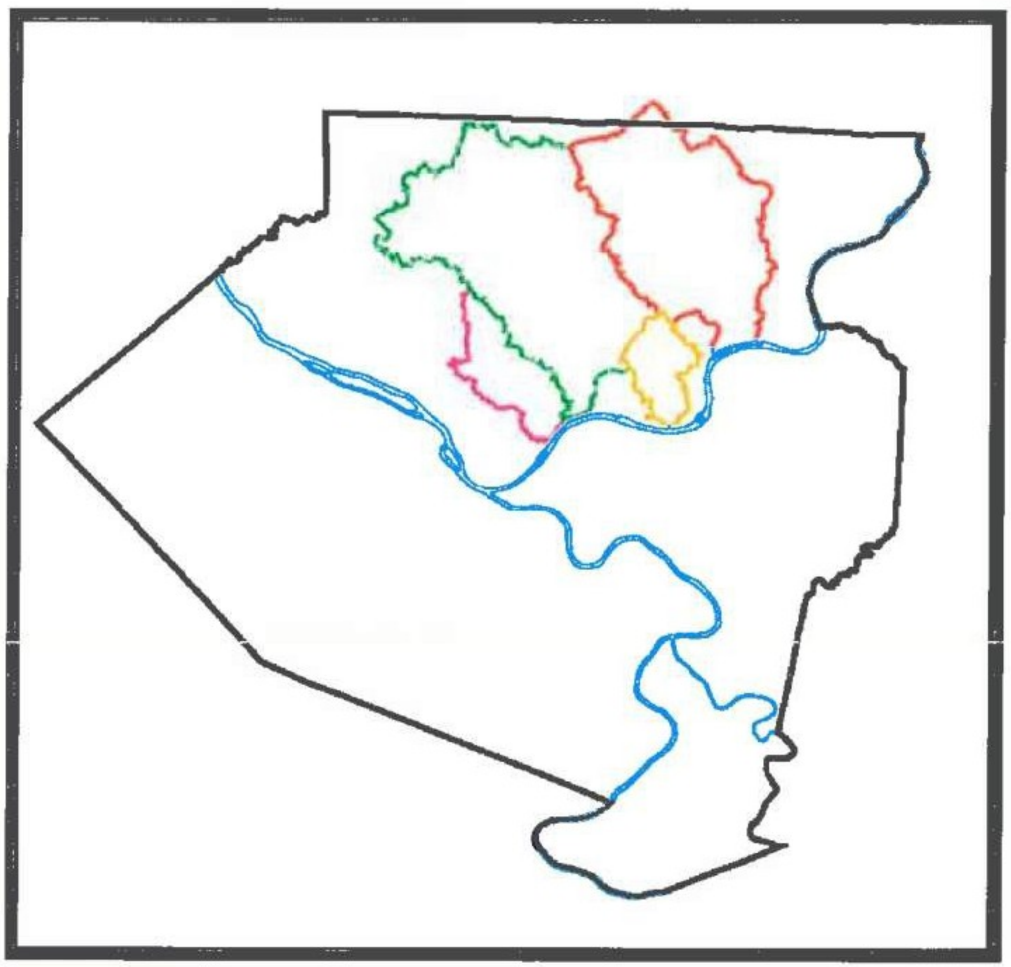
913 Attachment 6

Town of McCandless

Appendix F
Small Project Standardized SWM Planning Guidance

Small Project
Standardized Stormwater Management Planning Guidance



Standardized Stormwater Management Planning Guidance For Small Projects

Applicability

These criteria may be used to develop a stormwater management (SWM) plan for small projects, **as defined by this ordinance, in an area** where a 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.

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.

With the approval of Town Council, the following activities may be exempt from on-site stormwater runoff control. An exemption shall apply only to the requirement for on-site stormwater facilities and the preparation of a stormwater management plan. All other stormwater management design elements, such as a storm sewer system, road culverts, erosion and sedimentation control, and runoff quality, shall be required. All exemption requests must be filed with the Town Land Use Administrator and approved by the Engineer.

(a) Regulated activities smaller than 400 square feet of impervious area are exempt from the requirements of this article to implement SWM BMPs, unless the activity is found to be a significant contributor to pollution of the waters of this commonwealth.

(b) Small Project exemption.

(4) Table 1 and Table 2 present stormwater management requirements for small projects. For projects that propose additional impervious area or earth disturbance to a parcel, the total proposed impervious area and total proposed earth disturbance on the parcel is subject to the requirements of this Ordinance. Impervious area is described in § 913.07.

Table 1 - Stormwater Management Requirements for Increase in Impervious Area

No.	Sq. Ft. of Proposed Impervious Surface	Stormwater Management Requirement
1	<400	No requirements if there were no previous impervious surface additions
2	400 to 2,500 (Small Project)	Capture and detain the first 2" of any storm event (Appendix F)
3	>2,500	Comply with requirements of this ordinance

Table 2 - Stormwater Management Requirements for Proposed Earth Disturbance

No.	Sq. Ft. of Proposed Earth Disturbance	Stormwater Management Requirement
1	<10,890	No requirements if there were no previous impervious surface additions
2	10,890 to 43,559 (Small Project)	Capture and detain the first 2" of any storm event (Appendix F)
3	>43,559	Comply with requirements of this ordinance

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 than 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 shown.

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.

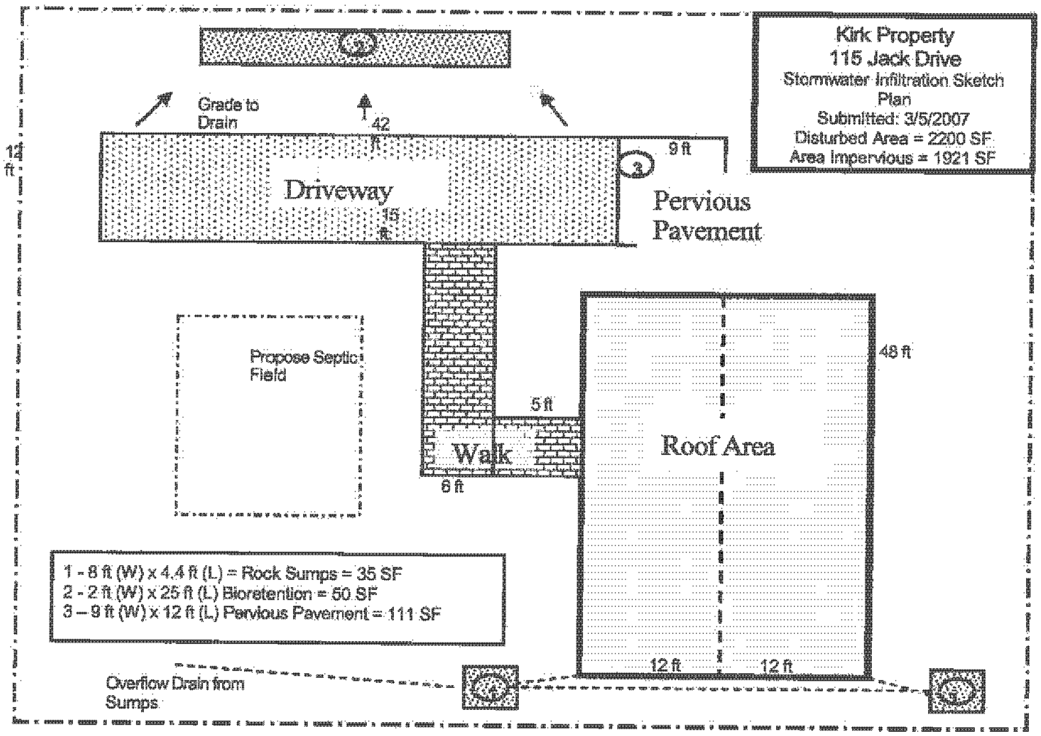
12) The location of all proposed utility lines and the associated "Limit of Disturbance".

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 plan with construction details.

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

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



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.

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.

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.

Guidance Sheet - Bioretention Areas

Standardized Residential SWM Facility
For Small Projects

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**
- **Channel Protection**

Extreme Flood Protection

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

- 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:

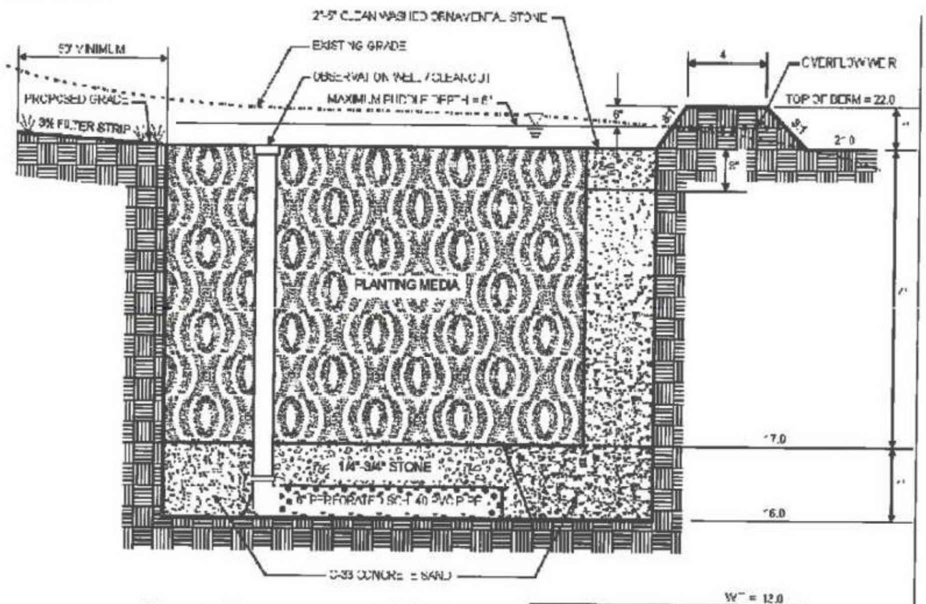
- *Use of native plants is recommended*

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

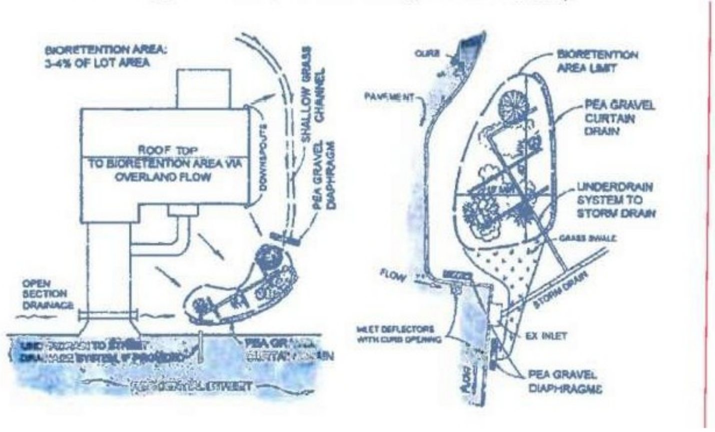
General Description

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, ponding 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 pond ing 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 1/4").

- The underdrain collection system is equipped with a 6-inch perforated PVC pipe (AASHTO M 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 pretreatment is provided when all of 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 non-erosive overflow channel must be provided to safely pass flows from the bioretention area that exceed the storage capacity to a stabilized downstream area or watercourse. If the system is located off-line, the overflow should be set above the shallow ponding limit.

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, sub-canopy 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 specified over non-native species.
  - Vegetation should be selected based on a specified zone of hydric tolerance.
  - A selection of trees with an understory 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:

- *Asclepias incarnata,* Swamp milkweed
- *Chelone glabra,* White turtlehead
- *Eupatorium maculatum,* Joe-pye weed
- *Lobelia cardinalis,* Cardinal flower
- *Lobelia syphilitica,* Blue lobelia
- *Monarda didyma,* Oswego tea
- *Vernonia noveboracensis,* Common ironweed
- *Athyrium filix-femina,* Lady fern
- *Osmunda regalis,* Royal fern
- *Osmunda cinnamomea,* Cinnamon fern
- *Carex pendula,* Drooping sedge
- *Carex stipata,* Tussock sedge

Trees and Shrubs:

- *Amelanchier laevis,* Shadbush
- *Asimina triloba,* Pawpaw
- *Betula nigra,* River birch
- *Cephalanthus occidentalis,* Buttonbush
- *Clethra alnifolia,* Sweet pepperbush
- *Cornus amomum,* Silky dogwood
- *Fothergilla gardenii,* Dwarf fothergilla
- *Ilex verticillata,* Winterberry holly
- *Lindera benzoin,* Spicebush
- *Liquidambar styraciflua,* Sweet gum
- *Sambucus canadensis,* American elderberry
- *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. Non-erosive 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)

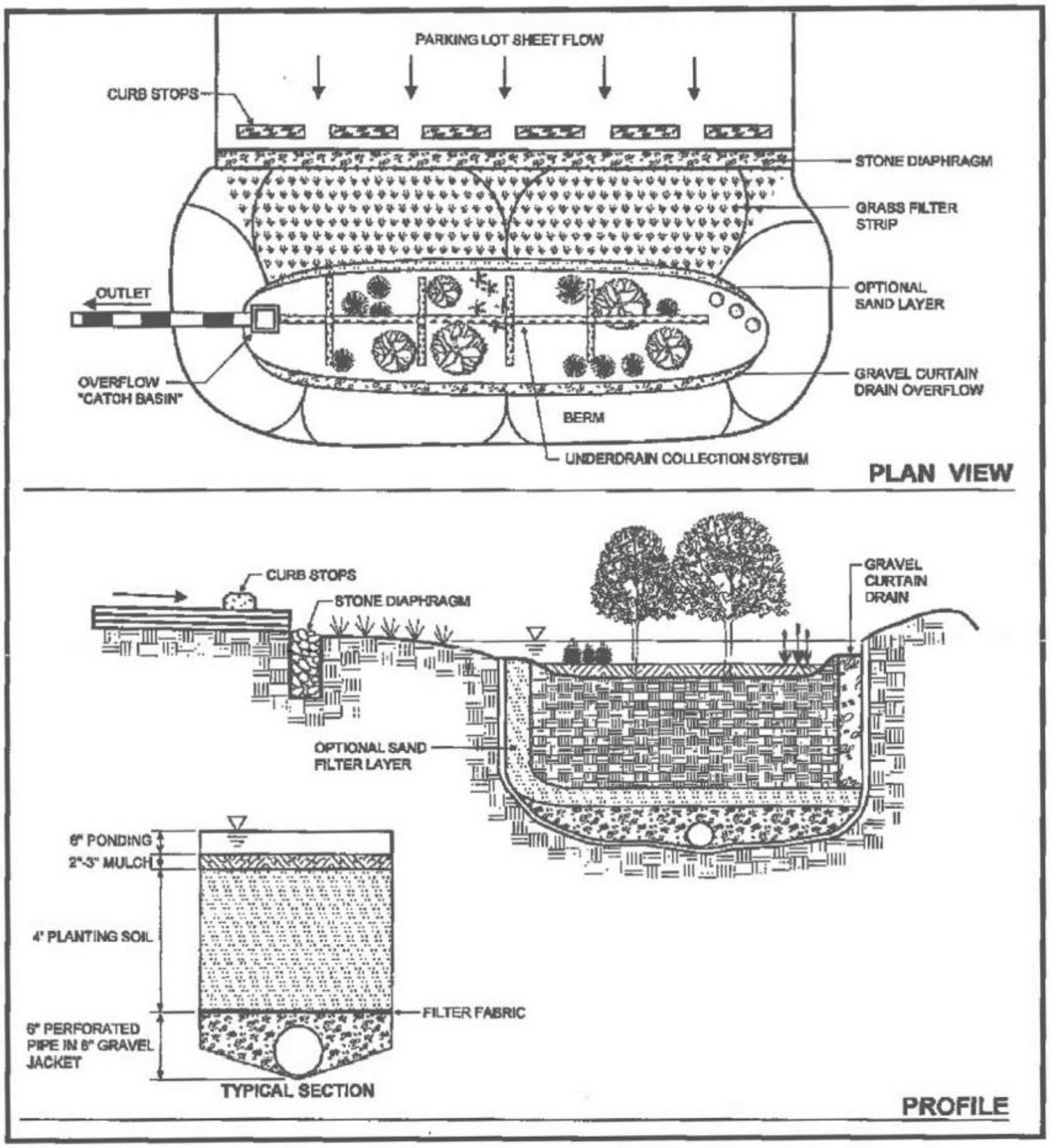
Activity	Schedule
▫ Pruning and weeding to maintain appearance. ▫ Mulch replacement when erosion is evident. ▫ Remove trash and debris.	As needed
▫ Inspect inflow points for clogging (off-line systems). Remove any sediment. ▫ Inspect filter strip/grass channel for erosion or gullying. Re-seed or sod 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

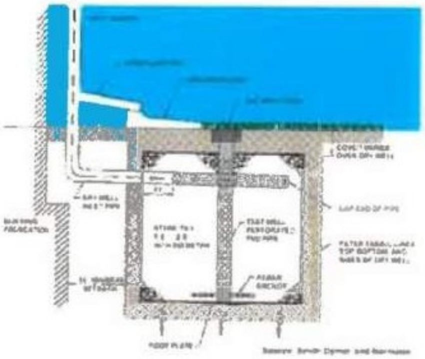


Schematic of a Typical On-line Bioretention Area
(Source: Claytor and Schueler, 1996)

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

Guidance Sheet - Rock Sumps

For Small Projects
Standardized Residential SWM Facility



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

(Source: PA BMP Manual)

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** • **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) • 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.

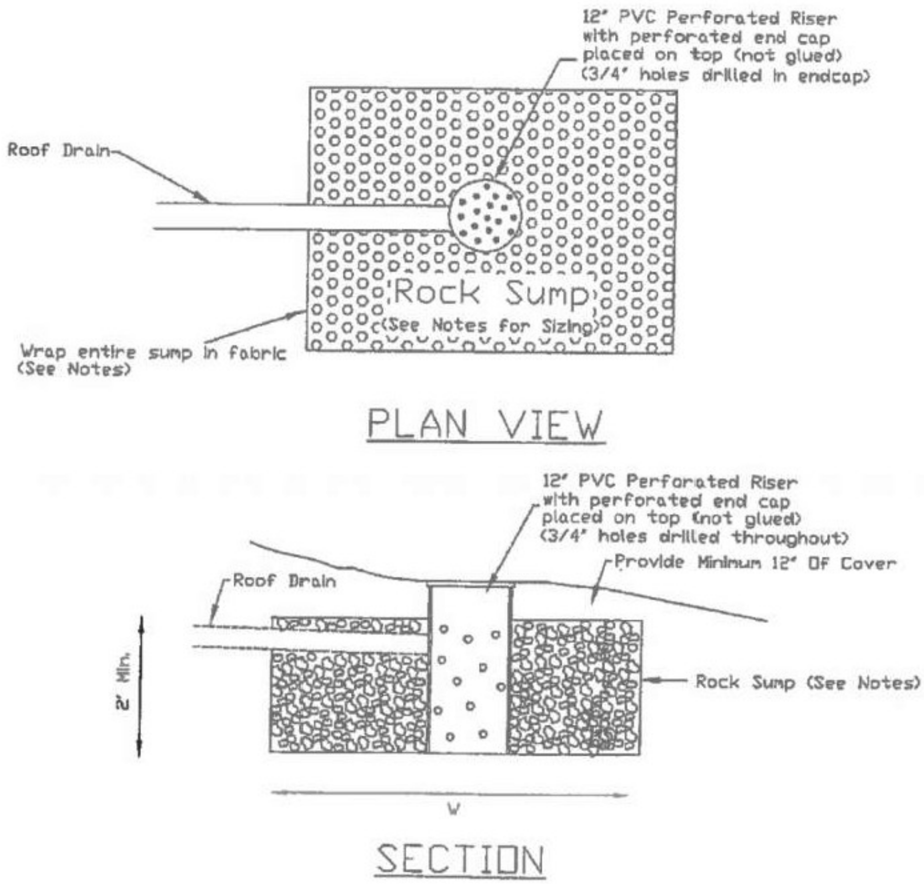
Prior to using the following procedure, the designer must verify that all of the above criteria apply to the subject project. Should any of the conditions not apply, the use of the procedure outlined herein is inappropriate and may result in either the over-design or under-design of the rock sump facility.

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.

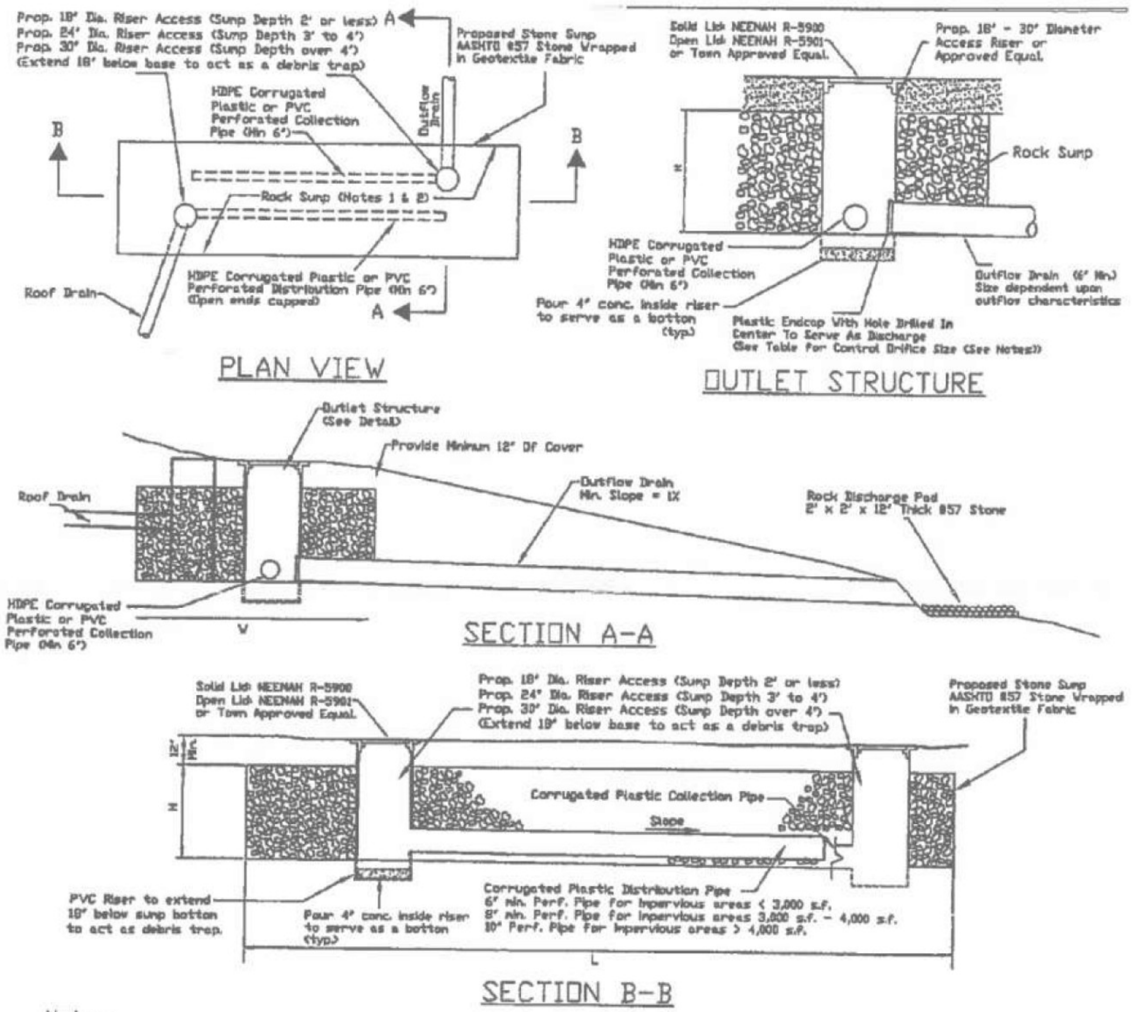


Notes:

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)



Notes:

1. N/A
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 pipe and fittings 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 of impervious area)

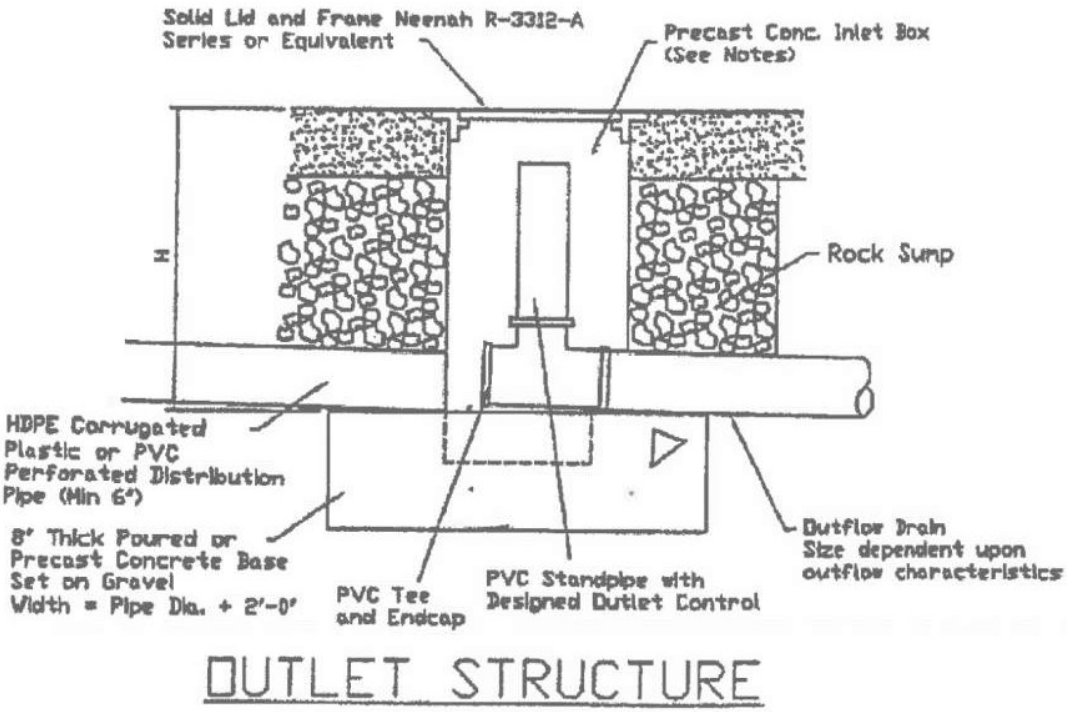


Figure S3 – Sump Outlet Structure
(Information from Town of McCandless / Partridge Venture Engineering)

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 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 - Porous Pavements

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

- 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

STORMWATER MANAGEMENT SUITABILITY

- ✓ **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)

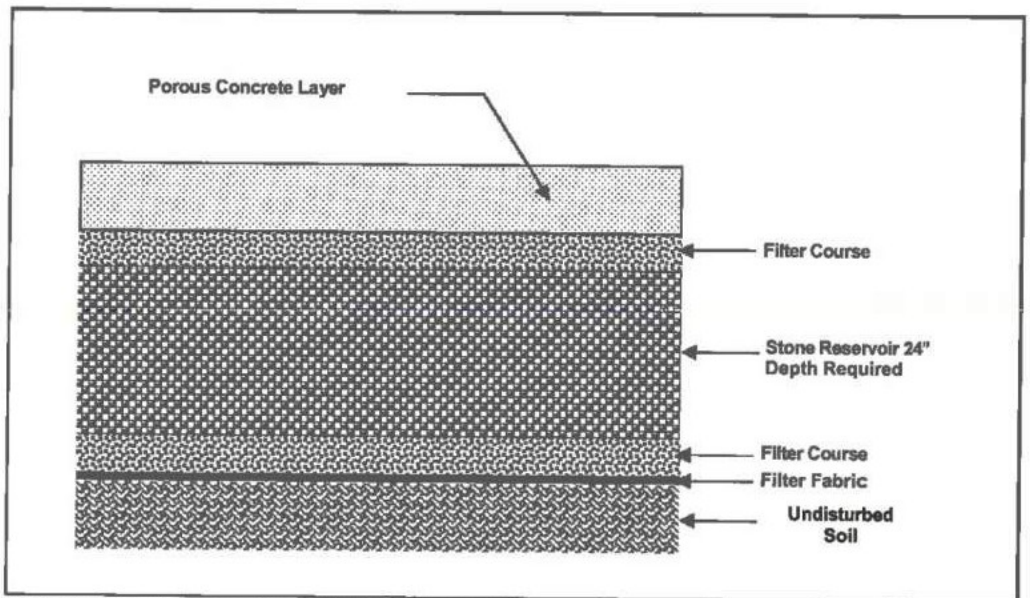
- in certain situations

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 consists of a specially formulated mixture of Portland cement, uniform, open graded 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 18 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 1 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, 1.5 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.

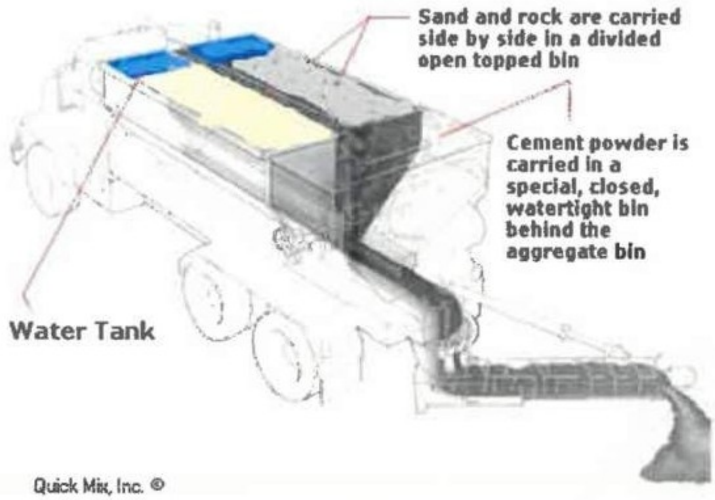
  Underlying Soil – The underlying soil should have an infiltration capacity of at least 0.5 in/hr, but preferably greater than 0.50 in/hr.

- 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 turf) 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)
WQv = 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 the porous paver surface is free of sediment	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.

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 ES-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. 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

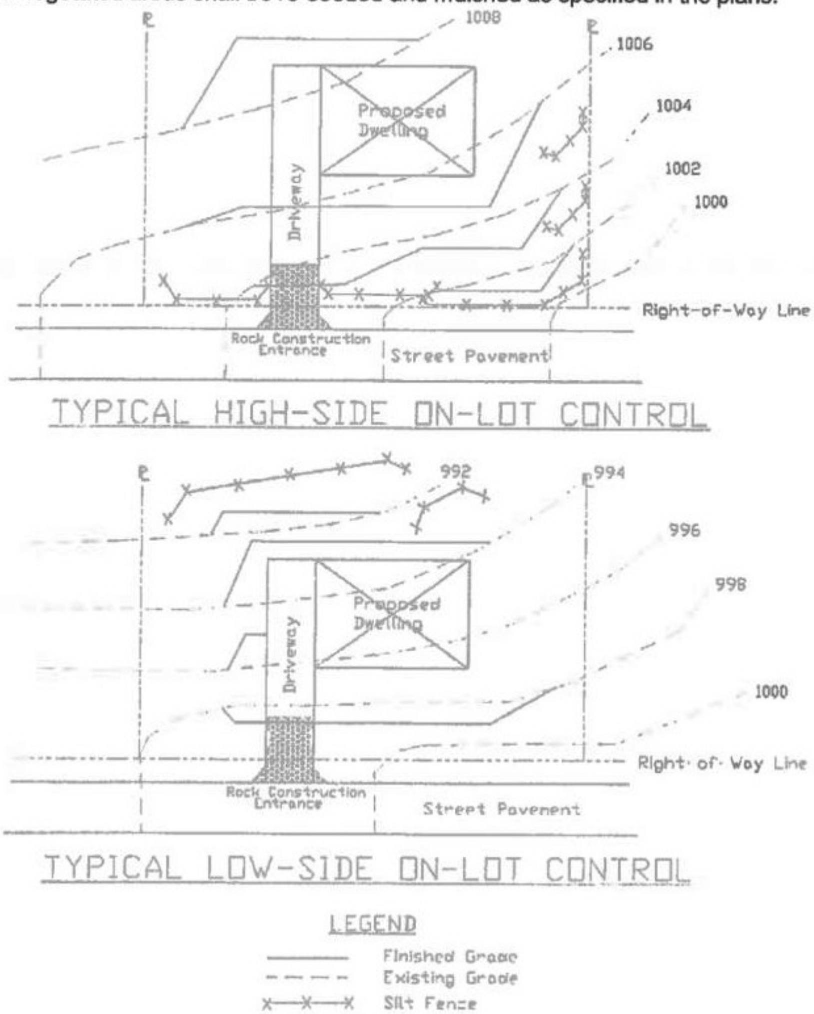
Maintenance checks shall include inspecting silt fence for undercutting, tears, collapse offence, and depths of sediment accumulation. All repairs of damaged fence must be performed immediately to ensure that the fence meets design specifications. Sediment should be removed periodically, and in all cases 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.

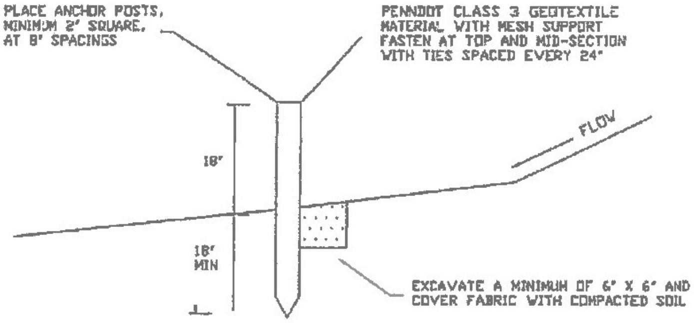
Vegetation

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.



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.

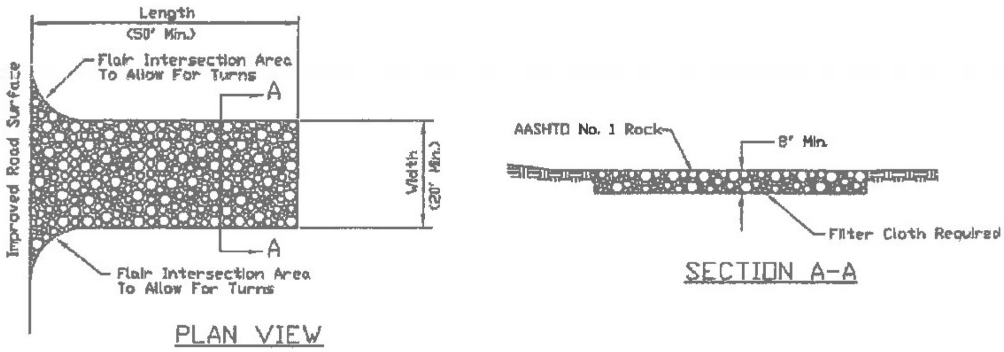
STRETCH AND FASTEN FABRIC TO THE UPSLOPE SIDE OF THE SUPPORT STAKES.

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



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)