Pervious Surfaces Guidance

Purpose & Benefits

- Stormwater runoff reduction
- High pollutant removal
- Control localized drainage problems
- Attractive alternative for walkways and driveways

Description

Pervious surfaces are alternatives to traditional paving materials that allow water to seep into the ground. They can be used in a wide range of residential settings, from a simple pathway or small patio up to a large driveway. Over the last few years, the market for these materials has grown. Currently, some very attractive and cost-effective options are available for small projects.

What to Expect

Pervious surfaces are quite similar to and replace traditional paving or hardscaped areas, except the water is intended to move through the surface and infiltrate into the ground, instead of running off as quickly as possible. The gravel bed underneath the pavement is designed to hold water temporarily, so it is deeper than that of traditional paving. Finally, the paved surface itself is different, and the contractor needs to ensure that the surface is installed correctly and does not become clogged during construction. Routine maintenance of pervious surface includes sweeping or using a leaf blower to remove fine particles from the pores in the concrete or between the pavers. A vacuum sweeper may be needed occasionally to keep the pavement surface from clogging.

1. Materials

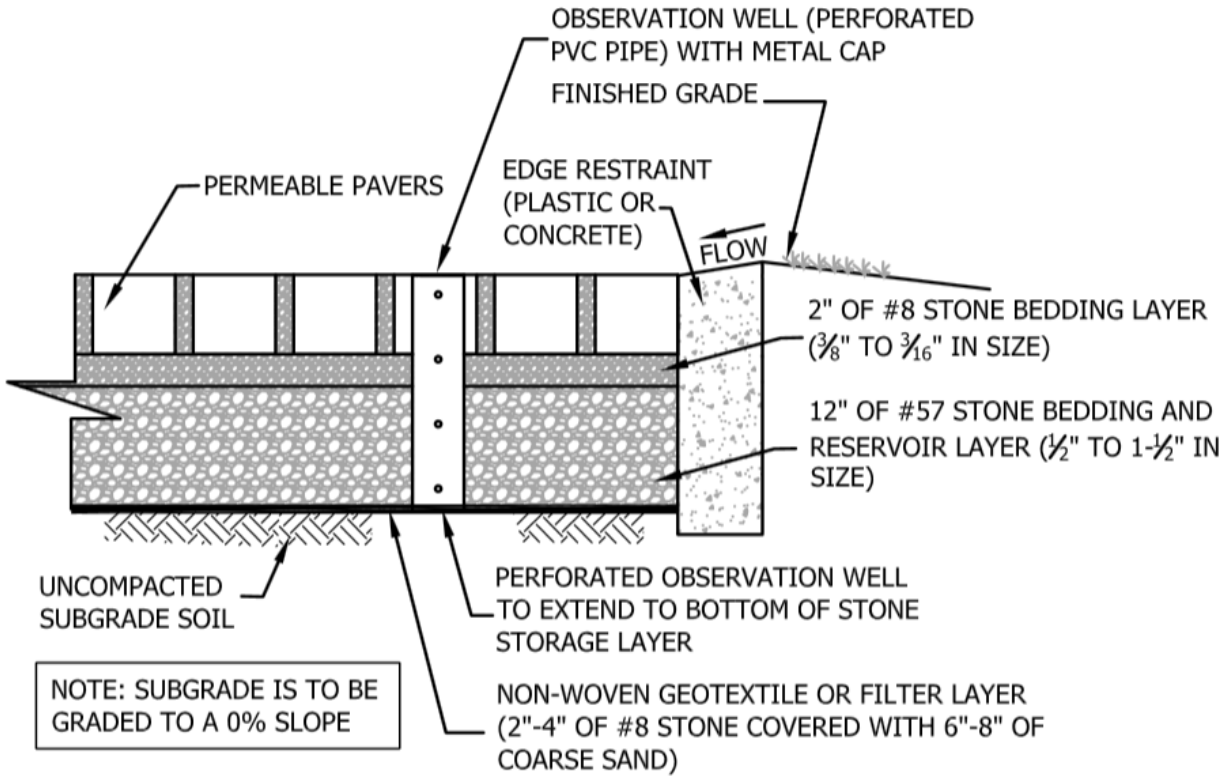

Figure 1. Typical Residential Permeable Paver Detail (N.T.S.)

Table 1 includes a list of materials needed to install pervious surface:

Table 1. Material Specifications for Pervious Surfaces

Material	Specification	Notes
Pavement	Acceptable pavement materials include permeable interlocking pavers with 5-15% open area (see Table 2 below for pavers that meet this requirement) and interlocking grids with gravel fill.	
Bedding Layer	Pervious Concrete: None Pavers: 2 inches of No. 8 stone	ASTM D448 size No. 8 stone (e.g. 3/8 to 3/16 inch in size). Should be double-washed and clean and free of all fines. Note: If you are adding additional drainage ("Run-On") an infiltration test must be performed. Additional bedding depth may be required depending on the infiltration rate. See infiltration test specification below.
Reservoir Layer	12 inches of No. 57 stone*	ASTM D448 size No. 57 stone (e.g. 1 1/2 to 1/2 inch in size). Should be washed and clean and free of all fines.
Filter Layer	The underlying native soils should be separated from the stone reservoir by a filter layer (filter fabric or sand layer). The filter fabric must have a flow rate greater than 125 gpm/sq. ft. (ASTM D4491), and an Apparent Opening Size (AOS) equivalent to a US #70 or #80 sieve (ASTM D4751). Or a layer of 2-3" of #8 stone with 6-8" of coarse sand may be used.	Not all filter fabric is the same. The flow rate and apparent opening size specifications are essential to the proper function of the filter fabric. Product examples that meet these specifications include Tencate Mirafi 140N or 140NC, Terratex SD, Propex 451, SRW NW4, and U.S. Fabrics US 100 NW
Observation Well	Use a perforated 4 to 6 inch vertical PVC pipe (AASHTO M 252) with a lockable cap, installed flush with the surface. Applications in driveways shall have a metal cap.	

* If an infiltration test is performed that documents an infiltration rate of at least 0.5 inches per hour, the reservoir layer depth can be reduced to 6 inches.

Table 2. Permeable Pavers with 5-15% Open Area

Manufacturer	Line	Surface Open Area
Belgard Commercial	Eco Dublin	7%
Belgard Commercial	Aqualine	6-14%, 12% 3-piece mix
Eagle Bay	Ecobay PICP	10%

EP Henry	Eco Bristol Salida	7%
EP Henry	Eco Paver II	10%
Nicolock	Eco Ridge	13%
Nicolock	Eco-Tre	10%
Newline Hardscapes	Aqua-flo	6%
Techo-bloc	Antika	Variable (993 in/hr)
Techo-bloc	Pure	5%
Techo-bloc	Hydra	8.3%

2. Location, Feasibility, and Design

The following must be considered when installing a pervious surface:

Location - If the permeable surface is replacing an existing impervious surface, check to see how dirty the existing surface is after a rain storm. This is a good indication of how much dirt and sediment will wash onto the permeable replacement. If the area appears to receive a significant amount of water and/or sediment from upslope areas, this may not be the best location for pervious paving. If it is really desired, it is important to consider installing a swale or French drain to divert runoff around the new pavement and preferably, stabilize upslope or eroding areas with more dense vegetation.

Although pervious surfaces are designed to infiltrate stormwater, heavy rains may overwhelm a pervious surface, regardless of the soil quality below the stone. When designing a pervious surface, make sure that the overflow from the surface is considered. This is no different than traditional pavement. The water flowing away from the pavement should be directed to a stable surface that will not erode and that can handle the volume of water, such as the street.

Groundwater Depth – Pervious surfaces filter pollutants as runoff flows through the natural soils. If the groundwater comes too close to the bottom of of the stone reservoir layer, pollutants can potentially flow through to the groundwater. In addition, these surfaces are more likely to have problems over the long term. It is recommended that groundwater depth be 2' deeper than the excavation depth. If groundwater intrusion is discovered during an infiltration test (see below) it is best to consider a different paving solution or StormwaterWise practice.

Setbacks – To avoid the risk of seepage, pervious surfaces should not be hydraulically connected to structure foundations. Pervious surface must be located at least 5 feet away from a building foundation if the surface is down-gradient from the building. Pervious surface must be located 25 feet away if the surface is located up-gradient from the building. These setback requirements can be relaxed if a 30 mil impermeable liner is installed along the sides and bottom of the pervious surface system wherever the setback distance is infringed upon.

Proximity to Utilities - Always call Miss Utility before digging. Interference with underground utilities should be avoided whenever possible, particularly water, sewer, electric and gas lines. Conflicts with water and sewer lateral pipes (e.g., house connections) might be unavoidable, in which case excavation should be done very carefully to avoid damaging those pipes. Also, be aware that Miss Utility may not always mark private cable, propane, electric, and similar lines, so some additional site work may be necessary to locate these.

Proximity to Trees – If tree branches extended over the proposed pervious surface, an arborist must be consulted to ensure that the required excavation will not harm the tree.

Site Drainage and Run On – Permeable pavement will function best if run-on from adjacent impervious and pervious surfaces is minimized. If additional "Run-On" from adjacent areas will occur, the following requirements apply:

- All contributing drainage areas must be fully stabilized. Areas of bare soil cannot be allowed to drain to the pervious surface. Turf and landscaped area should be minimized in the drainage area.
- Sump pumps should not discharge to the pervious pavement.
- The external drainage area must be less than 2.5 times the area of the pervious surface.
- Direct the run-on to the surface of the pervious pavement (as opposed to a buried pipe inside the pervious pavement layers).
- An infiltration test must be performed as close to the proposed pervious surface as is practicable, and calculations must be provided that show that the reservoir layer has sufficient depth to capture 1 inch of rainfall from the contributing drainage area (including the pervious surface itself) and that the reservoir will fully drain within 48 hours (How to Conduct Soil Infiltration Test).

Example Run-On Calculation

The surface area of the proposed pervious surface is 480 square feet. Runoff from an additional 1,000 square feet of impervious surface will be directed toward the pervious surface.

The following steps are required to ensure that this design meets the site drainage requirements.

1. Check that the external drainage area is less than 2.5 times the area of the pervious surface:

$$1{,}000\ sf/480sf = 2.1$$ Requirement met.

2. Determine the required volume of reservoir layer to capture 1 inch of rainfall:

$$(480\ sf + 1{,}000\ sf) \times 1in \times \frac{1\ ft}{12in} = 123.3\ cubic\ feet$$

3. Perform infiltration test:

Infiltration test yields and infiltration rate of 0.6 in / hr. (Since this rate is above 0.5 in / hr, the reservoir depth may be reduced to 6 inches, depending on the results of step 4 below.)

4. Determine the required depth of the reservoir layer, using a stone porosity of 0.4:

$$[(123.3\ cf/480\ sf)/0.4] \times (\tfrac{12in}{1ft}) = 7.7\ in$$ Use reservoir depth of 8 inches.

5. Check that the water in the reservoir layer will drain within 48 hours:

$$(8in \times 0.4)\ \times \tfrac{1hr}{0.6in} = 5.3\ hours$$ Requirement met.

This example design will drain within 48 hours and has an external drainage area less than 2.5 times the pervious surface area. Therefore, it meets the site drainage area requirements.

Slopes – Pervious surfaces are most effective when they are used on flat or nearly flat areas (less than or equal to 5% slope). Pervious surfaces may not be installed in areas adjacent to 20% or greater slopes, and the slope of the final, installed surface must be 10% or less.

The slope of the excavated area for a pervious surface installation should be as flat as possible (i.e., 0 percent longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater. On sloped sites (greater than 5%), internal flow barriers (i.e. check dams) can be used to achieve the 0% slope on the bottom. To reduce the depth of gravel fill needed to achieve a flat bottom, internal flow barriers (i.e. check dams) can be used to achieve the 0% slope on the bottom. Flow barriers must be constructed of concrete or impermeable geotextile. See figures 2 and 3.

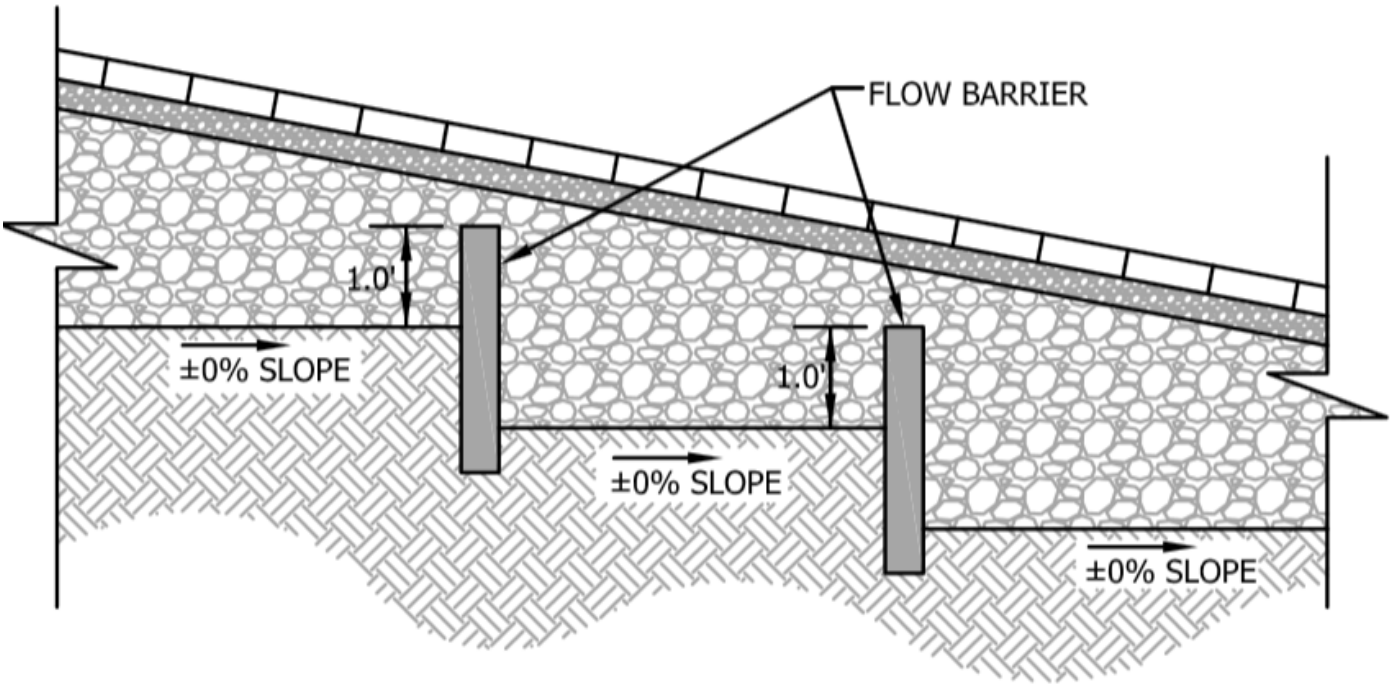

Figure 2. Typical Pervious Surface Concrete Flow Barrier Detail. (N.T.S.)

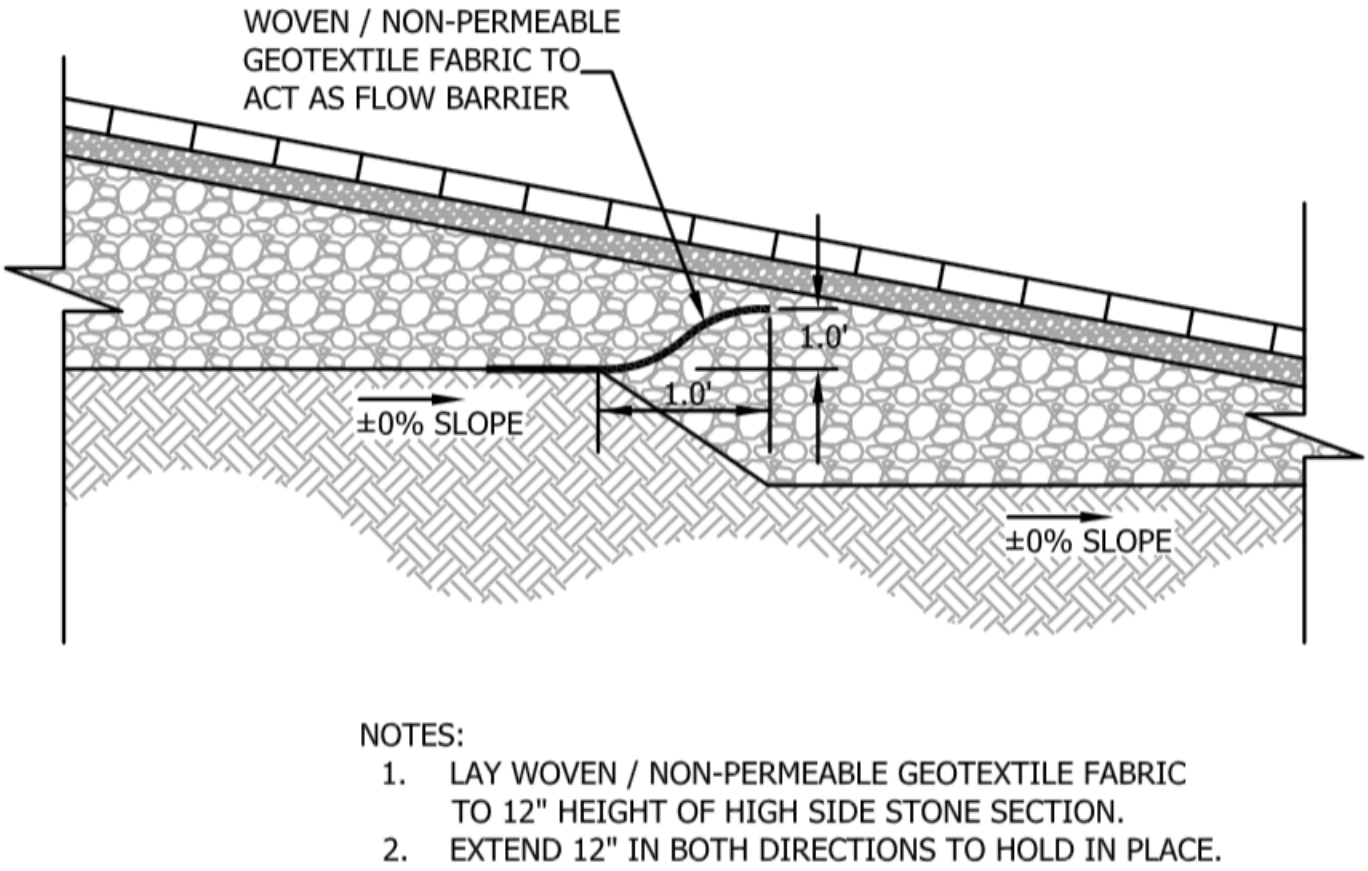

Figure 3. Typical Pervious Surface Fabric Flow Barrier Detail. (N.T.S.)

Edging – Edge restraints are required for all pervious surface installations. Concrete curbing/edging is preferred, but plastic edge restraints are also acceptable. Existing curbs may also be used as the edge restraint.

Public Right-of-Way – Driveway replacements may include impacts to the public right-of-way (i.e. the sidewalk, driveway apron, street, and adjacent County-owned land). If a portion of the project will be within the public right-of-way, a Public Right-of-Way Permit is required from the Permitting & Inspections Office. Permit information is available at http://topics.arlingtonva.us/permits-licenses/public-right-way-permit-guide/. Additional information on driveway apron replacements can be found at http://transportation.arlingtonva.us/streets/curbs-sidewalks/ .

Certified Installer – For permeable interlocking concrete pavers, installation must be done by an Interlocking Concrete Pavement Institute (ICPI) Certified Installer.

3. Construction

Surfaces should align and be flat, the base layers should be evenly applied and uniformly compacted to an appropriate degree. Pay particular attention to areas where pervious surface edges meet other surfaces (e.g., asphalt, grass areas). It is best to work from a thorough plan, including plan view, profile or cross-section views, with depths and dimensions labeled. Measure carefully and frequently to ensure the installation is staying on plan.

Step 1 – Call Miss Utility: Call Miss Utility before excavating, and also check for private cable, propane, electric, and other lines. Also try to identify private propane, cable, electric, and other small lines. Make sure to have a plan and phone numbers of whom to call in case there is any damage to utilities.

Step 2 - Outline the Project & Mark Utilities: Mark the excavation area for the proposed hardscape.

Step 3 – Excavate: It is best to excavate when the weather is expected to be dry for several days. Excavate to dimensions and depths, as per the plan.

*Remember to take a photograph with a tape measure!

Step 4 – Rake or Till: Rake or till the bottom soils to promote greater infiltration.

Step 5 – Filter Fabric: Line the bottom and sides of the excavated area with filter fabric. This can be held in place with landscape staples.

Step 6 – Install Flow Barriers (if necessary)

Step 7– Install Observation Well

Step 8 – Install Reservoir Layer and Bedding Layer: Install the various layers called for in the plans. Place gravel and other base materials in layers of no more than 4-6 inches. Compact layers of gravel and base materials with a vibratory plate compactor until there is no visible movement of aggregate.

*Remember to take a photograph with a tape measure!

Step 9 – Install Paving: Install permeable paving material at the surface. Ensure that the surface is even and flat, and level or with a very slight slope, based on the plans. When installing pavers, it is best to limit the difference between the elevations of two adjacent blocks to no more than ¼ inch to avoid tripping hazards and additional disturbance to the pavers. Spacing between pavers must be filled with #8 stone.

Step 10 – Install Gravel Fill between the pavers

Step 11 – Inspect: Inspect the area after several rain events to look for any needed adjustments. Ensure that the surface is draining properly and not becoming clogged.

4. Maintenance

The following maintenance should be performed to keep pervious pavement functioning properly:

- Prevent erosion in the area that drains to the pervious pavement to keep sediment from clogging the surface.
- During winter weather the snow may belt faster because of capillary action (the flow of air up through the paving). If you want to prevent icing however, do not use sand, kitty litter, or salt but instead shovel immediately after each snowfall or use an environmentally-friendly deicer.
- Do not seal the pervious pavement surface.
- Sweep up leaf litter and other debris regularly to limit clogging or blow this material off the driveway.
- Once a year, inspect the surface of the permeable pavement for evidence of clogging. Signs that your permeable pavement may be clogged include sediment deposition, staining or water ponding on the surface. If any signs of clogging are noted, the surface should be swept or vacuumed. Then, test sections by pouring water from a five gallon bucket to ensure they work.
- Once a year, inspect the surface for signs of deterioration, such as slumping, cracking, spalling, or broken pavers. Replace or repair affected areas, as necessary.
- As needed, replace the gravel fill between the pavers.

5. Resources

Arlington County, VA. 2016. *Stormwater Manual: A Guide to Stormwater Requirements for Land Disturbing Activities in Arlington County.* Available at: https://www.arlingtonva.us/files/sharedassets/public/building/documents/guidance_manual_lda2.0.pdf

Smith, D. 2006. Permeable Interlocking Concrete Pavement-selection design, construction and maintenance. Third Edition. Interlocking Concrete Pavement Institute. Herndon, VA

Virginia Department of Environmental Quality. 2013. *Virginia Stormwater BMP Specifications – Rev. 2013 (DRAFT).* Richmond, VA. Available at: http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications.aspx