2J-4 Permeable Pavers

Pollutant Removal **Low = <30% Medium = 30-65% High = 65-100%**			
	Low	Med	High
Suspended Solids			■
Nitrogen		■	■
Phosphorous		■	
Metals			■
Bacteriological			■
Hydrocarbons		■	

Description: Two types of permeable pavers are included in this section. The first type is monolithic units that do not have void areas incorporated in the pavers. The second type includes manufactured modular paving units with incorporated void areas that are filled with pervious materials such as gravel or grass turf. Permeable pavers are installed over a gravel base course that provides storage as runoff infiltrates through the permeable paver system into underlying permeable soils.

Typical Uses: Intended for low traffic areas, or for residential or overflow parking applications in higher density residential areas, high-density ultra urban areas, commercial areas.

Advantages:

- High level of pollutant removal
- Provides reduction in runoff volume
- Suitable for cold climates
- Available from commercial vendors

Limitations:

- Soil infiltration rate of 0.5 inches per hour or greater required
- High cost compared to conventional pavements
- High maintenance requirements
- Potential for high failure rate if not adequately maintained or used in unstabilized areas
- Potential for groundwater contamination

Maintenance Requirements:

- Prevent run-on of sediment in runoff from adjoining areas
- Sweep/vacuum one to two times per year
- Avoid (“prevent”) application of sand in winter

A. General description

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

There are many different types of modular permeable pavers available from different manufacturers, including both precast and mold in-place concrete blocks, concrete grids, interlocking bricks, and plastic mats with hollow rings or hexagonal cells (Figure 1).

Figure 1: Examples of modular permeable pavers

Figure 2: Examples of monolithic permeable pavers

Monolithic permeable pavers are solid units that when placed provide area between the units for stormwater infiltration. The monolithic permeable pavers are manufactured in many different shapes that provide for easier placement and increased permeable areas.

Permeable pavers are typically placed on a gravel (stone aggregate) base course. Runoff infiltrates through the permeable 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 infiltration capability of the soils.

Permeable paver systems are typically used in low-traffic areas such as the following types of applications:

- Parking pads in parking lots
- Overflow parking areas
- Residential driveways
- Residential street parking lanes
- Recreational trails
- Golf cart and pedestrian paths
- Emergency vehicle and fire access lanes

A major drawback is the cost and complexity of permeable paver systems compared to conventional pavements. Permeable pavers require a moderate 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. Therefore, consideration of permeable pavers should include the construction and maintenance requirements and costs.

B. Pollutant removal capabilities

As they provide for the infiltration of stormwater runoff, permeable pavers have a high removal of both soluble and particulate pollutants, where they become trapped, absorbed, or broken down in the underlying soil layers. Due to the potential for clogging, permeable paver surfaces should not be used for the removal of sediment or other coarse particulate pollutants. The following design pollutant removal rates are conservative average pollutant reduction percentages for design purposes:

- Total suspended solids - not applicable
- Total phosphorus - 80%
- Total nitrogen - 80%
- Fecal coliform - insufficient data
- Heavy metals - 90%

C. Design criteria and specifications

1. Permeable pavers can be used where the underlying in-situ subsoils have an infiltration rate between 0.5 and 3.0 inches per hour. Therefore, unless underdrains and pipe discharge are provided, permeable pavers are not suitable on sites with hydrologic group D or most group C soils, or soils with a high (>30%) clay content. During construction and preparation of the subgrade, special care must be taken to avoid compaction of the soils.

2. Permeable pavers should typically be used in applications where the pavement receives tributary runoff only from impermeable areas. The ratio of the contributing impermeable area to the permeable paver surface area should be no greater than 3:1.

3. If runoff is coming from adjacent permeable areas, it is important that those areas be fully stabilized to reduce sediment loads and prevent clogging of the permeable paver surface.

4. Permeable pavers are not recommended on sites with a slope greater than 2%.

5. A minimum of 2 feet of clearance is required between the bottom of the gravel base course and underlying bedrock or the seasonally high groundwater table.

6. Permeable pavers should be sited at least 10 feet down gradient from buildings and 100 feet away from drinking water wells.

7. An appropriate permeable paver should be selected for the intended application. A minimum of 40% of the surface area should consist of open void space. If it is a load-bearing surface, then the pavers should be able to support the maximum load.

8. The permeable paver infill is selected based upon the intended application and required infiltration rate. Masonry sand (such as ASTM C 33 concrete sand or Iowa DOT Fine Aggregate Size No. 10) has a high infiltration rate (8 inches per hour) and should be used in applications where no vegetation is desired. A sandy loam soil has a substantially lower infiltration rate (1 inch per hour), but will provide for growth of a grass ground cover.

9. The gravel base course should be designed to store at a minimum the water quality volume (WQv). The stone aggregate used should be washed, bank-run gravel, 0.75 to 1.0 inches in diameter with a void space of about 40% (Iowa DOT No. 5 or 57 Stone). Aggregate contaminated with soil should not be used. A porosity value (void space/total volume) of 0.32 should be used in calculations.

10. The gravel base course must have a minimum depth of 9 inches. The following equation can be used to determine if the depth of the storage layer (gravel base course) needs to be greater than the minimum depth:

    $d = V / A * n$

    Where:
    d = Gravel Layer Depth (feet)
    V = Water Quality Volume –or– Total Volume to be Infiltrated
    A = Surface Area (square feet)
    n = Porosity (use n = 0.32)

11. The surface of the subgrade should be lined with a non-woven geotextile filter fabric and be completely flat to promote infiltration across the entire surface.

12. Designs of permeable pavers 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 permeable paver system, or if the surface clogs.

13. For the purpose of sizing downstream conveyance and structural control system, permeable paver surface areas can be assumed to be 35% impermeable.

D. Inspection and maintenance requirements

Table 1: Typical maintenance activities for permeable pavers

Activity	Schedule
Ensure that the permeable surface is free of sediment.	Monthly
Check to make sure that the system dewaters between storms.	
Ensure that the contributing area and permeable surface are clear of debris.	As needed, based on inspection
Ensure that the contributing and adjacent area is stabilized and mowed with clippings removed.	
Vacuum sweep permeable surface to keep free of sediment.	Semi-annually
Inspect the surface for deterioration or spalling.	Annually