



GREEN INFRASTRUCTURE DESIGNS

PERMEABLE PAVEMENT

JULY 2015

PERMEABLE PAVEMENT SCALABLE TOOL AND DESIGN TEMPLATE

This tool and associated design files are one section of a larger toolkit: [Green Infrastructure Designs: Scalable Solutions to Local Challenges](#) that was developed with support from the National Oceanic and Atmospheric Administration through the Illinois Department of Natural Resources.

Download [Permeable Pavement CAD files](#)
at ftp://deltaweb@www.delta-institute.org/CAD/GI_PP/GI_PP.zip

Download full toolkit [Green Infrastructure Designs: Scalable Solutions to Local Challenges](#)
at www.delta-institute.org/tools.

PERMEABLE PAVEMENT

Permeable pavement allows the infiltration of rainwater through the jointing material placed in the spaces between the pavers. Permeable pavers are ideal for right-of-way applications, such as parallel parking lanes or gutter retrofits. This technique can also be used for green alley applications or in parking areas for the redevelopment for vacant lots.

Runoff then flows down through open graded stone layers that have a void ratio of approximately 40 percent. Void ratio is an expression for the amount of open area between the material where water flows. Larger aggregate will have a higher void ratio than smaller aggregate like pea gravel. After rainwater is stored in the stone layer, it can then infiltrate into the native soil. If the native soil infiltrates at less than 0.5 in/hr, then runoff must discharge through an underdrain to an existing storm network or other outlet. Concrete containment curbs are placed around the installation to prevent lateral movement.

CUSTOMIZATION OPTIONS

Permeable pavement can be located anywhere there is existing impervious surface area, including residential, commercial and industrial locations. The minimum width of

a permeable pavement design is 2 feet, and the maximum length and width are scalable. Oftentimes the pavers will be used on the edge of a road or in the parallel parking lane adjacent to the drive lane. Large storm events can discharge to an existing or proposed storm sewer inlet. There are many manufacturers for permeable pavers, allowing for many size, color and layout pattern configurations.

MAINTENANCE

Care should be taken to avoid the runoff of sediment from adjacent areas onto the permeable pavers as much as possible. Avoid the application of sand onto the pavers during the winter time. When infiltration through the pavers becomes unacceptable, a vacuum truck is required to remove joint material and sediment accumulated between the pavers. The joint material will then need to be replaced.



Frequency of replacement will depend on site conditions and pollutant loading. Maintenance costs from manufacturers is estimated to be approximately \$0.20 / square foot / year.

COST INFORMATION

Cost information is provided for each green infrastructure technique in Sections 5-9 of this report. The installed costs are based on project experience, bid tabs, and information from the RS Means trends, and the labor and bidding environment.

SPECIFICATIONS

Although permeable pavers function differently than stormwater planters, the construction required to build them is very similar to a stormwater planter, because they are both surrounded by concrete curbing. The main difference is that permeable pavers do not use engineered soil or plants. Refer to Appendix B for more information on how to customize the standard specifications from the Illinois Urban Manual.

Construction Specifications

2 - Clearing and Grubbing

5 - Pollution Control

7 - Construction Surveys

8 - Mobilization and Demobilization

10 - Water for Construction

21 - Excavation

23 - Earthfill

24 - Drainfill

25 - Rockfill

32 - Structure Concrete

34 - Steel Reinforcement

35 - Concrete Repair

44 - Corrugated Polyethylene Tubing

46 - Tile Drains

94 - Contractor Quality Control

95 - Geotextile

752 - Stripping, Stockpiling, Site Preparation and Spreading Topsoil

Material Specifications

521 - Aggregates for Drainfill and Filters

522 - Aggregates for Portland Cement Concrete

531 - Portland Cement

534 - Concrete Curing Compound

535 - Preformed Expansion Joint Filler

536 - Sealing Compound for Joints in Concrete and Concrete Pipe

539 - Steel Reinforcement (for Concrete)

548 - Corrugated Polyethylene Tubing

592 - Geotextile

Permeable Pavers - Manufacture specific

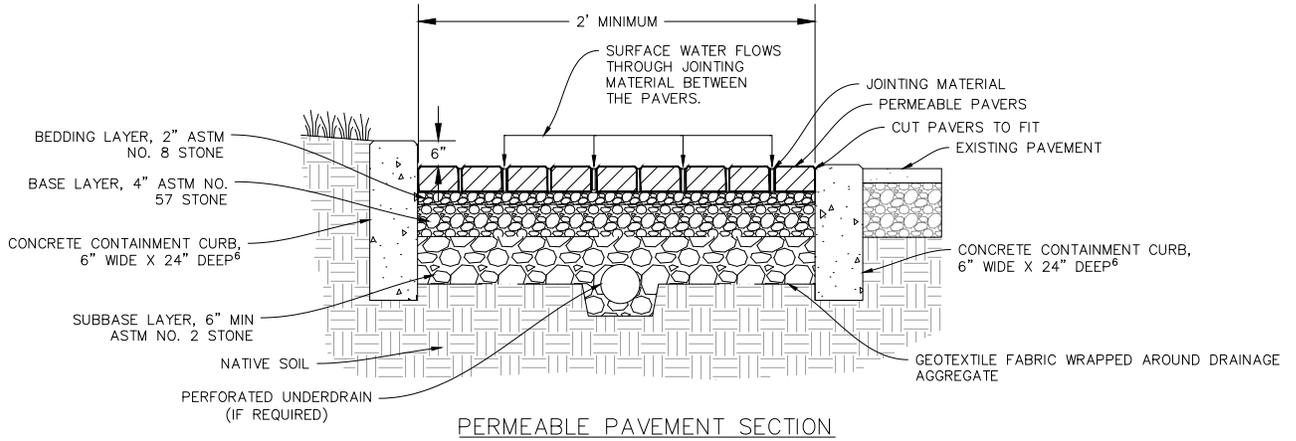
	Item	Description	Installed Cost ¹	Unit
<i>GI Technique</i>	<i>Permeable pavement</i>	<i>Pavers, stone layers (bedding, base, and subbase), geotextile and excavation</i>	<i>\$ 15.00</i>	<i>SF²</i>
<i>Required component</i>	<i>Bedding layer</i>	<i>2" ASTM No. 8 Stone</i>	<i>\$ 45.00</i>	<i>TON</i>
	<i>Base layer</i>	<i>4" ASTM No. 57 Stone</i>	<i>\$ 30.00</i>	<i>TON</i>
	<i>Subbase layer³</i>	<i>6" ASTM No. 2 Stone</i>	<i>\$ 35.00</i>	<i>TON</i>
	<i>Geotextile</i>	<i>Non-woven geotextile fabric</i>	<i>\$ 5.00</i>	<i>SY</i>
	<i>Curb</i>	<i>Containment curb</i>	<i>\$ 35.00</i>	<i>LF⁴</i>
<i>Custom options</i>	<i>Underdrain</i>	<i>12" HDPE perforated storm pipe</i>	<i>\$ 32.00</i>	<i>LF</i>
	<i>Connect to existing storm structure</i>	<i>Core drill existing structure, connect overflow pipe</i>	<i>\$ 1,500</i>	<i>EA</i>

¹ Installed cost include material and labor based on bid tabs from related projects and RS Means.

² Unit price based on a small (500 sf) urban alley retrofit project with hand placement of the permeable pavers. For larger installations, pavers can be machine installed, which increases efficiency and reduces the unit price. Unit prices for specific projects will vary based on scale, complexity, labor environment, and material cost trends. A detailed estimate should be prepared by the design engineer.

³ The system storage capacity can be increased by enlarging the stone envelope. Stone void space ratio is 40% and the unit weight is 100 lb/cf.

⁴ Multiply permeable pavement perimeter length by the unit price



PERMEABLE PAVERS¹

DESIGN GUIDANCE

TYPICAL LOCATION: PARALLEL PARKING LANE WITHIN RIGHT OF WAY OR IN PARKING AREA OF REDEVELOPMENT

WIDTH: 2' MIN, SCALEABLE

LENGTH: SCALABLE

CONTRIBUTING DRAINAGE AREA: VARIES ON SCALE

AVAILABLE OPTIONS: UNDERDRAIN
UNDERGROUND STORAGE (GI 5.01)

DETAILED DESIGN PRELIMINARY WORKSHEET

- NATIVE SOIL INFILTRATION²: _____ IN/HR
- REQUIRED STORAGE CAPACITY³: _____ CUBIC FT
- CONNECT TO EXISTING STORM NETWORK: YES/NO⁴
- DEPTH TO GROUNDWATER TABLE > 2 FT: YES/NO⁵

1. AQUA ROC PAVERS BY BELGARD SHOWN IN ALLEY RETROFIT (PHOTO BY GUIDON DESIGN)
 2. NATIVE SOIL INFILTRATION NEEDS TO BE GREATER THAN 0.5 INCHES/HOUR. IF IT IS NOT, AN UNDERDRAIN MUST BE INCLUDED.
 3. IF STORAGE CAPACITY EXCEEDS AVAILABLE FOOTPRINT SPACE, INCREASE THICKNESS OF DRAINAGE AGGREGATE OR CONSIDER UNDERGROUND STORAGE.
 4. IMPACT ON DOWNSTREAM SYSTEM TO BE ANALYZED BY DESIGNER.
 5. IF NO, TECHNIQUE IS NOT SUITABLE.
 6. CONCRETE CONTAINMENT CURB MUST BE INSTALLED ON ALL SIDES OF THE PERMEABLE PAVERS.

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GI 4.01
1 OF 2
SCALE: NTS

PERMEABLE PAVEMENT

A COLLABORATION OF:



PERMEABLE PAVEMENT NOTES

1. NATIVE SOIL INFILTRATION RATE TO BE 0.5 INCHES/HOUR OR GREATER. IF NOT, THEN AN UNDERDRAIN IS REQUIRED.
2. AGGREGATE BASE COURSE DEPTH DEPENDENT ON TRAFFIC LOADING AND NATIVE SOILS IN A WET, UNCOMPACTED STATE.
3. PERVIOUS PAVEMENT SURFACES NEED TO BE PROTECTED FROM SEDIMENT DURING THE ENTIRE CONSTRUCTION PROCESS.
4. FULL EXTENT OF POROUS PAVEMENT SHALL BE FENCED OFF DURING CONSTRUCTION TO PREVENT COMPACTION OF SUBGRADE AND STOCKPILING OF CONSTRUCTION MATERIALS OVER SURFACE.
5. IF DURING EXCAVATION OF NATIVE SOILS, THE BOTTOM OF THE TECHNIQUE IS EXPOSED TO RAIN, HAND RAKE THE SURFACE TO A DEPTH OF 3" TO RESTORE INFILTRATION CAPACITY.
6. AGGREGATE BASE COURSE SHALL BE WASHED ON-SITE TO REDUCE WASH LOSS TO 0.5%. ROCK SHOULD BE HOSED OFF WHILE ON TRUCK OR AFTER STOCKPILING. HOSE OFF AS PILE IS UTILIZED AS FINES WILL MIGRATE TO LOWER LEVELS OF PILE.

MAINTENANCE GUIDELINES

1. PREVENT RUN-ON OF SEDIMENT IN RUNOFF FROM ADJACENT AREAS.
2. SWEEP/VACUUM ONE OR TWO TIMES PER YEAR.
3. AVOID APPLICATION OF SAND DURING WINTER TIME.
4. WHEN INFILTRATION RATES THROUGH THE JOINTS BECOMES UNACCEPTABLE, USE A VAC TRUCK TO REMOVE JOINT MATERIAL ALONG WITH ACCUMULATED SEDIMENT. REPLACE JOINT MATERIAL. FREQUENCY OF THIS MAINTENANCE WILL VARY BASED ON SEDIMENT LOADING.

MATERIALS SPECIFICATIONS

1. BASE COURSE
 - 1.1. ALL AGGREGATES BENEATH THE PAVEMENT SHALL MEET THE FOLLOWING:
 - 1.1.1. MAXIMUM WASH LOSS OF 0.5%
 - 1.1.2. MINIMUM DURABILITY INDEX OF 35
 - 1.1.3. MAXIMUM ABRASION OF 10% FOR 100 REVOLUTIONS AND MAXIMUM OF 50% FOR 500 REVOLUTIONS
 - 1.2. UNLESS OTHERWISE APPROVED BY THE ENGINEER, COARSE AGGREGATE FOR THE AGGREGATE BASE COURSE SHALL BE UNIFORMLY GRADED WITH THE FOLLOWING GRADATION (ASTM NO. 57)

US STANDARD SIEVE SIZE	PERCENT PASSING
1 1/2"	100
1"	95-100
1/2"	25-60
4	0-10
8	0-5
 - 1.3. UNLESS OTHERWISE APPROVED BY THE ENGINEER, COARSE AGGREGATE FOR THE AGGREGATE BASE COURSE SHALL BE UNIFORMLY GRADED WITH THE FOLLOWING GRADATION (ASTM NO. 8)

US STANDARD SIEVE SIZE	PERCENT PASSING
1/2"	100
3/8"	85-100
4	10-30
8	0-10
16	0-5
 - 1.4. UNLESS OTHERWISE APPROVED BY THE ENGINEER, COARSE AGGREGATE FOR THE AGGREGATE BASE COURSE SHALL BE UNIFORMLY GRADED WITH THE FOLLOWING GRADATION (ASTM NO. 2)

US STANDARD SIEVE SIZE	PERCENT PASSING
3"	100
2.5"	90-100
2"	35-70
1.5"	0-15
3/4"	0-5
- 1.3. UNLESS OTHERWISE APPROVED BY THE ENGINEER, COARSE AGGREGATE FOR THE AGGREGATE BASE COURSE SHALL BE UNIFORMLY GRADED WITH THE FOLLOWING GRADATION (ASTM NO. 2)

US STANDARD SIEVE SIZE	PERCENT PASSING
3"	100
2.5"	90-100
2"	35-70
1.5"	0-15
3/4"	0-5
- 1.4. NON WOVEN GEOTEXTILE (DRAINAGE FILTER FABRIC, NEED PUNCHED) SHALL CONFORM TO THE FOLLOWING:
 - A. MINIMUM FLOW RATE OF 95 GAL/MIN/FT2 ASTM D-4491-85
 - B. GRAB TENSILE STRENGTH MIN 115 LB ASTM D-4632-86
 - C. BURST STRENGTH MIN 150 PSI ASTM D-3786-80A
 - D. PUNCTURE RESISTANCE MIN 45 LB ASTM D-4833-88
 - E. APPARENT OPENING SIZE 60-90 U.S. STANDARD SIEVE