A Homeowner's Guide to Stormwater Management

Dover, West Manchester, and Manchester Townships

April 13, 2023

C.S. DAVIDSON, INC.
100 YEARS

Presented by:
Derek J. Rinaldo, E.I.T.
Client Representative

STORMWATER

Stormwater is generated when precipitation from rain and snowmelt flows over land or impervious surfaces such as roads, parking lots and rooftops and **does not percolate** into the ground

EFFECTS OF ACCELERATED STORMWATER RUNOFF

- **Stormwater Rate:** is a measure of how fast stormwater is discharged. (Usually in cubic feet per second)
- **Stormwater Volume:** is a measure of how much stormwater is discharged. (Usually in cubic feet)

SMALL PROJECTS CONTROL

- Small Projects focus on Volume Control Only
  - Required to control the approximate volume increase of a Two-Year, 24-hour Storm
  - Capture 2” of runoff per new square foot of impervious
  - Infiltrate at least 1” of runoff per new square foot of impervious

Precipitation Data

NOAA's National Weather Service
Hydrometeorological Design Studies Center
Precipitation Frequency Data Server (PFDS)

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NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: PA

Data description

Data type: Precipitation depth | Units: English | Time series type: Partial duration

Select location

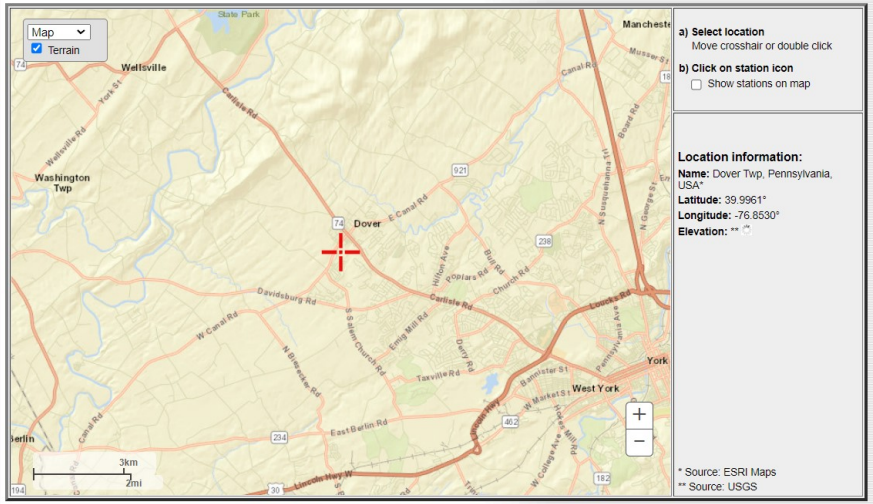
1) Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude: Longitude: Submit

b) By station (list of PA stations): Select station

c) By address: Search

2) Use map:



a) Select location
Move crosshair or double click

b) Click on station icon
Show stations on map

Location information:
Name: Dover Twp, Pennsylvania, USA*
Latitude: 39.9961°
Longitude: -76.8530°
Elevation: ** '*

* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 2, Version 3

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 2, Version 3

PF tabular | PF graphical | Supplementary information

Print page

PDS-based precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.320 (0.288-0.356)	0.381 (0.343-0.424)	0.450 (0.405-0.501)	0.500 (0.449-0.556)	0.563 (0.502-0.624)	0.608 (0.541-0.674)	0.653 (0.578-0.723)	0.696 (0.613-0.770)	0.748 (0.654-0.828)	0.789 (0.685-0.873)
10-min	0.511 (0.461-0.569)	0.610 (0.548-0.679)	0.721 (0.648-0.802)	0.800 (0.717-0.889)	0.898 (0.800-0.994)	0.969 (0.861-1.07)	1.04 (0.919-1.15)	1.10 (0.971-1.22)	1.18 (1.03-1.31)	1.24 (1.08-1.38)
15-min	0.639 (0.576-0.711)	0.766 (0.689-0.853)	0.912 (0.820-1.01)	1.01 (0.907-1.13)	1.14 (1.01-1.26)	1.23 (1.09-1.36)	1.31 (1.16-1.45)	1.39 (1.23-1.54)	1.49 (1.30-1.65)	1.56 (1.35-1.73)
30-min	0.876 (0.789-0.974)	1.06 (0.952-1.18)	1.30 (1.17-1.44)	1.47 (1.32-1.63)	1.69 (1.50-1.87)	1.85 (1.64-2.05)	2.01 (1.78-2.23)	2.17 (1.91-2.40)	2.37 (2.07-2.62)	2.53 (2.19-2.80)
60-min	1.09 (0.984-1.22)	1.33 (1.19-1.48)	1.66 (1.49-1.85)	1.91 (1.71-2.12)	2.24 (2.00-2.49)	2.50 (2.23-2.78)	2.77 (2.45-3.07)	3.04 (2.68-3.36)	3.40 (2.97-3.76)	3.69 (3.20-4.08)
2-hr	1.27 (1.15-1.42)	1.55 (1.40-1.72)	1.97 (1.76-2.18)	2.29 (2.05-2.54)	2.77 (2.46-3.06)	3.16 (2.80-3.48)	3.59 (3.15-3.95)	4.04 (3.52-4.44)	4.70 (4.06-5.17)	5.25 (4.49-5.77)
3-hr	1.39 (1.25-1.55)	1.69 (1.52-1.88)	2.14 (1.92-2.38)	2.50 (2.24-2.78)	3.01 (2.68-3.34)	3.44 (3.04-3.81)	3.90 (3.42-4.31)	4.38 (3.83-4.84)	5.10 (4.40-5.64)	5.69 (4.86-6.30)
6-hr	1.70 (1.53-1.92)	2.06 (1.85-2.32)	2.60 (2.33-2.93)	3.05 (2.72-3.43)	3.71 (3.29-4.15)	4.28 (3.76-4.78)	4.91 (4.28-5.46)	5.59 (4.83-6.21)	6.61 (5.63-7.34)	7.47 (6.29-8.30)
12-hr	2.07 (1.84-2.39)	2.50 (2.21-2.87)	3.17 (2.80-3.64)	3.74 (3.30-4.29)	4.61 (4.03-5.27)	5.38 (4.66-6.12)	6.24 (5.35-7.08)	7.20 (6.11-8.15)	8.67 (7.23-9.79)	9.95 (8.18-11.2)
24-hr	2.41 (2.22-2.64)	2.91 (2.69-3.19)	3.70 (3.41-4.06)	4.41 (4.04-4.81)	5.49 (4.99-5.96)	6.45 (5.82-6.98)	7.56 (6.74-8.14)	8.81 (7.77-9.47)	10.8 (9.33-11.5)	12.5 (10.7-13.4)
2-day	2.80 (2.57-3.09)	3.38 (3.11-3.73)	4.30 (3.94-4.75)	5.09 (4.65-5.61)	6.29 (5.71-6.91)	7.35 (6.61-8.05)	8.54 (7.62-9.34)	9.87 (8.72-10.8)	11.9 (10.4-13.0)	13.7 (11.8-15.0)
3-day	2.98 (2.74-3.28)	3.59 (3.31-3.96)	4.55 (4.18-5.01)	5.38 (4.93-5.92)	6.65 (6.04-7.28)	7.76 (7.00-8.49)	9.01 (8.06-9.84)	10.4 (9.23-11.4)	12.6 (11.0-13.7)	14.5 (12.5-15.8)
4-day	3.16 (2.91-3.47)	3.80 (3.51-4.18)	4.81 (4.43-5.28)	5.68 (5.20-6.23)	7.00 (6.37-7.66)	8.17 (7.38-8.92)	9.49 (8.50-10.3)	11.0 (9.74-12.0)	13.3 (11.6-14.5)	15.3 (13.2-16.7)
7-day	3.69 (3.41-4.05)	4.43 (4.10-4.87)	5.55 (5.11-6.09)	6.51 (5.98-7.13)	7.97 (7.27-8.72)	9.24 (8.37-10.1)	10.7 (9.59-11.6)	12.3 (10.9-13.4)	14.7 (12.9-16.1)	16.9 (14.6-18.4)
10-day	4.25 (3.94-4.63)	5.09 (4.72-5.55)	6.30 (5.82-6.86)	7.31 (6.75-7.95)	8.81 (8.08-9.58)	10.1 (9.21-11.0)	11.5 (10.4-12.5)	13.1 (11.7-14.2)	15.4 (13.6-16.7)	17.3 (15.2-18.8)
20-day	5.77 (5.42-6.18)	6.85 (6.44-7.33)	8.20 (7.70-8.79)	9.32 (8.73-9.98)	10.9 (10.2-11.7)	12.2 (11.4-13.1)	13.6 (12.6-14.5)	15.1 (13.9-16.1)	17.2 (15.7-18.4)	19.0 (17.1-20.3)
30-day	7.13 (6.74-7.59)	8.42 (7.95-8.96)	9.93 (9.36-10.6)	11.2 (10.5-11.9)	12.9 (12.1-13.7)	14.3 (13.4-15.2)	15.8 (14.7-16.8)	17.3 (16.0-18.4)	19.5 (17.9-20.7)	21.2 (19.4-22.6)
45-day	8.97 (8.54-9.46)	10.5 (10.0-11.1)	12.2 (11.6-12.9)	13.5 (12.9-14.3)	15.3 (14.5-16.2)	16.7 (15.8-17.6)	18.1 (17.1-19.1)	19.6 (18.4-20.6)	21.5 (20.1-22.7)	23.0 (21.4-24.4)
60-day	10.7 (10.2-11.3)	12.6 (12.0-13.2)	14.4 (13.7-15.1)	15.9 (15.1-16.6)	17.8 (16.9-18.6)	19.2 (18.3-20.2)	20.7 (19.6-21.7)	22.2 (20.9-23.3)	24.1 (22.6-25.4)	25.6 (23.9-27.0)

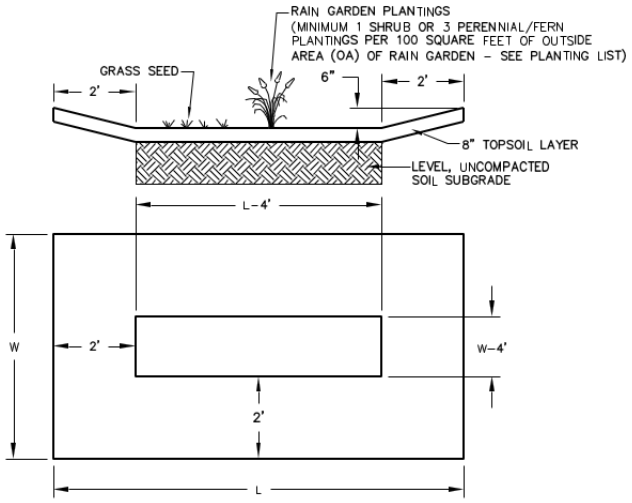
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: Precipitation frequency estimates | Submit

Above Ground Stormwater BMP



REQUIRED STORAGE VOLUME																
Impervious Area (SF)	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
Required Storage Volume of Rain Garden (CF)	42	50	58	67	75	83	92	100	108	117	125	133	142	150	158	167

Required Rain Garden Size											
		Width (x)									
		10	11	12	13	14	15	18	20	25	30
Length (L)	10	34	38	42	46	50	54	66	74	94	114
	11	38	43	47	52	56	61	74	83	106	128
	12	42	47	52	57	62	67	82	92	117	142
	13	46	52	57	63	68	74	90	101	129	156
	14	50	56	62	68	74	80	98	110	140	170
	15	54	61	67	74	80	87	106	119	152	-
	18	66	74	82	90	98	106	130	146	186	-
	20	74	83	92	101	110	119	146	164	-	-
	25	94	106	117	129	140	152	186	-	-	-
	30	114	128	142	156	170	-	-	-	-	-

RAIN GARDEN

Rain Garden Native Planting List

Perennials and Ferns:

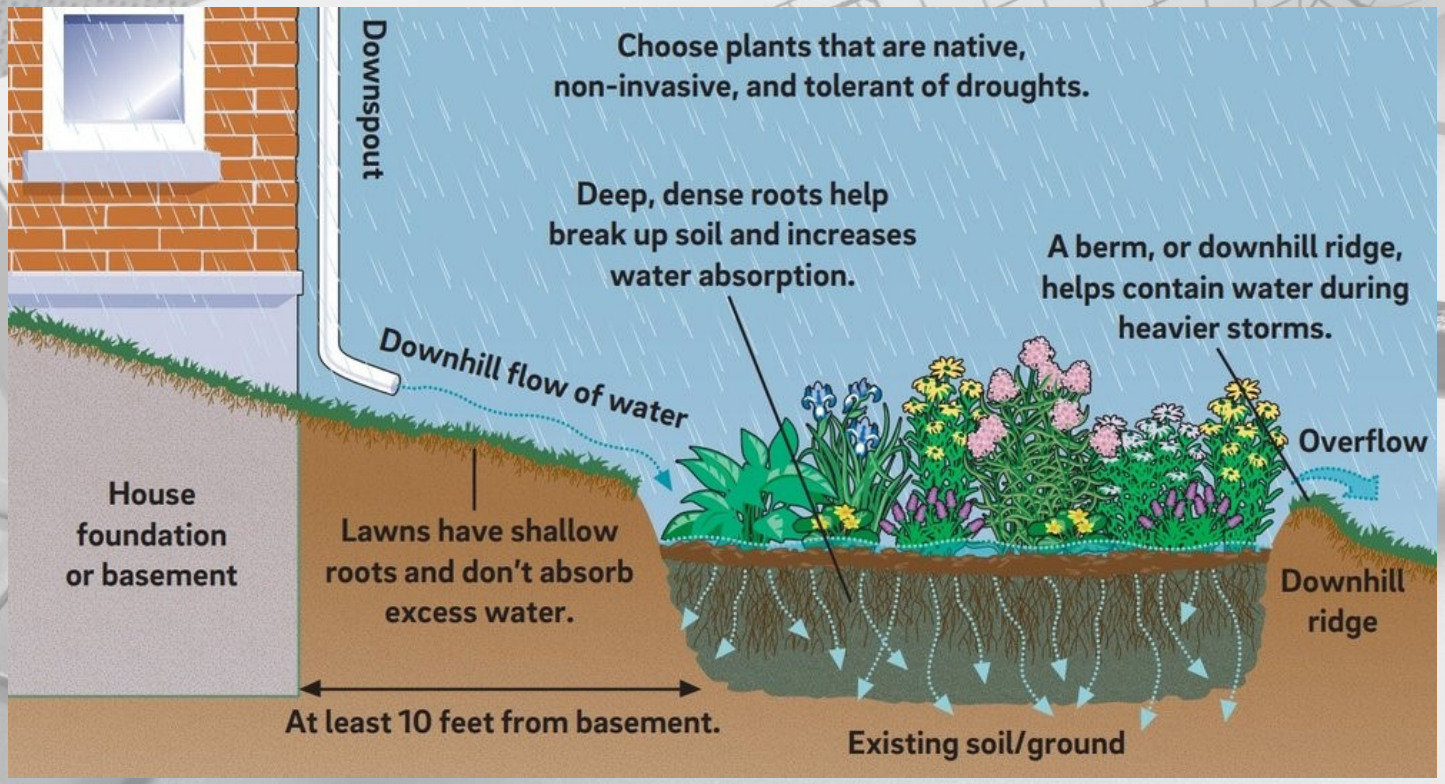
Blue false indigo (Baptisia australis)
Blue flag iris (Iris versicolor)
Blue star (Amsonia tabernaemontana)
Blue vervain (Verbena hastata)
Boltonia (Boltonia asteroides)
Boneset (Eupatorium perfoliatum)
Bottlebrush grass (Hystrix patula)
Broomsedge (Andropogon virginicus)
Cardinal flower (Lobelia cardinalis)
Cinnamon fern (Osmunda cinnamomea)
Culvers root (Veronicastrum virginicum)
Golden ragwort (Senecio aureus)
Goldenrod (Solidago patula, S. rugosa)
Great blue lobelia (Lobelia siphlitica)
Green bullrush (Scirpus atrovirens)
Horsetail (Equisetum species)
Marsh marigold (Caltha palustris)
Mistflower (Eupatorium colestinum)
Monkey flower (Mimulus ringens)
New England aster (Aster novae-anglia)
New York aster (Aster novi-belgii)
Obedient plant (Physotegia virginiana)
Royal fern (Osmunda regalis)
Seedbox (Ludwigia alternifolia)
Sensitive fern (Onoclea sensibilis)
Sneezeweed (Helenium autumnale)
Soft rush (Juncus effusus)
Swamp milkweed (Asclepias incarnata)
Swamp rose mallow (Hibiscus moscheutos)
Swamp sunflower (Helianthus angustifolius)
Switchgrass (Panicum virgatum)
Threadleaf coreopsis (Coreopsis verticillata)
Tussock sedge (Carex stricta)
White turtlehead (Chelone glabra)
Woolgrass (Scirpus cyperinus)

Shrubs:

American beautyberry (Calicarpa americana)
Arrowwood (Viburnum dentatum)
Black chokeberry (Aronia melanocarpa)
Broad-leaved meadowsweet (Spirea latifolia)
Buttonbush (Cephalanthus occidentalis)
Elderberry (Sambucus canadensis)
Inkberry (Ilex glabra)
Narrow-leaved meadowsweet (Spirea alba)
Ninebark (Physocarpus opulifolius)
Possumhaw (Viburnum nudum)
Red-osier dogwood (Cornus sericea)
St. Johnswort (Hypericum densiflorum)
Silky dogwood (Cornus amomum)
Smooth alder (Alnus serrulata)
Spicebush (Lindera benzoin)
Swamp azalea (Rhododendron viscosum)
Swamp rose (Rosa palustris)
Sweet pepperbush (Clethra alnifolia)
Wild raisin (Viburnum cassinoides)
Winterberry (Ilex verticillata)
Virginia sweetspire (Itea virginica)

Construction of Above Ground BMPs

- Install erosion and sedimentation control facilities
- Excavate the SWM Facility to the required depth Contact the municipality for inspection once excavated
- Place amended soil



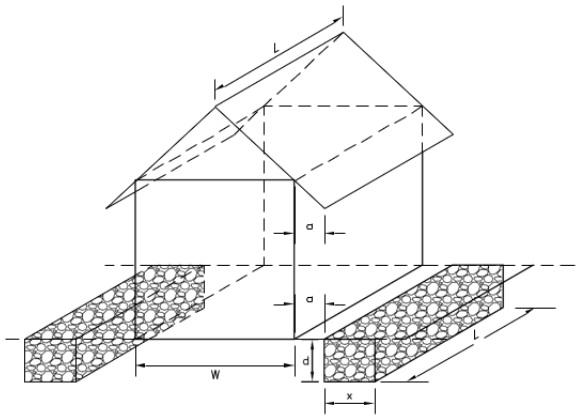
Construction of Above Ground BMPs

- Install plantings as shown on the plan. Mulch may be required for ground cover until plantings are established
- Stabilize and seed all disturbed areas

Maintenance for Above Ground BMPs

- Treat weeds/invasive species
- Replace any dead plantings
- Ensure ground within and around facility is stabilized
- Ensure the facility is dewatering within a 72 hour window

Subsurface Stormwater BMPs



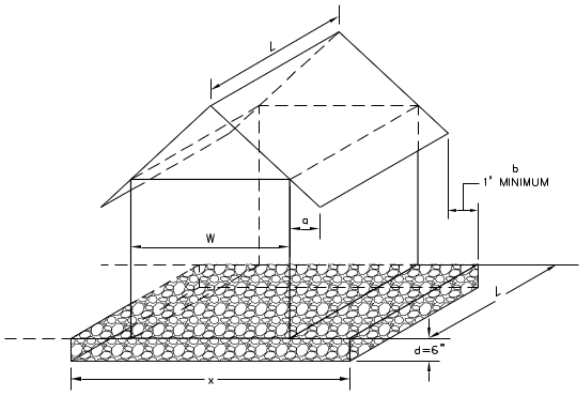
KEY
L = LENGTH OF STRUCTURE = LENGTH OF SEEPAGE TRENCH (FT.)
W = WIDTH STRUCTURE (FT)
a = EAVE OVERHANG (FT) = TRENCH DISTANCE FROM STRUCTURE (FT)
x = WIDTH OF SEEPAGE TRENCH (FT)
d = DEPTH OF SEEPAGE TRENCH (FT) = 2'

REQUIRED STORAGE VOLUME																
Impervious Area (SF)	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
Total Required Storage (CF)	83	100	117	133	150	167	183	200	217	233	250	267	283	300	317	333
Required Storage Volume Per Pit (CF)	42	50	58	67	75	83	92	100	108	117	125	133	142	150	158	167

Required Pit Size											
		Pit Width (x)									
		1	2	3	4	5	6	7	8	9	10
Pit Length (L)	10	8	16	24	32	40	48	56	64	72	80
	15	12	24	36	48	60	72	84	96	108	120
	20	16	32	48	64	80	96	112	128	144	160
	25	20	40	60	80	100	120	140	160	180	-
	30	24	48	72	96	120	144	168	192	-	-
	35	28	56	84	112	140	168	196	-	-	-
	40	32	64	96	128	160	192	-	-	-	-
	45	36	72	108	144	180	-	-	-	-	-
	50	40	80	120	160	-	-	-	-	-	-
	55	44	88	132	176	-	-	-	-	-	-

NOTES
1. TRENCH MUST BE PROVIDED ON EACH SIDE OF STRUCTURE.
2. SIDE OF TRENCH TO BE WRAPPED IN CLASS 1 GEOTEXTILE.
3. TRENCH TO BE FILLED WITH CLEAN STONE (3/4" MIN. SIZE).
4. TRENCH TO BE CONSTRUCTED AT 0% SLOPE ON UNDISTURBED SOIL.
5. TRENCH TO BE CHECKED REGULARLY TO MAINTAIN PROPER OPERATION.

STRUCTURES WITHOUT GUTTERS A



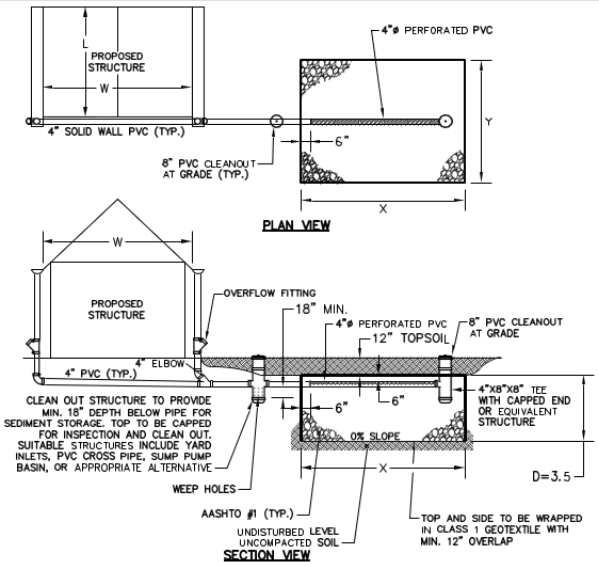
KEY
L = LENGTH OF STRUCTURE = LENGTH OF SEEPAGE BED (FT.)
W = WIDTH OF STRUCTURE (FT)
a = EAVE OVERHANG (FT)
b = DISTANCE FROM EAVE OVERHANG TO EDGE OF SEEPAGE BED (FT) = 1' MINIMUM
x = WIDTH OF SEEPAGE BED (FT)
x = W + 2 FT
d = DEPTH OF SEEPAGE BED = 6"

REQUIRED STORAGE VOLUME																
Impervious Area (SF)	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
Required Storage Volume Per Pit (CF)	42	50	58	67	75	83	92	100	108	117	125	133	142	150	158	167

NOTES
1.) SIDE OF BED TO BE WRAPPED IN CLASS 1 GEOTEXTILE.
2.) BED TO BE FILLED WITH CLEAN STONE (3/4" MIN. SIZE).
3.) BED TO BE CONSTRUCTED AT 0% SLOPE ON UNDISTURBED SOIL.
4.) BED TO BE CHECKED REGULARLY TO MAINTAIN PROPER OPERATION.

STRUCTURES WITHOUT GUTTERS B

Subsurface Stormwater BMPs

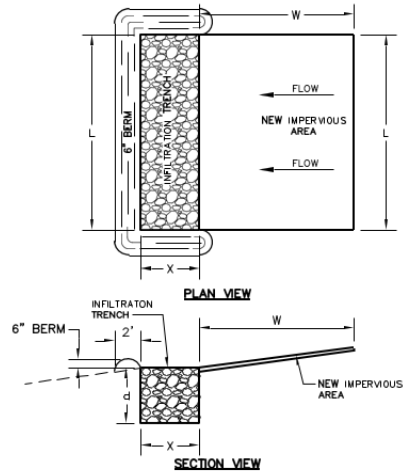


REQUIRED STORAGE VOLUME																
Impervious Area (SF)	500	600	700	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000
Required Storage Volume Per Pit (CF)	42	50	58	67	75	83	92	100	108	117	125	133	142	150	158	167

Required Pit Size											
		Pit Width (x)									
		5	6	7	8	9	10	11	12	15	20
Pit Length (Y)	5	35	42	49	56	63	70	77	84	105	140
	6	42	50	59	67	76	84	92	101	126	168
	7	49	59	69	78	88	98	108	118	147	196
	8	56	67	78	90	101	112	123	134	168	-
	9	63	76	88	101	113	126	139	151	189	-
	10	70	84	98	112	126	140	154	168	-	-
	11	77	92	108	123	139	154	169	185	-	-
	12	84	101	118	134	151	168	185	-	-	-
	15	105	126	147	168	189	-	-	-	-	-
	20	140	168	196	-	-	-	-	-	-	-

NOTES
1. BOTTOM OF BED ELEVATION TO BE 4.5' BELOW SURFACE TO ACCOUNT FOR 1' OF TOPSOIL OVER INFILTRATION BED.
2. PIPE TO BE APPROPRIATELY SIZED TO CARRY ROOF WATER. PVC PIPE SHALL HAVE A MIN. DIAMETER OF 4".
3. PIPING AND CLEANOUTS TO BE CENTERED WITHIN INFILTRATION BED.
4. BED TO BE CHECKED REGULARLY TO MAINTAIN PROPER OPERATION.

STRUCTURES WITH GUTTERS



KEY
L = LENGTH OF NEW IMPERVIOUS SURFACE (FT) = LENGTH OF INFILTRATION TRENCH
W = WIDTH OF NEW IMPERVIOUS SURFACE TRENCH
X = WIDTH OF SEEPAGE TRENCH (FT)
d = DEPTH OF SEEPAGE TRENCH (FT) = 3'

NOTES
1.) SIDE OF TRENCH TO BE WRAPPED IN PENNDOT CLASS 1 GEOTEXTILE.
2.) TRENCH TO BE FILLED WITH CLEAN STONE (3/4" MIN. SIZE).
3.) TRENCH TO BE CONSTRUCTED AT 0% SLOPE ON UNDISTURBED SOIL.
4.) TRENCH TO BE CHECKED REGULARLY TO MAINTAIN PROPER OPERATION.
5.) 6" BERM MAY BE REMOVED AS DEEMED APPROPRIATE BY THE MUNICIPALITY

Required Storage Volume														
Impervious Area Width (Ft) - W	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
Required Pit Width (Ft) - X	0.7	1.4	2.1	2.8	3.5	4.2	4.9	5.6	6.3	7.0	7.7	8.4	9.1	9.8	10.5

AT GRADE IMPERVIOUS

Construction of Subsurface BMPs

- Reminder: Only 40% of total facility volume may be credited for stormwater storage

- Install erosion and sedimentation control facilities
- Excavate the SWM Facility to the required depth. Contact the municipality for inspection once excavated

Construction of Subsurface BMPs

- Line sides of excavation with Geotextile, leaving enough to fold over top if a closed facility
- Backfill SWM Facility with required stone. Install piping, cleanouts, and associated facilities as detailed

Construction of Subsurface BMPs

- Close geotextile material over stone bedding if a closed facility, and place topsoil.
- Stabilize and seed all disturbed areas.

Maintenance for Subsurface BMPs

- Remove sediment and debris from cleanouts
- Check any pipe connections
- Ensure no settlement above or around facility

QUESTIONS?

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