

**Dr. Edward T.T. Chiang. PE.**  
Civil Consulting Engineer  
781-454-5615

Job: Lot 'A' (#19) Staniford St., Newton, MA

Sheet No. 1 of \_\_\_\_\_

Calculated By T.T.C Date 1/18/22

Checked By \_\_\_\_\_ Date Revised 2/18/23

Scale \_\_\_\_\_



## Storm Water Analysis & Control Facility Design

### I. Project Description

The proposed project is to construct a residential building includes driveway, parking, and utilities on lot with total land area of 10,070 ft<sup>2</sup> or 0.231 acre. All existing structures shall be razed. On site soil test, performed by Stephen Poole, indicates the soil is sandy gravel with percolation rate under 2 MPI. No sign of ground water can be found in the 8' deep test pits.

### II. Storm Water Analysis

Based on city of Newton requirement, any runoff increased, at 24 hours duration, 100-year storm with total rainfall of 8.78 inches, due to development shall be controlled on site. The increase of runoff due to addition of impervious area is the difference of runoff from an impervious area and landscaped area. It is difficult to seperated the runoff from addition, therefore, it is better to completely control the total runoff from the addition impervious area.

Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot A<sup>14</sup> (#19) Staniford St, Newton, MA  
Sheet No: 2 of \_\_\_\_\_  
Calculated By: T.T.C Date: 1/18/22  
Checked By: \_\_\_\_\_ Date: Revised 2/8/23  
Scale: \_\_\_\_\_

A. Land Use Analysis: Total Land Area = 10,070 Ft<sup>2</sup>, 0.231 Ac.

1. Pre-Development Land Use

Building Area 2013 Ft<sup>2</sup>

Pavement Area 2772 Ft<sup>2</sup>

Other Impervious Area - Ft<sup>2</sup>

Total Impervious Area 4785 Ft<sup>2</sup>

$$\text{Runoff Coefficient} = \frac{0.3 \times 5285 + 0.9 \times 4785}{10070} = 0.585$$

2. Post-Development Land Use

Building Area: 1,814 Ft<sup>2</sup>

Pavement Area: 1,070 Ft<sup>2</sup>

Other Impervious Area: 336 Ft<sup>2</sup> Patio & Walkway

Total Impervious Area: 3220 Ft<sup>2</sup>

$$\text{Runoff Coefficient} = \frac{0.3 \times 6850 + 0.9 \times 3220}{10070} = 0.492$$

B. Method Used To Analyze Storm Runoff

Due to small site area (much less than sq. mile)

Rational Formula shall be used for runoff analysis.



Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot<sup>1A</sup> (#19) Staniford St., Newton, MA

Sheet No: 3 of \_\_\_\_\_

Calculated By: T.T.C. Date: 1/18/22

Checked By: \_\_\_\_\_ Date: Revised 2/18/23

Scale: \_\_\_\_\_

Rational Formula:  $Q = CiA$ , where

$Q$  = Runoff peak rate, cfs

$i$  = Rainfall Intensity, in/hr

$A$ : Site Area, Acre



For compute runoff volume,  $V_R = CiAt$ , where

$t$  is rainfall duration time, Hr. Also,  $A$  is changed

to sq. ft ( $Ft^2$ ),  $i$ , rainfall intensity, in ft/hr, and

$V_R$  is total runoff volume of the storm from area  $A$ ,

in cu. Ft ( $Ft^3$ ).

$C$  is runoff coefficient,  $C = 0.9$  for impervious

Area,  $C = 0.3$  for wooded/grass, pervious area.

In general, peak runoff rate occurs at short duration high intensity storm, but runoff volume is larger at long duration storm. For small project site, it is difficult to control runoff rate. The easy way is to control the runoff from impervious area, so to reduce runoff volume.

**Dr. Edward T.T. Chiang, P.E.**  
 Civil Consulting Engineer  
 781-454-5615

Job: Lot A<sup>14</sup> (#19) Stanford St, Newton, MA  
 Sheet No: 4 of \_\_\_\_\_  
 Calculated By: T.T.C Date: 1/18/22  
 Checked By: \_\_\_\_\_ Date: Revised 2/8/23  
 Scale: \_\_\_\_\_

C. Storm Peak Runoff Rate & Total Runoff Volume @ 8.78"/24 Hr

storm Duration Hr	Rainfall Intensity In/Hr	Peak Runoff Rate, cfs			Total Runoff Volume, Cu. Ft.		
		Pre-Devel. Condition C=0.585	Post-Devel. Condition C=0.492	Increase (Decrease)	Pre-Develop. Condition C=0.585	Post-Develop. Condition C=0.492	Increase (Decrease)
24	0.37	0.05	0.042	(0.008)	4359.3	3666.3	(693.0)
0.5	4.6	0.622	0.523	(0.099)	1129.1	949.6	(179.5)

Minimum Total Runoff Volume Need To Be Controlled

24 Hr, 100-y storm:  $V_R = 0 \text{ Ft}^3$

0.5 Hr, 100-y storm:  $V_R = 0 \text{ Ft}^3$



Total Runoff Volume From New Impervious, It is recommended that runoff from all impervious area, new/old, shall be controlled.

24 Hr, 100-y storm,  $V_R = \frac{8.78}{12} \times 0.9 \times 3220 = 2120.4 \text{ Ft}^3$

0.5 Hr, 100-y storm,  $V_R = \frac{4.6}{12} \times 0.5 \times 0.9 \times 3220 = 555.5 \text{ Ft}^3$

There shall be much less runoff at post-condition than at pre-development condition from the site.

**Dr. Edward T.T. Chiang. PE.**  
 Civil Consulting Engineer  
 781-454-5615

Job: Lot A (#19)<sup>14</sup> Staniford St, Newton, MA  
 Sheet No. 5 of \_\_\_\_\_  
 Calculated By T.T.C Date 1/18/22  
 Checked By \_\_\_\_\_ Date Revised 2/8/23  
 Scale \_\_\_\_\_

### III. Runoff Control Facility Design

For small watershed area, control of the increased runoff rate is very difficult, therefore control runoff from selected impervious area is a better way to control the runoff increased due to development.

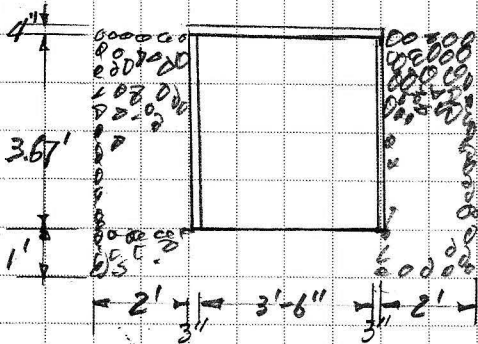
#### A. Minimum Required Control Volume - At 100-y Storm

0.5 Hour Duration,  $V_R = 0$

24 Hour Duration,  $V_R = 0$

#### B. Control Facility

1. Leaching Galley: 4'x4'x4' with 2 ft thickness crushed stone around it and 1.0 ft thickness crushed stone under it



$$\text{Storage Volume} = 3.5 \times 3.5 \times 3.67 = 45 \text{ ft}^3$$

$$\begin{aligned} \text{Stone Void} &= 0.35 [4 \times 4 \times 2 \times 2 \text{ (2-sides)} + 4 \times 8 \times 2 \times 2 \\ &\quad \text{(2-ends)} + 8 \times 8 \times 1 \text{ (bottom)}] \\ &= 0.35 \times 256 = 89.6 \text{ ft}^3/\text{Ea} \end{aligned}$$

$$\text{Total Storage Capacity} = 89.6 + 45 = 134.6 \text{ ft}^3/\text{Ea}$$

$$\begin{aligned} \text{Exfiltration Volume (Use Bottom Area Only)} &= 64 \times \frac{1}{12} \times \frac{60}{2} \times \frac{1}{2} \text{ (safety factor)} \\ &= 80 \text{ ft}^3/\text{Hr}/\text{Ea} \end{aligned}$$

Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot A (#19) Staniford St, Newton, MA  
Sheet No: 6 of \_\_\_\_\_  
Calculated By: T.T.C Date: 1/18/22  
Checked By: \_\_\_\_\_ Date: Revised 2/8/23  
Scale: \_\_\_\_\_

### Total Capacity of Galley

$$\text{At 0.5 Hr storm} = 134.6 + 0.5 \times 80 = 174.6 \text{ ft}^3/\text{Ea}$$

$$\text{At 24 Hr storm} = 134.6 \times 6 = 807.6 \text{ ft}^3/\text{Ea}$$

$$\text{or} \\ = 134.6 + 80 \times 24 = 2054.6 \text{ ft}^3/\text{Ea} \quad \text{Use the lower.}$$

### C. Control Area Analysis & Control System Design

#### 1. Front System - Control Area

Front Part of House 944 ft<sup>2</sup>

Walk & Pavement 1070 ft<sup>2</sup>

Total Impervious = 2014 ft<sup>2</sup>

100-year storm runoff volume =

$$\text{At 0.5 Hr storm} = 0.9 \times 2014 \times \frac{4.6}{12} \times 0.5 = 347.4 \text{ ft}^3$$

$$\text{At 24 Hr storm} = 0.9 \times 2014 \times \frac{0.37}{12} \times 24 = 1341.3 \text{ ft}^3$$

$$\text{Number of Galley Need} = \frac{347.4}{174.6} = 1.99 \text{ say } 2$$

$$= \frac{1341.3}{807.6} = 1.66 \text{ say } 2$$

Use Trench Grate to collect runoff from Paved Area  
and use a manhole with Sump and oil/gas Separator



Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot A (#9) Staniford St., Newton, MA  
Sheet No: 7 of \_\_\_\_\_  
Calculated By: T.T.C Date: 1/18/22  
Checked By: \_\_\_\_\_ Date: Revised 2/8/23  
Scale: \_\_\_\_\_

for control water quality before discharge to leaching galley.

## 2. Rear System - Control Area

Rear Part of House . 870  $\text{ft}^2$

Patio 336  $\text{ft}^2$   
Total Impervious Area 1206  $\text{ft}^2$

100-year storm runoff volume

$$\text{At } 0.5 \text{ Hr Storm} = 0.9 \times 1206 \times \frac{4.6}{12} \times 0.5 = 208.0 \text{ ft}^3$$

$$\text{At } 24 \text{ Hr Storm} = 0.9 \times 1206 \times \frac{0.37}{12} \times 24 = 803.2 \text{ ft}^3$$

$$\text{Number of Galley Need} = \frac{208}{174.6} = 1.19$$

$$\text{At } 24 \text{ Hr, } 100\text{-y storm} = \frac{803.2}{807.6} = 0.99$$

Use one galley with 3' thickness crushed around it and 1' thickness crushed stone under it, to increase the storage capacity and the exfiltration capacity

$$\text{Bottom Area increased} = 8 \times 2 + 10 \times 2 = 36 \text{ ft}^2$$

$$\text{Exfiltration Capacity increased} = \frac{36 \times 60}{12} \times \frac{1}{2} = 45 \text{ ft}^3/\text{Hr}$$

$$\text{Storage Capacity increased} = 0.35 [4.67(2 \times 8 + 2 \times 10)] = 58.8 \text{ ft}^3/\text{Eq.}$$



Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot A (#19) Stamford St, Newton, MA  
Sheet No: 8 of \_\_\_\_\_  
Calculated By: T.T.C Date: 1/18/22  
Checked By: \_\_\_\_\_ Date: Revised 2/8/23  
Scale: \_\_\_\_\_

Total Capacity of Galley:

$$\text{At } 0.5 \text{ Hr storm} = 174.6 + 58.8 + \frac{45}{2} = 255.9 \text{ ft}^3/\text{ea} \\ > 208 \text{ ft}^3/\text{ea}$$

#### D. Control Facilities Arrangement

As shown on Plan.

Notes: All PVC pipe under paved area shall be Sch. 40.

All downspouts shall have an overflow Y-section in case of strange storm, or suddenly weather changes.

#### E. Runoff Reduction Due to Development

##### 1. Controlled Impervious Area Runoff.

$$\text{At } 100\text{-y, } 24 \text{ Hr storm} = 803.2 + 1341.3 = 2144.5 \text{ ft}^3$$

##### 2. Change Impervious Area to Landscaping Area

$$\text{Area} = 4785 - 3220 = 1565 \text{ ft}^2$$

$$\text{At } 100\text{-y-} 24 \text{ Hr storm} = 1565 \times (0.9 - 0.3) \times \frac{0.37}{12} \times 24 \\ = 694.9 \text{ ft}^3$$

##### 3. Total Runoff Volume Reduction at 100-y, 24 Hr storm = 2839.4 ft<sup>3</sup>





**Dr. Edward T.T. Chiang. PE.**  
Civil Consulting Engineer  
781-454-5615

Job: Lot 14B(19) Staniford St., Newton, MA

Sheet No. 1 of \_\_\_\_\_

Calculated By T.T.C Date 1/20/22

Checked By \_\_\_\_\_ Date Revised 2/8/23

Scale \_\_\_\_\_

## Storm Water Analysis & Control Facility Design



### I. Project Description

The proposed project is to construct a residential house including driveway, and utilities on lot with total area of 15,297 ft<sup>2</sup> or 0.351 Ac. On site soil test, performed by Steve Poole, indicates the soil is sandy-gravel with percolation rate of less than 2 MPH. No sign of ground water can be found in the 8 ft deep test pits. It is recommended that runoff from all impervious area shall be controlled.

### II. Storm Water Analysis

Based on city of Newton requirement, any runoff increased, at 24 hours duration, 100-year storm with total rainfall of 8.78 inches, due to development shall be controlled on site. The increase of runoff due to addition of impervious area is the difference of runoff from an impervious area and landscaped area. It is difficult to separated the runoff from addition, therefore, it is better to completely control the total runoff from the addition impervious area.

Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot 14B (#19) Staniford St, Newton, MA

Sheet No: 2 of \_\_\_\_\_

Calculated By: T.T.C Date: 1/20/22

Checked By: \_\_\_\_\_ Date: Revised 2/8/23

Scale: \_\_\_\_\_

A. Land Use Analysis: Total Land Area = 15297 Ft<sup>2</sup>, 0.351 Ac.

1. Pre-Development Land Use

Building Area - Ft<sup>2</sup>

Pavement Area - Ft<sup>2</sup>

Other Impervious Area - Ft<sup>2</sup>

Total Impervious Area - Ft<sup>2</sup>

$$\text{Runoff Coefficient} = \frac{0.3 \times 15297 + 0.9 \times 0}{15297} = 0.30$$

2. Post-Development Land Use

Building Area = 1,832 Ft<sup>2</sup>

Pavement Area = Included Walk 7800 Ft<sup>2</sup>

Pavement Common Drives (Partial) 1000

Other Impervious Area: Patio 160 Ft<sup>2</sup>

Total Impervious Area: 4792 Ft<sup>2</sup>

$$\text{Runoff Coefficient} = \frac{0.3 \times 10505 + 0.9 \times 4792}{15297} = 0.488$$

B. Method Used To Analyze Storm Runoff

Due to small site area (much less than sq. mile)

Rational Formula shall be used for runoff analysis.



Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot 14B (#19) Staniford St, Newton, MA  
Sheet No: 3 of \_\_\_\_\_  
Calculated By: T.T.C Date: 1/20/22  
Checked By: \_\_\_\_\_ Date: Revised 2/18/23  
Scale: \_\_\_\_\_

Rational Formula:  $Q = CiA$ , where

$Q$  = Runoff peak rate, cfs

$i$  = Rainfall Intensity, in/hr

$A$  = Site Area, Acre



For compute runoff volume,  $V_R = CiAt$ , where  
 $t$  is rainfall duration time, Hr. Also,  $A$  is changed  
to sq. ft ( $FT^2$ ),  $i$ , rainfall intensity, in ft/hr, and  
 $V_R$  is total runoff volume of the storm from area  $A$ ,  
in cu. ft ( $FT^3$ ).

$C$  is runoff coefficient,  $C = 0.9$  for impervious  
Area,  $C = 0.3$  for wooded/grass, pervious area.

In general, peak runoff rate occurs at short  
duration high intensity storm, but runoff volume is larger  
at long duration storm. For small project site, it is  
difficult to control runoff rate. The easy way is to  
control the runoff from impervious area, so to reduce  
runoff volume.

Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot 14B (#9) Staniford St, Newton, MA

Sheet No: 4 of \_\_\_\_\_

Calculated By: T.T.C Date: 1/20/22

Checked By: \_\_\_\_\_ Date: \_\_\_\_\_

Scale: \_\_\_\_\_

C. Storm Peak Runoff Rate & Total Runoff Volume @ 8.78"/24 Hr

storm Duration Hr	Rainfall Intensity In/Hr	Peak Runoff Rate, cfs			Total Runoff Volume, Cu. Ft.		
		Pre-Devel. Condition C=0.30	Post-Devel. Condition C=0.488	Increase (Decrease)	Pre-Develop. Condition C=0.30	Post-Develop. Condition C=0.488	Increase (Decrease)
24	0.37	0.039	0.063	0.024	3395.9	5524.1	2128.2
0.5	4.6	0.484	0.788	0.304	879.6	1430.8	551.2

Project site = 0.351 Ac = 15,297 FT<sup>2</sup>

Minimum Total Runoff Volume Need To Be Controlled

24 Hr, 100-y storm:  $V_R = 2128.2 \text{ FT}^3$

0.5 Hr, 100-y storm:  $V_R = 551.2 \text{ FT}^3$



Total Runoff Volume From New Paved Area, It is recommended that runoff from impervious, should it be new, shall be controlled. Total Impervious Area = 4792 FT<sup>2</sup>

24 Hr, 100-y storm,  $V_R = \frac{8.78}{12} \times 0.9 \times 4792 = 3155.5 \text{ FT}^3$

0.5 Hr, 100-y storm,  $V_R = \frac{4.6}{12} \times 0.5 \times 0.9 \times 4792 = 826.6 \text{ FT}^3$

There shall be no increased runoff at post-condition than at pre-development condition from the site. Should the total runoff volume from new paved area is less than the minimum required control volume, addition impervious area need to be added to control area.

### III. Runoff Control Facility Design

For small watershed area, control of the increased runoff rate is very difficult, therefore control runoff from selected impervious area is a better way to control the runoff increased due to development.

#### A. Minimum Required Control Volume - At 100-y Storm

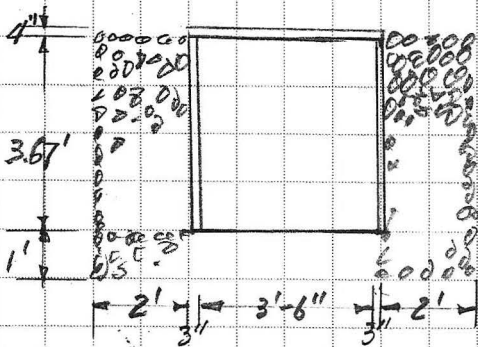
0.5 Hour Duration,  $V_R = 551.2$

24 Hour Duration,  $V_R = 2128.2$



#### B. Control Facility

1. Leaching Galley: 4'x4'x4' with 2 ft thickness crushed stone around it and 1.0 ft thickness crushed stone under it



$$\text{Storage Volume} = 3.5 \times 3.5 \times 3.67 = 45 \text{ ft}^3$$

$$\begin{aligned} \text{Stone Void} &= 0.35 [4 \times 4 \times 2 \times 2 (2\text{-sides}) + 4 \times 8 \times 2 \times 2 \\ &\quad (2\text{-Ends}) + 8 \times 8 \times 1 (bottom)] \\ &= 0.35 \times 256 = 89.6 \text{ ft}^3/\text{Ea.} \end{aligned}$$

$$\text{Total Storage Capacity} = 89.6 + 45 = 134.6 \text{ ft}^3/\text{Ea.}$$

$$\begin{aligned} \text{Exfiltration Volume (Use Bottom Area Only)} &= 64 \times \frac{1}{12} \times \frac{60}{2} \times \frac{1}{2} (\text{safety Factor}) \\ &= 80 \text{ ft}^3/\text{hr/Ea.} \end{aligned}$$

**Dr. Edward T.T. Chiang, P.E.**  
Civil Consulting Engineer  
781-454-5615

Job: Lot 14B Staniford St, Newton, MA

Sheet No: 6 of \_\_\_\_\_

Calculated By: T.T.C Date: 2/8/23

Checked By: \_\_\_\_\_ Date: \_\_\_\_\_

Scale: \_\_\_\_\_

Total Capacity of Galley:  $V_c$

$$\text{At } 0.5 \text{ Hr storm } V_c = 134.6 + 0.5 \times 80 = 174.6 \text{ ft}^3/\text{Eq}$$

$$\text{At } 24 \text{ Hr storm, } V_c = 134.6 \times 6 = 807.6 \text{ ft}^3/\text{Eq}$$

or

$$V_c = 134.6 + 24 \times 80 = 2054.6 \text{ ft}^3/\text{Eq}$$

Which ever is less

## C. Control Area Analysis & Control System Design

### 1. Northwesterly Drain System

Total Impervious Area = 1992  $\text{ft}^2$  House & Patio

$$\begin{aligned} \text{Runoff Volume } V_R &= 0.9 \times 1992 \times \frac{4.6}{12} \times 0.5 \\ \text{at } 0.5 \text{ Hr, } 100\text{-y storm} & \\ &= 343.6 \text{ ft}^3 \end{aligned}$$

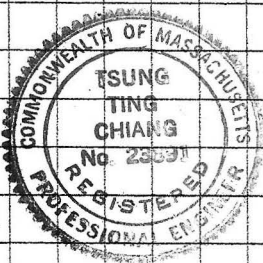
$$\begin{aligned} \text{Runoff Volume } V_R &= 0.9 \times 1992 \times \frac{0.37}{12} \times 24 \\ \text{at } 24 \text{ Hr, } 100\text{-year storm} & \\ &= 1326.7 \text{ ft}^3 \end{aligned}$$

$$\begin{aligned} \text{No. of Galley Need} &= \frac{343.6}{174.6} = 1.97 \quad \text{Use } 2 \text{ galleys} \\ \text{at } 100\text{-y, } 0.5 \text{ Hr storm} & \end{aligned}$$

$$\begin{aligned} \text{No. of Galley Need} &= \frac{1326.7}{807.6} = 1.64 \quad 2 \text{ galley} \\ \text{at } 100\text{-y, } 24 \text{ Hr storm} & \end{aligned}$$

### 2. Northeasterly Drain System: Need a catchbasin

Total Impervious Area = 1800  $\text{ft}^2$ , Walk & Pavement



**Dr. Edward T.T. Chiang, P.E.**  
Civil Consulting Engineer  
781-454-5615

Job: Lot 14B, Staniford St., Newton, MA

Sheet No: 7 of \_\_\_\_\_

Calculated By: T.T.C. Date: 2/8/23

Checked By: \_\_\_\_\_ Date: \_\_\_\_\_

Scale: \_\_\_\_\_

Runoff Volume  $V_R = 0.9 \times 1800 \times \frac{4.6}{12} \times 0.5$   
at 0.5 Hr, 100-year storm  
 $= 310.5 \text{ ft}^3$

No. of Galley Needed  $= \frac{310.5}{174.6} = 1.78$  Use 2 galley

### 3. Southeasterly Drain System

Total Impervious Area = 1000  $\text{ft}^2$ , Walkway & Driveway

Runoff Volume  $V_R = 0.9 \times 1000 \times \frac{4.6}{12} \times 0.5$   
at 0.5 Hr, 100 year storm  
 $= 172.5 \text{ ft}^3 < 174.6 \text{ ft}^3$

Use one galley. This system also require a drain catchbasin with 4' deep sump and gas/oil seperator.

The system shall locate at the driveway near the common driveway.

### D. Control Facilities Arrangement

Please refer to Plan of Land.

1. Use two catchbasins, one for Northeasterly System, one for southeasterly System.

2 All PVC pipe under paved area shall be Sch. 40.



Dr. Edward T.T. Chiang, P.E.  
Civil Consulting Engineer  
781-454-5615

Job: Lot 14B (#19) Stamford St., Newton, MA  
Sheet No: 8 of \_\_\_\_\_  
Calculated By: T.T.C. Date: 1/20/22  
Checked By: \_\_\_\_\_ Date: Revised 2/8/23  
Scale: \_\_\_\_\_

3. All downspouts shall have an overflow Y-sec  
in case of strange storm, or suddenly  
weather changes.

E. Runoff Reduction Due to Development

The controlled impervious area was wooded  
or landscaping area. After control the  
100-year storm, its runoff is reduced.

Runoff Volume Reduced at 24 hour, 100-year

$$\text{storm, } V_R = 0.3 \times 4792 \times \frac{0.37}{12} \times 24 \\ = 1063.8 \text{ ft}^3$$

