APPENDIX A
Release Rate Percentage Tables by Subarea

Note release rate subarea maps and release rate percentage tables may be obtained on the following web site;

http://www. ross.pa.us/engineer/Act % 20167/Act% 20167 % 20Update.htm

Original Act 167 Map Plates (tif format)

Plate 2.1 Girtys Run Release Rate Percentage

Plate 2.2 Pine Creek Release Rate Percentage

Plate 2.3 Deer Creek Release Rate Percentage

Plate 2.4 Squaw Run Release Rate Percentage

Original Act 167 Map Plates (pdf format)

,Plate 2.1 Girtys Run Release Rate Percentage

Girtys Release Rate Table

Plate 2.2 Pine Creek Release Rate Percentage

Pine Release Rate Table

Plate 2.3 Deer Creek Release Rate Percentage

Deer Release Rate Table

Plate 2.4 Squaw Run Release Rate Percentage

Squaw Release Rate Table

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
DEER CREEK WATERSHED

Subarea	Municipality	Release Rate Percentage
1	West Deer	100
2	Richland, West Deer	100
3	Richland, West Deer	100
4	Richland, West Deer	100
5	West Deer	100
6	Richland	100
7	Richland, West Deer	100
8	Richland, West Deer	95
9	West Deer	85
10	West Deer	100
11	West Deer	100
12	West Deer	75
13	Hampton, West Deer	75
14	West Deer	80
15	Indian, West Deer	100
16	Hampton, Indiana, West Deer	100
17	Indiana, West Deer	100
18	West Deer	100
19	West Deer	100
20	West Deer	100
21	Indiana, West Deer	100
22	Indiana	100
23	Indiana	100
24	Indiana	100
25	Harmar, Indiana	100
26	Indiana, West Deer	60
27	Harmar, Indiana	100
28	Harmar, Indiana	100
29	West Deer	100
30	West Deer	100
31	Prazer, West Deer	95
32	West Deer	100
33	Frazer, West Deer	100
34	Frazer, Indiana, West Deer	100
35	Indiana	90
36	Frazer, Indiana, West Deer	80
37	Frazer, Indiana	70
38	Harnar, Indiana	100
39	Harmar	100
40	Harmar	100

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
GIRTY'S RUN WATERSHED

Subarea	Municipality	Release Rate Percentage
1	Ross, McCandless	100
2	Ross	70
3	Ross	80
4	Ross	65
5	Ross, West View	100
6	West View	100
7	West View, Ross	100
8	West View, Ross	95
9	Ross	75
10	Ross, McCandless	100
11	Ross	100
12	Ross	100
13	Ross	100
14	Ross	65
15	Ross	75
16	Ross, Shaler	85
17	Ross	95
18	Ross, Pittsburgh	95
19	Ross, Pittsburgh	90
20	Ross, Shaler	70
21	Reserve, Ross, Shaler	95
22	Shaler	80
23	Shaler	90
24	Shaler	95
25	Shaler, Millvale, Reserve	100
26	Reserve, Millvale	100

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
SQUAW RUN WATERSHED

Subarea	Municipality	Release Rate Percentage
1	Fox Chapel, Indiana	100
2	Fox Chapel, Indiana	90
3	Fox Chapel, Indiana	90
4	Fox Chapel	100
5	Fox Chapel, Harmar, O'Hara	85
6	Fox Chapel, Harmar	65
7	Fox Chapel	100
8	Fox Chapel	100
9	Fox Chapel	80
10	Fox Chapel, Indiana, O'Hara	100
11	Fox Chapel	100
12	Fox Chapel	95
13	Fox Chapel	100
14	Fox Chapel, O'Hara	100
15	Fox Chapel, O'Hara	75
16	O'Hara, City of Pittsburgh	100
17	O'Hara	100

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
PINE CREEK WATERSHED

Subarea	Municipality	Release Rate Percentage
1	Bradford Woods, Marshall, Pine	100
2	Bradford Woods, Franklin Park, Marshall	100
3	Franklin Park, Marshall	100
4	Franklin Park, Marshall	100
5	Franklin Park, McCandless, Marshall	80
6	Franklin Park	100
7	Franklin Park	100
8	Franklin Park	85
9	Franklin Park, McCandless	75
10	Bradford Woods, Marshall, Pine	100
11	Bradford Woods, Pine	100
12	Marshall, Pine	100
13	Franklin Park, Marshall, Pine	95
14	Franklin Park, McCandless, Marshall, Pine	85
15	McCandless, Pine	75
16	Franklin Park, McCandless	60
17	McCandless, Pine	100
18	McCandless	75
19	McCandless	60
20	McCandless	100
21	McCandless	65
22	McCandless	100
23	McCandless	100
24	McCandless	100
25	McCandless, Pine	100
26	McCandless	100
27	McCandless	100
28	McCandless	100
29	McCandless	100
30	McCandless	100
31	Pine	100
32	Pine	90
33	Pine	100
34	Pine	85
35	Pine	80

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
PINE CREEK WATERSHED
(Continued)

Subarea	Municipality	Release Rate Percentage
36	Pine	70
37	Pine	85
38	Pine	55
39	Pine	100
40	Pine	75
41	Pine	85
42	Pine	85
43	Pine	100
44	McCandless, Pine	80
45	McCandless, Pine	65
46	Pine	100
47	McCandless, Pine	100
48	McCandless, Pine	95
49	McCandless	100
50	Hampton, McCandless	100
51	Hampton, McCandless	100
52	Pine, Richland	100
53	Pine	100
54	Pine, Richland	100
55	Pine, Richland	100
56	Pine, Richland	85
57	Pine, Richland	85
58	Hampton, McCandless, Pine, Richland	90
59	Hampton, McCandless, Richland	100
60	Hampton	100
61	Richland	100
62	Richland	95
63	Richland	100
64	Richland	90
65	Richland	85
66	Richland	80
67	Richland	70
68	Richland	75
69	Richland	65
70	Hampton, Richland	70

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
PINE CREEK WATERSHED
(Continued)

Subarea	Municipality	Release Rate Percentage
71	Hampton, Richland	85
72	Hampton	85
73	Hampton	65
74	Hampton	100
75	Hampton	100
76	Hampton	100
77	Hampton, McCandless	100
78	Hampton, McCandless	100
79	Richland	100
80	Hampton, Richland	90
81	Hampton, Richland	95
821	Hampton	75
83	Hampton, Richland	100
84	Hampton	85
85	Hampton	100
86	Hampton	85
87	Hampton	95
88	Hampton	80
89	Hampton	75
90	Hampton	75
91	Hampton	80
92	Hampton	60
93	Hampton	85
94	Hampton	100
95	Hampton, McCandless	100
96	Hampton, McCandless	100
97	Hampton, McCandless	100
98	Hampton	100
99	Hampton	85
100	Hampton	75
101	Hampton	75
102	Hampton	100
103	Hampton	100
104	Hampton	65
105	Hampton	95

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
PINE CREEK WATERSHED
(Continued)

Subarea	Municipality	Release Rate Percentage
106	Hampton	80
107	Hampton	80
108	Hampton	75
109	Hampton	65
110	Hampton	85
111	Hampton	60
112	Hampton, Shaler	100
113	Hampton, Shaler	100
114	Hampton, Shaler	100
115	Hampton, Shaler	100
116	Shaler	100
117	Shaler	100
118	Shaler	100
119	Shaler	100
120	Shaler	100
121	Shaler	100
122	Shaler	100
123	Shaler	100
124	Shaler	100
125	Shaler	100
126	Shaler	100
127	Etna, Shaler	100
128	Hampton, Indiana	100
19	Hampton, Indiana	100
130	Hampton, Indiana	70
131	Indiana	100
132	Hampton, Indiana	80
133	Indiana	70
134	Fox Chapel, Indiana	90
135	Hampton, Indiana	85
136	Fox Chapel, Indiana, O'Hara	95
137	Fox Chapel, Indiana, O'Hara	80
138	Indiana, O'Hara	65
139	Fox Chapel, Indiana, O'Hara, Shaler	100
140	O'Hara, Shaler	70

APPENDIX A

RELEASE RATE PERCENTAGES BY SUBAREA
PINE CREEK WATERSHED
(Continued)

Subarea	Municipality	Release Rate Percentage
141	O'Hara, Shaler	100
142	O'Hara, Shaler	100
143	Etna, Shaler	100
144	Etna	100
145	McCandless	100
146	McCandless, Ross	95
147	Hampton, McCandless	95
148	McCandless, Ross	90
149	McCandless, Ross	85
150	Hampton, McCandless, Ross Shaler	70
151	Ross, Shaler	70
152	Ross	75
153	Ross, Shaler	60
154	Ross, Shaler	70
155	Shaler	60
156	Shaler	100
157	Shaler	100
158	Etna, Shaler	100
159	Etna, Shaler	100
160	Etna, Shaler	100
161	Etna, Shaler	100
162	Etna, Shaler	100

APPENDIX B

NON-STRUCTURAL STORMWATER MANAGEMENT PRACTICES ALTERNATIVE APPROACH FOR MANAGING STORMWATER RUNOFF

Natural hydrologic conditions may be altered radically by poorly planned development practices, such as introducing unneeded impervious surfaces, destroying existing drainage swales, constructing unnecessary storm sewers, and changing local topography. A traditional drainage approach of development has been to remove runoff from a site as quickly as possible and capture it in a detention basin. This approach leads ultimately to the degradation of water quality as well as expenditure of additional resources for detaining and managing concentrated runoff at some downstream location.

The recommended alternative approach is to promote practices that will minimize post-development runoff rates and volumes, which will minimize needs for artificial conveyance and storage facilities. To simulate pre-development hydrologic conditions, forced infiltration is often necessary to offset the loss of infiltration by creation of impervious surfaces. The ability of the ground to infiltrate depends upon the soil types and its conditions.

Preserving natural hydrologic conditions requires careful alternative site design considerations. Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. A well-designed site will contain a mix of all those features. The following describes various techniques to achieve the alternative approach:

Preserving Natural Drainage Features. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. However, this objective is often not accomplished in land development. In fact, commonly held drainage philosophy encourages just the opposite pattern - streets and adjacent storm sewers typically are located in the natural headwater valleys and swales, thereby replacing natural drainage functions with a completely impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Developments designed to fit site topography also minimizes the amount of grading on site.

Protecting Natural Depression Storage Areas. Depressional storage areas have no surface outlet, or drain very slowly following a storm event. They can be commonly seen as ponded areas in farm fields during the wet season or after large runoff events. Traditional development practices eliminate these depressions by filling or draining, thereby obliterating their ability to reduce surface runoff volumes and trap pollutants. The volume and release-rate characteristics of depressions should be protected in the design of the development site. The depressions can be protected by simply avoiding the depression or by incorporating its storage as additional capacity ha required detention facilities.

Avoiding introduction of impervious areas. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints, sidewalks, driveways and other features producing impervious surfaces should be evaluated to minimize impacts on runoff.

Reducing the Hydraulic Connectivity of Impervious Surfaces. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as storm sewer). Two basic ways to reduce hydraulic connectivity are routing of roof runoff over lawns and

reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff, and should help reduce concentration of runoff to a single point in the development.

Routing Roof Runoff Over Lawns. Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connections of downspouts to storm sewers or parking lots. The practice also discourages sloping driveways and parking lots to the street. By routing roof drains and crowning the driveway to run off to the lawn, the lawn is essentially used as a filter strip.

Reducing the Use of Storm Sewers. By reducing use of storm sewers for draining streets, parking lots, and back yards, the potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical, for some development sites, especially if there are concerns for areas that do not drain in a "reasonable" time. The practice requires educating local citizens and public works officials, who expect runoff to disappear shortly after a rainfall event.

Reducing Street Widths. Street widths can be reduced by either eliminating on-street parking or by reducing roadway widths. Municipal planners and traffic designers should encourage narrower neighborhood streets which ultimately could lower maintenance.

Limiting Sidewalks to One Side of the Street. A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines. Where appropriate, backyard trails should be constructed using pervious materials.

Using Permeable Paving Materials. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads.

Reducing Building Setbacks. Reducing building setbacks reduces driveway and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

Constructing Cluster Developments. Cluster developments can also reduce the amount of impervious area for a given number of lots. The biggest savings is in street length, which also will reduce costs of the development. Cluster development clusters the construction activity onto less-sensitive areas without substantially affecting the gross density of development.
In summary, a careful consideration of the existing topography and implementation of a combination of the above mentioned techniques may avoid construction of costly stormwater control measures. Other benefits include reduced potential of downstream flooding, water quality degradation of receiving streams/water bodies and enhancement of aesthetics and reduction of development costs. Beneficial results include more stable baseflows in receiving streams, improved groundwater recharge, reduced flood flows, reduced pollutant loads, and reduced costs for conveyance and storage.

(Source: This appendix is taken from, Guidance on MS4 Ordinance Provisions, Document Number 392-0300-003, by the Pennsylvania Department of Environmental Protection, dated August 2, 2003.)

APPENDIX C

List of References Cited and Additional Sources of Information
Prepared: February 2007
Prepared By: NHCOG ACT 167 UPDATE

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APPENDIX D

Credits for Use of Nonstructural BMPs
Example Calculations

The developer may obtain credits for the use of nonstructural BMPs using the procedures outlined below.

Volume Reduction Method #1: Natural Area Conservation

A water quality volume reduction can be taken when undisturbed natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics. Under this method, a designer would be able to subtract the conservation areas from the total site area when computing the water quality protection volume. An added benefit is that the post-development peak discharges will be smaller, and hence, water quantity control volumes will be reduced due to lower post-development curve numbers or rational formula "C" values.

Rule: Subtract conservation areas from total site area when computing water quality protection volume requirements.

Criteria:

- Conservation area cannot be disturbed during project construction and must be protected from sediment deposition.
- Shall be protected by limits of disturbance clearly shown on all construction drawings.
- Shall be located within an acceptable conservation easement instrument that ensures perpetual protection of the proposed area. The easement must clearly specify how the natural area vegetation shall be managed and boundaries will be marked [Note: managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management]
- Shall have a minimum contiguous area requirement of 10,000 square feet
- R_v is kept constant when calculating WQ_v
- Must be forested or have a stable, natural ground cover.

Example:

Residential Subdivision
Area = 38 acres
Natural Conservation Area = 7 acres
Impervious Area = 13.8 acres

$R_v = 0.05 + 0.009\ (I) = 0.05 + 0.009\ (36.3\%) = 0.38$

Reduction:

7.0 acres in natural conservation area
New drainage area = 38 - 7 = 31 acres

Before reduction:

$\mathbf{WQ_v = (1.5)(0.38)(38)/12 = 1.81\ ac\text{-}ft}$

With reduction:

$\mathbf{WQ_v = (1.5)(0.38)(31)/12 = 1.47\ ac\text{-}ft}$

(19% reduction in water quality protection volume)

Volume Reduction Method #2' Stream Buffers

This reduction can be taken when a stream buffer effectively treats storm water runoff. Effective treatment constitutes treating runoff through overland flow in a naturally vegetated or forested buffer. Under the proposed method, a designer would be able to subtract areas draining via overland flow to the buffer from total site area when computing water quality protection volume requirements, In addition, the volume of runoff draining to the buffer can be subtracted, from the streambank protection volume. The design of the stream buffer treatment system must use appropriate methods for conveying flows above the annual recurrence (1-yr storm) event.

Rule: Subtract areas draining via overland flow to the buffer from total site area when computing water quality protection volume requirements.

Criteria:

- The minimum undisturbed buffer width shall be 50 feet
- The maximum contributing length shall be 150 feet for pervious surfaces and 75 feet for impervious surfaces
- The average contributing slope shall be 3% maximum unless, a flow spreader is used
- Runoff shall enter the buffer as overland sheet flow. A flow spreader can be installed to ensure this.
- Buffers shall remain as naturally vegetated or forested areas and will require only routine debris removal or erosion repairs
- R_v is kept constant when calculating WQ_v
- Not applicable if overland flow filtration/groundwater recharge reduction is already being taken

Example:

Residential Subdivision
Area = 38 acres
Impervious Area = 13.8 acres
Area Draining to Buffer = 5 acres
$R_v = 0.05 + 0.009\ (I) = 0.05 + 0{,}009\ (36.3\%) = 0{,}38$

Reduction:

5.0 acres draining to buffer

New drainage area = 38 - 5 = 33 acres

Before reduction:

WQ_v= (1.5)(0.38)(38)/12 = 1.81 ac-ft

With reduction:

WQ = (1.5)(0.38)(33)/12 = 1.57 ac-ft

(13% reduction in water quality protection volume)

Volume Reduction Method #3; Enhanced Swales

This reduction may be taken when enhanced swales are used for water quality protection, Under the proposed method, a designer would be able to subtract the areas draining to an enhanced swale from total site area when computing water quality protection volume requirements. An enhanced swale can fully meet the water quality protection volume requirements for certain lands of low-density residential development (see Volume Reduction Method #5). An added benefit is the post-development peak discharges will likely be lower due to a longer time of concentration for the site.

Rule: Subtract the areas draining to an enhanced swale from total site area when computing water quality protection volume requirements.

Criteria:

- This method is typically only applicable to moderate or low density residential land uses (3 dwelling units per acre maximum)
- The maximum flow velocity for water quality design storm shall be less than or equal to 1.0 feet per second
- The minimum residence time for the water quality storm shall be 5 minutes
- The bottom width shall be a maximum of 6 feet. If a larger channel is needed use of a compound cross section is required
- The side slopes shall be 3:1 (horizontal:vertical) or flatter
- The channel slope shall be 3 percent or less
- R_V is kept constant when calculating WQ_v

Example:
Residential Subdivision
Area = 38 acres
Impervious Area - 13.8 acres
$R_v = 0.05 + 0.009\ (I) = 0.05 + 0.009\ (36.3\%) = 0.38$

Reduction:

12.5 acres meet enhanced swale criteria

New drainage area = 38 - 12.5 = 25.5 acres
Before reduction:
$WQ_v = (1.5)(0.38)(38)/12 = 1.81$ ac-ft

With reduction:
$WQ_v = (1.5)(0.38)(25.5)/12 = 1.21$ ac-ft
(33% reduction in water quality protection volume)

Volume Reduction Method #4: Overland Flow Filtration/Groundwater Recharge Zones

This reduction can be taken when "overland flow filtration/infiltration zones" are incorporated into the site design to receive runoff from rooftops or other small impervious areas (e.g., driveways, small parking lots, etc). This can be achieved by grading the site to promote overland vegetative filtering or by providing infiltration or "rain garden" areas. If impervious areas are adequately disconnected, they can be deducted from total site area when computing the water quality protection volume requirements. An added benefit will be that the post-development peak discharges will likely be lower due to a longer time of concentration for the site.
Rule: If impervious areas are adequately disconnected, they can be deducted from total site area when computing the water quality protection volume requirements.

Criteria:

- Relatively permeable soils (hydrologic soil groups A and B) should be present
- Runoff shall not come from a designated hotspot
- The maximum contributing impervious flow path length shall be 75 feet
- Downspouts shall be at least 10 feet away from the nearest impervious surface to discourage “reconnections"
- The disconnection shall drain continuously through a vegetated channel, swale, or filter strip to the property line or structural storm water control.

- The length of the "disconnection" shall be equal to or greater than the contributing length
- The entire vegetative "disconnection" shall be on a slope less than or equal to 3 percent
- The surface imperviousness area to any one discharge location shall not exceed 5,000 square feet
- For those areas draining directly to a buffer, reduction can be obtained from either overland flow filtration *-or-* stream buffers (See Method #2)
- R_v is kept constant when calculating WQ_v

Example:
Site Area = 3.0 acres
Impervious Area = 1.9 acres (or 63.3% impervious cover)
"Disconnected" Impervious Area = 0.5 acres

$R_v = 0.05 + 0.009\ (I) = 0.05 + 0.009\ (63.3\%) = 0.62$

Reduction:

0.5 acres of surface imperviousness hydrologically disconnected
New drainage area = 3 - 0.5 = 2.5 acres
Before reduction:
WQ_v= (1.5)(0.62)(3)/12 = 0.23 ac-ft
With reduction:
WQ_v = (1.5)(0.62)(2.5)/12 = 0.19 ac-ft

(17% reduction in water quality protection volume)

<u>Volume Reduction Method #5: Environmentally Sensitive Large Lot Subdivisions</u>

This reduction can be taken when a group of environmental site design techniques are applied to low and very low density residential development (e.g., 1 dwelling unit per 2 acres [du/ac] or lower). The use of this method can eliminate the need for structural storm water controls to treat water quality protection volume requirements. Tiffs method is targeted towards large lot subdivisions and will likely have limited application.
Rule: Targeted towards large lot subdivisions (e.g. 2 acre 1ots and greater). The requirement for structural practices to treat the water quality protection volume shall be waived.

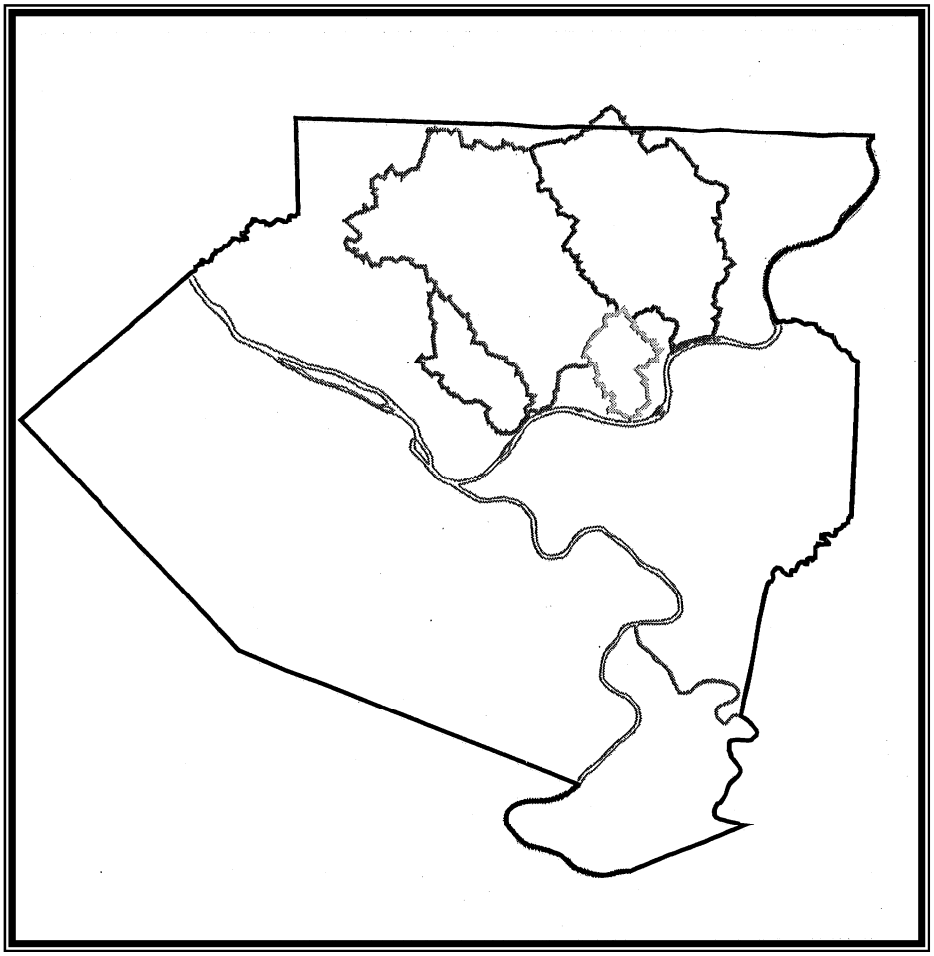
<u>Criteria:</u>
For Single Lot Development:

- Total site impervious cover is less than 15%
- Lot size shall be at least two acres
- Rooftop runoff is disconnected in accordance with the criteria in Method #4
- Grass channels are used to convey runoff versus curb and gutter

For Multiple Lots:

- Total impervious cover footprint shall be less than 15% of the area
- Lot areas should be at least 2 acres, unless clustering is implement. Open space developments should have a minimum of 25% of the site protected as natural conservation areas and shall be at least a half-acre average individual lot size
- Grass channels should be used to convey runoff versus curb and gutter (see Method #3)
- Overland flow filtration/infiltration zones should be established (see Method #4)

Small Project
Standardized Stormwater Management Planning Guidance



Act 167 Stormwater Management Plan Update
Girtys Runs, Pine Creek, Squaw Run and Deer Creek Watersheds
Allegheny County, Pennsylvania

Prepared by
Art Gazdik, P.E.

April 28, 2008

Applicability

These criteria may be used to develop a stormwater management (SWM) plan for a small projects, having a disturbed area of less than 5000 square feet, in an area where comprehensive subdivision SWM plan has not been planned or constructed. It is not to be used to plan for multiple lots without the written approval of the Municipal Engineer.

This guidance may not be appropriate for all locations (e,g., in areas on or adjacent to steep slopes, in areas on or adjacent to fill slopes, in areas having unsuitable soil conditions (e.g., clayey soils) or in areas having a high water table). The Municipal Building Inspector or Engineer may require that a more detailed stormwater management plan be prepared by a qualified design professional if, in their opinion, unusual site conditions exist.

These standardized SWM facilities, if properly sized and installed, should provide the water quality volume, infiltration volume and extended detention protections required by the municipality's SWM Ordinance. These standardized facilities are not specifically sized to provide for the peak flow reduction requirement, if any, but will generally provide peak flow control of storm events that do not exceed a 10 year- 24 hour return period.

What are the Standardized SWM facilities?

The Standardized SWM facilities (Standardized BMPs) are a set of three methods, or best management practices (BMPs), that have been selected because of their potential for being sited on individual residential lots. Each of the methods has been sized using a specific set of design assumptions. A list of the Standardized SWM facilities and the basic design assumptions used are outlined below. A more detailed set of the design assumptions used to size the Standardized SWM facilities is provided later in this Guide. It is the Applicant's responsibility to verify that the assumptions are appropriate for the subject property. Construction details and more detailed information about the design installation and maintenance requirements for of each of the facilities are also provided later in this document.

SWM Facility Name	Basic Design Assumptions		
Bioretention	4' Filter Bed Depth	0.5' Ponding Depth	Drain Time = 2 Days
Rock Sump	4' Rock Depth		
Porous Pavement	2' Gravel Depth	0.32 Gravel Porousity	Fill Time = 2 Hours

What is required?

A. Install "Stormwater Management Facilities (BMPs)" to reduce downstream flooding and protect the water quality of our streams.

B. Install erosion and sedimentation control devices during construction to keep silt and sediment from washing into the storm sewers, ditches or streams on or adjacent to the site.

C. Properly record a maintenance agreement to insure the continued maintenance and protection of the SWM facilities

When is it required?

Applicants will be required to file a SWM plan with their building permit or land disturbance /grading permit application as per the municipality's requirements.

Are professional services required?

Yes, the SWM facilities must be designed by a licensed professional engineer or other Qualified Professional experienced in the design of stormwater management.

Are the Standardized SWM facilities in this Guide required?

No, any SWM facilities meeting the municipality's Stormwater Management Regulations will be acceptable.

How should this Guide be used?

Step I - Determine the Impervious Area and the Disturbed Area

Calculate the following:

1. The total area in square feet of roofs, driveways, sidewalks, paved areas and any other impervious surfaces proposed for the lot.
2. The total area in square feet of the lot that is to be disturbed. "Disturbed Area" is all area that is to be stripped of natural vegetation and converted to lawn, roof, pavement, sidewalk or driveway.

Step 2 - Determine the required surface area of the Standardized BMPs

Go to the Determination of SWM Facility Sizing Tables (Disturbed Area Table) and find the table that is titled with a "Disturbed Area = [Value] SF" where [Value] is equal to or greater than the proposed "Disturbed Area" for the lot. For example, if the lot will have a disturbed area of 2200 SF, use the table titled "Disturbed Area = 2500 SF or Less" as shown below.

Using the correct Disturbed Area Table, determine the sizing of the standardized SWM facility or facilities to be used, using the area in square feet of all impervious surface tributary to the SWM facility or facilities. This area is referred to as "Area Impervious" on the Table and is found in Column "1".

Go down Column "1" to the "Area Impervious" value that is greater than or equal to the impervious area tributary to the SWM facilities, For example, if it is determined that the total area of all roof and pavements tributary to the SWM facilities will be 1921 square feet (SF), use a value of 2000 square feet to determine the SWM facility sizing for the three standardized best management practices provided in Columns 3, 4 and 5 of the table. NOTE: If runoff from existing impervious areas will also be tributary to the SWM facilities, that area must also be included in the calculations.

For this example where the Disturbed Area is 2200 SF and the Area Impervious is 1921 SF, the surface area (foot print size) of the Standardized BMP Options provided are:

Column 3 - Bioretention Surface Area = 151SF
Column 4 - Rock Sump Foot Print = 212.5 SF
Column 5 - Porous Pavement Surface Area = 222 SF

Disturbed Area = 2500 SF or Less

Determination of SWM Facility Sizing AG3/3/7	Bioretention Assumptions	Rock Sump Assumptions	Pourous Pavement Assumptions
Note: Disturbed area is all area that is to be stripped of natural vegetation and converted to lawn, roof, pavement, sidewalk or driveway	k=0.5 ft/day for silt loam df= filter bed depth = 4' hf= half of ponding depth = 0.25' tf= filter drain time = 2 days	Assume 4' Sump Depth	n= porosity of gravel=0.32 d= gravel depth = 2' k= percolation = 0.5in/hour t= fill time = 2 hours

1			2					3	4	5
Area Impervious	Area Impervious	Disturbed Area	Disturbed Area	Percent Impervious	Volumetric Runoff Coeficient	Water Quality Volume	Water Quality Volume	Bioretention Surface Area	Rock Sump Surface Foot Print	Pourous Pavement Surface Area
(square feet)	(acre)	(acre)	(square feet)	(%)	(Rv)	(acre-feet)	(cubic feet)	(square feet)	(square feet)	(square feet)
250	0.005739	0.0573921	2500	10.00%	0.1400	0.0006696	29	27	26.6	40
300	0.006887	0.0573921	2500	12.00%	0.1580	0.0007557	33	31	31.9	46
400	0.009183	0.0573921	2500	16.00%	0.1940	0.0009278	40	38	42.5	56
500	0.011478	0.0573921	2500	20.00%	0.2300	0.0011000	48	45	53.1	66
600	0.013774	0.0573921	2500	24.00%	0.2660	0.0012722	55	52	63.8	77
700	0.019070	0.0573921	2500	28.00%	0.3020	0.0014444	62	59	74.4	87
800	0.018365	0.0573921	2500	32.00%	0.3380	0.0016165	70	66	85.0	97
900	0.020661	0.0573921	2500	36.00%	0.3740	0.0017887	78	73	95.6	108
1000	0.022957	0.0573921	2500	40.00%	0.4100	0.0019609	85	80	106.3	118
1100	0.025253	0.0573921	2500	44.00%	0.4460	0.0021331	93	87	116.9	128
1200	0.027548	0.0573921	2500	48.00%	0.4820	0.0023052	100	95	127.5	139
1300	0.029844	0.0573921	2500	52.00%	0.5180	0.0024774	108	102	138.1	149
1400	0.032140	0.0573921	2500	56.00%	0.5540	0.0026496	115	109	148.8	160
1500	0.034435	0.0573921	2500	60.00%	0.5900	0.0028218	123	116	159.4	170
1600	0.036731	0.0573921	2500	64.00%	0.6260	0.0029940	130	123	170.0	180
1700	0.039027	0.0573921	2500	68.00%	0.6620	0.0031661	138	130	180.6	191
1800	0.041322	0.0573921	2500	72.00%	0.6980	0.0033383	145	137	191.3	201
1900	0.043618	0.0573921	2500	76.00%	0.7340	0.0035105	153	144	201.9	211
2000	0.045914	0.0573921	2500	80.00%	0.7700	0.0036827	160	151	212.5	222
2100	0.048209	0.0573921	2500	84.00%	0.8060	0.0038548	168	158	223.1	232
2200	0.050505	0.0573921	2500	88.00%	0.8420	0.0040270	175	165	233.8	243
2300	0.052801	0.0573921	2500	92.00%	0.8780	0.0041992	183	172	244.4	253
2400	0.055096	0.0573921	2500	96.00%	0.9140	0.0043714	190	179	255.0	263
2500	0.057392	0.0573921	2500	100.00%	0.9500	0.0045435	198	186	265.6	274

Figure – Example table "Determination of SWM Facility Sizing (Disturbed Area Table)

Applicants may use a single option to satisfy the SWM requirements or a combination of options.

For example, a single type of facility, say Bioretention, could be installed as set forth below:

SWM Facility Type	Total Required	Actual SF Installed	Percentage of SWM Requirement
	(SF)	(SF)	(%)
Bioretention	151	151	100%
Rock Sump	212.5	0	0%
Porous Pavement	222	0	0%
			100%

or multiple SWM facility types could be proposed'

SWM Facility Type	Total Required	Actual SF Installed	Percentage of SWM Requirement
	(SF)	(SF)	(%)
Bioretention	151	50	33%
Rock Sump	212.5	35	16%
Porous Pavement	222	111	50%
			100%

Step 3 - Preparing the SWM Site Plan

Applicants shall submit three (3) copies of a plot plan survey, or site plan drawn on a single sheet no larger that 8 1/2" x 14" (or folded to 8 1/2" x 11") containing all of the following information. (Submission of one plan showing existing conditions and a second Plan(s) showing proposed work generally will not be acceptable.)

1) Name and address of owner(s).

2) Lot number, name of subdivision, size of lot, street address, scale, date.

3) North arrow.

4) All existing and proposed structures, including accessory structures, additions, driveways, decks, patios, utilities, storm sewers, sanitary sewers including laterals,-fresh-air vents and cleanouts, storm water sumps, swimming pools and sports courts with all dimensions. When the existing sewer lateral is within the limit of disturbance, the site plan must show its exact location based on existing records. When no such records exist, laterals shall be located using underground pipe locator equipment.

5) Setback distances from all property lines. Building lines must be shown.

6) The distance and direction to the nearest intersection.

7) Existing topography by two foot (2') contours and all proposed grading clearly delineated to distinguish between existing and proposed grades and the datum upon which the grades are based.

8) The limits, type and degree of risk as shown on any Hazard Maps that the municipality has available.

9) Shading, coloring, cross-hatching, etc, between contour lines to clearly distinguish the areas of Steep Slopes (15% - 25%) and Very Steep Slopes (25%+).

10) The PRECISE "Limit of Disturbance" and the area thereof.

11) All right-of-ways, easements, streams or ponds.

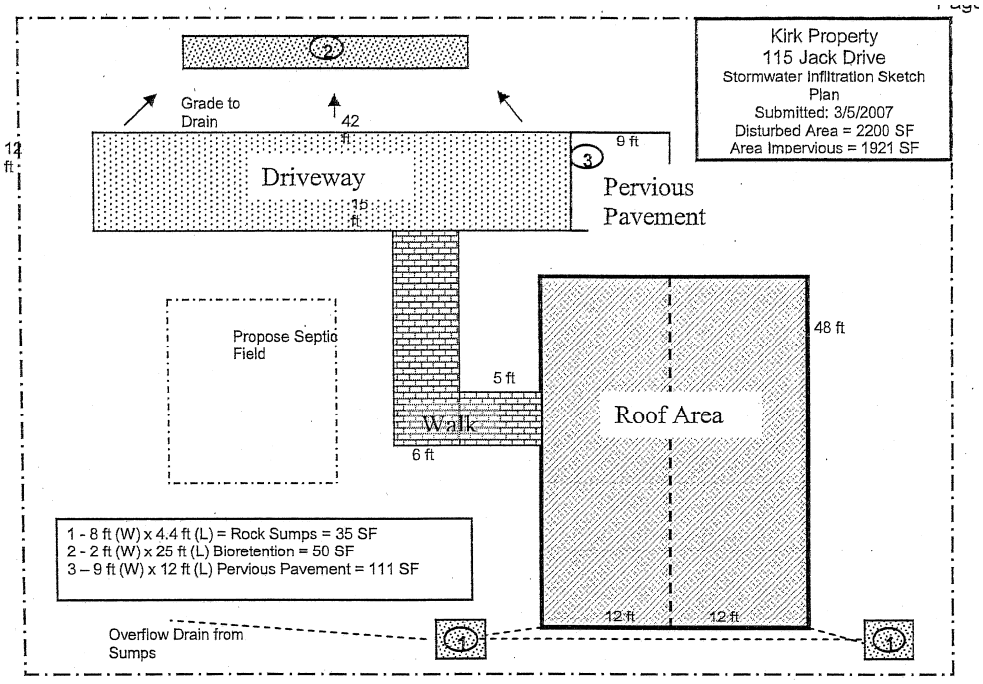
12) The location of all proposed utility lines and the associated "Limit of Disturbance".

13) The method of stormwater management in accordance with the requirements set forth in the municipality's Stormwater Management Regulations. The applicant shall include two (2) copies of the design criteria, and method of stormwater management with the application.

14) Soil erosion and sedimentation control measures.

15) A registered Engineer's or other Qualified Professionals seal.

A simple example site plan is provided on the next below.



Step 4 – Submitting the SWM Plan

The following information shall be submitted with the application for a building permit or, if applicable, the Environmental Disturbance / Grading Permit:

- The Standardized SWM Permit Application
- A fully executed "Stormwater BMPs Operations and Maintenance Agreement"
- The SWM site plan.
- A copy of the "Guidance Sheet" for each type of BMP used,

Step 5-Installing the Standardized BMPs

Insure that each SWM facility is installed as per the requirements of the "Guidance Sheet" for the type(s) of facilities proposed.

Step 6 - Understanding your maintenance responsibilities

In order to insure that the BMPs will continue to be protected and properly maintained, applicants will be required to enter into a "Stormwater Best Management Practices Operations and Maintenance Agreement". A copy of the agreement is provided in the Appendix C of this document.

Disturbed Area = 1000 SF or Less

Determination of SWM Facility Sizing AG3/3/7	Bioretention Assumptions	Rock Sump Assumptions	Pourous Pavement Assumptions
Note: Disturbed area is all area that is to be stripped of natural vegetation and converted to lawn, roof, pavement, sidewalk or driveway	k=0.5 ft/day for silt loam df= filter bed depth = 4' hf= half of ponding depth = 0.25' tf= filter drain time = 2 days	Assume 4' Sump Depth	n= porosity of gravel=0.32 d= gravel depth = 2' k= percolation = 0.5in/hour t= fill time = 2 hours

1			2					3	4	5
Area Impervious	Area Impervious	Disturbed Area	Disturbed Area	Percent Impervious	Volumetric Runoff Coeficient	Water Quality Volume	Water Quality Volume	Bioretention Surface Area	Rock Sump Surface Foot Print	Pourous Pavement Surface Area
(square feet)	(acre)	(acre)	(square feet)	(%)	(Rv)	(acre-feet)	(cubic feet)	(square feet)	(square feet)	(square feet)
250	0.005739	0.02295684	1000	25.00%	0.2750	0.0005261	23	22	NA	32
300	0.006887	0.02295684	1000	30.00%	0.3200	0.0006122	27	25	NA	37
400	0.009183	0.02295684	1000	40.00%	0.4100	0.0007844	34	32	42.5	47
500	0.011478	0.02295684	1000	50.00%	0.5000	0.0009565	42	39	53.1	58
600	0.013774	0.02295684	1000	60.00%	0.5900	0.0011287	49	46	63.8	68
700	0.016070	0.02295684	1000	70.00%	0.6800	0.0013009	57	53	74.4	78
800	0.018365	0.02295684	1000	80.00%	0.7700	0.0014731	64	60	85.0	89
900	0.020661	0.02295684	1000	90.00%	0.8600	0.0016452	72	67	95.6	99
1000	0.022957	0.02295684	1000	100.00%	0.9500	0.0018174	79	75	106.3	109

Disturbed Area = 2500 SF or Less

Determination of SWM Facility Sizing AG3/3/7	Bioretention Assumptions	Rock Sump Assumptions	Pourous Pavement Assumptions
Note: Disturbed area is all area that is to be stripped of natural vegetation and converted to lawn, roof, pavement, sidewalk or driveway	k=0.5 ft/day for silt loam df= filter bed depth = 4' hf= half of ponding depth = 0.25' tf= filter drain time = 2 days	Assume 4' Sump Depth	n= porosity of gravel=0.32 d= gravel depth = 2' k= percolation = 0.5in/hour t= fill time = 2 hours

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300	0.006887	0.00573921	2500	12.00%	0.1580	0.0007557	33	31	NA	46
400	0.009183	0.00573921	2500	16.00%	0.1940	0.0009278	40	38	42.5	56
500	0.011478	0.00573921	2500	20.00%	0.2300	0.0011000	48	45	53.1	66
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700	0.016070	0.00573921	2500	28.00%	0.3020	0.0014444	63	59	74.4	87
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900	0.020661	0.00573921	2500	36.00%	0.3740	0.0017887	78	73	95.6	108
1000	0.022957	0.00573921	2500	40.00%	0.4100	0.0019609	85	80	106.3	118
1100	0.025253	0.00573921	2500	44.00%	0.4460	0.0021331	93	87	116.9	128
1200	0.027548	0.00573921	2500	48.00%	0.4820	0.0023052	100	95	127.5	139
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1500	0.034435	0.00573921	2500	60.00%	0.5900	0.0028218	123	116	159.4	170
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1900	0.043618	0.00573921	2500	76.00%	0.7340	0.0035105	153	144	201.9	211
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2100	0.048209	0.00573921	2500	84.00%	0.8060	0.0038548	168	158	223.1	232
2200	0.050505	0.00573921	2500	88.00%	0.8420	0.0040270	175	165	233.8	243
2300	0.052801	0.00573921	2500	92.00%	0.8780	0.0041992	183	172	244.4	253
2400	0.055096	0.00573921	2500	96.00%	0.9140	0.0043714	190	179	255.0	263
2500	0.057391	0.00573921	2500	100..00%	0.9500	0.0045435	198	186	265.6	274

Disturbed Area =5000 SF or Less

Determination of SWM Facility Sizing AG3/3/7	Bioretention Assumptions	Rock Sump Assumptions	Pourous Pavement Assumptions
Note: Disturbed area is all area that is to be stripped of natural vegetation and converted to lawn, roof, pavement, sidewalk or driveway	k=0.5 ft/day for silt loam df= filter bed depth = 4' hf= half of ponding depth = 0.25' tf= filter drain time = 2 days	Assume 4' Sump Depth	n= porosity of gravel=0.32 d= gravel depth = 2' k= percolation = 0.5in/hour t= fill time = 2 hours

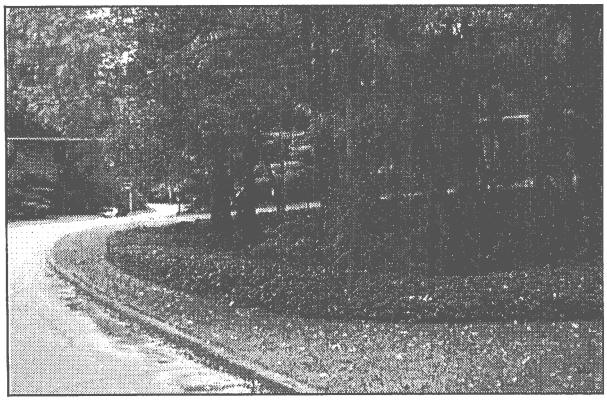
1			2					3	4	5
Area Impervious	Area Impervious	Disturbed Area	Disturbed Area	Percent Impervious	Volumetric Runoff Coeficient	Water Quality Volume	Water Quality Volume	Bioretention Surface Area	Rock Sump Surface Foot Print	Pourous Pavement Surface Area
(square feet)	(acre)	(acre)	(square feet)	(%)	(Rv)	(acre-feet)	(cubic feet)	(square feet)	(square feet)	(square feet)
250	0.005739	0.11478421	5000	5.00%	0.0950	0.0009087	40	37	NA	55
300	0.006887	0.11478421	5000	6.00%	0.1040	0.0009948	43	41	NA	60
400	0.009183	0.11478421	5000	8.00%	0.1220	0.0011670	51	48	42.5	70
500	0.011478	0.11478421	5000	10.00%	0.1400	0.0013391	58	55	53.1	81
600	0.013774	0.11478421	5000	12.00%	0.1580	0.0015113	66	62	63.8	91
700	0.016070	0.11478421	5000	14.00%	0.1760	0.0016835	73	69	74.4	101
800	0.018365	0.11478421	5000	16.00%	0.1940	0.0018557	81	76	85.0	112
900	0.020661	0.11478421	5000	18.00%	0.2120	0.0020279	88	83	95.6	122
1000	0.022957	0.11478421	5000	20.00%	0.2300	0.0022000	96	90	106.3	132
1100	0.025253	0.11478421	5000	22.00%	0.2480	0.0023722	103	97	116.9	143
1200	0.027548	0.11478421	5000	24.00%	0.2660	0.0025444	111	104	127.5	153
1300	0.029844	0.11478421	5000	26.00%	0.2840	0.0027166	118	111	138.1	164
1400	0.032140	0.11478421	5000	28.00%	0.3020	0.0028887	126	118	148.8	174
1500	0.034435	0.11478421	5000	30.00%	0.3200	0.0030609	133	125	159.4	184
1600	0.036731	0.11478421	5000	32.00%	0.3380	0.0032331	141	133	170.0	195
1700	0.039027	0.11478421	5000	34.00%	0.3560	0.0034053	148	140	180.6	205
1800	0.041322	0.11478421	5000	36.00%	0.3740	0.0035774	156	147	191.3	215
1900	0.043618	0.11478421	5000	38.00%	0.3920	0.0037496	163	154	201.9	226
2000	0.045914	0.11478421	5000	40.00%	0.4100	0.0039218	171	161	212.5	236
2100	0.048209	0.11478421	5000	42.00%	0.4280	0.0040940	178	168	223.1	247
2200	0.050505	0.11478421	5000	44.00%	0.4460	0.0042661	186	175	233.8	257
2300	0.052801	0.11478421	5000	46.00%	0.4640	0.0044383	193	182	244.4	267
2400	0.055096	0.11478421	5000	48.00%	0.4820	0.0046105	201	189	255.0	278
2500	0.057392	0.11478421	5000	50.00%	0.5000	0.0047827	208	196	265.6	288
2600	0.059688	0.11478421	5000	52.00%	0.5180	0.0049549	216	203	276.3	298
2800	0.064278	0.11478421	5000	56.00%	0.5540	0.0052992	231	217	297.5	319
3000	0.068871	0.11478421	5000	60.00%	0.5900	0.0056436	246	231	318.8	340
3250	0.074610	0.11478421	5000	65.00%	0.6350	0.0060740	265	249	345.3	366
3500	0.080349	0.11478421	5000	70.00%	0.6800	0.0065044	283	267	371.9	392
3750	0.86088	0.11478421	5000	75.00%	0.7250	0.0069349	302	284	398.4	418
4000	0.091827	0.11478421	5000	80.00%	0.7700	0.0073653	321	302	425.0	444
4250	0.097567	0.11478421	5000	85.00%	0.8150	0.0077958	340	320	451.6	469
4500	0.103306	0.11478421	5000	90.00%	0.8600	0.0082262	358	337	478.1	495
4750	0.109045	0.11478421	5000	95.00%	0.9050	0.0086566	377	355	504.7	521
5000	0.114784	0.11478421	5000	100.00%	0.9500	0.0090871	396	373	531.3	547

Disturbed Area =10,000 SF or Less

Determination of SWM Facility Sizing AG3/3/7	Bioretention Assumptions	Rock Sump Assumptions	Pourous Pavement Assumptions
Note: Disturbed area is all area that is to be stripped of natural vegetation and converted to lawn, roof, pavement, sidewalk or driveway	k=0.5 ft/day for silt loam df= filter bed depth = 4' hf= half of ponding depth = 0.25' tf= filter drain time = 2 days	Assume 4' Sump Depth	n= porosity of gravel=0.32 d= gravel depth = 2' k= percolation = 0.5in/hour t= fill time = 2 hours

1			2					3	4	5
Area Impervious	Area Impervious	Disturbed Area	Disturbed Area	Percent Impervious	Volumetric Runoff Coeficient	Water Quality Volume	Water Quality Volume	Bioretention Surface Area	Rock Sump Surface Foot Print	Pourous Pavement Surface Area
(square feet)	(acre)	(acre)	(square feet)	(%)	(Rv)	(acre-feet)	(cubic feet)	(square feet)	(square feet)	(square feet)
250	0.005739	0.22956841	10,000	2.50%	0.0725	0.0013870	60	57	NA	84
300	0.006887	0.22956841	10,000	3.00%	0.0770	0.0014731	64	60	NA	89
400	0.009183	0.22956841	10,000	4.00%	0.0860	0.0016452	72	67	42.5	99
500	0.011478	0.22956841	10,000	5.0%	0.0950	0.0018174	79	75	53.1	109
600	0.013774	0.22956841	10,000	6.00%	0.1040	0.0019896	87	82	63.8	120
700	0.016070	0.22956841	10,000	7.00%	0.1130	0.0021618	94	89	74.4	130
800	0.018365	0.22956841	10,000	8.00%	0.1220	0.0023339	102	96	85.0	141
900	0.020661	0.22956841	10,000	9.00%	0.1310	0.0025061	109	103	95.6	151
1000	0.022957	0.22956841	10,000	10.00%	0.1400	0.0026783	117	110	106.3	161
1100	0.025253	0.22956841	10,000	11.00%	0.1490	0.0028505	124	117	116.9	172
1200	0.027548	0.22956841	10,000	12.00%	0.1580	0.0030227	132	124	127.5	182
1300	0.029844	0.22956841	10,000	13.00%	0.1670	0.0031948	139	131	138.1	192
1400	0.032140	0.22956841	10,000	14.00%	0.1760	0.0033670	147	138	148.8	203
1500	0.034435	0.22956841	10,000	15.00%	0.1850	0.0035392	154	145	159.4	213
1600	0.036731	0.22956841	10,000	16.00%	0.1940	0.0037114	162	152	170.0	224
1700	0.039027	0.22956841	10,000	17.00%	0.2030	0.0038835	169	159	180.6	234
1800	0.041322	0.22956841	10,000	18.00%	0.2120	0.0040557	177	166	191.3	244
1900	0.043618	0.22956841	10,000	19.00%	0.2210	0.0042279	184	173	201.9	255
2000	0.045914	0.22956841	10,000	20.00%	0.2300	0.0044001	192	180	212.5	265
2100	0.048209	0.22956841	10,000	21.00%	0.2390	0.0045722	199	187	223.1	275
2200	0.050505	0.22956841	10,000	22.00%	0.2480	0.0047444	207	195	233.8	286
2300	0.052801	0.22956841	10,000	23.00%	0.2570	0.0049166	214	202	244.4	296
2400	0.055096	0.22956841	10,000	24.00%	0.2660	0.0050888	222	209	255.0	306
2500	0.057392	0.22956841	10,000	25.00%	0.2750	0.0052609	229	216	265.6	317
2600	0.059688	0.22956841	10,000	26.00%	0.2840	0.0054331	237	223	276.3	327
2800	0.064279	0.22956841	10,000	28.00%	0.3020	0.0057775	252	237	297.5	348
3000	0.068871	0.22956841	10,000	30.00%	0.3200	0.0061218	267	251	318.8	369
3250	0.074610	0.22956841	10,000	32.50%	0.3425	0.0065523	285	269	345.3	395
3500	0.080349	0.22956841	10,000	35.00%	0.3650	0.0069827	304	286	371.9	421
3750	0.086088	0.22956841	10,000	37.50%	0.3875	0.0074131	323	304	398.4	446
4000	0.091827	0.22956841	10,000	40.00%	0.4100	0.0078436	342	322	425.0	472
4250	0.097567	0.22956841	10,000	42.50%	0.4325	0.0082740	360	339	451.6	498
4500	0.103306	0.22956841	10,000	45.00%	0.4550	0.0087045	379	357	478.1	524
4750	0.109045	0.22956841	10,000	47.50%	0.4775	0.0091349	398	375	504.7	550
5000	0.114784	0.22956841	10,000	50.00%	0.5000	0.0095654	417	392	531.3	576

Guidance Sheet – Bioretention Areas



Description: Shallow stormwater basin or landscaped area that utilizes engineered soils and vegetation to capture and treat runoff.

KEY CONSIDERATIONS

DESIGN CRITERIA:

- Maximum contributing drainage area of 5 acres
- Often located in "landscaping islands"
- Treatment area consists of grass filter, sand bed, ponding area, organic/mulch layer, planting soil, and vegetation
- Typically requires 5 feet of head

ADVANTAGES / BENEFITS:

- Applicable to small drainage areas
- Good for highly impervious areas, particularly parking lots
- Good retrofit capability
- Relatively low maintenance requirements
- Can be planned as an aesthetic feature

DISADVANTAGES / LIMITATIONS:

- Requires extensive landscaping
- Not recommended for areas with steep slopes

MAINTENANCE REQUIREMENTS:

- Inspect and repair/replace treatment area components

POLLUTANT REMOVAL

80%	**Total Suspended Solids**
60/50%	**Nutrients** - Total Phosphorus / Total Nitrogen removal
M	**Metals** - Cadmium, Copper, Lead, and Zinc removal
No data	**Pathogens** - Coliform, Streptococci, E.Coli removal

STORMWATER MANAGEMENT SUITABILITY

- ✓ **Water Quality**
- ϑ **Channel Protection**
- ☐ **Extreme Flood Protection**

Accepts Hotspot Runoff: *Yes (requires impermeable liner)*

ϑ in certain situations

IMPLEMENTATION CONSIDERATIONS

M	**Land Requirement**
M	**Capital Cost**
L	**Maintenance Burden**

Residential Subdivision Use: *Yes*

High Density/Ultra-Urban: *Yes*

Drainage Area: *5 acres max.*

Soils: *Planting soils must meet specified criteria; No restrictions on surrounding soils*

Other Considerations:

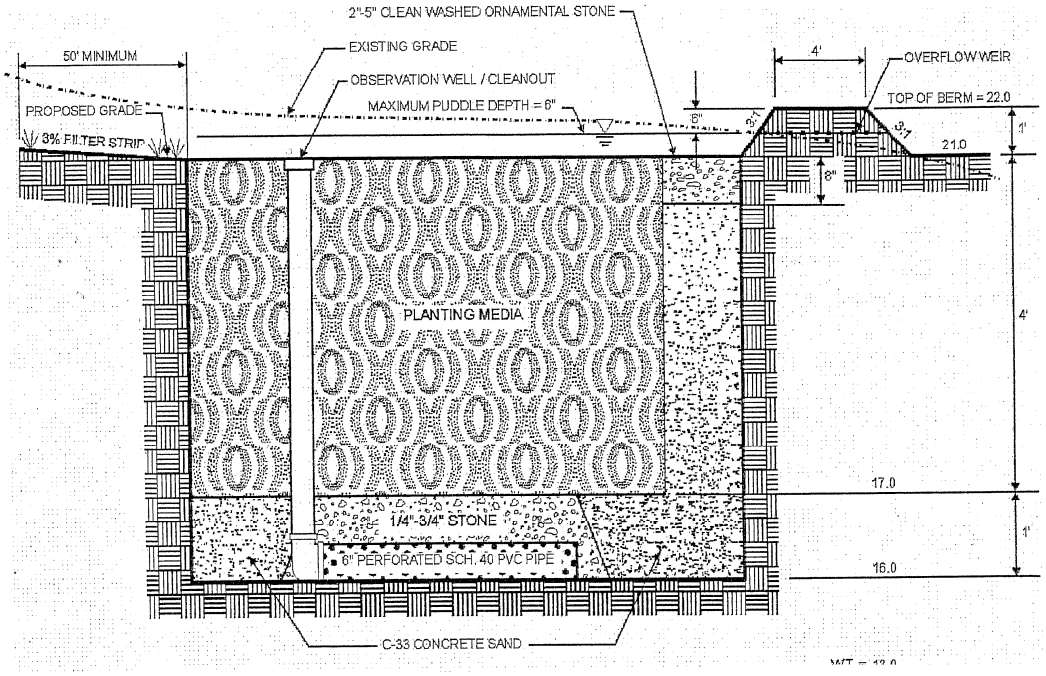
- *Use of native plants is recommended*

L=Low **M**=Moderate **H**=High

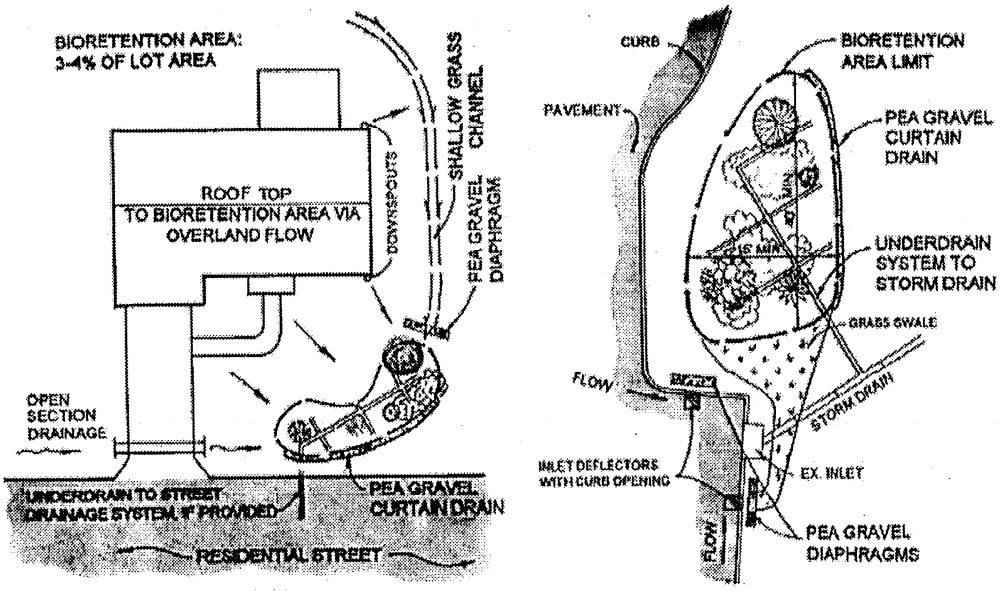
General Description

Bioretention areas (also referred to as *bioretention filters* or *rain gardens)* are structural stormwater controls that capture and temporarily store the water quality volume (WQ_v) using soils and vegetation in shallow basins or landscaped areas to remove pollutants from stormwater runoff,

Bioretention areas are engineered facilities in which runoff is conveyed as sheet flow to the "treatment area," which consists of a grass buffer strip, pending area, organic or mulch layer, planting soil, and vegetation. An optional sand bed can also be included in the design to provide aeration and drainage of the planting soil. The filtered runoff is typically collected and returned to the conveyance system, though it can also be exfiltrated into the surrounding soil in areas where appropriate.



Bioretention Typical Detail (Source: Georgia SWM Manual)



Application and Site Feasibility Criteria

Bioretention areas are suitable for single-family residential lots of 1 acre or less. Because of its ability to be incorporated in landscaped areas, the use of bioretention is extremely flexible.

The following criteria should be evaluated to ensure the suitability of a bioretention area for meeting stormwater management objectives on a site or development.

Physical Feasibility- Physical Constraints at Project Site

- Site Slope - No more than 6% slope
- Minimum Head - Elevation difference needed at a site from the inflow to the outflow: 5 feet
- Minimum Depth to Water Table - A separation distance of 2 feet recommended between the bottom of the bioretention facility and the elevation of the seasonally high water table.
- Soils - No restrictions; engineered media required

Other Constraints / Considerations

- Aquifer Protection - Do not allow exfiltration of filtered hotspot runoff into groundwater

Planning and Design Criteria

The following criteria are to be considered ***minimum*** *standards for the design of a bioretention facility* ***for a single family residential lot****. Consult with the local review authority to determine if there are any variations to these criteria or additional standards that must be followed.*

A. LOCATION AND SITING

- Residential Bioretention areas should have a maximum contributing drainage area of 0.25 acres or less; multiple bioretention areas can be used.

- Bioretention systems are designed for intermittent flow and must be allowed to drain and reaerate between rainfall events. They should not be used on sites with a continuous flow from groundwater, sump pumps, or other sources.

- Bioretention area locations should be integrated into the site planning process, and aesthetic considerations should be taken into account in their siting and design. Elevations must be carefully worked out to ensure that the desired runoff flow enters the facility with no more than the maximum design depth.

B. GENERAL DESIGN

- The Standardized bioretention area for a single residential lot consists of:

  (1) Grass filter strip (lawn areas) between the contributing drainage area and the ponding area should where possible be a minimum of 15' in length.
  (2) Ponding area containing vegetation with a planting soil bed.
  (3) Organic/mulch layer must be four (4') in depth.
  (4) Gravel and perforated pipe underdrain system to collect runoff that has filtered through the soil layers (bioretention areas can optionally be designed to infiltrate into the soil).

- A bioretention area design will also include some of the following:

  - Optional **sand filter layer** to spread flow, filter runoff, and aid in aeration and drainage of the planting soil.

  - **Stone diaphragm** at the beginning of the grass filter strip to reduce runoff velocities and spread flow into the grass filter.

C. PHYSICAL SPECIFICATIONS / GEOMETRY

- The planting soil filter bed is sized using a Darcy's Law equation with a filter bed drain time of 48 hours and a coefficient of permeability (k) of 0,5 ft/day.

- The ponding depth of the bioretention areas is 6 inches.

- The planting soil bed must be at least 4 feet in depth. Planting soils should be sandy loam, loamy sand, or loam texture with a clay content ranging from 10 to 25%. The soil must have an infiltration rate of at least 0.5 inches per hour and a pH between 5.5 and 6.5. In addition, the planting soil should have a 1.5 to 3% organic content and a maximum 500 ppm concentration of soluble salts.

- Water should be directed as sheet flow over lawn area to the bioretention area.

- The mulch layer should consist of 2 to 4 inches of commercially available fine shredded hardwood mulch or shredded hardwood chips.

- The sand bed should be 12 to 18 inches thick. Sand should be clean and have less than 15% silt or clay content.

- Pea gravel for the diaphragm and curtain, where used, should be ASTM D 448 size No. 6 (1/8" to ¼").

- The underdrain collection system is equipped with a 6-inch perforated PVC pipe (AASHTOM 252) in an 8-inch gravel layer. The pipe should have 3/8-inch perforations, spaced at 6-inch centers, with a minimum of 4 holes per row. The pipe is spaced at a maximum of 10 feet on center and a minimum grade of 0.5% must be maintained. A permeable filter fabric is placed between the gravel layer and the planting soil bed.

D. PRETREATMENT

- Adequate pretreatrnent is provided when al! o1: the following are provided: (a) water flows over grass filter strip (lawn area) prior to entering the bioretention area.

E. OUTLET STRUCTURES

- Outlet pipe is to be provided from the underdrain system to the facility discharge. Due to the slow rate of filtration, outlet protection is generally unnecessary.

F. EMERGENCY SPILLWAY

- An overflow structure and nonerosive overflow channel must be provided to safely pass flows from the bioretention area that exceed the storage capacity to a stabilized downstream area or watercoursel If the system is located off-line, the overflow should be set above the shallow pondinglimit.

G. MAINTENANCE ACCESS

- Adequate access must be provided for all bioretention facilities for inspection, maintenance, and landscaping upkeep, including appropriate equipment and vehicles.

H. SAFETY FEATURES

- Bioretention areas generally do not require any special safety features. Fencing of bioretention facilities is not generally desirable.

I. LANDSCAPING

- Landscaping is critical to the performance and function of bioretention areas.

- A dense and vigorous vegetative cover should be established over the contributing pervious drainage areas before runoff can be accepted into the facility.

- The bioretention area should be vegetated to resemble a terrestrial forest ecosystem, with a mature tree canopy, subcanopy of understory trees, scrub layer, and herbaceous ground cover. Three species each of both trees and scrubs are recommended to be planted.

- The tree-to-shrub ratio should be 2:1 to 3:1. On average, the trees should be spaced 8 feet apart. Plants should be placed at regular intervals to replicate a natural forest. Woody vegetation should not be specified at inflow locations.

- After the trees and shrubs are established, the ground cover and mulch should be established.

- Choose plants based on factors such as whether native or not, resistance to drought and inundation, cost aesthetics, maintenance, etc. Planting recommendations for bioretention facilities are as follows:

    - Native plant species should be speoified over non.native species.
    - Vegetation should be selected based on a specified zone of hydric tolerance.
    - A selection of trees with an understo.ry of shrubs and herbaceous materials should be provided.

The following are some native plants suitable for rain gardens for the Northeast Region. They are also attractive to butterflies, birds, and other wildlife. Be sure to choose species appropriate for the degree of sun or shade on the site.

Wildflowers, Ferns, Grasses, and Sedges:	Trees and Shrubs:
• *Asclepias incarnata,* Swamp milkweed	• *Amelanchierlaevis,* Shadbush
• *Chelone glabra,* White turtlehead	• *Asimina triloba,* Pawpaw
• *Eupatorium maculatum,* Joe-pye weed	• *Betula nigra,* River birch
• *Loblia cardinalis,* Cardinal flower	• *Cephalanthus occidentalis,* Buttonbush
• *Lobelia syphilitica,* Blue Iobelia	• *Clethra alnifolia,* Sweet pepperbush
• *Monarda didyma,* Oswego tea	• *Comus amomum,* Silky dogwood
• *Vernonia noveboracensis,* Common ironweed	• *Fothergilla gardenii,* Dwarf fothergilla
• *Athyrium filix-femina,* Lady fern	• *liex verticillata,* Winterberry holly
• *Osmunda.regalis,* Royal fern	• *Lindera~benzoin,* Spicebush
• *Osmunda cinnamomea,* Cinnamon fern	• *Liquidambar styraciflua,* Sweet gum
• *Carex pendula,* Drooping sedge	• *Sambucus canadensis,* American elderberry
• *Carex stipata,* Tussock sedge	• *Viburnum dentatum,* Arrowwood

Design Basis

The required planting soil filter bed area is computed using the following equation (based on Darcy's Law):

$$A_f = (WQv)\,(d_f) / [\,(k)\,(h_f + d_f)\,(t_f)]$$

where:

A_f = surface area of ponding area (ft^2)
WQ_v = water quality volume (or total volume to be captured in CF)
d_f = filter bed depth
(4 feet minimum)
k = coefficient of permeability of filter media (ft/day)
(use 0.5 ft/day for silt-loam)
h_f = average height of water above filter bed (ft)
(typically 3 inches, which is half of the 6-inch ponding depth)
t_f = design filter bed drain time (days)
(2.0 days or 48 hours is recommended maximum)

An overflow must be provided to bypass and/or convey larger flows to the downstream drainage system or stabilized watercourse. Nonerosive velocities need to be ensured at the outlet point.

A landscaping plan for the bioretention area should be prepared to indicate how it will be established with vegetation.

Inspection and Maintenance Requirements

Typical Maintenance Activities for Bioretention Areas
(source: EPA, 1999)

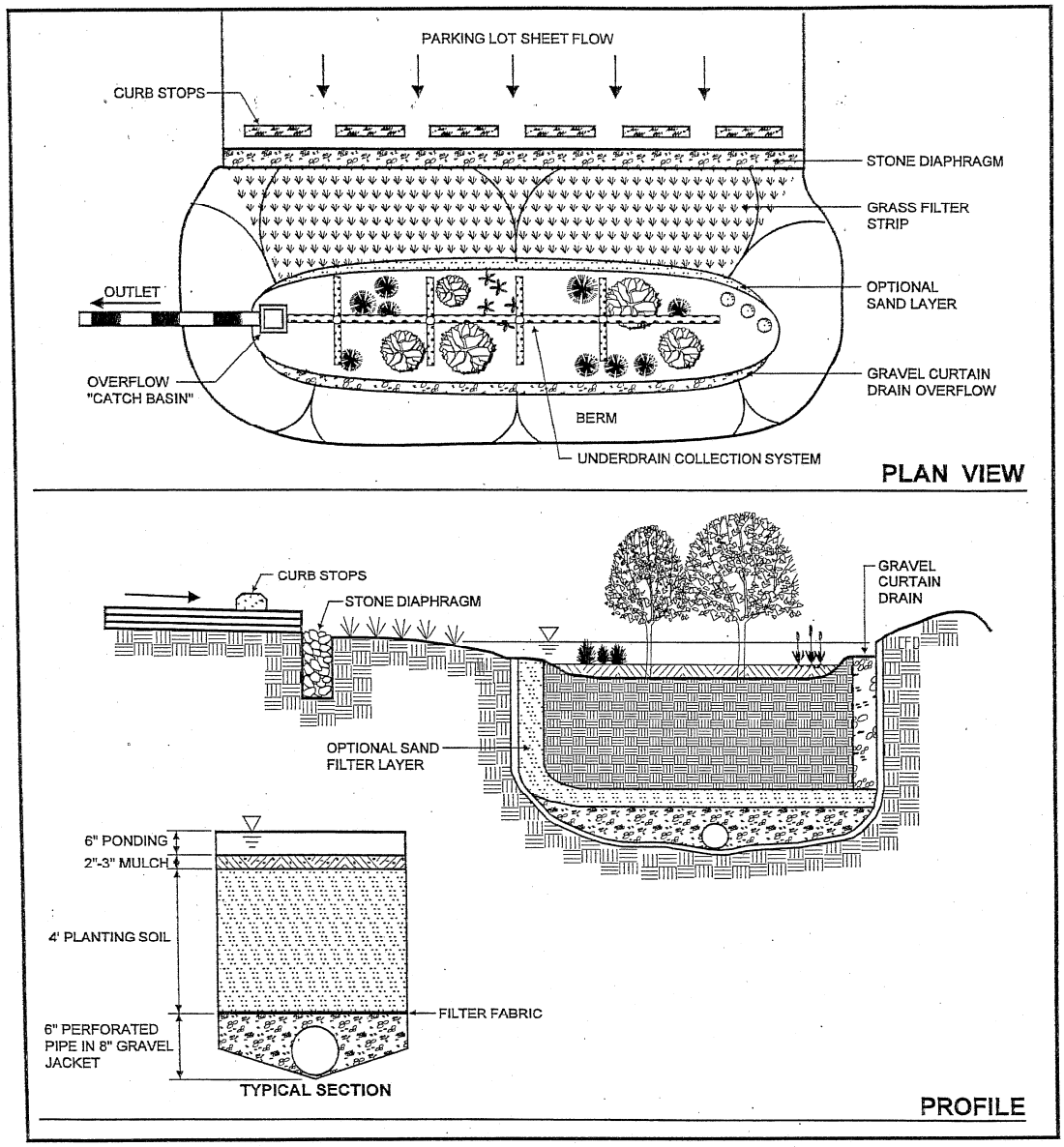
Activity	Schedule
• Pruning and weeding to maintain appearance. • Mulch replacement when erosion is evident. • Remove trash and debris.	As needed
• Inspect inflow points for clogging (off-line systems). Remove any sediment. • Inspect filter strip/grass channel for erosion or gullying. Re-seed or sod as necessary. • Trees and shrubs should be inspected to evaluate their health and remove any dead or severely, diseased vegetation.	Semi-annually
• The planting soils should be tested for pH to establish acidic levels. If the pH is below 5.2, limestone should be applied. If the pH is above 7.0 to 8.0, then iron sulfate plus sulfur can be added to reduce the pH.	Annually
• Replace mulch over the entire area. • Replace pea gravel diaphragm if warranted.	2 to 3 years.

Additional Maintenance Considerations and Requirements

➢ The surface of the ponding area may become clogged with fine sediment over time. Core aeration or cultivating of unvegetated areas may be required to ensure adequate filtration.

Regular inspection and maintenance is critical to the effective operation of bioretention facilities as designed. Maintenance responsibility for a bioretention area should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

Example Schematic

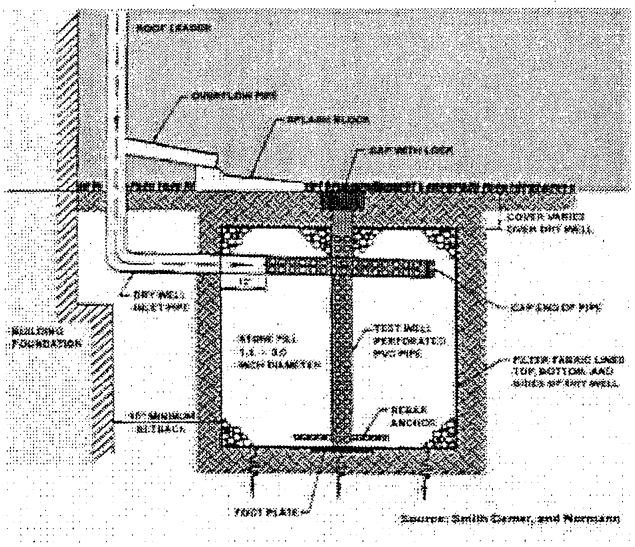


Schematic of Typical On-Line Bioretention Area
(Source: Claytor and Schueler, 1996)

This Guidance document is based upon information adapted from the Georgia Stormwater Manual and the Brooklyn Botanic Garden web site.

Guidance Sheet- Rock Sumps

Standardized Residential SWM Facility
For Small Projects



(Source: PA BMP Manual)

Description: A Dry Well, or Seepage Pit, is a variation on an Infiltration system that is designed to temporarily store and infiltrate rooftop runoff.

KEY CONSIDERATIONS	STORMWATER MANAGEMENT SUITABILITY
• Maintain a minimum 2-foot separation to bedrock and seasonally high water table, provide distributed infiltration area (5:1 impervious area to infiltration area - maximum), site on natural, uncompacted soils with acceptable infiltration capacity, and follow other guidelines described in Protocol 2: Infiltration Systems Guidelines • Maintain minimum distance from building foundation (typically 10 feet) • Provide adequate overflow outlet for large storms • Depth of Dry Well aggregate should be between 48 inches • At least one observation well; clean out is recommended • Wrap aggregate with nonwoven geotextile • Maximum drain-down time is 72 hours	☑ Water Quality ☑ ϑ Channel/Flood Protection **SPECIAL APPLICATIONS** ☐ Pretreatment ☑ High Density/Ultra-Urban ☑ Other: Overflow Parking, Driveways & related uses Residential Subdivision Use: *Yes* (in common areas that are maintained) ϑ in certain situations

General Description

A Dry Well, sometimes called a Seepage Pit, is a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roofs of structures, Roof leaders connect directly into the Dry Well, which may be either an excavated pit filled with uniformly graded aggregate wrapped in geotextile or a prefabricated storage chamber or pipe segment. Dry Wells discharge the stored runoff via infiltration into the surrounding soils. In the event that the Dry Well is overwhelmed in an intense storm event, an overflow mechanism (surcharge pipe, connection to larger infiltration area, etc.) will ensure that additional runoff is safely conveyed downstream.

By capturing runoff at the source, Dry Wells can dramatically reduce the increased volume of stormwater generated by the roofs of structures. Though roofs are generally not a significant source of runoff pollution, they are still one of the most important sources of new or increased runoff volume from developed areas. By decreasing the volume of stormwater runoff, Dry Wells can also reduce runoff rate and improve water quality. As with other infiltration practices, Dry Wells may not be appropriate for "hot spots" or other areas where high pollutant or sediment loading is expected without additional design considerations. Dry Wells are not recommended within a specified distance to structures or subsurface sewage disposal systems.

Design Criteria and Specifications

The use of a single stage rock sump is one of several alternatives that may be appropriate for small project area developments. Site parameters which must be considered when determining the suitability of a sump for stormwater control include the following'

- Soil type
- Slope
- Slope Stability
- Discharge location
- Basement elevation
- Offsite stormwater conveyance systems
- Offsite detention systems

Where it is determined that a single stage rock sump is appropriate, the following procedure is designed to provide a fast, simple method to determine the rock volume and orifice size required to provide adequate stormwater control for small projects, in order to develop a practical solution for this type of design problem, several qualifying assumptions are necessary to set the limits for which the procedure is applicable. Those limits were designed to incorporate the type of situation most often encountered. In general the following conditions must be satisfied in order for the use of single stage rock sumps to be appropriate:

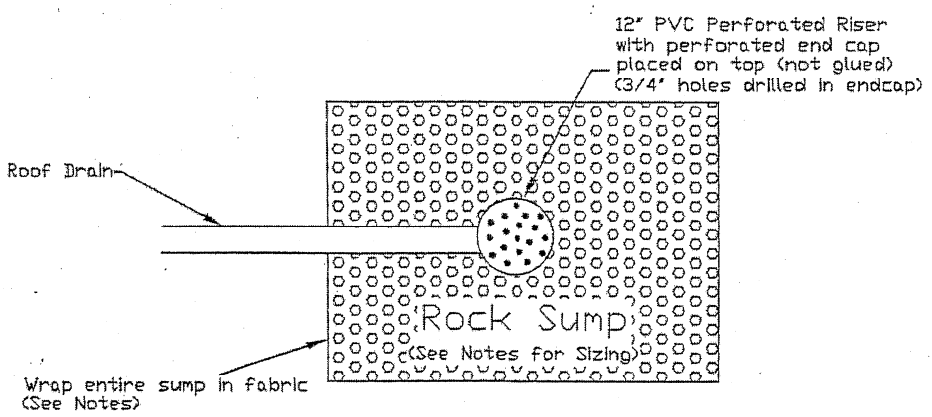
- The project area tributary to the proposed sump is less than 5000 square feet, and consists entirely of impervious (paved or roofed areas) surfaces, i.e., RCN = 98;
- To minimize the sump size, runoff from impervious surfaces may be divided and conveyed to the separate sumps. If runoff from impervious surfaces is not divided, the sump must be designed for the entire area that will be tributary to the facility;
- The pre-development area to be altered must have an existing time of concentration (Tc) of six (6) minutes or less; and
- The single stage rock sump must be designed according to the parameters shown in the attached drawing.

Prior to using the following procedure, the designer must verify that all of the above criteria apply to the subject project. Should any of the conditions not apply, the use of the procedure outlined herein is inappropriate and may result in either the over-design or Under-design of the rock sump facility.

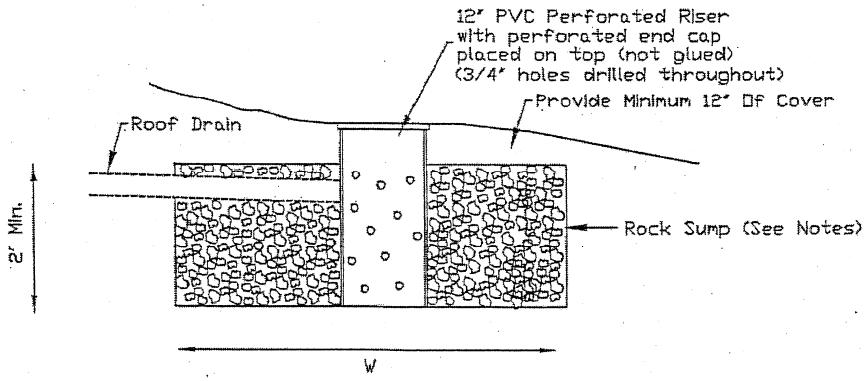
Design Sizing

1. Determine the area of the impervious surfaces that will be collected and conveyed to the sump.
2. Enter the sizing table and determine the size of the release orifice and volume of the sump.
3. Determine the sump dimensions based on the site topography and surface features.
4. Design the sump in accordance with the parameters shown in the attached drawing

NOTE: If the development will result in an increase in impervious surface of less than 400 square feet, the infiltration sump design (below) should be used, The sump volume should be based on 40 cubic feet of stone for each 100 square feet of impervious surface.



PLAN VIEW



SECTION

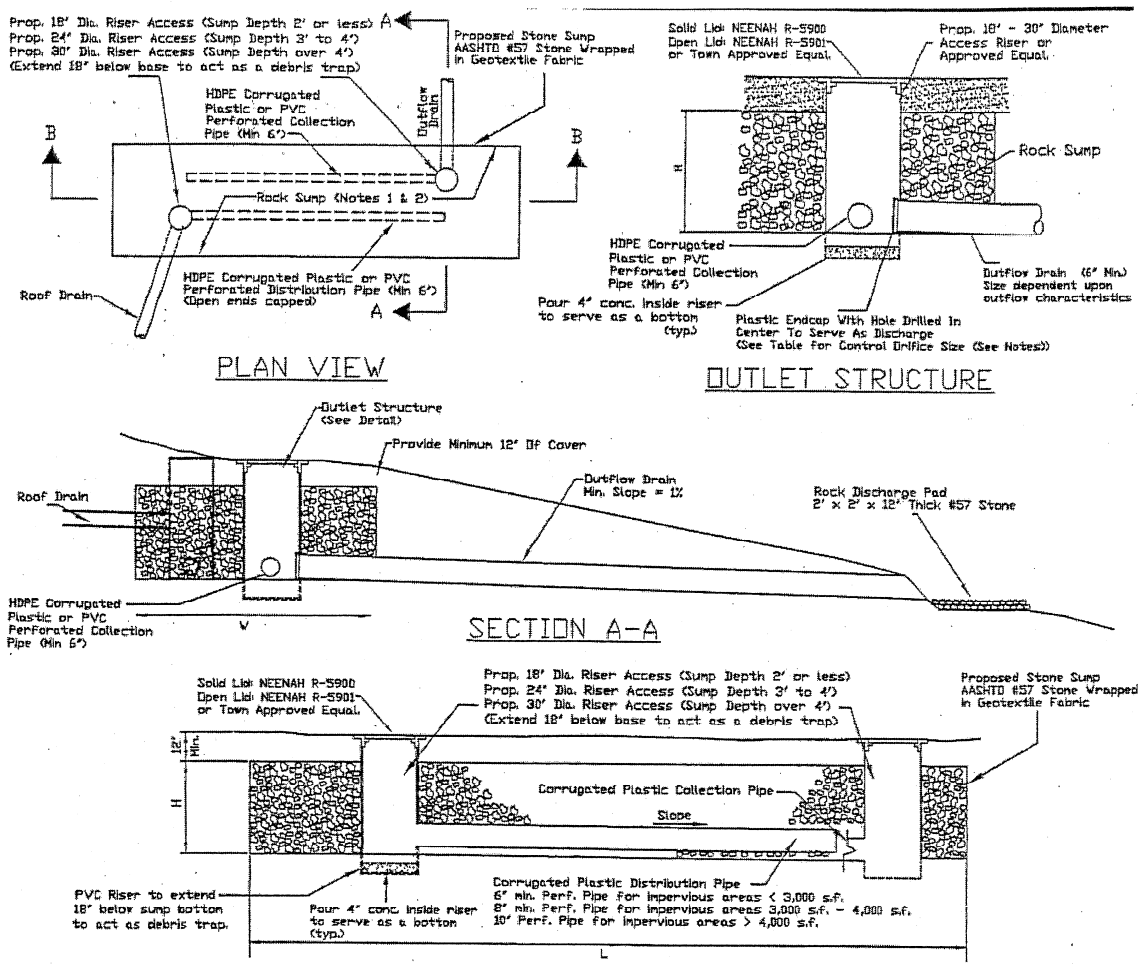
Notes:

1. The Rock Sump shall be designed as follows: 40 c.f. of Rock per 100 s.f. of impervious area.
2. Rock Sump shall be constructed of AASHTO #57 Limestone or 2B Gravel.
3. Wrap sump on all sides with PennDOT Class 2, Type B Non-woven Geotextile Material.
4. Dimensions and ratios shall vary as per design volume required.
5. Dry sumps in fill areas not permitted.
6. Cleanouts shall be located just before any horizontal bends.
7. When feasible, the Rock Sump should be located such that the top elevation of the riser pipe is below the basement floor elevation.

THIS DETAIL MAY BE UTILIZED FOR TOTAL IMPERVIOUS AREAS < 400 S.F.

Figure S1 – Rock Sump Detail (<400 SF of impervious area)

(Detailed from Town of McCandless / Partridge Venture Engineering)



SECTION B-B

Notes:

1. Design Parameters (volume and outlet control works) shall be based upon the Table of values as shown on Detail SW-5, (400 S.F. < Impervious Area < 5000 s.f.)
2. Rock Sump shall be constructed of AASHTO #57 Limestone or 2B Gravel.
3. Wrap sump on all sides with PennDOT Type B Non-woven Geotextile Material
4. Dimensions and ratios of L (Length), W (Width), and H (Height) shall vary as per design volume required.
5. Minimum ratio L to W is 3:1, (ie. L = 3W).
6. Dry sumps in fill areas not permitted.
7. Dimensions L (Length) shall be oriented to be parallel to the grade contour alignment.
8. No 90° elbows permitted on cleanout installations.
9. Cleanouts shall be located just before any horizontal bends.
10. All pip and fitting shall be ASTM D2729
11. When feasible, the Rock Sump should be located such that the outflow elevation is below the basement floor elevation

THIS DETAIL MAY BE UTILIZED FOR TOTAL IMPERVIOUS AREAS < 400 S.F.

Figure S2 – Rock Sump Detail (> 400 SF & , 5000 SF of impervious area)

(Detailed from Town of McCandless / Partridge Venture Engineering)

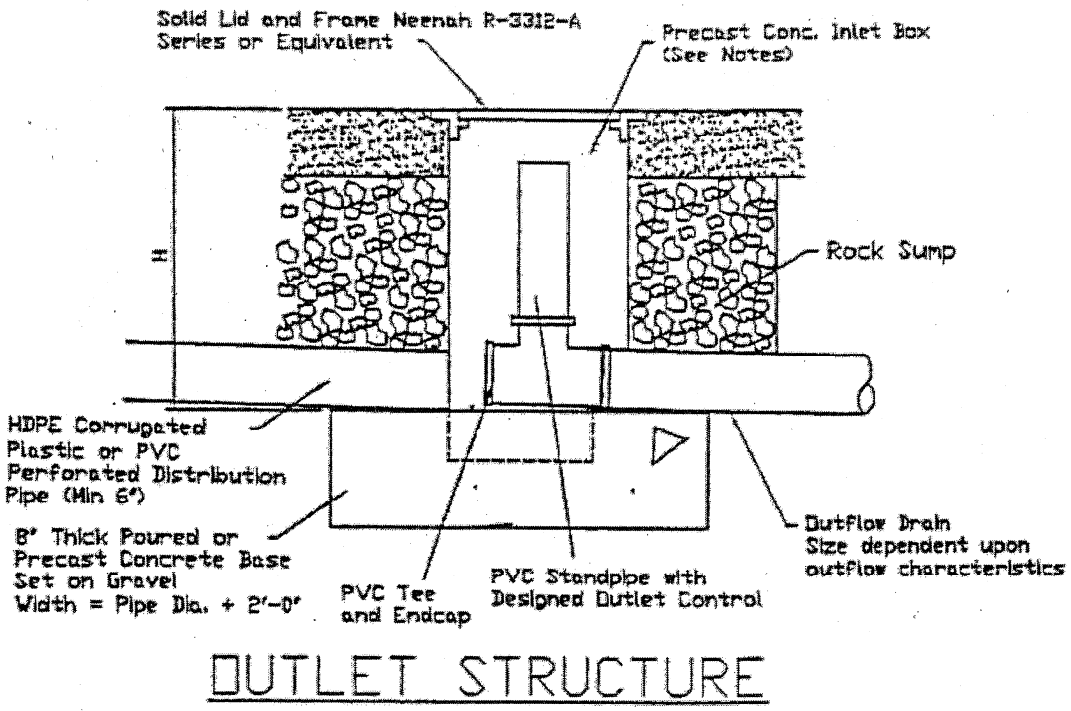


Figure S3 – Sump Outlet Structure
(Information from Town of McCandless / Partridge Venture Engineering)

DESIGN PARAMETERS
RESIDENTIAL ON-LOT SUMP
(TOTAL IMPERVIOUS AREA < 5,000 S.F.)

IMPERVIOUS AREA (SQ. FT.)	DEPTH OF SUMP (FT.)					SUMP VOLUME REQUIRED (CU. FT.)	
	1	2	3	4	5		
	DIAMETER OF OUTLET ORIFICE (IN)					NET	ROCK
400	11/16	9/16	1/2	1/2	1/2	68	170
600	13/16	11/16	5/8	9/16	9/16	102	255
800	15/16	13/16	11/16	5/8	5/8	136	340
1000	1-1/16	7/8	13/16	3/4	11/16	170	425
1200	1-3/16	1-0	7/8	13/16	3/4	204	510
1400	1-1/4	1-1/16	15/16	7/8	13/16	238	595
1600	1-3/8	1-1/8	1-0	15/16	7/8	272	680
1800	1-7/16	1-3/16	1-1/16	1-0	15/16	306	765
2000	1-1/2	1-1/4	1-1/8	1-1/16	1-0	340	850
2200	1-9/16	1-5/16	1-3/16	1-1/8	1-1/16	374	935
2400	1-5/8	1-3/8	1-1/4	1-3/16	1-1/8	408	1020
2600	1-11/16	1-7/16	1-5/16	1-1/4	1-1/8	442	1105
2800	1-3/4	1-1/2	1-3/8	1-1/4	1-3/16	476	1190
3000	1-13/16	1-9/16	1-3/8	1-5/16	1-1/4	510	1275
3200	1-7/8	1-5/8	1-7/16	1-3/8	1-1/4	544	1360
3400	1-15/16	1-5/8	1-1/2	1-3/8	1-5/16	578	1445
3600	2-0	1-11/16	1-9/16	1-7/16	1-3/8	612	1530
3800	2-1/16	1-3/4	1-9/16	1-7/16	1-3/8	646	1615
4000	2-1/8	1-13/16	1-5/8	1-1/2	1-7/16	680	1700
4200	2-3/16	1-13/16	1-11/16	1-9/16	1-7/16	714	1785
4400	2-1/4	1-7/8	1-11/16	1-9/16	1-1/2	748	1870
4600	2-5/16	1-15/16	1-3/4	1-5/8	1-9/16	782	1955
4800	2-5/16	1-15/16	1-3/4	1-5/8	1-9/16	816	2040
5000	2-3/8	2-0	1-13/16	1-11/16	1-5/8	850	2125

Table S1
(Information from Town of McCandless / Partridge Venture Engineering)

Design Basis

The sump designs are based upon documents and detail sheets provided by Partridge Venture Engineering,

Determine the square footage for the Standardized Rock Sump Foot Print from the “Determination of SWM Facility Sizing table (Disturbed Area Table).

Note that the square footage of the "sump foot print" for the Standardized Design provided in the Disturbed Area Table is based upon an assumed sump rock depth of 4'.

Different sump rock depths may be used, These may be determined by multiplying the "sump foot print" by the assumed rock depth of four (4') feet, to determine the cubic feet of rock required for the sump. Then use Table S1 to select determine the "diameter of the outlet orifice" need for the actual depth proposed,

To determine the sump foot print needed for the actual depth proposed, multiply the cubic feet of rock required by the actual depth of the sump proposed.

Inspection and Maintenance Requirements

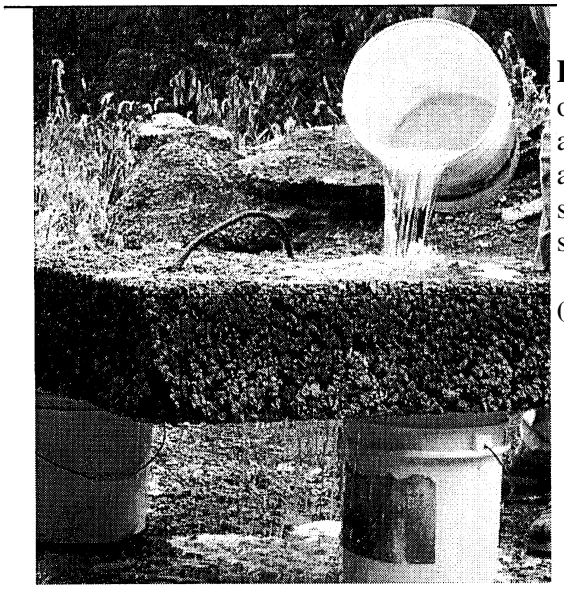
As with all infiltration practices, Dry Wells require regular and effective maintenance to ensure prolonged functioning. The following represent minimum maintenance requirements for Dry Wells:

Activity	Schedule
• Initial inspection	By Building Inspector to Insure Proper Sizing
• Ensure that sediment is not directed to the sump	As Needed
• Regularly clean out gutters and ensure proper connections to facilitate the effectiveness of the dry well,	As needed, based on inspection
• Evaluate the drain-down time of the Dry Well to ensure the maximum time of 72 hours is not being exceeded. If drain-down times are exceeding the maximum, drain the Dry Well via pumping and clean out inspection perforated piping, if included, If slow drainage persists, the system may need replacing,	As needed, based on inspection
• Reconstruct sump if its no longer functioning as originally Designed	As needed, based on inspection
• Replace filter screen that intercepts roof runoff as necessary. If an intermediate sump box exists, clean it out at least once per year.	Annually

This Guidance document is based upon information abstracted from the Georgia Stormwater Manual, the PA SW BMP Manual and the Town of McCandless.

Guidance Sheet- Rock Sumps

Standardized Residential SWM Facility
For Small Projects



Description: Porous concrete is the term for a mixture of coarse aggregate, Portland cement and water that allow for rapid infiltration of water and overlays a stone aggregate reservoir, This reservoir provides temporary storage as runoff infiltrates into underlying permeable soils and/or out through an underdrain system.

(Photograph Source: Pittsburgh Mobile Concrete)

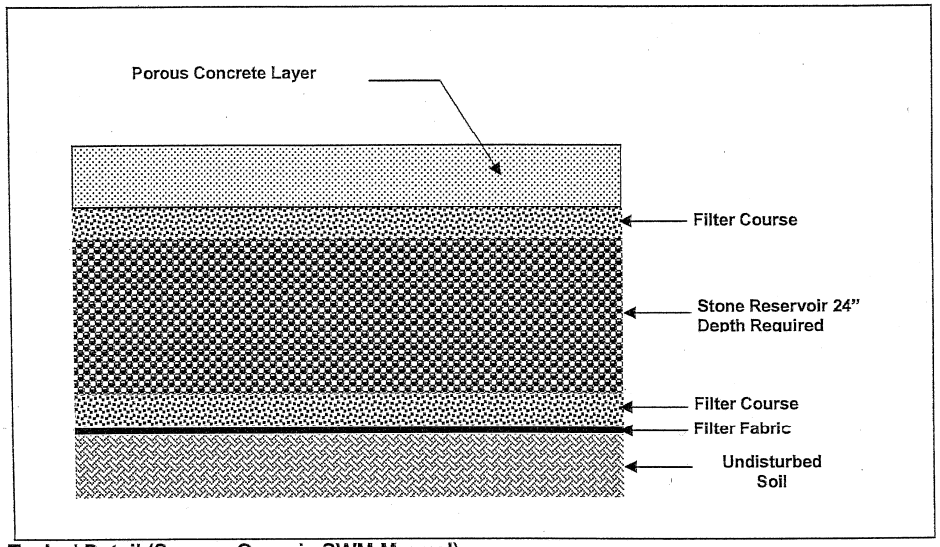
KEY CONSIDERATIONS	STORMWATER MANAGEMENT SUITABILITY
• Soil infiltration rate of 0.5 in/hr or greater required • Pour the concrete using a volumetric (mobile) mixer • Excavated area filled with stone media; gravel and sand filter layers with observation well • Pre-treat runoff if sediment present • Provides reduction in runoff volume • Somewhat higher cost when compared to conventional pavements • Potential for high failure rate if poorly designed, poorly constructed, not adequately maintained or used in unstabilized areas • Potential for groundwater contamination	☑ Water Quality ☑ Channel/Flood Protection **SPECIAL APPLICATIONS** ☐ Pretreatment ☑ High Density/Ultra-Urban ☑ Other: Overflow Parking, Driveways & related uses Residential Subdivision Use: *Yes* (in common areas that are maintained) ϑ in certain situations

General Description- Porous Concrete

Porous concrete (also referred to as *enhanced porosity concrete, porous concrete, portland cement pervious pavement* and *pervious pavement)* is a subset of a broader family of pervious pavements including porous asphalt, and various kinds of grids and paver systems. Porous concrete is thought to have a greater ability than porous asphalt to maintain its porosity in hot weather and thus is provided as a limited application control. Although, porous concrete has seen growing use, there is still very limited practical experience with this measure.

Porous concrete of a specially formulated mixture of Portland cement, uniform, open graded consists course aggregate, and water. The concrete layer has a high permeability often many times that of the underlying permeable soil layer, and allows rapid percolation of rainwater through the surface and into the layers beneath. The void space in porous concrete is in the 15% to 22% range compared to three to five percent for conventional pavements. The permeable surface is placed over a layer of open-graded gravel and crushed stone. The void spaces in the stone act as a storage reservoir for runoff.

Porous concrete is designed primarily for stormwater quality, i.e. the removal of stormwater pollutants. However, they can provide limited runoff quantity control, particularly for smaller storm events. For some smaller sites, trenches can be designed to capture and infiltrate the channel protection volume (Cp_v)in addition to WQ_v. Porous concrete will need to be used in conjunction with another structural control to provide overbank and extreme flood protection, if required.



Typical Detail (Source: Georgia SWM Manual)

Modifications or additions to the standard design have been used to pass flows and volumes in excess of the water quality volume, or to increase storage capacity or treatment. These include:

- Placing a perforated pipe near the top of the crushed stone reservoir to pass excess flows after the reservoir is filled
- Providing surface detention storage in a parking lot, adjacent swale, or detention pond with suitable overflow conveyance
- Connecting the stone reservoir layer to a stone filled trench
- Adding a sand layer and perforated pipe beneath the stone layer for filtration of the water quality volume
- Placing an underground detention tank or vault system beneath the layers

The infiltration rate of the soils in the subgrade should be adequate to support drawdown of the entire runoff capture volume within 24 to 48 hours. Special care must be taken during construction to avoid undue compaction of the underlying soils which could affect the soils' infiltration capability.

Slopes should be flat or gentle to facilitate infiltration versus runoff and the seasonally high water table or bedrock should be a minimum of two feet below the bottom of the gravel layer if infiltration is to be relied on to remove the stored volume.

Porous concrete has the positive characteristics of volume reduction due to infiltration, groundwater recharge, and an ability to blend into the normal urban landscape relatively unnoticed. It also allows a reduction in the cost of other stormwater infrastructure, a fact that may offset the greater placement cost somewhat.

A drawback is the cost and complexity of porous concrete systems compared to conventional pavements. Porous concrete systems require a very high level of construction workmanship to ensure that they function as designed. They experience a high failure rate if they are not designed, constructed and maintained properly.

Design Criteria and Specifications

- Porous concrete systems can be used where the underlying in-situ subsoils have an infiltration rate greater than 0.5 inches per hour. Therefore, porous concrete systems are not suitable on sites with hydrologic group D and many group C soils, or soils with a high (>30%) clay content. In areas where poor infiltration is expected the gravel bed should be properly graded and an overflow provided to drain the bed so that water will .not be trapped in the pervious concrete. During construction and preparation of the subgrade, special care must be taken to avoid compaction of the soils.

- Pour the concrete using volumetric (mobile) mixer.

- Porous concrete systems should typically be used in applications where the pavement receives tributary runoff only from impervious areas. Actual pervious surface area sizing will depend on achieving a 24 hour minimum and 48 hour maximum draw down time for the design storm volume.

- If runoff is coming from adjacent pervious areas, it is important that those areas be fully stabilized to reduce sediment loads and prevent clogging of the porous paver surface. Pretreatment using filter strips or vegetated swales for removal of course sediments is recommended. (see sections 3.3.1 and 3.3.2)

- Porous concrete systems should not be used on slopes greater than 5% with .slopes of no greater than 2% recommended. For slopes greater than 1% barriers perpendicular to the direction of drainage should be installed in sub-grade material to keep it from washing away, or filter fabric should be placed at the bottom and sides of the aggregate to keep soil from migrating into the aggregate and reducing porosity.

- A minimum of four feet of clearance is recommended (may be reduced to two feet in coastal areas) between the bottom of the gravel base course and underlying bedrock or the seasonally high groundwater table.

- Porous concrete systems should be sited at least 10 feet down-gradient from buildings and 100 feet away from drinking water wells.

- To protect groundwater from potential contamination, runoff from designated hotspot land uses or activities must not be infiltrated. Porous-concrete should not be used for manufacturing and industrial sites, where there is a potential for high concentrations of soluble pollutants and heavy metals. In addition, porous concrete should not be considered for areas with a high pesticide concentration. Porous concrete is also not suitable in areas with karst geology without adequate geotechnical testing by qualified individuals and in accordance with local requirements.

- Porous concrete system designs must use some method to convey larger storm event flows to the conveyance system. One option is to use storm drain inlets set slightly above the elevation of the pavement. This would allow for some ponding above the surface, but would accept bypass flows that are too large to be infiltrated by the porous concrete system, or if the surface clogs.

- For the purpose of sizing downstream conveyance and structural control system, porous concrete surface areas can be assumed to 35% impervious. In addition, credit can be taken for the runoff volume infiltrated from other impervious areas using the methodology in Section 3.1.

- For treatment control, the design volume should be, at a minimum, equal to the water quality volume. The water quality storage volume is contained in the surface layer, the aggregate reservoir, and the sub-grade above the seasonal high water table -if the sub-grade is sandy. The storm duration (fill time) is normally short compared to the infiltration rate of the sub-grade, a duration of two hours can be used for design purposes, The total storage volume in a layer is equal to the percent of voids times the volume of the layer, Alternately storage may be created on the surface through temporary ponding, though this would tend to accelerate clogging if course sediment or mud settles out on the surface,

- The cross-section typically consists of four layers, as shown on the Typical Detail, The aggregate reservoir can sometimes be avoided or minimized if the sub-grade is sandy and there is adequate time to infiltrate the necessary runoff volume into the sandy soil without by-passing the water quality volume. Descriptions of each of the layers is presented below:

Porous Concrete Layer- The porous concrete layer consists of an open-graded concrete mixture usually ranging from depths of 2 to 4 inches depending on required bearing strength and pavement design requirements. Porous concrete can be assumed to contain !8 percent voids (porosity = 0,18) for design purposes. The omission of the fine aggregate provides the porosity .of the porous pavement. To provide a smooth riding surface and to enhance handling and placement a coarse aggregate of 3/8 inch maximum size is normally used, Use No, 89 coarse aggregate (3/8 to No. 50) per ASTM D 448.

Top Filter Layer- Consists of a 0.5 inch diameter crushed stone to a depth of ! to 2 inches, This layer serves to stabilize the porous asphalt layer. Can be combined With reservoir layer using suitable stone.

Reservoir Layer- The reservoir gravel base course consists of washed, bank-run gravel, ! .5 to 2.5 inches in diameter with a void space of about 40% (Clean Washed No. 2B Stone). The depth of this layer shall be two (2') feet. A porosity-value (void space/total volume) of 0.32 was assumed.

Bottom Filter Layer- The surface of the subgrade should be an 6 inch layer of sand (ASTM.C-33 concrete sand) or a 2 inch thick layer of 0,5 inch crushed stone, and be completely flat to promote infiltration across the entire surface. This layer serves to stabilize the reservoir layer, to protect the underlying soil from compaction, and act as the interface between the reservoir layer and the filter fabric covering the underlying soil.

Filter Fabric- It is very important to line the entire trench area, including the sides, with filter fabric prior to placement of the aggregate. The filter fabric serves a very important function by inhibiting soil from migrating into the reservoir layer and reducing storage capacity. Fabric should be MIRFI # 14 N or equivalent.

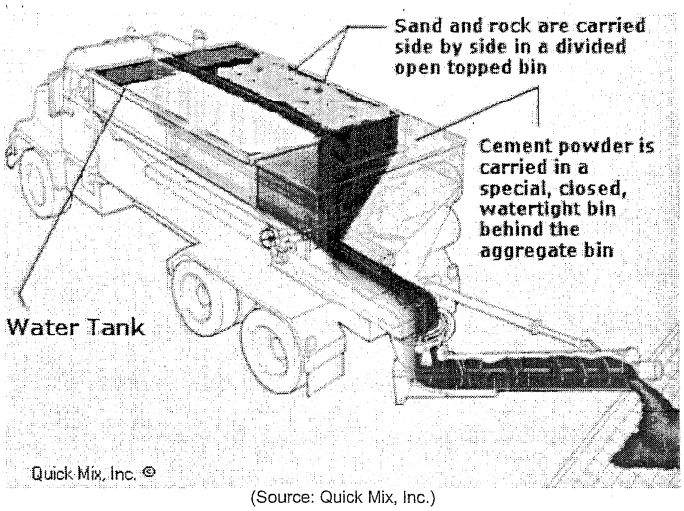
Underlying Soil- The underlying soil should have an infiltration capacity of at least 0.5 in/hr, but preferably greater than 0.50 in/hr.

- The pit excavation should be limited to the width and depth specified in the design. Excavated material should be placed away from the open trench as not to jeopardize the stability of the trench sidewalls. The bottom of the excavated trench should not be loaded so as to cause compaction, and should be scarified prior to placement of sand. The sides of the trench shall be trimmed of all large roots. The sidewalls shall be uniform with no voids and scarified prior to backfilling. All infiltration trench facilities should be protected during site construction, and should be constructed after upstream areas have been stabilized.

- An observation well consisting of perforated PVC pipe 4 to 6 inches in diameter may be placed at the. downstream end of the facility and protected. The well should be used to determine actual infiltration rates.

Volumetric (Mobile) Concrete Mixers

The Mobile Concrete Mixer is a combination materials transporter and mobile concrete mixing plant, mounted on a transport vehicle, usually a truck or trailer, which carries sufficient unmixed material, sand, cement, coarse aggregates, water (and any other chemicals that may be used for special mix designs) to the job to produce fresh concrete, mixed to design specifications.



(Source: Quick Mix, Inc.)

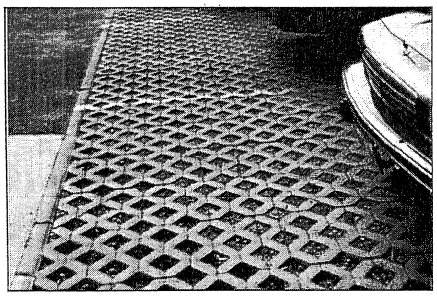
Sand and stone are accurately proportioned by adjusting gates to the correct height. The settings are based on actual calibration of the gate settings done with the specific aggregates being used.

(Source: Pittsburgh Mobile Concrete)

The three basic dry ingredients (sand, stone, and cement powder) simultaneously drop off the main conveyor into the charging end of the mixer at the rear of the unit. At this point, a predetermined metered flow of water also enters the mixer. Action of the combined auger and paddle mixer rapidly, thoroughly, and continuously mixes the ingredients and water to produce a continuous discharge of uniform quality concrete.

The materials blending action is continuous, and may proceed until the ingredient bins are empty. On the other hand, mixing and delivery may be stopped at any time and then started again at the will of the operator. This permits production to be balanced to the demands of the placing and finishing crews and other job requirements.

General Description Modular Paver Systems



Modular porous pavers are structural units, such as concrete blocks, bricks, or reinforced plastic mats, with regularly interdispersed void areas used to create a load-bearing pavement surface. The void areas are filled with pervious materials (gravel, sand, or grass tuff) to create a system that allows for the infiltration of stormwater runoff. Porous paver systems provide water quality benefits in addition to groundwater recharge and a reduction in stormwater volume. The use of porous paver systems results in a reduction of the effective impervious area on a site.

There are many different types of modular porous pavers available from different manufacturers, including both pre-cast and mold in-place concrete blocks, concrete grids, interlocking bricks, and plastic mats with hollow rings or hexagonal cells.

Modular porous pavers are typically placed on a gravel (stone aggregate) base course. Runoff infiltrates through the porous paver surface into the gravel base course, which acts as a storage reservoir as it exfiltrates to the underlying soil. The infiltration rate of the soils in the subgrade must be adequate to support drawdown of the entire runoff capture volume within 24 to 48 hours. Special care must be taken during construction to avoid undue compaction of the underlying soils, which could affect the soils' infiltration capability.

A drawback is the cost and complexity of modular porous paver systems compared to conventional pavements. Porous paver systems require a higher level of construction workmanship to ensure that they function as designed. In addition, there is the difficulty and cost of rehabilitating the surfaces should they become clogged.

The system must be installed based upon the manufactures recommendations. **The gravel layer required for the Standardized Single Lot Residential Facility is a minimum of two (2') feet in depth.**

Design Basis

For the Standardized BMP for a single residential lot, the minimum surface area of the porous pavement was determined from the following equation:

$$A = WQ_v/(n_g d_g + kT/12)$$

Where:

A = Surface Area Porous Pavement (SF)
WQ_v = Water Quality Volume in CF
n_g = 0.32 = porosity of the gravel
d_g = 2' = depth or gravel layer (feet)
k = percolation = 0.5 inches/hour assumed
T= Fill Time = 2 hours (time for the practice to fill with water), in hours

Inspection and Maintenance Requirements

Typical Maintenance Activities for Porous Concrete Systems

Activity	Schedule
• Initial inspection	Monthly for three months after installation
• Ensure that sediment is not directed to the sump	Monthly
• Ensure that the contributing and adjacent area is stabilized and mowed, with clippings removed.	As needed, based on inspection
• Vacuum sweep porous concrete surface followed by high pressure hosing to keep pores free of sediment	Four times a year
• Inspect the surface for deterioration or spalling • Check to make sure that the system dewaters between storms	Annually
• Spot clogging can be handled by drilling half-inch holes through the pavement every few feet • Rehabilitation of the porous concrete system, including the top and base course as needed	Upon failure

To ensure proper maintenance, of porous pavement, a carefully worded maintenance agreement is essential. It should include specific the specific requirements and establish the responsibilities of the property owner and provide for enforcement.

This Guidance document is based upon information abstracted from the Georgia Stormwater Manual and the Quick Mix, Inc., web site.

STANDARD PROCEDURES
EROSION AND SEDIMENTATION CONTROLS
FOR INDIVIDUAL RESIDENTIAL LOTS

General

Erosion and Sedimentation from individual residential lots can most often be controlled by silt fence along the lower perimeter of all disturbed areas and the installation of a rock construction entrance where construction traffic will enter and exit the site, Standard Construction Detail, Sheet E-1, shows the typical erosion controls that should be placed on high and low side lots. If the scope of the work requires additional measures on the site, an individual plan must be submitted and approved by the Township of Ross. In all cases, the Contractor is responsible for complying with the provisions of PA DEP Chapter 102.

Temporary Erosion Controls

Silt fence must be installed along the lower perimeter of all disturbed areas and will function as the primary control for the site. A stone construction entrance must be installed at the driveway entrance to the site to help prevent mud from being tracked out onto the roadway. When at all possible, construction vehicles should be restricted to paved surfaces.

All uncompleted disturbed areas on which activity will cease for more than twenty (20) days should be seeded and stabilized. After construction is complete and all areas are stabilized, all temporary control measures may be removed and all monitoring will cease. Stabilization is defined as the establishment of a uniform 70% perennial vegetal cover.

Staging Schedule

In general, the following staging schedule should be followed for small projects:

1. Install the silt fence in accordance with the standard detail shown on Detail Sheet ES-2 along the lower perimeter of all disturbed areas.

2. Install the rock construction entrance in accordance with the standard detail shown on Detail Sheet ES-2 at the entrance to the site. The stone base for the driveway should also be installed as soon as it is graded in order to prevent erosion.

3. Grub the construction area and remove the topsoil, stockpiling it at the area designated on the plans.

4. Construct the site improvements.

5. Seed and mulch all disturbed areas.

6. Remove all E & S Controls once the site is stabilized. An area will not be considered stabilized until a uniform 70% perennial vegetal cover is established over the disturbed area,

Maintenance Schedule

It shall be the sole responsibility of the contractor to execute the control of inspection, maintenance, and repair of various sediment control facilities according to the guidelines prescribed below.

All control measures must be inspected on a weekly basis, and in all cases immediately following each runoff event. All necessary repairs should be carried out immediately after their identification. Materials cleaned from the BMP's shall .be disposed of by spreading them in the topsoil stockpile area.

Silt Fence

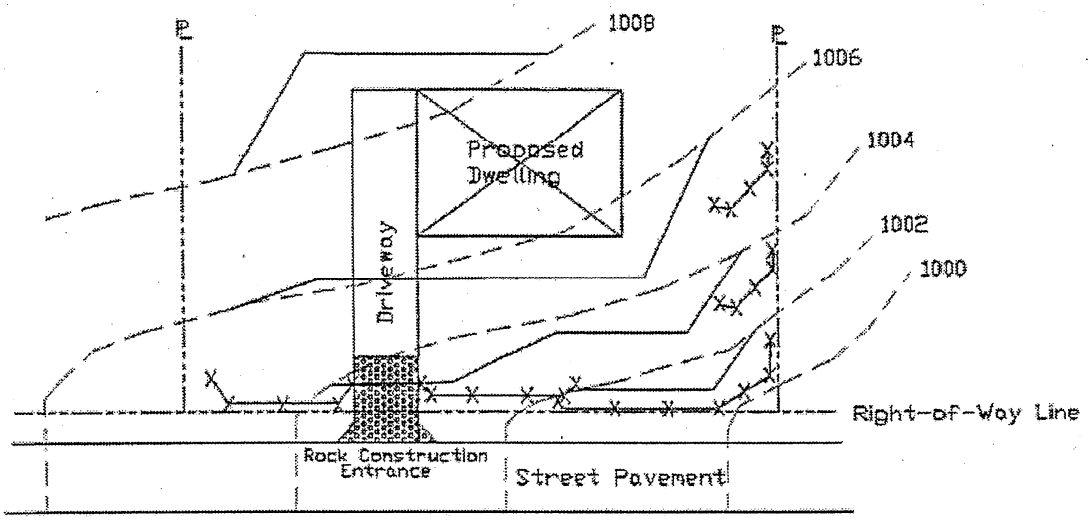
Maintenance checks shall include inspecting silt fence for undercutting, tears, collapse offence, and depths of sediment accumulation. All repairs of damaged fence must be performed immediately to ensure that the fence meets design specifications. Sediment should be removed periodically, and in all cases should accumulation attain depths equal to half the height of fence. Sediment deposits removed from the silt fence must be disposed of by spreading the material within the topsoil stockpile area. Undercutting of the toe shall be immediately repaired by installing a rock filter outlet.

Construction Entrance

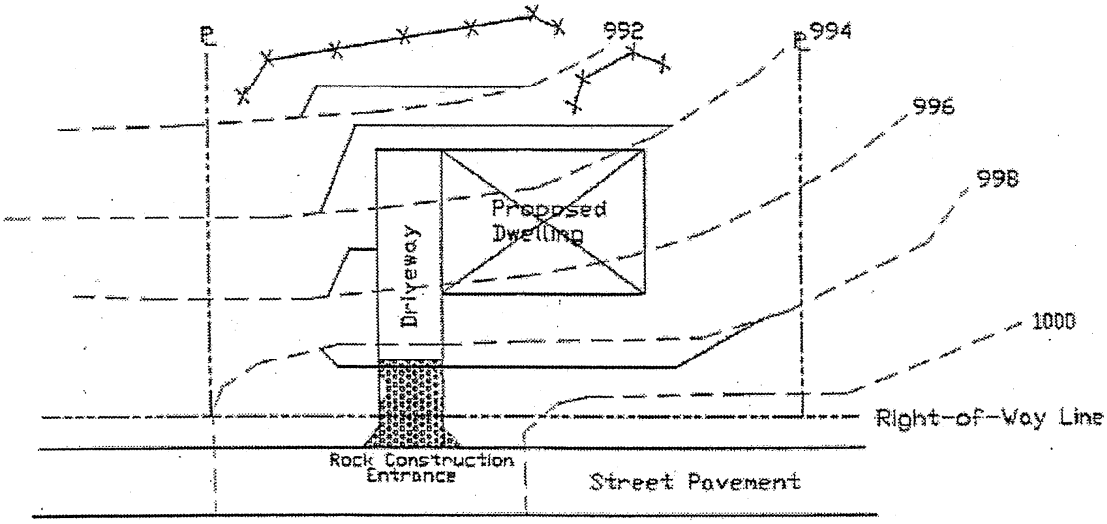
The stabilized construction entrance should be maintained so as to ensure a constant rock thickness. This will be achieved by the placement of additional rock to the specified dimension as required. A stockpile of rock must be maintained on-site for this purpose. At the completion of each work day, all sediment deposited on the public roadways must be removed and returned to the construction site. Washing of the roadway with water will be unacceptable.

Vegetation

All areas to be stabilized by vegetation should be inspected for rills and gullies, bare soil patches or accumulation of sediment at the toe of slopes. Eroded areas shall be regraded, and substandard vegetated areas shall be re-seeded and mulched as specified in the plans.



TYPICAL HIGH-SIDE ON-LOT CONTROL



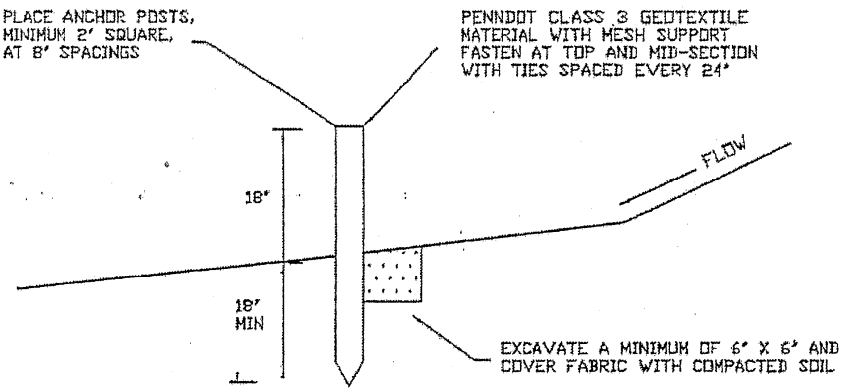
TYPICAL LOW-SIDE ON-LOT CONTROL

LEGEND

Finished Grade
Existing Grade
Silt Fence

Detail ES-1

(Detail from Town of McCandless / Partridge Venture Engineering)



INSTALLATION:

A TRENCH WILL BE PLOWED OR OTHERWISE EXCAVATED TO THE REQUIRED DEPTH WITH LITTLE, IF ANY, DISTURBANCE TO THE DOWNSLOPE SIDE OF THE TRENCH. THE BOTTOM OF THE TRENCH AND THE FENCE TOP WILL BE PLACED ON A LEVEL GRADE. WHEN IT IS NECESSARY TO CROSS SMALL DEPRESSIONS, THE TRENCH BOTTOM AND FENCE TOP EDGE MAY DEVIATE SLIGHTLY FROM LEVEL GRADE. GRADES IN SUCH SECTIONS WILL NOT EXCEED 1% NOR WILL THE DEVIATION EXTEND FOR MORE THAN 25 FEET.

SUPPORT STAKES WILL BE DRIVEN TO THE REQUIRED DEPTH BELOW THE EXISTING GROUND SURFACE AT SPECIFIED INTERVALS AS ILLUSTRATED.

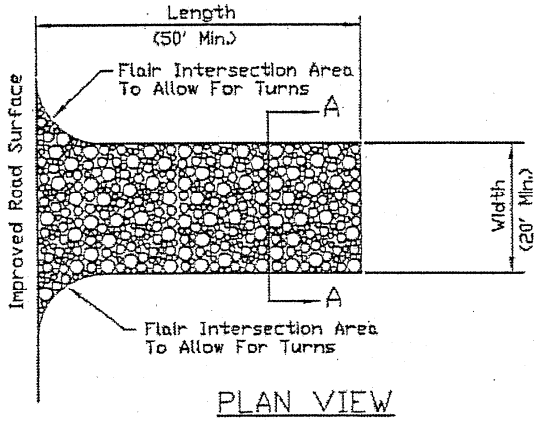
STRETCH AND FASTEN FABRIC TO THE UPSLOPE SIDE OF THE SUPPORT STAKES.

WHERE ENDS OF FABRIC COME TOGETHER, THEY WILL BE OVERLAPPED, FOLDED, AND STAPLED TO PREVENT SEDIMENT BYPASS. AT THE ENDS OF EACH LINE OF SILT FENCE, OR EVERY 100 FEET, WHICHEVER IS S SHORTER, EXTEND THE FENCE UPSLOPE AT A 90 DEGREE ANGLE FOR 4 FEET TO PREVENT ENDFLOW.

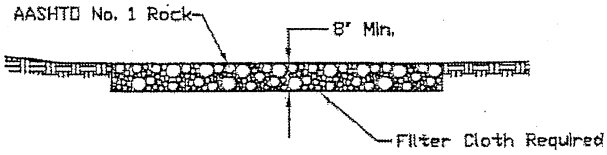
THE TOE ANCHOR WILL BE BACKFILLED AND COMPACTED TO A DENSITY EQUAL TO SURROUNDING SOILS.

SILT FENCE

NO SCALE



PLAN VIEW



SECTION A-A

MAINTENANCE: The structure's thickness will be constantly maintained to the specified dimensions by adding rock. A stockpile of rock material will be maintained on the site for this purpose. At the end of each construction day, all sediment deposited on public roadways will be removed and returned to the

ROCK CONSTRUCTION ENTRANCE DETAIL

NO SCALE

Detail ES-2

(Detail from Town of McCandless / Partridge Venture Engineering)