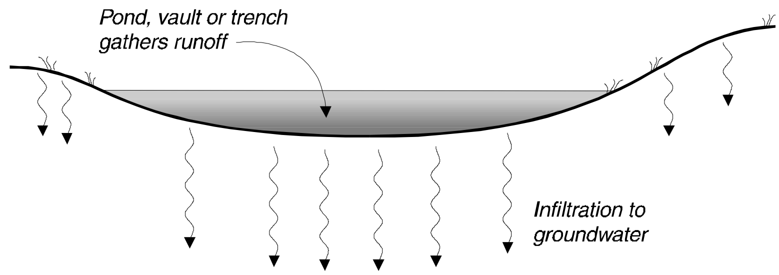
Definition and Purpose

An infiltration facility provides for the movement of stormwater into the soil in order to reduce runoff quantity and remove pollutants from the runoff through filtration in the soil matrix. Design configurations include basins, trenches, vaults, leach fields, and porous pavement.



Applications

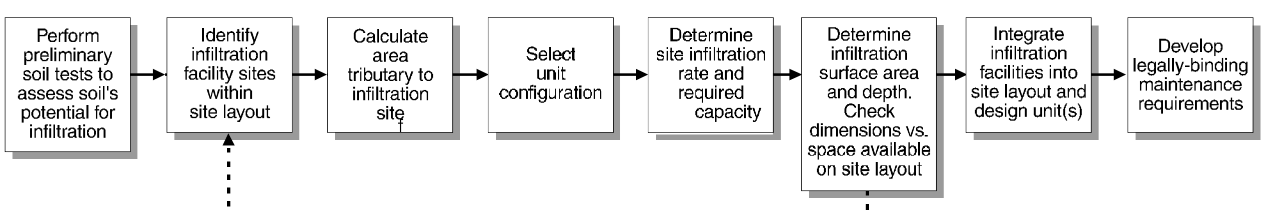
Infiltration facilities achieve some removal of sediment, heavy metals, toxic materials, floatable materials, oxygen demanding substances, oil and grease, bacteria, and viruses. Infiltration facilities also control runoff volume. Tributary areas to infiltration devices shall not exceed 50 acres. Land uses for which infiltration is appropriate include residential, commercial, and institutional land uses. These BMPs are most appropriate for sites with soil infiltration rates of 0.5 to 4 inches per hour, with low potential for long-term erosion in the contributing drainage area.

Limitations

- Loss of infiltrative capacity and high maintenance cost in fine soils.
- Low removal of dissolved pollutants in very coarse soils.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils, may require groundwater monitoring.
- Not to be used with land uses where spills of hazardous chemicals could occur.
- Facilities cannot be put into operation until upstream drainage area is stabilized.

Design Guidance, General

Infiltration facilities work by percolating water downward through the soil to remove pollutants. They offer storage in addition to effective pollutant removal. The storage capacity of infiltration facilities reduces downstream runoff, which may serve to reduce downstream bank erosion in watercourses. The flowchart below provides general guidance for planning an infiltration facility as part of the site design.



An important consideration for all infiltration facility configurations is that, during construction, great care must be taken not to reduce the infiltrative capacity of the soil in the facility through compaction or by using the infiltration area as a sediment trap. Infiltration facilities shall be constructed late in the site development after soils (that might erode and clog the units) have been stabilized, or shall be protected until the site is stabilized.

Infiltration facilities are sized to capture, store and infiltrate a volume of runoff, much in the same way that detention basins are sized to retain the volume of runoff produced by the design storm. Sizing guidelines are discussed in the following section, “Additional Criteria for Specific Configurations.”

Infiltration Basin

An infiltration basin consists of a shallow, flat basin in pervious soil, with an inlet structure and an outlet structure to regulate emergency overflow. It functions by retaining runoff in the basin, where it then percolates into the soil. An infiltration basin requires significant space and is suitable for large drainage areas (10 to 50 acres). These basins, which are empty when not in use, could be dual-purpose. A grass-covered area in a park, for example, could function as an infiltration basin during the wet season, and serve as a park when dry.

Infiltration Trench or Vault

An infiltration trench consists of a long, narrow subgrade gravel bed, where runoff is stored until it is infiltrated. Figure IN-1 illustrates an infiltration trench. Flow enters the trench from the ground surface. Vegetated banks provide a biofilter to remove some sediment and improve basin performance. Infiltration trenches are relatively unobtrusive BMPs, as they have a small, narrow footprint and are flush with the ground. This BMP is well suited for small drainage areas, and integrates well into site layouts with placement near parking areas and in yards. Small infiltration trenches may be used to treat the runoff from building downspouts. Vaults are similar to infiltration trenches, but have a permanent engineered cover and may be placed under parking areas.

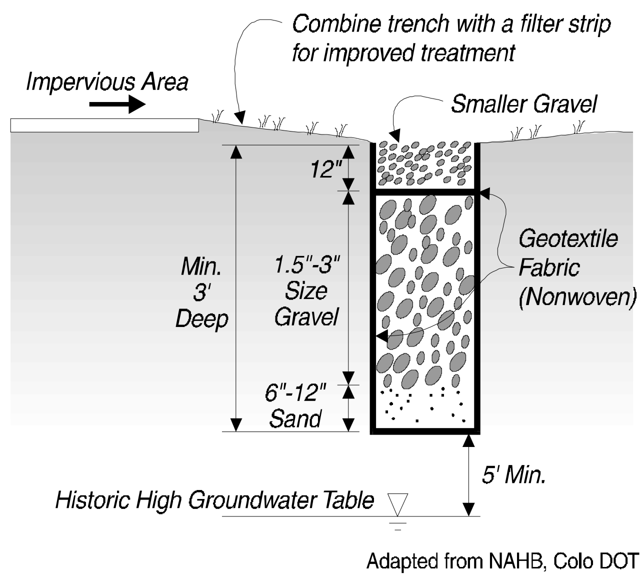


Figure IN – 1

Leach Field

A leach field is similar in concept to an infiltration trench in that it includes subgrade gravel beds for runoff storage and infiltration. Unlike trenches, however, flow enters the beds through a conduit, such as a perforated pipe. The gravel beds in a leach field are not exposed, as in a trench configuration. Rather, the entire facility is underground and may be covered. Figure IN-2 is a conceptual illustration of a leach field. A wide variety of conduits are available for use in leach fields. Equipment designed for septic systems may be applicable for stormwater use. Leach fields are well suited to unpaved areas such as lawns.

Porous Pavement

Porous pavement consists of a surface covered with a porous material such as a specially-mixed concrete, asphalt or modular block, placed over a sand and gravel bed. Porous pavement allows runoff to seep through and down into the infiltration bed below. This BMP is particularly flexible, in that it may be used in many locations where standard pavement may be placed. Unlike standard pavement, porous pavement reduces runoff and improves runoff quality through filtration through soil.

The performance of porous pavement is enhanced by the addition of an adjacent biofilter strip, either upstream to remove sediments or downstream to further clean runoff. Porous pavement must be engineered for anticipated loads and shall not be placed where it will be subjected to heavy vehicle traffic, but is ideal for applications such as temporary/infrequent parking spaces. Figure IN-3 shows an example of porous pavement placement.

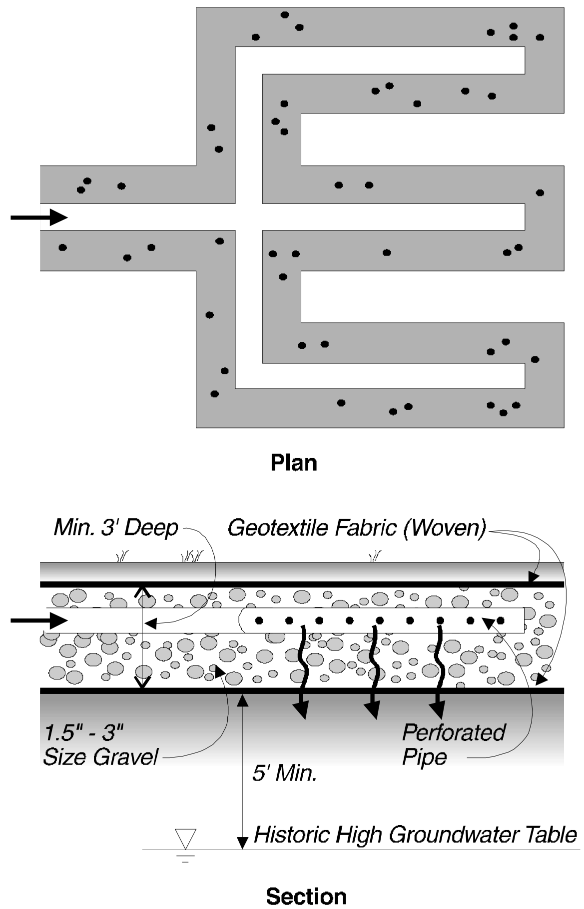
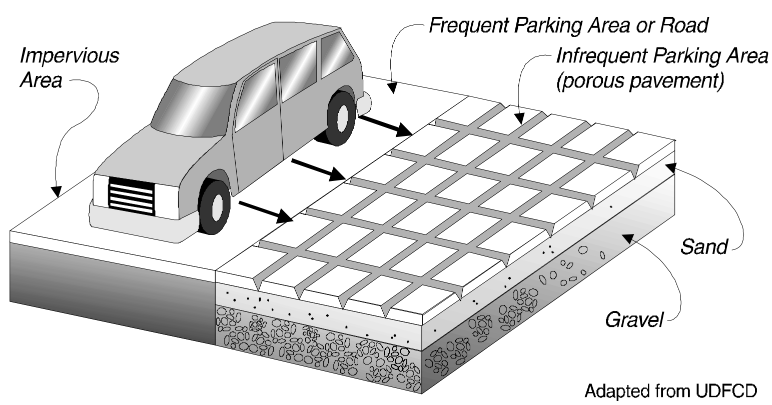


Figure IN – 2

Leach Field

Infiltration Rates

All of the infiltration facility configurations described above require adequate site infiltration rates. Before exploring the use of infiltration BMPs, preliminary soil investigations, including a percolation test, shall be performed to assess whether the soils on site have an extended infiltration rate of at least 0.5 inch per hour. Separate on-site infiltration systems from the groundwater table (or bedrock) by a minimum of 5 feet vertically to provide sufficient infiltration volume within the soil. Other suitability considerations include the soil makeup (Appendix C), site topography, and the location of other facilities.



Adapted from UDFCD

Figure IN – 3

Porous Pavement in an Infrequent Parking Area

The site must further provide a relatively flat area in which to construct the facility. Infiltration BMPs may be constructed on slopes of up to 15 percent, provided that the base has less than a 3 percent slope. Infiltration facilities shall be sited at least 50 feet away from slopes steeper than 15 percent. Adequate spacing (100 feet or more) shall be provided between infiltration facilities and non-potable wells, tanks, drain fields and springs. For separation between infiltration BMPs and potable water supply wells, follow Department of Health Services requirements in the Guidelines for Location of Water Wells.

These BMPs shall also be sited at least 20 feet down slope or 100 feet up slope from building foundations. A soils expert shall be consulted when necessary to verify appropriate placement on site.

Additional Criteria for Specific Configurations

Infiltration Basin

Figure IN-4 shows a typical infiltration basin. The basins may be designed in a variety of shapes, but shall be sized for 80 percent annual capture. Appendix B provides the relationship of basin size to percent capture for Ventura County. The steps used in designing an infiltration basin are listed below.

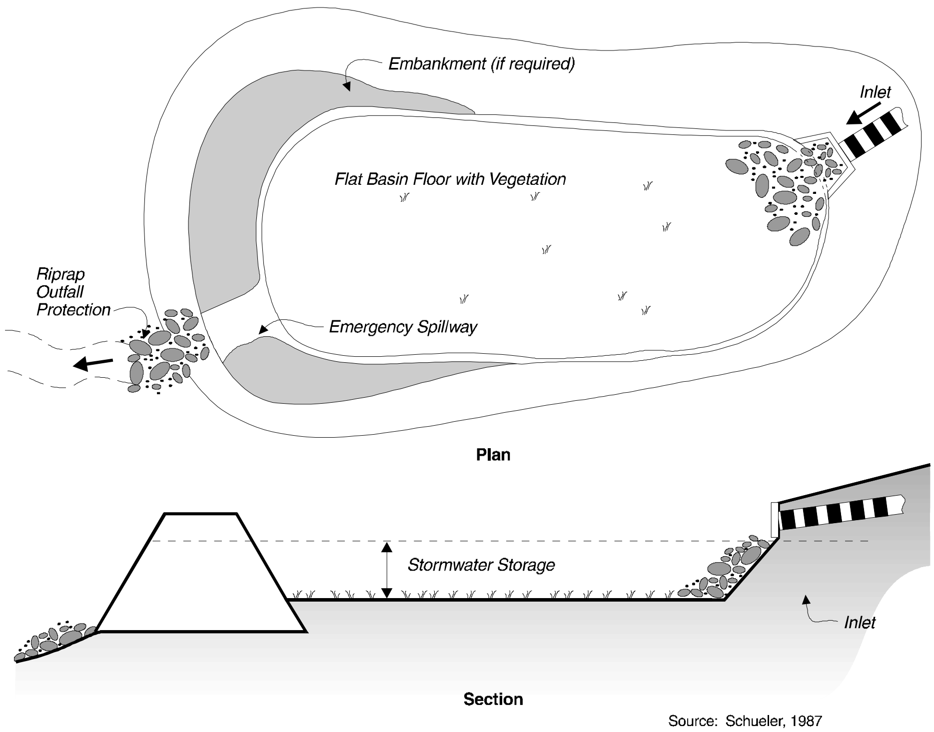


Figure IN – 4

Infiltration Basin

Size the Basin

Review the unit's drainage area and determine the percentage of impervious area. Impervious area includes paved areas, roofs, and other developed, non-vegetated areas. Non-vegetated, compacted soil areas shall be considered an impervious area. Porous pavements installed and maintained as a stormwater quality control BMP may be considered a pervious area. The percentage of impervious area will be used to determine the runoff coefficient ("C").

Using Table B-1 (Appendix B), determine the runoff coefficient ("C") for the unit's drainage area based on the percentage of impervious area. The runoff coefficient ("C") will be used to determine the appropriate curve in Figure B-1.

Enter Figure B-1 (Appendix B) on the vertical axis at 80% Annual Capture. Move horizontally to the right across Figure B-1 until the curve corresponding to the drainage area's runoff coefficient ("C") is intercepted. Move vertically down Figure B-1 from this point until the horizontal axis is intercepted. Read the Unit Basin Storage Volume along the horizontal axis. Interpolation between curves may be necessary.

Calculate the required basin volume by multiplying the Unit Basin Storage Volume by the unit's drainage area. Convert the required storage volume to cubic feet.

Calculate the minimum surface area of the infiltration system:

$$A_m = V/D_m$$

where:

A_m = minimum area required (ft^2)
V = volume of the infiltration basin (ft^3)
D_m = maximum allowable depth (ft) where:
$D_m = tI/12s$
and: I = site infiltration rate in (in/hr)
s = safety factor
t = minimum drawdown time = 40 hours

In the formula for maximum allowable depth, the safety factor accounts for the possibility of inaccuracy in the infiltration rate measurement. The less certain the infiltration rate the higher the safety factor shall be. Minimum safety factors shall be as follows:

Without site-specific borings and percolation tests, use s=10

With borings (but no percolation test), use s=6

With percolation test (but no borings), use s=5

With borings and percolation test, use s=3

Design the Basin Configuration

Lay out the basin shape and details according to site constraints and the additional design considerations listed below.

Do not locate the facility on fill sites, or on or near steep slopes.

Use energy dissipation at the inlet to minimize erosion scour.

Vegetate slopes to minimize erosion (may require irrigation during most of the year).

Vegetate bottom to reduce tendency to clog with fine materials (may require irrigation in summer).

Design for operation with 1 foot of freeboard, minimum.

- # Design side slopes of equal to or flatter than 3:1.

- # Basins may be on-line or off-line with flood control facilities.

- # Incorporate a bypass for flows exceeding the design capacity of the BMP.

- # For on-line basins, the water quality outlet may be superimposed on the flood control outlet or may be constructed as a separate outlet.

- # Provide dedicated access to the basin bottom (maximum slope 10 percent) for maintenance vehicles.

- # Provide security fencing, except when used as a recreation area.

See guidelines for biofilters (BMP BF) for information on selecting appropriate vegetative covers.

Design Infiltration Trench, Leach Field or Vault

Design trenches, leach fields and vaults to hold the water quality control volume.

- # Review the unit's drainage area and determine the percentage of impervious area. Impervious area includes paved areas, roofs, and other developed, non-vegetated areas. Non-vegetated, compacted soil areas shall be considered an impervious area. Porous pavements installed and maintained as a stormwater quality control BMP may be considered a pervious area. The percentage of impervious area will be used to determine the runoff coefficient ("C").

- # Using Table B-1 (Appendix B), determine the runoff coefficient ("C") for the unit's drainage area based on the percentage of impervious area. The runoff coefficient ("C") will be used to determine the appropriate curve in Figure B-1.

- # Enter Figure B-1 (Appendix B) on the vertical axis at 80% Annual Capture. Move horizontally to the right across Figure B-1 until the curve corresponding to the drainage area's runoff coefficient ("C") is intercepted. Move vertically down Figure B-1 from this point until the horizontal axis is intercepted. Read the Unit Basin Storage Volume along the horizontal axis. Interpolation between curves may be necessary.

- # Calculate the required basin volume by multiplying the Unit Basin Storage Volume by the unit's drainage area. Convert the required storage volume to cubic feet. Increase the basin volume to account for the volume occupied by the gravel in the bed (about 60%) by dividing the resulting volume by 0.40. The result is the design volume.

- Calculate the minimum surface area of the infiltration system:

$$A_m = V/D_m$$

where:

A_m = minimum area required (ft^2)
V = volume of the infiltration basin (ft^3)
D_m = maximum allowable depth (ft) where:
$D_m = tI/12s$ and shall be less than or equal to 8 feet.
and: I = site infiltration rate in (in/hr)
s = safety factor
t = minimum drawdown time = 40 hours

In the formula for maximum allowable depth, the safety factor accounts for the possibility of inaccuracy in the infiltration rate measurement. The less certain the infiltration rate is, the higher the safety factor shall be. Minimum safety factors shall be as follows:

- Without site-specific borings and percolation tests, use s = 10
- With borings (but no percolation test), use s = 6
- With percolation test (but no borings), use s = 5
- With borings and percolation test, use s = 3
- Adjust the length and width of the trench to suit site conditions and provide a reasonable construction configuration.

Additional design considerations for trenches, vaults and leach fields are listed below.

- Do not locate on fill sites, or on/near steep slopes.
- Include a 4- or 6-inch diameter observation well with locking cap, for monitoring (see observation well shown in Figure IN-5).
- Provide 6-inch to 12-inch sand layer on bottom.
- Include geotextile fabric around trench walls to prevent soils from migrating into the trench rock matrix.
- Include geotextile fabric 12 inches below ground surface with 3/4-inch rock on top, as a coarse filter.
- Use geotextile fabric with the minimum specifications listed in Table IN-1.

Table IN-1 Geotextile Properties			
Property	***Test Reference***	***Minimum Specification***	
		Woven (Slit Film)	***Nonwoven***
Grab Strength	ASTM D4632	200 lbs	90 lbs
Elongation at peak load	ASTM D4632	25 %	50 %
Puncture Strength	ASTM D3787	30 lbs	45 lbs
Permitivity	ASTM D4491	0.02/sec	0.7 sec^{-1}
Burst Strength	ASTM D3786	200 psi	180 psi
Toughness	% Elongation x Grab Strength	—	5,500 lbs
Ultraviolet Resistance (Percent strength retained at 500 Weatherometer hours)	ASTM D4355	70%	70%

Adapted from SSPWC, 1997.

Use backfill and filter rock that consist of clean, washed aggregate 1.5 to 3 inches in diameter.

Incorporate a bypass for flows that exceed the design capacity of the BMP.

Provide dedicated access for maintenance.

Figure IN-1 (p. IN-2) shows a side view of an infiltration trench. Figure IN-5 below shows the use of an infiltration trench for the storage and exfiltration of water from a downspout.

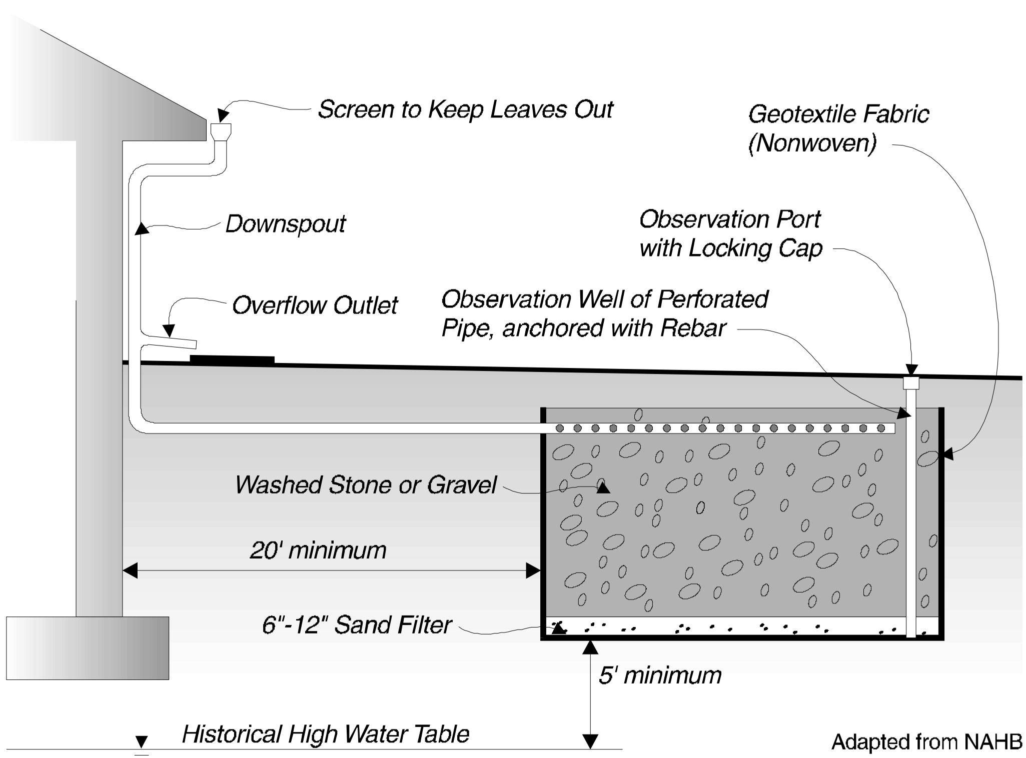


Figure IN – 5

Downspout Infiltration Unit

Porous Pavement

Porous pavement configurations consist of pavement with void spaces filled with pervious material. Possible configurations include:

- Poured in-place slabs, which are reinforced slabs covering large areas; special forms create void space
- Precast concrete grids, which are delivered to the site in small paving units and assembled on site
- Modular unit pavers, which are monolithic, but form void spaces when pieced together on site
- Large aggregate asphalt pavement slabs designed for perviousness

Figure IN-6 shows a side view of a typical porous pavement installation. The pavement is installed over a gravel reservoir-type bed, sized in the same manner as an infiltration trench. When design conditions warrant, the size of the reservoir may account for the incomplete infiltration of runoff through the porous pavement. When using proprietary materials, consult manufacturer's recommendations or follow these guidelines, whichever is more conservative.

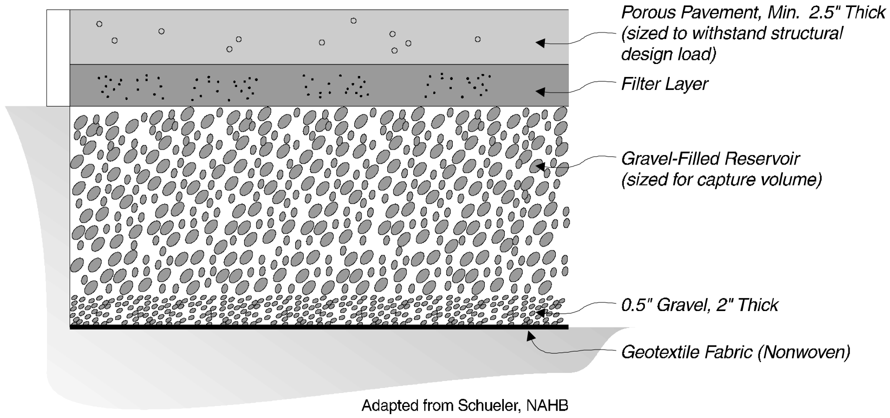


Figure IN – 6

Porous Pavement Installation

Maintenance and Inspection Requirements

Maintenance and inspection levels and frequencies depend on the amount of flow treated by the BMP. Most infiltration facilities require more maintenance initially and less as the site stabilizes. Wind blown dust, spills, tracking and other sources of pollutants can increase the need for and the frequency of maintenance. Use manufacturer's recommendations or the maintenance starting points listed below, whichever is more frequent, and adjust according to the facility's performance.

Infiltration BMPs require periodic maintenance and inspection, including the following practices:

- Inspect a minimum of twice a year, before and after the rainy season, after large storms, or more frequently if needed.

- Clean when loss of infiltrative capacity is observed.

    - If drawdown time is observed to have increased significantly over the design drawdown time, removal of sediment may be necessary. This is an expensive maintenance activity and the need for it can be minimized through prevention of upstream erosion.

< Porous pavement installations require continual maintenance to prevent clogging from sediments. Vacuum sweeping, followed by high-pressure jet hosing, is recommended 4 times annually. Inspections shall include a check for surface ponding, potholes and cracks.

Monitor health of vegetation and replace as necessary.

Mow, as appropriate for vegetative cover species.

Control mosquitoes as necessary.

Prepare and submit to the appropriate agency a maintenance manual prior to facility installation.

Report on maintenance to the appropriate agency.