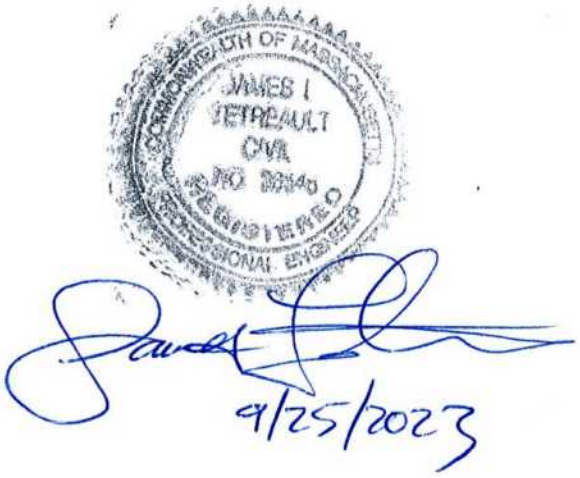
# DRAINAGE REPORT

# 49 UPLAND STREET
# WORCESTER, MA

Job #348-522 Client #522

SEPTEMBER 25, 2023

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## INTRODUCTION

The purpose of this Drainage Report is to confirm that the peak rate of runoff from the proposed apartment development at 49 and 39 Upland Street will not increase in any of the 2, 10, 25 or 100 year return frequency storm events.

This property is previously undeveloped with wooded cover. According to the web soil survey, attached at the end of this report, all soils on site are Paxton series soils categorized as hydrologic soil group C soils with the exception of the most southerly corner of the property which lies over Scarboro series soils categorized as hydrologic soil group D soils.

Stormwater runoff from this site drains to three abutting properties. Most drains to the adjacent apartment development to the south and southwest of this site. Some drains to the abutter Marotta and some to the abutter Bruneau. We will decrease the peak rate of flow to the latter two properties simply by decreasing that area that will drain to them. We will decrease the flow to the abutting existing apartment development by capturing stormwater runoff and then directing it through a CDS stormwater filtration unit and into an infiltration structure with a footprint measuring 60'x180' and with a depth of 8 feet. Inside that large stone envelope, there will be 154 Retain-It precast concrete chambers measuring 8'x8' and 5' high.

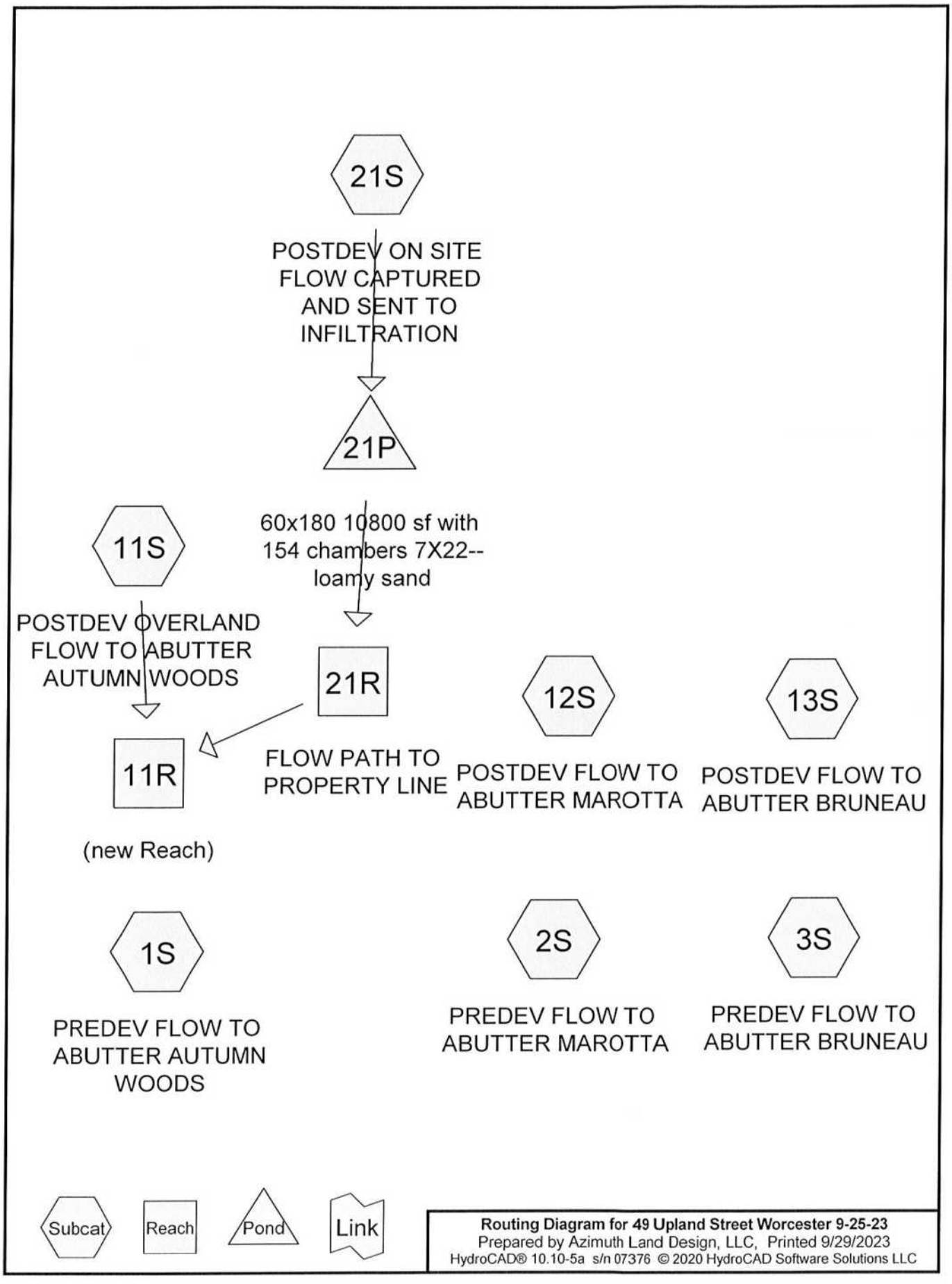
We excavated 3 deep observation holes on site to determine soil textures and depths to seasonal high groundwater for use in designing that infiltration structure. At deep observation holes #'s 2 and 3 in the area of that structure, we observed loamy sand texture soils with mottling indicating seasonal high groundwater (SHGW) at 60 inches and 90 inches respectively.

Calculations were made using the HydroCAD stormwater modeling program. This program calculates hydrographs using a method very similar to that outlined in the Soil Conservation Service Technical Release Number 20 (TR-20). HydroCAD uses the TR-20 "curve number" evaluations of ground cover and the same times of concentration. The 2, 10, 25 and 100 year storm rainfall amounts were taken from the Cornell web site and were 3.26, 4.92, 6.22 and 8.88 inches, respectively.

The following table compares the peak pre and post rates of flows of stormwater at the design points:

DESIGN POINT

| | PEAK FLOW RATE (in cfs) | | | |
|---|---|---|---|---|
| | 2 yr storm | 10 yr storm | 25 yr storm | 100 yr storm |
| Abutter Autumn Woods property line to the south | | | | |
| Subcat #1 pre | 7.66 pre | 18.02 pre | 27.06 pre | 46.62 pre |
| Reach #11 post | 2.81 | 8.38 | 17.43 | 38.77 |
| Abutter Marotta property Line to the southeast | | | | |
| Subcat #2 pre | 0.26 pre | 0.62 pre | 0.94 pre | 1.63 pre |
| Subcat #12 post | 0.16 | 0.36 | 0.54 | 0.91 |
| Abutter Bruneau property Line to the east | | | | |
| Subcat #3 pre | 0.25 pre | 0.44 pre | 0.59 pre | 0.89 pre |
| Subcat #13 post | 0.06 | 0.10 | 0.14 | 0.22 |


21S
POSTDEV ON SITE FLOW CAPTURED AND SENT TO INFILTRATION
21P
60x180 10800 sf with 154 chambers 7X22-- loamy sand
11S
POSTDEV OVERLAND FLOW TO ABUTTER AUTUMN WOODS
21R
11R
(new Reach)
FLOW PATH TO PROPERTY LINE
12S
POSTDEV FLOW TO ABUTTER MAROTTA
13S
POSTDEV FLOW TO ABUTTER BRUNEAU
1S
PREDEV FLOW TO ABUTTER AUTUMN WOODS
2S
PREDEV FLOW TO ABUTTER MAROTTA
3S
PREDEV FLOW TO ABUTTER BRUNEAU
Subcat
Reach
Pond
Link
Routing Diagram for 49 Upland Street Worcester 9-25-23
Prepared by Azimuth Land Design, LLC, Printed 9/29/2023
HydroCAD® 10.10-5a s/n 07376 © 2020 HydroCAD Software Solutions LLC

2 YEAR STORM

## Summary for Subcatchment 1S: PREDEV FLOW TO ABUTTER AUTUMN WOODS

Runoff = 7.66 cfs @ 12.15 hrs, Volume= 0.613 af, Depth> 0.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.26"

| Area (sf) | CN | Description |
|---|---|---|
| 10,000 | 98 | Paved parking, HSG C |
| 18,570 | 74 | >75% Grass cover, Good, HSG C |
| 59,395 | 74 | >75% Grass cover, Good, HSG C |
| 273,165 | 70 | Woods, Good, HSG C |
| 4,456 | 77 | Woods, Good, HSG D |
| 365,586 | 72 | Weighted Average |
| 355,586 | | 97.26% Pervious Area |
| 10,000 | | 2.74% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.9 | 585 | 0.1100 | 1.66 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 9.8 | 729 | Total | | | |

## Summary for Subcatchment 2S: PREDEV FLOW TO ABUTTER MAROTTA

Runoff = 0.26 cfs @ 12.11 hrs, Volume= 0.018 af, Depth> 0.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.26"

| Area (sf) | CN | Description |
|---|---|---|
| 1,653 | 74 | >75% Grass cover, Good, HSG C |
| 9,988 | 70 | Woods, Good, HSG C |
| 11,641 | 71 | Weighted Average |
| 11,641 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.1000 | 0.19 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 2.0 | 180 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.3 | 230 | Total | | | |

## Summary for Subcatchment 3S: PREDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.25 cfs @ 12.05 hrs, Volume= 0.015 af, Depth> 1.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.26"

| Area (sf) | CN | Description |
|---|---|---|
| 1,918 | 74 | >75% Grass cover, Good, HSG C |
| 2,457 | 98 | Paved parking, HSG C |
| 4,375 | 87 | Weighted Average |
| 1,918 | | 43.84% Pervious Area |
| 2,457 | | 56.16% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.6 | 31 | 0.1300 | 0.20 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.1 | 56 | 0.1400 | 7.60 | | **Shallow Concentrated Flow,** Paved Kv= 20.3 fps |
| 2.7 | 87 | Total | | | |

## Summary for Subcatchment 11S: POSTDEV OVERLAND FLOW TO ABUTTER AUTUMN WOODS

Runoff = 1.63 cfs @ 12.11 hrs, Volume= 0.115 af, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.26"

| Area (sf) | CN | Description |
|---|---|---|
| 4,456 | 77 | Woods, Good, HSG D |
| 45,936 | 74 | >75% Grass cover, Good, HSG C |
| 14,454 | 70 | Woods, Good, HSG C |
| 64,846 | 73 | Weighted Average |
| 64,846 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.5 | 302 | 0.0530 | 3.45 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.4 | 96 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.5 | 448 | Total | | | |

## Summary for Subcatchment 12S: POSTDEV FLOW TO ABUTTER MAROTTA

Runoff = 0.16 cfs @ 12.10 hrs, Volume= 0.011 af, Depth> 0.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.26"

| Area (sf) | CN | Description |
|---|---|---|
| 2,187 | 70 | Woods, Good, HSG C |
| 3,988 | 74 | >75% Grass cover, Good, HSG C |
| 6,175 | 73 | Weighted Average |
| 6,175 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.6 | 50 | 0.0850 | 0.18 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.2 | 110 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 5.8 | 160 | Total | | | |

## Summary for Subcatchment 13S: POSTDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.06 cfs @ 12.08 hrs, Volume= 0.004 af, Depth> 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.26"

| Area (sf) | CN | Description |
|---|---|---|
| 717 | 74 | >75% Grass cover, Good, HSG C |
| 480 | 98 | Paved parking, HSG C |
| 1,197 | 84 | Weighted Average |
| 717 | | 59.90% Pervious Area |
| 480 | | 40.10% Impervious Area |

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

## Summary for Subcatchment 21S: POSTDEV ON SITE FLOW CAPTURED AND SENT TO INFILTRATION

Runoff = 15.59 cfs @ 12.08 hrs, Volume= 1.044 af, Depth> 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.26"

| Area (sf) | CN | Description |
|---|---|---|
| 28,031 | 70 | Woods, Good, HSG C |
| 10,000 | 98 | Roofs, HSG C |
| 42,472 | 98 | Unconnected roofs, HSG C |
| 105,178 | 98 | Paved parking, HSG C |
| 7,134 | 74 | >75% Grass cover, Good, HSG C |
| 116,569 | 74 | >75% Grass cover, Good, HSG C |
| 309,384 | 86 | Weighted Average |
| 151,734 | | 49.04% Pervious Area |
| 157,650 | | 50.96% Impervious Area |
| 42,472 | | 26.94% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.5 | 187 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.4 | 331 | Total | | | |

## Summary for Reach 11R: (new Reach)

Inflow Area = 8.591 ac, 42.13% Impervious, Inflow Depth > 0.56" for 2 YEAR event
Inflow = 2.81 cfs @ 12.50 hrs, Volume= 0.400 af
Outflow = 2.81 cfs @ 12.50 hrs, Volume= 0.400 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

## Summary for Reach 21R: FLOW PATH TO PROPERTY LINE

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth = 0.48" for 2 YEAR event
Inflow = 2.37 cfs @ 12.54 hrs, Volume= 0.285 af
Outflow = 2.37 cfs @ 12.56 hrs, Volume= 0.285 af, Atten= 0%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.05 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.11 fps, Avg. Travel Time= 0.9 min

Peak Storage= 73 cf @ 12.55 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 13.88'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 228.16 cfs

10.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 20.0 '/' Top Width= 50.00'
Length= 63.0' Slope= 0.0635 '/'
Inlet Invert= 448.00', Outlet Invert= 444.00'

‡

## Summary for Pond 21P: 60x180 10800 sf with 154 chambers 7X22-- loamy sand

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth > 1.76" for 2 YEAR event
Inflow = 15.59 cfs @ 12.08 hrs, Volume= 1.044 af
Outflow = 2.97 cfs @ 12.54 hrs, Volume= 0.789 af, Atten= 81%, Lag= 27.5 min
Discarded = 0.60 cfs @ 11.05 hrs, Volume= 0.504 af
Primary = 2.37 cfs @ 12.54 hrs, Volume= 0.285 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 458.38' @ 12.54 hrs Surf.Area= 10,800 sf Storage= 19,479 cf

Plug-Flow detention time= 136.5 min calculated for 0.786 af (75% of inflow)
Center-of-Mass det. time= 77.2 min ( 863.7 - 786.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 456.00' | 12,220 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc)<br>86,400 cf Overall - 55,851 cf Embedded = 30,549 cf x 40.0% Voids |
| #2 | 456.50' | 44,255 cf | **retain_it retain_it 5.0'** x 154 Inside #1<br>Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf<br>Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf<br>7 Rows adjusted for 602.6 cf perimeter wall |
| | | 56,474 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 456.00 | 10,800 | 0 | 0 |
| 464.00 | 10,800 | 86,400 | 86,400 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 456.00' | **2.410 in/hr Exfiltration over Surface area** |
| #2 | Primary | 457.75' | **10.0" Round Culvert X 2.00** L= 70.0' Ke= 0.500<br>Inlet / Outlet Invert= 457.75' / 450.00' S= 0.1107 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.55 sf |
| #3 | Primary | 459.75' | **15.0" Round Culvert X 2.00** L= 50.0' Ke= 0.500<br>Inlet / Outlet Invert= 459.75' / 450.00' S= 0.1950 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Discarded OutFlow** Max=0.60 cfs @ 11.05 hrs HW=456.08' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

**Primary OutFlow** Max=2.37 cfs @ 12.54 hrs HW=458.38' (Free Discharge)
├**2=Culvert** (Inlet Controls 2.37 cfs @ 2.69 fps)
└**3=Culvert** ( Controls 0.00 cfs)

10 YEAR STORM

## Summary for Subcatchment 1S: PREDEV FLOW TO ABUTTER AUTUMN WOODS

Runoff = 18.02 cfs @ 12.15 hrs, Volume= 1.378 af, Depth> 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YEAR Rainfall=4.92"

| Area (sf) | CN | Description |
|---|---|---|
| 10,000 | 98 | Paved parking, HSG C |
| 18,570 | 74 | >75% Grass cover, Good, HSG C |
| 59,395 | 74 | >75% Grass cover, Good, HSG C |
| 273,165 | 70 | Woods, Good, HSG C |
| 4,456 | 77 | Woods, Good, HSG D |
| 365,586 | 72 | Weighted Average |
| 355,586 | | 97.26% Pervious Area |
| 10,000 | | 2.74% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.9 | 585 | 0.1100 | 1.66 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 9.8 | 729 | Total | | | |

## Summary for Subcatchment 2S: PREDEV FLOW TO ABUTTER MAROTTA

Runoff = 0.62 cfs @ 12.10 hrs, Volume= 0.042 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YEAR Rainfall=4.92"

| Area (sf) | CN | Description |
|---|---|---|
| 1,653 | 74 | >75% Grass cover, Good, HSG C |
| 9,988 | 70 | Woods, Good, HSG C |
| 11,641 | 71 | Weighted Average |
| 11,641 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.1000 | 0.19 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 2.0 | 180 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.3 | 230 | Total | | | |

## Summary for Subcatchment 3S: PREDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.44 cfs @ 12.05 hrs, Volume= 0.028 af, Depth> 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YEAR Rainfall=4.92"

| Area (sf) | CN | Description |
|---|---|---|
| 1,918 | 74 | >75% Grass cover, Good, HSG C |
| 2,457 | 98 | Paved parking, HSG C |
| 4,375 | 87 | Weighted Average |
| 1,918 | | 43.84% Pervious Area |
| 2,457 | | 56.16% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.6 | 31 | 0.1300 | 0.20 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.1 | 56 | 0.1400 | 7.60 | | **Shallow Concentrated Flow,** Paved Kv= 20.3 fps |
| 2.7 | 87 | Total | | | |

## Summary for Subcatchment 11S: POSTDEV OVERLAND FLOW TO ABUTTER AUTUMN WOODS

Runoff = 3.72 cfs @ 12.10 hrs, Volume= 0.254 af, Depth> 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YEAR Rainfall=4.92"

| Area (sf) | CN | Description |
|---|---|---|
| 4,456 | 77 | Woods, Good, HSG D |
| 45,936 | 74 | >75% Grass cover, Good, HSG C |
| 14,454 | 70 | Woods, Good, HSG C |
| 64,846 | 73 | Weighted Average |
| 64,846 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.5 | 302 | 0.0530 | 3.45 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.4 | 96 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.5 | 448 | Total | | | |

## Summary for Subcatchment 12S: POSTDEV FLOW TO ABUTTER MAROTTA

Runoff = 0.36 cfs @ 12.09 hrs, Volume= 0.024 af, Depth> 2.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YEAR Rainfall=4.92"

| Area (sf) | CN | Description |
|---|---|---|
| 2,187 | 70 | Woods, Good, HSG C |
| 3,988 | 74 | >75% Grass cover, Good, HSG C |
| 6,175 | 73 | Weighted Average |
| 6,175 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.6 | 50 | 0.0850 | 0.18 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.2 | 110 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 5.8 | 160 | Total | | | |

## Summary for Subcatchment 13S: POSTDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.10 cfs @ 12.07 hrs, Volume= 0.007 af, Depth> 3.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YEAR Rainfall=4.92"

| Area (sf) | CN | Description |
|---|---|---|
| 717 | 74 | >75% Grass cover, Good, HSG C |
| 480 | 98 | Paved parking, HSG C |
| 1,197 | 84 | Weighted Average |
| 717 | | 59.90% Pervious Area |
| 480 | | 40.10% Impervious Area |

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

## Summary for Subcatchment 21S: POSTDEV ON SITE FLOW CAPTURED AND SENT TO INFILTRATION

Runoff = 27.62 cfs @ 12.08 hrs, Volume= 1.889 af, Depth> 3.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 YEAR Rainfall=4.92"

| Area (sf) | CN | Description |
|---|---|---|
| 28,031 | 70 | Woods, Good, HSG C |
| 10,000 | 98 | Roofs, HSG C |
| 42,472 | 98 | Unconnected roofs, HSG C |
| 105,178 | 98 | Paved parking, HSG C |
| 7,134 | 74 | >75% Grass cover, Good, HSG C |
| 116,569 | 74 | >75% Grass cover, Good, HSG C |
| 309,384 | 86 | Weighted Average |
| 151,734 | | 49.04% Pervious Area |
| 157,650 | | 50.96% Impervious Area |
| 42,472 | | 26.94% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.5 | 187 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.4 | 331 | Total | | | |

## Summary for Reach 11R: (new Reach)

Inflow Area = 8.591 ac, 42.13% Impervious, Inflow Depth > 1.75" for 10 YEAR event
Inflow = 8.38 cfs @ 12.15 hrs, Volume= 1.253 af
Outflow = 8.38 cfs @ 12.15 hrs, Volume= 1.253 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

## Summary for Reach 21R: FLOW PATH TO PROPERTY LINE

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth = 1.69" for 10 YEAR event
Inflow = 6.79 cfs @ 12.45 hrs, Volume= 0.998 af
Outflow = 6.79 cfs @ 12.46 hrs, Volume= 0.998 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.87 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 0.8 min

Peak Storage= 149 cf @ 12.45 hrs
Average Depth at Peak Storage= 0.18' , Surface Width= 17.00'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 228.16 cfs

10.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 20.0 '/' Top Width= 50.00'
Length= 63.0' Slope= 0.0635 '/'
Inlet Invert= 448.00', Outlet Invert= 444.00'

‡

## Summary for Pond 21P: 60x180 10800 sf with 154 chambers 7X22-- loamy sand

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth > 3.19" for 10 YEAR event
Inflow = 27.62 cfs @ 12.08 hrs, Volume= 1.889 af
Outflow = 7.40 cfs @ 12.45 hrs, Volume= 1.578 af, Atten= 73%, Lag= 21.9 min
Discarded = 0.60 cfs @ 9.70 hrs, Volume= 0.580 af
Primary = 6.79 cfs @ 12.45 hrs, Volume= 0.998 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 459.81' @ 12.45 hrs Surf.Area= 10,800 sf Storage= 32,737 cf

Plug-Flow detention time= 94.9 min calculated for 1.573 af (83% of inflow)
Center-of-Mass det. time= 48.7 min ( 821.2 - 772.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 456.00' | 12,220 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc)<br>86,400 cf Overall - 55,851 cf Embedded = 30,549 cf x 40.0% Voids |
| #2 | 456.50' | 44,255 cf | **retain_it retain_it 5.0'** x 154 Inside #1<br>Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf<br>Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf<br>7 Rows adjusted for 602.6 cf perimeter wall |
| | | 56,474 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 456.00 | 10,800 | 0 | 0 |
| 464.00 | 10,800 | 86,400 | 86,400 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 456.00' | **2.410 in/hr Exfiltration over Surface area** |
| #2 | Primary | 457.75' | **10.0" Round Culvert X 2.00** L= 70.0' Ke= 0.500<br>Inlet / Outlet Invert= 457.75' / 450.00' S= 0.1107 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.55 sf |
| #3 | Primary | 459.75' | **15.0" Round Culvert X 2.00** L= 50.0' Ke= 0.500<br>Inlet / Outlet Invert= 459.75' / 450.00' S= 0.1950 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Discarded OutFlow** Max=0.60 cfs @ 9.70 hrs HW=456.08' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

**Primary OutFlow** Max=6.78 cfs @ 12.45 hrs HW=459.81' (Free Discharge)
├**2=Culvert** (Inlet Controls 6.74 cfs @ 6.18 fps)
└**3=Culvert** (Inlet Controls 0.04 cfs @ 0.85 fps)

25 YEAR STORM

## Summary for Subcatchment 1S: PREDEV FLOW TO ABUTTER AUTUMN WOODS

Runoff = 27.06 cfs @ 12.14 hrs, Volume= 2.060 af, Depth> 2.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YEAR Rainfall=6.22"

| Area (sf) | CN | Description |
|---|---|---|
| 10,000 | 98 | Paved parking, HSG C |
| 18,570 | 74 | >75% Grass cover, Good, HSG C |
| 59,395 | 74 | >75% Grass cover, Good, HSG C |
| 273,165 | 70 | Woods, Good, HSG C |
| 4,456 | 77 | Woods, Good, HSG D |
| 365,586 | 72 | Weighted Average |
| 355,586 | | 97.26% Pervious Area |
| 10,000 | | 2.74% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.9 | 585 | 0.1100 | 1.66 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 9.8 | 729 | Total | | | |

## Summary for Subcatchment 2S: PREDEV FLOW TO ABUTTER MAROTTA

Runoff = 0.94 cfs @ 12.10 hrs, Volume= 0.064 af, Depth> 2.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YEAR Rainfall=6.22"

| Area (sf) | CN | Description |
|---|---|---|
| 1,653 | 74 | >75% Grass cover, Good, HSG C |
| 9,988 | 70 | Woods, Good, HSG C |
| 11,641 | 71 | Weighted Average |
| 11,641 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.1000 | 0.19 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 2.0 | 180 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.3 | 230 | Total | | | |

## Summary for Subcatchment 3S: PREDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.59 cfs @ 12.04 hrs, Volume= 0.037 af, Depth> 4.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YEAR Rainfall=6.22"

| Area (sf) | CN | Description |
|---|---|---|
| 1,918 | 74 | >75% Grass cover, Good, HSG C |
| 2,457 | 98 | Paved parking, HSG C |
| 4,375 | 87 | Weighted Average |
| 1,918 | | 43.84% Pervious Area |
| 2,457 | | 56.16% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.6 | 31 | 0.1300 | 0.20 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.1 | 56 | 0.1400 | 7.60 | | **Shallow Concentrated Flow,** Paved Kv= 20.3 fps |
| 2.7 | 87 | Total | | | |

## Summary for Subcatchment 11S: POSTDEV OVERLAND FLOW TO ABUTTER AUTUMN WOODS

Runoff = 5.53 cfs @ 12.10 hrs, Volume= 0.378 af, Depth> 3.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YEAR Rainfall=6.22"

| Area (sf) | CN | Description |
|---|---|---|
| 4,456 | 77 | Woods, Good, HSG D |
| 45,936 | 74 | >75% Grass cover, Good, HSG C |
| 14,454 | 70 | Woods, Good, HSG C |
| 64,846 | 73 | Weighted Average |
| 64,846 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.5 | 302 | 0.0530 | 3.45 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.4 | 96 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.5 | 448 | Total | | | |

## Summary for Subcatchment 12S: POSTDEV FLOW TO ABUTTER MAROTTA

Runoff = 0.54 cfs @ 12.09 hrs, Volume= 0.036 af, Depth> 3.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YEAR Rainfall=6.22"

| Area (sf) | CN | Description |
|---|---|---|
| 2,187 | 70 | Woods, Good, HSG C |
| 3,988 | 74 | >75% Grass cover, Good, HSG C |
| 6,175 | 73 | Weighted Average |
| 6,175 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.6 | 50 | 0.0850 | 0.18 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.2 | 110 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 5.8 | 160 | Total | | | |

## Summary for Subcatchment 13S: POSTDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.14 cfs @ 12.07 hrs, Volume= 0.009 af, Depth> 4.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YEAR Rainfall=6.22"

| Area (sf) | CN | Description |
|---|---|---|
| 717 | 74 | >75% Grass cover, Good, HSG C |
| 480 | 98 | Paved parking, HSG C |
| 1,197 | 84 | Weighted Average |
| 717 | | 59.90% Pervious Area |
| 480 | | 40.10% Impervious Area |

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

## Summary for Subcatchment 21S: POSTDEV ON SITE FLOW CAPTURED AND SENT TO INFILTRATION

Runoff = 37.10 cfs @ 12.08 hrs, Volume= 2.580 af, Depth> 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 YEAR Rainfall=6.22"

| Area (sf) | CN | Description |
|---|---|---|
| 28,031 | 70 | Woods, Good, HSG C |
| 10,000 | 98 | Roofs, HSG C |
| 42,472 | 98 | Unconnected roofs, HSG C |
| 105,178 | 98 | Paved parking, HSG C |
| 7,134 | 74 | >75% Grass cover, Good, HSG C |
| 116,569 | 74 | >75% Grass cover, Good, HSG C |
| 309,384 | 86 | Weighted Average |
| 151,734 | | 49.04% Pervious Area |
| 157,650 | | 50.96% Impervious Area |
| 42,472 | | 26.94% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.5 | 187 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.4 | 331 | Total | | | |

## Summary for Reach 11R: (new Reach)

Inflow Area = 8.591 ac, 42.13% Impervious, Inflow Depth > 2.79" for 25 YEAR event
Inflow = 17.43 cfs @ 12.28 hrs, Volume= 2.001 af
Outflow = 17.43 cfs @ 12.28 hrs, Volume= 2.001 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

## Summary for Reach 21R: FLOW PATH TO PROPERTY LINE

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth > 2.74" for 25 YEAR event
Inflow = 14.75 cfs @ 12.29 hrs, Volume= 1.623 af
Outflow = 14.77 cfs @ 12.30 hrs, Volume= 1.623 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.63 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.63 fps, Avg. Travel Time= 0.6 min

Peak Storage= 257 cf @ 12.30 hrs
Average Depth at Peak Storage= 0.27' , Surface Width= 20.65'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 228.16 cfs

10.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 20.0 '/' Top Width= 50.00'
Length= 63.0' Slope= 0.0635 '/'
Inlet Invert= 448.00', Outlet Invert= 444.00'

‡

## Summary for Pond 21P: 60x180 10800 sf with 154 chambers 7X22-- loamy sand

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth > 4.36" for 25 YEAR event
Inflow = 37.10 cfs @ 12.08 hrs, Volume= 2.580 af
Outflow = 15.35 cfs @ 12.29 hrs, Volume= 2.248 af, Atten= 59%, Lag= 12.9 min
Discarded = 0.60 cfs @ 8.85 hrs, Volume= 0.625 af
Primary = 14.75 cfs @ 12.29 hrs, Volume= 1.623 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 460.68' @ 12.29 hrs Surf.Area= 10,800 sf Storage= 40,731 cf

Plug-Flow detention time= 82.9 min calculated for 2.248 af (87% of inflow)
Center-of-Mass det. time= 43.1 min ( 808.1 - 765.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 456.00' | 12,220 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc)<br>86,400 cf Overall - 55,851 cf Embedded = 30,549 cf x 40.0% Voids |
| #2 | 456.50' | 44,255 cf | **retain_it retain_it 5.0'** x 154 Inside #1<br>Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf<br>Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf<br>7 Rows adjusted for 602.6 cf perimeter wall |
| | | 56,474 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 456.00 | 10,800 | 0 | 0 |
| 464.00 | 10,800 | 86,400 | 86,400 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 456.00' | **2.410 in/hr Exfiltration over Surface area** |
| #2 | Primary | 457.75' | **10.0" Round Culvert X 2.00** L= 70.0' Ke= 0.500<br>Inlet / Outlet Invert= 457.75' / 450.00' S= 0.1107 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.55 sf |
| #3 | Primary | 459.75' | **15.0" Round Culvert X 2.00** L= 50.0' Ke= 0.500<br>Inlet / Outlet Invert= 459.75' / 450.00' S= 0.1950 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Discarded OutFlow** Max=0.60 cfs @ 8.85 hrs HW=456.08' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

**Primary OutFlow** Max=14.73 cfs @ 12.29 hrs HW=460.68' (Free Discharge)
├**2=Culvert** (Inlet Controls 8.32 cfs @ 7.63 fps)
└**3=Culvert** (Inlet Controls 6.41 cfs @ 3.28 fps)

100 YEAR STORM

## Summary for Subcatchment 1S: PREDEV FLOW TO ABUTTER AUTUMN WOODS

Runoff = 46.62 cfs @ 12.14 hrs, Volume= 3.582 af, Depth> 5.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YEAR Rainfall=8.88"

| Area (sf) | CN | Description |
|---|---|---|
| 10,000 | 98 | Paved parking, HSG C |
| 18,570 | 74 | >75% Grass cover, Good, HSG C |
| 59,395 | 74 | >75% Grass cover, Good, HSG C |
| 273,165 | 70 | Woods, Good, HSG C |
| 4,456 | 77 | Woods, Good, HSG D |
| 365,586 | 72 | Weighted Average |
| 355,586 | | 97.26% Pervious Area |
| 10,000 | | 2.74% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.9 | 585 | 0.1100 | 1.66 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 9.8 | 729 | Total | | | |

## Summary for Subcatchment 2S: PREDEV FLOW TO ABUTTER MAROTTA

Runoff = 1.63 cfs @ 12.10 hrs, Volume= 0.112 af, Depth> 5.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YEAR Rainfall=8.88"

| Area (sf) | CN | Description |
|---|---|---|
| 1,653 | 74 | >75% Grass cover, Good, HSG C |
| 9,988 | 70 | Woods, Good, HSG C |
| 11,641 | 71 | Weighted Average |
| 11,641 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.3 | 50 | 0.1000 | 0.19 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 2.0 | 180 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.3 | 230 | Total | | | |

## Summary for Subcatchment 3S: PREDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.89 cfs @ 12.04 hrs, Volume= 0.058 af, Depth> 6.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YEAR Rainfall=8.88"

| Area (sf) | CN | Description |
|---|---|---|
| 1,918 | 74 | >75% Grass cover, Good, HSG C |
| 2,457 | 98 | Paved parking, HSG C |
| 4,375 | 87 | Weighted Average |
| 1,918 | | 43.84% Pervious Area |
| 2,457 | | 56.16% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.6 | 31 | 0.1300 | 0.20 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.1 | 56 | 0.1400 | 7.60 | | **Shallow Concentrated Flow,** Paved Kv= 20.3 fps |
| 2.7 | 87 | Total | | | |

## Summary for Subcatchment 11S: POSTDEV OVERLAND FLOW TO ABUTTER AUTUMN WOODS

Runoff = 9.41 cfs @ 12.10 hrs, Volume= 0.651 af, Depth> 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YEAR Rainfall=8.88"

| Area (sf) | CN | Description |
|---|---|---|
| 4,456 | 77 | Woods, Good, HSG D |
| 45,936 | 74 | >75% Grass cover, Good, HSG C |
| 14,454 | 70 | Woods, Good, HSG C |
| 64,846 | 73 | Weighted Average |
| 64,846 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.5 | 302 | 0.0530 | 3.45 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.4 | 96 | 0.0500 | 1.12 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 6.5 | 448 | Total | | | |

## Summary for Subcatchment 12S: POSTDEV FLOW TO ABUTTER MAROTTA

Runoff = 0.91 cfs @ 12.09 hrs, Volume= 0.062 af, Depth> 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YEAR Rainfall=8.88"

| Area (sf) | CN | Description |
|---|---|---|
| 2,187 | 70 | Woods, Good, HSG C |
| 3,988 | 74 | >75% Grass cover, Good, HSG C |
| 6,175 | 73 | Weighted Average |
| 6,175 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.6 | 50 | 0.0850 | 0.18 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 1.2 | 110 | 0.0900 | 1.50 | | **Shallow Concentrated Flow,** Woodland Kv= 5.0 fps |
| 5.8 | 160 | Total | | | |

## Summary for Subcatchment 13S: POSTDEV FLOW TO ABUTTER BRUNEAU

Runoff = 0.22 cfs @ 12.07 hrs, Volume= 0.015 af, Depth> 6.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YEAR Rainfall=8.88"

| Area (sf) | CN | Description |
|---|---|---|
| 717 | 74 | >75% Grass cover, Good, HSG C |
| 480 | 98 | Paved parking, HSG C |
| 1,197 | 84 | Weighted Average |
| 717 | | 59.90% Pervious Area |
| 480 | | 40.10% Impervious Area |

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

## Summary for Subcatchment 21S: POSTDEV ON SITE FLOW CAPTURED AND SENT TO INFILTRATION

Runoff = 56.39 cfs @ 12.08 hrs, Volume= 4.021 af, Depth> 6.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 YEAR Rainfall=8.88"

| Area (sf) | CN | Description |
|---|---|---|
| 28,031 | 70 | Woods, Good, HSG C |
| 10,000 | 98 | Roofs, HSG C |
| 42,472 | 98 | Unconnected roofs, HSG C |
| 105,178 | 98 | Paved parking, HSG C |
| 7,134 | 74 | >75% Grass cover, Good, HSG C |
| 116,569 | 74 | >75% Grass cover, Good, HSG C |
| 309,384 | 86 | Weighted Average |
| 151,734 | | 49.04% Pervious Area |
| 157,650 | | 50.96% Impervious Area |
| 42,472 | | 26.94% Unconnected |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 3.6 | 50 | 0.1600 | 0.23 | | **Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22" |
| 0.3 | 94 | 0.1200 | 5.20 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 1.5 | 187 | 0.0200 | 2.12 | | **Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps |
| 5.4 | 331 | Total | | | |

## Summary for Reach 11R: (new Reach)

Inflow Area = 8.591 ac, 42.13% Impervious, Inflow Depth > 5.06" for 100 YEAR event
Inflow = 38.77 cfs @ 12.16 hrs, Volume= 3.624 af
Outflow = 38.77 cfs @ 12.16 hrs, Volume= 3.624 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

## Summary for Reach 21R: FLOW PATH TO PROPERTY LINE

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth > 5.03" for 100 YEAR event
Inflow = 31.82 cfs @ 12.20 hrs, Volume= 2.974 af
Outflow = 31.68 cfs @ 12.21 hrs, Volume= 2.974 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.50 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.97 fps, Avg. Travel Time= 0.5 min

Peak Storage= 443 cf @ 12.20 hrs
Average Depth at Peak Storage= 0.39' , Surface Width= 25.75'
Bank-Full Depth= 1.00' Flow Area= 30.0 sf, Capacity= 228.16 cfs

10.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 20.0 '/' Top Width= 50.00'
Length= 63.0' Slope= 0.0635 '/'
Inlet Invert= 448.00', Outlet Invert= 444.00'

‡

## Summary for Pond 21P: 60x180 10800 sf with 154 chambers 7X22-- loamy sand

Inflow Area = 7.102 ac, 50.96% Impervious, Inflow Depth > 6.79" for 100 YEAR event
Inflow = 56.39 cfs @ 12.08 hrs, Volume= 4.021 af
Outflow = 32.42 cfs @ 12.20 hrs, Volume= 3.666 af, Atten= 43%, Lag= 7.3 min
Discarded = 0.60 cfs @ 7.50 hrs, Volume= 0.691 af
Primary = 31.82 cfs @ 12.20 hrs, Volume= 2.974 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 463.24' @ 12.20 hrs Surf.Area= 10,800 sf Storage= 53,177 cf

Plug-Flow detention time= 68.9 min calculated for 3.665 af (91% of inflow)
Center-of-Mass det. time= 38.4 min ( 793.8 - 755.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 456.00' | 12,220 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc)<br>86,400 cf Overall - 55,851 cf Embedded = 30,549 cf x 40.0% Voids |
| #2 | 456.50' | 44,255 cf | **retain_it retain_it 5.0'** x 154 Inside #1<br>Inside= 84.0"W x 60.0"H => 36.41 sf x 8.00'L = 291.3 cf<br>Outside= 96.0"W x 68.0"H => 45.33 sf x 8.00'L = 362.7 cf<br>7 Rows adjusted for 602.6 cf perimeter wall |
| | | 56,474 cf | Total Available Storage |

| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 456.00 | 10,800 | 0 | 0 |
| 464.00 | 10,800 | 86,400 | 86,400 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 456.00' | **2.410 in/hr Exfiltration over Surface area** |
| #2 | Primary | 457.75' | **10.0" Round Culvert X 2.00** L= 70.0' Ke= 0.500<br>Inlet / Outlet Invert= 457.75' / 450.00' S= 0.1107 '/' Cc= 0.900<br>n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.55 sf |
| #3 | Primary | 459.75' | **15.0" Round Culvert X 2.00** L= 50.0' Ke= 0.500<br>Inlet / Outlet Invert= 459.75' / 450.00' S= 0.1950 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf |

**Discarded OutFlow** Max=0.60 cfs @ 7.50 hrs HW=456.08' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.60 cfs)

**Primary OutFlow** Max=31.81 cfs @ 12.20 hrs HW=463.23' (Free Discharge)
├**2=Culvert** (Inlet Controls 11.82 cfs @ 10.84 fps)
└**3=Culvert** (Inlet Controls 19.98 cfs @ 8.14 fps)

Soil Map—Worcester County, Massachusetts, Northeastern Part; and Worcester County, Massachusetts, Southern Part


Map Scale: 1:4,720 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

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 scales ranging from 1:20,000 to 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: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 16, Sep 3, 2021

Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 14, Sep 3, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

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

Date(s) aerial images were photographed: Jul 26, 2019—Oct 5, 2019

## MAP LEGEND

## MAP INFORMATION

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 |
|---|---|---|---|
| 6A | Scarboro mucky fine sandy loam, 0 to 3 percent slopes | 3.5 | 3.3% |
| 31A | Walpole sandy loam, 0 to 3 percent slopes | 2.9 | 2.7% |
| 71A | Ridgebury fine sandy loam, 0 to 3 percent slopes, extremely stony | 6.2 | 5.8% |
| 102C | Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes | 1.7 | 1.6% |
| 102D | Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes | 0.9 | 0.8% |
| 254A | Merrimac fine sandy loam, 0 to 3 percent slopes | 0.2 | 0.2% |
| 254B | Merrimac fine sandy loam, 3 to 8 percent slopes | 4.2 | 3.9% |
| 305B | Paxton fine sandy loam, 3 to 8 percent slopes | 0.7 | 0.7% |
| 305C | Paxton fine sandy loam, 8 to 15 percent slopes | 23.0 | 21.5% |
| 305D | Paxton fine sandy loam, 15 to 25 percent slopes | 9.5 | 8.8% |
| 306C | Paxton fine sandy loam, 8 to 15 percent slopes, very stony | 7.7 | 7.2% |
| 306D | Paxton fine sandy loam, 15 to 25 percent slopes, very stony | 2.9 | 2.7% |
| 310B | Woodbridge fine sandy loam, 3 to 8 percent slopes | 16.7 | 15.5% |
| **Subtotals for Soil Survey Area** | | **80.1** | **74.7%** |
| **Totals for Area of Interest** | | **107.2** | **100.0%** |

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 71A | Ridgebury fine sandy loam, 0 to 3 percent slopes, extremely stony | 10.5 | 9.8% |
| 305B | Paxton fine sandy loam, 3 to 8 percent slopes | 7.0 | 6.6% |
| 305C | Paxton fine sandy loam, 8 to 15 percent slopes | 6.0 | 5.6% |
| 305D | Paxton fine sandy loam, 15 to 25 percent slopes | 1.2 | 1.1% |

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 310B | Woodbridge fine sandy loam, 3 to 8 percent slopes | 2.3 | 2.2% |
| **Subtotals for Soil Survey Area** | | **27.1** | **25.3%** |
| **Totals for Area of Interest** | | **107.2** | **100.0%** |