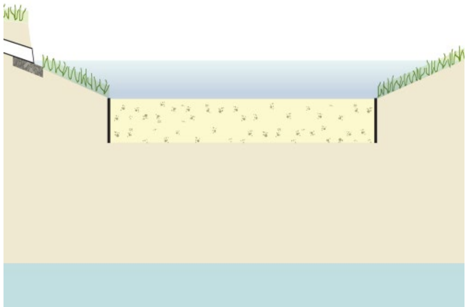
9.8 Small-Scale Infiltration Basins



Small-scale infiltration basins are stormwater management systems constructed with highly permeable components designed to both maximize the removal of pollutants from stormwater and to promote groundwater recharge. Pollutants are treated through settling, filtration of the runoff through and biological and chemical activity within, the components. The total suspended solids (TSS) removal rate is 80%.

N.J.A.C. 7:8 Stormwater Management Rules – Applicable Design and Performance Standards		
	Green Infrastructure	Yes
	Water Quantity	Yes, when designed as an on-line system
GR	Groundwater Recharge	Yes
%	Water Quality	80% TSS Removal

Water Quality Mechanisms and Corresponding Criteria	
Settling	
Storage Volume	Entire Water Quality Design Storm Volume
Infiltration	
Maximum Contributory Drainage Area	2.5 acres
Maximum Design Storm Drain Time	72 hours, Using Slowest Design Permeability Rate
Permeability Rate Factor of Safety	2
Minimum Subsoil Design Permeability Rate	0.5 inches/hour
Maximum Design Permeability Rate	10 inches/hour
Soil Testing Consistent with Chapter 12: Soil Testing Criteria	Required
Minimum Distance between Basin Bottom and Seasonal High Water Table	2 feet
Biological and Chemical Activity	
Minimum Sand Layer Thickness	6 inches
Minimum Sand Layer Permeability Rate	20 inches/hour, tested per *Chapter 12: Soil Testing Criteria*
Maximum % Fines in Sand Layer	15%

Introduction

Small-scale infiltration basins are stormwater management systems constructed in areas of highly permeable soil that provide temporary storage of stormwater runoff and can help to reduce increases in both the peak rate and total volume of runoff caused by land development. Pollutants in runoff are treated through the processes of filtration through and biological and chemical activity within the soil.

In these systems, the rate of infiltration is affected by the hydraulic conductivity of the underlying soil, the distance separating the lowest basin elevation from the seasonal high water table (SHWT) and the area of the basin bottom. While loss of subsoil hydraulic conductivity through soil compaction is a concern, transport of dissolved pollutants by highly permeable subsoil is of equal concern; therefore, care must be taken when using fertilizers and herbicides upgradient of a small-scale infiltration basin.

Additionally, due to the potential for groundwater contamination, the use of small-scale infiltration basins, and all stormwater infiltration best management practices (BMPs), is prohibited in areas where high pollutant or sediment loading is anticipated. For more information regarding stormwater runoff that may not be infiltrated, refer to N.J.A.C. 7:8-5.4(b)3. However, this prohibition is limited only to areas onsite where this type of loading is expected. Additionally, small-scale infiltration basins may only be used on these types of sites provided the location of the small-scale infiltration basin is not inconsistent with a remedial action work plan or landfill closure plan.

Discharge from small-scale infiltration basins of the smaller storm events occurs through the subsoil; therefore, they may not be used where their installation would create a significant risk of adverse hydraulic impacts. These impacts may include exacerbating a naturally or seasonally high water table so as to cause surficial ponding, flooding of basements, or interference with the proper operation of a subsurface sewage disposal system or other subsurface structure, or where their construction will compact the subsoil. Hydraulic impacts on the groundwater table must be assessed. For more information on groundwater mounding analysis, refer to *Chapter 13: Groundwater Table Hydraulic Impact Assessments for Infiltration BMPs* and the *USGS Paper on Assessment of Impacts* link on the *Additional Guidance Documents* page at www.njstormwater.org.

Finally, a small-scale infiltration basin must have a maintenance plan and must be reflected in a deed notice recorded in the county clerk's office to prevent alteration or removal.

Applications

Pursuant to N.J.A.C. 7:8-5.2(a)(2), the minimum design and performance standards for groundwater recharge, stormwater runoff quality and stormwater runoff quantity at N.J.A.C. 7:8-5.4, 5.5 and 5.6 shall be met by incorporating green infrastructure in accordance with N.J.A.C. 7:8-5.3.

Small-scale infiltration basins may be designed to reduce peak runoff rates when designed as an on-line system in combination with an extended detention basin; however, regardless of the design storm chosen, all small-scale infiltration basins must be designed for stability and in accordance with the *Standards for Soil Erosion and Sediment Control in New Jersey*.

Small-scale infiltration basins may be used to meet the groundwater recharge requirements of the Stormwater Management rules found at N.J.A.C. 7:8. For more information on computing groundwater recharge, see *Chapter 6: Groundwater Recharge.*

To merit the approved TSS removal rate of 80%, small-scale infiltration basins must be designed to treat the Water Quality Design Storm (WQDS) and in accordance with all of the following criteria.

Design Criteria

Basic Requirements

A small-scale infiltration basin may be designed as a surface or subsurface system. The following criteria apply to both configurations. Design criteria specific to small-scale surface infiltration basins may be found beginning on Page 10; design criteria specific to small-scale subsurface infiltration basins may be found beginning on Page 13. Additional requirements for the extended detention option may be found beginning on Page 8.

Contributory Drainage Area

- Pursuant to N.J.A.C. 7:8-5.3(b), the maximum contributory drainage area to a small-scale infiltration basin is 2.5 acres.
- The entire contributory drainage area must be completely stabilized prior to use of the small-scale infiltration basin.

Inflow

- All inflow must be stable and non-erosive and must be consistent with the *Standards for Soil Erosion and Sediment Control in New Jersey*.

Storage Volume

- Small-scale infiltration basins may be constructed as either off-line or on-line systems. In off-line systems, most, or all, of the runoff from storms larger than the Water Quality Design Storm (WQDS) bypass the infiltration basin through an upgradient diversion; this reduces the size of the required basin storage volume, the system's long-term pollutant loading and associated maintenance. On-line systems receive stormwater runoff from all storms events; they provide treatment for the WQDS and they convey the runoff from larger storms through an overflow. These on-line systems store and attenuate flow produced by the larger storm events and provide stormwater runoff quantity control; in such systems, the invert of the lowest quantity control outlet is set at the water surface elevation of the WQDS. Further details are provided beginning on Page 8 under the sub-heading *Requirements for Extended Detention Option.*
- The system must have sufficient storage volume to contain the WQDS stormwater runoff volume without overflow.

- Exfiltration can be used in the design of a small-scale infiltration basin, provided all of the conditions regarding the use of exfiltration in stormwater runoff calculations, as published in *Chapter 5: Stormwater Management Quantity and Quality Standards and Computations* are met. This information is published in the section beginning on Page 7 of *Chapter 5*, entitled "*Conditions Regarding the Use of Exfiltration in Stormwater Runoff Calculations*."

- Small-scale infiltration basins are intended to be free of standing water between storm events in order to allow for sufficient storage for the next rain event; therefore, the drain time for standing water present on the surface of the basin bottom or in the overflow structure must not exceed 72 hours after any rain event. Storage times in excess of 72 hours may render a small-scale infiltration basin ineffective and may result in anaerobic conditions, odor, and both stormwater quality and mosquito breeding issues. If the small-scale infiltration basin is installed in an area subject to pedestrian traffic, such as sidewalk or pedestrian accessible area in parking lot, the drain time should be reduced to 24 hours.

Geometry

- Small-scale infiltration basins may not be constructed in areas where the surrounding slopes are 15% or greater.

- The area of the basin intended for infiltration, or footprint, must be as level as possible in order to uniformly distribute runoff infiltration into the subsoil.

- The system must have a sufficient surface area to prevent the accumulated volume of stormwater runoff from exceeding the maximum depth requirement, which is specific to the type of small-scale infiltration basin. More information is found on Page 12 for surface type small-scale infiltration basins.

- The seasonal high water table (SHWT) or bedrock must be at least 2 feet below the lowest extent of the basin bottom. In surface basins, this distance is measured from the bottom of the sand layer.

Permeability Rates

- The use of small-scale infiltration basins for stormwater management is only feasible where the subsoil is sufficiently permeable to meet the minimum permeability rate as stated below.

- Soil tests are required at the exact location of the proposed basin in order to confirm its ability to function as designed. A minimum of two soil profile pits are required within the infiltration area of any proposed small-scale infiltration basin. Take note that permits may be required for soil testing in regulated areas, such as areas regulated under the Flood Hazard Area Control Act Rules (N.J.A.C. 7:13), the Freshwater Wetlands Protection Act Rules (N.J.A.C. 7:7A), the Coastal Zone Management Rules (N.J.A.C. 7:7) and the Highlands Water Protection and Planning Rules (N.J.A.C. 7:38).

- The testing of all permeability rates must be consistent with *Chapter 12: Soil Testing Criteria* in this manual, including the required information to be included in the soil logs, which can be found in section *3.b Soil Logs*. In accordance with N.J.A.C. 7:9A-6.2(j)1, *Standards for Individual Subsurface Sewage Disposal Systems*, the slowest tested permeability must be used for design purposes.

- Since the actual permeability rate may vary from soil testing results and may decrease over time, a factor of safety of 2 must be applied to the slowest tested permeability rate to determine the design permeability rate. The design permeability rate would then be used to compute the basin's drain time for the maximum design volume. The drain time is defined as the time it takes to fully infiltrate the maximum design storm runoff volume through the most hydraulically restrictive layer.
- The maximum design permeability rate is 10 inches/hour for any tested permeability rate of 20 inches/hour or more.
- The minimum design permeability rate of the subsoil is 0.5 inches/hour, which equates to a minimum tested permeability rate of 1.0 inch/hour.
- As with any infiltration BMP, groundwater mounding impacts must be assessed, as required by N.J.A.C. 7:8-5.2(h). This includes an analysis of the reduction in permeability rate when groundwater mounding is present to confirm the system will drain within 72 hours after the precipitation stops.
    - □ Additional trials may be required, including using a reduced recharge rate in accordance with the method published in *Chapter 5*, should the calculations demonstrate an adverse impact is produced. Refer to the information labeled "*Steps to Follow When an Adverse Impact is Encountered*" found on Page 53 of *Chapter 5*.
    - □ Where the mounding analysis identifies adverse impacts, the small-scale infiltration basin must be redesigned or relocated, as appropriate. The mounding analysis must provide details and supporting documentation on the methods used and assumptions made, including values used in calculations. For further information on the required groundwater mounding assessment, *see Chapter 13*.

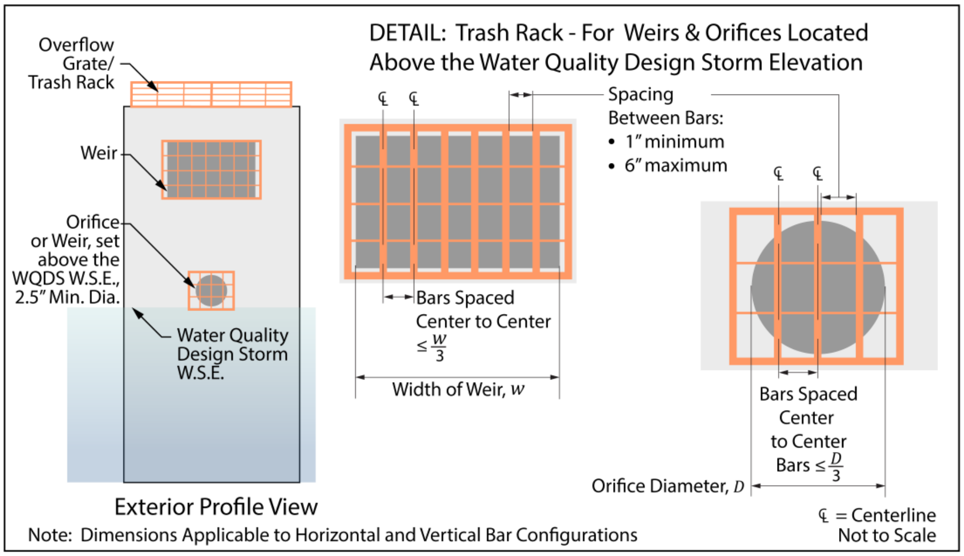
Safety

- All small-scale infiltration basins must be designed to safely convey overflows to downstream drainage systems. The design of any overflow structure must be sufficient to provide safe, stable discharge of stormwater in the event of an overflow. Safe and stable discharge minimizes the possibility of adverse impacts, including erosion and flooding in down-gradient areas. Therefore, discharge in the event of an overflow must be consistent with the Standards for Off-Site Stability found in the *Standards for Soil Erosion and Sediment Control in New Jersey*.
- Small-scale infiltration basins that are classified as dams under the NJDEP Dam Safety Standards at N.J.A.C. 7:20 must meet the overflow requirements under these regulations. Overflow capacity can be provided by a hydraulic structure, such as a weir or orifice, or a surface feature, such as a swale or open channel.

Outlet Structure

- Trash racks must be installed at the intake to the outlet structure. They must meet the following criteria and the detail below illustrates these requirements:
    - □ Parallel bars with 1-inch spacing between the bars up to the elevation of the WQDS;
    - □ Parallel bars higher than the elevation of the WQDS must be spaced no greater than one-third the width of the diameter of the orifice or one-third the width of the weir, with minimum spacing between bars of 1 inch and a maximum spacing between the bars of six inches;
    - □ The trash rack must be designed so as not to adversely affect the hydraulic performance of the outlet pipe or structure;
    - □ Constructed of rigid, durable and corrosion-resistant material; and

□ Designed to withstand a perpendicular live loading of 300 lbs/sf.



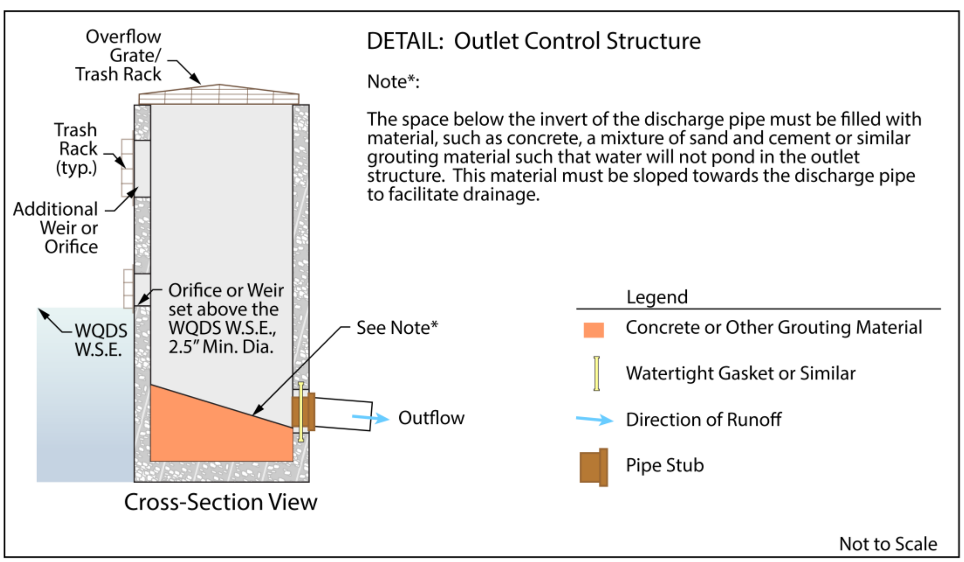
- An overflow grate is designed to prevent obstruction of the overflow structure. If an outlet structure has an overflow grate, the grate must comply with the following requirements:

  □ The overflow grate must be secured to the outlet structure but removable for emergencies and maintenance;

  □ The overflow grate spacing must be no greater than 2 inches across the smallest dimension; and

  □ The overflow grate must be constructed of rigid, durable and corrosion resistant material and designed to withstand a perpendicular live loading of 300 lbs./sf.

- The space below the invert of the discharge pipe must be filled with material, such as concrete, a mixture of sand and cement, or similar grouting material, such that water will not pond in the outlet structure. This material must be sloped towards the discharge pipe to facilitate drainage, as shown in the detail below.



- The minimum diameter of any overflow orifice is 2.5 inches.

- Blind connections to down-gradient facilities are prohibited. Any connection to down-gradient stormwater management facilities must include access points such as inspections ports and manholes, for visual inspection and maintenance, as appropriate, to prevent blockage of flow and ensure operation as intended. All entrance points must adhere to all State, County and municipal safety standards such as those for confined space entry.

- In instances where the lowest invert in the outlet or overflow structure is below the flood hazard area design flood or tide elevation in a down-gradient waterway or stormwater collection system, the effects of tailwater on the hydraulic design of the overflow system, as well as any stormwater quantity control outlets must be analyzed. Two methods to analyze tailwater are:

  - A simple method entails inputting flood elevations for the 2-, 10- and 100-year events as static tailwater during routing calculations for each storm event. These flood elevations are either obtained from a Department flood hazard area delineation or a FEMA flood hazard area delineation that includes the 100-year flood elevation or derived using a combination of NRCS hydrologic methodology and a standard step backwater analysis or level pool routing, where applicable. In areas where the 2-year or 10-year flood elevation does not exist in a FEMA or Department delineation, it may be interpolated or extrapolated from the existing data. If this method demonstrates that the requirements of the regulations are met with the tailwater effect, then the design is acceptable. If the analysis shows that the requirements are not met with the tailwater effects, the detailed method below can be used or the BMP must be redesigned.

  - A detailed method entails the calculation of hydrographs for the watercourse during the 2-, 10- and 100-year events using NRCS hydrologic methodology. These hydrographs are input into a computer program to calculate rating curves for each event. Those rating curves are then input as a dynamic tailwater during the routing calculations for each of the 2-, 10- and 100-year events. This method may be used in all circumstances; however, it may require more advanced computer programs. If this method demonstrates that the requirements of the regulations are met with the tailwater effect, then the design is acceptable. If the analysis shows that the requirements are not met with the tailwater effects, the BMP must be redesigned.

Construction Requirements

- During clearing and grading of the site, measures must be taken to eliminate soil compaction at the location of a proposed small-scale infiltration basin.

- The location of the proposed small-scale infiltration basin must be cordoned off during construction to prevent compaction of the subsoil by construction equipment or stockpiles.

- The use of the location proposed for a small-scale infiltration basin to provide sediment control during construction is discouraged; however, when unavoidable, excavation for the sediment control basin must be at least 2 feet above the final design elevation of the basin bottom.

- Excavation and construction of a small-scale infiltration basin must be performed using equipment placed outside the limits of the basin.

- The excavation to the final design elevation of the small-scale infiltration basin bottom may only occur after all construction within its contributory drainage area is completed and the contributory drainage area is stabilized. If construction of the small-scale infiltration basin cannot be delayed, berms must be placed around the perimeter of the basin during all phases of construction to divert all flows away from the basin. The berms may not be removed until all construction within the contributory drainage area is completed and the area is stabilized.

- The contributing drainage area must be completely stabilized prior to small-scale infiltration basin use.

- Post-construction testing must be performed on the as-built small-scale infiltration basin in accordance with the Construction and Post-Construction Oversight and Soil Permeability Testing section in *Chapter 12* of this manual. Where as-built testing shows a longer drain time than designed, corrective action must be taken. The drain time is defined as the time it takes to fully infiltrate the maximum design storm runoff volume through the most hydraulically restrictive layer.

Access Requirements

- An access roadway must be included in the design to facilitate monitoring and maintenance. If the access roadway is constructed of impervious material, take note that it may be subject to the stormwater runoff quality, quantity and/or groundwater recharge requirements at N.J.A.C. 7:8-5.4, 5.5 and 5.6.

- Additional steps may be necessary to eliminate vehicular intrusion into the basin, such as from all-terrain vehicles and utility trucks.

Requirements for Extended Detention Option

A small-scale infiltration basin may be constructed as part of an on-line, combination system to provide extended detention for larger storms. Such a system could include a level-graded infiltration zone such as that defined by a smaller contour, oval or other discrete area within the basin bottom. Runoff up to the WQDS water surface elevation is temporarily stored and exits the system through infiltration into the subsoil. Runoff in excess of this elevation exits the system through various quantity control devices in the outlet structure. Keep in mind that too small of an infiltration zone is likely to experience groundwater mounding impacts, as discussed in *Chapter 13*.

Storage Volume

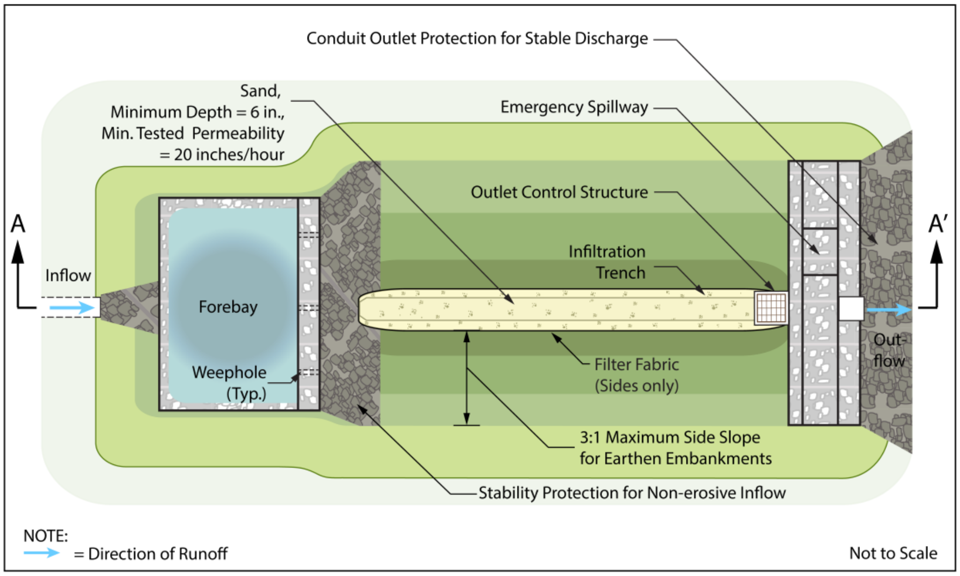
- Small-scale infiltration – extended detention basins may be designed to treat and temporarily store stormwater runoff produced by both small storms, such as the WQDS and larger storms such as the 2-, 10- and 100-year design storms.

- Exfiltration can be used in the design of a small-scale infiltration basin designed to provide extended detention for stormwater runoff quantity control, provided all of the conditions regarding the use of exfiltration in stormwater runoff calculations published in *Chapter 5* are met. This information is published in the section beginning on Page 7 of *Chapter 5*, entitled "*Conditions Regarding the Use of Exfiltration in Stormwater Runoff Calculations*."

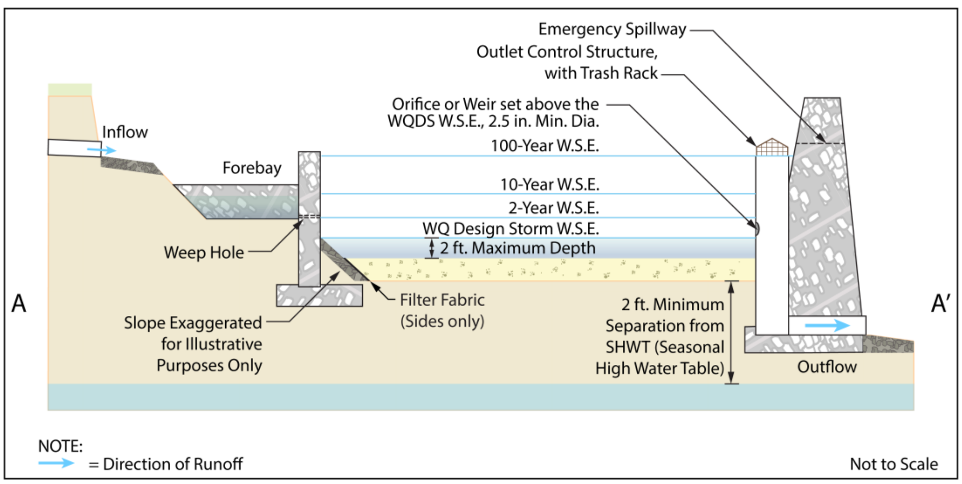
- For additional information on the design, operation and maintenance of the extended detention components, refer to *Chapter 11.2*: *Extended Detention Basins.*

  The following illustrations depict a surface infiltration – extended detention basin in both plan and profile views; a concrete forebay was selected to provide pretreatment. Although not shown, stormwater quantity control outlets are provided at the water surface elevations of the 2-, 10- and 100-year storm events. To prevent the accumulation of stormwater runoff from exceeding the 2 foot maximum depth limit, an orifice is set at the water surface elevation of the WQDS. For additional information on the design, operation and maintenance of the extended detention components, refer to *Chapter 11.2*: *Extended Detention Basins*.

Small-scale Infiltration - Extended Detention Basin: Plan View



Small-scale Infiltration – Extended Detention Basin: Profile View



Types of Small-Scale Infiltration Basins

There are two types of small-scale infiltration basins:

1. Small-Scale Surface Infiltration Basins
2. Small-Scale Subsurface Infiltration Basins

Individual Types of Small-Scale Infiltration Basins

The following section provides detailed design criteria for each type of small-scale infiltration basin. The illustrations depict possible configurations and flow paths and are not intended to limit the design.

Small-Scale Surface Infiltration Basins

Pretreatment for Small-Scale Surface Infiltration Basins

- Pretreatment is a requirement for small-scale infiltration basins that include exfiltration in the stormwater routing calculations for the 2-, 10- and 100-year design storms.

- Pretreatment may consist of a forebay or any of the BMPs found in *Chapters 9 or 11.*

- There is no adopted TSS removal rate associated with forebays; therefore, their inclusion in any design should be solely for the purpose of facilitating maintenance. Forebays may be earthen, constructed of riprap, or made of concrete and must comply with the following requirements:

    - The forebay must be designed to prevent scour of the receiving basin by outflow from the forebay.
    - The forebay should provide a minimum storage volume of 10% of the WQDS and be sized to hold the sediment volume expected between clean-outs.
    - The forebay should fully drain within nine hours in order to facilitate maintenance and to prevent mosquito issues. Under no circumstances should there be any standing water in the forebay 72 hours after a precipitation event.
    - Surface forebays must meet or exceed the sizing for preformed scour holes in the *Standard for Conduit Outlet Protection* in the *Standards for Soil Erosion and Sediment Control in New Jersey* for a surface forebay.
    - If a concrete forebay is utilized, it must have at least two weep holes to facilitate low level drainage.

- When using another BMP for pretreatment, it must be designed in accordance with the design requirements outlined in its respective chapter. For additional information on the design requirements of each BMP, refer to the appropriate chapter in this manual.

- Any roof runoff that discharges to the small-scale infiltration basin may be pretreated by leaf screens, first flush diverters or roof washers. For details of these pretreatment measures, see Pages 5 and 6 of *Chapter 9.1: Cisterns.*

- The pretreatment requirement for roof runoff can be waived by the review agency if the building in question has no potential for debris and other vegetative material to be present in the roof runoff. For example, a building that is significantly taller than any surrounding trees and does not have vegetative roof should not need the pretreatment. However, in making this determination, the review agency must consider the mature height of any surrounding trees.

Geometry

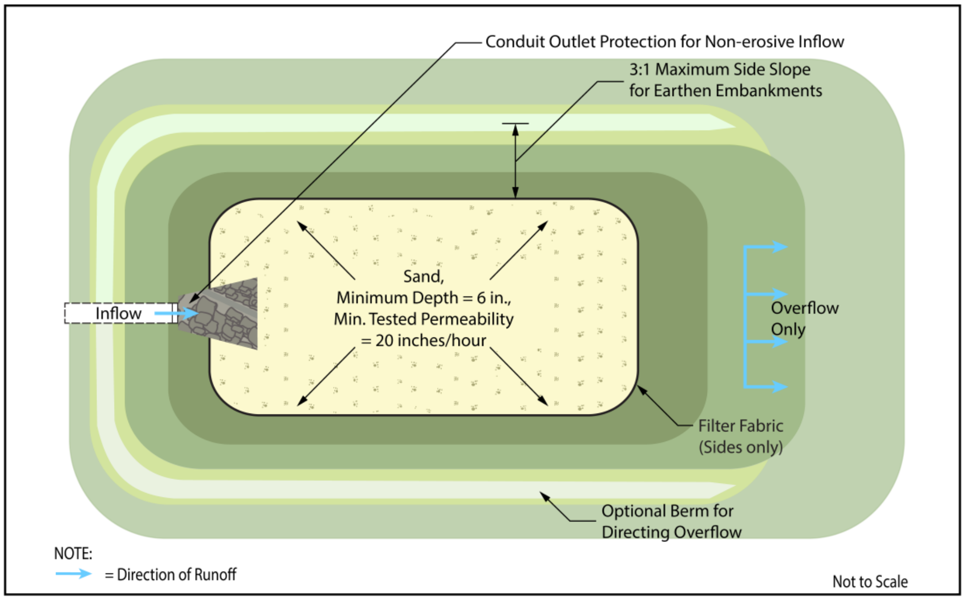
- The maximum interior slope for an earthen dam, embankment or berm is 3:1.
- The vertical distance between the upper surface of the basin bottom and the WQDS water surface elevation must be no greater than 2 feet. This distance is also referred to as the maximum depth of stormwater runoff to be infiltrated.

Sand Layer

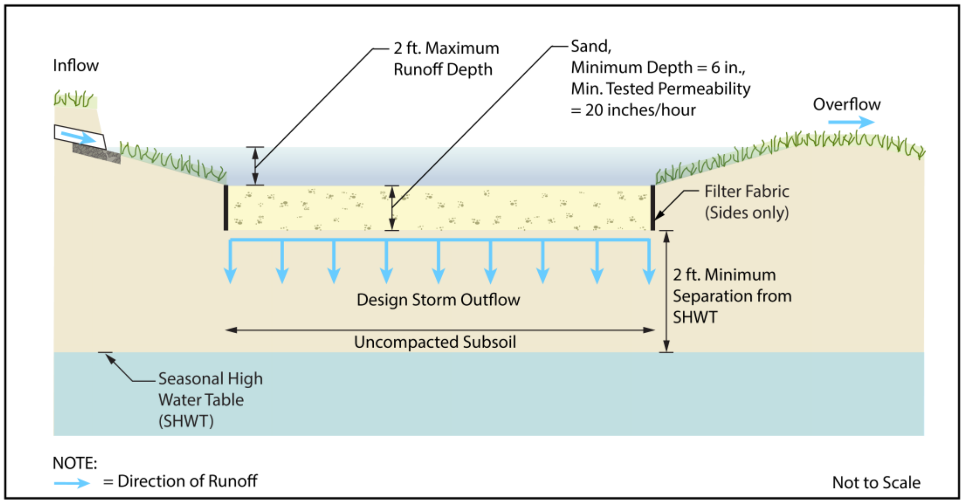
- To ensure that the design permeability rate is maintained over time, a sand layer is required at the bottom of every surface type of small-scale infiltration basin.
- The minimum depth is 6 inches.
- The sand must meet all the specifications for clean, medium-aggregate concrete sand in accordance with AASHTO M-6 or ASTM C-33, as certified by a professional engineer licensed in the State of New Jersey.
- The maximum percentage of fines is 15%.
- The minimum tested permeability rate is 20 inches/hour.
- The use of topsoil and vegetation is prohibited. If a vegetated BMP is desired, refer to *Chapter 10.1: Bioretention Systems (Large-scale)* or *Chapter 9.7: Small-scale Bioretention Systems*.
- Filter fabric is required along the sides of the small-scale infiltration basin to prevent the migration of fine particles from the surrounding soil; filter fabric may not be used along the bottom of the basin because it may result in a loss of permeability.

The following graphics depict a small-scale surface infiltration basin in both plan and profile view. These illustrations show possible configurations and flow paths and are not intended to limit the design.

Small-Scale Surface Infiltration Basin – Plan View



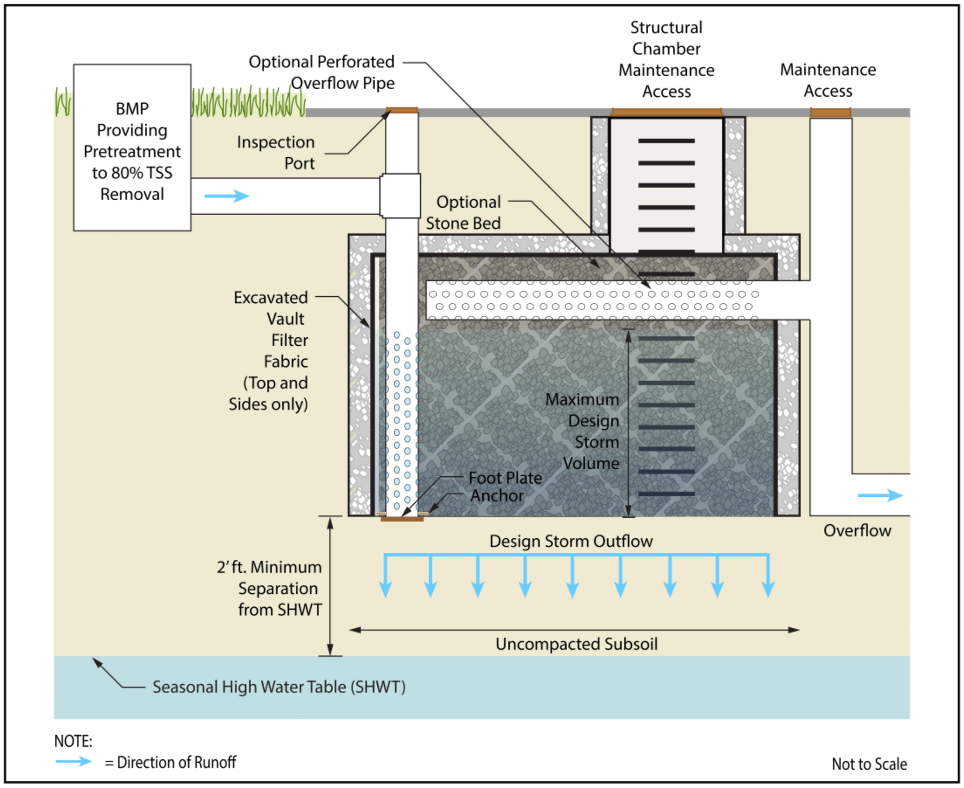
Small-Scale Surface Infiltration Basin – Profile View



Small-Scale Subsurface Infiltration Basins

A small-scale subsurface infiltration basin may consist of a vault, or a network of one or more perforated pipes, either of which may include a stone bed. A typical subsurface infiltration basin constructed as a vault is depicted in the following illustration as an example, but it is not intended to limit the design configuration. Design criteria specific to this type of small-scale infiltration basin immediately follows.

Small-Scale Subsurface Infiltration Basin – Profile View



Pretreatment for Small-Scale Subsurface Infiltration Basins

- Pretreatment is required on all small-scale subsurface infiltration basins.
- Roof runoff that directly discharges into the small-scale subsurface infiltration basin can be pretreated by leaf screens, first flush diverters or roof washers. For details of these pretreatment measures, see Pages 5 and 6 of *Chapter 9.1: Cisterns*.
  - This pretreatment requirement can be waived by the review agency if the building in question has no potential for debris and other vegetative material to be present in the roof runoff. For example, a building that is significantly taller than any surrounding trees and does not have vegetative roof should not need the pretreatment. However, in making this determination, the review agency must consider the mature height of any surrounding trees.

- Pretreatment for non-roof runoff, or roof runoff comingled with stormwater from other surfaces, must remove 80% of the total suspended solids (TSS) in the runoff generated by the WQDS.
- Pretreatment may consist of any of the BMPs found in *Chapters 9 or 11.*
- When using another BMP for pretreatment, it must be designed in accordance with the design requirements outlined in its respective chapter. For additional information on the design requirements of each BMP, refer to the appropriate chapter in this manual.

Component Requirements for Small-Scale Subsurface Infiltration Basins

- Filter fabric is required along the top and sides of a small-scale subsurface infiltration basin to prevent the migration of fine particles from the surrounding soil, unless the basin is enclosed in an impermeable structural housing. Filter fabric may not be used along the bottom of the basin because it may result in a loss of permeability.
- Any aggregate used in a small-scale subsurface infiltration basin must be free from debris, silt or other material that could contribute to clogging.

Access Requirements

- At least one inspection port that extends into the subsoil must be provided in the area of the small-scale infiltration basin to monitor the functionality of the basin. The location of the inspection port must be shown in the maintenance plan. Additionally, the maximum design storm depth of stormwater runoff must be marked on the structure and its level included in the design report and maintenance plan.
- All points of access must also be covered in such a way as to prevent sediment or other material from entering the system and to prevent the accumulation of standing water, which could lead to mosquito breeding.

Designing a Small-Scale Infiltration Basin

The following examples show how to design various small-scale infiltration basins to treat the runoff generated by the WQDS. The examples below are two of many possible ways to configure these basins and are not intended to limit the design.

Example 1: For one acre of regulated motor vehicle surface, design a small-scale infiltration basin to infiltrate the runoff generated by the WQDS. Runoff will receive pretreatment by a forebay designed in accordance with the criteria established in this chapter. Runoff volumes in excess of the WQDS generated volume will discharge via an emergency spillway. The following parameters apply:

Inflow Drainage Area =	1 ac (100% impervious)
Pavement NRCS Curve Number (CN) =	98
Tested Sand Permeability Rate =	40 in/hr
Tested Subsoil Permeability Rate =	8 in/hr
Maximum Depth of Runoff to be Infiltrated =	2 ft
Sand Layer Depth =	6 in

Step 1: Runoff Calculations

Using the NRCS method described in the *National Engineering Handbook, Part 630* (*NEH*) discussed in *Chapter 5*, the runoff volume for the WQDS was calculated to be 3,755 cf.

Step 2: Forebay Sizing

The forebay must be sized to hold 10% of the WQDS volume. Assuming the depth of water in the forebay is equal to 1 ft, a square forebay with a width of 20 ft and a length of 20 ft will provide adequate storage volume. In order to facilitate drainage, the bottom of the forebay must be elevated above the sand layer in the small-scale infiltration basin; in addition, the perforations in the riser pipe must be designed to ensure that the forebay will drain within 9 hours.

Step 3: Small-Scale Infiltration Basin Sizing

When designing a small-scale infiltration basin, the permeability rate of the subsoil is usually the limiting factor in the design of the system, as is demonstrated in the following analysis. The tested permeability rate of the sand layer is reduced by a safety factor of 2; however, the resulting 20 inches/hour design permeability rate cannot be used in calculations because the maximum design permeability rate allowed is 10 in/hr. As stated, the subsoil has a tested permeability rate of 8 in/hr, which is reduced by the same safety factor to yield the design permeability rate of 4 in/hr; therefore, the design permeability rate of the subsoil will be used in sizing calculations for the bottom of the basin, also known as the infiltration area.

The design soil permeability rate, 4 in/hr, is used for the exfiltration rate in the routing calculation. The maximum depth of stormwater runoff, situated above the sand bed cannot exceed 2 ft. Sizing an infiltration basin with exfiltration as a means of discharge is a trial and error process because the size of the basin footprint is related to the stormwater runoff volume temporarily stored above the sand bed, and it is this volume that is exfiltrated during the routing. Adjusting the basin size will change the drain time, which will further change the exfiltration volume that will, in turn, affect the volume of stormwater runoff temporarily located above the sand bed.

An initial routing calculation for the basin is performed. It is assumed the basin shape is a rectangular prism with vertical sides.

Summary Report:

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Inflow Area =      43,560 sf,100.00% Impervious,  Inflow Depth =  1.03"
Inflow     =     2.66 cfs @    1.13 hrs,  Volume=          3,755 cf
Outflow    =     0.14 cfs @    0.75 hrs,  Volume=          3,755 cf,  Atten= 95%,  Lag= 0.0 min
Discarded =      0.14 cfs @    0.75 hrs,  Volume=          3,755 cf

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 2.00' @ 1.94 hrs   Surf.Area= 1,500 sf   Storage= 3,005 cf

Plug-Flow detention time= 187.9 min calculated for 3,752 cf (100% of inflow)
Center-of-Mass det. time= 188.1 min ( 261.2 - 73.1 )
```

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	4,500 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	1,500	0	0
1.00	1,500	1,500	1,500
2.00	1,500	1,500	3,000
3.00	1,500	1,500	4,500

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**4.00 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.14 cfs @ 0.75 hrs HW=0.04' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.14 cfs)

Source: HydroCAD® Summary Report; HydroCAD is a register trademark of HydroCAD Software Solutions LLC. Used with permission

Routing Report Excerpt:

Time (hours)	Elevation (feet)	Discarded (cfs)
1.00	0.25	0.14
1.05	0.42	0.14
1.10	0.67	0.14
1.15	0.96	0.14
1.20	1.23	0.14
1.25	1.44	0.14
1.30	1.58	0.14
1.35	1.68	0.14
1.40	1.75	0.14
1.45	1.79	0.14
1.50	1.83	0.14
1.55	1.86	0.14
1.60	1.89	0.14
1.65	1.92	0.14
1.70	1.94	0.14
1.75	1.96	0.14
1.80	1.98	0.14
1.85	1.99	0.14
1.90	2.00	0.14
1.95	**2.00**	0.14
2.00	2.00	0.14
2.05	2.00	0.14
2.10	1.99	0.14
2.15	1.98	0.14
2.20	1.97	0.14

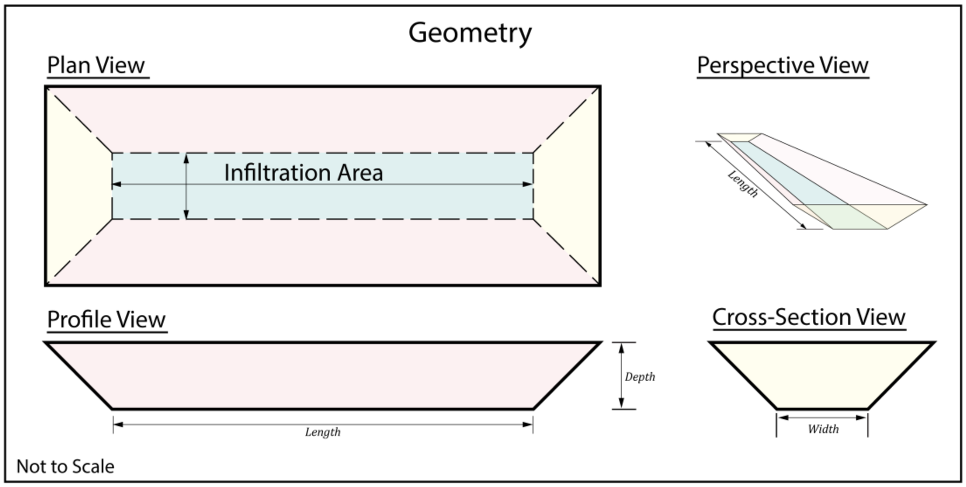
Source: HydroCAD® Report; HydroCAD is a registered trademark of HydroCAD Software Solutions LLC. Used with permission.

The routing report excerpt depicted at left shows that the maximum depth of stormwater runoff generated by the WQDS will be 2 ft when the basin bottom area, or "footprint" is 1,500 sf.

Because the maximum slope of the earthen embankments may not be steeper than 3:1, the small-scale infiltration basin shape cannot be a simple rectangular prism. Therefore, the shape of the basin will initially be set as a trapezoidal prism, as shown below. The infiltration area is shown in blue, the side slopes in pink and the end slopes in yellow. The dimensions of this assumed shape can be calculated by computer programs based on the depth and side slopes.

However, the sloped sides above the 1,500 sf footprint, increase the storage volume available in the basin, meaning, the footprint can be reduced since it is geometrically related to the depth maintained. With this information, a new routing analysis was performed for a trapezoidal prism shaped basin having a footprint of 1,200 sf,and the summary report is provided on the following page.

Example 1 - Geometry



Summary Report:

Inflow Area = 43,560 sf, 100.00% Impervious, Inflow Depth = 1.03"
Inflow = 2.66 cfs @ 1.13 hrs, Volume= 3,755 cf
Outflow = 0.19 cfs @ 1.89 hrs, Volume= 3,755 cf, Atten= 93%, Lag= 45.3 min
Discarded = 0.19 cfs @ 1.89 hrs, Volume= 3,755 cf

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1.80' @ 1.89 hrs Surf.Area= 2,045 sf Storage= 2,911 cf

Plug-Flow detention time= 155.5 min calculated for 3,752 cf (100% of inflow)
Center-of-Mass det. time= 155.7 min (228.8 - 73.1)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	5,790 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	1,200	0	0
1.00	1,656	1,428	1,428
2.00	2,142	1,899	3,327
3.00	2,784	2,463	5,790

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**4.00 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.19 cfs @ 1.89 hrs HW=1.80' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.19 cfs)

Source: HydroCAD® Summary Report; HydroCAD is a registered trademark of HydroCAD Software Solutions LLC. Used with permission.

The summary above shows that with a reduced footprint of 1,200 sf, the greatest depth of stormwater runoff temporarily stored above the basin bottom is 1.8 ft, which is less than the 2 ft maximum depth of stormwater runoff requirement. An excerpt from the tabular hydrograph is provided on the following page.

Tabular Hydrograph Report Excerpt:

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Discarded (cfs)
1.00	1.20	397	0.31	0.12
1.05	1.95	658	0.50	0.13
1.10	2.52	1,036	0.75	0.14
1.15	**2.63**	1,472	1.03	0.15
1.20	2.15	1,874	1.26	0.17
1.25	1.55	2,177	1.43	0.17
1.30	1.10	2,385	1.54	0.18
1.35	0.79	2,523	1.61	0.18
1.40	0.59	2,615	1.65	0.18
1.45	0.48	2,677	1.69	0.18
1.50	0.43	2,725	1.71	0.19
1.55	0.40	2,766	1.73	0.19
1.60	0.37	2,802	1.75	0.19
1.65	0.33	2,831	1.76	0.19
1.70	0.31	2,855	1.77	0.19
1.75	0.30	2,876	1.78	0.19
1.80	0.29	2,895	1.79	0.19
1.85	0.24	2,908	1.80	0.19
1.90	0.17	**2,911**	**1.80**	**0.19**
1.95	0.13	2,904	1.80	0.19
2.00	0.11	2,892	1.79	0.19

Source: HydroCAD® Report; HydroCAD is a registered trademark of HydroCAD Software Solutions LLC. Used with permission.

Step 4: Estimated Drain Time Calculation

As previously stated, the drain time of the basin is determined by the design permeability rate of the subsoil. Note that only the infiltration area, i.e. the footprint, can be credited for infiltration, meaning infiltration may not be applied to the side slopes. The drain time calculation is based on the area of the footprint, which is 1,200 sf.

$$Drain\ Time = \frac{WQDS\ Volume}{Infiltration\ Area\ \ x\ \ Design\ Permeability\ Rate}$$

$$= \frac{3{,}755\ cf\ x\ (12\ in/ft)}{(1{,}200\ sf\ \ x\ 4\ in/hr)} = 9.39\ \text{hr}$$

Since this is less than the allowable maximum drain time of 72 hours, the small-scale infiltration basin has been sized correctly, on an initial basis, to ensure the surface and sand layer are fully drained within the maximum allowable time frame.

Step 5: Check Separation from SHWT

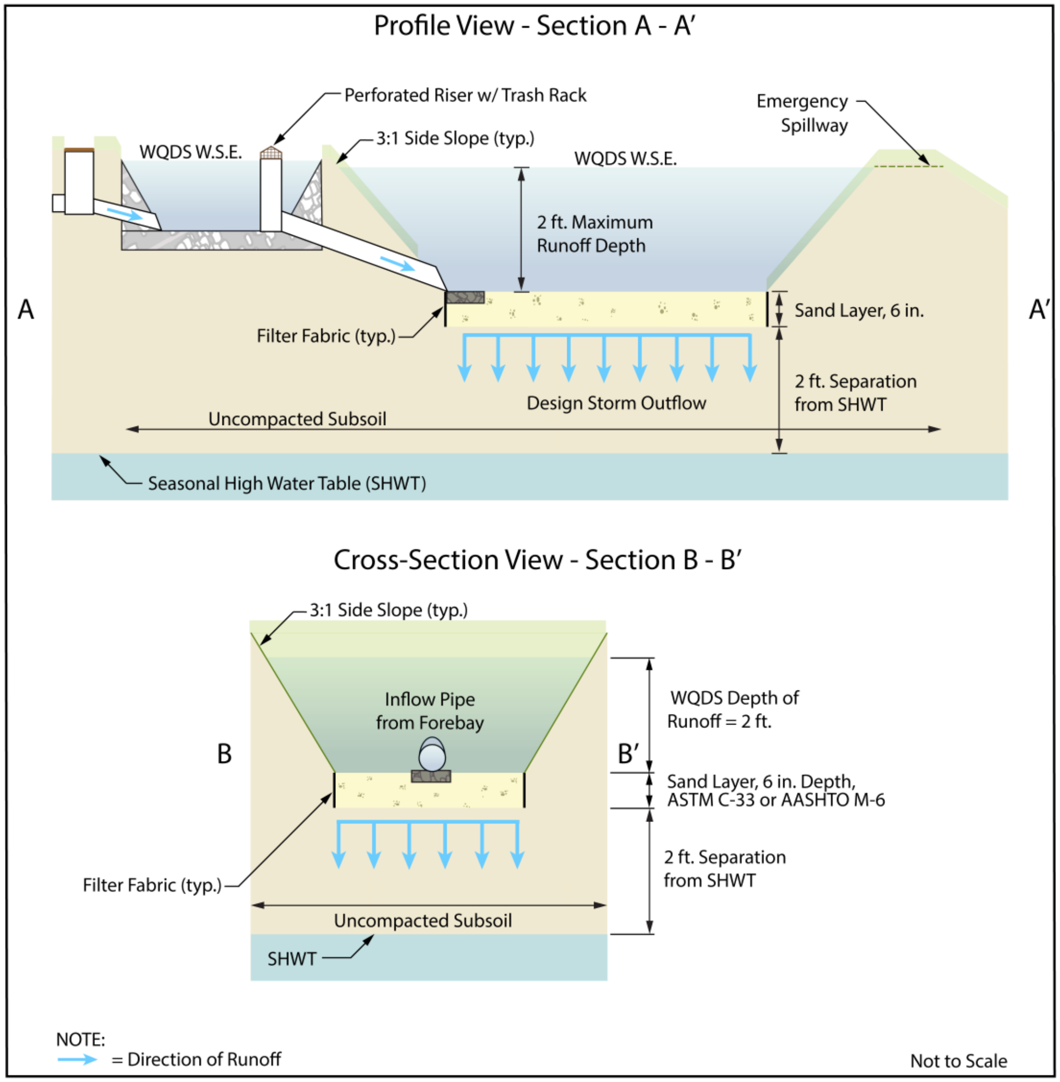
The vertical distance between the lowest elevation of the sand layer and the SHWT must be checked to ensure it meets the minimum requirements. By inspection, the required 2 foot separation from the SHWT is provided.

Step 6: Groundwater Mounding Analysis

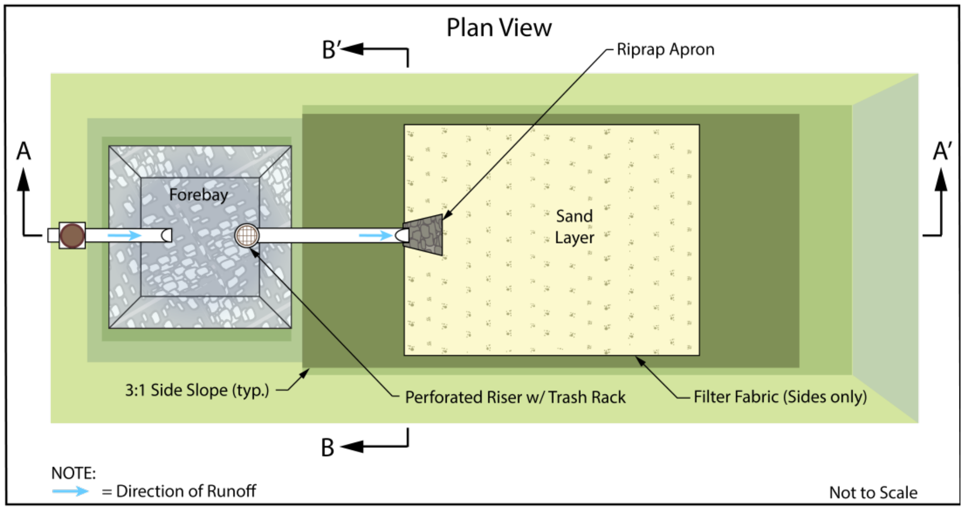
Calculate the height of the groundwater mound caused by infiltration to ensure that it will neither prevent infiltration nor damage nearby structures. For information on conducting a groundwater mounding analysis, see *Chapter 13: Groundwater Table Hydraulic Impact Assessments for Infiltration BMPs*. For this example, it is assumed the design meets the necessary groundwater mound requirements.

Illustrations for this example, exclusive of any refinements, are shown below and on the following page.

Example 1 – Profile and Cross-Section View



Example 1 – Plan View



Example 2: Using the following parameters, design a small-scale subsurface infiltration basin sized both for the WQDS and to provide groundwater recharge. Assume the site is not in an Urban Redevelopment Area. Assume pretreatment to provide 80% TSS removal is provided by an appropriate BMP or MTD.

Inflow Contributory Drainage Area =	1 ac
Existing Conditions:	
Cover = Office Building -	25% Directly Connected Impervious Cover and 75% Lawn and Landscaping Areas
Proposed Conditions:	
Cover = Auto Dealership -	75% Directly Connected Impervious Cover and 25% Lawn and Landscaping Areas
Lawn NRCS Curve Number (CN) =	49
Pavement NRCS Curve Number (CN) =	98
Tested Subsoil Permeability Rate =	4 in/hr
Elevation of the SHWT =	10 ft below the surface

Step 1: Runoff Calculations

Using the NRCS method described in *National Engineering Handbook, Part 630* (*NEH*) and discussed in the NRCS Methodology section of *Chapter 5*, the post-construction runoff volume from the proposed 0.75 acre impervious surface is calculated to be 2,817 cf.

Step 2: Design Volume Calculations

The *New Jersey Groundwater Recharge Spreadsheet* (NJGRS) is used to calculate the amount of groundwater recharge required. Land cover is changed from 25% impervious in the existing condition to 75% in the proposed, resulting in a post-development annual recharge deficit of 20,499 cf, as shown in the following image of the *Annual Recharge Worksheet*:

Example 2 – Post-Development Annual Recharge Deficit Calculation

New Jersey Groundwater Recharge Spreadsheet
Version 2.0
November 2003

Annual Groundwater Recharge Analysis (based on GSR-32)

Select Township ↓	Average Annual P (in)	Climatic Factor
MERCER CO., HAMILTON TWP	44.9	1.43

Project Name:	Sample Project
Description:	This is a test application
Analysis Date:	09/01/03

Pre-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	0.25	Impervious areas	Woodstown	0.0	-
2	0.75	Open space	Woodstown	11.3	30,748
3	0				
4	0				
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	1.0			Total Annual Recharge (in)	Total Annual Recharge (cu-ft)
				8.5	30,748

Post-Developed Conditions

Land Segment	Area (acres)	TR-55 Land Cover	Soil	Annual Recharge (in)	Annual Recharge (cu.ft)
1	0.75	Impervious areas	Woodstown	0.0	-
2	0.25	Open space	Woodstown	11.3	10,249
3	0				
4	0				
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				
Total =	1.0			Total Annual Recharge (in)	Total Annual Recharge (cu.ft)
				2.8	10,249
				Total Impervious Area (sq.ft)	32,670

Annual Recharge Requirements Calculation ↓

% of Pre-Developed Annual Recharge to Preserve =	100%	
Post-Development Annual Recharge Deficit=	*20,499*	(cubic feet)

Recharge Efficiency Parameters Calculations (area averages)

RWC=	2.90	(in)	DRWC=	0.81	(in)
ERWC =	0.83	(in)	EDRWC=	0.23	(in)

Procedure to fill the Pre-Development and Post-Development Conditions Tables

For each land segment, first enter the area, then select TR-55 Land Cover, then select Soil. Start from the top of the table and proceed downward. Don't leave blank rows (with A=0) in between your segment entries. Rows with A=0 will not be displayed or used in calculations. For impervious areas outside of standard lots select "Impervious Areas" as the Land Cover. Soil type for impervious areas are only required if an infiltration facility will be built within these areas.

The design volume for a basin treating the WQDS is 2,817 cf. Setting the exfiltration rate to 2 in/hr, results from stormwater modeling software show that an infiltration basin with a footprint of 1,250 sf will provide the required storage volume for the stormwater runoff generated by the WQDS and will yield a maximum depth of runoff of 1.99 ft, which is less than the 2 ft maximum allowable depth. For design purposes, 1 ft of freeboard is included in the software model. The summary report and routing table excerpt are provided on the following page.

WQDS Summary Report

Inflow Area =	32,670 sf,100.00% Impervious,	Inflow Depth = 1.03"		
Inflow =	2.17 cfs @	1.09 hrs, Volume=	2,817 cf	
Outflow =	0.06 cfs @	0.65 hrs, Volume=	2,817 cf,	Atten= 97%, Lag= 0.0 min
Discarded =	0.06 cfs @	0.65 hrs, Volume=	2,817 cf	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 1.99' @ 2.05 hrs Surf.Area= 1,250 sf Storage= 2,490 cf

Plug-Flow detention time= 367.4 min calculated for 2,814 cf (100% of inflow)
Center-of-Mass det. time= 367.7 min (438.0 - 70.3)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	3,750 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
0.00	1,250	0	0
3.00	1,250	3,750	3,750

Device	Routing	Invert	Outlet Devices
#1	Discarded	0.00'	**2.00 in/hr Exfiltration over Surface area**
#2	Primary	2.00'	**2.5" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.06 cfs @ 0.65 hrs HW=0.03' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
↑**2=Orifice/Grate** (Controls 0.00 cfs)

Source: HydroCAD® Summary Report; HydroCAD is a registered trademark of HydroCAD Software Solutions LLC. Used with permission.

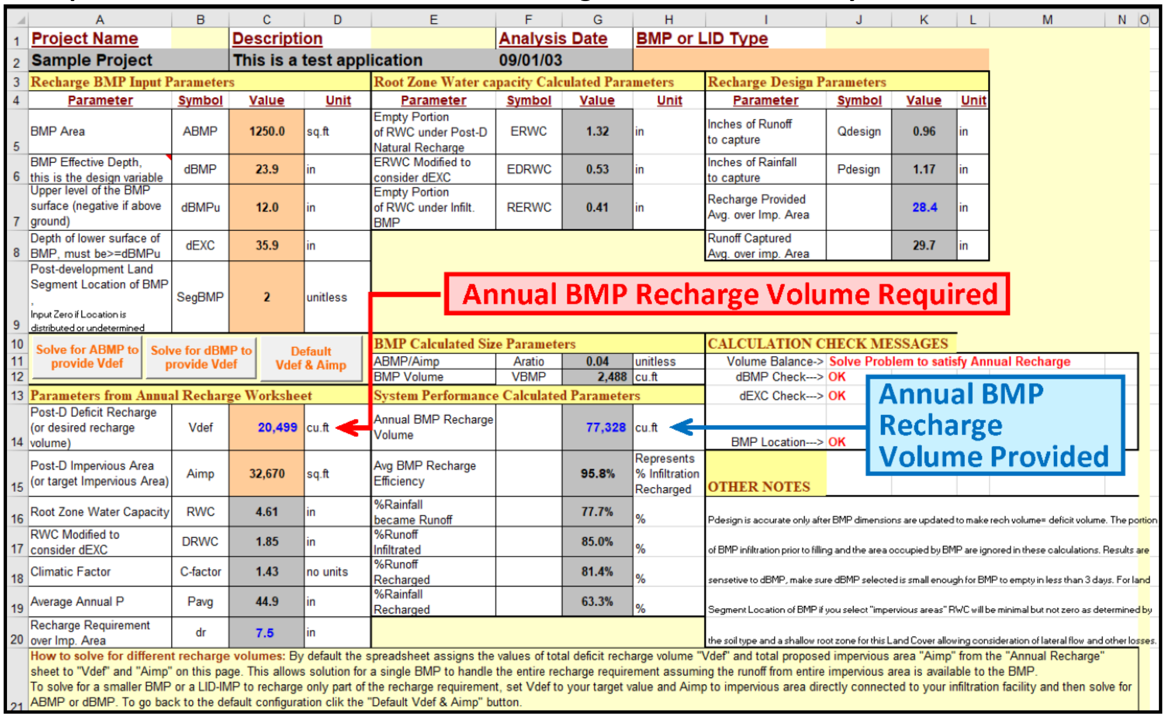
Routing Table Excerpt

Time (hours)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)
0.00	0.00	0.00	0.00
0.50	0.01	**0.02**	**0.02**
1.00	0.39	**0.06**	**0.06**
1.50	1.80	0.06	0.06
2.00	**1.99**	0.06	0.06
2.50	**1.93**	0.06	0.06
3.00	1.84	0.06	0.06
3.50	1.76	0.06	0.06
4.00	1.68	0.06	0.06
4.50	1.59	0.06	0.06

Source: HydroCAD® Routing Table; HydroCAD is a registered trademark of HydroCAD Software Solutions LLC. Used with permission.

However, the calculated area must be checked using the NJGRS to see if it is large enough to meet the annual recharge deficit requirement. To do this, first enter 1,250 for the area of the proposed small-scale infiltration basin, which is representated by the variable ABMP, in Cell C5 on the *BMP Calculations Worksheet* of the NJGRS and set the BMP Effective Depth (dBMP) to 1.99 ft x 12 in/ft = 23.88 in (Cell C6). The value to be entered in Cell C7 for dBMPu, which is the vertical distance from the vegetated ground surface to the maximum water surface level in the BMP and is positive when the maximum water surface level is below the vegetated ground surface, is 12 in, which is the 1 ft of freeboard mentioned above. The next value entered is that for dEXC, which is the vertical distance from the vegetated ground surface to the top of the sand layer in the bottom of the BMP, and is equal to 23.88 in (maximum runoff depth) + 12 in (freeboard) = 35.88 in. Lastly, we must identify the post-developed condition land segment from the *Annual Recharge Worksheet* in which this BMP is located, which is represented by the variable segBMP, and is 2 in this case. The NJGRS calculates the annual BMP recharge volume provided by the proposed small-scale infiltration basin is 77,328 cf, which is greater than the deficit volume (Vdef) of 20,499 cf, as shown in the image below.

Example 2 –Calculation of Groundwater Recharge Volume Provided by the BMP



Step 3: Initial Drain Time Calculation

As previously stated, the drain time of the basin is determined by the design permeability rate of the subsoil.

$$Drain\ Time = \frac{WQDS\ Volume}{Infiltration\ Area\ \ x\ \ Design\ Permeability\ Rate}$$

$$= \frac{2{,}817\ cf\ x\ (12\ in/ft)}{(1{,}250\ sf\ \ x\ 2\ in/hr)} = 13.52\ \text{hr}$$

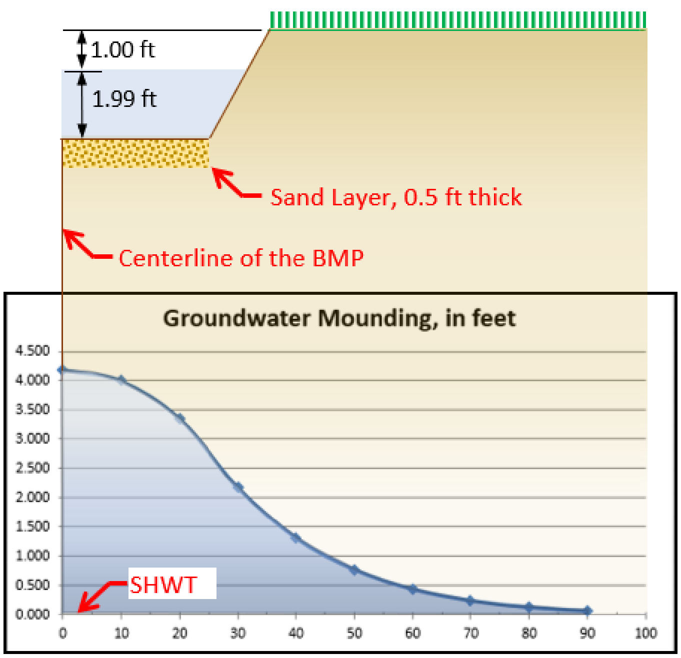
Since this is less than the allowable maximum drain time of 72 hours, the small-scale infiltration basin has been sized correctly.

Step 4: Check for Required Separation from the SHWT

The bottom of the small-scale subsurface infiltration basin must be 2 ft above the SHWT. For this example, the SHWT is located 10 ft below the surface. The basin was designed to provide storage 1.99 ft in depth for the WQDS plus an additional 1 ft of freeboard, which sets the elevation of the surface of the required sand layer at 2.99 ft below ground level. The sand layer is 0.5 ft in thickness. Therefore, the SHWT is 6.51 ft below the bottom of the sand layer, which meets the separation requirement. However, a groundwater mounding analysis is required for any infiltration practice to check whether infiltration of stormwater creates any adverse hydraulic impacts to . For the purpose of this example, assume the basin footprint measures 50 ft by 25 ft and the project area lies within the portion of Hamilton Township that is within the coastal plain. Following the requirements for using the *Hantush Spreadsheet* as addressed in *Chapter 13*, the following results were calculated.

Hantush Spreadsheet Input Values and Calculated Height of Groundwater Mounding

	A	B	C	D
6	Input Values			
7	*2.00*	***R***		Recharge rate (permeability rate) (in/hr)
8	*0.150*	Sy		Specific yield, Sy (dimensionless) default value is 0.15; max value is 0.2 provided that a lab test data is submitted
9	10.00	Kh		Horizontal hydraulic conductivity (in/hr) Kh = 5xRecharge Rate (R) in the costal plan; Kh=R outside the coastal plan
10	25.000	x		1/2 length of basin (x direction, in feet)
11	12.500	y		1/2 width of basin (y direction, in feet)
12	13.52	t		Duration of infiltration period (hours)
13	10.000	hi(0)		Initial thickness of saturated zone (feet)
14				
15	14.19	h(max)		Maximum thickness of saturated zone (beneath center of basin at end of infiltration period)
16	4.19	Δh(max)		Maximum groundwater mounding (beneath center of basin at end of infiltration period)



The maximum mounding height is 4.19 feet. In the *Hantush Spreadsheet*, the SHWT forms the x-axis. For this example, ground level is 10 ft above the SHWT, meaning, the top of the groundwater mounding will be 5.81 feet below the surface. As stated above, the surface of the basin sand layer is 2.99 ft below the adjacent ground surface. Therefore, the top of the groundwater mounding is 2.82 ft below the top of the sand layer forming the basin bottom and will not interfere with the infiltration of stormwater runoff, as depicted in the image to the right. However, the design engineer must also check if there are any underground structures within the extents of the groundwater mounding curve plotted by the *Hantush Spreadsheet*, and the temporary rise in the elevation of the groundwater table, caused by the small-scale infiltration basin, must not adversely impact any underground structure.

Considerations

When planning a small-scale infiltration basin, consideration should be given to soil characteristics, depth to the groundwater table, sensitivity of the region and inflow water quality. It is also important to note that the use of small-scale infiltration basins is recommended in this manual only where the WQDS or smaller storm events are contained below the first outlet control structure. Use of these basins to store larger volumes below the first outlet control structure should only be considered when another applicable rule or regulation requires the infiltration of a larger storm event. In such a case, the small-scale infiltration basin should be designed to store the minimum storm event required to address that rule or regulation, below the first outlet control structure.

In addition to the prohibition of recharge in the areas with high pollutant loading or with runoff exposed to source material as defined in N.J.A.C. 7:8-5.4(b)3, the utilization of small-scale infiltration basins should consider the impact of infiltration on subsurface sewage disposal systems, water supply wells, groundwater recharge areas protected under the Ground Water Quality Standards rules at N.J.A.C 7:9C, streams under antidegradation protection by the Surface Water Quality Standards rules at N.J.A.C. 7:9B, or similar facilities or areas geologically and ecologically sensitive to pollutants or hydrological changes. Furthermore, the location and minimum distance of the small-scale infiltration basin from other facilities or systems shall also comply with all applicable laws and rules adopted by Federal, State and local government entities.

Pretreatment

As with all other best management practices, pretreatment may extend the functional life and increase the pollutant removal capability of a small-scale infiltration basin by reducing incoming velocities and capturing coarser sediments. Note that pretreatment is a requirement for small-scale surface infiltration basins that include exfiltration in the stormwater routing calculations and small-scale subsurface infiltration basins. Pretreatment requirements specific to these types of infiltration basins can be found in the above section entitled *"Individual Types of Small-Scale Infiltration Basins."*

- Pretreatment may consist of a forebay or any of the BMPs found in *Chapters 9 or 11.*

- There is no adopted TSS removal rate associated with forebays; therefore, their inclusion in any design should be solely for the purpose of facilitating maintenance. Forebays may be earthen, constructed of riprap, or made of concrete and must comply with the following requirements:

    - The forebay must be designed to prevent scour of the receiving basin by outflow from the forebay.
    - The forebay should provide a minimum storage volume of 10% of the WQDS and be sized to hold the sediment volume expected between clean-outs.
    - The forebay should fully drain within nine hours in order to facilitate maintenance and to prevent mosquito issues. Under no circumstances should there be any standing water in the forebay 72 hours after a precipitation event.
    - Surface forebays must meet or exceed the sizing for preformed scour holes in the *Standard for Conduit Outlet Protection* in the *Standards for Soil Erosion and Sediment Control in New Jersey* for a surface forebay.
    - If a concrete forebay is utilized, it must have at least two weep holes to facilitate low level drainage.

- When using another BMP for pretreatment, it must be designed in accordance with the design requirements outlined in its respective chapter. For additional information on the design requirements of each BMP, refer to the appropriate chapter in this manual.

- Any roof runoff that discharges to the small-scale infiltration basin may be pretreated by leaf screens, first flush diverters or roof washers. For details of these pretreatment measures, see Pages 5 and 6 of *Chapter 9.1: Cisterns.*

    - The pretreatment requirement for roof runoff can be waived by the review agency if the building in question has no potential for debris and other vegetative material to be present in the roof runoff. For example, a building that is significantly taller than any surrounding trees and does not have vegetative roof should not need the pretreatment. However, in making this determination, the review agency must consider the mature height of any surrounding trees.

Soil Characteristics

Soils are perhaps the most important consideration for site suitability. In general, County Soil Surveys may be used to obtain necessary soil data for planning and preliminary design of small-scale infiltration basins. However, as previously mentioned, for final design and construction, soil tests are required at the exact location of the proposed basin in order to confirm its ability to function properly without failure. In order to confirm reasonable data consistency, the results of soil testing should be compared with the County Soil Survey data that was used in the computation of runoff rates and volumes and the design of on-site BMPs. If significant differences exist between the soil test results and the County Soil Survey data, additional soil tests are recommended to determine and evaluate the extent of the data inconsistency and whether there is a need for revised site runoff and BMP design computations. All significant inconsistencies should be discussed with the local Soil Conservation District prior to proceeding with such a redesign to help ensure that the final site soil data is accurate.

Geology

The presence or absence of Karst topography is an important consideration when designing a small-scale infiltration basin; in areas of the State with this type of geology, the bedrock is composed of highly soluble rock. If Karst topography is present, infiltration of runoff may lead to subsidence and sinkholes; therefore, careful consideration must be taken in these areas. For more information on design and remediation in areas of Karst topography, refer to the *Standards for Soil Erosion and Sediment Control in New Jersey: Investigation, Design and Remedial Measures for Areas Underlain by Cavernous Limestone.*

Maintenance

Regular and effective maintenance is crucial to ensure effective small-scale infiltration basin performance; in addition, maintenance plans are required for all stormwater management facilities on a major development. There are a number of required elements in all maintenance plans, pursuant to N.J.A.C. 7:8-5.8; these are discussed in more detail in *Chapter 8: Maintenance of Stormwater Management*

Measures. Furthermore, maintenance activities are required through various regulations, including the New Jersey Pollutant Discharge Elimination System (NJPDES) rules, N.J.A.C. 7:14A. Specific maintenance requirements for small-scale infiltration basins are presented below; these requirements must be included in the basin's maintenance plan.

General Maintenance

- Proper and timely maintenance is essential to continuous, effective operation; therefore, an access route must be incorporated into the design and it must be properly maintained.
- All structural components must be inspected, at least once annually, for cracking, subsidence, spalling, erosion and deterioration.
- Components expected to receive and/or trap debris and sediment must be inspected for clogging at least four times annually, as well as after every storm exceeding 1 inch of rainfall.
- Sediment removal should take place when all runoff has drained and the basin is dry.
- Disposal of debris, trash, sediment and other waste material must be done at suitable disposal/recycling sites and in compliance with all applicable local, state and federal waste regulations.
- Access points for maintenance are required on all enclosed areas within a small-scale infiltration basin; these access points must be clearly identified in the maintenance plan. In addition, any special training required for maintenance personnel to perform specific tasks, such as confined space entry, must be included in the plan.
- Stormwater BMPs may not be used for stockpiling of plowed snow and ice, compost, or any other material.

Drain Time

- The basin must be inspected at least twice annually to determine if the permeability of the basin has decreased.
- The design drain time for the maximum design storm runoff volume must be indicated in the maintenance manual.
- If the actual drain time is longer than the design drain time, the components must be evaluated and appropriate measures taken to return the small-scale infiltration basin to the original tested as-built condition.
- If the small-scale infiltration basin fails to drain the WQDS within 72 hours, corrective action must be taken and the maintenance manual revised accordingly to prevent similar failures in the future. Note that annual tilling of the sand layer, using lightweight equipment, may assist in maintaining the infiltration capacity of a surface type system by breaking up clogged surfaces.

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