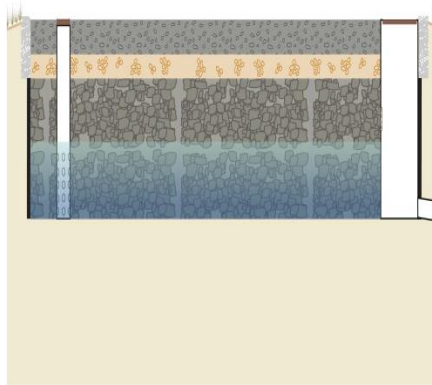






9.7 PERVIOUS PAVING SYSTEMS



A pervious paving system is a stormwater management facility used to address the impacts of land development. The system consists of a durable, permeable surface course, which allows stormwater to move through it; this surface course is placed over a transition layer and a storage bed of open-graded, meaning devoid of fine particles, aggregate. There are two types: underdrained systems and systems designed to infiltrate into the subsoil. When designed in accordance with this chapter, the total suspended solid (TSS) removal rate is 80%.

N.J.A.C. 7:8 Stormwater Management Rules - Design and Performance Standards		
	Nonstructural Strategy	Assist with Strategy #2; See Page 3
	Water Quantity	Yes
	Groundwater Recharge	Yes, for systems designed to infiltrate into the subsoil
	Water Quality	80% TSS Removal

Water Quality Mechanisms and Corresponding Criteria	
Filtering	
Porous Asphalt, Pervious Concrete and Permeable Interlocking Paver Units	6.4 inches/hour Minimum Infiltration Rate

Introduction

A pervious paving system is a stormwater management facility that filters stormwater runoff as it moves vertically through the system by either infiltrating through the void spaces in the surface course or infiltrating through the joints in paver units. The system consists of a surface course, a transition layer and a storage bed of open-graded aggregate, where runoff is temporarily stored. Discharge of runoff from pervious paving systems is either through an underdrain or through infiltration into the subsoil. In order to receive a TSS removal rate for Water Quality, these systems must be designed to treat the entire Water Quality Design Storm volume without overflow; the adopted total suspended solids (TSS) removal rate is 80%.

Permeable surface courses have many benefits, including improved traction, reduced noise and reduced surface ponding. Additionally, there is a biofilm micro-ecosystem in the system that can filter and biodegrade a wide variety of pollutants, including hydrocarbons. Finally, the moist environment in the sub-layers results in a higher temperature in the system that makes it more resistant to frost and may significantly reduce the area that needs to be de-iced.

Due to the potential for groundwater contamination, the use of pervious paving systems designed to infiltrate into the subsoil, 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(a)2.iii. However, this prohibition is limited only to areas onsite where this type of loading is expected. Additionally, pervious paving systems may only be used on these types of sites provided the location of the infiltration basin is not inconsistent with an NJDEP-approved remedial action work plan or landfill closure plan.

Systems designed to infiltrate into the subsoil 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 that results in 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 the *USGS Paper on Assessment of Impacts* link on the *Additional Guidance Documents* page at www.njstormwater.org.

Finally, pervious paving systems must have a maintenance plan and must be protected by easement, deed restriction, ordinance, or other legal measures that prevent its neglect, adverse alteration and removal.

Applications



The nonstructural stormwater management strategies design standard in the Stormwater Management rules must be addressed for all major development, pursuant to N.J.A.C. 7:8-5.3(a). The site evaluation for nonstructural strategies should consider all nine strategies. When used close to the source of stormwater runoff, the design of a pervious paving system may assist in maximizing the following strategy:

- Strategy #2: The minimization of impervious surfaces and breaking up or disconnection of the flow of runoff over impervious surfaces.



Pervious paving systems may be designed to convey storm events larger than the Water Quality Design Storm; however, regardless of the design storm chosen, all pervious paving systems must be designed for stability and in accordance with the Standards for Soil Erosion and Sediment Control in New Jersey.



Pervious paving systems designed to infiltrate into the subsoil may be used to meet the groundwater recharge requirements. For more information on computing groundwater recharge, see *Chapter 6: Groundwater Recharge*.



To receive credit for a TSS removal rate of 80%, pervious paving systems must be designed to treat the Water Quality Design Storm and in accordance with all of the following criteria.



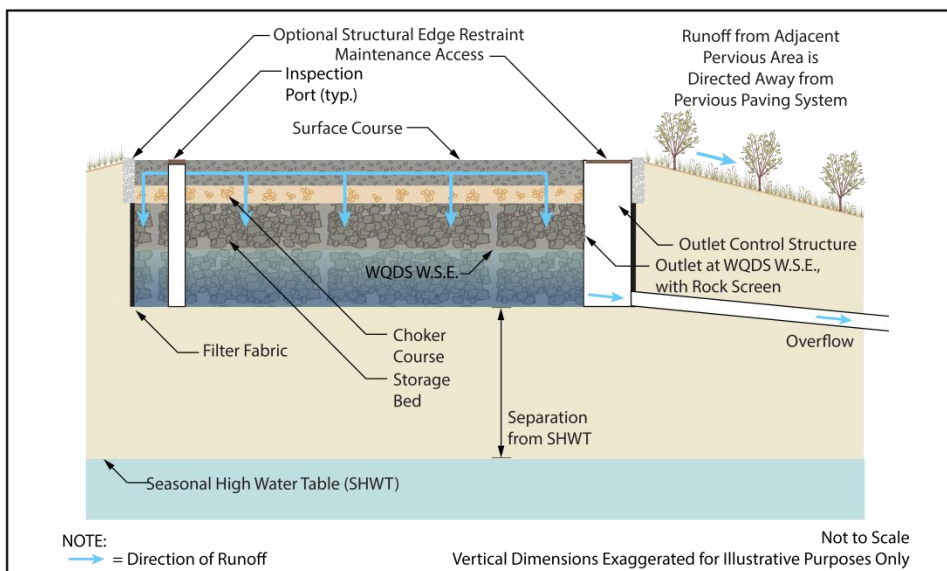
Pervious paving systems may be used to reduce the volume of runoff discharged to a downstream facility. For more information on calculating the volume reduction, refer to the example beginning on page 18.

Design Criteria

Basic Requirements

The graphic below illustrates the basic elements common to a variety of pervious pavement systems and the flow of runoff through the system.

Profile View – Porous Pavement Basics



The following design criteria apply to all pervious paving systems. Additional design criteria may be found, beginning on page 10, for a system with and underdrain and page 12, for a system designed to infiltrate into the subsoil.

Inflow

- All inflow must be stable, non-erosive and designed in accordance with the *Standards for Soil Erosion and Sediment Control in New Jersey*.
- Runoff that flows through the surface course must meet the following criteria:
 - The maximum ratio of additional inflow drainage area to surface area of the pervious paving system is 3:1.
 - The entire contributing drainage area must be completely stabilized prior to use of the pervious paving system.
- Runoff may bypass the surface course and directly discharge into the storage bed. However, any runoff collected from a surface traveled by vehicles must be pretreated. Pretreatment must provide 80% TSS removal for the Water Quality Design Storm, subject to the following requirements:
 - When using a structural 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 structural BMP, refer to the appropriate chapter in this manual.

- The pretreatment requirement does not apply to non-vehicular surfaces. However, in order to maintain capacity in the storage bed, it is crucial to minimize the amount of sediment and particulates in runoff by installing gutter guards, sumps and traps with maintenance access points, where feasible, in the conduits to the storage bed.

Surface Course

- The surface course must be designed to support, without lateral movement of the components, the anticipated traffic and other design loads, including additional stresses that may be anticipated at the edges of the installation.
- For a system designed for the Water Quality Design Storm, the minimum tested infiltration rate of the surface course is 6.4 inches per hour. Systems designed to address quantity control must have a minimum tested infiltration rate of the surface course of 20 inches per hour. Appropriate testing methods are outlined in the section of this chapter entitled *Types of Surface Courses for Pervious Paving Systems*, beginning on page 15. While it is likely that the surface course of a pervious paving system will have much higher tested infiltration rate, this is the minimum rate required to prevent surface ponding and meet the requirements of the Stormwater Management rules.
- Sealant, prime coat and other treatments that could reduce the rate of infiltration may not be applied to the surface course.
- The maximum surface course slope is 5%.
- After installation, measures must be taken to ensure the surface course does not become clogged until all aspects of the project are completed.

Choker Course

- The choker course must consist of clean, washed broken stone whose thickness is appropriate for the surface course desired and design load conditions.
- The choker course must consist of clean, washed AASHTO No. 57 broken stone.

Storage Bed

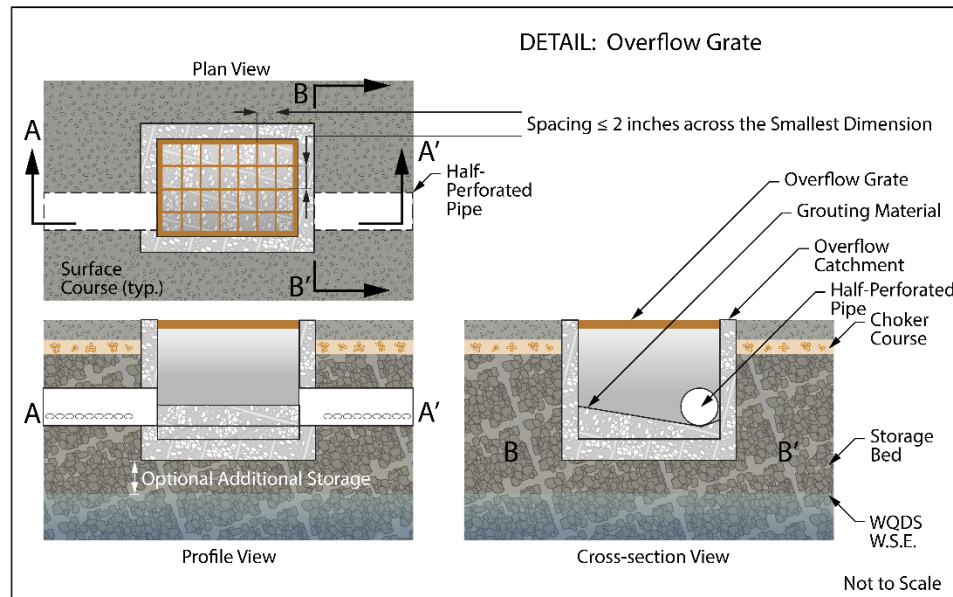
- Storage bed aggregate must be clean, open-graded broken stone with a size designation appropriate for the desired surface course and design load conditions. The stone must be washed, prior to placement, to minimize the amount of stone dust and other fine particles.
- Storage bed aggregate must be placed in lifts and compacted using plate compactors. The maximum recommended loose lift thickness is 6 inches.
- The system must have sufficient volume to fully contain the Water Quality Design Storm runoff volume in the storage bed without overflow, including any additional runoff that enters the storage bed through a piping system.

- A system designed to provide quantity control must include additional storage volume in the storage bed, above the water surface elevation (W.S.E.) of the Water Quality Design Storm (WQDS), in order to provide detention of stormwater runoff. Refer to the detail illustration found on page 7 for clarification.
- Infiltration may not be included in routing calculations for quantity control. Infiltration is defined as any discharge of runoff from the system into the subsoil and is sometimes referred to as exfiltration.
- No standing water may remain in the storage bed 72 hours after a rain event in order to allow for sufficient storage for the next rain event. Storage times in excess of 72 hours may render the system ineffective and may result in anaerobic conditions, odor, and both water quality and mosquito breeding issues.

Safety

- All pervious paving systems 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*.
- For systems designed to provide quantity control, emergency overflow catchments must be provided to direct surface runoff in excess of that generated by the maximum design storm into the storage bed. Calculations to determine location, elevation, size and efficiency of these structures must assume the surface course is completely impervious (i.e. CN = 98; C = .99) and be in accordance with applicable Federal, State, county and local requirements. The following criteria apply to overflow catchments:
 - Overflow grates are required at each overflow catchment and are illustrated in the detail provided on the following page. They must comply with the following requirements:
 1. The overflow grate must be secured to the outlet structure but removable for emergencies and maintenance;
 2. The overflow grate spacing must be no greater than 2 inches across the smallest dimension; and
 3. The overflow grate must be constructed of rigid, durable, and corrosion resistant material and designed to withstand traffic loads.
 - Excess runoff diverted into the overflow catchments must be distributed over the area of the storage bed through half-perforated pipes, which are solid on top, subject to the following requirements.
 1. The lateral pipe network must be designed for positive drainage,
 2. The pipes must be of sufficient strength and installed at adequate depth to withstand the anticipated loads,

3. The pipe laterals may connect to the inspection ports, which are discussed on page 10 for a system designed with an underdrain and on pages 12 and 13 for systems designed to infiltrate into the subsoil, and
4. Grouting material such as concrete, a mixture of sand and cement or similar must fill the space below the invert of the discharge pipe so 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.



Take note the optional additional storage shown above is for pervious paving systems designed for quantity control.

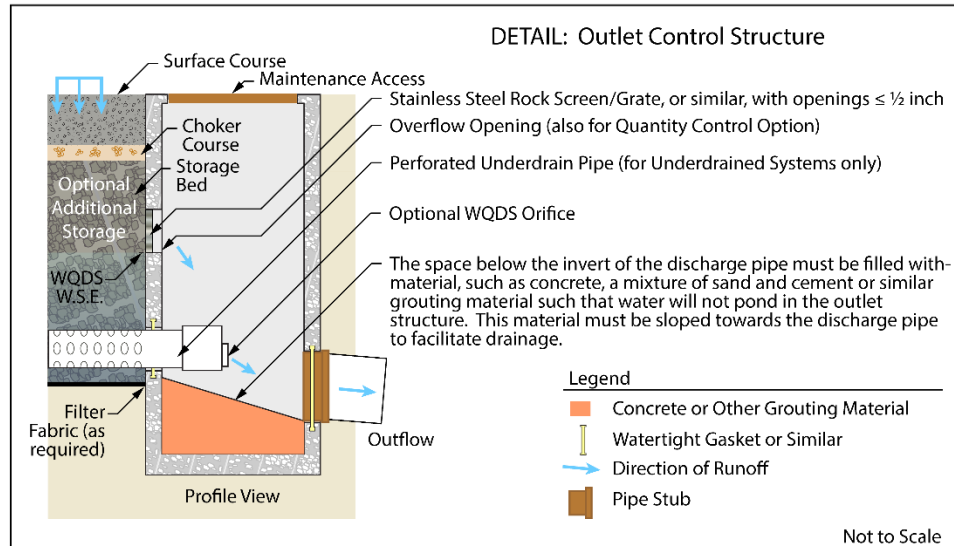
Outlet Structure

Pervious paving systems designed to provide quantity control or designed with underdrains must also be designed with an outlet structure.

- The outlet structure must be designed to safely control the discharge of runoff in excess of the maximum design storm.
- All access points must conform to all Federal, State, County and municipal safety standards such as those for confined space entry.
- Any maintenance access hatch or cover must be watertight to ensure that stormwater runoff does not bypass the surface course.
- 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 below.

- Any opening for discharge of runoff from the storage bed must be covered with a stainless steel or equivalently durable grate or rock screen which has openings less than or equal to one-half inch in size.
- When modeling a pervious paving system with an outlet structure, the effective opening of the outlet structure must be calculated as if it is partially obstructed by the rock screen and the stone of the storage bed. The calculated effective opening size must then be used in the model.

The detail on the following page illustrates the requirements for the outlet control structure; the optional elements are solely for illustrative purposes and are not intended to limit the design.



- Blind connections to downstream facilities are prohibited. Any connection to downstream 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 Federal, State, County and municipal safety standards such as those for confined space entry.
- The effects of tailwater on the hydraulic design of the underdrain and overflow systems, as well as any stormwater quantity control outlets, must be analyzed 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 downstream waterway or stormwater collection system. 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 obtained from either 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 may 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

- Construction may not take place during rain or snow, nor when the subsoil is frozen. Frozen aggregate materials may not be installed.
- The proposed area of the pervious pavement system must be kept free from sediment during the entire construction process. Construction materials contaminated by sediments must be removed and replaced with clean materials.
- The location of the proposed pervious paving system should not be used to provide sediment control during construction; however, when unavoidable, the bottom of the sediment control basin should be at least 2 feet above the final design elevation of the bottom of the storage bed in the pervious paving system.
- The excavation to the final design elevation of the storage bed may only occur after all construction within its drainage area is completed and the drainage area is stabilized. If construction of the pervious paving system cannot be delayed, during all phases of construction all flows must be diverted away from the pervious paving system. The diversions may not be removed until all construction within the drainage area is completed and the area is stabilized.
- The contributing drainage area must be completely stabilized prior to pervious paving system use.

Cold Weather Requirements

- Snow and ice, especially from areas treated with sand, cinders or de-icing materials, may not be stockpiled on a pervious paving system.
- A grade-separated area must be designated on the plan for stockpiling snow and ice separate from the pervious paving system.

Types of Pervious Paving Systems

There are two types of pervious paving systems:

1. Pervious Paving Systems with Underdrains
2. Pervious Paving Systems Designed to Infiltrate into the Subsoil

Individual Types of Pervious Paving Systems

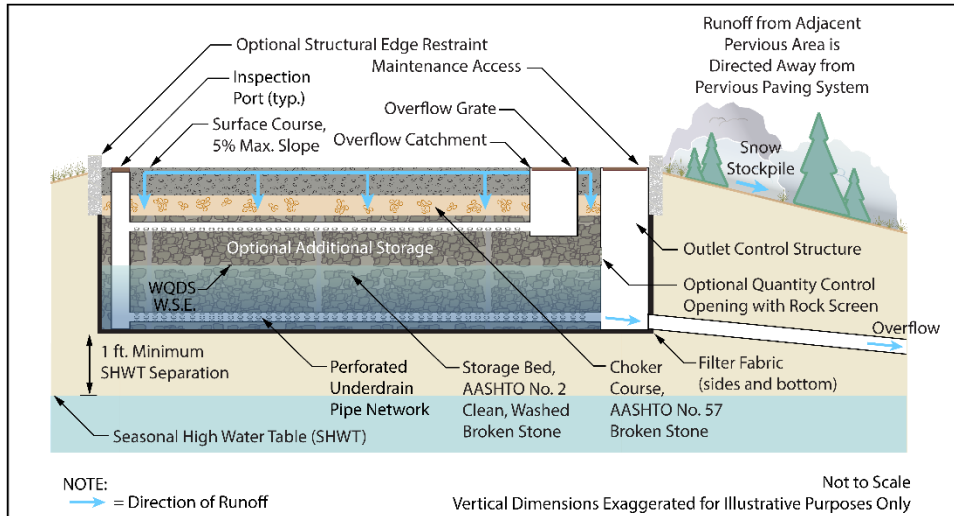
The following section provides detailed design criteria for each type of pervious paving system. The illustrations show possible configurations and flow paths and are not intended to limit the design. An additional illustration providing a side-by-side comparison of the two types of pervious paving systems is found on page 14.

Pervious Paving Systems with Underdrains

- Filter fabric is required along the sides and the bottom of the system to prevent migration of fines from the surrounding soil.
- The storage bed in this type of system consists of an aggregate layer and an underdrain, which is a network of pipes that collect runoff and transport it to the outflow section of the system.
 - The aggregate layer must have sufficient depth to provide at least 3 inches of aggregate above and below the pipe network. It must consist of clean, washed, open-graded AASHTO No. 2 broken stone.
 - Within the aggregate layer, the network of pipes must be able to withstand the design loads.
 - The manifold or other mechanisms used to collect flow from the pervious paving system must be non-perforated.
 - All joints must be secure and watertight.
 - The capacity of the underdrain must be sufficient to allow the system to drain within 72 hours.
- The seasonal high water table (SHWT) or bedrock must be at least 1 foot below the bottom of the storage bed.
- At least one inspection port, with a removable cap, must be provided at the upstream and downstream ends of the perforated section of the network of pipes and be flush with the surface of the surface layer and each location denoted in the maintenance plan. Each inspection port must be placed at least 3 feet from any edge. The size of the inspection port must be large enough to allow for maintenance activities. Additionally, each inspection port must extend down to the underdrain pipe network.

The illustration below shows an underdrained pervious paving system; it is only one possible configuration and flow path and is not intended to limit the design. Details of the overflow catchment and outlet control structure are provided on pages 6 through 9.

Profile View – Pervious Paving System with Underdrain



Pervious Paving Systems Designed to Infiltrate into the Subsoil

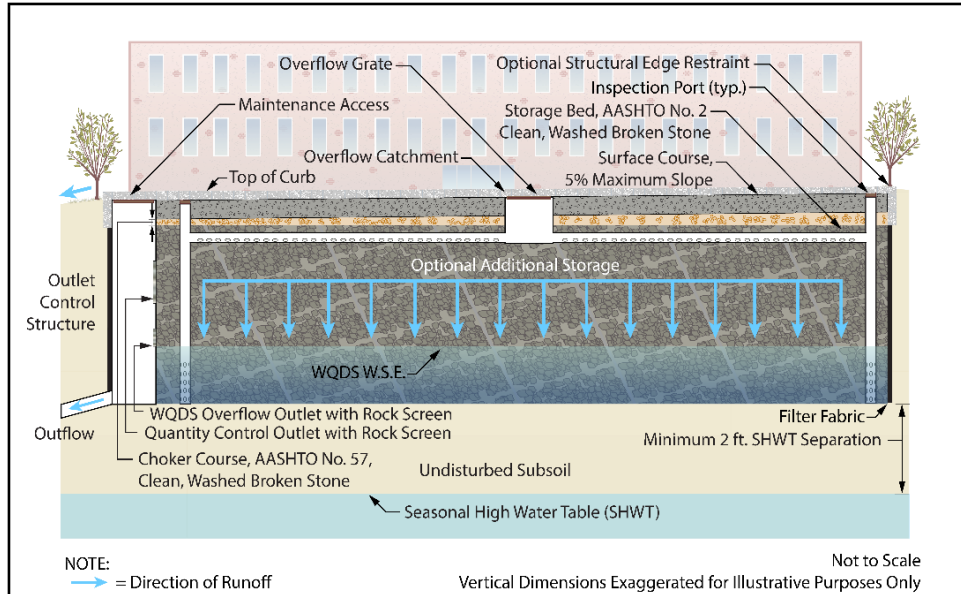
- The bottom of the storage bed must be as level as possible in order to allow runoff to uniformly infiltrate into the subsoil.
- The seasonal high water table (SHWT) or bedrock must be at least 2 feet below the bottom of the storage bed.
- The following subsoil permeability requirements apply:
 - The permeability of the subsoil must be sufficient to allow the system to drain within 72 hours.
 - Soil tests are required at the exact location of the proposed system in order to confirm its ability to function as designed. 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 *Appendix E: 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 *Appendix E: Soil Testing Criteria*, 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 rate would then be used to compute the system'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.
- Filter fabric is required along the sides of the storage bed to prevent the migration of fine particles from the surrounding soil. However, unlike systems with underdrains, filter fabric may not be used along the bottom of the storage bed because it may result in a loss of permeability.
- An outlet at the elevation of the Water Quality Design Storm is required to prevent the infiltration of larger storm events; however, additional storage above this elevation may be included to address quantity control requirements.
- At least one inspection port, with a removable cap, must be provided in the storage bed with its location denoted in the maintenance plan. The inspection port must be placed at least 3 feet from any edge. Additionally, each inspection port must be flush with the surface of the surface layer and extend down 4 – 6 inches into the subsoil, and the depth of runoff for the Water Quality Design Storm must be marked on each structure and its level included in the design

report and maintenance plan. The size of the inspection port must be large enough to allow for maintenance activities.

- As with any infiltration BMP, groundwater mounding impacts must be assessed, as required by N.J.A.C. 7:8-5.4(a)2.iv. This includes an analysis of the reduction in permeability rate when groundwater mounding is present. Where the mounding analysis identifies adverse impacts, the pervious paving system 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.
- Testing must be performed on the subsoil below the storage bed after excavation but prior to placement of the stone in accordance with the Construction and Post-Construction Oversight and Soil Permeability Testing section in *Appendix E: Soil Testing Criteria* 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.

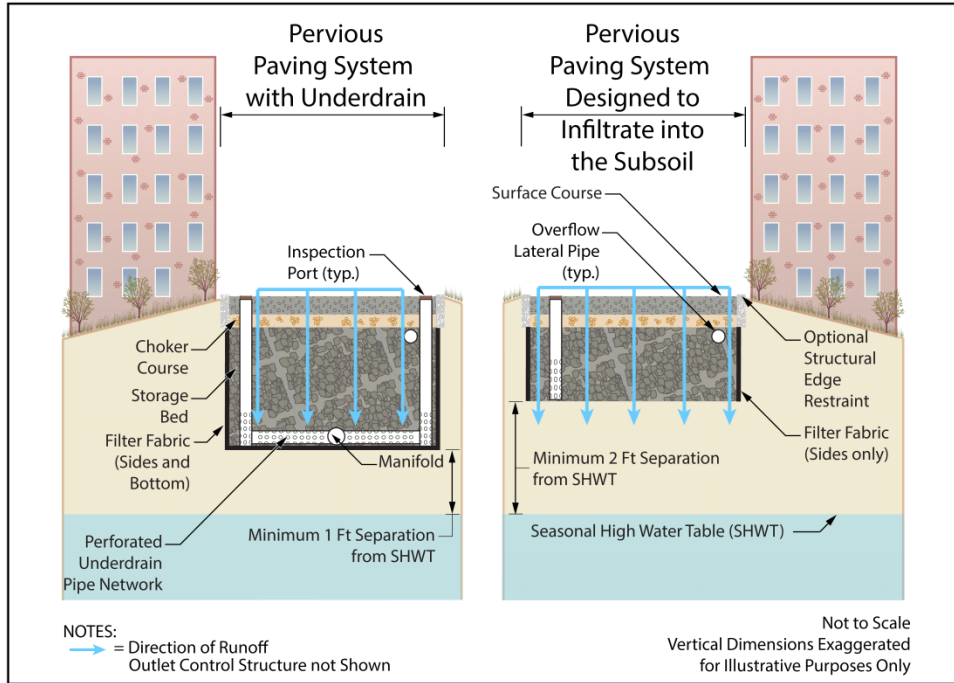
The illustration below shows one possible configuration and flow path of a pervious paving system designed to infiltrate into the subsoil and is not intended to limit the design. Details of the overflow catchment and outlet control structure are provided on pages 6 through 9. Note that the surface of the system is sloped and the choker course varies in depth. This example provides additional storage for runoff generated by storm events larger than the Water Quality Design Storm and the perforated inspection ports are tied in to the laterals for distribution of excess runoff at the surface.

Profile View – Pervious Paving System Designed to Infiltrate into the Subsoil



The following illustration shows the differences between the basic components of a pervious paving system with an underdrain and one designed to infiltrate.

Cross Section Views – A Comparison of the Two Types of Pervious Paving Systems



Types of Surface Courses for Pervious Paving Systems

There are two kinds of surface courses: porous pavement and permeable interlocking pavers. These types of surface courses are discussed below along with their design criteria.

Porous Pavement

Porous pavement consists of a contiguous permeable asphalt or pervious concrete surface course installed over a storage bed; runoff moves vertically through the pores of the surface course and temporarily accumulates in the underlying storage bed until it is discharged from the system or infiltrated into the subsoil. The high rate of infiltration through the surface course is achieved by eliminating the finer aggregates that are typically used in conventional pavement. The remaining aggregates are bound together with an asphalt or Portland cement binder.

Permeable Asphalt

Depending upon the design loads and desired engineering properties of the surface course, permeable asphalt may consist of a permeable asphalt surface course and a permeable asphalt base course over the storage bed, or may only include a permeable asphalt surface course over the storage bed. Permeable asphalt is also referred to as an open graded friction course (OGFC). In some instances, a project may specify an OGFC be installed over an impervious base course, usually to increase vehicular traction; however, such a design is ineligible for consideration as a pervious paving system. In order to receive the 80% TSS Removal Rate for water quality, permeable asphalt must be designed and constructed with a storage bed and in accordance with all of the requirements in this chapter.

- The porosity of the permeable asphalt surface course must be 15-25%.
- The binder used in the surface course must be performance graded for the type of use; therefore, the asphalt plant must also be advised of the type of surface course specified in order to use the correct binder for the installation. For parking lots, polymer modified binder PG 64E-22 must be specified as it has been shown to minimize scuffing caused by automobiles with power steering.
- The porosity of any permeable asphalt base course must be $\geq 25\%$.
- Minimum air temperature for paving: 50 °F.
- Installation of permeable asphalt requires different temperature guidelines, as follows, than that those of impervious asphalt:
 - Asphalt base course: 200 - 245 °F,
 - Finish rolling base course: 140 – 150 °F,
 - Asphalt surface course: 200 – 220 °F and
 - Finish rolling surface course: 110 - 140 °F.
- Vehicular use is prohibited for at least 48 hours once the pavement installation is complete.
- The minimum choker course thickness is 1 inch.

- Storage bed aggregate must be clean, washed and open-graded AASHTO No. 2 broken stone.
- Post-construction testing of the permeable asphalt surface course is required and must conform to the methods of either ASTM C1701: *Standard Test Method for Infiltration Rate of In-Place Pervious Concrete* or ASTM C1781: *Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems*. At least three locations must be used for the test, and they should be spaced evenly across the pervious paving system. Failure to achieve the minimum design infiltration rate of the surface course at one or more location indicates the system cannot be put in service until the system is corrected to yield all passing values. Unlike the test methodology outlined in the ASTM standards, the test results must not be averaged. The maintenance plan must include a log for recording each location and its test result for future reference.

Pervious Concrete

Pervious concrete is similar to conventional concrete except the fine particles, such as sand, are generally absent. The system of interconnected voids created by the removal of the fines promotes rapid drainage. Flow rates through pervious concrete are generally in the range of 192 – 1,724 inches/hour. In order to receive the 80% TSS Removal Rate for water quality, pervious concrete must be designed and constructed with a storage bed and in accordance with all of the requirements in this chapter.

- The porosity of the pervious concrete surface course must be 15-25%.
- If required for added strength, the percentage and type of synthetic fibers or quantity of fine sand required in the mix must be specified and testing must be in accordance with current pervious concrete industry standards.
- The air temperature must be above 32 degrees Fahrenheit on the day of placement and for seven calendar days prior.
- Finishing techniques, such as floating or troweling must not be used, because this would close the surface voids of the concrete.
- Covering pervious concrete with plastic sheeting during curing is required, as it prohibits moisture loss in the concrete mix. Plastic sheeting placement must conform to industry standards for timing and duration. While the plastic sheeting is in place, the pervious concrete must be blocked off from pedestrian or vehicular traffic.
- Post-construction testing of the pervious concrete surface course is required and must conform to the methods of ASTM C1701: *Standard Test Method for Infiltration Rate of In-Place Pervious Concrete*, on the day the plastic sheeting is removed. At least three locations must be used for the test, and they should be spaced evenly across the pervious paving system. Failure to achieve the minimum design infiltration rate of the surface course at one or more location indicates the system cannot be put in service until the system is corrected to yield all passing values. Unlike the test methodology outlined in the ASTM standards, the test results must not be averaged. The maintenance plan must include a log for recording each location and its test result for future reference.

- A choker course is not required.
- Storage bed aggregate must be clean, washed and open-graded broken stone with a minimum size designation of AASHTO No. 57.

Permeable Interlocking Paver Units

Permeable interlocking paver units (PICPs) are similar to porous pavement; however, instead of a contiguous permeable surface course, this system uses an arrangement of pavers installed over a bedding course. These units are most commonly manufactured from concrete or clay or are cut from stone, and the individual units may be shaped to create interesting patterns that interlock. Runoff moves vertically through the joints between the pavers, or through the voids in a permeable unit, followed by the voids in the bedding and choker courses, respectively; runoff temporarily accumulates in the underlying storage bed until it is discharged from the system. In order to receive the 80% TSS Removal Rate for water quality, permeable interlocking paver systems must be designed and constructed with a storage bed and in accordance with all of the requirements in this chapter.

- Permeable interlocking paver units and the manner in which they are arranged must be able to withstand the traffic and other design loads without moving, cracking or deforming.
- The following standards apply to the respective classifications of paver materials:
 - Concrete pavers must conform to ASTM C936 and have a minimum thickness of 3.125 inches when subject to vehicular traffic,
 - Clay pavers must conform to ASTM C1272 and have a minimum thickness of 2.75 inches and
 - Cut stone pavers must conform to ASTM C615 and be at least 3 inches thick.
- The surface slope must not create conditions for erosion of any joint filling material for the maximum design storm.
- The spacing of paver units must provide adequate drainage of the design storm and ensure safe conditions for pedestrians.
- If the proposed edge restraint is flush curb, the subgrade or base material under the curb portion only must be compacted.
- In order to receive an 80% TSS removal rate for water quality, joint filling material must be used, and it must meet one of the following requirements:
 - The joint filling material must be angular, durable and open-graded, such as ASTM No. 89 or 9 aggregate. The aggregate selected must be clean, i.e., washed, prior to installation, to prevent introduction of fines into the supporting layers.
 - Sand may not be used as a joint filling material.
- Paver units must be installed over a bedding course consisting of clean, washed open-graded AASHTO No. 8 broken stone.
- The minimum choker course thickness is 4 inches.

- Storage bed aggregate must be clean, washed and open-graded AASHTO No. 2 broken stone.
- Post-construction testing of the permeable interlocking paver unit surface course is required and must conform to the methods of ASTM C1781: *Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems*. At least three locations must be used for the test, and they should be spaced evenly across the pervious paving system. Failure to achieve the minimum design infiltration rate of the surface course at one or more location indicates the system cannot be put in service until the system is corrected to yield all passing values. Unlike the test methodology outlined in the ASTM standard, the test results must not be averaged. The maintenance plan must include a log for recording each location and its test result for future reference.

Designing Pervious Paving Systems

Below are two examples on the same site showing the basics of designing a pervious paving system to treat the runoff from the Water Quality Design Storm; these examples are only two of many ways to configure these systems and are not intended to limit the design. The first example is for a system designed to infiltrate and the second for an underdrained system. Note that both examples show the use of pervious paving systems only in the parking stalls; however, these systems may be used in higher traffic areas as long as the system is designed to withstand the anticipated traffic loads.

Example 1 – Permeable Asphalt Parking Lot Designed to Infiltrate: A proposed commercial site includes a 1-acre parking lot and 0.25-acre roof. The parking stalls will be permeable asphalt and will manage the runoff generated by the Water Quality Design Storm that falls on both them and the adjacent aisles and driveway. Additionally, clean roof runoff will be piped directly to the system's storage bed for volume reduction credit for the Water Quality Design Storm. Runoff from all events larger than Water Quality Design Storm will be temporarily stored in the system and discharge into a downstream collection system.

The following parameters apply:

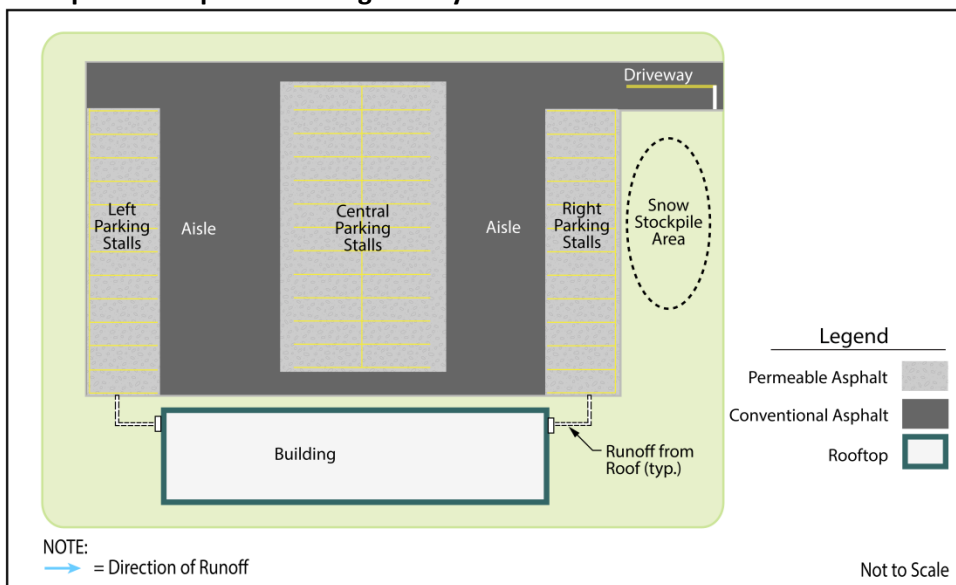
Inflow Drainage Area	Pavement Type	Acreage	CN Value
Driveway and Aisles	Conventional Asphalt	0.50	98
Central Parking Stalls	Permeable Asphalt	0.25	98
Left Parking Stalls	Permeable Asphalt	0.125	98
Right Parking Stalls	Permeable Asphalt	0.125	98
Rooftop	Roof	0.25	98

Tested Subsoil Permeability Rate = 1.00 inches/hour
 Water Quality Design Storm: 1.25 inches in 2 hours

Note that even though a pervious paving system does not produce runoff, the permeable asphalt surface course must be assigned a CN value of 98 in order to calculate the volume of precipitation collected by the system.

In this example, the pervious paving system is designed for both stormwater quality and quantity control. Therefore, in addition to designing the storage bed to hold the entire runoff volume generated by the Water Quality Design Storm below the outlet, the storage bed must also be sized to provide detention for larger storm events above invert of the outlet. The sizing calculations for the larger storm events are beyond the scope of this chapter. The layout of the site is illustrated as follows:

Example 1 – Proposed Parking Lot Layout



Step #1: Runoff Calculations for the Water Quality Design Storm

Using the runoff calculation method described in *Technical Release 55 – Urban Hydrology for Small Watersheds* (TR-55) and discussed in the NRCS Methodology section of *Chapter 5: Computing Stormwater Runoff Rates and Volumes*, the Water Quality Design Storm runoff volumes were calculated to be as shown below:

Area Producing Runoff	Runoff Volume (cf)
Driveway and Aisles	1,878
Parking Stalls	1,878
Roof	939
Total Runoff Volume	4,695

Step #2: Storage Volume and Depth of Bed Sizing

As shown in the illustration above, there are three separate permeable asphalt paving areas, which will manage the precipitation falling on them and runoff from the adjacent aisles and from the driveway. For the purposes of this example, the runoff is assumed to be evenly distributed across the three areas. The storage bed underneath the parking stalls is filled with AASHTO No. 2 coarse aggregate assumed to have 40% voids. Therefore, to manage the entire volume generated by the Water Quality Design Storm for the inflow drainage area, the required depth of the three storage beds is:

$$\begin{aligned}\text{Storage Bed Depth} &= \frac{\text{Water Quality Design Storm Runoff Volume}}{\% \text{ Voids} \times \text{Storage Bed Area}} \\ &= \frac{1,878 \text{ cf} + 1,878 \text{ cf}}{0.40 \times \left(0.50 \text{ ac} \times \frac{43,560 \text{ sf}}{\text{ac}} \times \frac{12 \text{ inches}}{\text{ft}} \right)} = 5.2 \text{ inches}\end{aligned}$$

However, clean roof runoff from the buildings adjacent to both the the right and left parking stalls will be piped directly to the storage beds via leaders connected to the downspouts from the right and left sides of the building; therefore, additional depth will be required for these storage beds. The total combined area of the right and left parking stalls is 0.25 acre. The additional storage depth required is:

$$= \frac{939 \text{ cf}}{0.40 \times \left(0.25 \text{ ac} \times \frac{43,560 \text{ sf}}{\text{ac}} \times \frac{12 \text{ inches}}{\text{ft}} \right)} = 2.6 \text{ inches}$$

The total required depth of the left and right storage beds, for infiltration of the Water Quality Design Storm generated by the parking and rooftop surfaces, is therefore 7.8 inches.

Step #3: Drain Time Calculation

The drain time of a pervious paving system is determined by the design permeability of the most hydraulically restrictive layer, which, in this case, is the subsoil. For the left and right storage beds, the drain time is calculated as follows:

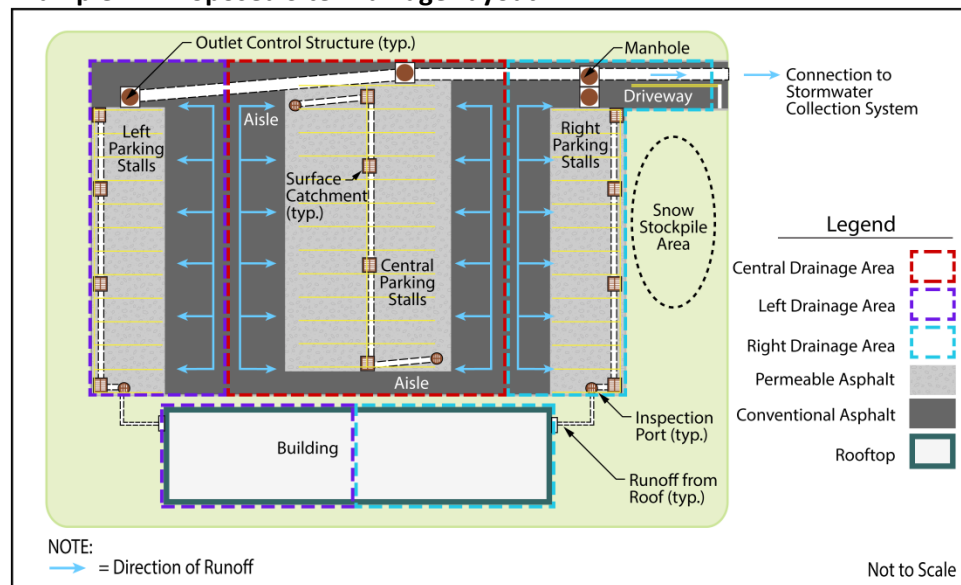
$$\begin{aligned}\text{Drain Time} &= \frac{\text{Water Quality Design Storm Runoff Volume}}{\text{Surface Area} \times \text{Subsoil Design Permeability Rate}} \\ &= \frac{1,878 \text{ cf} + 939 \text{ cf}}{\left(0.25 \text{ ac} \times \frac{43,560 \text{ sf}}{\text{ac}} \times \frac{0.5 \text{ inches}}{\text{hour}} \times \frac{1 \text{ ft}}{12 \text{ inches}} \right)} = 6.2 \text{ hours}\end{aligned}$$

Since this is less than the allowable maximum drain time of 72 hours, the storage bed appears, at this stage, to meet the drain time requirements. Using this method, the shallower central storage bed will have a shorter drain time, which is equal to 4.2 hours.

Step #4: Quantity Control for Large Storm Events

As previously stated, stormwater quantity control design will require routing calculations for the runoff generated by the 2-, 10-, and 100-year storm events as well as the hydraulic calculations for the controlled peak flow through the outlets that are beyond the scope of this chapter. Although the design for water quantity control is not shown here, for the purpose of this example, the storage beds and outlet control structures were designed to provide additional storage with detention. Therefore, the first water quantity control outlet is at the water surface elevation (W.S.E.) of the Water Quality Design Storm, as shown in the detail provided on page 8. Additionally, overflow provisions are required for the surface course, as shown in the outlet structure design criteria found on pages 6 through 9. The site layout is shown in the illustration below:

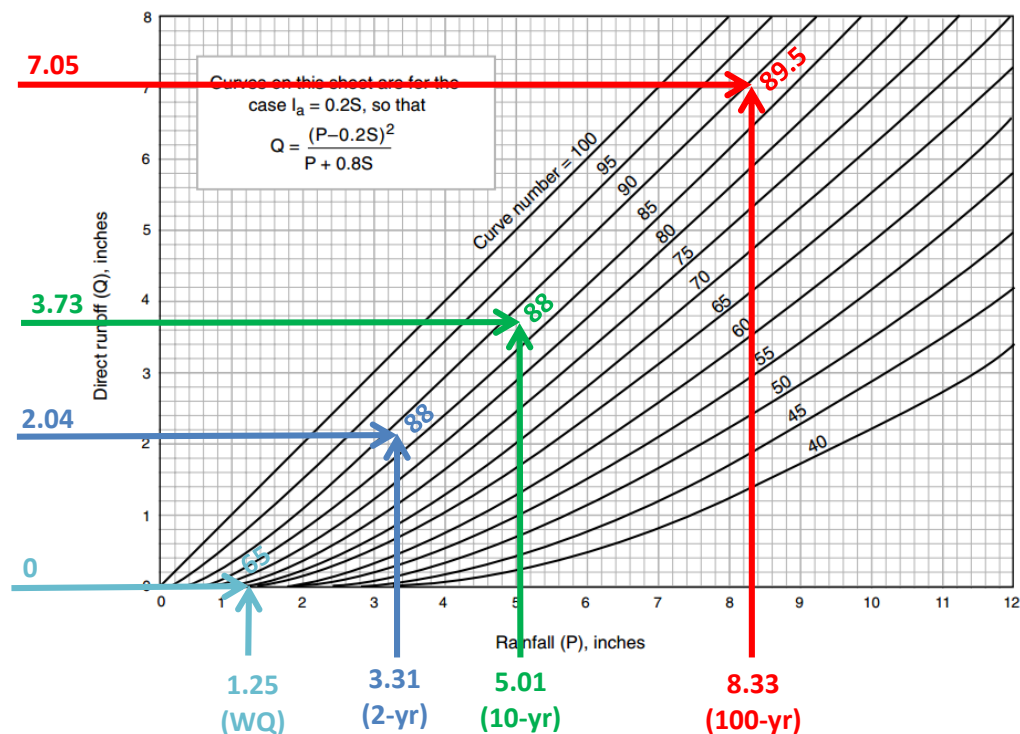
Example 1 – Proposed Site Drainage Layout



Step #5: Reduced CN

The volume retained in the pervious paving system reduces the direct runoff leaving the site. Therefore, a reduced CN can be calculated by using the reduced direct runoff, rainfall depth, and Fig 2-1 in Technical Release 55 – Urban Hydrology for Small Watersheds (TR-55), as shown on the graph below. The drainage area is 1.25 acre including the pervious driveway, aisles, pervious asphalt, and the roof area.

Storm Event	Rainfall (in)	Direct Runoff Volume without Pervious Paving (cf)	Retention Volume (cf)	Runoff Volume Leaving Pervious Paving (cf)	Reduced Direct Runoff (in)	Reduced CN (from Graph)
WQ	1.25	4,695	4,695	0	0.00	65
2-year	3.31	13,946	4,695	9,251	2.04	88
10-year	5.01	21,633	4,695	16,938	3.73	88
100-year	8.33	36,666	4,695	31,971	7.05	89.5



The Reduced CN can be used to calculate the runoff volume. However, when calculating peak flow rate, a routing calculation must be performed on the pervious paving system.

Example 2 – Permeable Asphalt Parking Lot Designed with an Underdrained System: A proposed commercial site includes a 1-acre parking lot and 0.25-acre roof. The parking stalls will be permeable asphalt and will manage the runoff generated by the Water Quality Design Storm that falls on both them and the adjacent aisles and driveway. In this example, the permeable asphalt system will be designed solely to meet the stormwater quality design and performance standards; stormwater quantity control requirements will be met by a downgradient extended detention basin.

The following parameters apply:

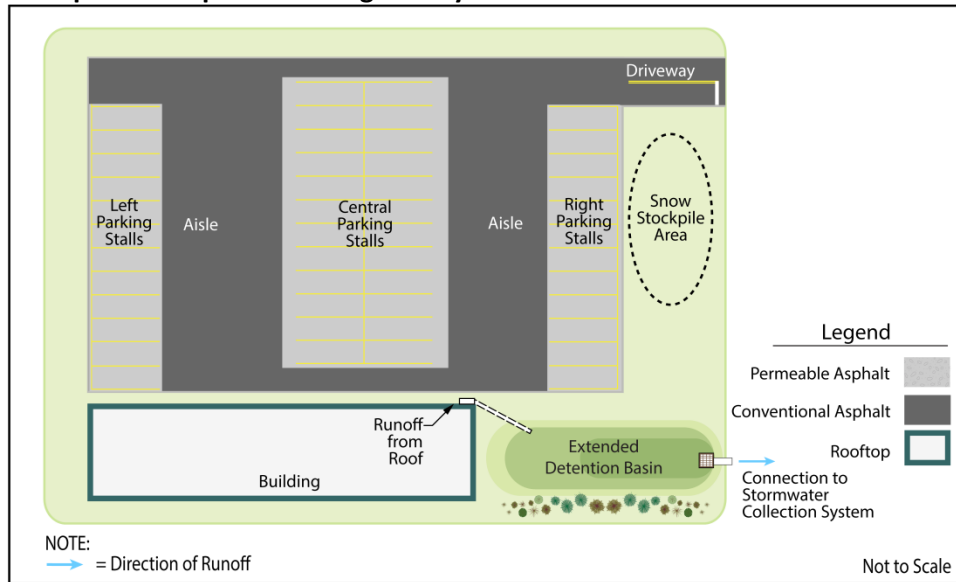
Inflow Drainage Area	Pavement Type	Acreage	CN Value
Driveway and Aisles	Conventional Asphalt	0.50	98
Central Parking Stalls	Permeable Asphalt	0.25	98
Left Parking Stalls	Permeable Asphalt	0.125	98
Right Parking Stalls	Permeable Asphalt	0.125	98
Rooftop	Roof	0.25	98

Tested Subsoil Permeability Rate = 0.50 inches/hour
 Water Quality Design Storm: 1.25 inches in 2 hours

Note that even though a pervious paving system does not produce runoff, the permeable asphalt surface course must be assigned a CN value of 98 in order to calculate the volume of precipitation collected by the system.

As stated above, the tested subsoil permeability rate is 0.5 in/hr, which is below the minimum design permeability rate, which is 1 in/hr. Therefore, a pervious paving system designed to infiltrate into the subsoil may not be used on this site; however, an underdrained system may be used instead. Unlike Example 1, the clean roof runoff is not directed to the storage bed because a pervious paving system with an underdrain cannot be used to reduce volume. The layout of the site is illustrated on the following page:

Example 2 – Proposed Parking Lot Layout



Step #1: Runoff Calculations for the Water Quality Design Storm

Using the runoff calculation method described in *Technical Release 55 – Urban Hydrology for Small Watersheds* (TR-55) and discussed in the NRCS Methodology section of *Chapter 5: Computing Stormwater Runoff Rates and Volumes*, the Water Quality Design Storm runoff volumes were calculated to be as shown below:

Area Producing Runoff	Runoff Volume (cf)
Driveway and Aisles	1,878
Parking Stalls	1,878
Total Runoff Volume	3,765

Step #2: Storage Volume and Depth of Bed Sizing

As shown in the illustration above, there are three separate permeable asphalt paving areas, which will manage the precipitation falling on them and runoff from the adjacent aisles and from the driveway. For the purpose of this example, the runoff is assumed to be evenly distributed across the three areas. The storage bed underneath the parking stalls is filled with AASHTO No. 2 coarse aggregate assumed to have 40% voids. Therefore, to manage the entire volume generated by the Water Quality Design Storm for the inflow drainage area, the required depth of the three storage beds is:

$$\begin{aligned}
 \text{Storage Bed Depth} &= \frac{\text{Water Quality Design Storm Runoff Volume}}{\% \text{ Voids} \times \text{Storage Bed Area}} \\
 &= \frac{1,878 \text{ cf} + 1,878 \text{ cf}}{0.40 \times \left(0.50 \text{ ac} \times \frac{43,560 \text{ sf}}{\text{ac}} \times \frac{12 \text{ inches}}{\text{ft}} \right)} = 5.2 \text{ inches}
 \end{aligned}$$

Step #3: Design of the Underdrain Pipe Network

As stated earlier, the capacity of the underdrain must be sufficient to drain the runoff stored in the system within 72 hours. Therefore, dividing the Water Quality Design Storm runoff volume by 72 hours is the minimum flow rate required for the underdrain. More precise pipe sizing may be determined by a routing calculation. The actual pipe sizes must be recorded in the maintenance plan.

Step #4: Quantity Control for Large Storm Events and Overflow Measures

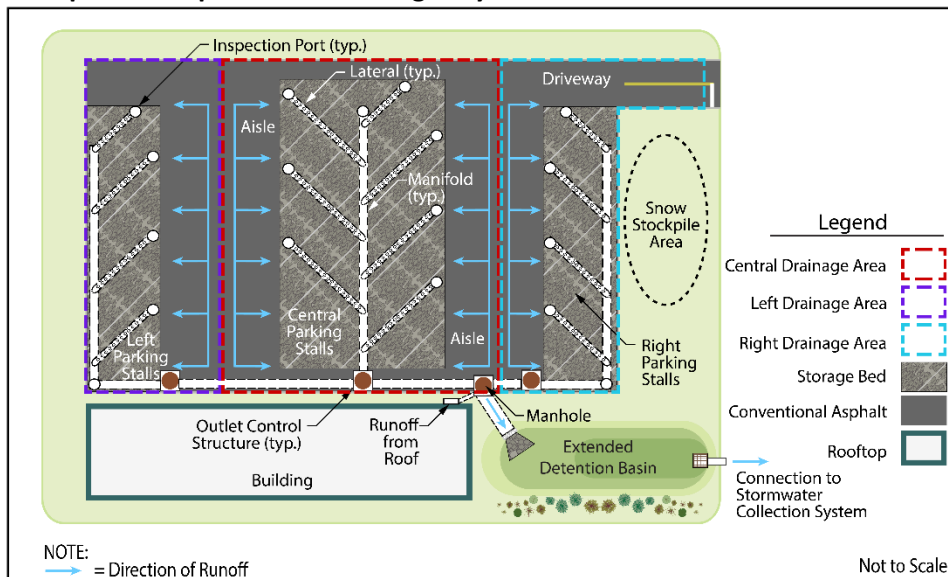
In this design example, the permeable asphalt system is not designed to provide water quantity control; therefore, additional storage volume for the larger storm events is not required. However, the outlet control structure design criteria found on pages 7 through 9 still apply. Solid pipe will be provided to convey runoff from larger storms from the outlet control structures to the downstream detention basin.

Step #5: Drain Time Calculation

The drain time of a pervious paving system is determined by the design permeability of the most hydraulically restrictive component, which, in this case, is the flow capacity of the underdrain, the sizing of which is beyond the scope of this chapter.

The site layout is shown in the illustration below. For illustrative purposes, a horizontal slice has been taken through each of the storage beds to show both the layout of the underdrain manifold with the laterals and the relationship of the storage beds to the areas of conventional asphalt pavement.

Example 2 – Proposed Site Drainage Layout



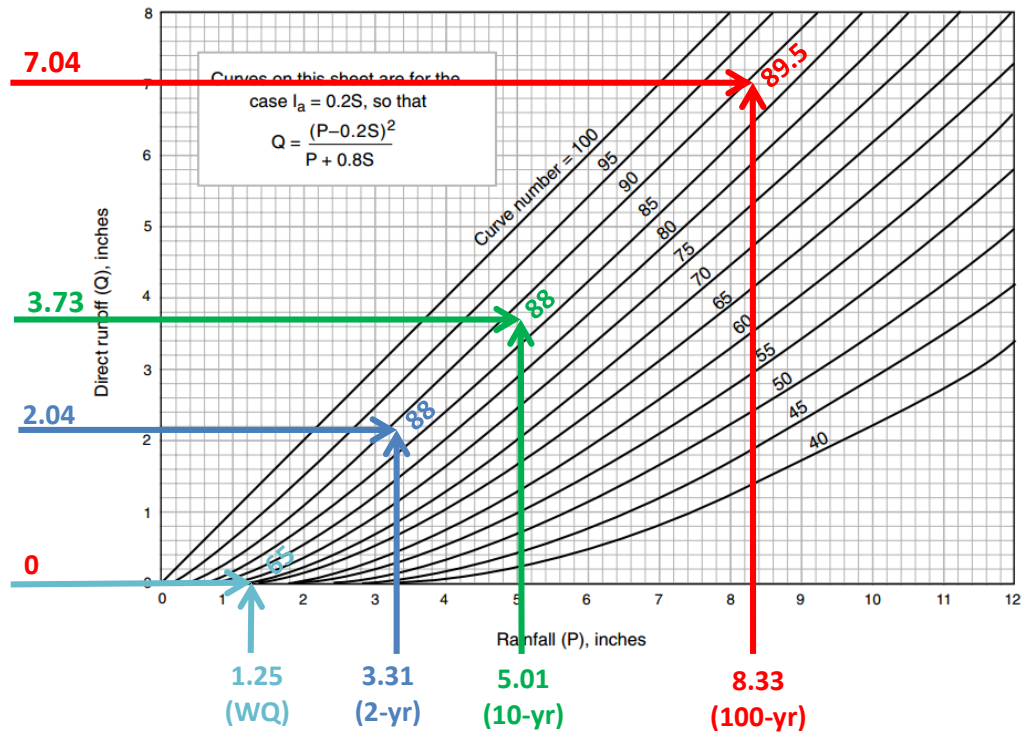
Step #6: Reduced CN

The volume retained in the pervious paving can be reduced from the direct runoff from the parking lot and the roof area. Therefore, a reduced CN can be calculated by using the reduced direct runoff, rainfall depth, and Fig 2-1 in Technical Release 55 – Urban Hydrology for Small Watersheds (TR-55).

Take note that, unlike in example 1, in this example, the runoff from the impervious driveway, impervious aisles, and the pervious parking stalls are retained in the storage bed under the pervious asphalt sections. The roof runoff is directed to the nearby detention basin. Therefore, the drainage area in the reduced CN calculation is only 1 acre.

Storm Event	Rainfall (in)	Direct Runoff Volume without Pervious Paving (cf)	Retention Volume (cf)	Runoff Volume Leaving Pervious Paving (cf)	Reduced Direct Runoff (in)	Reduced CN (from Graph)
WQ	1.25	3,765	3,765	0	0.00	65
2-year	3.31	11,157	3,765	7,392	2.04	88
10-year	5.01	17,306	3,765	13,541	3.73	88
100-year	8.33	29,333	3,765	25,568	7.04	89.5

The Reduced CN values shown in the table above were derived from the graph provided on the following page.



The Reduced CN can be used to calculate the runoff volume. However, when calculating peak flow rate, the routing calculation must consider the pervious paving system as a storage structure.

Considerations

When planning a pervious paving system, consideration should be given to a number of factors, including soil characteristics, depth to the groundwater table, site location and shading, sensitivity of the region, and inflow water quality. It is also important to note that the use of pervious paving designed to infiltrate into the subsoil is recommended in this manual only for the Water Quality Design Storm or smaller storm events. Use of these systems to infiltrate larger volumes, should only be considered when another applicable rule or regulation requires the infiltration of a larger storm event. In such a case, the pervious paving system should be designed to infiltrate the minimum storm event required to address that rule or regulation.

The placement of pervious paving systems must comply with all applicable laws and rules adopted by Federal, State, and local government entities. Additionally pervious paving systems designed to infiltrate into the subsoil could negatively impact other facilities. Therefore, consideration should be given to the siting of these systems in areas where such facilities exist. These facilities include 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.

Soil Characteristics

For pervious paving systems designed to infiltrate into the subsoil, soils are perhaps the most important consideration for site suitability. In general, County Soil Surveys may be used to obtain necessary soil data for the planning and preliminary design of pervious paving systems; however, for final design and construction, soil tests are required at the exact location of a proposed system. The results of this soil testing should be compared with the County Soil Survey data used to calculate runoff rates and volumes and to design BMPs on-site to ensure reasonable data consistency. If significant differences exist between the soil test results and the County Soil Survey data, additional soil tests are recommended to determine 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 redesign to help ensure that the final site soil data is accurate.

Geology

The presence or absence of Karst topography, which is characterized by highly soluble bedrock, is an important consideration when planning a pervious paving system designed to infiltrate into the subsoil. If Karst topography is present, infiltration of runoff may lead to subsidence and sinkholes; therefore, only pervious paving systems designed with underdrains should be used 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*.

Surface Course

The surface course must be durable and have sufficient thickness to resist the wear and tear of traffic patterns and the deformation that may occur in warmer months. Additionally, in order to minimize the possibility of edge collapse, the inclusion of edge restraints in the design is strongly recommended. Edge restraints may consist of depressed curbs or paver blocks, staking or strip edging and may be combined with vehicular intrusion deterrents, such as planted shrubs, wheel stops and bollards.

In systems where pervious pavement is adjacent to traditional pavement, a full-depth dividing strip between the two types of pavement may be necessary to ensure that structural integrity is maintained and to prevent inadvertent saturation of the adjacent impervious pavement surface course. Additional information regarding current design codes and standards, project cost estimation, detailed maintenance practices, and other related topics may be obtained from professional organizations such as, but not limited to, the National Ready Mix Concrete Association, the National Asphalt Pavement Association, and the Interlocking Concrete Pavement Institute, along with the Federal Highway Administration.

Construction of a pervious paving system surface course is entirely different from similar looking impervious versions. Care should be taken in hiring and training all contractors and subcontractors, inspectors and other personnel to ensure proper methods and sequences are followed. Construction of a test strip prior to installation of the proposed pervious paving system is recommended to nail down site specific issues. Additionally, until any adjacent landscaping is complete, it is strongly recommended that the surface course be covered with plastic film and held in place with timber to discourage vehicular access and storage of landscaping materials on the surface course.

After construction is complete, a clogged surface does not necessarily mean a pervious paving system is sealed. High efficiency cyclone machines or other emerging technologies may be necessary to restore the infiltration capabilities of a clogged surface course and therefore should be included in the corrective maintenance measures portion of the maintenance plan. Should a surface become clogged, the manufacturer should be consulted for information on the latest and most efficient restoration measures necessary, and afterwards, the infiltration rate of the surface course should be tested and recorded in the maintenance plan.

Alternate Underdrain Design

Where this is sufficient clearance above the seasonal high water table, pervious systems designed with an underdrain may place the underdrain pipe in a trench excavated into the subsoil rather than in the aggregate-filled storage bed. For this option the pipe should be surrounded with a minimum of 3 inches of clean, washed open-graded AASHTO No. 57 broken stone. Filter fabric should line the bottom and sides of the trench as well. This method may be faster to construct and may protect the underdrain pipes from cracking during compaction of the storage bed aggregate.

Cold Weather

Unlike traditional pavement, consideration should be given to where a pervious paving system will be sited in relation to other site features and how it will be managed during winter months. Locating a pervious pavement system in an area that receives full sun during the winter months may greatly reduce the need for de-icers. In general, due to the lack of surface ponding and the latent heat resulting from moisture in the subsoil, correctly constructed pervious paving systems are more resistant to freezing than traditional pavements. However, de-icing may still be necessary, and some de-icing compounds may react chemically with one or more components in a pervious paving system resulting in deterioration; therefore, care should be taken when selecting these compounds. Take into consideration that some of the volume of commercially available products may contain magnesium or other damaging compounds without being declared on the product packaging; therefore, any compound selected should be used on a test area prior to applying to the whole system. Take further note that de-icing compounds used on adjacent, traditional pavement may be tracked onto a pervious paving system, and consideration should also be given to the selection of those compounds. The application of a penetrating silane based sealant to a pervious concrete or concrete paver surface course is strongly recommended as additional protection against chemical degradation by de-icing compounds, as long as the chosen sealant does not impair the rate of infiltration of the surface course.

During design, frost penetration and the ability of each layer to fully drain should also be taken into account when calculating layer thicknesses to ensure that each component is thick enough to prevent frost heave. Finally, because stored runoff may expand during freezing, provisions, such as a lateral drainpipe or an increased depth of the storage bed below the frost line, should be included in the design to reduce the likelihood of frost heave.

Signage

Because pervious paving systems look like traditional pavement, signage may be necessary to eliminate improper application of de-icing compounds, to prevent dumping of hazardous materials and to eliminate the intrusion of vehicles exceeding the design-loading rate of the system, which could compact and deform the surface course.

Trees

Trees may be planted near a pervious parking lot, provided ample clearance and sufficient soil volume for maturation are included, as it is essential to prevent tree roots from penetrating into the stone bed of a pervious pavement installation; however, consideration must also be given to the location of the arboreal dripline and the potential for fallen leaves, icicles and snow to cover the surface of the pervious pavement after a wind event.

Adjacent Landscaping

- Runoff from pervious areas should be directed away from the pervious paving system, where possible.
- Where it is not possible to direct runoff from adjacent landscaping away from a pervious paving system, a gravel strip or swale should be provided to filter and reduce the intrusion of sediment, with additional monitoring and corrective measures added to the maintenance plan.

Care should be taken in the selection of top dressing for nearby vegetated areas; particulates transported by wind or during rainfall or snowmelt could result in the clogging of the surface course. Preventative measures should be included in the maintenance plan and should be re-evaluated as necessary to ensure long-term functionality of the system.

Maintenance

Regular and effective maintenance is crucial to ensure effective pervious paving system performance; in addition, maintenance plans are required for all stormwater management facilities on a major development. In addition to the manufacturer's maintenance requirements, 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 pervious paving systems are presented below; these requirements must be included in the maintenance plan for pervious paving systems.

General Maintenance

- Failure to correctly maintain a pervious paving system will shorten its lifespan or result in system failure; therefore, the maintenance plan must ensure proper training of personnel and include the special equipment necessary in accordance with the industry's or manufacturer's requirements.
- The surface course must be inspected, at least once annually, for cracking, subsidence, spalling, erosion, deterioration and unwanted vegetation. Remedial measures must be taken as soon as possible. Herbicides must not be applied.
- The surface course of a pervious paving system must be vacuum swept, not power swept, at least four times per year. Vacuum sweeping must be followed by either air blowing or high-pressure power washing performed in accordance with the specifications recommended for the particular type of system. All dislodged material must be promptly removed.
 - The first annual maintenance must be performed in the spring.
 - Maintenance must additionally be performed in the autumn, after the fallen leaves are collected and removed.

- Each spring, after the last snow or ice event, the infiltration rate of the surface course must be tested in accordance with the methods of either ASTM C1701 or C1781, as corresponds to the post-construction test performed for the system. At least 3 locations must be tested. One of the locations must be in an area where sediment is most likely to be deposited, such as, but not limited to, a parking lot entrance. The other test locations must be evenly spaced across the system surface. The locations and results obtained must be recorded in the maintenance plan for future reference and compared to the as-built testing results as a metric for determining if a system requires corrective action. The chart provided below shows the approximate infiltration rate based upon the time it takes to infiltrate either 8 or 40 pounds of water specified in the above-cited tests. This chart should be included in the maintenance plan for future reference. The infiltration rate, I , is based upon the following calculation:

$$I = (K * M) / (D^2 * t), \text{ where}$$

K = 126,870 in-lbs

M = water mass, lbs

D = ring diameter = 12 inches

t = time, in seconds

Test Methods Per ASTM C1701 or C1781		
Time to Infiltrate the Specified Amount of Water (seconds)	Approximate Surface Infiltration Rate (inches per hour)	
	$M = 8$ lbs	$M = 40$ lbs
30	235	1175
60	118	587
100	70.5	352
200	35.2	176
350	20.1	100.7
360	19.6	97.9
380	18.5	92.7
900	7.8	39.2
1760	4.0	20.0
1910	3.7	18.5
3600	2.0	9.8
5400	1.3	6.5
5470	1.3	6.4
6000	1.2	5.9

Take note that should the test be performed with a different quantity of water, the values in the chart above cannot be used.

- Corrective action must be immediately taken to restore the infiltration capacity of the pervious paving system under the following scenarios:
 - Standing water is observed on the surface course; or
 - The testing methods above show an infiltration rate of 20 inches per hour or less for a system designed for quantity control or 6.4 or less for a system designed for water quality control only.
- If mud or sediment is tracked onto the surface course, it must be removed as soon as possible. Removal should take place when all runoff has drained from the surface course.
- 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.
- Under no circumstances may any sealants or coatings be applied to pervious paving systems, except for those approved by the manufacturer to improve surface course resistance to de-icing chemicals or refresh traffic striping.
- Over the lifetime of the surface course, no more than 10% of its surface area may be patched with impervious material such as bituminous asphalt or concrete. All patching must be recorded in the maintenance manual for future reference to prevent exceedance of this maximum.

Storage Bed Drain Time

- The approximate drain time for the maximum design storm runoff volume below the top of the surface course must be indicated in the maintenance manual.
- If the actual drain time is significantly different from the design drain time, the components and groundwater levels must be evaluated and appropriate measures taken to return the pervious paving system to minimum and maximum drain time requirements.
- If the system fails to drain the maximum design storm volume within 72 hours, corrective action must be taken.

Cold Weather Maintenance

- Care must be taken when removing snow from the surface course; pervious paving surface courses may be damaged by snowplows or loader buckets set too low to the ground or not equipped with a rubber blade guard. Sand, grit or cinders may not be used on surface courses for snow/ice control.
- De-icing chemicals may not be used on pervious concrete less than one year old.
- De-icers containing magnesium chloride, calcium magnesium acetate or potassium acetate may never be used on pervious concrete.

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