STORMWATER MANAGEMENT DESIGN CALCULATIONS

Primrose School

Assessors Map 9 Lots 9, 38, 41, & 42, Rockland, Massachusetts



Prepared for

ADA Architects c/o Melissa Pless 17710 Detroit Road Lakewood, OH 44107

July 2, 2020

Table of Contents

Table of Contents Summary Peak Flow Summary		2 3-4 5-6
Overall Site Analysis	Section I	
Peak Rate Analysis HydroCAD Report		7-87
Stormwater Compliance Standard 1-4 Mounding TSS Stormwater Compliance Checklist Standard 5-10 Operation and Maintenance Plan During Construction Post Construction	Section III	88 89-90 91-95 96-103 104-111 112 113 114-116 117-121
BMP's Deep Sump Catch Basin Oil & Grit Separators Sediment Forebay Subsurface Infiltration		122-125 126-129 130-133 134-137
XGrass Specification		138
NRCS Soils Report Soil Logs by Grady Consulting		139-159 160-167
Site Plan & Tributary Area Plans		Attached

SUMMARY

This analysis was prepared to demonstrate Compliance with the Massachusetts Stormwater Management Regulations and the Town of Rockland Conservation Commission & Planning Board Rules and Regulations for Stormwater Management. The proposed project is for the construction of a Pre-school/Childcare facility.

The property is currently vacant. The site has been previously disturbed. The site was previously designed and approved for a restaurant. The Order of Conditions filed under file Number SE 273-0395. The vegetation in the area of the proposed work primarily consists of grass brush and weeds. The mature woodland is located outside of the proposed work area at the rear of the property within or adjacent to the wetland resource area. Stormwater currently flows from Hingham Street to the wetland resource area without any stormwater controls.





The attenuation of storm water flows has been achieved by routing runoff from the proposed development through BMP's prior to discharge to the wetlands resource (BVW). The Peak Rate attenuation will therefore focus on the discharge to the wetland located to the East side of the property.

The post development runoff is broken up into 6 catchment areas

- **Post 1** Parking lot runoff routed through a deep sump hooded catch basin, Oil & Grit Separator, subsurface infiltration #1 to silt trap erosion control pad to woodland and wetland.
- **Post 2** Playground runoff routed through a Nyoplast drain grates, 2- Structural Sediment Forebays, subsurface infiltration #2 to silt trap erosion control pad to woodland and wetland.
- **Post 3** Overland flow from vegetated area flows to 2- Sediment Forebays an infiltration basin. Emergency overflow above the 100 Year Storm Event is routed through a standpipe to silt trap erosion control pad to woodland and wetland.
- **Post 4** Overland flow from the remaining unimproved land is routed to the woodland and resource area.
- **Post 5** Roof runoff is routed to subsurface infiltration system #1.
- **Post 6** Front Yard overland flow is routed to a deep sump hooded catch basin, Structural Sediment Forebay, subsurface infiltration #1 to silt trap erosion control pad to woodland and wetland.

The design as proposed reduces peak runoff rates, improves and promotes infiltration, improves stormwater quality and treatment including temperature moderation prior to discharge to the downgradient wetland

This analysis is divided into the following sections:

Section I Overall Site Analysis

Section II Compliance with Massachusetts Storm water Management Regulations

Section III Operation And Maintenance Plan

The calculations have been performed for the 2, 10, 25, 100-year 24 hour storm event, using the Autodesk Storm and Sanitary Analysis 2015 extension for AutoCad Civil 3D 2015 computer program. This computer program is based upon the Soils Conservation Service (SCS) TR-20 and TR-55 computer models and uses the SCS Curvilinear Unit rainfall distribution.

SUMMARY OF STORMWATER FLOWS

Outlets	2 YR	10 YR	25 YI	R 1	LOO YR
Pre 1		0	0.01	0.03	0.22
Total		0	0.01	0.03	0.22
Post Catchments					
Outlets	2 YR	10 YR	25 YI	R 1	LOO YR
Post 2		0	0	0	0
Post 3		0	0	0	0
Post 4		0	0	0	0.03
Post 1 + 5 + 6		0	0	0	0.13
Total		0	0	0	0.16

Events for Pond 3P: Galley System #1 (front)

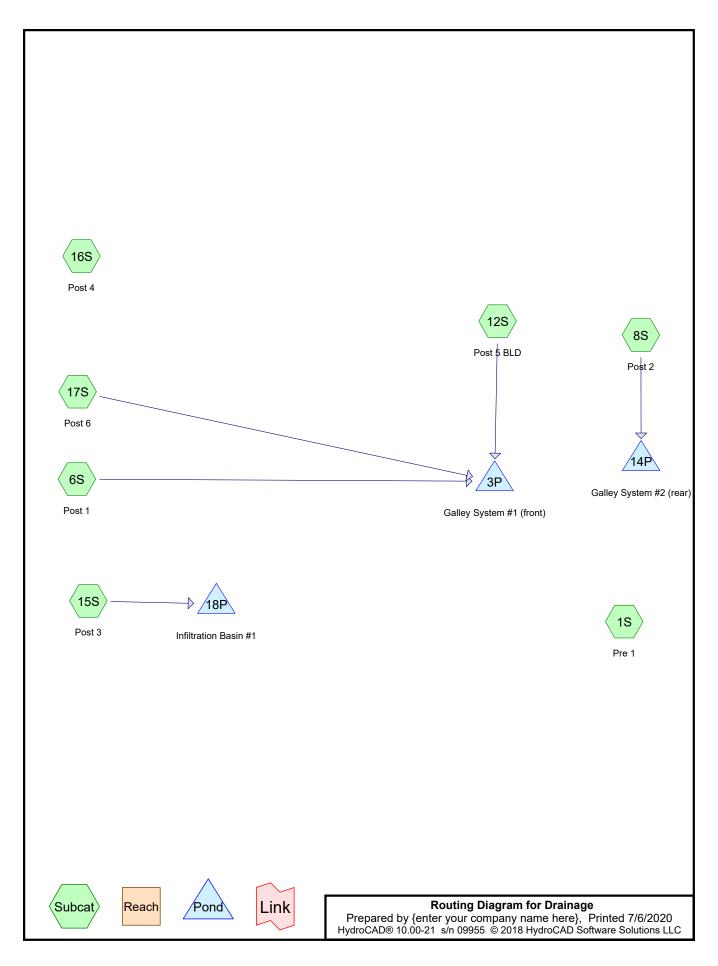
					mary Elev		Storage
(C.	fs) (cf 	(cf	s) (cis	(1ee	t) (cubic- 		
2-Year	2.56	0.20	0.20	0.00	136.49	2,959	
10-Year	3.65	0.21	0.21	0.00	137.34	4,868	
25-Year	4.40	0.22	0.22	0.00	138.03	6,390	
100-Year	5.65	0.37	0.24	0.13	139.26	8,627	,

Events for Pond 14P: Galley System #2 (rear)

			Elevation	
(c:	is) (ci	s) (1ee	et) (cubic-	1eet)
2-Year	0.01	0.01	134.94	1
10-Year	0.07	0.04	135.48	38
25-Year	0.17	0.05	136.52	148
100-Year	0.39	0.08	138.83	392
Events for	r Pond 18	3P: Infil	tration Bas	in #1
Event	Inflow I	Discarde	d Elevation	1 Storage
(c:	fs) (cf	s) (fee	et) (cubic-	feet)
2-Year	0.00	0.00	135.00	2
10-Year	0.00	0.00	135.07	29
25-Year	0.01	0.00	135.16	69
100-Vear	0.06	0.01	135 36	165

		CF	Gal
Oil & Grit sizing	10664 x 400 cf/imp acre	98	732 CB 2
	12963 x 400 cf/imp acre	119	890 CB 1
		217	1623 combined
	Impervious area		Provided
Sediment forebay Post 3	0 x.1inch/imp acre	0 cf	Use 25 cf min
Sediment forebay Post 6	505 x.1inch/imp acre	4.2 cf	50 CF
Sediment forebay Post 2	1860 x.1inch/imp acre	15.5 cf	50 CF

Section I Overall Site Analysis



Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
28,590	39	>75% Grass cover, Good, HSG A (6S, 8S, 15S, 16S, 17S)
56,007	35	Brush, Fair, HSG A (1S)
25,992	98	Paved parking, HSG A (6S, 8S, 17S)
7,012	98	Roofs, HSG A (12S)
38,803	30	Woods, Good, HSG A (1S, 16S)
156,404	48	TOTAL AREA

Soil Listing (all nodes)

Area	Soil	Subcatchment
(sq-ft)	Group	Numbers
156,404	HSG A	1S, 6S, 8S, 12S, 15S, 16S, 17S
0	HSG B	
0	HSG C	
0	HSG D	
0	Other	
156,404		TOTAL AREA

> Sub Nun

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
28,590	0	0	0	0	28,590	>75% Grass
						cover, Good
56,007	0	0	0	0	56,007	Brush, Fair
25,992	0	0	0	0	25,992	Paved parking
7,012	0	0	0	0	7,012	Roofs
38,803	0	0	0	0	38,803	Woods, Good
156.404	0	0	0	0	156.404	TOTAL AREA

Type III 24-hr 2-Year Rainfall=3.40"

Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 5

Time span=1.00-24.00 hrs, dt=0.02 hrs, 1151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre 1 Runoff Area=77,969 sf 0.00% Impervious Runoff Depth=0.00"

Flow Length=265' Tc=17.4 min CN=34 Runoff=0.00 cfs 0 cf

Subcatchment6S: Post 1 Runoff Area=25,533 sf 92.54% Impervious Runoff Depth>2.74"

Flow Length=131' Slope=0.0200 '/' Tc=1.2 min CN=94 Runoff=2.11 cfs 5,826 cf

Subcatchment8S: Post 2 Runoff Area=12,029 sf 15.46% Impervious Runoff Depth>0.13"

Flow Length=136' Slope=0.0150 '/' Tc=6.7 min CN=48 Runoff=0.01 cfs 126 cf

Subcatchment 12S: Post 5 BLD Runoff Area=7,012 sf 100.00% Impervious Runoff Depth>3.16"

Tc=5.0 min CN=98 Runoff=0.55 cfs 1,849 cf

Subcatchment 15S: Post 3 Runoff Area=5,544 sf 0.00% Impervious Runoff Depth>0.00"

Flow Length=88' Slope=0.0700 '/' Tc=3.3 min CN=39 Runoff=0.00 cfs 2 cf

Subcatchment 16S: Post 4 Runoff Area=20,361 sf 0.00% Impervious Runoff Depth=0.00"

Flow Length=116' Tc=4.1 min CN=32 Runoff=0.00 cfs 0 cf

Subcatchment 17S: Post 6 Runoff Area=7,956 sf 6.35% Impervious Runoff Depth>0.04"

Flow Length=116' Tc=4.1 min CN=43 Runoff=0.00 cfs 26 cf

Pond 3P: Galley System #1 (front) Peak Elev=136.49' Storage=2,959 cf Inflow=2.56 cfs 7,701 cf

Discarded=0.20 cfs 7,694 cf Primary=0.00 cfs 0 cf Outflow=0.20 cfs 7,694 cf

Pond 14P: Galley System #2 (rear) Peak Elev=134.94' Storage=1 cf Inflow=0.01 cfs 126 cf

Outflow=0.01 cfs 126 cf

Pond 18P: Infiltration Basin #1 Peak Elev=135.00' Storage=1 cf Inflow=0.00 cfs 2 cf

Outflow=0.00 cfs 1 cf

Total Runoff Area = 156,404 sf Runoff Volume = 7,829 cf Average Runoff Depth = 0.60" 78.90% Pervious = 123,400 sf 21.10% Impervious = 33,004 sf

Page 6

Summary for Subcatchment 1S: Pre 1

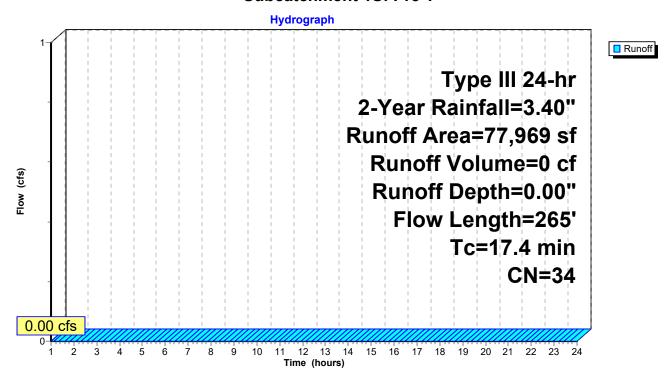
[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Α	rea (sf)	CN [Description		
		21,962	30 \	Noods, Go	od, HSG A	
		56,007	35 E	Brush, Fair,	HSG A	
		77,969	34 \	Neighted A	verage	
		77,969	•	100.00% Pe	ervious Are	a
	_					
	Tc	Length	Slope		Capacity	Description
	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	13.8	50	0.0130	0.06		Sheet Flow, 1
						Woods: Light underbrush n= 0.400 P2= 3.60"
	2.2	145	0.0480	1.10		Shallow Concentrated Flow, 2
						Woodland Kv= 5.0 fps
	1.4	70	0.0280	0.84		Shallow Concentrated Flow, 3
						Woodland Kv= 5.0 fps
	17 <i>4</i>	265	Total			

Subcatchment 1S: Pre 1



Page 7

Summary for Subcatchment 6S: Post 1

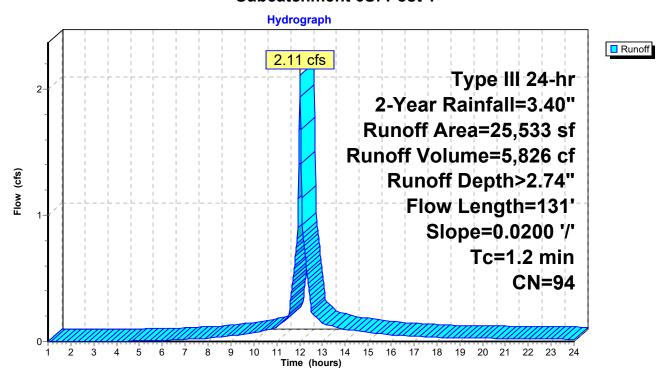
[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.11 cfs @ 12.02 hrs, Volume= 5,826 cf, Depth> 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 2-Year Rainfall=3.40"

A	rea (sf)	CN E	escription		
	1,906	39 >	75% Gras	s cover, Go	ood, HSG A
	23,627	98 F	aved park	ing, HSG A	
	25,533	94 V	Veighted A	verage	
	1,906	7	.46% Perv	ious Area	
	23,627	9	2.54% Imp	ervious Are	ea
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
0.7	50	0.0200	1.27		Sheet Flow,
					Smooth surfaces n= 0.011 P2= 3.60"
0.5	81	0.0200	2.87		Shallow Concentrated Flow,
					Paved Kv= 20.3 fps
1.2	131	Total			

Subcatchment 6S: Post 1



Page 8

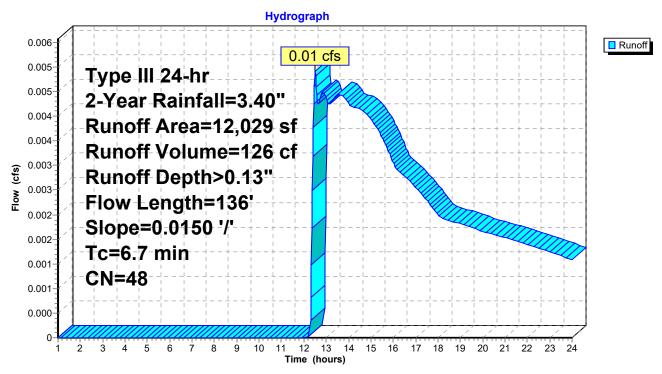
Summary for Subcatchment 8S: Post 2

Runoff = 0.01 cfs @ 12.51 hrs, Volume= 126 cf, Depth> 0.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 2-Year Rainfall=3.40"

	Α	rea (sf)	CN	CN Description							
		834	39	39 >75% Grass cover, Good, HSG A							
		9,335	39	>75% Gras	s cover, Go	ood, HSG A					
_		1,860	98	Paved park	ing, HSG A	\					
		12,029	48	Weighted A	verage						
		10,169		84.54% Per	vious Area						
		1,860		15.46% Imp	pervious Ar	ea					
	_		01			B					
	Tc	Length	Slope	,	Capacity	Description					
_	(min)	(feet)	(ft/ft		(cfs)						
	6.0	50	0.0150	0.14		Sheet Flow,					
						Grass: Short n= 0.150 P2= 3.60"					
	0.7	86	0.0150	1.97		Shallow Concentrated Flow,					
_						Unpaved Kv= 16.1 fps					
	6.7	136	Total								

Subcatchment 8S: Post 2



Page 9

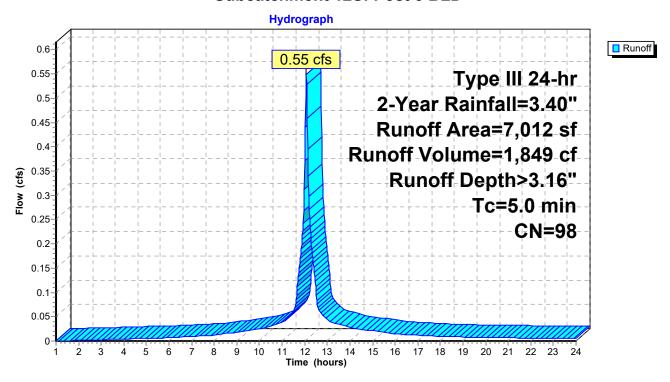
Summary for Subcatchment 12S: Post 5 BLD

Runoff = 0.55 cfs @ 12.07 hrs, Volume= 1,849 cf, Depth> 3.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 2-Year Rainfall=3.40"

	Area (sf)	CN	Description						
	7,012	98	Roofs, HSC	Roofs, HSG A					
	7,012		100.00% Impervious Area						
	Γc Length	•	Velocity		Description				
(mi	n) (feet)) (ft/ft	(ft/sec)	(cfs)					
5	.0				Direct Entry, Roof				

Subcatchment 12S: Post 5 BLD



Page 10

Summary for Subcatchment 15S: Post 3

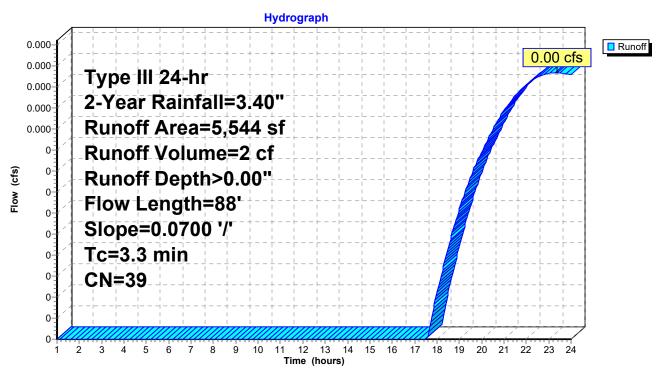
[73] Warning: Peak may fall outside time span

Runoff = 0.00 cfs @ 23.36 hrs, Volume= 2 cf, Depth> 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Α	rea (sf)	CN E	Description							
		5,544	39 >	39 >75% Grass cover, Good, HSG A							
		5,544	1	00.00% Pe	ervious Are	a					
	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description					
_	3.2	50	0.0700	0.26	` '	Sheet Flow,					
	0.1	38	0.0700	4.26		Grass: Short n= 0.150 P2= 3.60" Shallow Concentrated Flow, Unpaved Kv= 16.1 fps					
	3.3	88	Total	·	·	<u> </u>					

Subcatchment 15S: Post 3



Page 11

Summary for Subcatchment 16S: Post 4

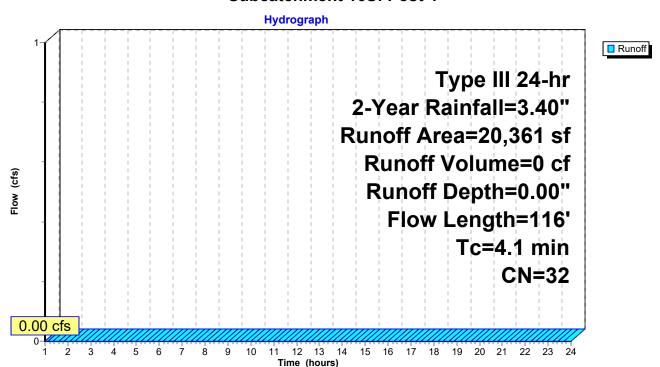
[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 2-Year Rainfall=3.40"

_	Α	rea (sf)	CN	N Description						
		3,520	520 39 >75% Grass cover, Good, HSG A							
		16,841	30	Woods, Go	od, HSG A					
		20,361	32	Weighted A	verage					
		20,361		100.00% P	ervious Are	a				
	_									
	Tc	Length	Slope	•	Capacity	Description				
	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
	3.0	50	0.0800	0.27		Sheet Flow,				
						Grass: Short n= 0.150 P2= 3.60"				
	0.1	10	0.2000	3.13		Shallow Concentrated Flow,				
						Short Grass Pasture Kv= 7.0 fps				
	1.0	56	0.0350	0.94		Shallow Concentrated Flow,				
_						Woodland Kv= 5.0 fps				
	<i>4</i> 1	116	Total							

Subcatchment 16S: Post 4



Page 12

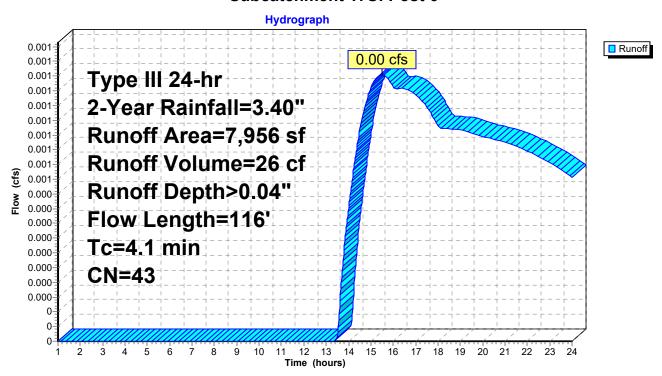
Summary for Subcatchment 17S: Post 6

Runoff = 0.00 cfs @ 15.50 hrs, Volume= 26 cf, Depth> 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 2-Year Rainfall=3.40"

	Α	rea (sf)	CN I	Description								
		4,496	39	39 >75% Grass cover, Good, HSG A								
		2,955	39 :	>75% Gras	75% Grass cover, Good, HSG A							
_		505	98 I	Paved park	ing, HSG A	·						
		7,956	43 \	Neighted A	verage							
		7,451	(93.65% Pei	rvious Area							
		505	6	6.35% Impe	ervious Are	a						
	Tc	Length	Slope	•	Capacity	Description						
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)							
	3.0	50	0.0800	0.27		Sheet Flow,						
						Grass: Short n= 0.150 P2= 3.60"						
	0.1	10	0.2000	3.13		Shallow Concentrated Flow,						
						Short Grass Pasture Kv= 7.0 fps						
	1.0	56	0.0350	0.94		Shallow Concentrated Flow,						
_						Woodland Kv= 5.0 fps	_					
	<i>4</i> 1	116	Total									

Subcatchment 17S: Post 6



Drainage

Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 13

Summary for Pond 3P: Galley System #1 (front)

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 136.49' @ 12.95 hrs Surf.Area= 3,096 sf Storage= 2,959 cf

Plug-Flow detention time= 119.1 min calculated for 7,694 cf (100% of inflow) Center-of-Mass det. time= 118.5 min (893.8 - 775.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	2,039 cf	25.17'W x 123.00'L x 4.50'H Field A
			13,930 cf Overall - 8,831 cf Embedded = 5,098 cf x 40.0% Voids
#2A	135.43'	6,652 cf	Concrete Galley 4x4x4 x 150 Inside #1
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf
			5 Rows of 30 Chambers
		0.004 (T () A ())) O(

8,691 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.93'	2.410 in/hr Exfiltration over Wetted area
#2	Primary	139.00'	4.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.20 cfs @ 12.95 hrs HW=136.49' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=134.93' (Free Discharge) 2=Orifice/Grate (Controls 0.00 cfs)

Page 14

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Pond 3P: Galley System #1 (front) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

52.8" Wide + 0.5" Spacing = 53.3" C-C Row Spacing

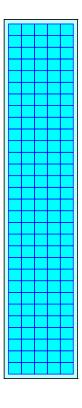
30 Chambers/Row x 4.00' Long = 120.00' Row Length +18.0'' End Stone x 2 = 123.00' Base Length 5 Rows x 52.8" Wide + 0.5" Spacing x 4 + 18.0'' Side Stone x 2 = 25.17' Base Width 6.0" Base + 48.0'' Chamber Height = 4.50' Field Height

150 Chambers x 44.3 cf = 6,651.7 cf Chamber Storage 150 Chambers x 58.9 cf = 8,831.5 cf Displacement

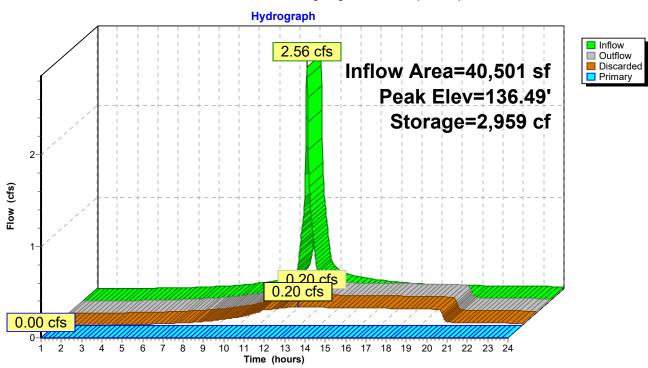
13,929.8 cf Field - 8,831.5 cf Chambers = 5,098.3 cf Stone x 40.0% Voids = 2,039.3 cf Stone Storage

Chamber Storage + Stone Storage = 8,691.0 cf = 0.200 af Overall Storage Efficiency = 62.4% Overall System Size = 123.00' x 25.17' x 4.50'

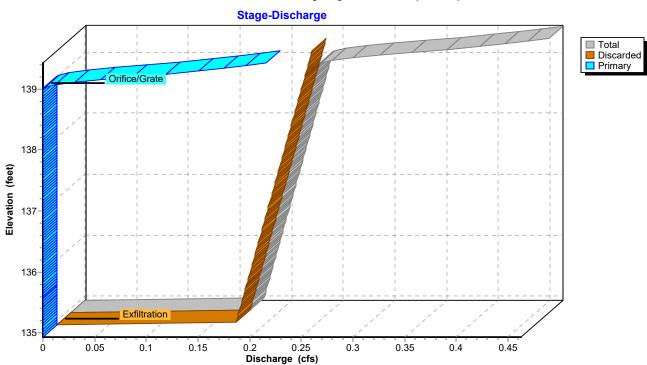
150 Chambers 515.9 cy Field 188.8 cy Stone



Pond 3P: Galley System #1 (front)

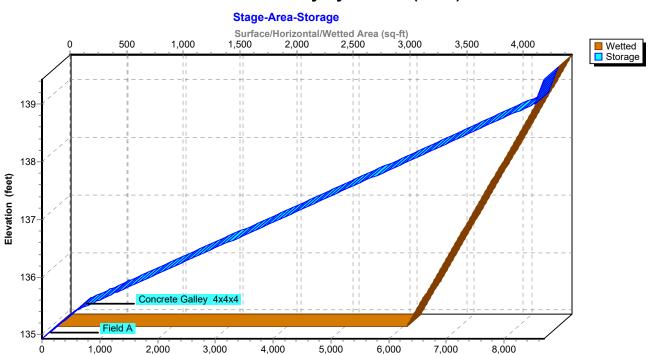


Pond 3P: Galley System #1 (front)



Page 16

Pond 3P: Galley System #1 (front)



Storage (cubic-feet)

Drainage

Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 17

Summary for Pond 14P: Galley System #2 (rear)

Inflow Area = 12,029 sf, 15.46% Impervious, Inflow Depth > 0.13" for 2-Year event

Inflow = 0.01 cfs @ 12.51 hrs, Volume= 126 cf

Outflow = 0.01 cfs @ 12.54 hrs, Volume= 126 cf, Atten= 2%, Lag= 1.8 min

Primary = 0.01 cfs @ 12.54 hrs, Volume= 126 cf

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 134.94' @ 12.54 hrs Surf.Area= 166 sf Storage= 1 cf

Plug-Flow detention time= 1.6 min calculated for 126 cf (100% of inflow)

Center-of-Mass det. time= 1.1 min (1,016.9 - 1,015.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	175 cf	6.40'W x 26.00'L x 4.75'H Field A
			790 cf Overall - 353 cf Embedded = 437 cf x 40.0% Voids
#2A	135.43'	266 cf	Concrete Galley 4x4x4 x 6 Inside #1
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

441 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134.93'	8.270 in/hr Exfiltration over Wetted area

Primary OutFlow Max=0.03 cfs @ 12.54 hrs HW=134.94' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.03 cfs)

Page 18

Pond 14P: Galley System #2 (rear) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

6 Chambers/Row x 4.00' Long = 24.00' Row Length +12.0" End Stone x 2 = 26.00' Base Length

1 Rows x 52.8" Wide + 12.0" Side Stone x 2 = 6.40' Base Width

6.0" Base + 48.0" Chamber Height + 3.0" Cover = 4.75' Field Height

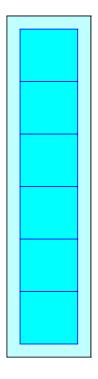
6 Chambers x 44.3 cf = 266.1 cf Chamber Storage

6 Chambers x 58.9 cf = 353.3 cf Displacement

790.4 cf Field - 353.3 cf Chambers = 437.1 cf Stone x 40.0% Voids = 174.9 cf Stone Storage

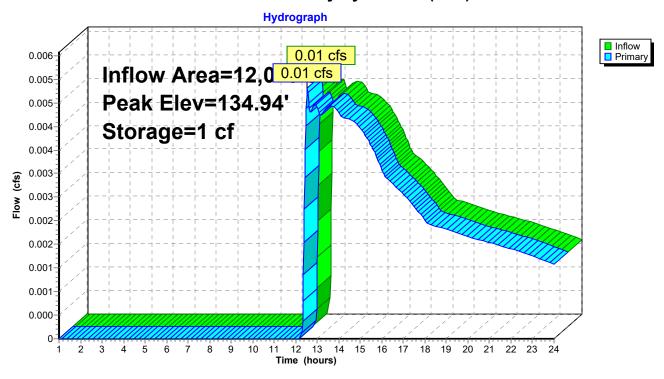
Chamber Storage + Stone Storage = 440.9 cf = 0.010 af Overall Storage Efficiency = 55.8% Overall System Size = 26.00' x 6.40' x 4.75'

6 Chambers 29.3 cy Field 16.2 cy Stone

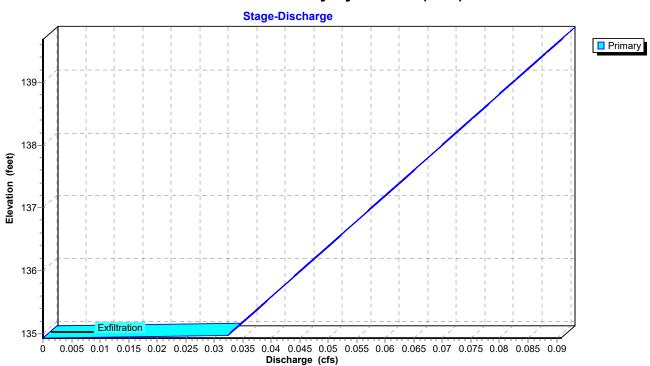




Pond 14P: Galley System #2 (rear)



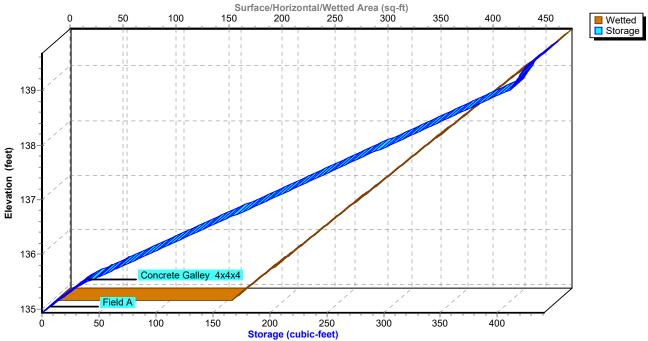
Pond 14P: Galley System #2 (rear)



Page 20

Pond 14P: Galley System #2 (rear)





Drainage

Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 21

Summary for Pond 18P: Infiltration Basin #1

5,544 sf, 0.00% Impervious, Inflow Depth > 0.00" for 2-Year event Inflow Area =

0.00 cfs @ 23.36 hrs, Volume= Inflow 2 cf

0.00 cfs @ 24.00 hrs, Volume= Outflow = 1 cf, Atten= 52%, Lag= 38.3 min

0.00 cfs @ 24.00 hrs, Volume= Discarded = 1 cf

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 135.00' @ 24.00 hrs Surf.Area= 411 sf Storage= 1 cf

Plug-Flow detention time= 162.6 min calculated for 1 cf (29% of inflow)

Center-of-Mass det. time= 39.7 min (1,328.8 - 1,289.1)

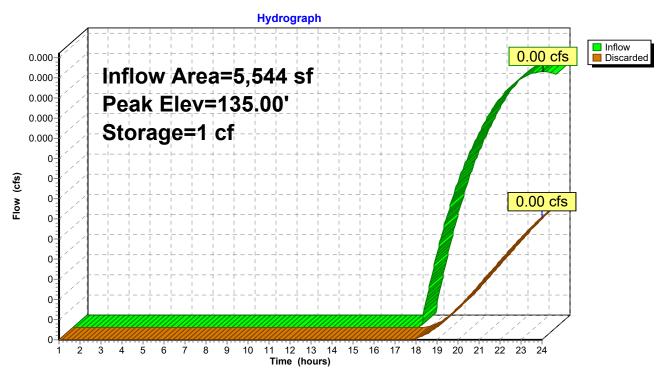
Volume	Invert	Avail.Sto	rage Storage	Description			
#1	135.00'	3,16	60 cf Custom	Stage Data (Cor	nic) Listed below (F	Recalc)	
Elevatio (feet		rf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)		
135.0	0	410	0	0	410		
136.0	0	748	571	571	758		
138.0	0	1,934	2,590	3,160	1,971		
Device	Routing	Invert	Outlet Device	S			
#1	Discarded	135.00'	2.410 in/hr Exfiltration over Wetted area above 135.00' Excluded Wetted area = 410 sf				

Discarded OutFlow Max=0.00 cfs @ 24.00 hrs HW=135.00' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.00 cfs)

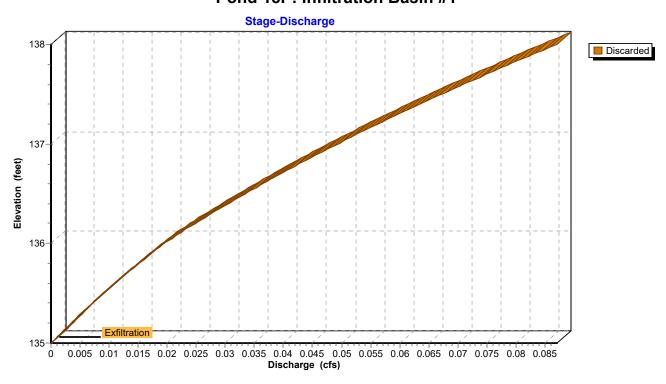
28

Page 22

Pond 18P: Infiltration Basin #1

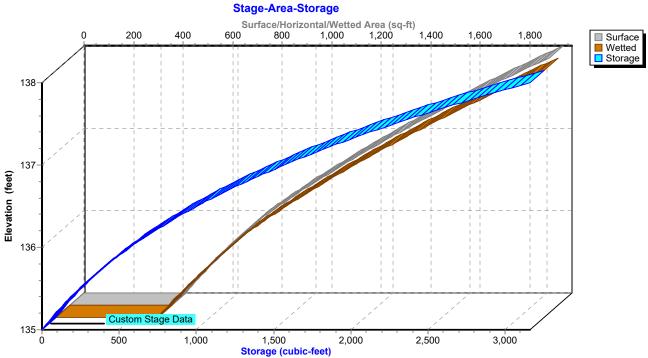


Pond 18P: Infiltration Basin #1



Pond 18P: Infiltration Basin #1





Type III 24-hr 10-Year Rainfall=4.70"

Prepared by {enter your company name here}
HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Printed 7/6/2020

Page 24

Time span=1.00-24.00 hrs, dt=0.02 hrs, 1151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre 1 Runoff Area=77,969 sf 0.00% Impervious Runoff Depth>0.03"

Flow Length=265' Tc=17.4 min CN=34 Runoff=0.01 cfs 209 cf

Subcatchment 6S: Post 1 Runoff Area = 25,533 sf 92.54% Impervious Runoff Depth > 4.01"

Flow Length=131' Slope=0.0200 '/' Tc=1.2 min CN=94 Runoff=3.03 cfs 8,536 cf

Subcatchment8S: Post 2 Runoff Area=12,029 sf 15.46% Impervious Runoff Depth>0.48"

Flow Length=136' Slope=0.0150 '/' Tc=6.7 min CN=48 Runoff=0.07 cfs 480 cf

Subcatchment 12S: Post 5 BLD Runoff Area=7,012 sf 100.00% Impervious Runoff Depth>4.46"

Tc=5.0 min CN=98 Runoff=0.76 cfs 2,607 cf

Subcatchment 15S: Post 3 Runoff Area=5,544 sf 0.00% Impervious Runoff Depth>0.14"

Flow Length=88' Slope=0.0700 '/' Tc=3.3 min CN=39 Runoff=0.00 cfs 66 cf

Subcatchment 16S: Post 4 Runoff Area=20,361 sf 0.00% Impervious Runoff Depth>0.01"

Flow Length=116' Tc=4.1 min CN=32 Runoff=0.00 cfs 16 cf

Subcatchment 17S: Post 6 Runoff Area=7,956 sf 6.35% Impervious Runoff Depth>0.27"

Flow Length=116' Tc=4.1 min CN=43 Runoff=0.02 cfs 181 cf

Pond 3P: Galley System #1 (front) Peak Elev=137.34' Storage=4,868 cf Inflow=3.65 cfs 11,324 cf

Discarded=0.21 cfs 11,071 cf Primary=0.00 cfs 0 cf Outflow=0.21 cfs 11,071 cf

Pond 14P: Galley System #2 (rear) Peak Elev=135.48' Storage=38 cf Inflow=0.07 cfs 480 cf

Outflow=0.04 cfs 480 cf

Pond 18P: Infiltration Basin #1 Peak Elev=135.07' Storage=29 cf Inflow=0.00 cfs 66 cf

Outflow=0.00 cfs 38 cf

Total Runoff Area = 156,404 sf Runoff Volume = 12,096 cf Average Runoff Depth = 0.93" 78.90% Pervious = 123,400 sf 21.10% Impervious = 33,004 sf

Page 25

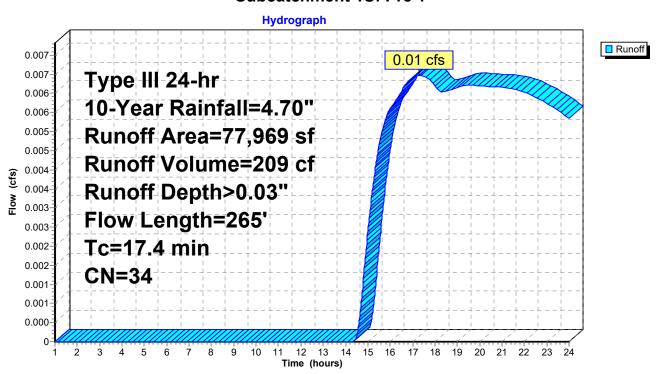
Summary for Subcatchment 1S: Pre 1

Runoff = 0.01 cfs @ 17.30 hrs, Volume= 209 cf, Depth> 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 10-Year Rainfall=4.70"

	Α	rea (sf)	CN [Description		
21,962 30 Woods, Good, HSG A						
		56,007	35 E	Brush, Fair,	HSG A	
		77,969	34 V	Neighted A	verage	
		77,969	1	100.00% Pe	ervious Are	a
	_		01			D 1.0
	Tc	Length	Slope	Velocity	Capacity	Description
	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	13.8	50	0.0130	0.06		Sheet Flow, 1
						Woods: Light underbrush n= 0.400 P2= 3.60"
	2.2	145	0.0480	1.10		Shallow Concentrated Flow, 2
						Woodland Kv= 5.0 fps
	1.4	70	0.0280	0.84		Shallow Concentrated Flow, 3
						Woodland Kv= 5.0 fps
	17.4	265	Total			

Subcatchment 1S: Pre 1



Page 26

Summary for Subcatchment 6S: Post 1

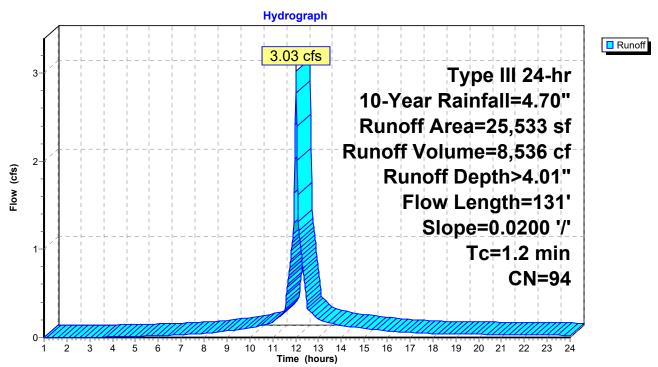
[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.03 cfs @ 12.02 hrs, Volume= 8,536 cf, Depth> 4.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 10-Year Rainfall=4.70"

	\rea (sf)	CN E	escription						
	1,906	39 >	39 >75% Grass cover, Good, HSG A						
	23,627	98 F	aved park	ing, HSG A	·				
	25,533	94 V	Veighted A	verage					
	1,906	7	.46% Perv	ious Area					
	23,627	9	2.54% Imp	ervious Are	ea				
_				_					
Tc		Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
0.7	50	0.0200	1.27		Sheet Flow,				
					Smooth surfaces n= 0.011 P2= 3.60"				
0.5	81	0.0200	2.87		Shallow Concentrated Flow,				
					Paved Kv= 20.3 fps				
1.2	131	Total							

Subcatchment 6S: Post 1



Page 27

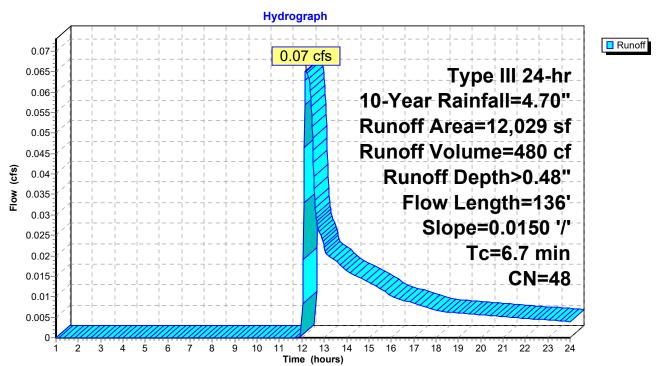
Summary for Subcatchment 8S: Post 2

Runoff = 0.07 cfs @ 12.17 hrs, Volume= 480 cf, Depth> 0.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 10-Year Rainfall=4.70"

A	rea (sf)	CN [Description						
	834	39 >	75% Gras	s cover, Go	ood, HSG A				
	9,335	39 >	75% Gras	s cover, Go	ood, HSG A				
	1,860	98 F	Paved park	ing, HSG A	\				
	12,029	48 \	Veighted A	verage					
	10,169	8	34.54% Per	rvious Area					
	1,860	1	5.46% Imp	pervious Ar	ea				
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
6.0	50	0.0150	0.14		Sheet Flow,				
					Grass: Short n= 0.150 P2= 3.60"				
0.7	86	0.0150	1.97		Shallow Concentrated Flow,				
					Unpaved Kv= 16.1 fps				
6.7	136	Total		·					

Subcatchment 8S: Post 2



Page 28

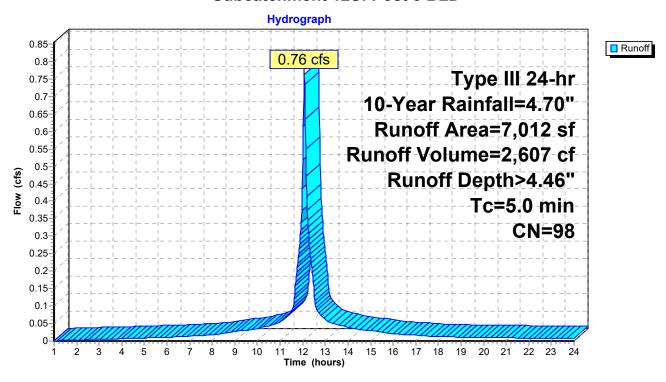
Summary for Subcatchment 12S: Post 5 BLD

Runoff = 0.76 cfs @ 12.07 hrs, Volume= 2,607 cf, Depth> 4.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description	escription						
	7,012	98	Roofs, HSC	Roofs, HSG A						
	7,012		100.00% Impervious Area							
	Γc Length	•	Velocity		Description					
(mi	n) (feet)) (ft/ft	(ft/sec)	(cfs)						
5	.0				Direct Entry, Roof					

Subcatchment 12S: Post 5 BLD



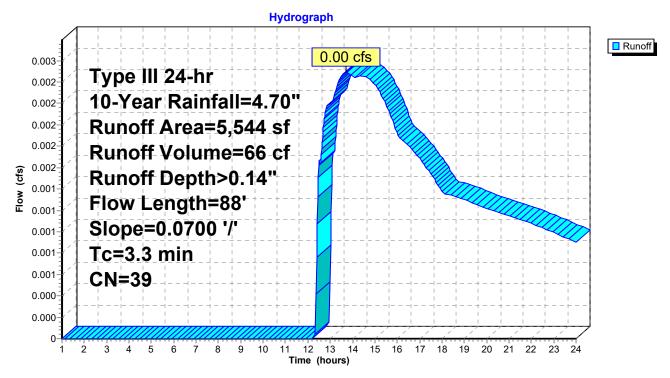
Summary for Subcatchment 15S: Post 3

Runoff = 0.00 cfs @ 13.72 hrs, Volume= 66 cf, Depth> 0.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 10-Year Rainfall=4.70"

_	Α	rea (sf)	CN E	Description		
		5,544	39 >75% Grass cover, Good, HSG A			
		5,544	1	00.00% Pe	a	
	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
•	3.2	50	0.0700	0.26	, ,	Sheet Flow,
	0.1	38	0.0700	4.26		Grass: Short n= 0.150 P2= 3.60" Shallow Concentrated Flow, Unpaved Kv= 16.1 fps
	3.3	88	Total			

Subcatchment 15S: Post 3



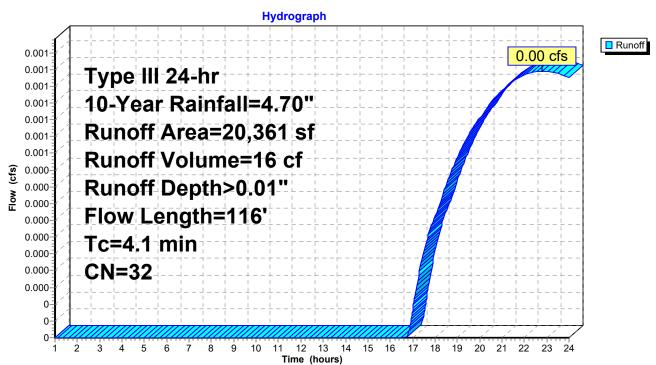
Summary for Subcatchment 16S: Post 4

Runoff = 0.00 cfs @ 22.81 hrs, Volume= 16 cf, Depth> 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 10-Year Rainfall=4.70"

	Α	rea (sf)	CN [Description				
3,520 39 >75% Grass cover, Good, HSG A								
_		16,841	30 V	Noods, Go	od, HSG A			
		20,361	32 \	Veighted A	verage			
		20,361	1	100.00% Pe	ervious Are	a		
	Тс	Length	Slope		Capacity	Description		
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
	3.0	50	0.0800	0.27		Sheet Flow,		
						Grass: Short n= 0.150 P2= 3.60"		
	0.1	10	0.2000	3.13		Shallow Concentrated Flow,		
						Short Grass Pasture Kv= 7.0 fps		
	1.0	56	0.0350	0.94		Shallow Concentrated Flow,		
_						Woodland Kv= 5.0 fps		
	4.1	116	Total					

Subcatchment 16S: Post 4



Page 31

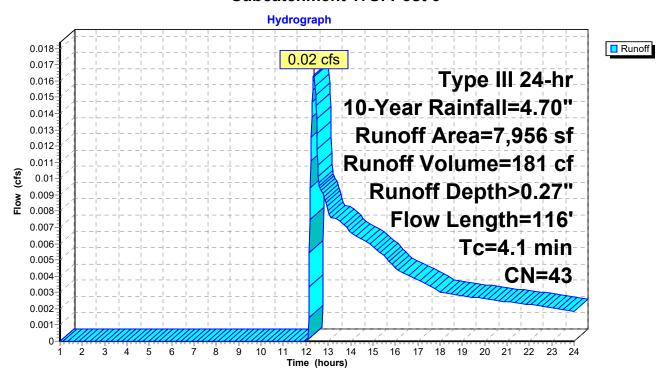
Summary for Subcatchment 17S: Post 6

Runoff = 0.02 cfs @ 12.36 hrs, Volume= 181 cf, Depth> 0.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 10-Year Rainfall=4.70"

A	rea (sf)	CN E	escription						
	4,496	39 >	75% Gras	s cover, Go	ood, HSG A				
	2,955	39 >	75% Gras	s cover, Go	ood, HSG A				
	505	98 F	aved park	ing, HSG A	L Company of the Comp				
	7,956	43 V	, <u> </u>						
	7,451	g	3.65% Per	vious Area					
	505	6	.35% Impe	ervious Area	a				
			•						
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
3.0	50	0.0800	0.27		Sheet Flow,				
					Grass: Short n= 0.150 P2= 3.60"				
0.1	10	0.2000	3.13		Shallow Concentrated Flow,				
					Short Grass Pasture Kv= 7.0 fps				
1.0	56	0.0350	0.94		Shallow Concentrated Flow,				
					Woodland Kv= 5.0 fps				
4.1	116	Total							

Subcatchment 17S: Post 6



Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

<u>Page 32</u>

Summary for Pond 3P: Galley System #1 (front)

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 137.34' @ 13.61 hrs Surf.Area= 3,096 sf Storage= 4,868 cf

Plug-Flow detention time= 203.6 min calculated for 11,061 cf (98% of inflow) Center-of-Mass det. time= 189.6 min (958.3 - 768.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	2,039 cf	25.17'W x 123.00'L x 4.50'H Field A
			13,930 cf Overall - 8,831 cf Embedded = $5,098$ cf x 40.0% Voids
#2A	135.43'	6,652 cf	Concrete Galley 4x4x4 x 150 Inside #1
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf
			5 Rows of 30 Chambers
		0.004 .5	Total Accellable Otomore

8,691 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.93'	2.410 in/hr Exfiltration over Wetted area
#2	Primary	139.00'	4.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.21 cfs @ 13.61 hrs HW=137.34' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=134.93' (Free Discharge) 2=Orifice/Grate (Controls 0.00 cfs)

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 33

Pond 3P: Galley System #1 (front) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

52.8" Wide + 0.5" Spacing = 53.3" C-C Row Spacing

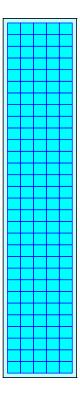
30 Chambers/Row x 4.00' Long = 120.00' Row Length +18.0'' End Stone x 2 = 123.00' Base Length 5 Rows x 52.8" Wide + 0.5" Spacing x 4 + 18.0'' Side Stone x 2 = 25.17' Base Width 6.0" Base + 48.0'' Chamber Height = 4.50' Field Height

150 Chambers x 44.3 cf = 6,651.7 cf Chamber Storage 150 Chambers x 58.9 cf = 8,831.5 cf Displacement

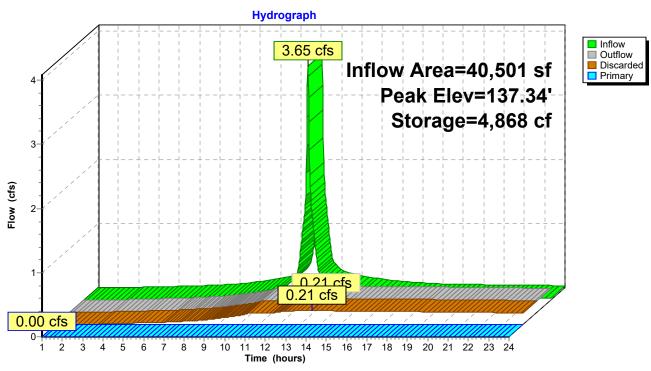
13,929.8 cf Field - 8,831.5 cf Chambers = 5,098.3 cf Stone x 40.0% Voids = 2,039.3 cf Stone Storage

Chamber Storage + Stone Storage = 8,691.0 cf = 0.200 af Overall Storage Efficiency = 62.4% Overall System Size = 123.00' x 25.17' x 4.50'

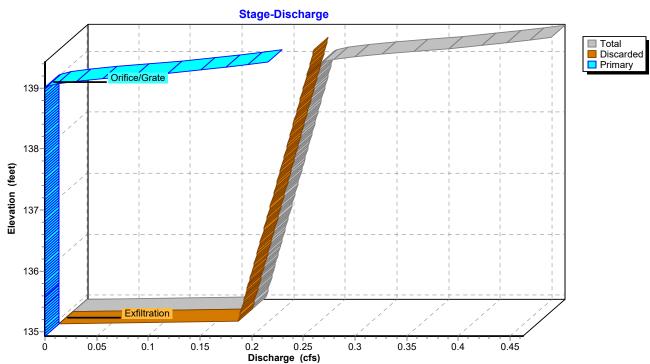
150 Chambers 515.9 cy Field 188.8 cy Stone



Pond 3P: Galley System #1 (front)



Pond 3P: Galley System #1 (front)



1,000

2,000

3,000

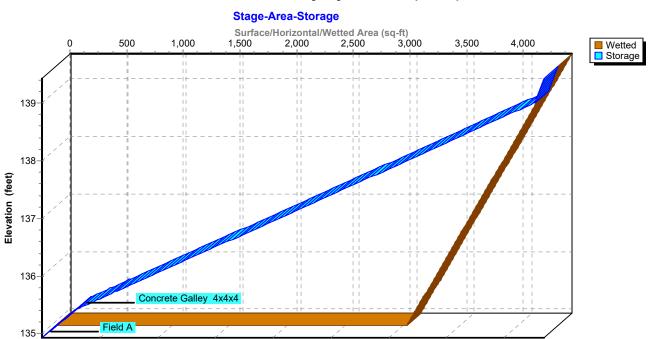
4,000

Storage (cubic-feet)

Printed 7/6/2020

Page 35

Pond 3P: Galley System #1 (front)



5,000

6,000

7,000

8,000

Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 36

Summary for Pond 14P: Galley System #2 (rear)

Inflow Area = 12,029 sf, 15.46% Impervious, Inflow Depth > 0.48" for 10-Year event

Inflow = 0.07 cfs @ 12.17 hrs, Volume= 480 cf

Outflow = 0.04 cfs @ 12.55 hrs, Volume= 480 cf, Atten= 41%, Lag= 22.3 min

Primary = 0.04 cfs @ 12.55 hrs, Volume= 480 cf

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 135.48' @ 12.55 hrs Surf.Area= 166 sf Storage= 38 cf

Plug-Flow detention time= 4.7 min calculated for 480 cf (100% of inflow)

Center-of-Mass det. time= 4.3 min (939.4 - 935.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	175 cf	6.40'W x 26.00'L x 4.75'H Field A
			790 cf Overall - 353 cf Embedded = 437 cf x 40.0% Voids
#2A	135.43'	266 cf	Concrete Galley 4x4x4 x 6 Inside #1
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

441 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134.93'	8.270 in/hr Exfiltration over Wetted area

Primary OutFlow Max=0.04 cfs @ 12.55 hrs HW=135.48' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.04 cfs)

Prepared by {enter your company name here} HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC Printed 7/6/2020

Page 37

Pond 14P: Galley System #2 (rear) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

6 Chambers/Row x 4.00' Long = 24.00' Row Length +12.0" End Stone x 2 = 26.00' Base Length

1 Rows x 52.8" Wide + 12.0" Side Stone x 2 = 6.40' Base Width

6.0" Base + 48.0" Chamber Height + 3.0" Cover = 4.75' Field Height

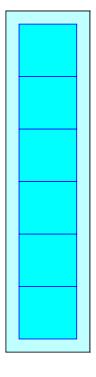
6 Chambers x 44.3 cf = 266.1 cf Chamber Storage

6 Chambers x 58.9 cf = 353.3 cf Displacement

790.4 cf Field - 353.3 cf Chambers = 437.1 cf Stone x 40.0% Voids = 174.9 cf Stone Storage

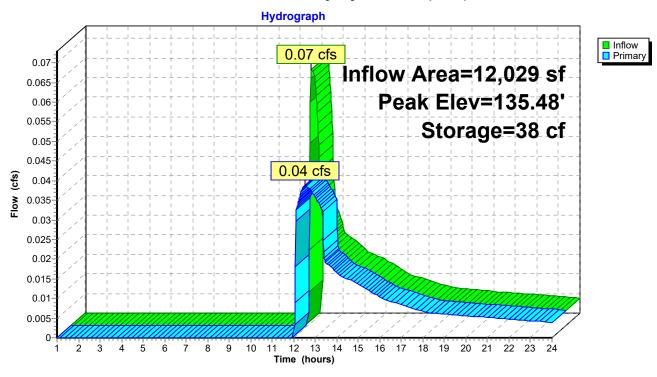
Chamber Storage + Stone Storage = 440.9 cf = 0.010 af Overall Storage Efficiency = 55.8% Overall System Size = 26.00' x 6.40' x 4.75'

6 Chambers 29.3 cy Field 16.2 cy Stone

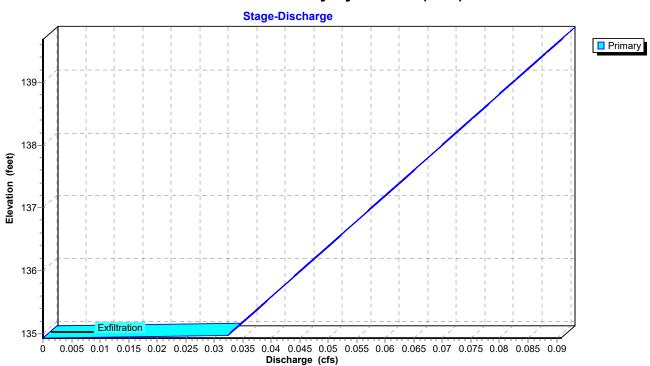




Pond 14P: Galley System #2 (rear)

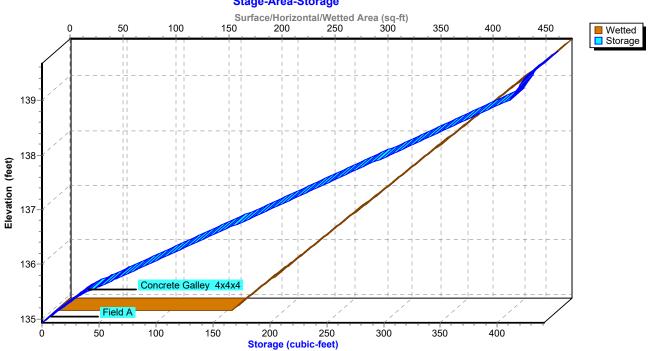


Pond 14P: Galley System #2 (rear)



Pond 14P: Galley System #2 (rear)





Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 40

Summary for Pond 18P: Infiltration Basin #1

Inflow Area = 5,544 sf, 0.00% Impervious, Inflow Depth > 0.14" for 10-Year event

Inflow = 0.00 cfs @ 13.72 hrs, Volume= 66 cf

Outflow = 0.00 cfs @ 21.00 hrs, Volume= 38 cf, Atten= 54%, Lag= 436.3 min

Discarded = 0.00 cfs @ 21.00 hrs, Volume= 38 cf

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 135.07' @ 21.00 hrs Surf.Area= 430 sf Storage= 29 cf

Plug-Flow detention time= 264.1 min calculated for 38 cf (58% of inflow)

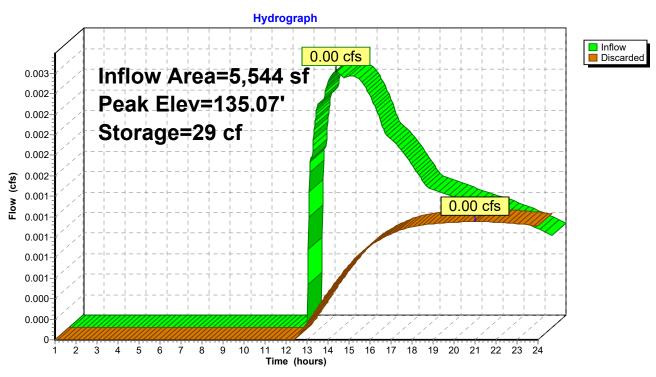
Center-of-Mass det. time= 121.3 min (1,152.2 - 1,030.9)

Volume	Inver	t Avail.Sto	rage Storage	Description		
#1	135.00	' 3,1	60 cf Custom	n Stage Data (Cor	nic) Listed below (Recalc)
Elevation (fee		urf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
135.0 136.0 138.0	00	410 748 1,934	0 571 2,590	0 571 3,160	410 758 1,971	
Device #1	Routing Discarded	Invert 135.00'	Outlet Device 2.410 in/hr E	s xfiltration over W	/etted area above	e 135.00'

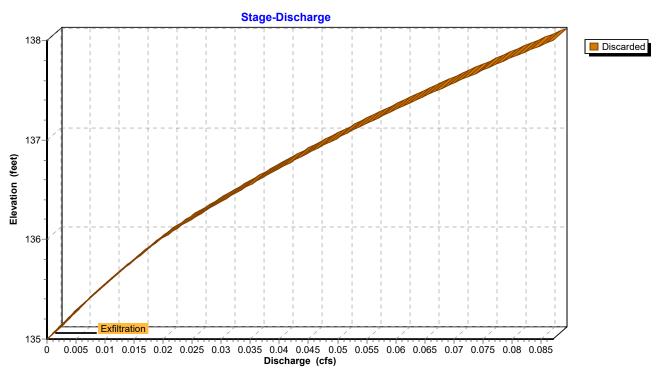
Excluded Wetted area = 410 sf

Discarded OutFlow Max=0.00 cfs @ 21.00 hrs HW=135.07' (Free Discharge) **1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Pond 18P: Infiltration Basin #1



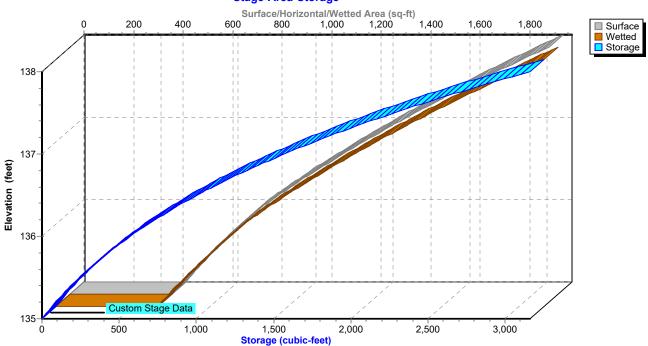
Pond 18P: Infiltration Basin #1



Page 42

Pond 18P: Infiltration Basin #1





Type III 24-hr 25-Year Rainfall=5.60"

Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 43

Time span=1.00-24.00 hrs, dt=0.02 hrs, 1151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre 1 Runoff Area=77,969 sf 0.00% Impervious Runoff Depth>0.14"

Flow Length=265' Tc=17.4 min CN=34 Runoff=0.03 cfs 895 cf

Subcatchment6S: Post 1 Runoff Area=25,533 sf 92.54% Impervious Runoff Depth>4.90"

Flow Length=131' Slope=0.0200 '/' Tc=1.2 min CN=94 Runoff=3.66 cfs 10,427 cf

Subcatchment8S: Post 2 Runoff Area=12,029 sf 15.46% Impervious Runoff Depth>0.82"

Flow Length=136' Slope=0.0150 '/' Tc=6.7 min CN=48 Runoff=0.17 cfs 826 cf

Subcatchment 12S: Post 5 BLD Runoff Area=7,012 sf 100.00% Impervious Runoff Depth>5.36"

Tc=5.0 min CN=98 Runoff=0.91 cfs 3,131 cf

Subcatchment 15S: Post 3 Runoff Area=5,544 sf 0.00% Impervious Runoff Depth>0.34"

Flow Length=88' Slope=0.0700 '/' Tc=3.3 min CN=39 Runoff=0.01 cfs 156 cf

Subcatchment 16S: Post 4 Runoff Area=20,361 sf 0.00% Impervious Runoff Depth>0.08"

Flow Length=116' Tc=4.1 min CN=32 Runoff=0.00 cfs 136 cf

Subcatchment 17S: Post 6 Runoff Area=7,956 sf 6.35% Impervious Runoff Depth>0.54"

Flow Length=116' Tc=4.1 min CN=43 Runoff=0.05 cfs 355 cf

Pond 3P: Galley System #1 (front) Peak Elev=138.03' Storage=6,390 cf Inflow=4.40 cfs 13,913 cf

Discarded=0.22 cfs 12,017 cf Primary=0.00 cfs 0 cf Outflow=0.22 cfs 12,017 cf

Pond 14P: Galley System #2 (rear) Peak Elev=136.52' Storage=148 cf Inflow=0.17 cfs 826 cf

Outflow=0.05 cfs 826 cf

Pond 18P: Infiltration Basin #1 Peak Elev=135.16' Storage=69 cf Inflow=0.01 cfs 156 cf

Outflow=0.00 cfs 97 cf

Total Runoff Area = 156,404 sf Runoff Volume = 15,926 cf Average Runoff Depth = 1.22" 78.90% Pervious = 123,400 sf 21.10% Impervious = 33,004 sf

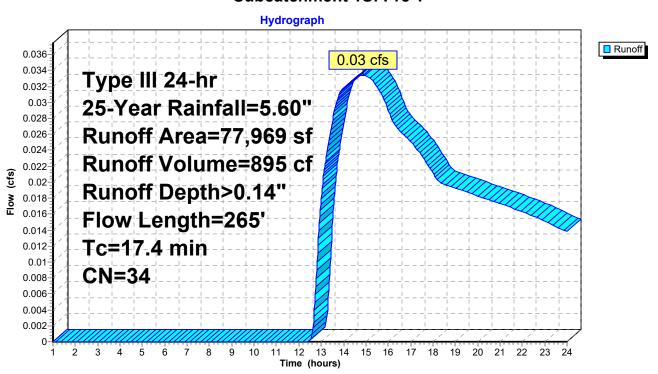
Summary for Subcatchment 1S: Pre 1

Runoff = 0.03 cfs @ 14.86 hrs, Volume= 895 cf, Depth> 0.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 25-Year Rainfall=5.60"

_	Α	rea (sf)	CN	Description		
		21,962		Woods, Go	,	
_		56,007	35	<u>Brush, Fair,</u>	HSG A	
		77,969	34	Weighted A	verage	
		77,969		100.00% Pe	ervious Are	a
	Tc	Length	Slope	Velocity	Capacity	Description
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	13.8	50	0.0130	0.06		Sheet Flow, 1
						Woods: Light underbrush n= 0.400 P2= 3.60"
	2.2	145	0.0480	1.10		Shallow Concentrated Flow, 2
						Woodland Kv= 5.0 fps
	1.4	70	0.0280	0.84		Shallow Concentrated Flow, 3
_						Woodland Kv= 5.0 fps
	17 <u>4</u>	265	Total	_	_	

Subcatchment 1S: Pre 1



Summary for Subcatchment 6S: Post 1

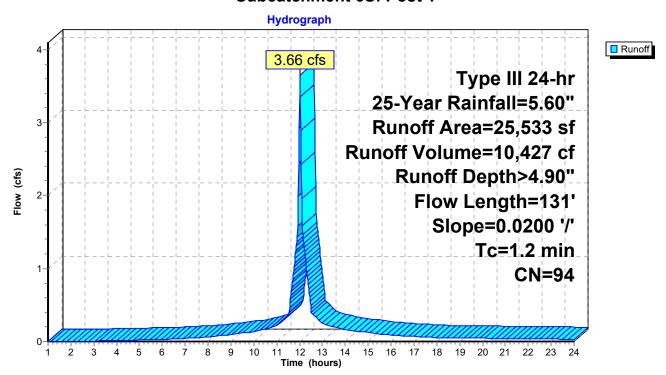
[49] Hint: Tc<2dt may require smaller dt

Runoff = 3.66 cfs @ 12.02 hrs, Volume= 10,427 cf, Depth> 4.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 25-Year Rainfall=5.60"

A	rea (sf)	CN E	escription						
1,906 39 >75% Grass cover, Good, HSG A									
	23,627 98 Paved parking, HSG A								
	25,533	94 V	Veighted A	verage					
	1,906	7	.46% Perv	ious Area					
	23,627	9	2.54% Imp	ervious Are	ea				
Tc	Length	Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
0.7	50	0.0200	1.27		Sheet Flow,				
					Smooth surfaces n= 0.011 P2= 3.60"				
0.5	81	0.0200	2.87		Shallow Concentrated Flow,				
					Paved Kv= 20.3 fps				
1.2	131	Total							

Subcatchment 6S: Post 1



Page 46

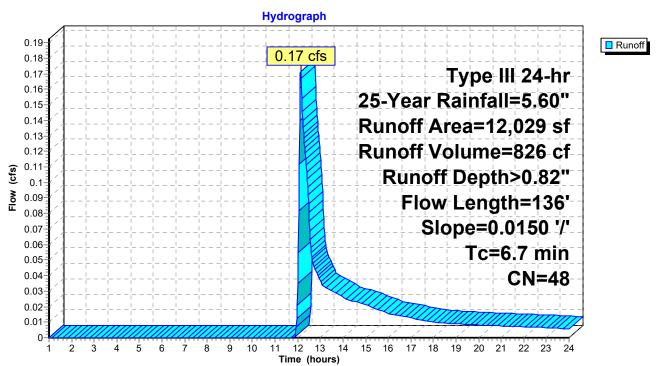
Summary for Subcatchment 8S: Post 2

Runoff = 0.17 cfs @ 12.13 hrs, Volume= 826 cf, Depth> 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 25-Year Rainfall=5.60"

_	Α	rea (sf)	CN I	Description			
		834	39	>75% Gras	s cover, Go	ood, HSG A	
		9,335	39	>75% Gras	s cover, Go	ood, HSG A	
_		1,860	98	Paved park	ing, HSG A	· · · · · · · · · · · · · · · · · · ·	
	12,029 48 Weighted Average						
		10,169	;	34.54% Per	vious Area		
		1,860		15.46% lmp	ervious Ar	ea	
	Тс	Length	Slope	Velocity	Capacity	Description	
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)		
	6.0	50	0.0150	0.14		Sheet Flow,	
						Grass: Short n= 0.150 P2= 3.60"	
	0.7	86	0.0150	1.97		Shallow Concentrated Flow,	
_						Unpaved Kv= 16.1 fps	
	6.7	136	Total				

Subcatchment 8S: Post 2



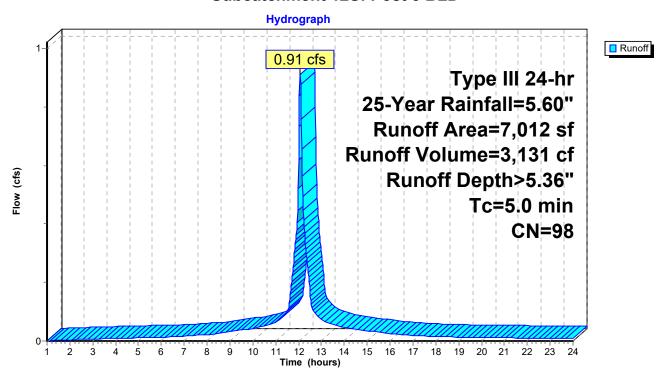
Summary for Subcatchment 12S: Post 5 BLD

Runoff = 0.91 cfs @ 12.07 hrs, Volume= 3,131 cf, Depth> 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 25-Year Rainfall=5.60"

A	rea (sf)	CN I	Description					
	7,012	98 F	Roofs, HSG					
	7,012	•	100.00% Impervious Area					
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description			
5.0	(ICCI)	(IVIL)	(10/360)	(013)	Direct Entry, Roof			

Subcatchment 12S: Post 5 BLD



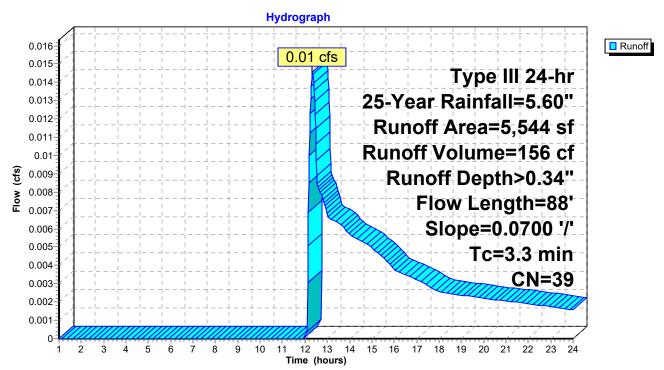
Summary for Subcatchment 15S: Post 3

Runoff = 0.01 cfs @ 12.34 hrs, Volume= 156 cf, Depth> 0.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 25-Year Rainfall=5.60"

_	Α	rea (sf)	CN E	Description						
	5,544 39 >75% Grass cover, Good, HSG A									
		5,544	1	100.00% Pervious Area						
	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description				
-	3.2	50	0.0700	0.26	,	Sheet Flow,				
	0.1	38	0.0700	4.26		Grass: Short n= 0.150 P2= 3.60" Shallow Concentrated Flow, Unpaved Kv= 16.1 fps				
	3.3	88	Total							

Subcatchment 15S: Post 3



HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 49

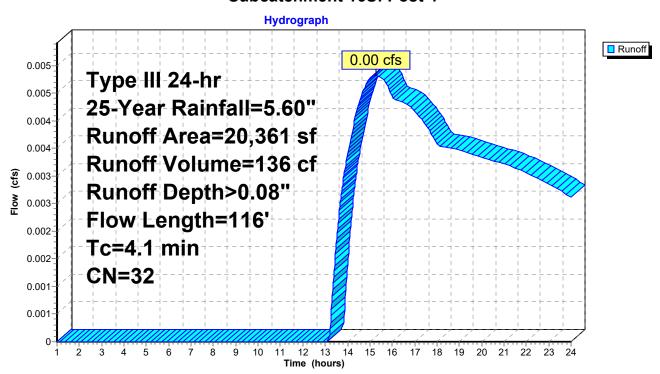
Summary for Subcatchment 16S: Post 4

Runoff = 0.00 cfs @ 15.27 hrs, Volume= 136 cf, Depth> 0.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 25-Year Rainfall=5.60"

_	Α	rea (sf)	CN [Description						
		3,520	39 >	39 >75% Grass cover, Good, HSG A						
_		16,841	30 \	Noods, Go	od, HSG A					
		20,361	32 \	Weighted A	verage					
		20,361	1	100.00% Pe	ervious Are	a				
	Tc	Length	Slope	Velocity	Capacity	Description				
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
	3.0	50	0.0800	0.27		Sheet Flow,				
						Grass: Short n= 0.150 P2= 3.60"				
	0.1	10	0.2000	3.13		Shallow Concentrated Flow,				
						Short Grass Pasture Kv= 7.0 fps				
	1.0	56	0.0350	0.94		Shallow Concentrated Flow,				
_						Woodland Kv= 5.0 fps				
	4.1	116	Total							

Subcatchment 16S: Post 4



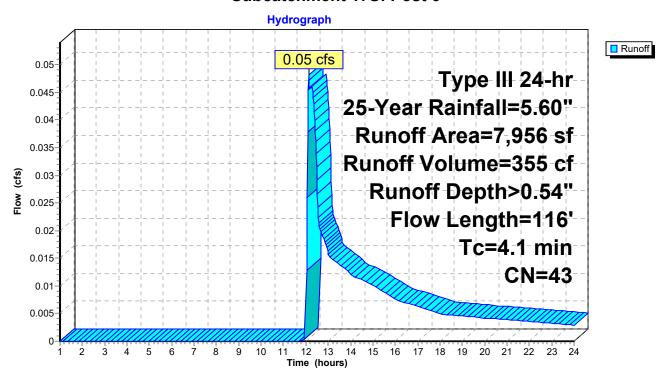
Summary for Subcatchment 17S: Post 6

Runoff = 0.05 cfs @ 12.12 hrs, Volume= 355 cf, Depth> 0.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 25-Year Rainfall=5.60"

_	Α	rea (sf)	CN I	Description						
		4,496	39	>75% Grass cover, Good, HSG A						
		2,955	39	>75% Gras	s cover, Go	ood, HSG A				
_		505	98	Paved park	ing, HSG A	· ·				
		7,956	43 \	Neighted A	verage					
		7,451	9	93.65% Pei	vious Area					
		505	(6.35% Impe	ervious Are	a				
	Tc	Length	Slope		Capacity	Description				
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
	3.0	50	0.0800	0.27		Sheet Flow,				
						Grass: Short n= 0.150 P2= 3.60"				
	0.1	10	0.2000	3.13		Shallow Concentrated Flow,				
						Short Grass Pasture Kv= 7.0 fps				
	1.0	56	0.0350	0.94		Shallow Concentrated Flow,				
_						Woodland Kv= 5.0 fps				
	41	116	Total							

Subcatchment 17S: Post 6



Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 51

Summary for Pond 3P: Galley System #1 (front)

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 138.03' @ 13.95 hrs Surf.Area= 3,096 sf Storage= 6,390 cf

Plug-Flow detention time= 242.4 min calculated for 12,007 cf (86% of inflow) Center-of-Mass det. time= 181.3 min (946.9 - 765.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	2,039 cf	25.17'W x 123.00'L x 4.50'H Field A
			13,930 cf Overall - 8,831 cf Embedded = 5,098 cf x 40.0% Voids
#2A	135.43'	6,652 cf	
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf
			5 Rows of 30 Chambers
•		0.004 .5	Tatal Assallable Ottomore

8,691 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.93'	2.410 in/hr Exfiltration over Wetted area
#2	Primary	139.00'	4.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.22 cfs @ 13.95 hrs HW=138.03' (Free Discharge) **1=Exfiltration** (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=134.93' (Free Discharge) 2=Orifice/Grate (Controls 0.00 cfs)

Prepared by {enter your company name here}

Printed 7/6/2020

Page 52

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Pond 3P: Galley System #1 (front) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

52.8" Wide + 0.5" Spacing = 53.3" C-C Row Spacing

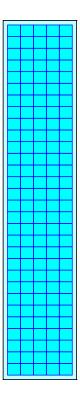
30 Chambers/Row x 4.00' Long = 120.00' Row Length +18.0'' End Stone x 2 = 123.00' Base Length 5 Rows x 52.8" Wide + 0.5" Spacing x 4 + 18.0'' Side Stone x 2 = 25.17' Base Width 6.0" Base + 48.0'' Chamber Height = 4.50' Field Height

150 Chambers x 44.3 cf = 6,651.7 cf Chamber Storage 150 Chambers x 58.9 cf = 8,831.5 cf Displacement

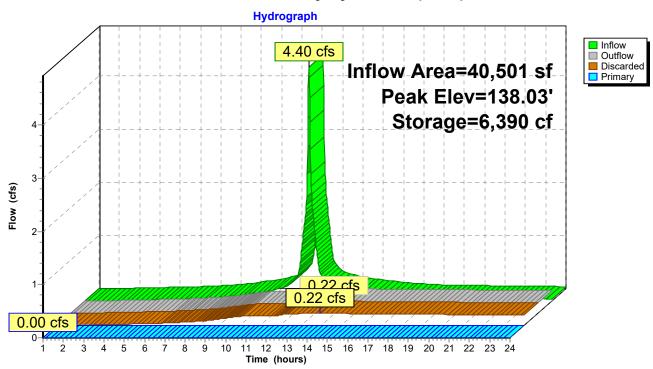
13,929.8 cf Field - 8,831.5 cf Chambers = 5,098.3 cf Stone x 40.0% Voids = 2,039.3 cf Stone Storage

Chamber Storage + Stone Storage = 8,691.0 cf = 0.200 af Overall Storage Efficiency = 62.4% Overall System Size = 123.00' x 25.17' x 4.50'

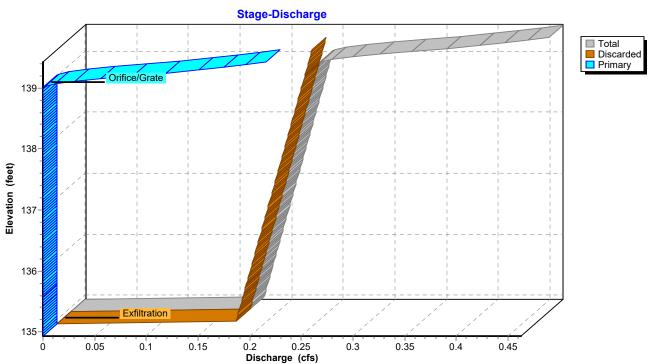
150 Chambers 515.9 cy Field 188.8 cy Stone



Pond 3P: Galley System #1 (front)



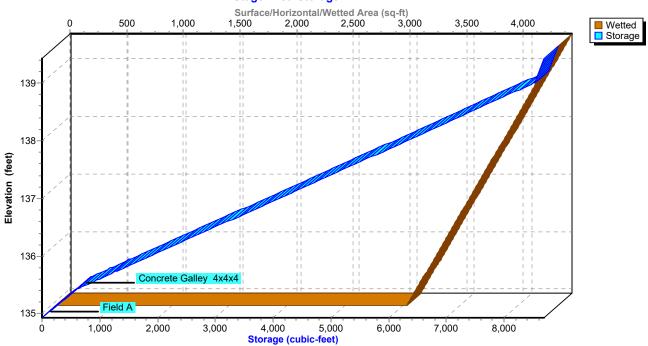
Pond 3P: Galley System #1 (front)



Page 54

Pond 3P: Galley System #1 (front)





Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 55

Summary for Pond 14P: Galley System #2 (rear)

Inflow Area = 12,029 sf, 15.46% Impervious, Inflow Depth > 0.82" for 25-Year event

Inflow = 0.17 cfs @ 12.13 hrs, Volume= 826 cf

Outflow = 0.05 cfs @ 12.62 hrs, Volume= 826 cf, Atten= 70%, Lag= 29.7 min

Primary = 0.05 cfs @ 12.62 hrs, Volume= 826 cf

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 136.52' @ 12.62 hrs Surf.Area= 166 sf Storage= 148 cf

Plug-Flow detention time= 20.3 min calculated for 825 cf (100% of inflow)

Center-of-Mass det. time= 20.0 min (930.1 - 910.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	175 cf	6.40'W x 26.00'L x 4.75'H Field A
			790 cf Overall - 353 cf Embedded = 437 cf x 40.0% Voids
#2A	135.43'	266 cf	Concrete Galley 4x4x4 x 6 Inside #1
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

441 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134.93'	8.270 in/hr Exfiltration over Wetted area

Primary OutFlow Max=0.05 cfs @ 12.62 hrs HW=136.52' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.05 cfs)

Page 56

Pond 14P: Galley System #2 (rear) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

6 Chambers/Row x 4.00' Long = 24.00' Row Length +12.0" End Stone x 2 = 26.00' Base Length

1 Rows x 52.8" Wide + 12.0" Side Stone x 2 = 6.40' Base Width

6.0" Base + 48.0" Chamber Height + 3.0" Cover = 4.75' Field Height

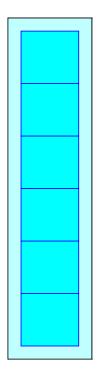
6 Chambers x 44.3 cf = 266.1 cf Chamber Storage

6 Chambers x 58.9 cf = 353.3 cf Displacement

790.4 cf Field - 353.3 cf Chambers = 437.1 cf Stone x 40.0% Voids = 174.9 cf Stone Storage

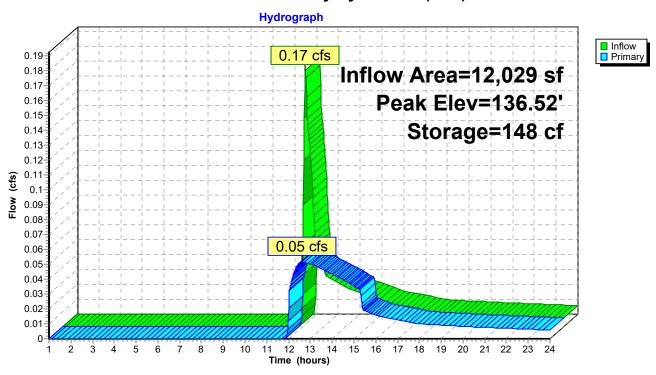
Chamber Storage + Stone Storage = 440.9 cf = 0.010 af Overall Storage Efficiency = 55.8% Overall System Size = 26.00' x 6.40' x 4.75'

6 Chambers 29.3 cy Field 16.2 cy Stone

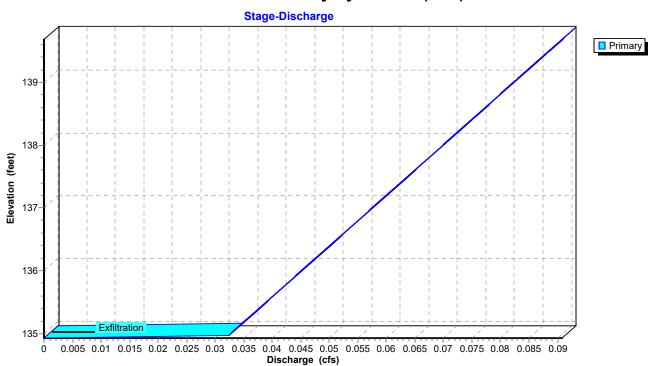




Pond 14P: Galley System #2 (rear)



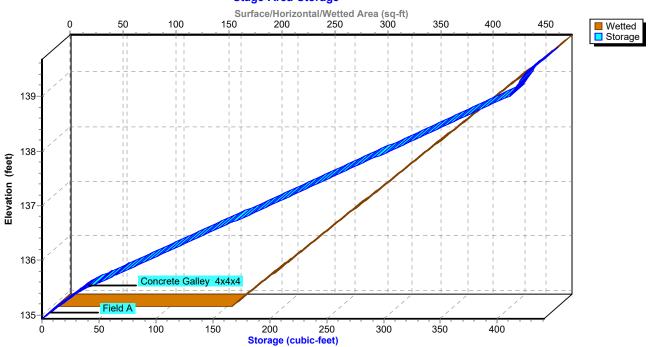
Pond 14P: Galley System #2 (rear)



Page 58

Pond 14P: Galley System #2 (rear)





Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 59

Summary for Pond 18P: Infiltration Basin #1

Inflow Area = 5,544 sf, 0.00% Impervious, Inflow Depth > 0.34" for 25-Year event

Inflow = 0.01 cfs @ 12.34 hrs, Volume= 156 cf

Outflow = 0.00 cfs @ 17.81 hrs, Volume= 97 cf, Atten= 82%, Lag= 328.2 min

Discarded = $0.00 \text{ cfs } \bar{\text{@}} 17.81 \text{ hrs, Volume} = 97 \text{ cf}$

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 135.16' @ 17.81 hrs Surf.Area= 457 sf Storage= 69 cf

Plug-Flow detention time= 278.0 min calculated for 97 cf (63% of inflow)

Center-of-Mass det. time= 143.7 min (1,116.5 - 972.8)

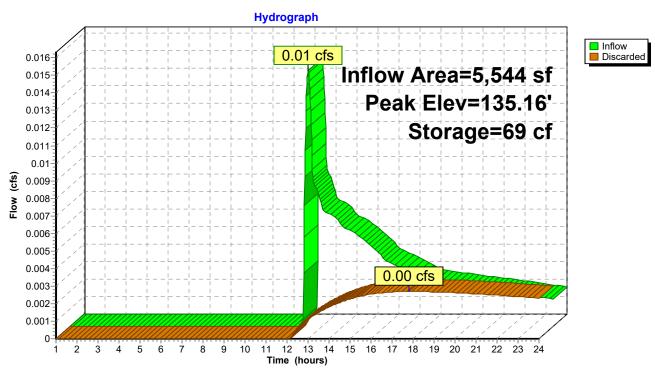
Volume	Invert	Avail.Sto	rage Stora	ge Description		
#1	135.00'	3,1	60 cf Custo	om Stage Data (Co	onic)Listed below	(Recalc)
Elevation (feet)	Su	ırf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
135.00 136.00		410 748	571	0 571	410 758	
138.00		1,934	2,590	3,160	1,971	
Device R	outing	Invert	Outlet Devi	ices		

#1 Discarded 135.00' **2.410 in/hr Exfiltration over Wetted area above 135.00'** Excluded Wetted area = 410 sf

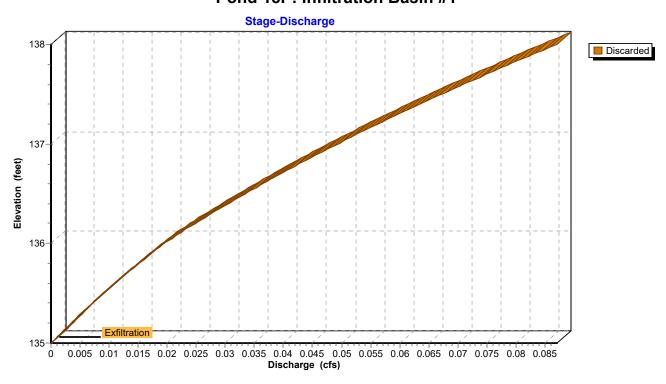
Discarded OutFlow Max=0.00 cfs @ 17.81 hrs HW=135.16' (Free Discharge) **1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Printed 7/6/2020 Page 60

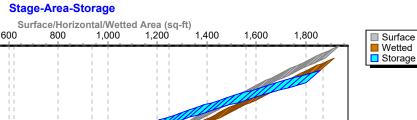
Pond 18P: Infiltration Basin #1

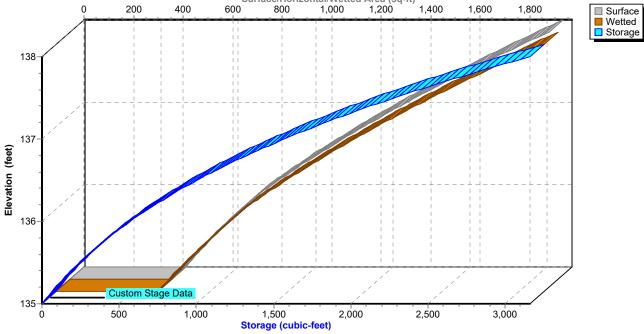


Pond 18P: Infiltration Basin #1



Pond 18P: Infiltration Basin #1





Type III 24-hr 100-Year Rainfall=7.00"

Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 62

Time span=1.00-24.00 hrs, dt=0.02 hrs, 1151 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Pre 1 Runoff Area=77,969 sf 0.00% Impervious Runoff Depth>0.43"

Flow Length=265' Tc=17.4 min CN=34 Runoff=0.22 cfs 2,777 cf

Subcatchment6S: Post 1 Runoff Area=25,533 sf 92.54% Impervious Runoff Depth>6.29"

Flow Length=131' Slope=0.0200 '/' Tc=1.2 min CN=94 Runoff=4.63 cfs 13,379 cf

Subcatchment8S: Post 2 Runoff Area=12,029 sf 15.46% Impervious Runoff Depth>1.49"

Flow Length=136' Slope=0.0150 '/' Tc=6.7 min CN=48 Runoff=0.39 cfs 1,492 cf

Subcatchment 12S: Post 5 BLD Runoff Area=7,012 sf 100.00% Impervious Runoff Depth>6.75"

Tc=5.0 min CN=98 Runoff=1.14 cfs 3,947 cf

Subcatchment 15S: Post 3 Runoff Area=5,544 sf 0.00% Impervious Runoff Depth>0.77"

Flow Length=88' Slope=0.0700 '/' Tc=3.3 min CN=39 Runoff=0.06 cfs 355 cf

Subcatchment 16S: Post 4 Runoff Area=20,361 sf 0.00% Impervious Runoff Depth>0.31"

Flow Length=116' Tc=4.1 min CN=32 Runoff=0.03 cfs 533 cf

Subcatchment 17S: Post 6 Runoff Area=7,956 sf 6.35% Impervious Runoff Depth>1.07"

Flow Length=116' Tc=4.1 min CN=43 Runoff=0.17 cfs 711 cf

Pond 3P: Galley System #1 (front) Peak Elev=139.26' Storage=8,627 cf Inflow=5.65 cfs 18,037 cf

Discarded=0.24 cfs 13,349 cf Primary=0.13 cfs 446 cf Outflow=0.37 cfs 13,795 cf

Pond 14P: Galley System #2 (rear) Peak Elev=138.83' Storage=392 cf Inflow=0.39 cfs 1,492 cf

Outflow=0.08 cfs 1,491 cf

Pond 18P: Infiltration Basin #1 Peak Elev=135.36' Storage=165 cf Inflow=0.06 cfs 355 cf

Outflow=0.01 cfs 231 cf

Total Runoff Area = 156,404 sf Runoff Volume = 23,194 cf Average Runoff Depth = 1.78" 78.90% Pervious = 123,400 sf 21.10% Impervious = 33,004 sf

Prepared by {enter your company name here}
HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Printed 7/6/2020

Page 63

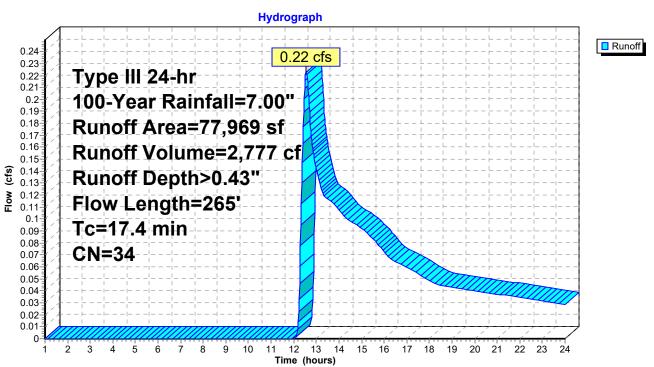
Summary for Subcatchment 1S: Pre 1

Runoff = 0.22 cfs @ 12.55 hrs, Volume= 2,777 cf, Depth> 0.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 100-Year Rainfall=7.00"

_	Α	rea (sf)	CN [Description		
		21,962	30 \	Noods, Go	od, HSG A	
_		56,007	35 E	Brush, Fair,	HSG A	
		77,969	34 \	Neighted A	verage	
		77,969	1	100.00% Pe	ervious Are	a
	_		01			D 1.0
	Tc	Length	Slope	Velocity	Capacity	Description
-	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
	13.8	50	0.0130	0.06		Sheet Flow, 1
						Woods: Light underbrush n= 0.400 P2= 3.60"
	2.2	145	0.0480	1.10		Shallow Concentrated Flow, 2
						Woodland Kv= 5.0 fps
	1.4	70	0.0280	0.84		Shallow Concentrated Flow, 3
						Woodland Kv= 5.0 fps
	17.4	265	Total			

Subcatchment 1S: Pre 1



Prepared by {enter your company name here}
HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Printed 7/6/2020

Page 64

Summary for Subcatchment 6S: Post 1

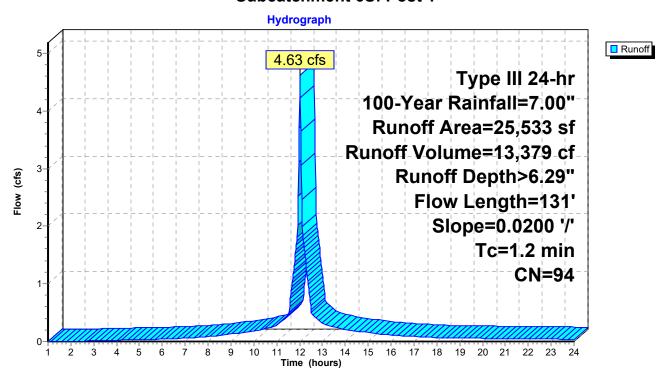
[49] Hint: Tc<2dt may require smaller dt

Runoff = 4.63 cfs @ 12.02 hrs, Volume= 13,379 cf, Depth> 6.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 100-Year Rainfall=7.00"

	Area (sf)	CN [Description						
	1,906	39 >	>75% Grass cover, Good, HSG A						
	23,627	98 F	Paved park	ing, HSG A	.				
	25,533	94 \	Veighted A	verage					
	1,906	7	7.46% Perv	ious Area					
	23,627	(92.54% lmp	pervious Ar	ea				
To		Slope	Velocity	Capacity	Description				
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)					
0.7	50	0.0200	1.27		Sheet Flow,				
					Smooth surfaces n= 0.011 P2= 3.60"				
0.5	81	0.0200	2.87		Shallow Concentrated Flow,				
					Paved Kv= 20.3 fps				
1.2	131	Total							

Subcatchment 6S: Post 1



Prepared by {enter your company name here}
HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Printed 7/6/2020

Page 65

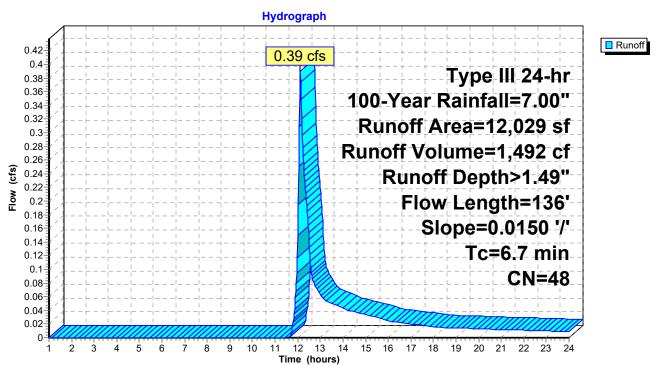
Summary for Subcatchment 8S: Post 2

Runoff = 0.39 cfs @ 12.12 hrs, Volume= 1,492 cf, Depth> 1.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 100-Year Rainfall=7.00"

	rea (sf)	CN I	Description		
	834	39 :	>75% Gras	s cover, Go	ood, HSG A
	9,335	39	>75% Gras	s cover, Go	ood, HSG A
	1,860	98 I	Paved park	ing, HSG A	\
	12,029	48 \	Weighted A	verage	
	10,169	8	34.54% Per	vious Area	
	1,860	•	15.46% lmp	pervious Ar	ea
Tc	Length	Slope	Velocity	Capacity	Description
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)	
6.0	50	0.0150	0.14		Sheet Flow,
					Grass: Short n= 0.150 P2= 3.60"
0.7	86	0.0150	1.97		Shallow Concentrated Flow,
					Unpaved Kv= 16.1 fps
6.7	136	Total			

Subcatchment 8S: Post 2



Printed 7/6/2020

Page 66

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

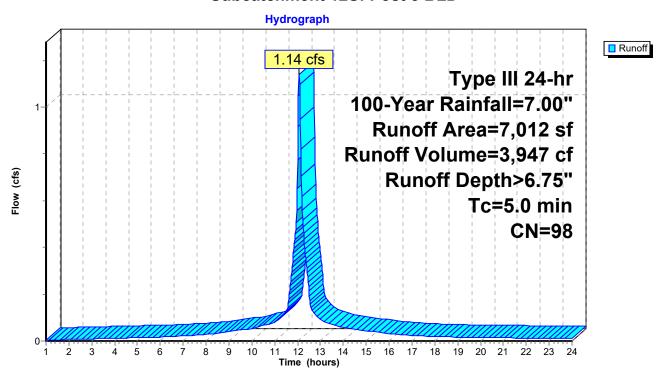
Runoff = 1.14 cfs @ 12.07 hrs, Volume= 3,947 cf, Depth> 6.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 100-Year Rainfall=7.00"

A	rea (sf)	CN I	Description		
	7,012	98 F	Roofs, HSG	A A	
	7,012	•	100.00% Im	npervious A	Area
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	(ICCI)	(IVIL)	(10/360)	(013)	Direct Entry, Roof

Summary for Subcatchment 12S: Post 5 BLD

Subcatchment 12S: Post 5 BLD



Prepared by {enter your company name here}
HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Printed 7/6/2020

Page 67

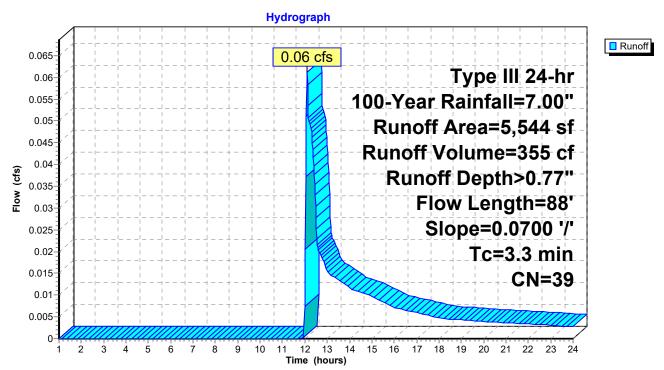
Summary for Subcatchment 15S: Post 3

Runoff = 0.06 cfs @ 12.10 hrs, Volume= 355 cf, Depth> 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 100-Year Rainfall=7.00"

_	Α	rea (sf)	CN E	Description								
		5,544	39 >	39 >75% Grass cover, Good, HSG A								
		5,544	1	00.00% Pe	ervious Are	a						
	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description						
-	3.2	50	0.0700	0.26		Sheet Flow,						
	0.1	38	0.0700	4.26		Grass: Short n= 0.150 P2= 3.60" Shallow Concentrated Flow, Unpaved Kv= 16.1 fps						
	3.3	88	Total									

Subcatchment 15S: Post 3



Prepared by {enter your company name here}
HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Printed 7/6/2020

Page 68

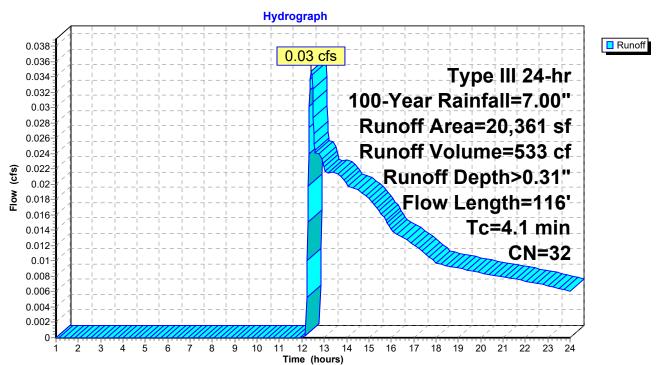
Summary for Subcatchment 16S: Post 4

Runoff = 0.03 cfs @ 12.42 hrs, Volume= 533 cf, Depth> 0.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 100-Year Rainfall=7.00"

	Α	rea (sf)	CN [Description									
		3,520	39 >	>75% Grass cover, Good, HSG A									
_		16,841	30 V	Noods, Go	/oods, Good, HSG A								
		20,361	32 \	Veighted A	verage								
		20,361	1	100.00% Pe	ervious Are	a							
	Тс	Length	Slope		Capacity	Description							
_	(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)								
	3.0	50	0.0800	0.27		Sheet Flow,							
						Grass: Short n= 0.150 P2= 3.60"							
	0.1	10	0.2000	3.13		Shallow Concentrated Flow,							
						Short Grass Pasture Kv= 7.0 fps							
	1.0	56	0.0350	0.94		Shallow Concentrated Flow,							
_						Woodland Kv= 5.0 fps							
	4.1	116	Total										

Subcatchment 16S: Post 4



Prepared by {enter your company name here}
HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Printed 7/6/2020

Page 69

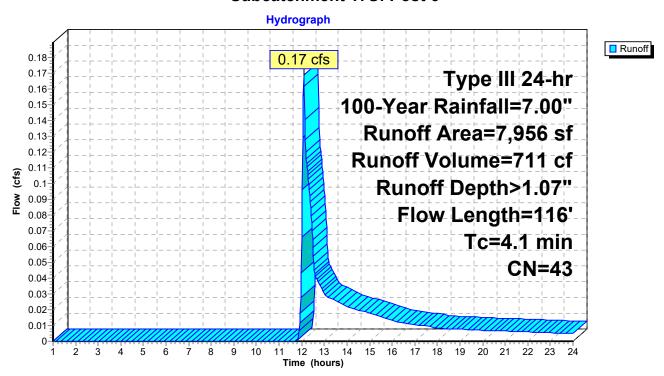
Summary for Subcatchment 17S: Post 6

Runoff = 0.17 cfs @ 12.09 hrs, Volume= 711 cf, Depth> 1.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Type III 24-hr 100-Year Rainfall=7.00"

A	rea (sf)	CN E	escription								
	4,496	39 >	>75% Grass cover, Good, HSG A								
	2,955	39 >	>75% Grass cover, Good, HSG A								
	505	98 F	aved park	ing, HSG A	L Company of the Comp						
	7,956	43 V	Veighted A	verage							
	7,451	g	3.65% Per	vious Area							
	505	6	.35% Impe	ervious Area	a						
			•								
Tc	Length	Slope	Velocity	Capacity	Description						
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)							
3.0	50	0.0800	0.27		Sheet Flow,						
					Grass: Short n= 0.150 P2= 3.60"						
0.1	10	0.2000	3.13		Shallow Concentrated Flow,						
					Short Grass Pasture Kv= 7.0 fps						
1.0	56	0.0350	0.94		Shallow Concentrated Flow,						
					Woodland Kv= 5.0 fps						
4.1	116	Total									

Subcatchment 17S: Post 6



Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 70

Summary for Pond 3P: Galley System #1 (front)

Inflow Area = 40,501 sf, 76.90% Impervious, Inflow Depth > 5.34" for 100-Year event Inflow = 5.65 cfs @ 12.02 hrs, Volume= 18,037 cf Outflow = 0.37 cfs @ 13.31 hrs, Volume= 13,795 cf, Atten= 93%, Lag= 77.3 min Discarded = 0.24 cfs @ 13.31 hrs, Volume= 13,349 cf Primary = 0.13 cfs @ 13.31 hrs, Volume= 446 cf

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 139.26' @ 13.31 hrs Surf.Area= 3,096 sf Storage= 8,627 cf

Plug-Flow detention time= 252.1 min calculated for 13,795 cf (76% of inflow) Center-of-Mass det. time= 167.2 min (929.0 - 761.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	2,039 cf	25.17'W x 123.00'L x 4.50'H Field A
			13,930 cf Overall - 8,831 cf Embedded = 5,098 cf x 40.0% Voids
#2A	135.43'	6,652 cf	J
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf
			5 Rows of 30 Chambers
•		0.004 .5	Tatal Assallable Ottomore

8,691 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.93'	2.410 in/hr Exfiltration over Wetted area
#2	Primary	139.00'	4.0" Vert. Orifice/Grate C= 0.600

Discarded OutFlow Max=0.24 cfs @ 13.31 hrs HW=139.26' (Free Discharge) 1=Exfiltration (Exfiltration Controls 0.24 cfs)

Primary OutFlow Max=0.13 cfs @ 13.31 hrs HW=139.26' (Free Discharge) 2=Orifice/Grate (Orifice Controls 0.13 cfs @ 1.75 fps)

Printed 7/6/2020

Page 71

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Pond 3P: Galley System #1 (front) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

52.8" Wide + 0.5" Spacing = 53.3" C-C Row Spacing

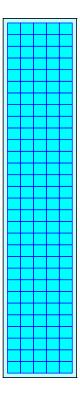
30 Chambers/Row \times 4.00' Long = 120.00' Row Length +18.0" End Stone \times 2 = 123.00' Base Length 5 Rows \times 52.8" Wide + 0.5" Spacing \times 4 + 18.0" Side Stone \times 2 = 25.17' Base Width 6.0" Base + 48.0" Chamber Height = 4.50' Field Height

150 Chambers x 44.3 cf = 6,651.7 cf Chamber Storage 150 Chambers x 58.9 cf = 8,831.5 cf Displacement

13,929.8 cf Field - 8,831.5 cf Chambers = 5,098.3 cf Stone x 40.0% Voids = 2,039.3 cf Stone Storage

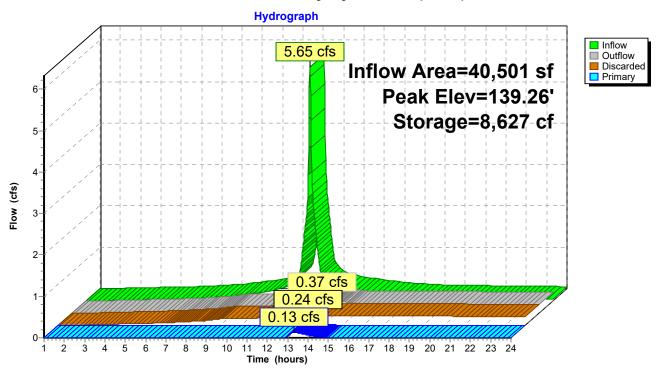
Chamber Storage + Stone Storage = 8,691.0 cf = 0.200 af Overall Storage Efficiency = 62.4% Overall System Size = 123.00' x 25.17' x 4.50'

150 Chambers 515.9 cy Field 188.8 cy Stone

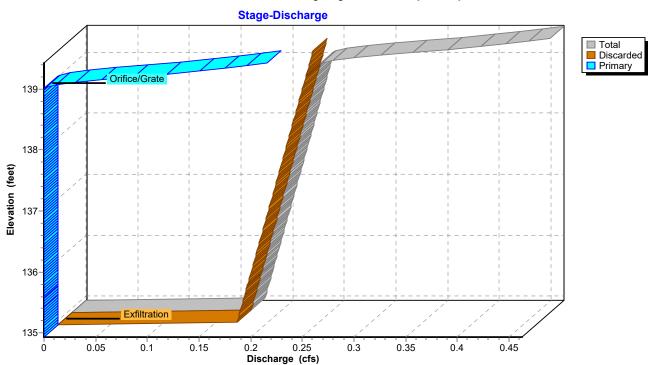


Page 72

Pond 3P: Galley System #1 (front)



Pond 3P: Galley System #1 (front)

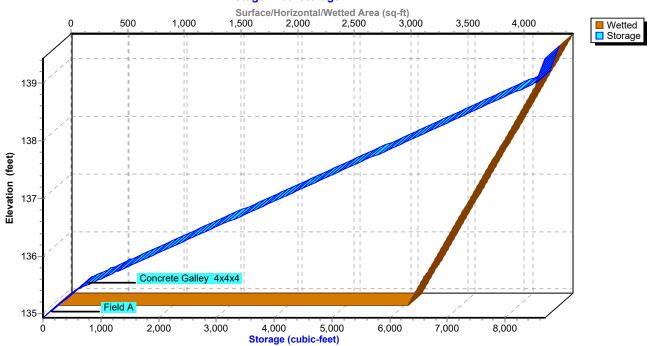


Printed 7/6/2020

Page 73

Pond 3P: Galley System #1 (front)





Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 74

Summary for Pond 14P: Galley System #2 (rear)

Inflow Area = 12,029 sf, 15.46% Impervious, Inflow Depth > 1.49" for 100-Year event

Inflow = 0.39 cfs @ 12.12 hrs, Volume= 1,492 cf

Outflow = 0.08 cfs @ 12.71 hrs, Volume= 1,491 cf, Atten= 79%, Lag= 35.5 min

Primary = 0.08 cfs @ 12.71 hrs, Volume= 1,491 cf

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 138.83' @ 12.71 hrs Surf.Area= 166 sf Storage= 392 cf

Plug-Flow detention time= 47.2 min calculated for 1,490 cf (100% of inflow) Center-of-Mass det. time= 46.8 min (933.9 - 887.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.93'	175 cf	6.40'W x 26.00'L x 4.75'H Field A
			790 cf Overall - 353 cf Embedded = 437 cf x 40.0% Voids
#2A	135.43'	266 cf	Concrete Galley 4x4x4 x 6 Inside #1
			Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf
			Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

441 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134 93'	8 270 in/hr Exfiltration over Wetted area

Primary OutFlow Max=0.08 cfs @ 12.71 hrs HW=138.83' (Free Discharge) **1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Prepared by {enter your company name here} HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC Printed 7/6/2020

Page 75

Pond 14P: Galley System #2 (rear) - Chamber Wizard Field A

Chamber Model = Concrete Galley 4x4x4 (Concrete Galley, UCPI 4x4x4 Galley or equivalent)

Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf

6 Chambers/Row x 4.00' Long = 24.00' Row Length +12.0" End Stone x 2 = 26.00' Base Length

1 Rows x 52.8" Wide + 12.0" Side Stone x 2 = 6.40' Base Width

6.0" Base + 48.0" Chamber Height + 3.0" Cover = 4.75' Field Height

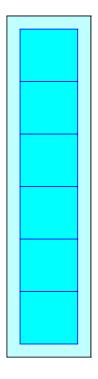
6 Chambers x 44.3 cf = 266.1 cf Chamber Storage

6 Chambers x 58.9 cf = 353.3 cf Displacement

790.4 cf Field - 353.3 cf Chambers = 437.1 cf Stone x 40.0% Voids = 174.9 cf Stone Storage

Chamber Storage + Stone Storage = 440.9 cf = 0.010 af Overall Storage Efficiency = 55.8% Overall System Size = 26.00' x 6.40' x 4.75'

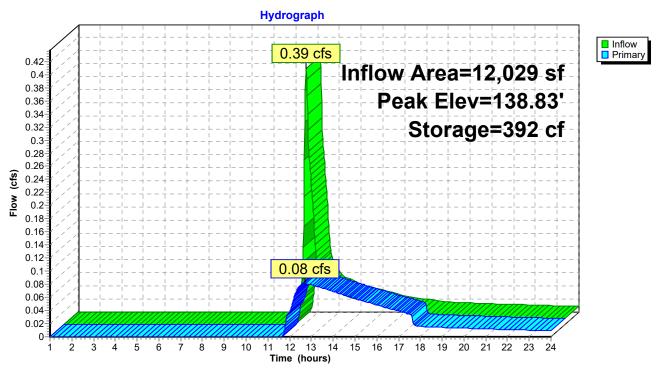
6 Chambers 29.3 cy Field 16.2 cy Stone



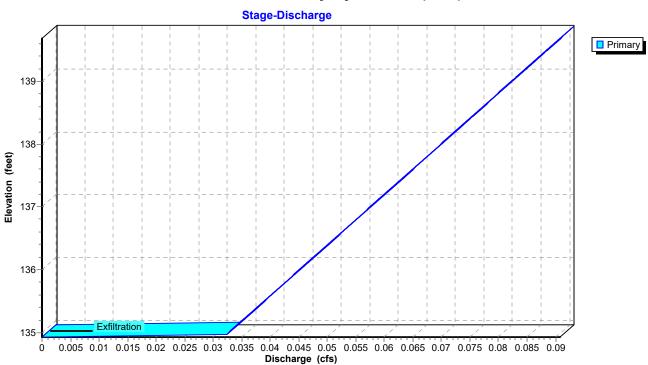


Page 76

Pond 14P: Galley System #2 (rear)



Pond 14P: Galley System #2 (rear)



139

138

136

135

Elevation (feet)

100

Concrete Galley 4x4x4

150

200

Storage (cubic-feet)

250

300

350

400

50

Field A

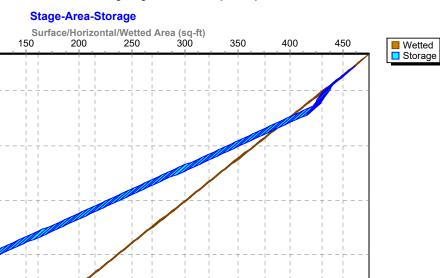
100

50

Printed 7/6/2020

Page 77

Pond 14P: Galley System #2 (rear)



Prepared by {enter your company name here}

Printed 7/6/2020

HydroCAD® 10.00-21 s/n 09955 © 2018 HydroCAD Software Solutions LLC

Page 78

Summary for Pond 18P: Infiltration Basin #1

Inflow Area = 5,544 sf, 0.00% Impervious, Inflow Depth > 0.77" for 100-Year event

Inflow = 0.06 cfs @ 12.10 hrs, Volume= 355 cf

Outflow = 0.01 cfs @ 16.77 hrs, Volume= 231 cf, Atten= 90%, Lag= 280.2 min

Discarded = $0.01 \text{ cfs } \bar{\text{@}} 16.77 \text{ hrs, Volume} = 231 \text{ cf}$

Routing by Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.02 hrs Peak Elev= 135.36' @ 16.77 hrs Surf.Area= 519 sf Storage= 165 cf

Plug-Flow detention time= 289.6 min calculated for 231 cf (65% of inflow)

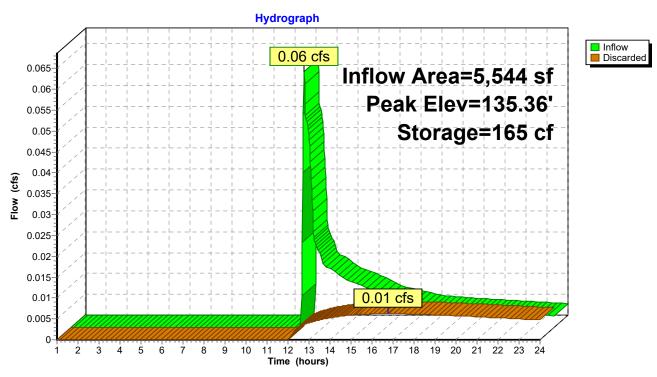
Center-of-Mass det. time= 163.9 min (1,091.6 - 927.7)

Volume	Invert	Avail.Sto	rage Stora	ge Description		
#1	135.00'	3,1	60 cf Cust	om Stage Data (Co	onic)Listed below	(Recalc)
Elevation (feet)	Su	rf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)	
135.00 136.00		410 748	571	0 571	410 758	
138.00		1,934	2,590	3,160	1,971	
Device R	outing	Invert	Outlet Dev	ices		

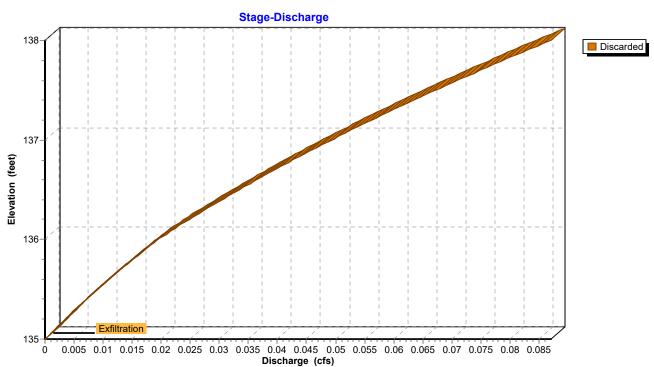
#1 Discarded 135.00' **2.410 in/hr Exfiltration over Wetted area above 135.00'** Excluded Wetted area = 410 sf

Discarded OutFlow Max=0.01 cfs @ 16.77 hrs HW=135.36' (Free Discharge) **1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Pond 18P: Infiltration Basin #1



Pond 18P: Infiltration Basin #1



500

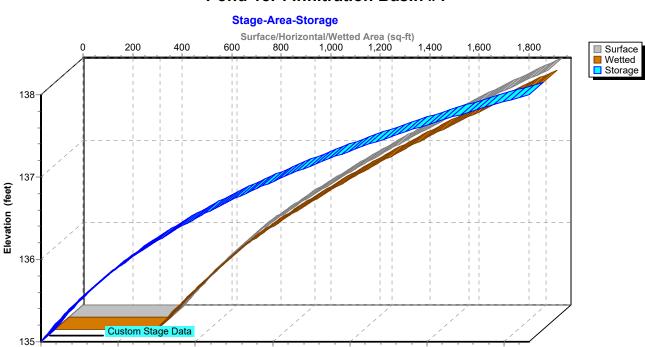
1,000

1,500

Storage (cubic-feet)

Page 80

Pond 18P: Infiltration Basin #1



2,000

2,500

3,000

Section II Stormwater Management

♦ STANDARD #1 No New Stormwater Conveyances

The proposed development proposes no new stormwater conveyances that discharge untreated stormwater off-site or cause down gradient erosion.

♦ STANDARD #2 Post Development Peak Discharge

The overall site analysis demonstrates that the stormwater management system has been designed so that the post-development peak discharge rates do not exceed the pre-development discharge rate for the 2yr, 10 yr, 25yr & 100 yr 24 hr storm events.

♦ STANDARD #3 RECHARGE TO GROUNDWATER

Parking Lot: area = 23,627 s.f.

23,627 sf (A-soils) x (D) 0.6" x
$$\frac{1}{12}$$
 = 1182 cf

Proposed:

Retained volume in subsurface system (2 year Storm) = 2959 (galley system) cf

Drawdown Within 72 Hours

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:

 $Rv = Storage\ Volume\ (required\ recharge\ volume)$

K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, use Rawls Rate (see Table 2.3.3). For "Dynamic Field" Method, use 50% of the in-situ saturated hydraulic conductivity.

Bottom Area = Bottom Area of Recharge Structure

Subsurface System #1 (Total impervious = 23,627) Rv = 1182 CF Storage Volume (galley system) = 8627 CF stored below outlet

Time =
$$\frac{8627 \text{ CF}}{(8.27")(1'/12")(2972 \text{ SF})}$$
 = 4.2 hours < 72 hours

Subsurface System #2 (Total impervious = 1,860) Rv = 1182 CF Storage Volume (galley system) = 392 CF stored below outlet

Time =
$$\frac{392 \text{ CF}}{(8.27")(1'/12")(252 \text{ SF})}$$
 = 2.25 hours < 72 hours

Infiltration Basin #1 (Total impervious = 0)

165 CF stored below outlet

Time =
$$\frac{165 \text{ CF}}{(8.27")(1'/12")(410 \text{ SF})}$$
 = 0.58 hours < 72 hours

♦ STANDARD #4 WATER QUALITY

WATER QUALITY TREATMENT VOLUME

 $V_{WQ} = (D_{WQ}/12 \text{ inches/foot}) * (A_{IMP} * 43,560 \text{ square feet/acre})$

 V_{WQ} = Required Water Quality Volume (in cubic feet)

Dwo = Water Quality Depth: one-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near another critical area, runoff from a LUHPPL, or exfiltration to soils with infiltration rate greater than 2.4 inches/hour or greater; ½-inch for discharges near or to other areas.

 A_{IMP} = Impervious Area (in acres)

The site is not located within a Zone II or Interim Wellhead Protection Area, to or near another critical area, runoff from a LUHPPL. The site is located in an area with exfiltration to soils with infiltration rate equal 2.4 inches/hour or greater so a Water Quality Depth of 1-inch is required.

Required water quality volume

 $V_{WQ} = (1 \text{ inch/}12 \text{ inches/foot}) * (23,627 \text{ square feet}) = 1969 \text{ CF}$

Total Proposed:

Retained volume in Subsurface system #2 = 8627 cf (100 year Storm)

Mounding Analysis

"Mounding analysis is required when the vertical separation from the bottom of an exfiltration system to seasonal high groundwater is less than four (4) feet and the recharge system is proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm (e.g., 10-year, 25-year, 50-year, or 100-year 24-hour storm). In such cases, the mounding analysis must demonstrate that the Required Recharge Volume (e.g., infiltration basin storage) is fully dewatered within 72 hours (so the next storm can be stored for exfiltration). The mounding analysis must also show that the groundwater mound that forms under the recharge system will not break out above the land or water surface of a wetland (e.g., it doesn't increase the water sheet elevation in a Bordering Vegetated Wetland, Salt Marsh, or Land Under Water within the 72-hour evaluation period)."

"The Hantush" or other equivalent method may be used to conduct the mounding analysis. The Hantush method predicts the maximum height of the groundwater mound beneath a rectangular or circular recharge area. It assumes unconfined groundwater flow, and that a linear relation exists between the water table elevation and water table decline rate. It results in a water table recession hydrograph depicting exponential decline. The Hantush method is available in proprietary software and free on-line calculators on theWeb in automated format. If the analysis indicates the mound will prevent the infiltration BMP from fully draining within the 72-hour period, an iterative process must be employed to determine an alternative design that drains within the 72-hour period."

No modifications were made to the existing bio-retention basin, no analysis for this system.

Mounding analysis is required when the vertical separation from the bottom of the exfiltration system to seasonal high groundwater is less than 4 ft. The mounding analysis must show that the groundwater mound that forms under the recharge system will not breakout above the land.

<u>Subsurface System #1</u> using the Hantush Method, 2972 sf bottom area (123 x 24), volume below outlet 8627. Recharge infiltration rate = 8627/2972 = 2.9 ft\day and an initial saturated thickness of 40 feet, we calculated a groundwater mounding of 1.92 feet. Groundwater separation = 2 ft groundwater separation mounding will not breakout above the land

<u>Subsurface System #2</u> using the Hantush Method, 252 sf bottom area (42 x 6), volume below outlet 392. Recharge infiltration rate = 392/252 = 1.5 ft\day and an initial saturated thickness of 40 feet, we calculated a groundwater mounding of 0.16 feet.

Groundwater separation = 2 ft mounding will not breakout above the land

-

¹ Hantush 1967 – See Reference for Standard 3.

<u>Infiltration Basin #1</u> using the Hantush Method, 748 sf bottom area (40 x 20), volume below outlet 165. Recharge infiltration rate = 165/748 = 0.22 ft\day and an initial saturated thickness of 40 feet, we calculated a groundwater mounding of 0.07 feet.

Groundwater separation = 2 ft mounding will not breakout above the land

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

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.

Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

Input Values		use consistent units (e.g. feet & days or inches & hours) Conversion Table inch/hour feet/day	
0.2200	R	Recharge (infiltration) rate (feet/day) 0.67 1.33	
0.270	Sy	Specific yield, Sy (dimensionless, between 0 and 1)	
20.00	K	Hartmantal hardwards conductivity. Wh. Mart I do 18	
20.000	x	1/2 length of basin (x direction, in feet) 1/2 length of basin (x direction, in feet) 1/2 length of basin (x direction, in feet) (USGS SIR 2010-5102), vertical soil permeability	hv
10.000	у	1/2 width of basin (y direction, in feet) hours days (ft/d) is assumed to be one-tenth horizontal	у
1.000	ť	duration of infiltration period (days) 36 1.50 hydraulic conductivity (ft/d).	
40.000	hi(0)	initial thickness of saturated zone (feet)	
water Mounding, in	h(max) Δh(max) Distance from center of basin in x direction, in feet 0 20	maximum thickness of saturated zone (beneath center of basin at end of infiltration period) maximum groundwater mounding (beneath center of basin at end of infiltration period) Re-Calculate Now	
0.029	40		
0.022	50	Groundwater Mounding in feet	
0.017	60	Groundwater Mounding, in feet	
0.013	70	0.080	
0.010	80	0.070	
0.007	90	0.060	
0.006	100	0.050	
0.003	120	0.040	
		0,030	
		0.020	
		0.010	
		0.000	

Disclaimer

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

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

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.

Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

		use consistent	units (e.g. fee	et & days o	r inches & l	hours)	Conve	rsion 1	Table		
Input Values							inch/h	our	feet/da	у	
2.9000	R	Recharge (in	filtration) rat	e (feet/da	ay)			0.67	,	1.33	
0.270	Sy	Specific yield	l, Sy (dimens	ionless, be	etween 0 a	and 1)					
20.00	K	Horizontal h	ydraulic cond	luctivity, k	(h (feet/d	lay)*		2.00)	4.00	In the report accompanying this spreadsheet
61.500	x	1/2 length of	f basin (x dire	ection, in f	eet)						(USGS SIR 2010-5102), vertical soil permeability
11.500	у	1/2 width of	basin (y dire	ction, in f	eet)		hours		days		(ft/d) is assumed to be one-tenth horizontal
1.000	t	duration of i	nfiltration pe	riod (days	s)			36	6	1.50	hydraulic conductivity (ft/d).
40.000	hi(0)	initial thickn	ess of satura	ted zone (feet)						
water Mounding, in	h(max) Δh(max) Distance from center of basin in x direction, in feet	maximum th maximum gr	oundwater r	nounding	•						•
1.859	20	Re-Ca	alculate	Now							
1.651 1.466	40 50										
1.185	60			Grou	undwa	ter Mou	ınding,	in f	eet		
0.867	70		2.500 —								
0.647	80		2.500								
0.488	90		2.000								
0.369	100				_						
0.210	120		1.500								
			1.000			-					_
			0.500					—			
			0.000							•	
Diselain			0.000	20	40	60	80	100	12	0	140

Disclaimer

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

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

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.

Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

Input Values		use consistent	units (e.g. fe	et & days or i	inches & ho	urs)	Conver		able feet/da	v	
1.5000	R	Recharge (inf	filtration) ra	te (feet/day	₍)		•	0.67	-	1.33	
0.270	Sy	Specific yield			-	d 1)					
20.00	K	Horizontal hy				•		2.00		4.00	In the report accompanying this spreadsheet
21.000	x	1/2 length of	, f basin (x dir	ection, in fe	et)						(USGS SIR 2010-5102), vertical soil permeability
3.000	У	1/2 width of	•		•		hours		days		(ft/d) is assumed to be one-tenth horizontal
1.000	t	duration of in	nfiltration p	eriod (days)	•			36	•		hydraulic conductivity (ft/d).
40.000	hi(0)	initial thickne	ess of satura	ited zone (fe	eet)						
0.169	h(max) Δh(max)	maximum th maximum gr			•						•
	ance from										
	ter of basin										
Mounding, in in x feet feet											
0.169	0										
0.129	20	Re-Ca	alculate	Now							
0.064	40										
0.049	50										
0.037	60			Grou	ndwate	er Mound	ding,	in fe	eet		
0.029	70		0.180				•				
0.022	80		0.160								
0.017	90		0.140								
0.013	100		0.120	X							
0.008	120		0.100								
			0.080								
			0.060								
			0.040		_						
			0.020					_			
			0.000							•	
			0	20	40	60 8	80	100	12	0	140

Disclaimer

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

INSTRUCTIONS: Version 1, Automated: Mar. 4, 2008

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

Location: Primrose School - Pretreatment Post #1

	В	С	D	Е	F
		TSS Removal	Starting TSS	Amount	Remaining
	BMP ¹	Rate ¹	Load*	Removed (C*D)	Load (D-E)
neet	Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Removal on Worksheet	Oil Grit Separator	0.25	0.75	0.19	0.56
Remion W		0.00	0.56	0.00	0.56
TSS ReCalculation		0.00	0.56	0.00	0.56
Cal		0.00	0.56	0.00	0.56
	5		SS Removal =		Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 20-083
Prepared By: KG
Date: 7/6/2020

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

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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

Location: Primrose School - Post 1

	В	С	D	E	F
		TSS Removal	Starting TSS	Amount	Remaining
	BMP ¹	Rate ¹	Load*	Removed (C*D)	Load (D-E)
neet	Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Removal on Workshe	Oil Grit Separator	0.25	0.75	0.19	0.56
Rem on W	Subsurface Infiltration Structure	0.80	0.56	0.45	0.11
TSS Reculation		0.00	0.11	0.00	0.11
T					
		0.00	0.11	0.00	0.11
					Separate Form Needs to

Total TSS Removal =

be Completed for Each
Outlet or BMP Train

Project: 20-083
Prepared By: KG
Date: 7/6/2020

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

INSTRUCTIONS: Version 1, Automated: Mar. 4, 2008

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

Location: Primrose School - Post 3

	В	С	D	E	F
		TSS Removal	Starting TSS	Amount	Remaining
	BMP ¹	Rate ¹	Load*	Removed (C*D)	Load (D-E)
+					
Removal	Sediment Forebay	0.25	1.00	0.25	0.75
0 2	Sediment Forebay	0.25	0.75	0.19	0.56
e ≥					
S 5		0.00	0.56	0.00	0.56
SS					
⊢ =		0.00	0.56	0.00	0.56
TSS Re					
		0.00	0.56	0.00	0.56
		Total 7	CC Domovel -		Separate Form Needs to be Completed for Each
		i otai i	SS Removal =	44%	Outlet or BMP Train

Project: 20-083 Prepared By: KG Date: 7/6/2020

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

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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

Location: Primrose School - Post 3

	В	С	D	E	F
		TSS Removal	Starting TSS	Amount	Remaining
	BMP ¹	Rate ¹	Load*	Removed (C*D)	Load (D-E)
neet	Sediment Forebay	0.25	1.00	0.25	0.75
Removal on Worksheet	Sediment Forebay	0.25	0.75	0.19	0.56
Rem on W	Subsurface Infiltration Structure	0.80	0.56	0.45	0.11
SS ati		0.00	0.11	0.00	0.11
T					
		0.00	0.11	0.00	0.11

Total TSS Removal =

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

Project: 20-083

Prepared By: KG

Date: 7/6/2020

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

INSTRUCTIONS: Version 1, Automated: Mar. 4, 2008

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

Location: Primrose School - Post 3 - Pre-Treatment

F В C D Ε TSS Removal **Starting TSS Amount** Remaining Rate¹ BMP¹ Load* Removed (C*D) Load (D-E) **Calculation Worksheet Sediment Forebay** 0.25 0.25 0.75 1.00 **TSS Removal Sediment Forebay** 0.25 0.75 0.19 0.56 0.00 0.56 0.00 0.56 0.00 0.56 0.00 0.56 0.00 0.56 0.00 0.56 Separate Form Needs to be Completed for Each Total TSS Removal = Outlet or BMP Train 44%

Project: 20-083
Prepared By: KG
Date: 7/6/2020

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

Version 1, Automated: Mar. 4, 2008

INSTRUCTIONS:

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

Location: Primrose School - Post 3

	В	С	D	Е	F
		TSS Removal	Starting TSS	Amount	Remaining
	BMP ¹	Rate ¹	Load*	Removed (C*D)	Load (D-E)
eet	Sediment Forebay	0.25	1.00	0.25	0.75
Removal on Worksheet	Sediment Forebay	0.25	0.75	0.19	0.56
Remo	Infiltration Basin	0.80	0.56	0.45	0.11
TSS ReCalculation		0.00	0.11	0.00	0.11
Calc		0.00	0.11	0.00	0.11
					Separate Form Needs to

Total TSS Removal =

be Cor Outlet

be Completed for Each
Outlet or BMP Train

Project: 20-083
Prepared By: KG
Date: 7/6/2020

*Equals remaining load from previous BMP (E)

which enters the BMP

INSTRUCTIONS: Version 1, Automated: Mar. 4, 2008

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

Date: 7/6/2020

Location: Primrose School - Post 6 - Pretreatment

	В	С	D	E	F
		TSS Removal	Starting TSS	Amount	Remaining
	BMP ¹	Rate ¹	Load*	Removed (C*D)	Load (D-E)
•	Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Removal	Deep Sump and Hooded Catch Basin Sediment Forebay	0.25	0.75	0.19	0.56
		0.00	0.56	0.00	0.56
TSS	Calculation	0.00	0.56	0.00	0.56
•	Ca	0.00	0.56	0.00	0.56
			SS Removal =	44%	Separate Form Needs to be Completed for Each Outlet or BMP Train
	Project:	20-083			_
	Prepared By:			*Equals remaining load from	n previous BMP (E)

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

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

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

Location: Primrose School - Post 6

	В	C TSS Removal	D Starting TSS	E Amount	F Remaining
	BMP ¹	Rate ¹	Load*	Removed (C*D)	Load (D-E)
neet	Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Removal on Worksheet	Sediment Forebay	0.25	0.75	0.19	0.56
Rem on W	Subsurface Infiltration Structure	0.80	0.56	0.45	0.11
TSS Re Calculation		0.00	0.11	0.00	0.11
Cal		0.00	0.11	0.00	0.11
					Separate Form Needs to

Total TSS Removal =

89%

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

Project: 20-083
Prepared By: KG
Date: 7/6/2020

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



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

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





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

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals. This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8²
- Operation and Maintenance Plan required by Standard 9

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

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

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

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

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



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Regis	ered Professional Engineer Block and Signature
	Signature and Date
	Checklist
	et Type: Is the application for new development, redevelopment, or a mix of new and elopment?
× N	ew development
☐ F	edevelopment
□ N	x of New Development and Redevelopment



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued)

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

	No disturbance to any Wetland Resource Areas
	Site Design Practices (e.g. clustered development, reduced frontage setbacks)
	Reduced Impervious Area (Redevelopment Only)
	Minimizing disturbance to existing trees and shrubs
	LID Site Design Credit Requested:
	☐ Credit 1
	☐ Credit 2
	☐ Credit 3
	Use of "country drainage" versus curb and gutter conveyance and pipe
	Bioretention Cells (includes Rain Gardens)
	Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
	Treebox Filter
	Water Quality Swale
	Grass Channel
	Green Roof
	Other (describe):
Sta	ndard 1: No New Untreated Discharges
\boxtimes	No new untreated discharges
\boxtimes	Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
\boxtimes	Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued) Standard 2: Peak Rate Attenuation Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding. Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm. Calculations provided to show that post-development peak discharge rates do not exceed predevelopment rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24hour storm. Standard 3: Recharge Soil Analysis provided. Required Recharge Volume calculation provided. Required Recharge volume reduced through use of the LID site Design Credits. Sizing the infiltration, BMPs is based on the following method: Check the method used. Static Simple Dynamic Dynamic Field¹ Runoff from all impervious areas at the site discharging to the infiltration BMP. Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume. Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason: Site is comprised solely of C and D soils and/or bedrock at the land surface ☐ Solid Waste Landfill pursuant to 310 CMR 19.000 Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable. Calculations showing that the infiltration BMPs will drain in 72 hours are provided. Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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



Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Standard 3: Recharge (continued)

- The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

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

- · Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
- ☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

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

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

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



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

Checklist for Stormwater Report

Cł	necklist (continued)
Sta	ndard 4: Water Quality (continued)
\boxtimes	The BMP is sized (and calculations provided) based on:
	☐ The ½" or 1" Water Quality Volume or
	☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
	The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
	A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.
Sta	ndard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)
	The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report. The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted <i>prior to</i> the discharge of stormwater to the post-construction stormwater BMPs.
\boxtimes	The NPDES Multi-Sector General Permit does <i>not</i> cover the land use.
	LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
\boxtimes	All exposure has been eliminated.
	All exposure has <i>not</i> been eliminated and all BMPs selected are on MassDEP LUHPPL list.
	The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.
Sta	ndard 6: Critical Areas
	The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
	Critical areas and BMPs are identified in the Stormwater Report.



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued)

indard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum ent practicable
The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
☐ Limited Project
 ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area. ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected
from exposure to rain, snow, snow melt and runoff
Bike Path and/or Foot Path
Redevelopment Project
Redevelopment portion of mix of new and redevelopment.
Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

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

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

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Massachusetts Department of Environmental Protection

Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

Checklist (continued) Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued) The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has not been included in the Stormwater Report but will be submitted **before** land disturbance begins. The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report. The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins. Standard 9: Operation and Maintenance Plan The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information: Name of the stormwater management system owners; Party responsible for operation and maintenance; Schedule for implementation of routine and non-routine maintenance tasks; Plan showing the location of all stormwater BMPs maintenance access areas; Description and delineation of public safety features; Estimated operation and maintenance budget; and □ Operation and Maintenance Log Form. The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions: A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs; A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions. Standard 10: Prohibition of Illicit Discharges ☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges; An Illicit Discharge Compliance Statement is attached; NO Illicit Discharge Compliance Statement is attached but will be submitted *prior to* the discharge of

any stormwater to post-construction BMPs.

♦ STANDARD #5 Land Uses With Higher Potential Pollutant Loads

Daycare/pre-schools are not a land use with higher potential pollutant load.

♦ STANDARD #6 Critical Areas

The site is not located within an aquifer protection Zone II or Interim Wellhead Protection Area.

♦ STANDARD #7 Redevelopment

The project is not a redevelopment project.

♦ STANDARD #8 Erosion & Sediment Control Plan

Erosion and sediment controls are detailed within the site plan.

♦ STANDARD #9 Operation & Maintenance Plan

See O&M plan attached hereto.

♦ STANDARD #10 Illicit Discharge Statement

"All illicit discharges to the stormwater management system are prohibited."

This statement is intended to meet Standard #10 of the Stormwater Management requirements

Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater.

Except for the potential for deliberate criminal act of discharge by an unauthorized entity for which the property owner has no control, there are to be no illicit discharges into the stormwater system.

Applicant\Owner	

Section III Operation & Maintenance

OPERATION AND MAINTENANCE PLAN

PROPOSED SITE WORK – DURING CONSTRUCTION Map 9 Lot 9, 38, 41 & 42 - Hingham Street Rockland, Massachusetts

Owner:

Deluca Properties Limited Partnership
885 Washington Street
Weymouth, MA 02189
Contact: (781) 331-1100

Party Responsible for Operation and Maintenance:

ADA Architects – c/o Melissa Pless 17710 Detroit Road Lakewood, OH 44107 Contact: 216-521-5134

Source of Funding:

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

During Construction:

Construction activities shall follow the Construction Sequence shown on the approved plans. During periods of active construction the stormwater management system shall be inspected on a weekly basis and within 24 hours of a storm event of greater than ½". Maintenance tasks shall be performed monthly or after significant rainfall events of 1" of rain or greater. During construction, silt-laden runoff shall be prevented from entering the drainage system and off-site properties. Temporary swales shall be constructed as needed during construction to direct runoff to sediment traps. Infiltration systems and subsurface storage systems shall not be placed in service until after the installation of base course pavement and vegetative stabilization of the areas contributing to the systems.

During dewatering operations, all water pumped from the dewatering shall be directed to a "dirt bag" pumped sediment removal system (or approved equal) as manufactured by ACF Environmental. Water from construction dewatering activities should not be directed into any of the existing or proposed stormwater management facilities system unless it is fully treated prior to discharge. The unit shall be placed on a crushed stone blanket. Disposal of such "dirt bag" shall occur when the device is full and can no longer effectively filter sediment or allow water to pass at a reasonable flow rate. Disposal of this unit shall be the responsibility of the contractor and shall be as directed by the owner in accordance with applicable local, state, and federal guidelines and regulations.

Stabilized construction entrances shall be placed at the entrances and shall consist of $1\frac{1}{2}$ " to 2" stone and be constructed as shown on the approved plans.

All erosion and sedimentation control measures shall be in place prior to the commencement of any site work or earthwork operations, and shall be maintained during construction, and shall remain in place until all site work is complete and ground cover is established.

Heavy equipment shall not be used on basin bottoms.

All exposed soils not to be paved shall be stabilized as soon as practical. Seed mixes shall only be applied during appropriate periods as recommended by the seed supplier, typically May 1 to October 15. Any exposed soils that cannot be stabilized by vegetation during these dates shall be stabilized with hay bales, hay mulch, check dams, jute netting or other acceptable means.

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

During dry periods where dust is created by construction activities the following control measures should be implemented.

- Sprinkling The contractor may sprinkle the ground along haul roads and traffic areas until moist.
- Vegetative cover Areas that are not expected to be disturbed regularly may be stabilized with vegetative cover.
- Mulch Mulching can be used as a quick and effective means of dust control in recently disturbed areas.
- Spray on chemical soil treatments may be utilized. Application rates shall conform to manufacturers recommendations.

Illicit Discharges

Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Illicit discharges are prohibited from the stormwater management system and the stormwater management system shall be inspected for illicit discharges annually.

The following is a list of discharges that are allowed under the EPA Construction General Permit (CGP) provided that appropriate stormwater controls are designed, installed, and maintained:

- a. Stormwater discharges, including stormwater runoff, snowmelt runoff, and surface runoff and drainage, associated with construction activity under 40 CFR §122.26(b)(14) or § 122.26(b)(15)(i);
- b. Stormwater discharges designated by EPA as needing a permit under 40 CFR § 122.26(a)(1)(v) or §122.26(b)(15)(ii);
- c. Stormwater discharges from construction support activities (e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas) provided:
- i. The support activity is directly related to the construction site required to have permit coverage for stormwater discharges;
- ii. The support activity is not a commercial operation, nor does it serve multiple unrelated construction projects;
- iii. The support activity does not continue to operate beyond the completion of the construction activity at the project it supports; and
 - iv. Stormwater controls are implemented in accordance with Part 2 of the CGP and, if applicable, Part 3 of the CGP, for discharges from the support activity areas.

The following non-stormwater discharges from your construction activity, provided

that, with the exception of water used to control dust and to irrigate areas to be vegetatively stabilized, these discharges are not routed to areas of exposed soil on your site and you comply with any applicable requirements for these discharges in Part 2 of the CGP:

- i. Discharges from emergency fire-fighting activities;
- ii. Fire hydrant flushings;
- iii. Landscape irrigation;
- iv. Water used to wash vehicles and equipment, provided that there is no discharge of soaps, solvents, or detergents used for such purposes;
 - v. Water used to control dust;
 - vi. Potable water including uncontaminated water line flushings;
 - vii. Routine external building washdown that does not use detergents;
- viii. Pavement wash waters provided spills or leaks of toxic or hazardous materials have not occurred (unless all spill material has been removed) and where detergents are not used. You are prohibited from directing pavement wash waters directly into any surface water, storm drain inlet, or stormwater conveyance, unless the conveyance is connected to a sediment basin, sediment trap, or similarly effective control;
 - ix. Uncontaminated air conditioning or compressor condensate;
 - x. Uncontaminated, non-turbid discharges of ground water or spring water;
- xi. Foundation or footing drains where flows are not contaminated with process materials such as solvents or contaminated ground water; and
- xii. Construction dewatering water that has been treated by an appropriate control under Part 2.1.3.4 of the CGP; and
- e. Discharges of stormwater listed above in Parts a, b, and c, or authorized nonstormwater discharges in Part d above, commingled with a discharge authorized by a different NPDES permit and/or a discharge that does not require NPDES permit authorization.

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

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

PROJECT LOCATION: <u>Primrose School</u>	Latest Revision:	July 6, 2020
Stormwater Control Manager:		Stamp

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/ Repair Needed yes/no List items	Date of Cleaning/Repair	Performed By	Water Level in Detention System
Silt socks & swales and silt traps	After every major storm event							
Dewatering Operations	Daily- during actual dewatering							
Temporary Construction Entrance	Daily or as needed.							

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

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended. Slow release fertilizer recommended.

Other notes:(Include deviations from: Con Com Order of Conditions, PB Approval, Construction Sequence and Approved Plan)

OPERATION AND MAINTENANCE PLAN PROPOSED DRAINAGE SYSTEM – POST CONSTRUCTION

Map 9 Lot 9, 38, 41 & 42 - Hingham Street Rockland, Massachusetts

Owner:

ADA Architects – c/o Melissa Pless 17710 Detroit Road Lakewood, OH 44107 Contact: 216-521-5134

2

Party Responsible for Operation and Maintenance:

After construction is complete the owner will be the party responsible for operation and maintenance of the drainage system. When the property is conveyed, the new owner will be the party responsible for operation and maintenance.

Source of Funding:

Operation and Maintenance of this stormwater management system will be the responsibility of the owner. The estimated annual budget for the operation and maintenance of the stormwater system is \$3000.

Schedule for Inspection and Maintenance:

Deep Sump Catch Basins and structural Sediment Forebays

Deep sump catch basins shall be inspected after every major storm event during construction and cleaned when sediment exceeds 18" depth. After construction when all slopes have been stabilized, basins shall be cleaned a minimum of twice per year. Disposal of the accumulated sediment shall be in accordance with applicable local, state, and federal guidelines and regulations.

Oil & Grit Separator

Responsibility for maintenance: Owner

At a minimum, inspect sediment forebays monthly and clean them out at least 2 times per year. The tank can be cleaned with a vacuum truck or standard catch basin device. Cleaning includes removal of accumulated oil grease and sediment.

Any sediment removed from all drainage systems should be disposed of in accordance with Town, State and Federal Regulations.

Local companies that provide vacuum cleaning include:

John Hoadley & Sons, 672 Union St, Rockland, MA 02370, (781) 878-8098

Salt shall not be used on paved surfaces.

Subsurface Drainage Systems Maintenance Schedule

Activity Time of Year Frequency

Inspect Inlets and access manholes twice per year Remove any debris that might clog the system

After construction, the systems should be inspected for standing water 1-2 days after any significant rainfall exceeding 1" of rainfall in 24 hours or major storm event. If the system is continuing to hold standing water after 2 days the owner should have it inspected and repaired. The systems should also be inspected to verify whether infiltration function has been lost. If infiltration capacity has become degraded, it should be restored under the direction of a qualified professional.

The subsurface systems should be inspected twice per year and at least once per year by a drainage system professional to ensure that the system is operating as intended. The owner shall implement and pay for the inspector's recommendations.

Sediment Forebays (at grade)

At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational. When mowing grasses, keep the grass height lower than 6 inches, check for signs of riling and gullying and repair as needed. After removing sediment, replace any vegetation damaged during the clean-out by re-seeding or sodding. When re-seeding, incorporate practices such as hydro seeding with a tackifier, blanket or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Any sediment removed from the infiltration systems should be disposed of in accordance with Town, State and Federal Regulations.

Infiltration Basin

The Infiltration BMP's should be inspected on a quarterly basis: additional inspections should be scheduled during the first few months to make sure the vegetation is established adequately and also following major storm events. Additional inspections are required following any storm event that exceeds 2.5 inches in 24-hour period (the one-year frequency storm). Evidence of standing water for more than 48 hours following a storm would indicate possible failure of the infiltration surface. In that case, a qualified professional engineer should be retained to assess the cause of failure and recommend corrective action, which should be immediately implemented to restore the function of the system. The basin should be inspected for slope integrity, soil moisture, vegetative health, soil stability, soil compaction, soil erosion, ponding and sedimentation. The basin should be mowed twice per year.

Regular maintenance tasks include mowing, watering, and weed and pest control. Only organic fertilizers, weed and pest control will be utilized.

Sediment and debris should be removed manually, at least twice per year, before the vegetation is impacted adversely. Periodic mowing (Twice per year) may be required to maintain the dense growth of vegetation. Care should be taken to protect basin from snow removal procedures and off street parking.

Lawn Fertilization

Lawn fertilizer shall be slow release and limited to 3 lbs per 1000 s.f. per year.

Stormwater Contamination Prevention

Exterior storage of hazardous materials including deicing chemicals, fertilizers, herbicides, pesticides, and other hazardous materials is prohibited. All materials are to be stored inside of the buildings no exterior storage of materials is allowed. No fueling of equipment is allowed on the premises and is prohibited.

Individual storage unit users shall be notified of the prohibition of illicit discharges to the stormwater management system.

Snow Removal and De-icing

Snow removal will be the responsibility of the Owner. Snow will be plowed from Parking areas and driveways and shoveled or removed with a snow blower from walkways. Snow will be stored along roadways and walkways as shown on the Site Plan. If additional stockpiling area is needed, excess snow will be removed from the site with proper off-site disposal. Snow shall be stockpiled in areas where melting will be directed through the drainage systems and not directly to the wetlands. Stockpiling within any rain garden and infiltration areas is prohibited.

Inspections

Yearly inspections of the stormwater management system shall be performed and an Inspection Schedule and Evaluation Checklist shall be maintained by the Owner and made available to regulatory officials if requested. Copies of the receipts for cleaning of the systems shall also be maintained.

The Owner shall be responsible to secure the services of a Licensed Engineer on an on-going basis. The inspector shall review the project with respect to the following:

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

The Engineer shall prepare, stamp and submit, to the Owner, a report documenting the findings and should request the required maintenance or repair for the pollution prevention controls when the inspector finds that it is necessary for the control to be effective (see attached Inspection Schedule and Evaluation Checklist). The inspector shall notify the Owner to make the changes.

The owner and/or their employees responsible for the O&M of the stormwater management system shall be trained annually. Records of trained individuals shall be kept and submitted to the town with the check list. The records shall indicate the latest training date.

The attached inspection form shall be retained and kept available for a minimum of three years.

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

Definition of Major Storm Event

For the purposes of this operation and maintenance plan a major storm event should be defined as a rainfall of such intensity or duration that causes observable movement of sediment on the roadway or site. It is the intent of this plan to prevent this sediment from entering the drainage system. Prior to stabilization of the site this may occur more frequently with less intense storms. As the site is stabilized with ground cover the movement of sediment will only occur during more severe storms.

Illicit Discharges

Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Illicit discharges are prohibited from the stormwater management system and the stormwater management system shall be inspected for illicit discharges annually.

This Standard prohibits illicit discharges to stormwater management systems. The stormwater management system is the system for conveying, treating, and infiltrating stormwater on-site, including stormwater best management practices and any pipes intended to transport stormwater to the groundwater, a surface water, or municipal separate storm sewer system. Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Notwithstanding the foregoing, an illicit discharge does not include discharges from the following activities or facilities: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents.

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

STORMWATER MANAGEMENT **BEST MANAGEMENT PRACTICES**

INSPECTION SCHEDULE AND EVALUATION CHECKLIST – POST CONSTRUCTION PHASE

PROJECT LOCATION: <u>Primrose Schools</u> Latest Revision July 6, 2020

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/ Repair Needed yes/no List items	Date of Cleaning/ Repair	Performed By	Water Level in Drainage System
Deep Sump Hooded Catch Basins	Twice per year							
Oil & Grit Separator	Twice per yea							
Subsurface Infiltration system	Twice per year							
Structural Forbay	Twice per year							
Surface Forebay	Twice per year							
Infiltration Basin	Twice per year							

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

(2) records shall be kept for a minimum of three years.

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

Stormwater Control Manager:	Stamp

Deep Sump Catch Basin



Description: Deep sump catch basins, also known as oil and grease or hooded catch basins, are underground retention systems designed to remove trash, debris, and coarse sediment from stormwater runoff, and serve as temporary spill containment devices for floatables such as oils and greases.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	25% TSS removal credit when used for pretreatment. Because of their limited effectiveness and storage capacity, deep sump catch basins receive credit for removing TSS only if they are used for pretreatment and designed as off-line systems.
5 - Higher Pollutant Loading	Recommended as pretreatment BMP. Although provides some spill control capability, a deep sump catch basin may not be used in place of an oil grit separator or sand filter for land uses that have the potential to generate runoff with high concentrations of oil and grease such as: high-intensity-use parking lots, gas stations, fleet storage areas, vehicle and/or equipment maintenance and service areas.
6 - Discharges near or to Critical Areas	May be used as pretreatment BMP. not an adequate spill control device for discharges near or to critical areas.
7 - Redevelopment	Highly suitable.

Advantages/Benefits:

- Located underground, so limited lot size is not a deterrent.
- Compatible with subsurface storm drain systems.
- Can be used for retrofitting small urban lots where larger BMPs are not feasible.
- Provide pretreatment of runoff before it is delivered to other BMPs.
- Easily accessed for maintenance.
- Longevity is high with proper maintenance.

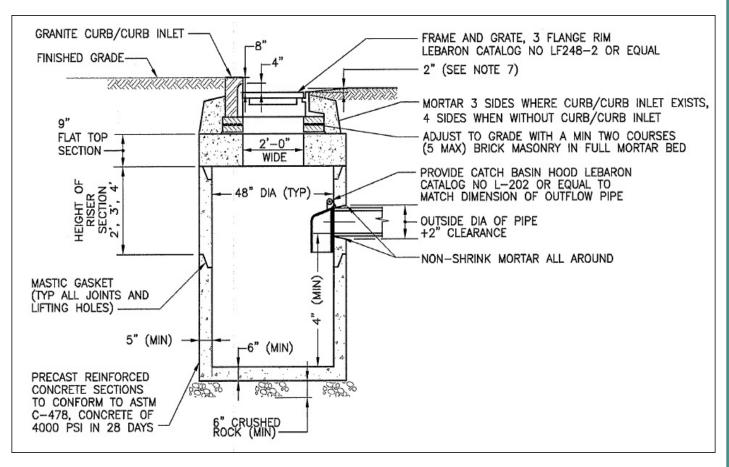
Disadvantages/Limitations:

- Limited pollutant removal.
- Expensive to install and maintain, resulting in high cost per unit area treated.
- No ability to control volume of stormwater
- Frequent maintenance is essential
- Requires proper disposal of trapped sediment and oil and grease
- Entrapment hazard for amphibians and other small animals

Pollutant Removal Efficiencies

- Total Suspended Solids (TSS) 25% (for regulatory purposes)
- Nutrients (Nitrogen, phosphorus) -Insufficient data
- Metals (copper, lead, zinc, cadmium) -Insufficient data
- Pathogens (coliform, e coli) Insufficient data

Structural BMPs - Volume 2 | Chapter 2 page 2



adapted from the University of New Hampshire

Maintenance

Activity	Frequency
Inspect units	Four times per year
Clean units	Four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.

Special Features

All deep sump catch basins must include hoods. For MassHighway projects, consult the Stormwater Handbook for Highways and Bridges for hood requirements.

LID Alternative

Reduce Impervious Surface Disconnect rooftop and non-rooftop runoff Vegetated Filter Strip

Deep Sump Catch Basin

Suitable Applications

- Pretreatment
- · Residential subdivisions
- Office
- Retail

Design Considerations

- The contributing drainage area to any deep sump catch basin should not exceed ¹/₄ acre of impervious cover.
- Design and construct deep sump catch basins as off-line systems.
- Size the drainage area so that the flow rate does not exceed the capacity of the inlet grate.
- Divert excess flows to another BMP intended to meet the water quantity requirements (peak rate attenuation) or to a storm drain system.
 An off-line design enhances pollutant removal efficiency, because it prevents the resuspension of sediments in large storms.

Make the sump depth (distance from the bottom of the outlet pipe to the bottom of the basin) at least four feet times the diameter of the outlet pipe and more if the contributing drainage area has a high sediment load. The minimum sump depth is 4 feet. Double catch basins, those with 2 inlet grates, may require deeper sumps. Install the invert of the outlet pipe at least 4 feet from the bottom of the catch basin grate.

The inlet grate serves to prevent larger debris from entering the sump. To be effective, the grate must have a separation between the grates of one square inch or less. The inlet openings must not allow flows greater than 3 cfs to enter the deep sump catch basin. If the inlet grate is designed with a curb cut, the grate must reach the back of the curb cut to prevent bypassing. The inlet grate must be constructed of a durable material and fit tightly into the frame so it won't be dislodged by automobile traffic. The inlet grate must not be welded to the frame so that sediments may be easily removed. To facilitate maintenance, the inlet grate must be placed along the road shoulder or curb line rather than a traffic lane.

Note that within parking garages, the State Plumbing Code regulates inlet grates and other stormwater

management controls. Inlet grates inside parking garages are currently required to have much smaller openings than those described herein.

To receive the 25% removal credit, hoods must be used in deep sump catch basins. Hoods also help contain oil spills. MassHighway may install catch basins without hoods provided they are designed, constructed, operated, and maintained in accordance with the Mass Highway Stormwater Handbook.

Install the weep hole above the outlet pipe. Never install the weep hole in the bottom of the catch basin barrel.

Site Constraints

A proponent may not be able to install a deep sump catch basin because of:

- Depth to bedrock;
- High groundwater;
- Presence of utilities; or
- Other site conditions that limit depth of excavation because of stability.

Maintenance

Regular maintenance is essential. Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. One study found that once 50% of the sump volume is filled, the catch basin is not able to retain additional sediments.

Inspect or clean deep sump basins at least four times per year and at the end of the foliage and snow-removal seasons. Sediments must also be removed four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin. If handling runoff from land uses with higher potential pollutant loads or discharging runoff near or to a critical area, more frequent cleaning may be necessary.

Clamshell buckets are typically used to remove sediment in Massachusetts. However, vacuum trucks are preferable, because they remove more trapped sediment and supernatant than clamshells. Vacuuming is also a speedier process and is less likely to snap the cast iron hood within the deep sump catch basin.

Always consider the safety of the staff cleaning deep sump catch basins. Cleaning a deep sump catch basin within a road with active traffic or even within a parking lot is dangerous, and a police detail may be necessary to safeguard workers.

Although catch basin debris often contains concentrations of oil and hazardous materials such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Unless there is evidence that they have been contaminated by a spill or other means, MassDEP does not routinely require catch basin cleanings to be tested before disposal. Contaminated catch basin cleanings must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.000, and handled as hazardous waste.

In the absence of evidence of contamination, catch basin cleanings may be taken to a landfill or other facility permitted by MassDEP to accept solid waste, without any prior approval by MassDEP. However, some landfills require catch basin cleanings to be tested before they are accepted.

With prior MassDEP approval, catch basin cleanings may be used as grading and shaping materials at landfills undergoing closure (see Revised Guidelines for Determining Closure Activities at Inactive Unlined Landfill Sites) or as daily cover at active landfills. MassDEP also encourages the beneficial reuse of catch basin cleanings whenever possible. A Beneficial Reuse Determination is required for such use.

MassDEP regulations prohibit landfills from accepting materials that contain free-draining liquids. One way to remove liquids is to use a hydraulic lift truck during cleaning operations so that the material can be decanted at the site. After loading material from several catch basins into a truck, elevate the truck so that any free-draining liquid can flow back into the structure. If there is no free water in the truck, the material may be deemed to be sufficiently dry. Otherwise the catch basin cleanings must undergo a Paint Filter Liquids Test. Go to www. Mass.gov/dep/recycle/laws/cafacts.doc for information on all of the MassDEP requirements pertaining to the disposal of catch basin cleanings.

Oil/Grit Separators



Advantages/Benefits:

- Located underground so limited lot size not a deterrent in urban areas with small lots
- Can be used for retrofits
- Can be installed in any soil or terrain.
- Public safety risks are low.

Disadvantages/Limitations:

- Limited pollutant removal; cannot effectively remove soluble pollutants, fine particles, or bacteria
- Can become a source of pollutants due to resuspension of sediment unless properly maintained
- Susceptible to flushing during large storms
- Limited to relatively small contributing drainage
- Requires proper disposal of trapped sediments and oils
- May be expensive to construct and maintain
- Entrapment hazard for amphibians and other small animals

Pollutant Removal Efficiencies

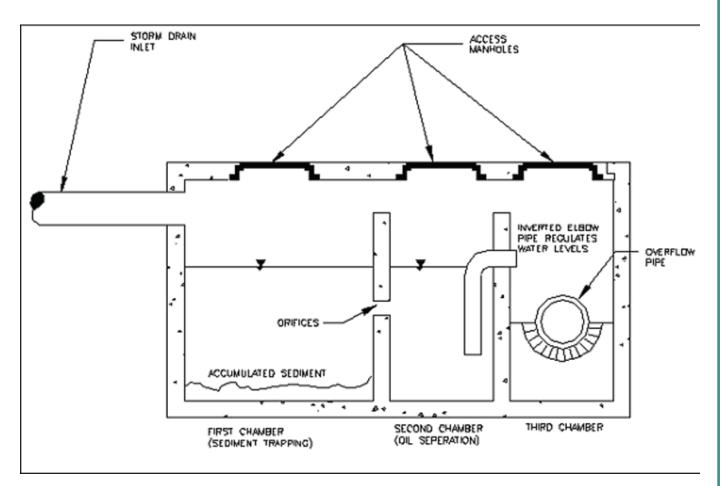
- Total Suspended Solids (TSS) 25% for oil grit separator, only when placed off-line and only when used for pretreatment
- Nutrients (Nitrogen, phosphorus) Insufficient data
- Metals (copper, lead, zinc, cadmium) -Insufficient data
- Pathogens (coliform, e coli) Insufficient data

Description: Oil/grit separators are underground storage tanks with three chambers designed to remove heavy particulates, floating debris and hydrocarbons from stormwater.

Stormwater enters the first chamber where heavy sediments and solids drop out. The flow moves into the second chamber where oils and greases are removed and further settling of suspended solids takes place. Oil and grease are stored in this second chamber for future removal. After moving into the third outlet chamber, the clarified stormwater runoff is then discharged to a pipe and another BMP. There are other separators that may be used for spill control.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	25% TSS removal credit when used for pretreatment and placed off-line.
5 - Higher Pollutant Loading	MassDEP requires a pretreatment BMP, such as an oil/grit separator that is capable of removing oil and grease, for land uses with higher potential pollutant loads where there is a risk of petroleum spills such as: high intensity use parking lots, gas stations, fleet storage areas, vehicle and/or equipment maintenance and service areas.
6 - Discharges near or to Critical Areas	May be a pretreatment BMP when combined with other practices. May serve as a spill control device.
7 - Redevelopment	Highly suitable.



MassHighway 2004

Maintenance

Activity	Frequency
Inspect units	After every major storm but at least monthly
Clean units	Twice a year

Oil/Grit Separators

Applicability

Oil grit separators must be used to manage runoff from land uses with higher potential pollutant loads where there is a risk that the stormwater is contaminated with oil or grease. These uses include the following:

- High-Intensity-Use Parking Lots
- Gas Fueling Stations
- Vehicles (including boats, buses, cars, and trucks) and Equipment Service and Maintenance Areas
- Fleet Storage Areas

Design Considerations

- Dovetail design practices, source controls and pollution prevention measures with separator design.
- Place separators before all other structural stormwater treatment practices (except for structures associated with source control/ pollution prevention such as drip pans and structural treatment practices such as deep sump catch basins that double as inlets).
- Limit the contributing drainage area to the oil/grit separator to one acre or less of impervious cover.
- Use oil grit separators only in off-line configurations to treat the required water quality volume.
- Provide pool storage in the first chamber to accommodate the required water quality volume or 400 cubic feet per acre of impervious surface. Confirm that the oil/grit separator is designed to treat the required water quality volume.
- Make the permanent pool at least 4 feet deep.
- Design the device to pass the 2-year 24-hour storm without interference and provide a bypass for larger storms to prevent resuspension of solids.
- Make oil/grit separator units watertight to prevent possible groundwater contamination.
- Use a trash rack or screen to cover the discharge outlet and orifices between chambers.
- Provide each chamber with manholes and access stepladders to facilitate maintenance and allow cleaning without confined space entry.
- Seal potential mosquito entry points.
- Install any pump mechanism downstream of the separator to prevent oil emulsification.
- Locate an inverted elbow pipe between the second and third chambers and with the bottom

- of the elbow pipe at least 3 feet below the second chamber's permanent pool.
- Provide appropriate removal covers that allow access for observation and maintenance.
- Where the structure is located below the seasonal high groundwater table, design the structure to prevent flotation.
- For gas stations, automobile maintenance and service areas, and other areas where large volumes of petroleum and oil are handled, consider adding coalescing plates to increase the effectiveness of the device and reduce the size of the units. A series of coalescing plates constructed of oil-attracting materials such as polypropylene typically spaced one inch apart attracts small droplets of oil, which begin to concentrate until they are large enough to float to the surface.

Maintenance

Sediments and associated pollutants and trash are removed only when inlets or sumps are cleaned out, so regular maintenance is essential. Most studies have linked the failure of oil grit separators to the lack of regular maintenance. The more frequent the cleaning, the less likely sediments will be resuspended and subsequently discharged. In addition, frequent cleaning also makes more volume available for future storms and enhances overall performance. Cleaning includes removal of accumulated oil and grease and sediment using a vacuum truck or other ordinary catch basin cleaning device. In areas of high sediment loading, inspect and clean inlets after every major storm. At a minimum, inspect oil grit separators monthly, and clean them out at least twice per year. Polluted water or sediments removed from an oil grit separator should be disposed of in accordance with all applicable local, state and federal laws and regulations including M.G.L.c. 21C and 310 CMR 30.00.

References:

American Petroleum Institute, 2002, Management of Water Discharges: Design and Operations of Oil-Water Separators, 1st Edition, Revision 90, American Petroleum Institute.

Arizona Department of Environmental Quality, 1996, BADCT Guidance Document for Pretreatment with Oil/Water Separators, OFR 96-15, http://www.azdeq.gov/environ/water/permits/download/owsbadct.pdf

Beychok, Milton, Wikipedia, API Oil-Water Separator, http://en.wikipedia.org/wiki/API oil-water separator

Center for Watershed Protection, Performance of Oil-Grit Separators in Removing Pollutants at Small Sites, Technical Note #101 from Watershed Protection Techniques. 2(3): 539-542

Houston, City of, Harris County, Harris County Flood Control District, 2001, Storm Water Quality Management Guidance Manual, Section 4.4.2, p. 4-84 to 4-89, http://www.cleanwaterclearchoice.org/downloads/professional/guidance_manual_full.pdf

Idaho Department of Environmental Quality, 2005, Storm Water Best Management Practices Catalog, Oil/Water Separator, BMP 18, pp. 91 to 95, http://www.deq.idaho.gov/water/data_reports/storm_water/catalog/sec_4/bmps/18.pdf

Massachusetts Highway Department, 2004, Storm Water Handbook for Highways and Bridges, p.

Minton, Gary. 2002, Stormwater Treatment, RPA Associates, Seattle, WA, p. 120

New Zealand Water Environment Research Foundation, 2004, On-Site Stormwater Management Guideline, Section 5.10, pp. 23 to 24, http://www.nzwwa.org.nz/Section%205.pdf

Schueler, T.R., 1987, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, Metropolitan Washington Council of Governments, Washington, DC.

U.S. EPA, 1999, Storm Water Technology Fact Sheet, Water Quality Inlets, EPA 832-F-99-029, http://www.epa.gov/owm/mtb/wtrqlty.pdf

Sediment Forebays



Description: A sediment forebay is a post-construction practice consisting of an excavated pit, bermed area, or cast structure combined with a weir, designed to slow incoming stormwater runoff and facilitating the gravity separation of suspended solids. This practice is different from a sediment trap used as a construction period BMP.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	Provides no peak flow attenuation
3 - Recharge	Provides no groundwater recharge
4 - TSS Removal	MassDEP requires a sediment forebay as pretreatment before stormwater is discharged to an extended dry detention basin, wet basin, constructed stormwater wetland or infiltration basin. No separate credit is given for the sediment forebay. For example, extended dry detention basins with sediment forebays receive a credit for 50% TSS removal. Wet basins and constructed stormwater wetlands with sediment forebays receive a credit for 80% TSS removal. When they provide pretreatment for other BMPs, sediment forebays receive a 25% TSS removal credit.
5 - Higher Pollutant Loading	Recommended as a pretreatment BMP
6 - Discharges near or to Critical Areas	Recommended as a pretreatment BMP
7 - Redevelopment	Usually not suitable due to land use constraints

Advantages/Benefits:

- Provides pretreatment of runoff before delivery to other BMPs.
- Slows velocities of incoming stormwater
- · Easily accessed for sediment removal
- Longevity is high with proper maintenance
- Relatively inexpensive compared to other BMPs
- Greater detention time than proprietary separators

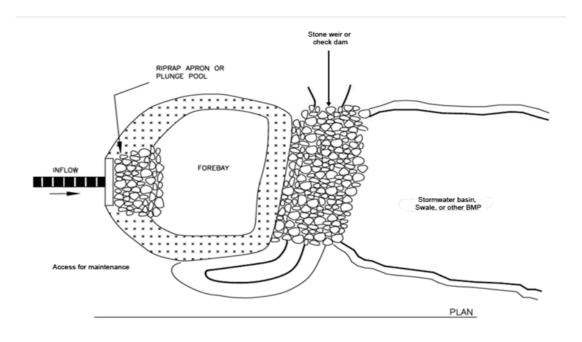
Disadvantages/Limitations:

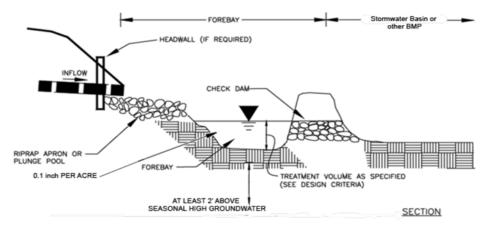
- Removes only coarse sediment fractions
- No removal of soluble pollutants
- Provides no recharge to groundwater
- No control of the volume of runoff
- Frequent maintenance is essential

Pollutant Removal Efficiencies

- Total Suspended Solids (TSS) 25%
- Nutrients (Nitrogen, phosphorus) Insufficient data
- Metals (copper, lead, zinc, cadmium) -Insufficient data
- Pathogens (coliform, e coli) Insufficient data

Structural BMPs - Volume 2 | Chapter 2 page 13





adapted from the Vermont Stormwater Handbook

Maintenance

Activity	Frequency
Inspect sediment forebays	Monthly
Clean sediment forebays	Four times per year and when sediment depth is between 3 to 6 feet.

Special Features

MassDEP requires a sediment forebay as pretreatment before discharging to a dry extended detention basin, wet basin, constructed stormwater wetland, or infiltration basin.

MassDEP uses the term sediment forebay for BMPs used to pretreat stormwater after construction is complete and the site is stabilized. MassDEP uses the term sediment trap to refer to BMPs used for erosion and sedimentation control during construction. For information on the design and construction of sediment traps used during construction, consult the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas: A Guide for Planners, Designers and Municipal Officials.

Sediment Forebays

Design

Sediment forebays are typically on-line units, designed to slow stormwater runoff and settle out sediment.

At a minimum, size the volume of the sediment forebay to hold 0.1-inch/impervious acre to pretreat the water quality volume.

When routing the 2-year and 10-year storms through the sediment forebay, design the forebay to withstand anticipated velocities without scouring.

A typical forebay is excavated below grade with earthen sides and a stone check dam.

Design elevated embankments to meet applicable safety standards.

Stabilize earth slopes and bottoms using grass seed mixes recommended by the NRCS and capable of resisting the anticipated shearing forces associated with velocities to be routed through the forebay. Use only grasses. Using other vegetation will reduce the storage volume in the forebay. Make sure that the selected grasses are able to withstand periodic inundation under water, and drought-tolerant during the summer. MassDEP recommends using a mix of grasses rather than relying upon a single grass species.

Alternatively, the bottom floor may be stabilized with concrete or stone to aid maintenance. Concrete floors or pads, or any hard bottom floor, greatly facilitate the removal of accumulated sediment.

When the bottom floor is vegetated, it may be necessary to remove accumulated sediment by hand, along with re-seeding or re-sodding grasses removed during maintenance.

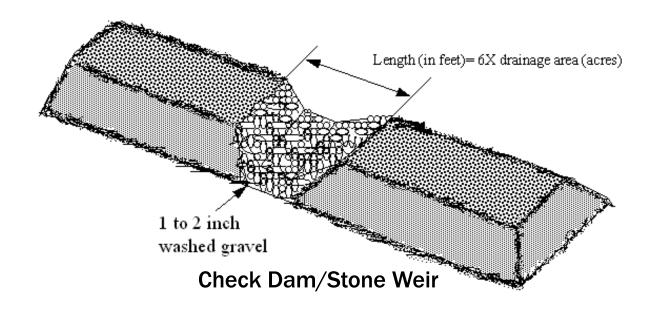
Design sediment forebays to make maintenance accessible and easy. If machinery is required to remove the sediment, carefully incorporate equipment access in the design. Sediment forebays may require excavation so concrete flooring may not always be appropriate.

Include sediment depth markers to simplify inspections. Sediment markers make it easy to determine when the sediment depth is between 3 and 6 feet and needs to be removed. Make the side slopes of sediment forebays no steeper than 3:1. Design the sediment forebay so that the discharge or outflow velocity can control the 2-year peak discharge without scour. Design the channel geometry to prevent erosion from the 2-year peak discharge.

Do not confuse post-construction sediment forebays with the sediment traps used as a construction-period control. Construction-period sediment control traps are sized larger than forebays, because there is a greater amount of suspended solids in construction period runoff. Construction-period sediment traps are sized based on drainage area and not impervious acre. Never use a construction-period sediment trap for post-construction drainage purposes unless it is first brought off-line, thoroughly cleaned (including check dam), and stabilized before being made reoperational.

Refer to the section of this chapter for information on the design of the check dam component of the sediment forebay. Set the minimum elevation of the check dam to hold a volume of 0.1-inch of runoff/impervious acre. Check dam elevations may be uniform or they may contain a weir (e.g., when the top of the check dam is set to the 2-year or 10-year storm, and the bottom of the weir is set to the top of the 0.1-inch/impervious acre volume). When a weir is included in a stone berm, make sure that the weir is able to hold its shape. Fabric or wire may be required.

Unless part of a wet basin, post construction sediment forebays must be designed to dewater between storms. Set the bottom of the forebay at a minimum of 2 feet above seasonal high groundwater, and place pervious material on the bottom floor to facilitate dewatering between storms. For design purposes, use 72 hours to evaluate dewatering, using the storm that produces either the ½ inch or 1-inch of runoff (water quality volume) in a 24-hour period. A stone check dam can act as a filter berm, allowing water to percolate through the check dam. Depending on the head differential, a stone check dam may allow greater dewatering than an earthen berm.



MassDEP Stormwater Handbook, 1996

Maintenance

Sediments and associated pollutants are removed only when sediment forebays are actually cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended

sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or resodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Subsurface Structures



Description: Subsurface structures are underground systems that capture runoff, and gradually infiltrate it into the groundwater through rock and gravel. There are a number of underground infiltration systems that can be installed to enhance groundwater recharge. The most common types include pre-cast concrete or plastic pits, chambers (manufactured pipes), perforated pipes, and galleys.

Ability to meet specific standards

Standard	Description
2 - Peak Flow	N/A
3 - Recharge	Provides groundwater recharge
4 - TSS Removal	80%
5 - Higher Pollutant Loading	May be used if 44% of TSS is removed with a pretreatment BMP prior to infiltration. Land uses with the potential to generate runoff with high concentrations of oil and grease require an oil grit separator or equivalent prior to discharge to the infiltration structure. Infiltration must be done in accordance with 314 CMR 5.00.
6 - Discharges near or to Critical Areas	Highly recommended
7 - Redevelopment	Suitable with pretreatment

Advantages/Benefits:

- Provides groundwater recharge
- Reduces downstream flooding
- Preserves the natural water balance of the site
- Can remove other pollutants besides TSS
- Can be installed on properties with limited space
- Useful in stormwater retrofit applications

Disadvantages/Limitations:

- Limited data on field performance
- Susceptible to clogging by sediment
- Potential for mosquito breeding due to standing water if system fails

Pollutant Removal Efficiencies

• Total Suspended Solids (TSS)

• Nutrients (Nitrogen, phosphorus)

• Metals (copper, lead, zinc, cadmium)

• Pathogens (coliform, e coli)

80%

Insufficient data

Insufficient data

Insufficient data

Structural BMPs - Volume 2 | Chapter 2 page 103

Subsurface Structures

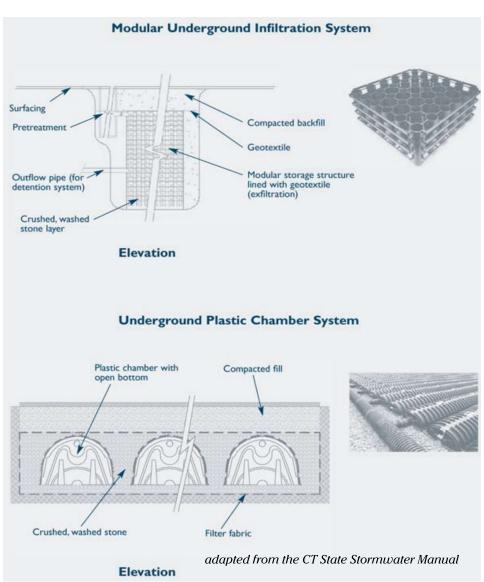
There are different types of subsurface structures:

Infiltration Pit: A pre-cast concrete or plastic barrel with uniform perforations. The bottom of the pit should be closed with the lowest row of perforations at least 6 inches above the bottom, to serve as a sump. Infiltration pits typically include an observation well. The pits may be placed linearly, so that as the infiltrative surfaces in the first pit clog, the overflow moves to the second pit for exfiltration. Place an outlet near the top of the infiltration pit to accommodate emergency overflows. MassDEP provides recharge credit for storage below the emergency outflow invert. To make an infiltration pit, excavate the pit, wrap fabric around the barrel, place stone in the bottom of the pit, place the barrel in the pit, and then backfill stone around the barrel. Take a boring or dig an observation trench at the site of each proposed pit.

<u>Chambers:</u> These are typically manufactured pipes containing open bottoms and sometimes

perforations. The chambers are placed atop a stone bed. Take the same number of borings or observation pits as for infiltration trenches. Do not confuse these systems with underground detention systems (UDS) that use similar chambers. UDS are designed to attenuate peak rates of runoff--not to recharge groundwater.

Perforated Pipes: In this system, pipes containing perforations are placed in a leaching bed, similar to a Title 5 soil absorption system (SAS). The pipes dose the leaching bed. Take the same number of borings or observation pits as for infiltration trenches. Perforated pipes by themselves do not constitute a stormwater recharge system and receive no credit pursuant to Stormwater Standard No. 3. Do not confuse recharge systems that use perforated pipes with perforated pipes installed to lower the water table or divert groundwater flows.



Galleys: Similar to infiltration pits. Some designs consist of concrete perforated rectangular vaults. Others are modular systems usually placed under parking lots. When the galley design consists of a single rectangular perforated vault, conduct one boring or observation trench per galley. When the galleys consist of interlocking modular units, take the same number of borings or observation pits as for infiltration trenches. Do not confuse these galleys with vaults storing water for purposes of underground detention, which do not contain perforations.

Applicability

Subsurface structures are constructed to store stormwater temporarily and let it percolate into the underlying soil. These structures are used for small drainage areas (typically less than 2 acres). They are feasible only where the soil is adequately permeable and the maximum water table and/or bedrock

elevation is sufficiently low. They can be used to control the quantity as well as quality of stormwater runoff, if properly designed and constructed. The structures serve as storage chambers for captured stormwater, while the soil matrix provides treatment.

Without adequate pretreatment, subsurface structures are not suitable for stormwater runoff from land uses or activities with the potential for high sediment or pollutant loads. Structural pretreatment BMPs for these systems include, but are not limited to, deep sump catch basins, proprietary separators, and oil/grit separators. They are suitable alternatives to traditional infiltration trenches and basins for space-limited sites. These systems can be installed beneath parking lots and other developed areas provided the systems can be accessed for routine maintenance.

Subsurface systems are highly prone to clogging. Pretreatment is always required unless the runoff is strictly from residential rooftops.

Effectiveness

Performance of subsurface systems varies by manufacturer and system design. Although there are limited field performance data, pollutant removal efficiency is expected to be similar to those of infiltration trenches and basins (i.e., up to 80% of TSS removal). MassDEP awards a TSS removal credit of 80% for systems designed in accordance with the specifications in this handbook.

Planning Considerations

Subsurface structures are excellent groundwater recharge alternatives where space is limited. Because infiltration systems discharge runoff to groundwater, they are inappropriate for use in areas with potentially higher pollutant loads (such as gas stations), unless adequate pretreatment is provided. In that event, oil grit separators, sand filters or equivalent BMPs must be used to remove sediment, floatables and grease prior to discharge to the subsurface structure.

Design

Unlike infiltration basins, widely accepted design standards and procedures for designing subsurface structures are not available. Generally, a subsurface structure is designed to store a "capture volume" of runoff for a specified period of "storage time." The definition of capture volume differs depending on the purpose of the subsurface structure and the stormwater management program being used. Subsurface structures should infiltrate good quality runoff only. Pretreatment prior to infiltration is essential. The composition, configuration and layout of subsurface structures varies considerably depending on the manufacturer. Follow the design criteria specified by vendors or system manufacturers. Install subsurface structures in areas that are easily accessible for routine and non-routine maintenance.

As with infiltration trenches and basins, install subsurface structures only in soils having suitable infiltration capacities as determined through field testing. Determine the infiltrative capacity of the underlying native soil through the soil evaluation set forth in Volume 3. Never use a standard septic system percolation test to determine soil permeability because this test tends to greatly overestimate the infiltration capacity of soils.

Subsurface structures are typically designed to function off-line. Place a flow bypass structure upgradient of the infiltration structure to convey high flows around the structure during large storms.

Design the subsurface structure so that it drains within 72 hours after the storm event and completely dewaters between storms. Use a minimum draining time of 6 hours to ensure adequate pollutant removal. Design all ports to be mosquito-proof, i.e., to inhibit or reduce the number of mosquitoes able to breed within the BMP.

The minimum acceptable field infiltration rate is 0.17 inches per hour. Subsurface structures must be sized in accordance with the procedures set forth in Volume 3. Manufactured structures must also be sized in accordance with the manufacturers' specifications. Design the system to totally exfiltrate within 72 hours.

Design the subsurface structure for live and dead loads appropriate for their location. Provide measures to dissipate inlet flow velocities and prevent channeling of the stone media. Generally, design the system so that inflow velocities are less than 2 feet per second (fps).

All of these devices must have an appropriate number of observation wells, to monitor the water surface elevation within the well, and to serve as a sampling port. Each of these different types of structures, with the exception of perforated pipes in leaching fields similar to Title 5 systems, must have entry ports to allow worker access for maintenance, in accordance with OSHA requirements.

Construction

Stabilize the site prior to installing the subsurface structure. Do not allow runoff from any disturbed areas on the site to flow to the structure. Rope off the area where the subsurface structures are to be placed. Accomplish any required excavation with equipment placed just outside of this area. If the size of the area intended for exfiltration is too large to accommodate this approach, use trucks with lowpressure tires to minimize compaction. Do not allow any other vehicles within the area to be excavated. Keep the area above and immediately surrounding the subsurface structure roped off to all construction vehicles until the final top surface is installed (either paving or landscaping). This prevents additional compaction. When installing the final top surface, work from the edges to minimize compaction of the underlying soils.

Before installing the top surface, implement erosion and sediment controls to prevent sheet flow or wind blown sediment from entering the leach field. This includes, but is not limited to, minimizing land disturbances at any one time, placing stockpiles away from the area intended for infiltration, stabilizing any stockpiles through use of vegetation or tarps, and placing sediment fences around the perimeter of the infiltration field.

Provide an access port, man-way, and observation well to enable inspection of water levels within the system. Make the observation well pipe visible at grade (i.e., not buried).

Maintenance

Because subsurface structures are installed underground, they are extremely difficult to maintain. Inspect inlets at least twice a year. Remove any debris that might clog the system. Include mosquito controls in the Operation and Maintenance Plan.

Adapted from:

Connecticut Department of Environmental Conservation. Connecticut Stormwater Quality Manual. 2004. MassHighway. Storm Water Handbook for Highways and Bridges. May 2004.



INNOVATIVE TURF SOLUTIONS

XGRASS PRIME

SPECIFICATIONS:

Face Weight: 53 oz

Pile Height: 1.5"

Color: Summer Blend

Thatch: Green

Secondary Backing: Duraflo, 10.0 oz/yd²

Fiber Type: Omega S, 100% Polyethylene

Fiber Mass: 10800 Denier, 7300 Denier Thatch

Tufting Gauge: 1/4"

Primary Backing: 7.1 oz/yd²

Stablized Multi-layer Woven Polypropylene

Non Woven Scrim: 2.7 oz/yd²

Total Weight: 72.7 oz/yd²





BACKING: DURAFLO



RECYCLABLE COMPONENTS



HEAT BLOCK With Heat Block color

than the competitions' artificial grass systems.



SHINE BLOCK

Shine Block blade profiles reduce the reflective quality of the fiber allowing our grass to appear more like a healthy, well-trimmed, natural lawn.

^{*} Specifications provided above are tufted measurements. Final measurements can change during backing processes. Thatch height may vary based on lot. XGrass is not responsible for typing errors on specifications listed above.















NRCS

Natural Resources Conservation Service A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Plymouth County, Massachusetts



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2 053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface	2
How Soil Surveys Are Made	
Soil Map	
Soil Map	9
Legend	10
Map Unit Legend	11
Map Unit Descriptions	11
Plymouth County, Massachusetts	
6A—Scarboro muck, coastal lowland, 0 to 3 percent slopes	13
253B—Hinckley loamy sand, 3 to 8 percent slopes	14
453B—Gloucester - Canton complex, 3 to 8 percent slopes, extremely	
bouldery	16
640B—Urban land, till substratum, 0 to 8 percent slopes	18
655A—Udorthents, wet substratum, 0 to 3 percent slopes	18
References	20

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

Custom Soil Resource Report

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.



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

 \boxtimes

Borrow Pit

Ж

Clay Spot

^

Closed Depression

Š

Gravel Pit

.

Gravelly Spot

0

Landfill

٨.

Lava Flow

Marsh or swamp

衆

Mine or Quarry

0

Miscellaneous Water
Perennial Water

0

Rock Outcrop

+

Saline Spot Sandy Spot

0.0

Severely Eroded Spot

Δ :

Sinkhole

Ø

Slide or Slip Sodic Spot

8

Spoil Area



Stony Spot



Very Stony Spot



Wet Spot Other



Special Line Features

Water Features

_

Streams and Canals

Transportation

ransp

Rails

~

Interstate Highways

~

US Routes

~

Major Roads Local Roads

Background

100

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12.000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Plymouth County, Massachusetts Survey Area Data: Version 9, Sep 14, 2016

Soil map units are labeled (as space allows) for map scales 1:50.000 or larger.

Date(s) aerial images were photographed: Aug 26, 2014—Sep 4, 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

Plymouth County, Massachusetts (MA023)					
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI		
6A	Scarboro muck, coastal lowland, 0 to 3 percent slopes	1.9	28.6%		
253B	Hinckley loamy sand, 3 to 8 percent slopes	1.9	30.0%		
453B	Gloucester - Canton complex, 3 to 8 percent slopes, extremely bouldery	0.5	8.2%		
640B	Urban land, till substratum, 0 to 8 percent slopes	1.7	26.0%		
655A	Udorthents, wet substratum, 0 to 3 percent slopes	0.5	7.3%		
Totals for Area of Interest	,	6.5	100.0%		

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it

was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An association is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Plymouth County, Massachusetts

6A—Scarboro muck, coastal lowland, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkw

Elevation: 0 to 650 feet

Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F

Frost-free period: 140 to 240 days

Farmland classification: Not prime farmland

Map Unit Composition

Scarboro, coastal lowland, and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scarboro, Coastal Lowland

Setting

Landform: Depressions, outwash terraces, drainageways, outwash deltas

Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope, tread, dip

Down-slope shape: Concave

Across-slope shape: Concave, linear

Parent material: Sandy glaciofluvial deposits derived from schist and/or gneiss

and/or granite

Typical profile

Oa - 0 to 8 inches: muck

A - 8 to 14 inches: mucky fine sandy loam

Cq1 - 14 to 22 inches: sand

Cg2 - 22 to 65 inches: gravelly sand

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches Natural drainage class: Very poorly drained

Runoff class: Negligible

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to

high (1.42 to 14.17 in/hr)

Depth to water table: About 0 to 2 inches

Frequency of flooding: None Frequency of ponding: Frequent

Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0

mmhos/cm)

Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 5w

Hydrologic Soil Group: A/D Hydric soil rating: Yes

Minor Components

Swansea

Percent of map unit: 10 percent Landform: Bogs, swamps

Landform position (three-dimensional): Dip

Down-slope shape: Concave Across-slope shape: Concave

Hydric soil rating: Yes

Mashpee

Percent of map unit: 5 percent

Landform: Depressions, terraces, drainageways

Landform position (two-dimensional): Footslope, toeslope

Landform position (three-dimensional): Tread

Down-slope shape: Concave Across-slope shape: Concave

Hydric soil rating: Yes

253B—Hinckley loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2sym8

Elevation: 0 to 1,430 feet

Mean annual precipitation: 36 to 53 inches Mean annual air temperature: 39 to 55 degrees F

Frost-free period: 140 to 250 days

Farmland classification: Farmland of statewide importance

Map Unit Composition

Hinckley and similar soils: 85 percent Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley

Setting

Landform: Eskers, kames, kame terraces, outwash plains, outwash terraces, moraines, outwash deltas

Landform position (two-dimensional): Summit, shoulder, backslope, footslope Landform position (three-dimensional): Nose slope, side slope, base slope, crest,

tread, riser

Down-slope shape: Linear, convex, concave Across-slope shape: Convex, linear, concave

Parent material: Sandy and gravelly glaciofluvial deposits derived from gneiss

and/or granite and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material

A - 1 to 8 inches: loamy sand

Bw1 - 8 to 11 inches: gravelly loamy sand Bw2 - 11 to 16 inches: gravelly loamy sand BC - 16 to 19 inches: very gravelly loamy sand C - 19 to 65 inches: very gravelly sand

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: More than 80 inches Natural drainage class: Excessively drained

Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to

very high (1.42 to 99.90 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None Frequency of ponding: None

Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0

mmhos/cm)

Available water storage in profile: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3s

Hydrologic Soil Group: A Hydric soil rating: No

Minor Components

Windsor

Percent of map unit: 8 percent

Landform: Eskers, kames, kame terraces, outwash plains, outwash terraces, moraines, outwash deltas

Landform position (two-dimensional): Summit, shoulder, backslope, footslope Landform position (three-dimensional): Nose slope, side slope, base slope, crest, tread, riser

Down-slope shape: Linear, convex, concave Across-slope shape: Convex, linear, concave

Hydric soil rating: No

Sudburv

Percent of map unit: 5 percent

Landform: Kame terraces, outwash plains, outwash terraces, moraines, outwash deltas

Landform position (two-dimensional): Backslope, footslope

Landform position (three-dimensional): Side slope, base slope, head slope, tread

Down-slope shape: Concave, linear Across-slope shape: Linear, concave

Hydric soil rating: No

Agawam

Percent of map unit: 2 percent

Landform: Eskers, kames, kame terraces, outwash plains, outwash terraces, moraines, outwash deltas

Landform position (two-dimensional): Summit, shoulder, backslope, footslope Landform position (three-dimensional): Nose slope, side slope, base slope, crest, tread, riser

Down-slope shape: Linear, convex, concave Across-slope shape: Convex, linear, concave

Hydric soil rating: No

453B—Gloucester - Canton complex, 3 to 8 percent slopes, extremely bouldery

Map Unit Setting

National map unit symbol: bd1b

Elevation: 0 to 400 feet

Mean annual precipitation: 41 to 54 inches Mean annual air temperature: 43 to 54 degrees F

Frost-free period: 145 to 240 days

Farmland classification: Not prime farmland

Map Unit Composition

Gloucester, extremely bouldery, and similar soils: 50 percent Canton, extremely bouldery, and similar soils: 45 percent

Minor components: 5 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gloucester, Extremely Bouldery

Settina

Landform: Ground moraines, hills

Landform position (two-dimensional): Summit, shoulder

Landform position (three-dimensional): Interfluve

Down-slope shape: Convex Across-slope shape: Convex

Parent material: Sandy and gravelly supraglacial meltout till

Typical profile

A - 0 to 3 inches: gravelly fine sandy loam

Bw1 - 3 to 11 inches: very gravelly fine sandy loam Bw2 - 11 to 15 inches: very gravelly sandy loam C1 - 15 to 24 inches: very gravelly loamy sand C2 - 24 to 87 inches: very gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent

Percent of area covered with surface fragments: 9.0 percent

Depth to restrictive feature: More than 80 inches Natural drainage class: Somewhat excessively drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95

to 19.98 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None Frequency of ponding: None

Available water storage in profile: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s

Hydrologic Soil Group: A Hydric soil rating: No

Description of Canton, Extremely Bouldery

Setting

Landform: Ridges, hills, till plains

Landform position (two-dimensional): Summit, shoulder Landform position (three-dimensional): Interfluve

Down-slope shape: Convex Across-slope shape: Convex

Parent material: Coarse-loamy eolian deposits over sandy and gravelly

supraglacial meltout till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material Oe - 1 to 2 inches: moderately decomposed plant material

A - 2 to 3 inches: very fine sandy loam
E - 3 to 4 inches: very fine sandy loam
Bw1 - 4 to 5 inches: very fine sandy loam
Bw2 - 5 to 15 inches: very fine sandy loam
Bw3 - 15 to 24 inches: fine sandy loam
BC - 24 to 28 inches: gravelly loamy sand
2C1 - 28 to 49 inches: gravelly coarse sand
2C2 - 49 to 73 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 8 to 15 percent

Percent of area covered with surface fragments: 9.0 percent

Depth to restrictive feature: 20 to 36 inches to strongly contrasting textural

stratification

Natural drainage class: Well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95

in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None Frequency of ponding: None

Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s

Hydrologic Soil Group: A Hydric soil rating: No

Minor Components

Hinckley, bouldery

Percent of map unit: 3 percent

Landform: Eskers, kames, terraces, outwash deltas Landform position (two-dimensional): Summit, shoulder

Landform position (three-dimensional): Tread

Down-slope shape: Convex Across-slope shape: Convex

Hydric soil rating: No

Hollis

Percent of map unit: 2 percent

Landform: Ridges, hills

Landform position (two-dimensional): Summit, shoulder

Landform position (three-dimensional): Interfluve

Down-slope shape: Convex Across-slope shape: Convex

Hydric soil rating: No

640B—Urban land, till substratum, 0 to 8 percent slopes

Map Unit Composition

Urban land, till substratum: 100 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

655A—Udorthents, wet substratum, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: bd0f

Elevation: 0 to 390 feet

Mean annual precipitation: 41 to 54 inches Mean annual air temperature: 43 to 54 degrees F

Frost-free period: 145 to 240 days

Farmland classification: Not prime farmland

Map Unit Composition

Udorthents, wet substratum, and similar soils: 85 percent

Minor components: 15 percent

Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents, Wet Substratum

Settina

Landform position (two-dimensional): Footslope Landform position (three-dimensional): Tread

Down-slope shape: Linear Across-slope shape: Linear

Parent material: Coarse-loamy human transported material

Typical profile

^A - 0 to 5 inches: loam

^C1 - 5 to 21 inches: gravelly loam

^C2 - 21 to 80 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Natural drainage class: Moderately well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very

high (0.01 to 14.17 in/hr)

Depth to water table: About 20 to 21 inches

Frequency of flooding: None Frequency of ponding: None

Available water storage in profile: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: B/D Hydric soil rating: No

Minor Components

Udipsamments, wet substratum

Percent of map unit: 5 percent

Landform: Dikes

Landform position (two-dimensional): Footslope Landform position (three-dimensional): Tread

Down-slope shape: Linear, convex

Across-slope shape: Linear Hydric soil rating: No

Udipsamments

Percent of map unit: 5 percent

Landform: Dikes

Landform position (two-dimensional): Summit Landform position (three-dimensional): Tread

Down-slope shape: Linear, convex

Across-slope shape: Linear Hydric soil rating: No

Udorthents, loamy

Percent of map unit: 5 percent

Landform position (three-dimensional): Tread

Down-slope shape: Linear Across-slope shape: Linear

Hydric soil rating: No

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2 054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2 053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2 053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2 053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

Commonwealth of Massachusetts <u>Roculary()</u>, Massachusetts <u>Soil Suitability Assessment for On-site Sewage Disposal</u>

Performed by: Kevin Grady Date: 4/13/17
GRADY CONSULTING, L.L.C.
71 Evergreen Street, Suite 1
Kingston, MA 02364
Phone: (781) 585-2300 Fax: (781) 585-2378
Witnessed by:
Location Address or Lot # *Owner's Name
*Address &
835 Hingham St. *Telephone #
New Construction Repair Title V Inspection O Callog C Th
Office Review
Published Soil Survey Available: No Yes
Year Published: Publication Scale: Soil Map Unit:
Drainage Class: Soil Limitations:
Surficial Geology Report Available: No Yes
Year Published: Publication Scale:
Geologic Material (Map Unit):
Landioini.
Flood Insurance Rate Map:
Above 500 year flood boundary: No Yes
Above 500 year flood boundary: No Yes Within 500 year flood boundary No Yes Within 100 year flood boundary No Yes Yes
Within 100 year flood boundary No X Yes
Wetland Area: Netional Wetland Inventory Man (man unit): V / A
National Wetland Inventory Map (map unit):
Wetlands Conservancy Program Map (map unit):
Current Water Resource Conditions (USGS): Month:
Range: Above Normal Below Normal
Other References Reviewed:
Depth of Naturally Occurring Pervious Material
Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the
area proposed for the soil absorption system?
, , , , , , , , , , , , , , , , , , ,
If not, what is the depth of naturally occurring pervious material?
Certification
I certify that on April 6, 1999 (date) I have passed the soil evaluator examination approved by the
Department of Environmental Protection and that the above analysis was performed by me consistent with
the required training, expertise and experience described in 310 CMR 15.017.
Signature: Date: Date:

Deep Hole #	Da	te 4/13/17	Time <u> 10 `. (</u>	<u>)() </u>	eather partly summy 50°)
Location(identify on Land Use \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	Site Plan) ∖ ↑	Slope(%) 2	 Surface	Stones_ <i>V</i> \0	one	
Vegetation GAR	5es		Landfor	ʻm		
					king Water Wellft.	
Drai	nageway	ft. Propertyline_	ft Othe	ər		
DEEP OBSERVA			0 11 0 1	0-11-14-410	Oth an Church was Stone	_
Depth From Surface (Inches)		n Soil Texture (Munsell)	Soil Color	Soil Mottlii	ng Other: Structures, Stones Boulders, Consistency,%Gra	
0"-78"		Fill				_
78-66	A	Loam	10-12-3			
86-106	B	Loans Sand	10-185/6		France for solver, 30%, 30%, 1	
106-130	_	Grandil-1	3/		for solutions, 30% of a	, in
106-190		Coarse Sand	51(13	106	Lower	
Parent Material (geol Depth to Groundwat	er: Sta	コートしょくト Inding Water in Ho Imated Seasonal H	le: V	Veeping fron	n Pit Face <u>\0 🕼</u>	<u> </u>
Depth to weepin	<u>DETE</u> standing in o g from side o Reading Date	RMINATION FOR Sobservation hole: _ f observation hole i Index well i	EASONAL HIC inches _ e:inches _ evel Adj.	H WATER T Depth to Ground factor		
Observation Hole # Depth of Perc						
Start Presoak						
End Presoak						
Site Suitability Asses						
Performed By				Certificati	ion #	
Witnessed By						
Comments:						

Deep Hole #) Dat	e 4/13/17	Time <u>\0`.0</u>	<u>00</u> Wea	ather faith so	nny 50°
Location(identify Land Use <u>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</u>	on Site Plan) [ムハナ	Slope(%) 2		e Stones_ <u>^\^\</u>	ne	
Vegetation			Landfo	orm		
		ft. Possil				
[Drainageway	ft. Propertyline_	75 ft Oth	ner		
DEEP OBSER	RVATION HOLE L	.og				
Depth From Surfaction (Inches)			Soil Color	Soil Mottling	Other: Struc Boulders, Consi	tures, Stones, <u>stency,%Gravel</u>
0"-47"	F, Y	·		-		
412'- 54	4	Five bound	2.575/4		Remove	nogravel
64-70	(2	Egypyell-f	57R3/3	54	20056 3	ologrand
Parent Material (o Depth to Ground	water: Sta	rખલડ બ nding Water in Ho imated Seasonal	ole: 5'0"	_ Depth to Bedi Weeping from l vater _ Ҷ゚ー゚。''	rock_ Pit FaceS'-0"	
Depth to wee	<u>DETEI</u> red standing in o ping from side o Reading Date	RMINATION FOR Servation hole: f observation hole: index well	SEASONAL HI inches e:inches level Ad	GH WATER TA Depth to s Groundw Jacob A	oil mottles: <u>[/]5</u> t ater adjustment dj.Groundwater	ft level
PERCOL	ATION TEST					
Observation Hole						
Depth of Perc						
Start Presoak						
End Presoak						
-		e Passed S	ite Failed			
Performed By				Certificatio	n #	
Witnessed By						
Comments:						

Deep Hole #3	Date	4/13/17	Time 10%	30 w	eather PSVH Sunv	14 50°
I acetion/identify on	Site Plan)				•	
Land Use Vacav	77	Slope(%) <u></u>	<u>್ 5</u> Surfac	e Stones	<u>one</u>	
Vegetation — 150	226.7		Landfo	orm		
Distances from: Ope			_		king Water Well	ft.
Drair	nagewayf	t. Propertyline_	15_ft Oth	ner		
DEEP OBSERVA	TION HOLE LO	<u>G</u>				
Depth From Surface (Inches)	Soil Horizon (USDA	Soil Texture (Munsell)	Soil Color	Soil Mottlin	g Other: Structure Boulders, Consiste	
0-10"	Fill					
10.60	C	Excessively	25/5/4	24		
		Franch 1	•	#5 C*	30% grave)	
60.84	1- (DEALTH Som	25/1/2		Level,	
	the state of the s	24 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	23.13			
	4.0	W45h				
Parent Material (geol Depth to Groundwate	ogic) <u> </u>	ing Water in Ho	nle: 5'-0''	_ Depth to Bed Weening from	Pit Face 출설	
Depth to Groundwate	Estim	ated Seasonal	High Groundv	vater <u>a 4</u>		
	APTEDIA.	INATION FOR	CEACONAL UI	CH WATER T	ADI E	
Method Used: Depth observed: Depth to weeping Index Well # I	standing in obs	bservation hole	inches e:inches	Depth to Groundy	soil mottles: 28	π
PERCOLATIO	N TEST	Date_		Time	9	
Observation Hole #			_ Time at 9"			
Depth of Perc						
Start Presoak)		
End Presoak						
Site Suitability Asses						
Performed By					on #	
Witnessed By						
Comments:						

3

Performed by:	Kevin Grady		Date: (013.11)
	GRADY CONSULTING, L.L.C.	4	
	71 Evergreen Street, Suite	1	
	Kingston, MA 02364 Phone: (781) 585-2300 F	Fax: (781) 585-2378	
	· · · · · · · · · · · · · · · · · · ·	ax: (701) 000 2010	
Witnessed by:			
Location Address		*Owner's Name	Delucy Properties Limited Firtnersh
Hinghown Stre	eet Assessors May 9	*Address & *Telephone #	action to the transfer the transfer to the tra
New Construction	n <u>¼</u> Repair Title V Insp	pection	
Office Review			
Published Soil S	Survey Available: No 🔀 Yes_		an I Inite
Year Published: _	Publication Scale:	Soil Ma	.p onit:
Drainage Class:	Soil Limitations:		. _
Surficial Geolog	gy Report Available: No 🔽 Yes	;	
Year Published:	Publication Scale:		
Geologic Materia	al (Map Unit):		
Landform:	<u> </u>	.	
Flaad Ingungsaa	- Dete Men		
Flood Insurance	e nate map: flood boundary: No Yes	X	
	flood boundary: No Yes		
	flood boundary No 🛨 Yes		
,	•		
Wetland Area:		Al / A	
National Wetland	d Inventory Map (map unit):	/	
Wetlands Conse	ervancy Program Map (map unit):	. \	
Current Water B	Resource Conditions (USGS):	Month: <u>Oct</u> e	ber
	ve Normal	Normal	Below Normal
.		``	
Other Reference	es Reviewed:		
Danth of Noturali	by Occurring Porvious Material		
Deptri of Naturali Does at I	ly Occurring Pervious Material Jeast four feet of naturally occurring	nervious material exis	st in all areas observed throughout the
	posed for the soil absorption system	-0 1/1 -	
aroa pro	poods (c. 11.0 com character)	"MA Drail	Mage
If not, wh	hat is the depth of naturally occurrin	ng pervious material?	
<u>Certification</u>			
<u>cermicanon</u> I certify ti	that on April 6, 1999 (date) I have p	assed the soil evaluate	or examination approved by the
Departm	nent of Environmental Protection an	d that the above analy	rsis was performed by me consistent with
the requi	ired∕tқaining, expertise and experie	nce described in 3 10 C	MR 15.017.
'n	Y 😕	10/2/1	\Box
Ottom materials I f	4 _ '1 1	13010 1111 111	4 F

Deep Hole #	1 142	Date_(v\3\17	Time W 💯	Wea	ther SUNN	4
Location(ident	ify on Site Plan)₋ ∖/₅(⋴∧ડે	Slope(%)_	↑ # Surface	Stones MON	e	
Vegetation	Vice()	Siope(/e)_	Landfo	rm		
Distances from		odyft. Pos	_			
	Drainageway	tt. Propertylin	e <u>t≪O</u> nt Oth	er		
	ERVATION HOL		Sail Color	Cail Mattlina	Othor: C	tructures, Stones,
Depth From Sur (Inches)	face Soil Hori (<u>USDA</u>	zon Soil Texture (<u>Munsell)</u>	Soil Color	Soil Mottling		onsistency,%Gravel
0-36	F;11					
0-36 36-50	C,	Gravellt Sand	251/6	·	i Loose	- Friasle 25% grave
SO -N"	ري	Med-lance	Send 251/16	40"	Loose	- Friable 25% grave
Parent Material Depth to Groun	ndwater:	りよいならり Standing Water in I Estimated Seasona	Hole: <u>^\0^と</u> V	Depth to Bedr Veeping from F ater _ ろっぱ	Pit Face <u> ১৫</u>	one_
Depth to w	erved standing in eeping from side	ERMINATION FOR n observation hole of observation ho ate Index wel	:inches _ ble:inches _	义 Depth to se Groundwa	oil mottles:_ ater adjustm	entft
PERCO	LATION TEST	Date	9	Time_		
Observation Ho	ole #		Time at 9"			
Depth of Perc		· · · · · · · · · · · · · · · · · · ·	Time at 6"			
Start Presoak		 	Time (9"-6")			
End Presoak			Rate Min/Inc	h		
Site Suitability	Assessment: S	Site Passed	Site Failed	Additional Te	sting Neede	ed:
Performed By_			-	Certification	ı #	
Witnessed By_			-			
Comments:						

Deep Hole # 2 Date 10/3/17 Time 1/1.00 Weather SUNNY	_
Location(identify on Site Plan)Slope(%)_2-4 Surface Stones	
Vegetation Fire de Stope Stope Stones Vegetation Landform	
Distances from: Open Water Bodyft. Possible Wet Areaft. Drinking Water Wellft. Drainagewayft. Propertylineft Other	
Drainageway π. Propertyline b Ο π Other	
DEEP OBSERVATION HOLE LOG	
Depth From Surface Soil Horizon Soil Texture Soil Color Soil Mottling Other: Structures, St (Inches) (USDA (Munsell) Boulders, Consistency,%	
0-6 Fill	
6-10 A Loavy	
10-ay: B Sindy Coam 10485/6	
4 - 49 C. Gravell-15and 2.5/16 34" 25/0gravel Frank	11-60
49-100 C2 Sand 25/6 34 25/09 rul Frus 49-100 C2 Sand 25/6 Loose 62%	j revel
Parent Material (geologic) Depth to Groundwater: Standing Water in Hole: ** \$\frac{1}{2} \frac{1}{2}	
DETERMINATION FOR SEASONAL HIGH WATER TABLE	_
PERCOLATION TEST Date Time	
Observation Hole # Time at 9"	
Depth of Perc Time at 6"	
Start Presoak Time (9"-6")	
End Presoak Rate Min/Inch	
Site Suitability Assessment: Site Passed Site Failed Additional Testing Needed:	
Performed By Certification #	
Witnessed By	
Comments:	

TITLE 5 ON-SITE REVIEW Date_ 16/3/17 Time \\`.00 Weather SUNNY Deep Hole # Location(identify on Site Plan)_____ Slope(%) 2-4 Surface Stones 107 l Land Use Vacant Vegetation Landform **Distances from:** Open Water Body____ ft. Possible Wet Area 150 ft. Drinking Water Well ____ ft. Drainageway ft. Propertyline 50 ft Other____ **DEEP OBSERVATION HOLE LOG** Depth From Surface Soil Horizon Soil Texture Soil Color Other: Structures. Stones. Soil Mottling (Inches) (USDA (Munsell) Boulders, Consistency,%Gravel FILL 0-40 10-1R3/2 Loan Gravelt 54" 25/09 Much no gravel Frash 100-114 Outwash Parent Material (geologic) __ Depth to Bedrock__ Standing Water in Hole: Mone Weeping from Pit Face nowl Depth to Groundwater: Estimated Seasonal High Groundwater 4-6" **DETERMINATION FOR SEASONAL HIGH WATER TABLE** Method Used: ____ Depth observed standing in observation hole: ____inches ____ Depth to soil mottles: _____ inches ____ Groundwater adjustment ____ ft Index Well # Reading Date Index well level Adj.factor Adj.Groundwater level Time PERCOLATION TEST Date Observation Hole # _____ Time at 9" _____ Time at 6" **Depth of Perc** Start Presoak _____ Time (9"-6")

Rate Min/Inch

Site Suitability Assessment: Site Passed_____ Site Failed____ Additional Testing Needed:

End Presoak

Comments:

Performed By_____

Witnessed By

Rt.

Certification #