Options to consider include:
      - Increasing the length of the runoff flow path
      - Increasing the surface roughness of the flow path
      - Detaining flows on site
      - Minimizing land disturbance
      - Creating flatter slopes.
   2) Disconnecting impervious areas – Breaking up large impervious expanses with vegetated zones will reduce the potential temperature increases of stormwater flowing across hot pavement.

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C. Brownfield Redevelopment – Redeveloping urban and non-urban brownfield sites (which in Massachusetts includes most "disposal sites" under the Massachusetts Contingency Plan [MCP]) are a Commonwealth priority, with ramifications for urban sprawl as well as the remediation of historically contaminated properties. Proponents of brownfield redevelopment projects should evaluate BMPs that will prevent the significant uncontrolled mobilization or remobilization of soil or ground water contamination. BMP considerations at these sites should consider such factors as:
   - The location of stormwater infiltration units with respect to contaminated areas
   - Ground water mounding effects on the rate and direction of migration of ground water contaminants
   - The location of outfalls
   - Water quality BMPs.

D. Runoff to Impaired Water Bodies – If MassDEP has issued a Total Maximum Daily Load (TMDL) that establishes a waste load allocation for stormwater discharge and/or a TMDL Implementation Plan that identifies remedies aimed at reducing the amount of pollutants from stormwater discharges, proponents may be required to install stormwater BMPs that are consistent with the TMDL.

E. Runoff to Areas of Localized Flooding – Project proponents must also understand the potential impacts of stormwater runoff in areas prone to localized flooding. When completing the checklist, proponents should consider the capacity of the receiving water and/or storm drainage system. When evaluating discharges to areas subject to localized flooding, the proponent should evaluate the ability to maintain and/or improve existing site cover and reduce runoff volume.

Appendix E
Standard 8 Supporting Information

- Erosion & Sedimentation Control Measures
- BMP Maintenance Checklist

Erosion & Sedimentation Control Measures

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Siltsock Barriers

Siltsock barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Siltsocks will be set with a minimum of five feet storage area at toes of slopes greater than 4:1. Siltsocks shall have a two foot overlap at ends.

Silt Fencing

In areas where high runoff velocities or high sediment loads are expected, hay bale barriers will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and hay bale barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing catch basins will be protected with Flexstorm® Catch-It Inlet Filters and hay bale barriers (where appropriate) throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 2:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.

- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.

- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.

- Damaged or deteriorated items will be repaired immediately after identification.

- The underside of hay bales should be kept in close contact with the earth and reset as necessary.

- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.
- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

The sedimentation and erosion control plan is included in project plan set; a reduced version and Erosion Control Maintenance checklist is included here for quick reference.

Construction Best Management Practices - Maintenance/Evaluation Checklist

Dunstan East Mixed-Use Redevelopment – Newton, MA
Construction Period Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐yes ☐no (List Items)	Date of Cleaning/Repair	Performed by:
Silt Sock	Weekly and after storm events			• Accumulated sediment • Damaged or broken wattles • Erosion overflowing top of wattle	☐yes ☐no		
Gravel Construction Entrance	Weekly and after storm events			• Accumulated sediment • Tracking of sediment outside limit of work	☐yes ☐no		
Catch Basin Protection	Weekly and after storm events			• Accumulated sediment within silt sacks • Rips or torn silt sacks	☐yes ☐no		
Vegetated Slope Stabilization	Weekly and after storm events			• Ripping of blanket protection • Erosion • Non-growth in vegetation	☐yes ☐no		

Stormwater Control Manager ______________________________________

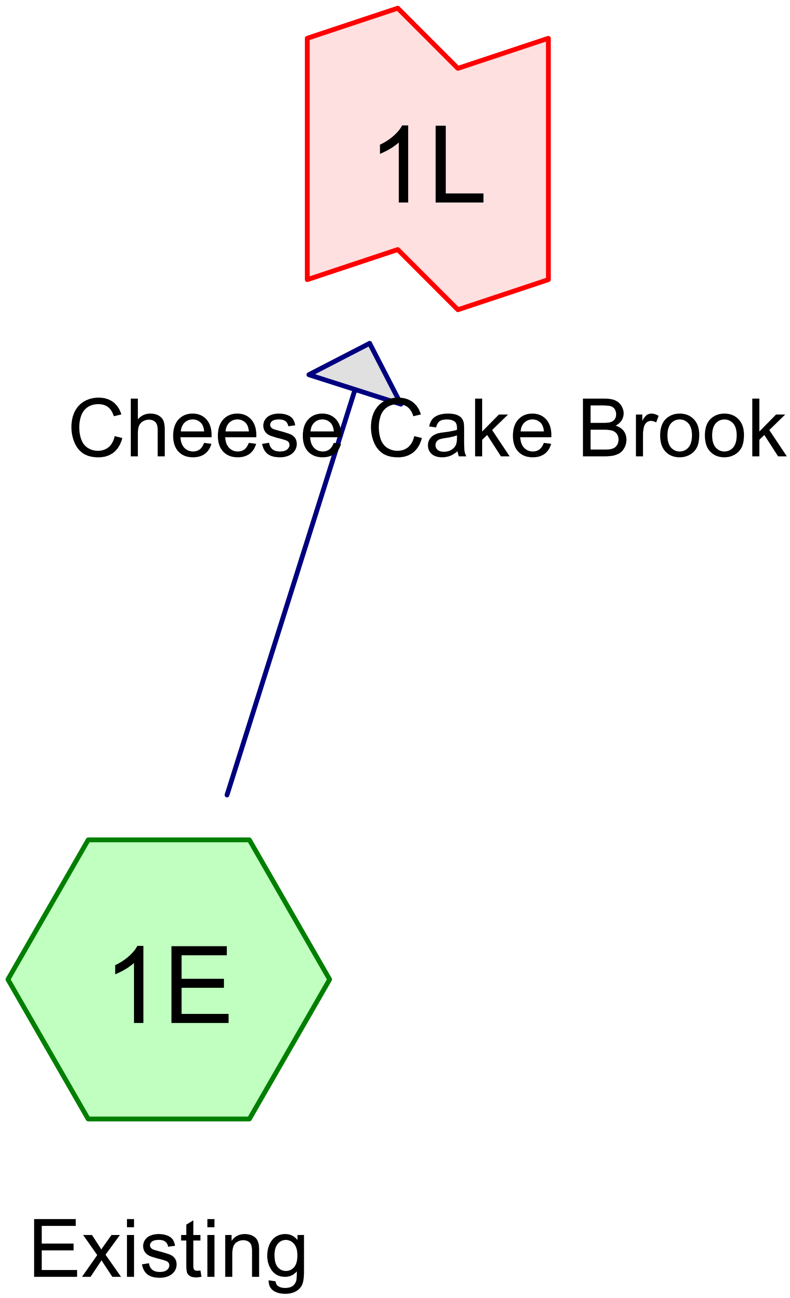
Washington Street Mixed-Use Redevelopment – Newton, MA
Long Term Operation and Maintenance – Maintenance/ Evaluation Checklist

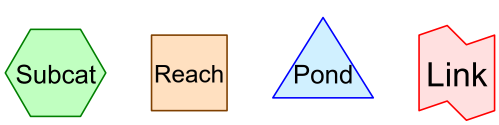
Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐yes ☐no (List Items)	Date of Cleaning/Repair	Performed by:
Catch Basin	Four times annually			• Accumulated sediment within sump • Accumulated debris within catch basins	☐yes ☐no		
Vegetated Slope Stabilization	Weekly and after storm events			• Ripping of blanket protection • Erosion • Non-growth in vegetation	☐yes ☐no		
Sand Filter	Monthly and after large storm events			• Accumulated sediment within sump • Erosion of sand from overflowing top of weir	☐yes ☐no		

Stormwater Control Manager ____

Appendix F
Hydrologic Analysis

- HydroCAD Analysis: Existing Conditions
- HydroCAD Analysis: Proposed Conditions





Routing Diagram for HydroCAD-EX - Copy
Prepared by VHB, Printed 5/17/2021
HydroCAD® 10.10-5a s/n 01038 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.26	2
2	10-Year	Type III 24-hr		Default	24.00	1	5.13	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.30	2
4	100-Year	Type III 24-hr		Default	24.00	1	8.78	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.360	61	>75% Grass cover, Good, HSG B (1E)
3.227	98	Paved parking, HSG B (1E)
3.586	**94**	**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.360	0.000	0.000	0.000	0.360	>75% Grass cover, Good	1E
0.000	3.227	0.000	0.000	0.000	3.227	Paved parking	1E
0.000	**3.586**	**0.000**	**0.000**	**0.000**	**3.586**	**TOTAL AREA**	

Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1E: Existing Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=2.60"
Flow Length=495' Tc=5.0 min CN=94 Runoff=10.53 cfs 0.778 af

Link 1L: Cheese Cake Brook Inflow=10.53 cfs 0.778 af
Primary=10.53 cfs 0.778 af

Total Runoff Area = 3.586 ac Runoff Volume = 0.778 af Average Runoff Depth = 2.60"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: Tc<2dt may require smaller dt

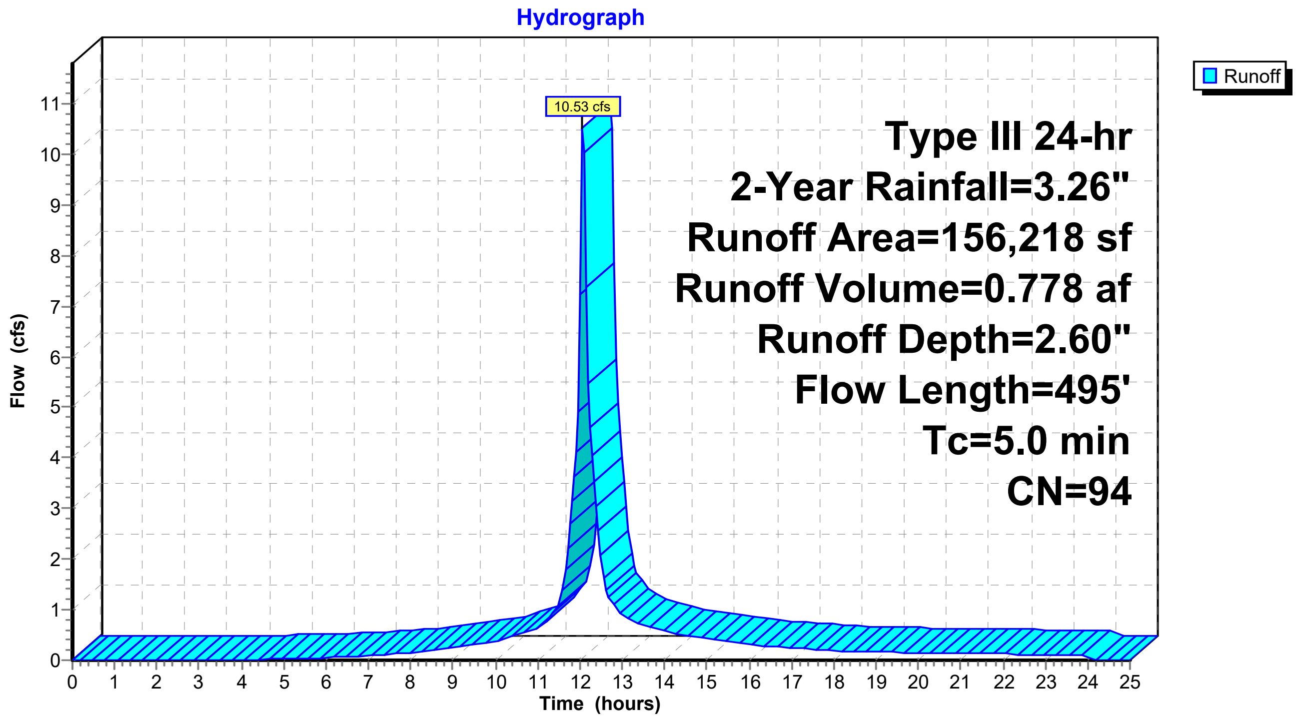
Runoff = 10.53 cfs @ 12.07 hrs, Volume= 0.778 af, Depth= 2.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		**Sheet Flow, Pavement Sheet Flow** Smooth surfaces n= 0.011 P2= 3.26"
2.0	445	0.0350	3.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.5	495	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing

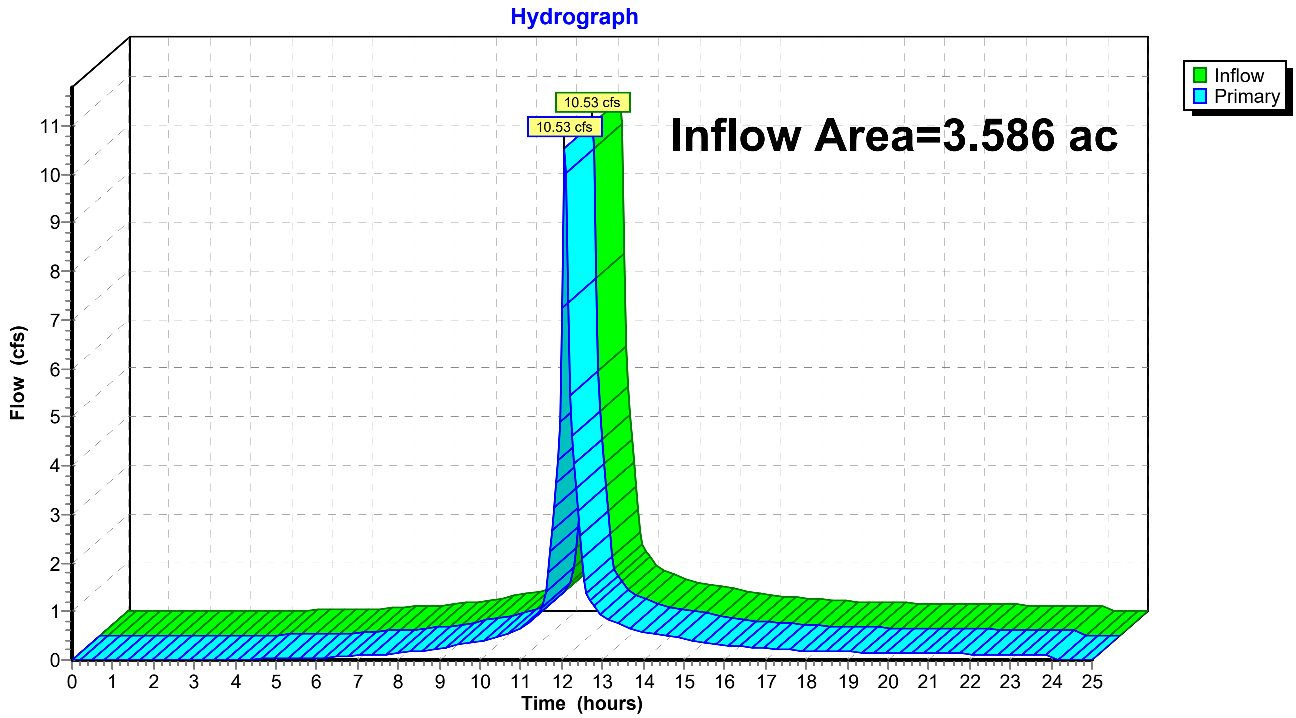


Summary for Link 1L: Cheese Cake Brook

Inflow Area = 3.586 ac, 89.97% Impervious, Inflow Depth = 2.60" for 2-Year event
Inflow = 10.53 cfs @ 12.07 hrs, Volume= 0.778 af
Primary = 10.53 cfs @ 12.07 hrs, Volume= 0.778 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1E: Existing Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=4.44"
Flow Length=495' Tc=5.0 min CN=94 Runoff=17.42 cfs 1.326 af

Link 1L: Cheese Cake Brook Inflow=17.42 cfs 1.326 af
Primary=17.42 cfs 1.326 af

Total Runoff Area = 3.586 ac Runoff Volume = 1.326 af Average Runoff Depth = 4.44"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: Tc<2dt may require smaller dt

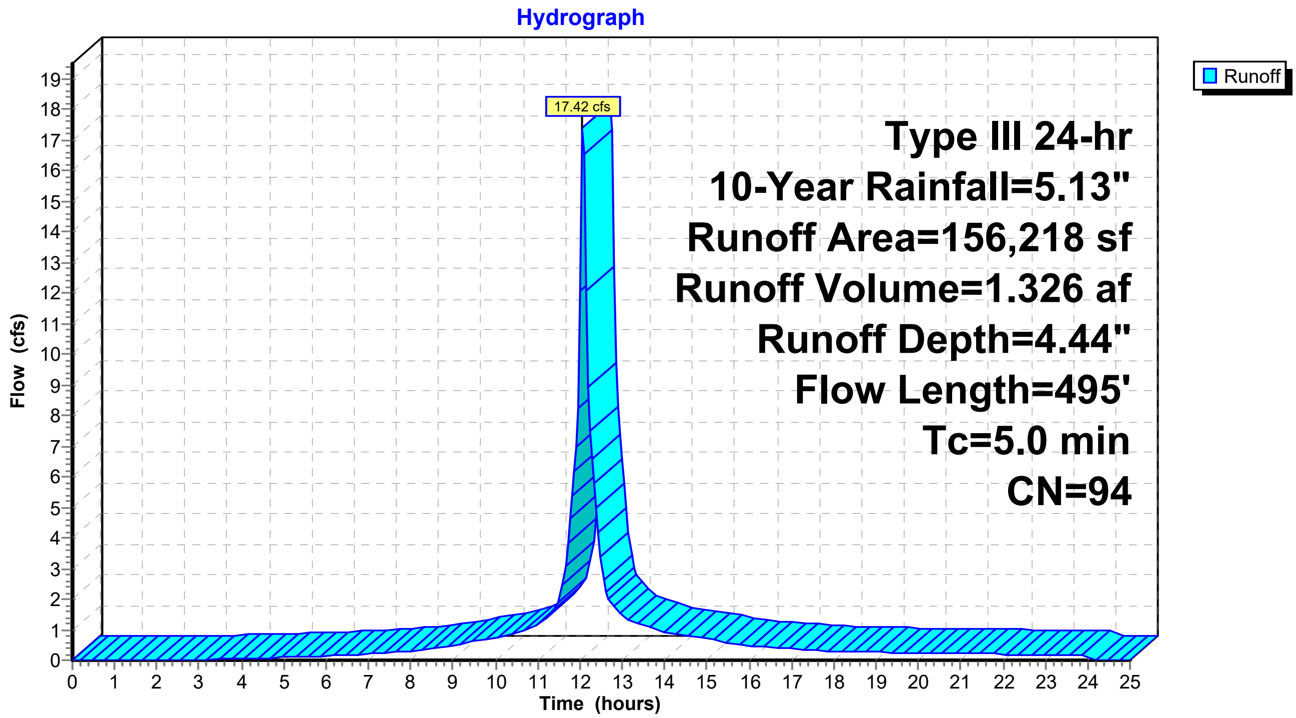
Runoff = 17.42 cfs @ 12.07 hrs, Volume= 1.326 af, Depth= 4.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		**Sheet Flow, Pavement Sheet Flow** Smooth surfaces n= 0.011 P2= 3.26"
2.0	445	0.0350	3.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.5	495	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing

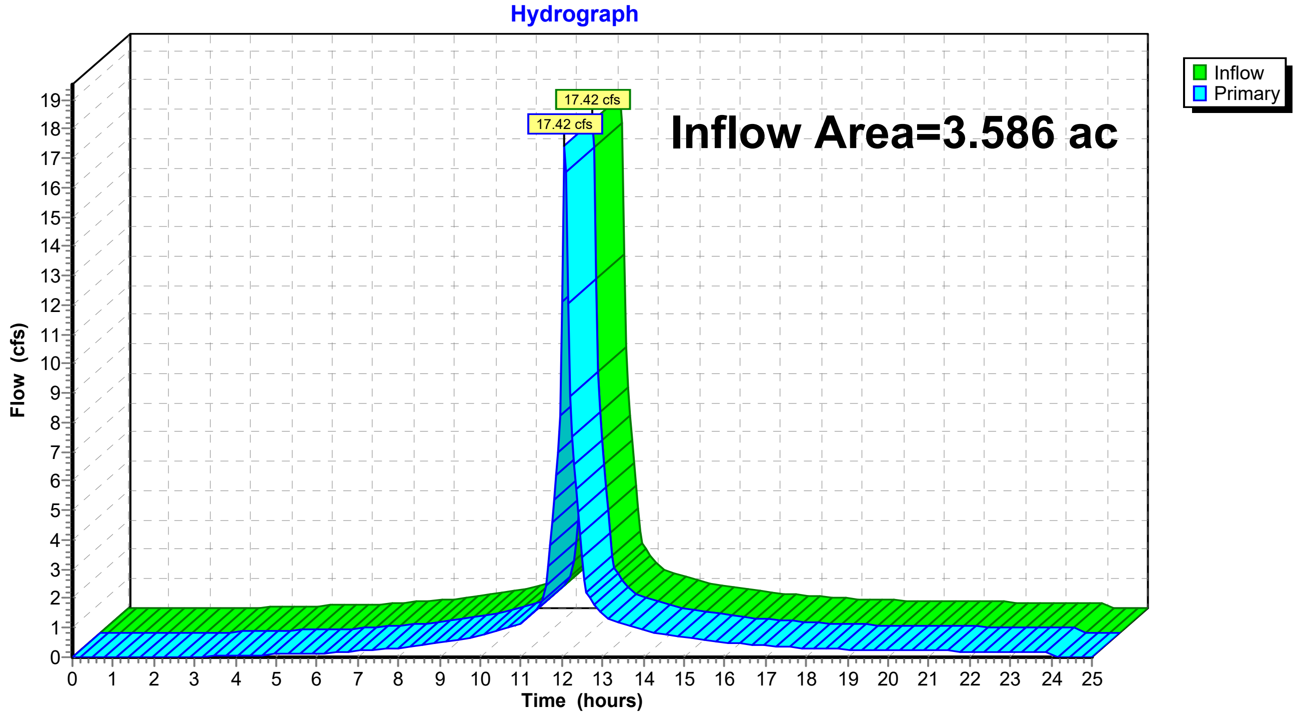


Summary for Link 1L: Cheese Cake Brook

Inflow Area = 3.586 ac, 89.97% Impervious, Inflow Depth = 4.44" for 10-Year event
Inflow = 17.42 cfs @ 12.07 hrs, Volume= 1.326 af
Primary = 17.42 cfs @ 12.07 hrs, Volume= 1.326 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1E: Existing Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=5.59"
Flow Length=495' Tc=5.0 min CN=94 Runoff=21.68 cfs 1.672 af

Link 1L: Cheese Cake Brook Inflow=21.68 cfs 1.672 af
Primary=21.68 cfs 1.672 af

Total Runoff Area = 3.586 ac Runoff Volume = 1.672 af Average Runoff Depth = 5.59"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: Tc<2dt may require smaller dt

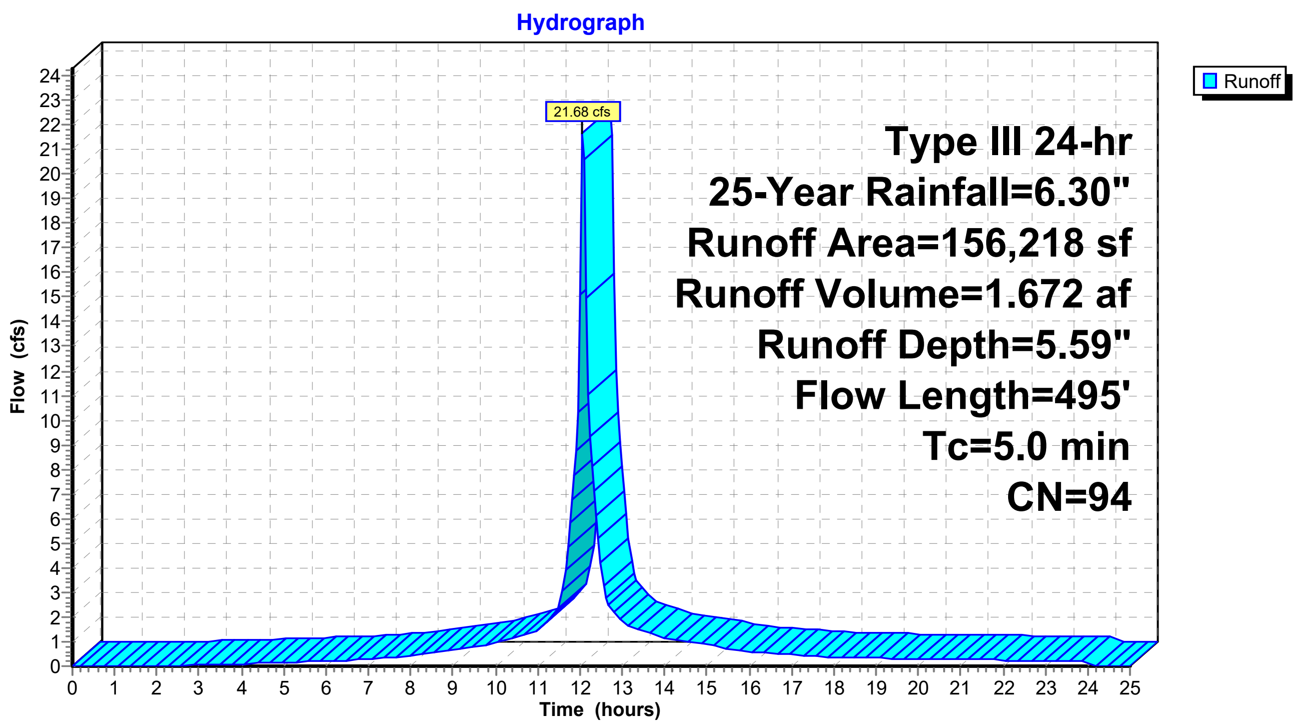
Runoff = 21.68 cfs @ 12.07 hrs, Volume= 1.672 af, Depth= 5.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		**Sheet Flow, Pavement Sheet Flow** Smooth surfaces n= 0.011 P2= 3.26"
2.0	445	0.0350	3.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.5	495	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing

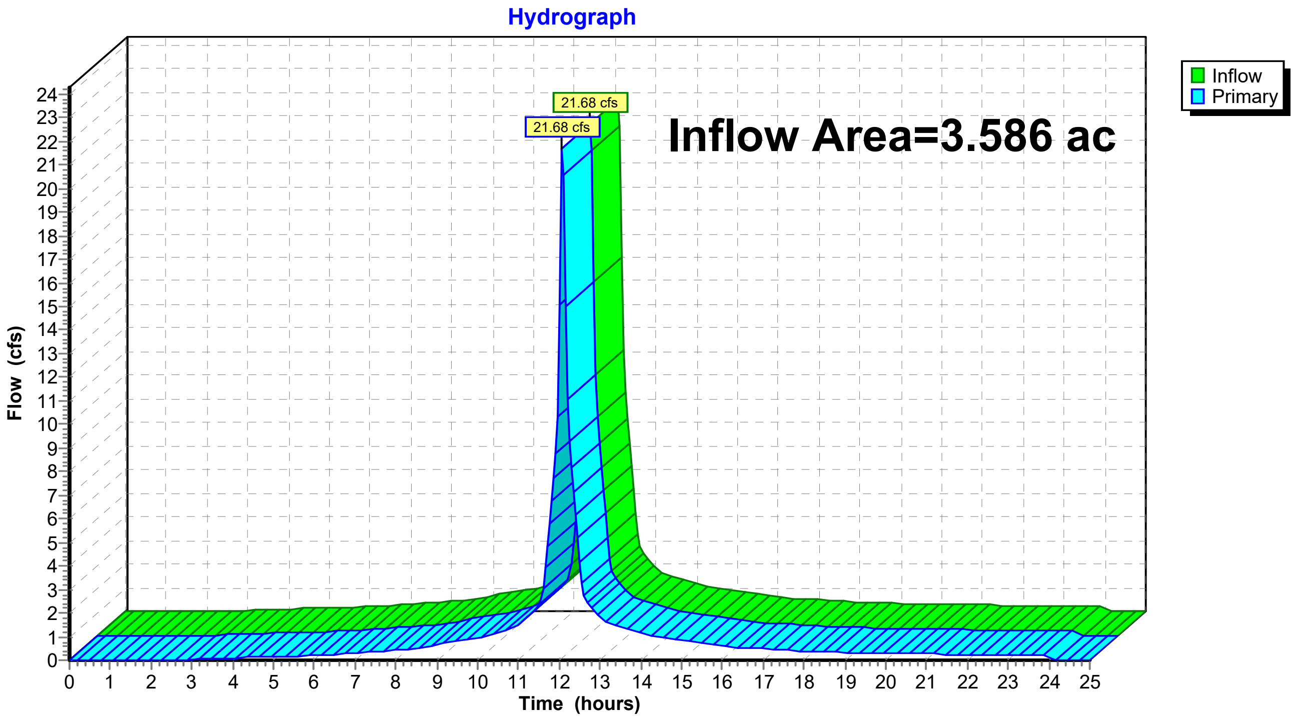


Summary for Link 1L: Cheese Cake Brook

Inflow Area =	3.586 ac,	89.97% Impervious,	Inflow Depth = 5.59"	for 25-Year event	
Inflow =	21.68 cfs @	12.07 hrs,	Volume=	1.672 af	
Primary =	21.68 cfs @	12.07 hrs,	Volume=	1.672 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1E: Existing Runoff Area=156,218 sf 89.97% Impervious Runoff Depth=8.06"
Flow Length=495' Tc=5.0 min CN=94 Runoff=30.65 cfs 2.408 af

Link 1L: Cheese Cake Brook Inflow=30.65 cfs 2.408 af
Primary=30.65 cfs 2.408 af

Total Runoff Area = 3.586 ac Runoff Volume = 2.408 af Average Runoff Depth = 8.06"
10.03% Pervious = 0.360 ac 89.97% Impervious = 3.227 ac

Summary for Subcatchment 1E: Existing

[49] Hint: Tc<2dt may require smaller dt

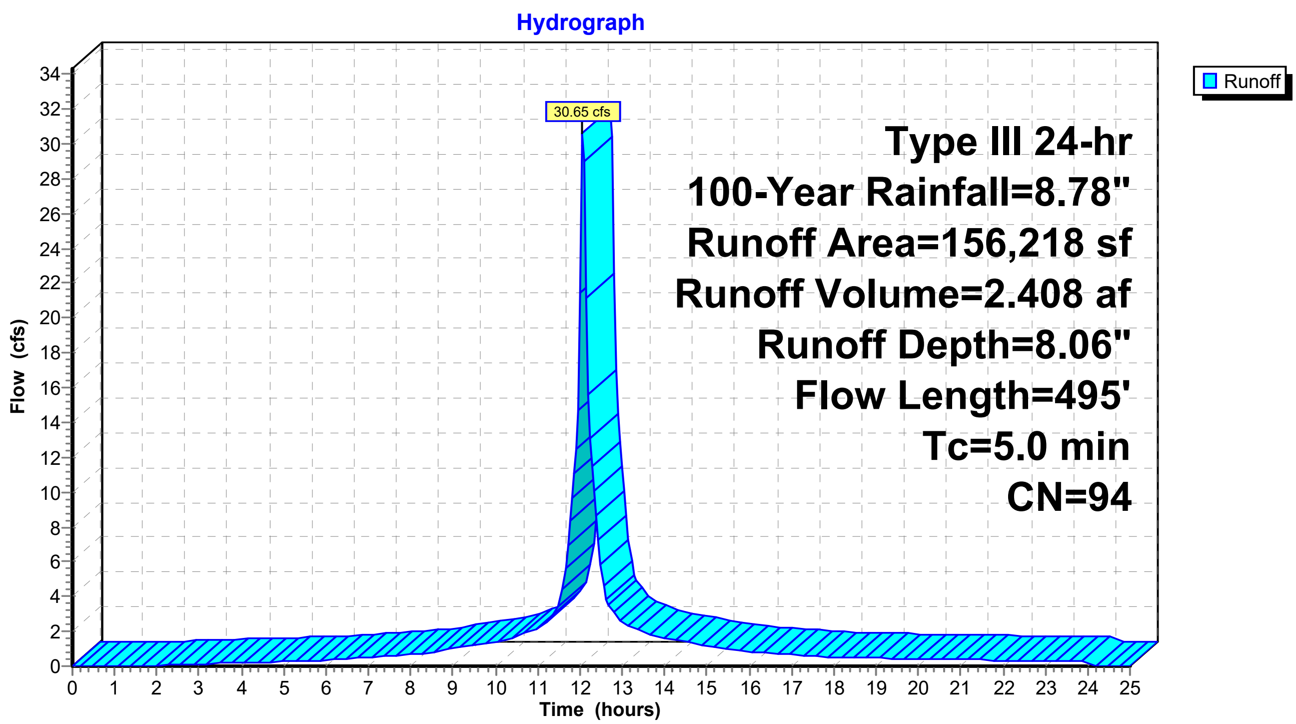
Runoff = 30.65 cfs @ 12.07 hrs, Volume= 2.408 af, Depth= 8.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Description
15,666	61	>75% Grass cover, Good, HSG B
140,552	98	Paved parking, HSG B
156,218	94	Weighted Average
15,666		10.03% Pervious Area
140,552		89.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0400	1.59		**Sheet Flow, Pavement Sheet Flow** Smooth surfaces n= 0.011 P2= 3.26"
2.0	445	0.0350	3.80		**Shallow Concentrated Flow, Pavement** Paved Kv= 20.3 fps
2.5	495	Total, Increased to minimum Tc = 5.0 min			

Subcatchment 1E: Existing

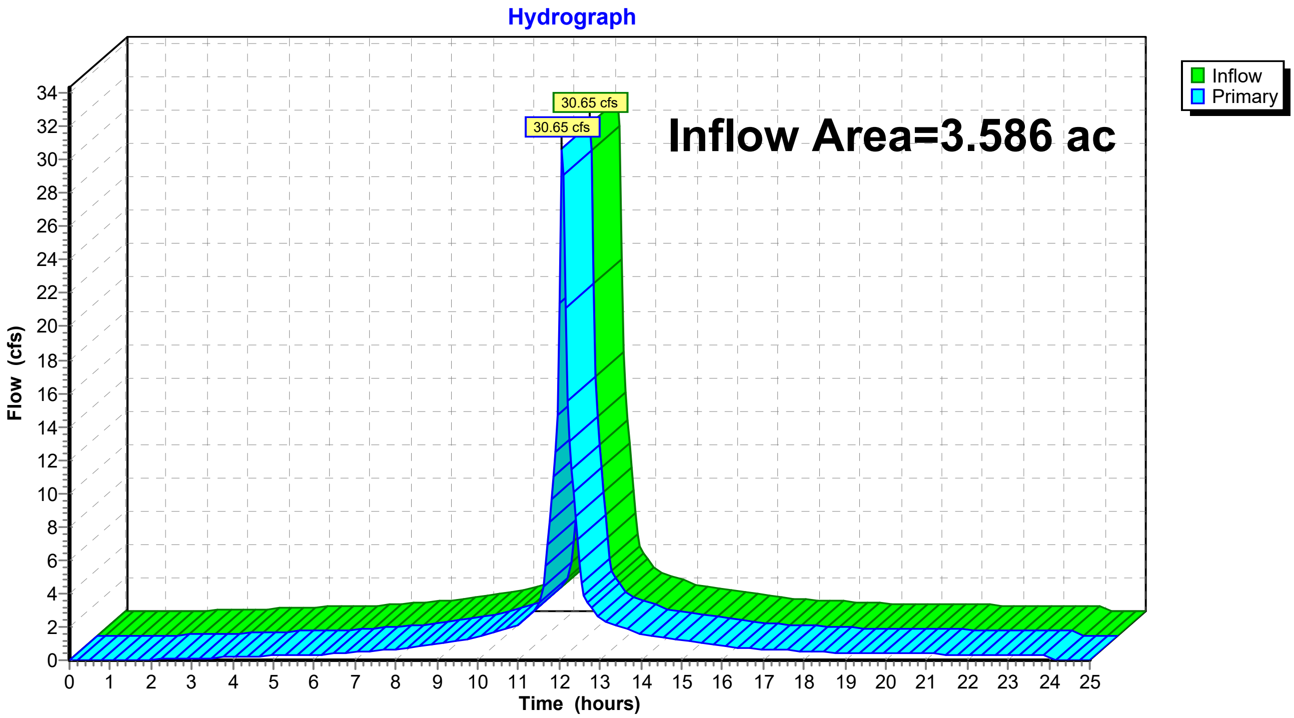


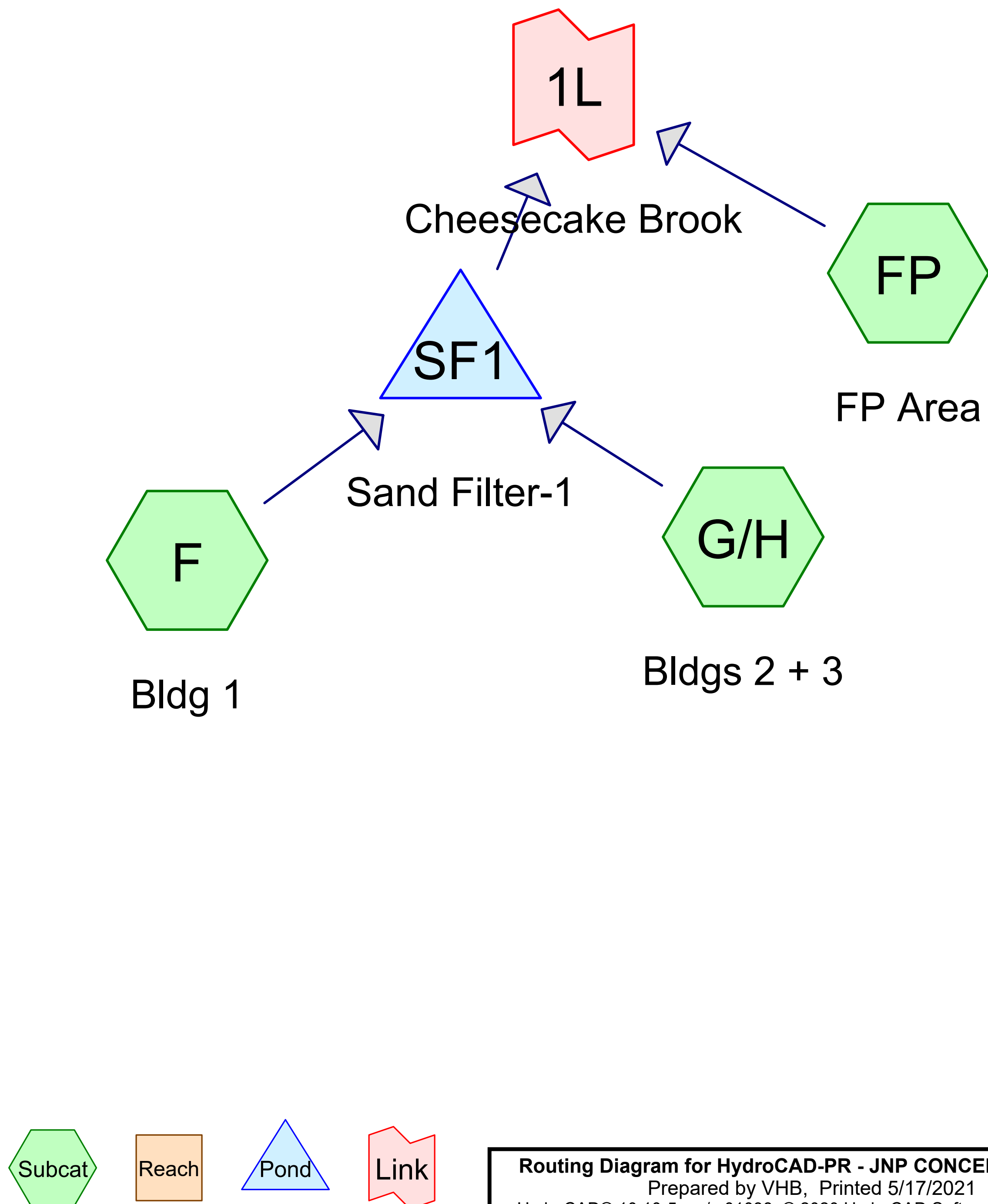
Summary for Link 1L: Cheese Cake Brook

Inflow Area = 3.586 ac, 89.97% Impervious, Inflow Depth = 8.06" for 100-Year event
Inflow = 30.65 cfs @ 12.07 hrs, Volume= 2.408 af
Primary = 30.65 cfs @ 12.07 hrs, Volume= 2.408 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheese Cake Brook





Routing Diagram for HydroCAD-PR - JNP CONCEPT_2021-05-04
Prepared by VHB, Printed 5/17/2021
HydroCAD® 10.10-5a s/n 01038 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.26	2
2	10-Year	Type III 24-hr		Default	24.00	1	5.13	2
3	25-Year	Type III 24-hr		Default	24.00	1	6.30	2
4	100-Year	Type III 24-hr		Default	24.00	1	8.78	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.582	61	>75% Grass cover, Good, HSG B (F, FP, G/H)
2.904	98	Paved parking, HSG B (F, G/H)
0.098	98	Unconnected pavement, HSG B (FP)
3.584	**92**	**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.582	0.000	0.000	0.000	0.582	>75% Grass cover, Good	F, FP, G/H
0.000	2.904	0.000	0.000	0.000	2.904	Paved parking	F, G/H
0.000	0.098	0.000	0.000	0.000	0.098	Unconnected pavement	FP
0.000	**3.584**	**0.000**	**0.000**	**0.000**	**3.584**	**TOTAL AREA**	

Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=2.50"
Tc=5.0 min CN=93 Runoff=3.77 cfs 0.275 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=0.67"
Tc=5.0 min UI Adjusted CN=66 Runoff=0.24 cfs 0.020 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=2.81"
Tc=5.0 min CN=96 Runoff=5.87 cfs 0.446 af

Pond SF1: Sand Filter-1 Peak Elev=35.14' Storage=380 cf Inflow=9.63 cfs 0.721 af
Outflow=9.54 cfs 0.716 af

Link 1L: CheesecakeBrook Inflow=9.76 cfs 0.736 af
Primary=9.76 cfs 0.736 af

Total Runoff Area = 3.584 ac Runoff Volume = 0.741 af Average Runoff Depth = 2.48"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: Tc<2dt may require smaller dt

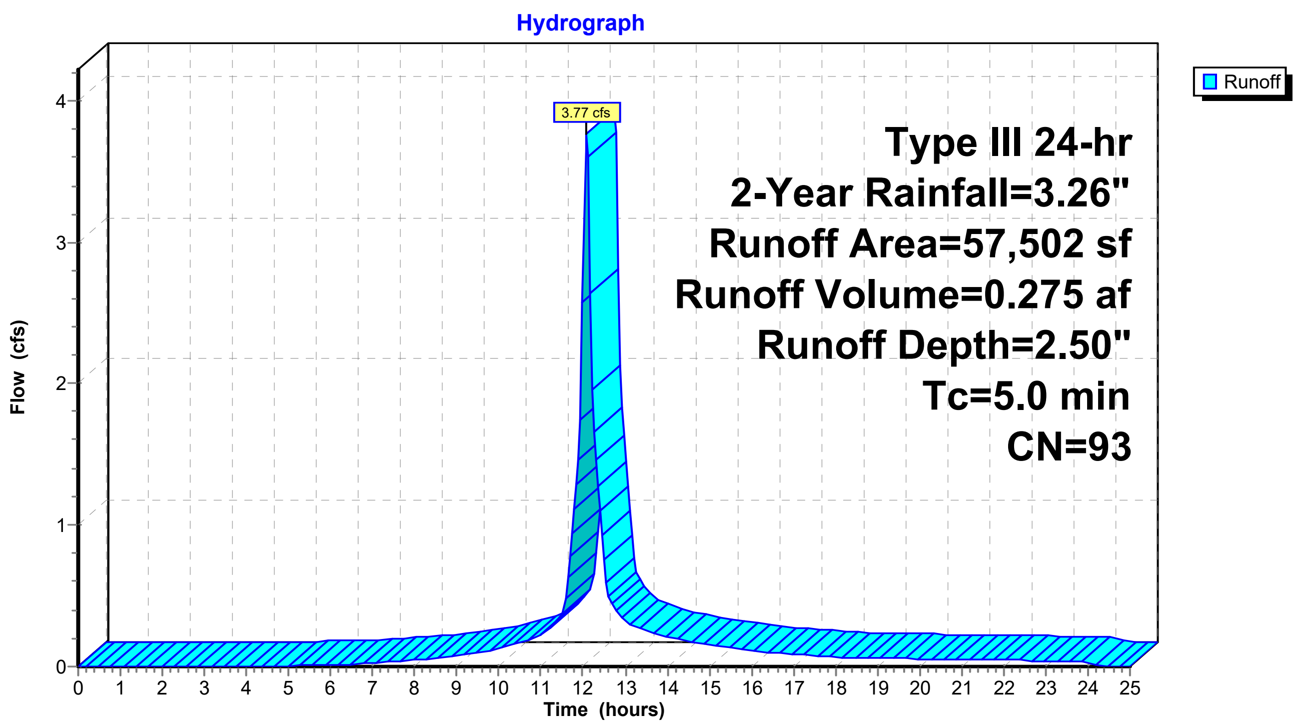
Runoff = 3.77 cfs @ 12.07 hrs, Volume= 0.275 af, Depth= 2.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1



Summary for Subcatchment FP: FP Area

[49] Hint: Tc<2dt may require smaller dt

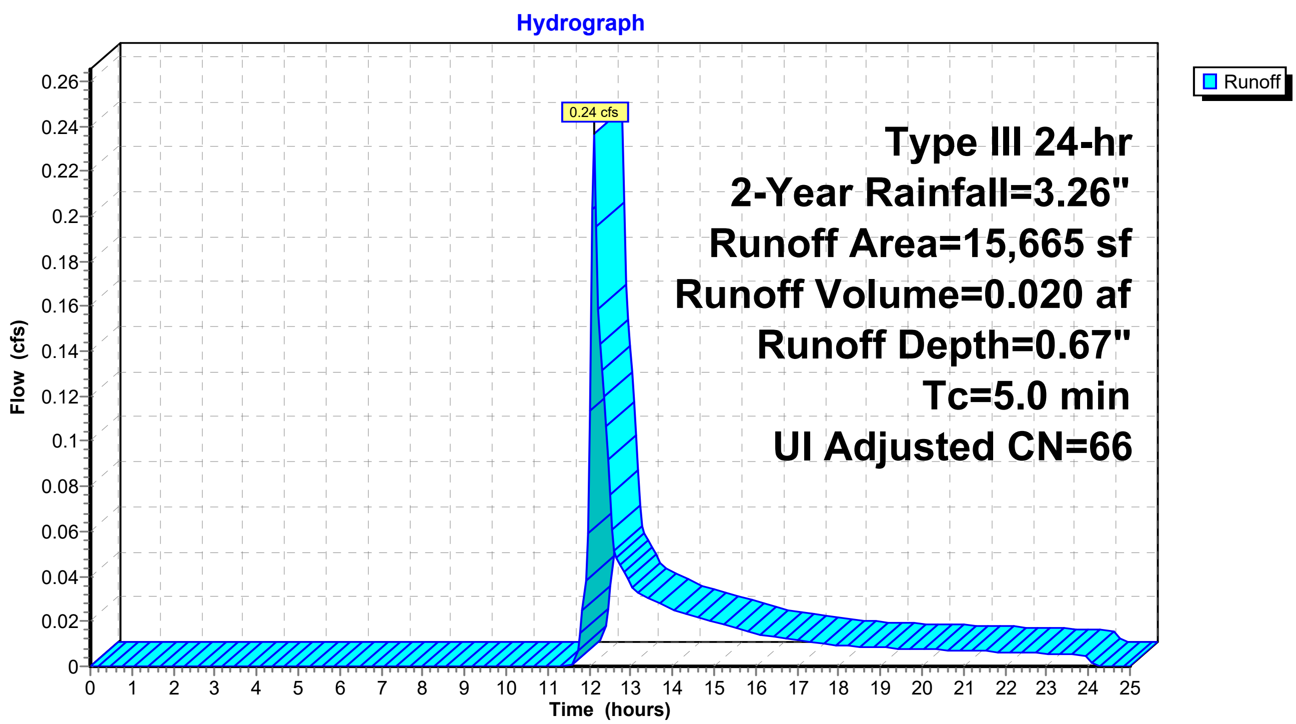
Runoff = 0.24 cfs @ 12.10 hrs, Volume= 0.020 af, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area



Summary for Subcatchment G/H: Bldgs 2 + 3

[49] Hint: Tc<2dt may require smaller dt

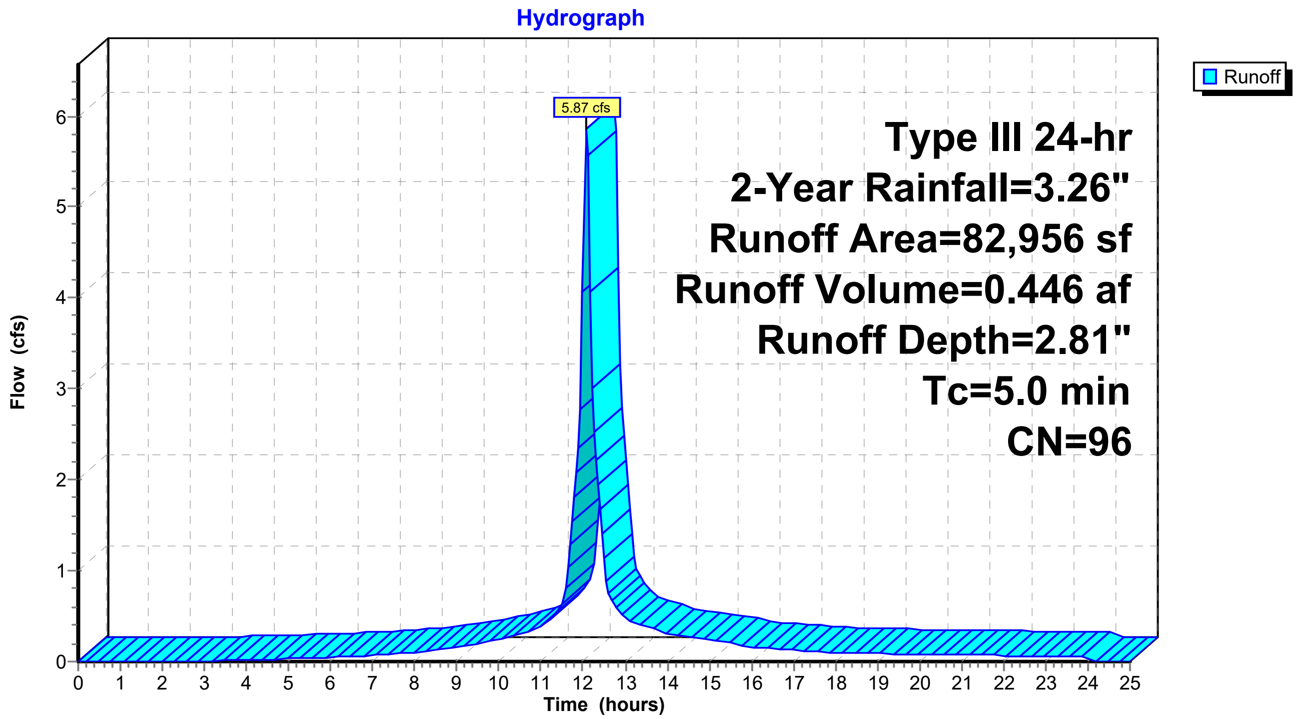
Runoff = 5.87 cfs @ 12.07 hrs, Volume= 0.446 af, Depth= 2.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.26"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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

Subcatchment G/H: Bldgs 2 + 3



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 2.68" for 2-Year event
Inflow = 9.63 cfs @ 12.07 hrs, Volume= 0.721 af
Outflow = 9.54 cfs @ 12.07 hrs, Volume= 0.716 af, Atten= 1%, Lag= 0.1 min
Primary = 9.54 cfs @ 12.07 hrs, Volume= 0.716 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 35.14' @ 12.07 hrs Surf.Area= 590 sf Storage= 380 cf
Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

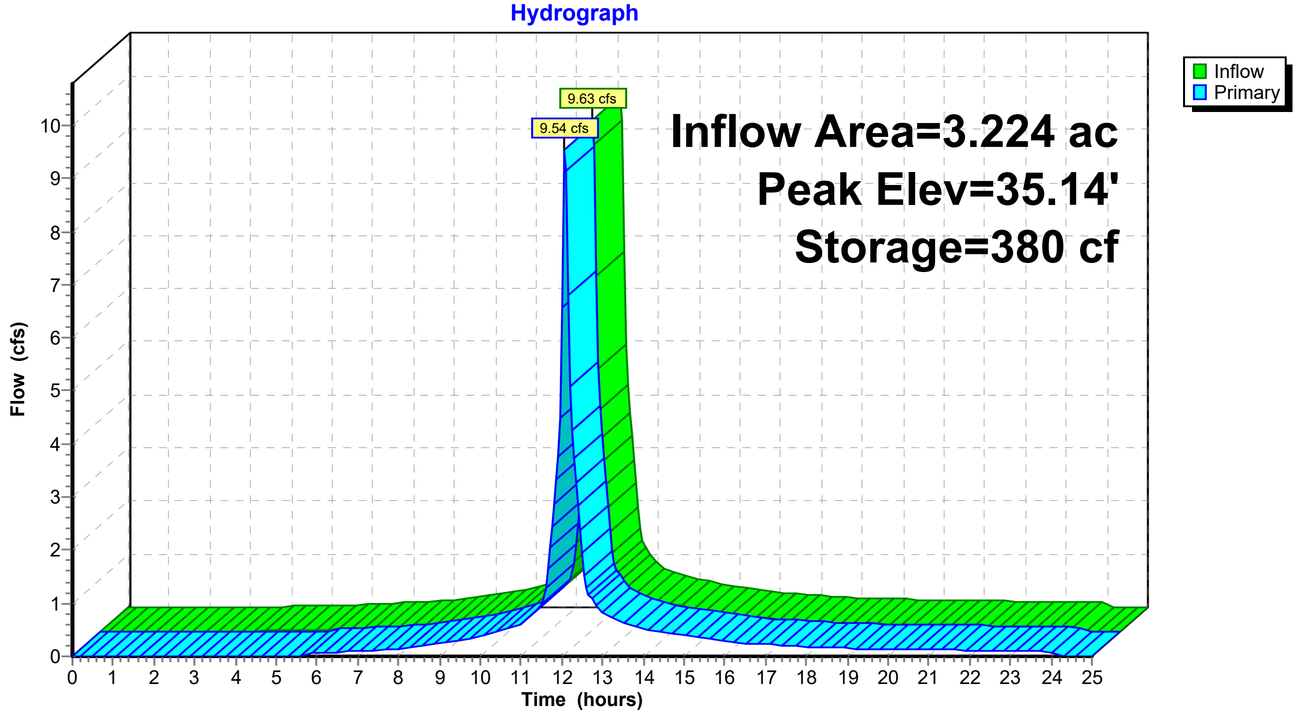
Plug-Flow detention time= 8.9 min calculated for 0.716 af (99% of inflow)
Center-of-Mass det. time= 4.3 min (784.0 - 779.7)

Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	**10.00'W x 59.00'L x 2.70'H Prismatoid**
#2	35.21'	1,053 cf	**10.00'W x 39.00'L x 2.70'H Forebay-West** Impervious
#3	35.17'	1,170 cf	**7.50'W x 39.00'L x 4.00'H Forebay-East**
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	**24.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.7' Crest Height

Primary OutFlow Max=9.16 cfs @ 12.07 hrs HW=35.14' (Free Discharge)
└─**1=Orifice/Grate** (Passes 9.16 cfs of 30.02 cfs potential flow)
  └─**2=Sharp-Crested Rectangular Weir** (Weir Controls 9.16 cfs @ 1.61 fps)

Pond SF1: Sand Filter-1

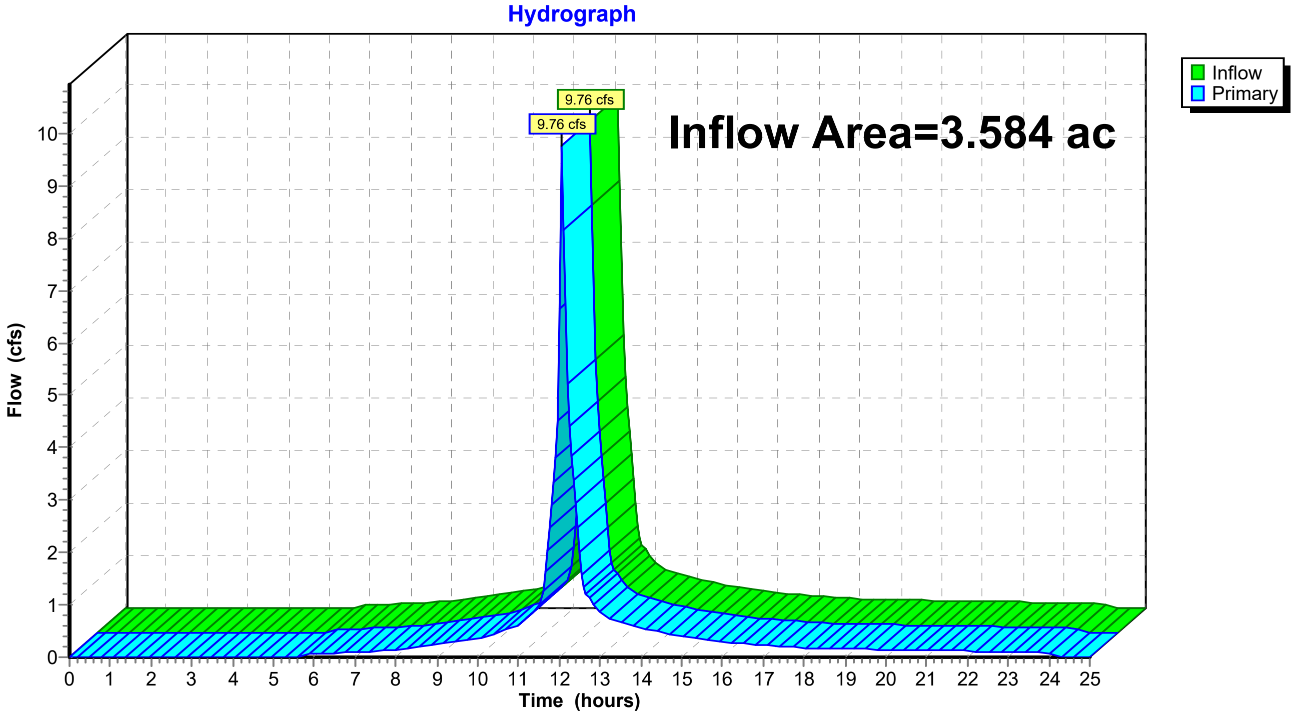


Summary for Link 1L: Cheesecake Brook

Inflow Area =	3.584 ac,	83.75% Impervious,	Inflow Depth = 2.46"	for 2-Year event
Inflow =	9.76 cfs @	12.07 hrs,	Volume=	0.736 af
Primary =	9.76 cfs @	12.07 hrs,	Volume=	0.736 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheesecake Brook



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=4.33"
Tc=5.0 min CN=93 Runoff=6.32 cfs 0.476 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=1.82"
Tc=5.0 min UI Adjusted CN=66 Runoff=0.74 cfs 0.054 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=4.66"
Tc=5.0 min CN=96 Runoff=9.47 cfs 0.740 af

Pond SF1: Sand Filter-1 Peak Elev=35.24' Storage=464 cf Inflow=15.79 cfs 1.216 af
Outflow=15.49 cfs 1.210 af

Link 1L: CheesecakeBrook Inflow=16.19 cfs 1.264 af
Primary=16.19 cfs 1.264 af

Total Runoff Area = 3.584 ac Runoff Volume = 1.270 af Average Runoff Depth = 4.25"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: Tc<2dt may require smaller dt

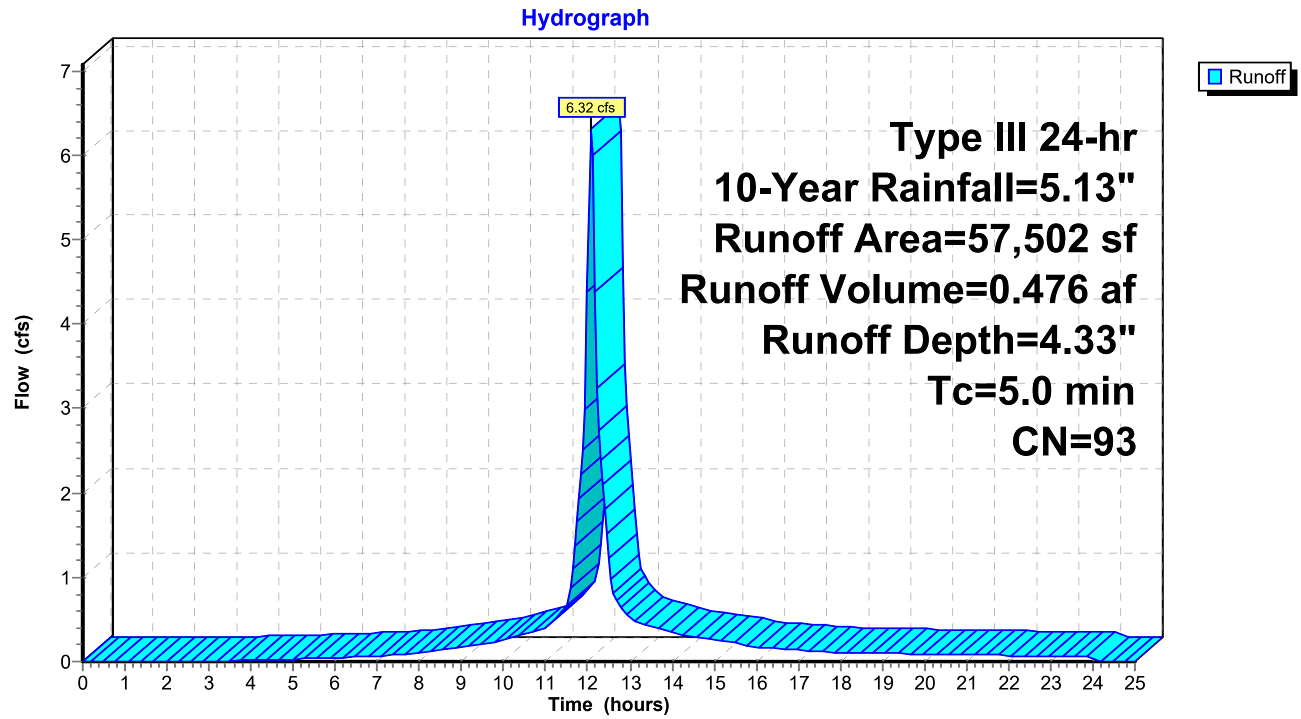
Runoff = 6.32 cfs @ 12.07 hrs, Volume= 0.476 af, Depth= 4.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1



Summary for Subcatchment FP: FP Area

[49] Hint: Tc<2dt may require smaller dt

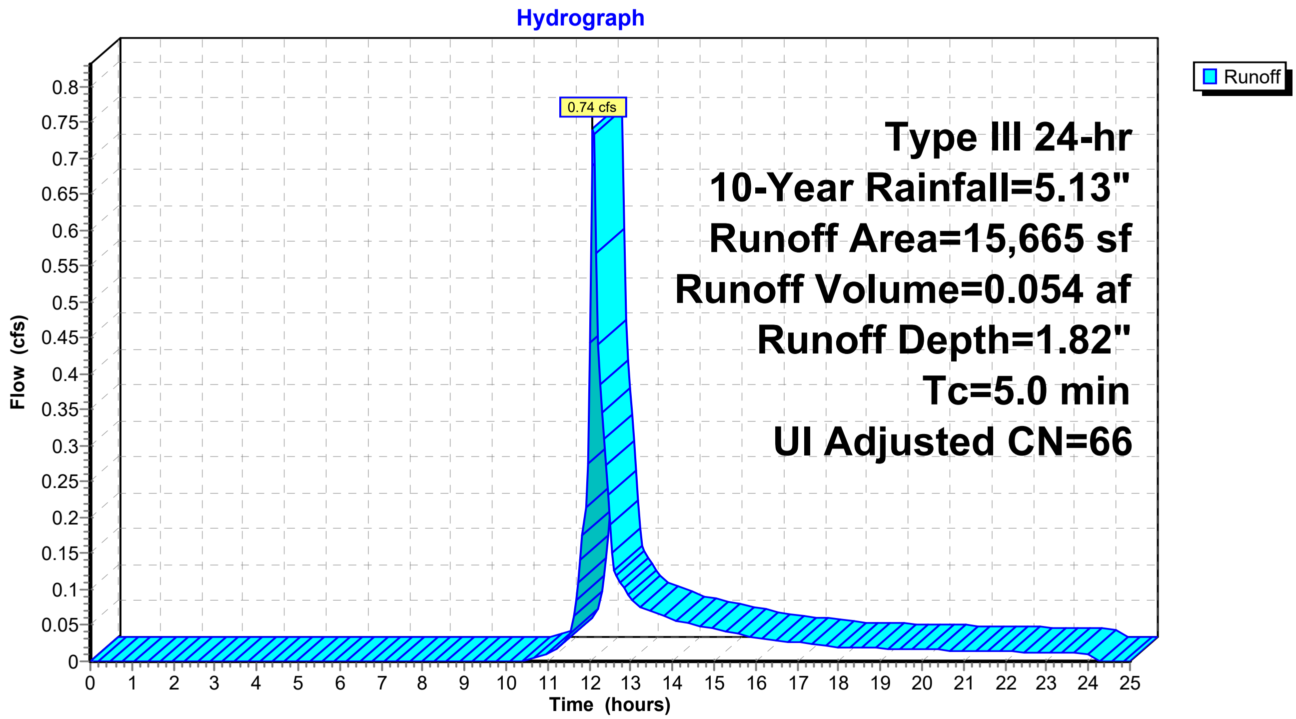
Runoff = 0.74 cfs @ 12.09 hrs, Volume= 0.054 af, Depth= 1.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area



Summary for Subcatchment G/H: Bldgs 2 + 3

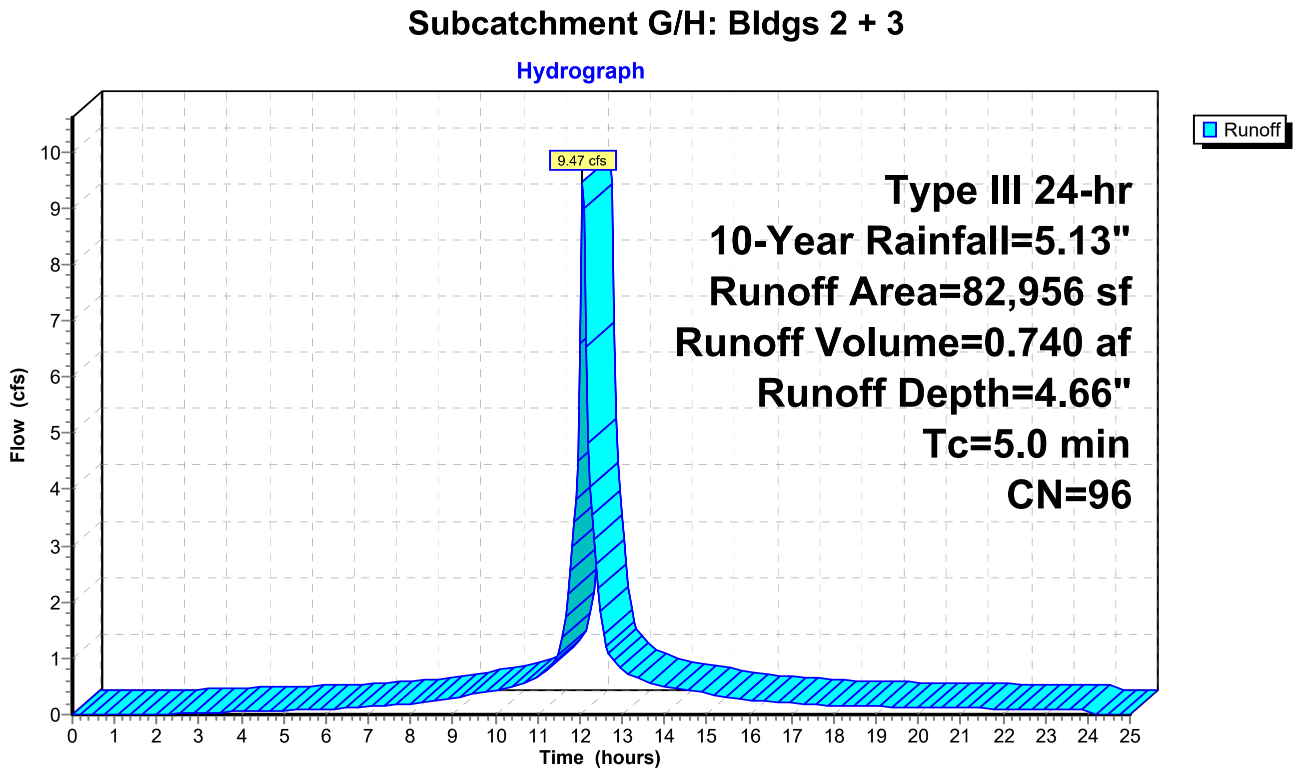
[49] Hint: Tc<2dt may require smaller dt

Runoff = 9.47 cfs @ 12.07 hrs, Volume= 0.740 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=5.13"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 4.52" for 10-Year event
Inflow = 15.79 cfs @ 12.07 hrs, Volume= 1.216 af
Outflow = 15.49 cfs @ 12.07 hrs, Volume= 1.210 af, Atten= 2%, Lag= 0.2 min
Primary = 15.49 cfs @ 12.07 hrs, Volume= 1.210 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 35.24' @ 12.07 hrs Surf.Area= 883 sf Storage= 464 cf
Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

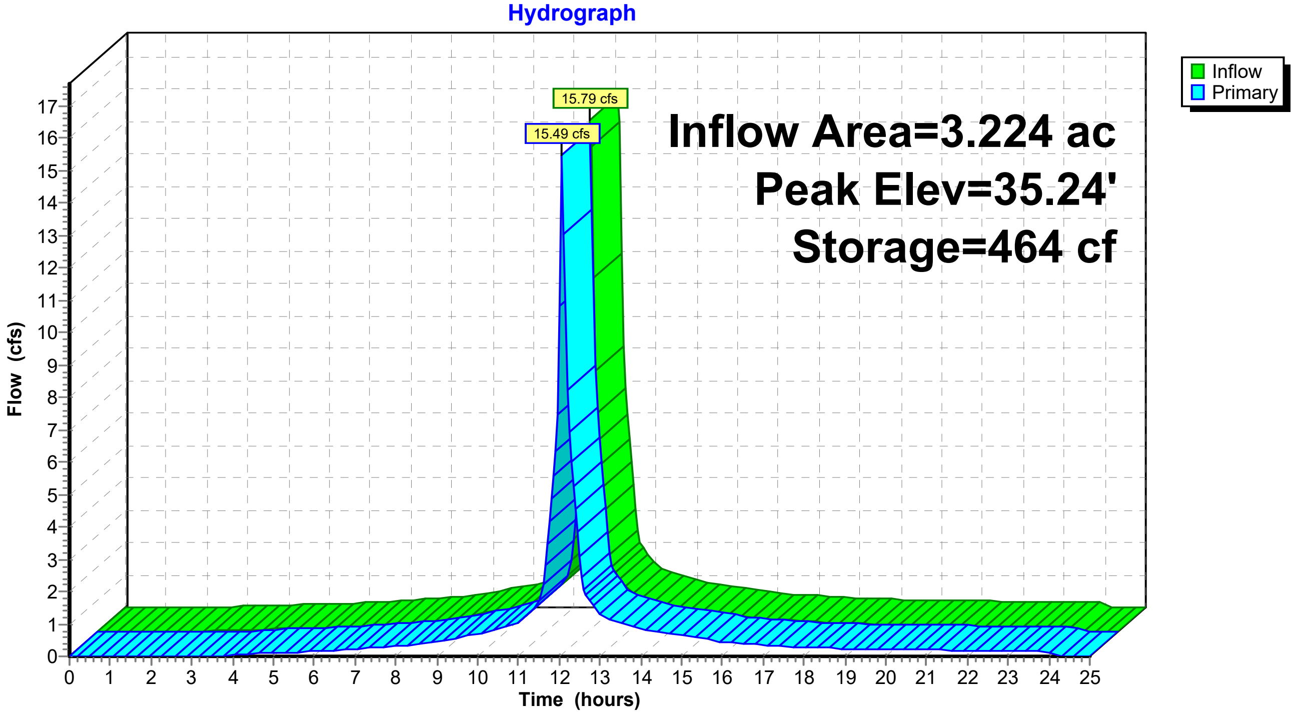
Plug-Flow detention time= 6.0 min calculated for 1.208 af (99% of inflow)
Center-of-Mass det. time= 3.0 min (770.1 - 767.0)

Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	**10.00'W x 59.00'L x 2.70'H Prismatoid**
#2	35.21'	1,053 cf	**10.00'W x 39.00'L x 2.70'H Forebay-West** Impervious
#3	35.17'	1,170 cf	**7.50'W x 39.00'L x 4.00'H Forebay-East**
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	**24.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.7' Crest Height

Primary OutFlow Max=14.95 cfs @ 12.07 hrs HW=35.23' (Free Discharge)
└─**1=Orifice/Grate** (Passes 14.95 cfs of 30.36 cfs potential flow)
  └─**2=Sharp-Crested Rectangular Weir** (Weir Controls 14.95 cfs @ 1.90 fps)

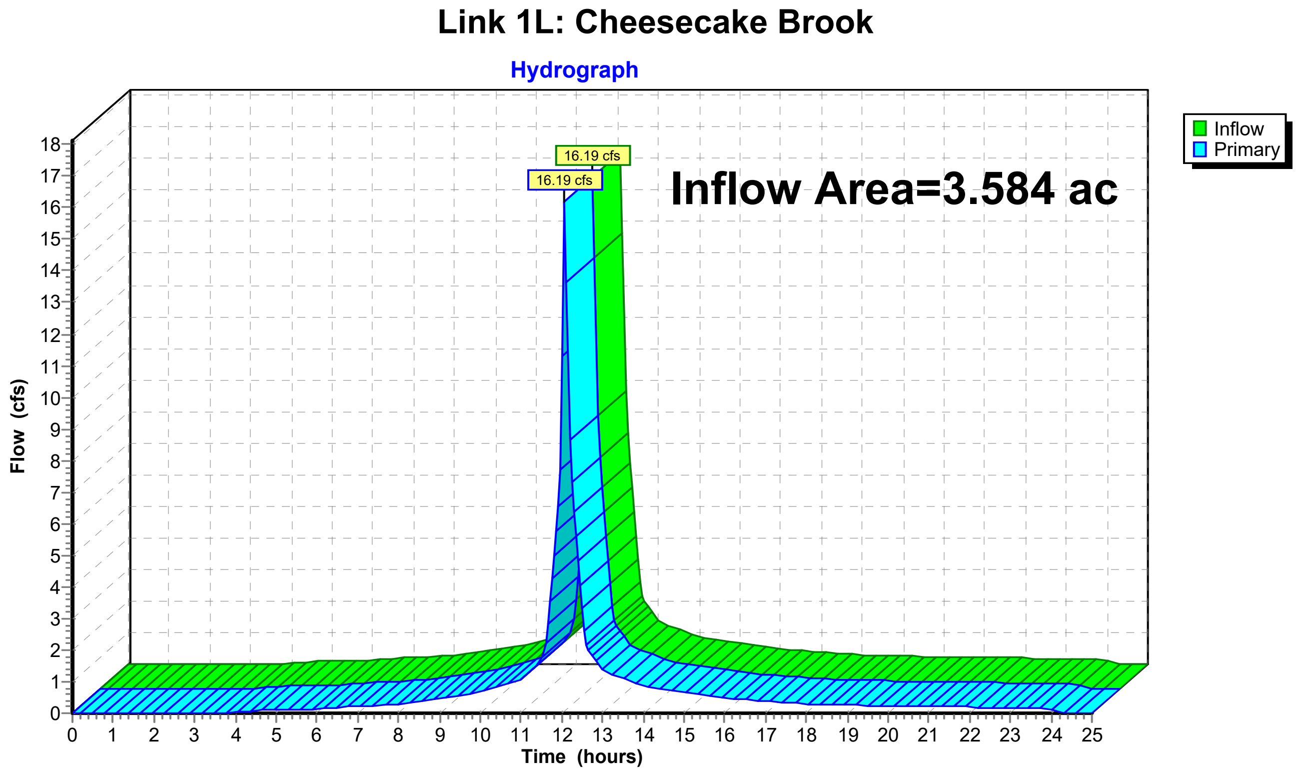
Pond SF1: Sand Filter-1



Summary for Link 1L: Cheesecake Brook

Inflow Area =	3.584 ac, 83.75% Impervious,	Inflow Depth = 4.23"	for 10-Year event	
Inflow =	16.19 cfs @	12.08 hrs, Volume=	1.264 af	
Primary =	16.19 cfs @	12.08 hrs, Volume=	1.264 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=5.48"
Tc=5.0 min CN=93 Runoff=7.90 cfs 0.603 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=2.66"
Tc=5.0 min UI Adjusted CN=66 Runoff=1.11 cfs 0.080 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=5.83"
Tc=5.0 min CN=96 Runoff=11.71 cfs 0.925 af

Pond SF1: Sand Filter-1 Peak Elev=35.29' Storage=530 cf Inflow=19.61 cfs 1.527 af
Outflow=19.24 cfs 1.522 af

Link 1L: CheesecakeBrook Inflow=20.35 cfs 1.602 af
Primary=20.35 cfs 1.602 af

Total Runoff Area = 3.584 ac Runoff Volume = 1.607 af Average Runoff Depth = 5.38"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: Tc<2dt may require smaller dt

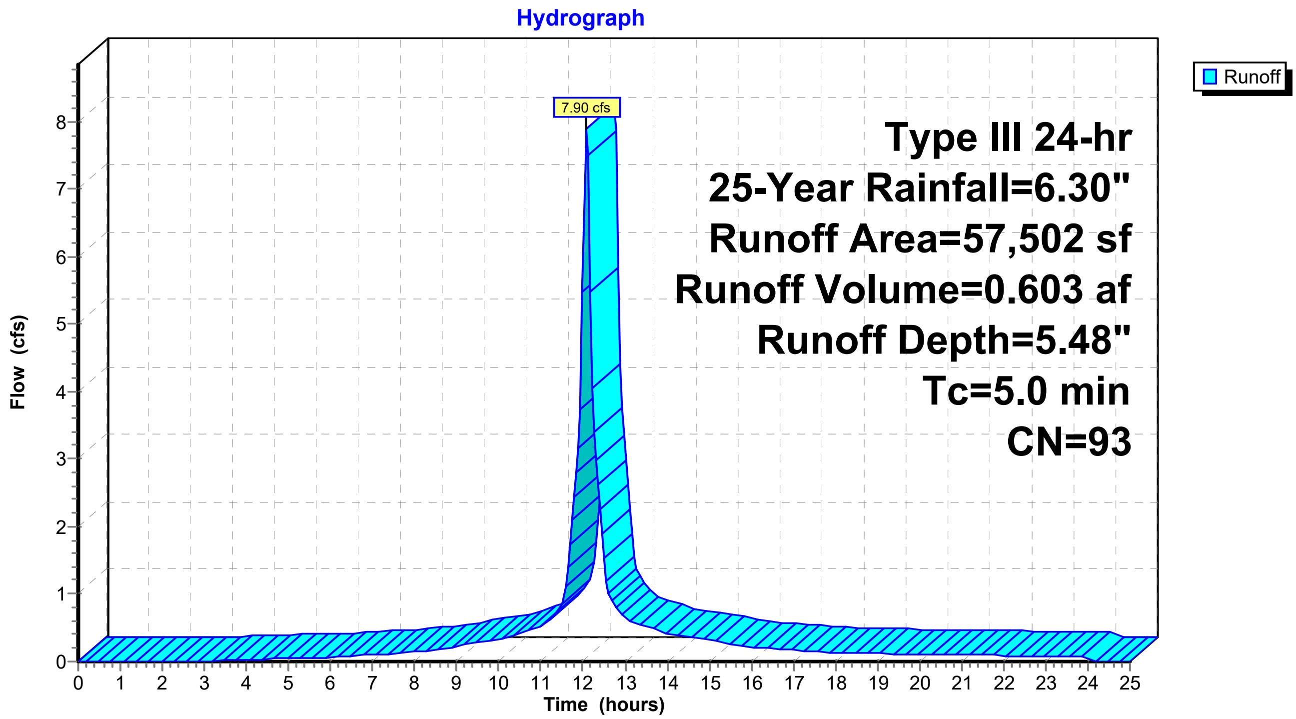
Runoff = 7.90 cfs @ 12.07 hrs, Volume= 0.603 af, Depth= 5.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1



Summary for Subcatchment FP: FP Area

[49] Hint: Tc<2dt may require smaller dt

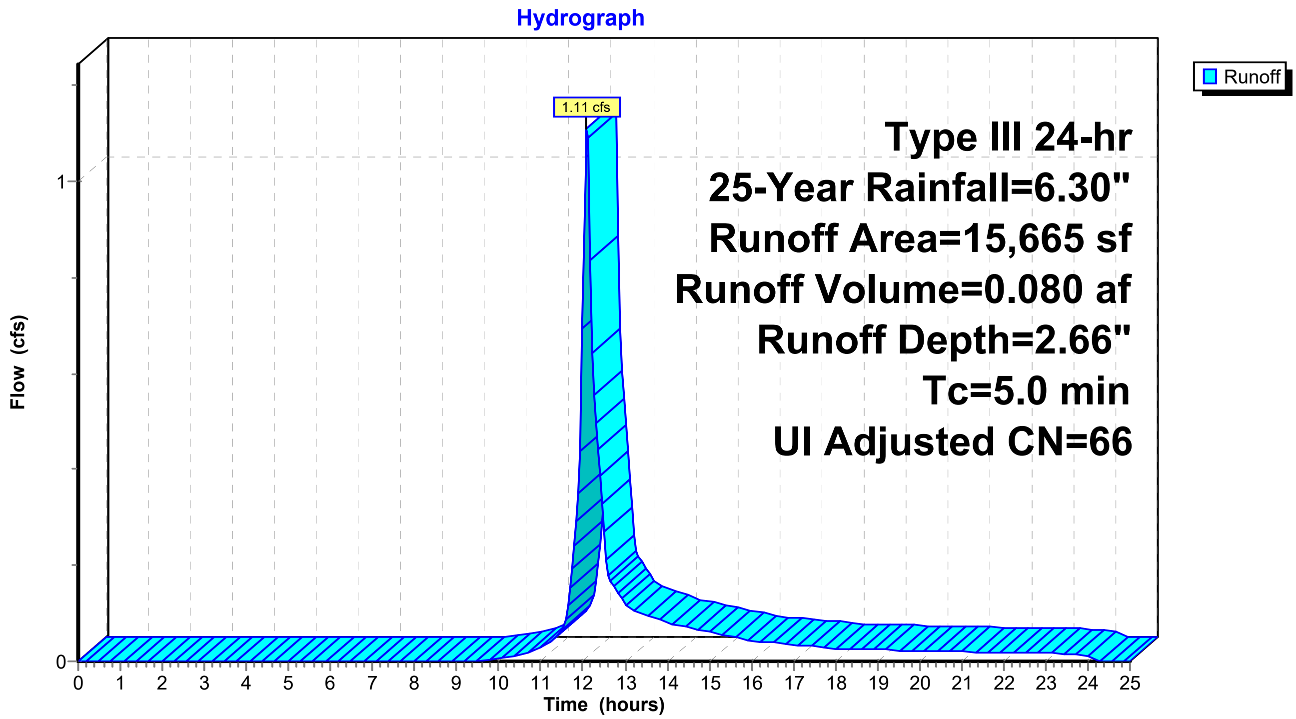
Runoff = 1.11 cfs @ 12.08 hrs, Volume= 0.080 af, Depth= 2.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area



Summary for Subcatchment G/H: Bldgs 2 + 3

[49] Hint: Tc<2dt may require smaller dt

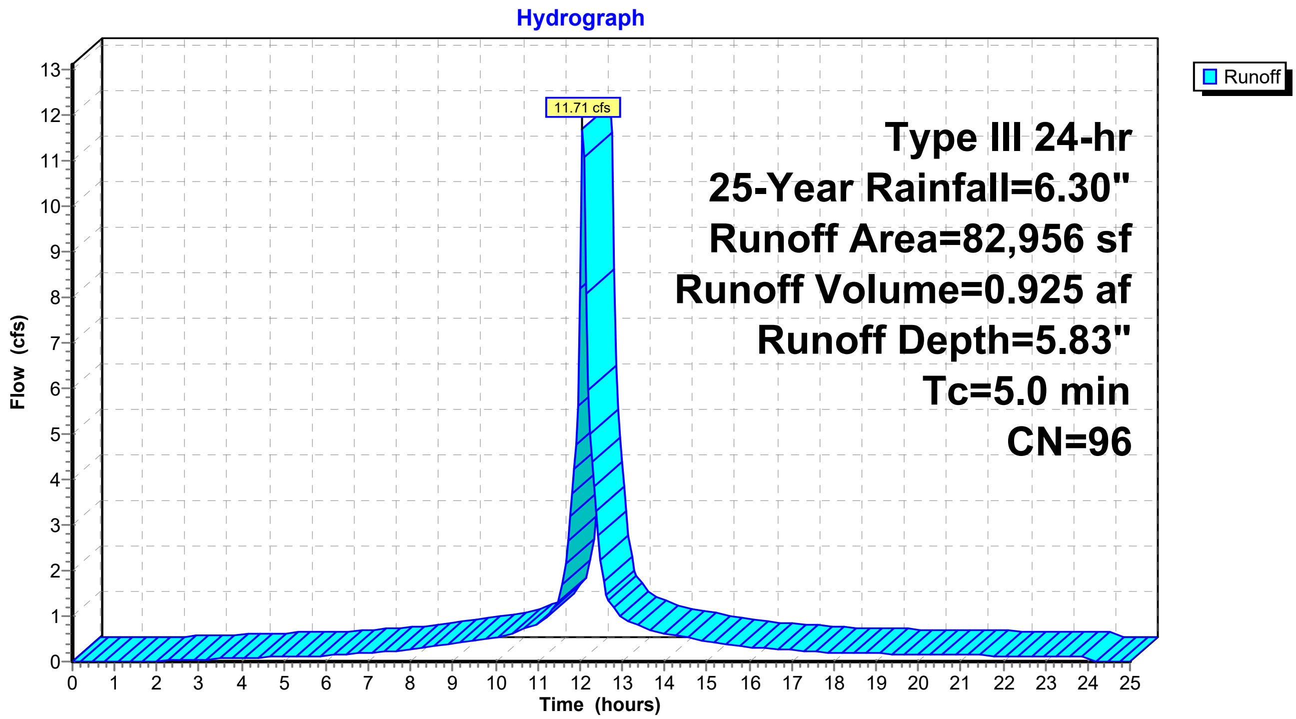
Runoff = 11.71 cfs @ 12.07 hrs, Volume= 0.925 af, Depth= 5.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-Year Rainfall=6.30"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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

Subcatchment G/H: Bldgs 2 + 3



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 5.68" for 25-Year event
Inflow = 19.61 cfs @ 12.07 hrs, Volume= 1.527 af
Outflow = 19.24 cfs @ 12.07 hrs, Volume= 1.522 af, Atten= 2%, Lag= 0.2 min
Primary = 19.24 cfs @ 12.07 hrs, Volume= 1.522 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 35.29' @ 12.07 hrs Surf.Area= 883 sf Storage= 530 cf
Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

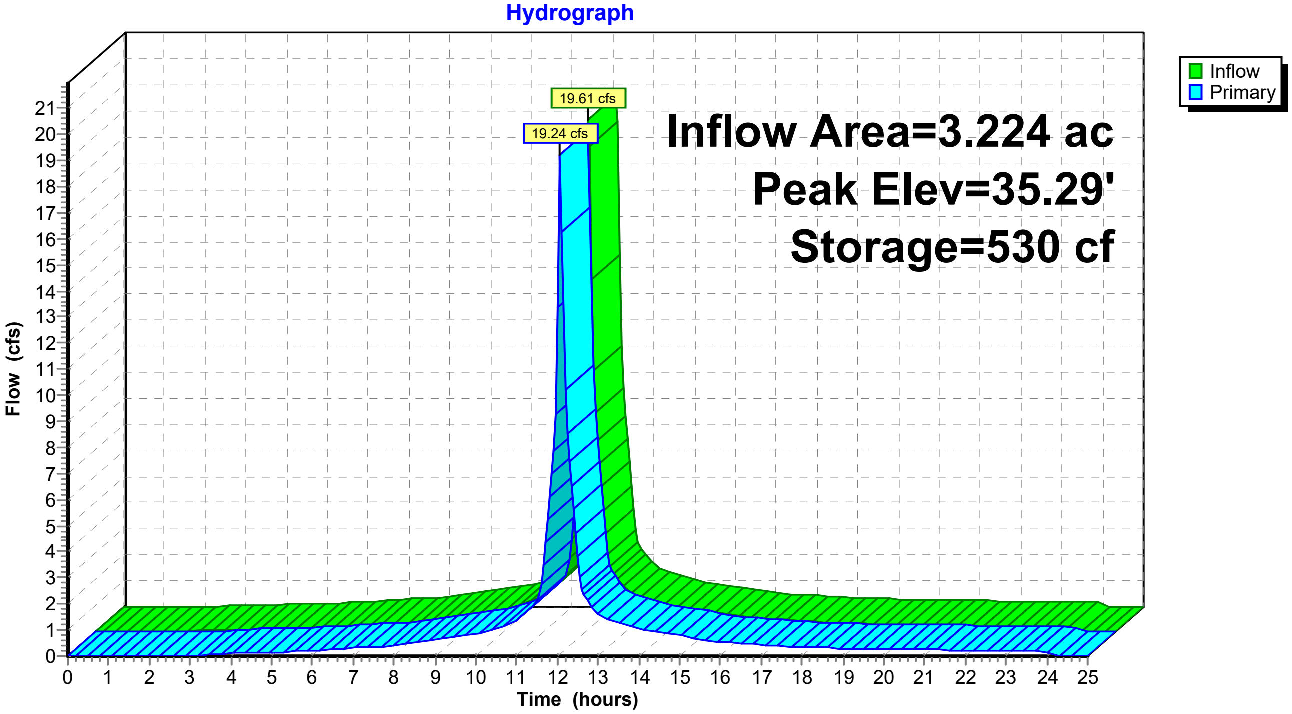
Plug-Flow detention time= 4.8 min calculated for 1.519 af (99% of inflow)
Center-of-Mass det. time= 2.6 min (764.5 - 762.0)

Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	**10.00'W x 59.00'L x 2.70'H Prismatoid**
#2	35.21'	1,053 cf	**10.00'W x 39.00'L x 2.70'H Forebay-West** Impervious
#3	35.17'	1,170 cf	**7.50'W x 39.00'L x 4.00'H Forebay-East**
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	**24.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.7' Crest Height

Primary OutFlow Max=18.55 cfs @ 12.07 hrs HW=35.28' (Free Discharge)
└─**1=Orifice/Grate** (Passes 18.55 cfs of 30.55 cfs potential flow)
  └─**2=Sharp-Crested Rectangular Weir** (Weir Controls 18.55 cfs @ 2.05 fps)

Pond SF1: Sand Filter-1

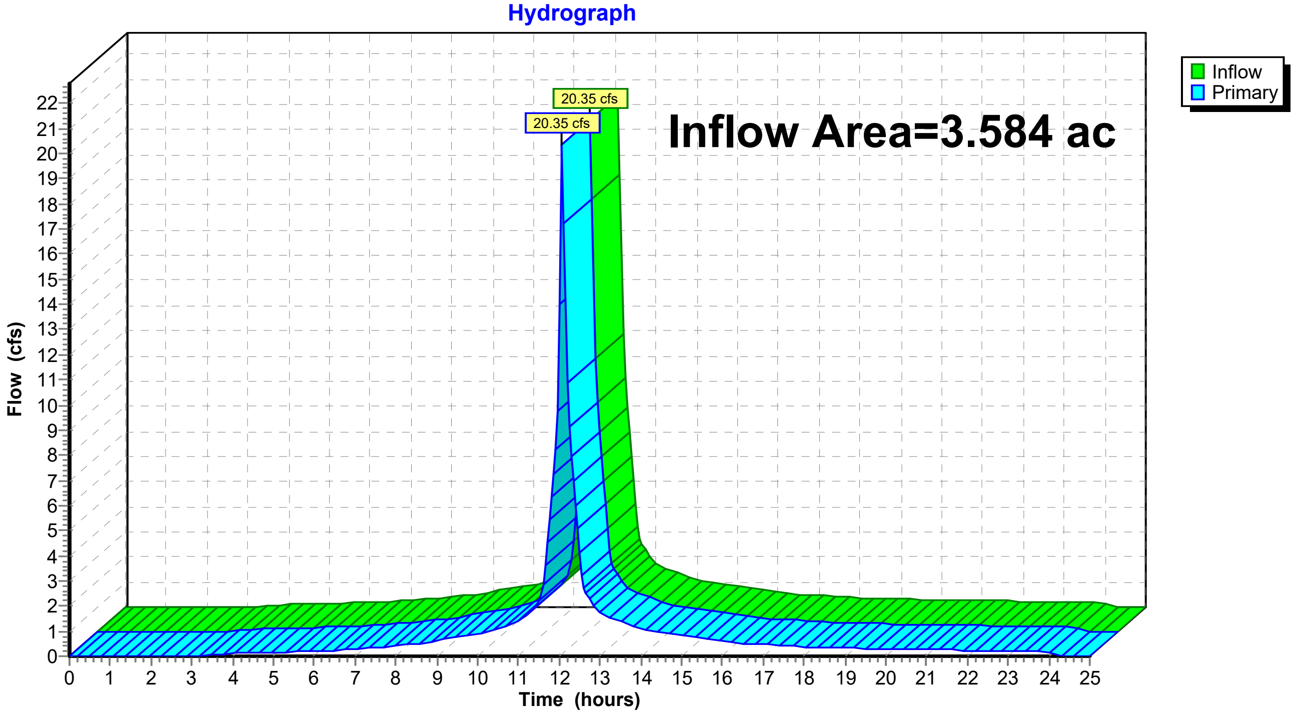


Summary for Link 1L: Cheesecake Brook

Inflow Area =	3.584 ac,	83.75% Impervious, Inflow Depth = 5.36"	for 25-Year event	
Inflow =	20.35 cfs @	12.07 hrs, Volume=	1.602 af	
Primary =	20.35 cfs @	12.07 hrs, Volume=	1.602 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheesecake Brook



Time span=0.00-25.00 hrs, dt=0.05 hrs, 501 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentF: Bldg 1 Runoff Area=57,502 sf 85.38% Impervious Runoff Depth=7.94"
Tc=5.0 min CN=93 Runoff=11.21 cfs 0.873 af

SubcatchmentFP: FP Area Runoff Area=15,665 sf 27.12% Impervious Runoff Depth=4.66"
Tc=5.0 min UI Adjusted CN=66 Runoff=1.96 cfs 0.140 af

SubcatchmentG/H: Bldgs 2 + 3 Runoff Area=82,956 sf 93.32% Impervious Runoff Depth=8.30"
Tc=5.0 min CN=96 Runoff=16.43 cfs 1.317 af

Pond SF1: Sand Filter-1 Peak Elev=35.39' Storage=657 cf Inflow=27.64 cfs 2.190 af
Outflow=27.19 cfs 2.185 af

Link 1L: CheesecakeBrook Inflow=29.16 cfs 2.325 af
Primary=29.16 cfs 2.325 af

Total Runoff Area = 3.584 ac Runoff Volume = 2.330 af Average Runoff Depth = 7.80"
16.25% Pervious = 0.582 ac 83.75% Impervious = 3.002 ac

Summary for Subcatchment F: Bldg 1

[49] Hint: Tc<2dt may require smaller dt

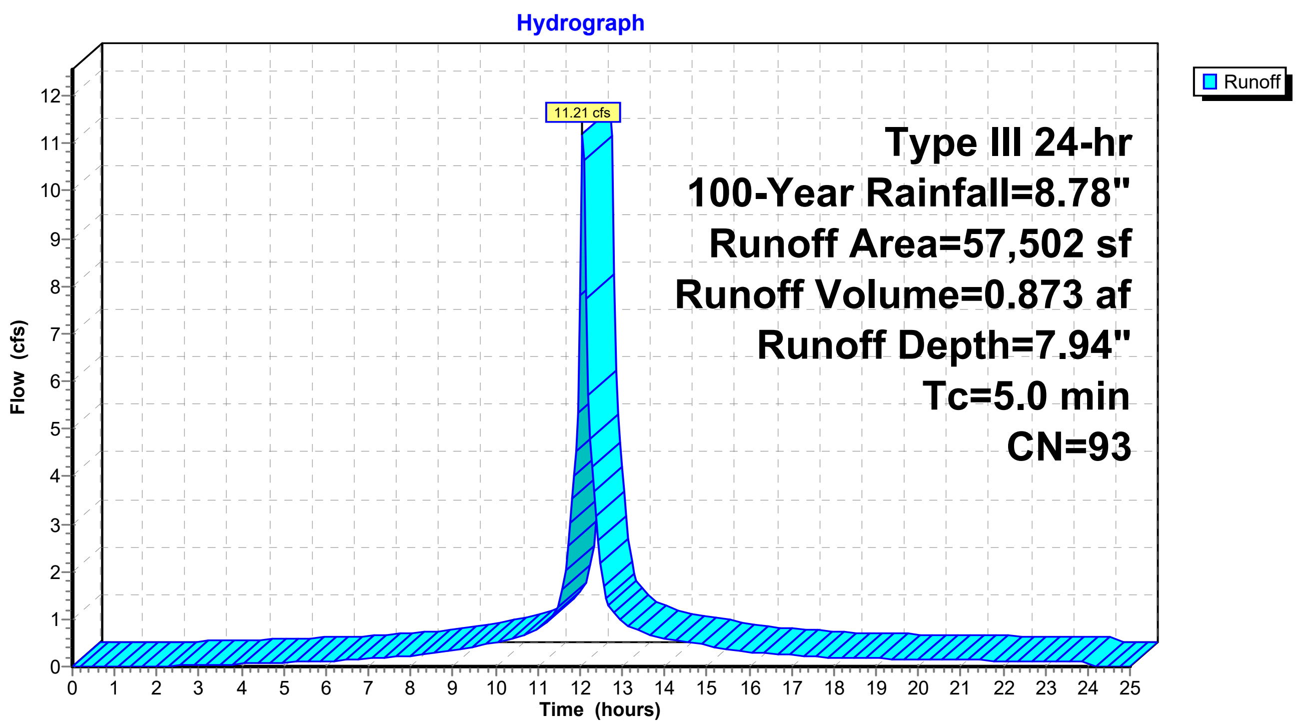
Runoff = 11.21 cfs @ 12.07 hrs, Volume= 0.873 af, Depth= 7.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Description
8,404	61	>75% Grass cover, Good, HSG B
49,098	98	Paved parking, HSG B
57,502	93	Weighted Average
8,404		14.62% Pervious Area
49,098		85.38% Impervious Area

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

Subcatchment F: Bldg 1



Summary for Subcatchment FP: FP Area

[49] Hint: Tc<2dt may require smaller dt

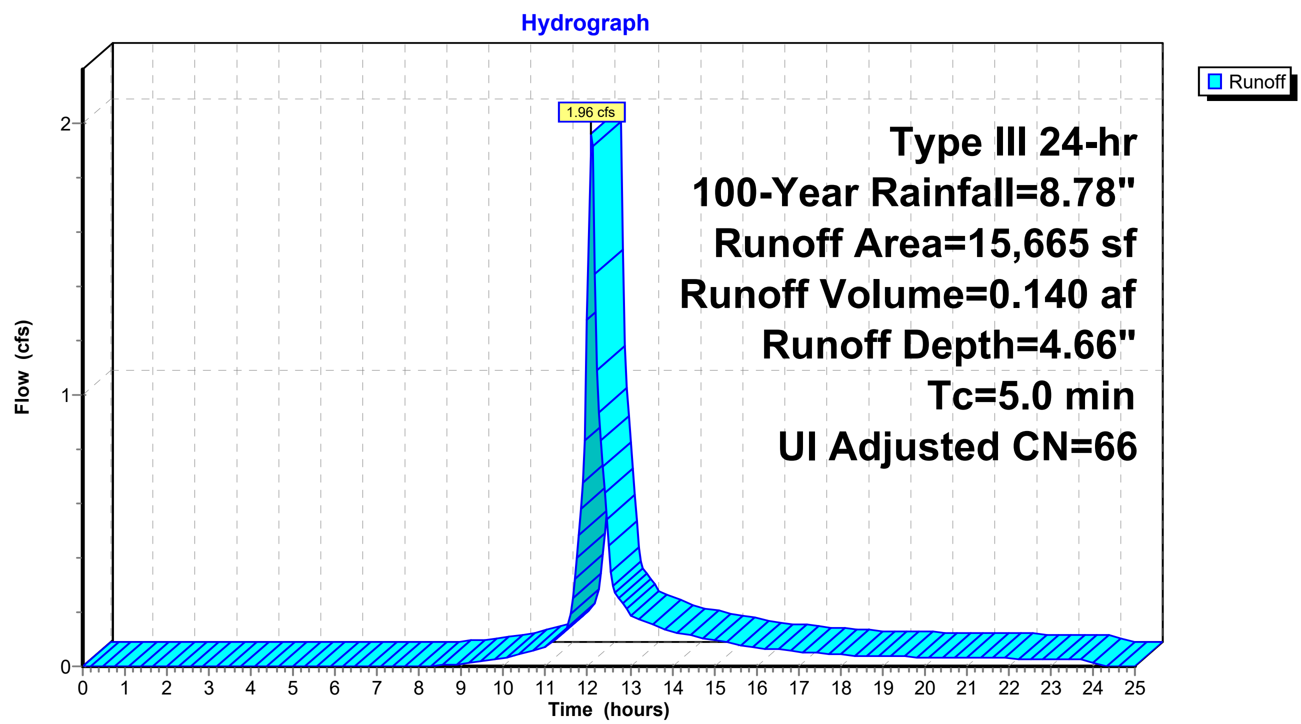
Runoff = 1.96 cfs @ 12.08 hrs, Volume= 0.140 af, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Adj	Description
11,416	61		>75% Grass cover, Good, HSG B
4,249	98		Unconnected pavement, HSG B
15,665	71	66	Weighted Average, UI Adjusted
11,416			72.88% Pervious Area
4,249			27.12% Impervious Area
4,249			100.00% Unconnected

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

Subcatchment FP: FP Area



Summary for Subcatchment G/H: Bldgs 2 + 3

[49] Hint: Tc<2dt may require smaller dt

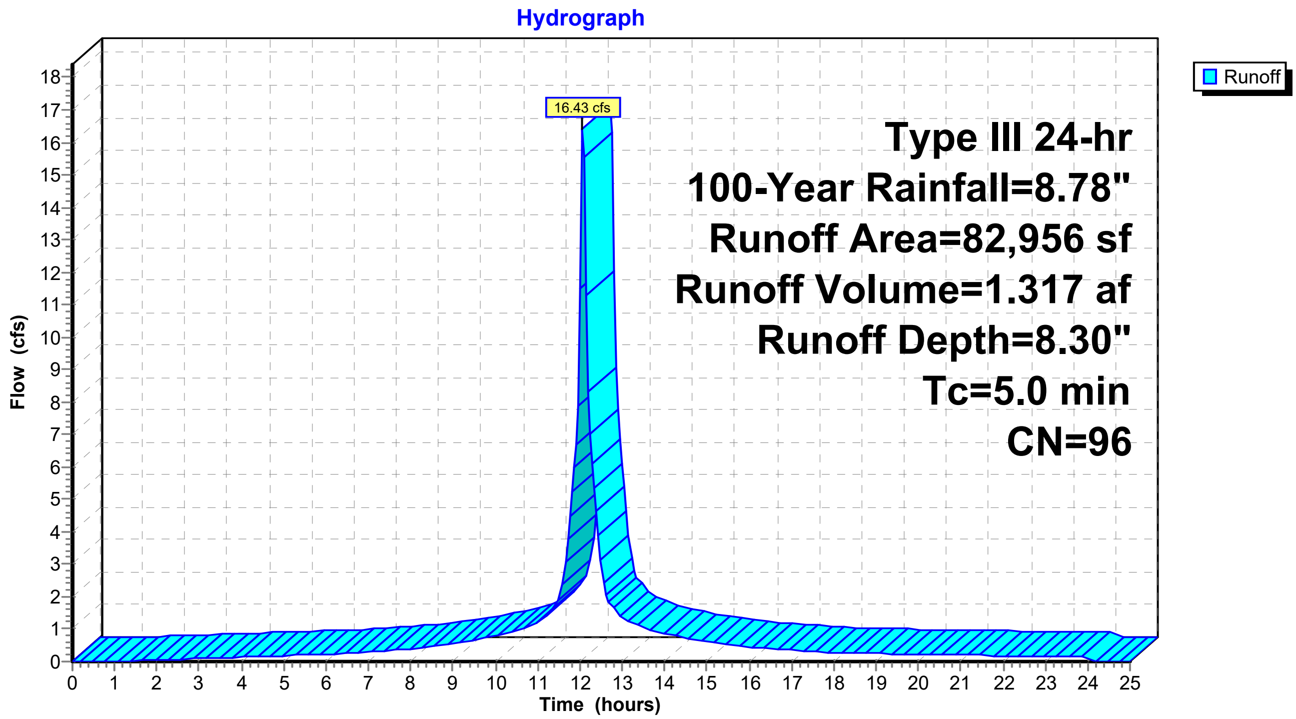
Runoff = 16.43 cfs @ 12.07 hrs, Volume= 1.317 af, Depth= 8.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.78"

Area (sf)	CN	Description
5,544	61	>75% Grass cover, Good, HSG B
77,412	98	Paved parking, HSG B
82,956	96	Weighted Average
5,544		6.68% Pervious Area
77,412		93.32% Impervious Area

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

Subcatchment G/H: Bldgs 2 + 3



Summary for Pond SF1: Sand Filter-1

Inflow Area = 3.224 ac, 90.07% Impervious, Inflow Depth = 8.15" for 100-Year event
Inflow = 27.64 cfs @ 12.07 hrs, Volume= 2.190 af
Outflow = 27.19 cfs @ 12.07 hrs, Volume= 2.185 af, Atten= 2%, Lag= 0.2 min
Primary = 27.19 cfs @ 12.07 hrs, Volume= 2.185 af

Routing by Stor-Ind method, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 35.39' @ 12.07 hrs Surf.Area= 883 sf Storage= 657 cf
Flood Elev= 36.00' Surf.Area= 883 sf Storage= 1,436 cf

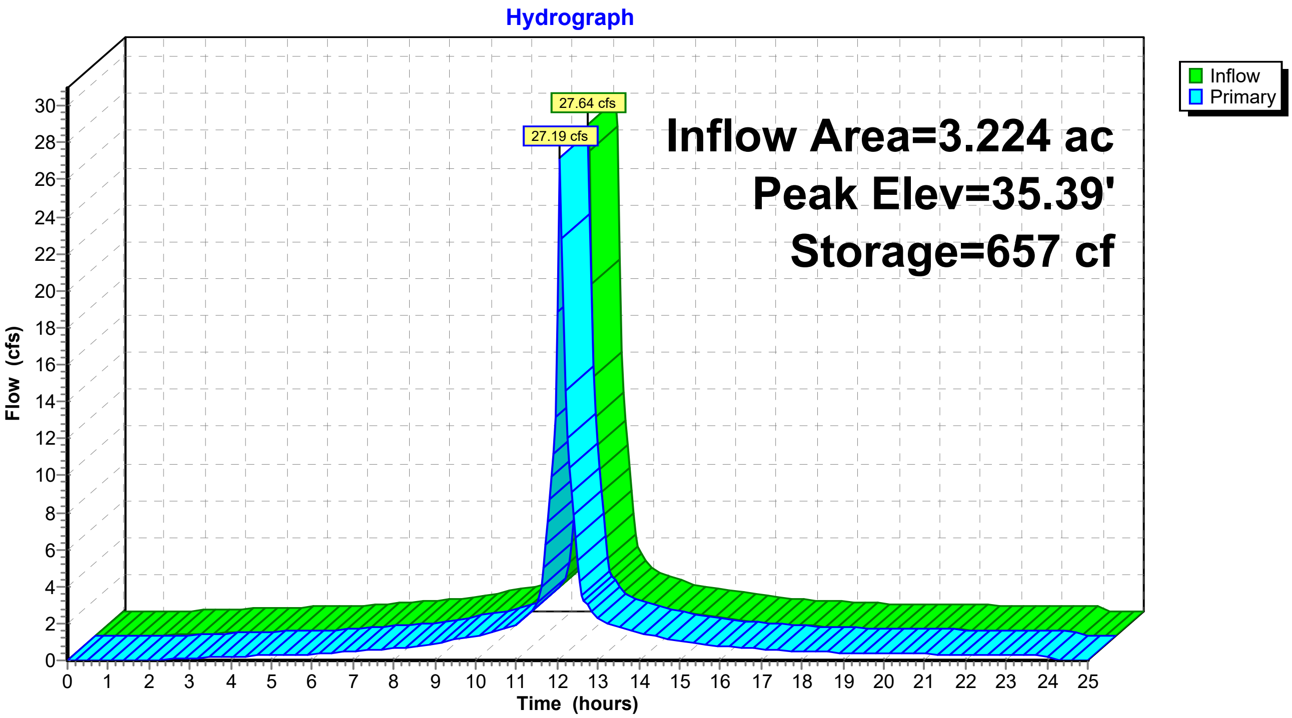
Plug-Flow detention time= 3.5 min calculated for 2.181 af (100% of inflow)
Center-of-Mass det. time= 2.0 min (756.7 - 754.7)

Volume	Invert	Avail.Storage	Storage Description
#1	34.50'	1,593 cf	**10.00'W x 59.00'L x 2.70'H Prismatoid**
#2	35.21'	1,053 cf	**10.00'W x 39.00'L x 2.70'H Forebay-West** Impervious
#3	35.17'	1,170 cf	**7.50'W x 39.00'L x 4.00'H Forebay-East**
		3,816 cf	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	30.20'	**24.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Device 1	34.90'	**24.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.7' Crest Height

Primary OutFlow Max=26.20 cfs @ 12.07 hrs HW=35.38' (Free Discharge)
└─**1=Orifice/Grate** (Passes 26.20 cfs of 30.91 cfs potential flow)
  └─**2=Sharp-Crested Rectangular Weir** (Weir Controls 26.20 cfs @ 2.30 fps)

Pond SF1: Sand Filter-1



Summary for Link 1L: Cheesecake Brook

Inflow Area = 3.584 ac, 83.75% Impervious, Inflow Depth = 7.78" for 100-Year event
Inflow = 29.16 cfs @ 12.07 hrs, Volume= 2.325 af
Primary = 29.16 cfs @ 12.07 hrs, Volume= 2.325 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-25.00 hrs, dt= 0.05 hrs

Link 1L: Cheesecake Brook