02839 POROUS PAVEMENT GREEN INFRASTRUCTURE STRATEGY

[NTS: This specification is intended to be used as part of the Milwaukee Metropolitan Sewerage District's Green Solutions Program for implementation of green infrastructure strategies into Contract Documents by local municipalities or other entities. The specification is also intended to be used in conjunction with the Green Infrastructure Sizing Calculator and the Green Infrastructure Typical Details developed for the Green Solutions Program. The specification is considered to be a technical guidance document to assist users with the design of green infrastructure strategies. It is the responsibility of the local municipality or design engineer to make revisions to the specification as needed for specific design projects. It is recommended the documents are reviewed by a licensed professional engineer before releasing for construction. Note that the specification was last updated by the District in 2016.]

A. SCOPE

This Section covers the work necessary to furnish and install porous pavement green infrastructure strategies, including the porous pavement surface, bedding aggregate layer, base course aggregate layer, stormwater storage aggregate layer, underdrain piping, cleanouts, and observation wells.

1. GENERAL

[NTS: Update language of this Section as necessary based on applicable references to front-end specifications.]

See CONDITIONS OF THE CONTRACT, and Division 1, GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this project.

2. RELATED WORK

[NTS: The list below may not be fully inclusive depending upon the specifics of each individual project. Update language of this Section as necessary based on applicable references to other technical specification sections.]

The applicable requirements, materials and workmanship specified in the following Sections are included by reference in this Section. The list below is from the Wisconsin Department of Transportation (WisDOT) Standards and Specifications for Highway and Structure Construction, latest edition.

Section 201 Clearing and Grubbing
Section 205 Roadway and Drainage Excavation
Section 301 General Requirements for Base Aggregates
Section 501 Concrete
Section 601 Concrete Curb and Gutter
Section 612 Underdrains
Section 628 Erosion Control

Section 645 Geotextile Fabrics

In addition to the WisDOT Standards and Specifications for Highway and Structure Construction, latest edition, the American Concrete Institute (ACI) Specification for Pervious Concrete Pavement (ACI 522.1-08) is also included by reference.

3. SUBMITTALS

a. SUBMITTALS REQUIRED PRIOR TO BID OPENING

Prebid approval of materials is not required. Suppliers and products have been identified as a means of establishing quality, but not for purposes of limiting competition.

b. SUBMITTALS DURING CONSTRUCTION

[NTS: Update language of this Section as necessary based on applicable references to front-end specifications.]

Submittals during construction shall be made in accordance with Section 01300 in Division 1, GENERAL REQUIREMENTS. In addition, the following specific information shall be provided:

1. CONTRACTOR's Qualifications: CONTRACTOR shall submit information showing conformance with qualification requirements listed in specifications. Submit CONTRACTOR Qualifications to OWNER for review prior Notice to Proceed.

2. Porous Pavement Surface: CONTRACTOR shall submit drawings and documentation for the porous pavement surface in accordance with the respective industry standards, including:

   a. ACI Specification for Pervious Concrete or the recommendations of the Wisconsin or National Ready Mixed Concrete Associations for pervious concrete. Only one test panel, as described in ACI 522.1-1.5.3.4, shall be required to be placed. If total proposed pervious concrete area is less than the required 225 square feet for a test panel, the test panel shall be the entire proposed pervious concrete area;

   b. Wisconsin or National Asphalt Pavement Associations for porous asphalt;

   c. Concrete Pavement Institute, Brick Industry Association, or National Concrete Masonry Association for permeable interlocking pavers and permeable blocks.

CONTRACTOR may submit drawings and documentation conforming to other industry standard sources for review by OWNER. OWNER will review and inform CONTRACTOR in writing that drawings and documentation conforming to industry standards not specifically mentioned here are either approved or not approved. Only those approved in writing by OWNER will be accepted.

Submit shop drawings to OWNER for review and approval prior to installation.

3. Bedding Aggregate Layer, Base Course Aggregate Layer, Stormwater Storage Aggregate Layer: CONTRACTOR shall submit sieve analysis by a qualified testing laboratory and other documentation necessary showing conformance with specifications for each aggregate layer. Submit sieve analysis and other documentation to OWNER for review and approval prior to installation.

4. Underdrain Piping: CONTRACTOR shall submit shop drawings of underdrain piping showing conformance with specifications. Submit shop drawings to OWNER for review and approval prior to installation.

5. Porous Pavement Surface Performance Infiltration Testing: CONTRACTOR shall submit results of surface infiltration testing completed in accordance with applicable standards to OWNER for review and approval prior to final acceptance.

4. SUBSTITUTION OF MATERIALS

The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with GENERAL CONDITIONS.

5. SHOP DRAWINGS, MATERIAL REVIEW AND SAMPLES

a. Porous Pavement Surface

b. Bedding Aggregate Layer

c. Base Course Aggregate Layer

d. Stormwater Storage Aggregate Layer

e. Underdrain Piping

6. CONTRACTOR QUALIFICATIONS

The CONTRACTOR shall have five years' experience (minimum) and shall have completed green infrastructure work similar in material, design, and extent to that indicated for this Project. CONTRACTOR must provide five or more successful installations of green infrastructure projects.

7. TOLERANCES

Tolerances for porous pavement green infrastructure strategy construction and materials shall conform to the requirements hereinafter specified. The finished surface elevation of the porous pavement green infrastructure strategy shall be as required by the respective industry standards referenced in the specification. If tolerance for surface elevations are not discussed in industry standard specifications, elevations shall be within 0.06 feet (+/-) of the finished elevations as specified in the drawings. Subgrade elevations shall be within 0.12 feet (+/-) of the finished elevations as specified in the drawings.

B. MATERIALS

1. GENERAL

All porous pavement green infrastructure strategies shall meet the requirements of the following specifications. The OWNER reserves the right to take samples of materials whenever deemed necessary.

2. POROUS PAVEMENT SURFACE

The porous pavement surface shall conform to the following specifications:

a. Pervious concrete shall conform with all requirements of ACI 522.1, "Specification for Pervious Concrete Pavement," published by the ACI, Farmington Hills, Michigan, except as modified by these Specifications

b. Porous asphalt shall conform with all requirements of the Wisconsin or National Asphalt Pavement Associations, except as modified by these Specifications.

c. Permeable interlocking pavers and permeable blocks shall conform with all requirements of the Concrete Pavement Institute, Brick Industry Association, or National Concrete Masonry Association, except as modified by these Specifications.

d. All porous pavement green infrastructure strategy surface treatments shall have a percent voids less than 25 percent and meet the porous pavement surface performance requirements listed in Section C.1 of this

specification.

3. BEDDING AGGREGATE LAYER/JOINT FILL AGGREGATE

Bedding aggregate layer is intended to provide a suitable surface on which to place the permeable interlocking pavers and permeable blocks. The bedding aggregate layer is not required for pervious concrete or porous asphalt. The minimum depth of the bedding aggregate layer shall be 5 inches for permeable interlocking pavers and permeable blocks. Aggregate shall be provided in accordance with ASTM C-33 and size No. 8, 89, 9, or 57 aggregate. Aggregate shall be kept sediment-free during storage and handling and placed to avoid segregation of aggregate.

If required by drawings, joint fill aggregate shall be provided between the joints of the permeable interlocking pavers and permeable blocks. Joint fill material depth can be included to meet the total depth for bedding aggregate layer for the permeable interlocking pavers or permeable blocks so long as the total combined depth of the two layers is 5 inches. Aggregate shall be provided in accordance with ASTM C-33 and size No. 8, 89, 9, or 57 aggregate. Aggregate shall be kept sediment-free during storage and handling and placed to avoid segregation of aggregate.

4. BASE COURSE LAYER

Base course layer is required for permeable interlocking pavers. Base course layer shall be installed to depth shown on the drawings and a minimum of 4 inches in depth. Aggregate shall be provided in accordance with ASTM C-33 and size No. 57 aggregate. Base course aggregate conforming to these specifications may be considered part of the aggregate storage depth. Aggregate shall be kept sediment-free during storage and handling and placed to avoid segregation of aggregate.

5. STORAGE LAYER

The storage layer below the porous pavement surface is intended for temporary storage of stormwater runoff. Storage layer shall be installed to depth shown on the drawings and a minimum of 12 inches in depth. The storage layer shall consist of aggregate that shall conform to the following specifications:

a. The aggregate shall be open graded consisting of crushed stone or crushed gravel with no greater than 5 percent passing the No. 200 sieve.

b. Aggregate shall have a minimum porosity of 30 percent in accordance with ASTM C29 Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate.

c. Aggregate shall be in accordance with soundness, wear, and fracture requirements listed in WisDOT Standards and Specifications for Highway and Structure Construction Section 301.2.4.5 - Aggregate Base Physical Properties.

d. Aggregate shall be kept sediment-free during storage and handling and placed to avoid segregation of aggregate.

6. UNDERDRAIN PIPING

The underdrain pipe shall conform to the following specifications:

a. The underdrain pipe shall have a minimum diameter of 4 inches and be made of SDR-35 PVC or other material approved by the OWNER. The pipe shall be capable of withstanding expected traffic loads over portions of the pipe extending beyond the soil planting bed.

b. The underdrain orifice shall be restricted as necessary so that the design infiltration rate plus the underdrain rate equals the design draw down rate. The restriction shall be achieved by using an adjustable restrictor plate or valve. The restriction device shall be accessible for adjustment.

c. The total opening area of all perforation holes combined shall be sufficient to allow the underdrain pipe to discharge at full capacity, as would occur if there were no orifice restriction. The amount of perforations shall be increased to provide a margin of safety but shall not be so great as to compromise structural integrity of the pipe material. The size of the perforations shall be small enough to prevent surrounding aggregate material from traveling through the perforations. A minimum of three rows of perforations shall be used.

d. The underdrain pipe shall be protected from clogging by use of a cover of pea gravel. The pea gravel shall conform to the following specifications:

1. Pea gravel - The pea gravel layer shall be at least 4 inches thick on all sides of the underdrain. Pea gravel shall be washed. Pea gravel shall be large enough to prevent its falling through the perforations of the underdrain pipe. The pea gravel shall be sized in accordance with AASHTO No. 8 aggregate (size number according to AASHTO M43) to meet the following gradation requirements:

Sieve Size	Percent Passing by Weight
1/2-inch	100
3/8-inch	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

e. The underdrain pipe shall have a vertical, connecting standpipe to serve as a clean-out port for the underdrain pipe. The pipe shall be rigid, non-perforated SDR-35 PVC pipe, a minimum of 6 inches in diameter and covered with a watertight cap. Watertight cap shall be installed flush with porous pavement surface. Watertight cap assembly shall be southern code countersunk brass screw plug with 6 inch ASTM D3034 PVC gasketed adapter (to accept PVC pipe) fitted with cast iron top, which is internally threaded.

7. OBSERVATION WELLS

If there is no underdrain or the underdrain is located above the bottom of the storage layer, an observation well shall be installed to monitor drainage from the porous pavement green infrastructure strategy. If the porous pavement green infrastructure strategy exceeds one acre, one additional observation well shall be installed per additional acre. The observation wells shall conform to the following specifications:

a. The observation well shall be a minimum 6 inch diameter slotted SDR 35 PVC pipe from the bottom of the storage layer to the top of the storage layer and then solid wall PVC pipe from the top of the storage layer to the porous pavement surface, anchored vertically to a footplate at the bottom of the storage layer. Observation well shall be covered with a watertight cap. Watertight cap shall be installed flush with porous pavement surface. Watertight cap assembly shall be southern code countersunk brass screw plug with 6 inch ASTM D3034 PVC gasketed adapter (to accept PVC pipe) fitted with cast iron top, which is internally threaded.

b. Foot plate shall be 24 inch by 24 inch by 3/8 inch thick HDPE sheet with PVC cap to match dimension of the observation well pipe and shall be anchored to the HDPE sheet with four 3/8 inch stainless steel bolts and washers to prevent movement and rotation. Observation well PVC pipe shall be connected to PVC cap in accordance with manufacturer's recommendations.

8. NON-WOVEN GEOTEXTILE FILTER FABRIC

Porous pavement green infrastructure strategy shall include non-woven geotextile filter fabric as shown on drawings. Non-woven geotextile fabric shall be in accordance with WisDOT Standards and Specifications for Highway and Structure Construction Section 645 - Geotextile Fabrics.

9. CONCRETE CURB

Porous pavement green infrastructure strategy shall be surrounded by concrete curb in accordance with WisDOT Type "A" Concrete Curb without deformed tie bars. Concrete curb shall be provided in accordance with WisDOT Standards and

Specifications for Highway and Structure Construction Section 601 - Concrete Curb and Gutter. Concrete curb shall be installed to elevations shown on the drawings.

C. WORKMANSHIP

1. POROUS PAVEMENT SURFACE PERFORMANCE

a. CONTRACTOR shall complete testing of installed porous pavement green infrastructure strategies to determine the surface infiltration rate upon completion of installation is a minimum of 100 inches/hour. Porous pavement green infrastructure strategies not meeting this criteria will not be accepted. Porous pavement green infrastructure strategies shall be tested in accordance with the following criteria:

1. Pervious concrete shall be tested in accordance with ASTM C1701 - Standard Test Method for Infiltration Rate of In Place Pervious Concrete.

2. Porous asphalt shall be tested in accordance with ASTM D6390 - Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures.

3. Permeable interlocking pavers and permeable blocks shall be tested in accordance with ASTM C1781 - Standard Test Method for Surface Infiltration Rate of Permeable Unit pavement Systems.

2. STORAGE LAYER INSTALLATION

a. Aggregate shall be installed in accordance with WisDOT Standards and Specifications for Highway and Structure Construction Section 301.3.

3. CONSTRUCTION SITE STABILIZATION

a. CONTRACTOR shall not construct porous pavement strategies until all of the contributing drainage areas are stabilized to the satisfaction of the OWNER. Do not use the porous pavement strategies as temporary sediment control facilities during construction. It is the responsibility of the CONTRACTOR to sequence the construction of the porous pavement strategies in a manner such to prevent sediment from entering the porous pavement strategies as a result of construction activities.

b. Construction site runoff from disturbed areas shall not be allowed to discharge onto the surface of the porous pavement. CONTRACTOR shall use sediment control measures as necessary to prevent construction site runoff from discharging onto the surface of the porous pavement. Sediment control measures indicated on design drawings are not

intended to limit the CONTRACTOR in the manner and techniques to control erosion. It is the responsibility of the CONTRACTOR to control erosion from this site during construction.

c. Sediment that discharges onto the surface of the porous pavement during construction as a result of construction activities shall be removed by the CONTRACTOR at no cost to the OWNER. In circumstances where, in the opinion of the OWNER, sediment significantly impacts the functionality of the underdrains, observation wells, aggregate materials, or porous pavements, these items shall be completely replaced by the CONTRACTOR at no cost to the OWNER.

d. CONTRACTOR shall not store any equipment or materials within the perimeter of the porous pavement area.

4. SUITABLE WEATHER

a. Construction of the porous pavement strategies shall be suspended during periods of rainfall or snowmelt. Construction shall remain suspended if ponded water is present or if residual soil moisture contributes significantly to the potential for soil smearing, clumping, or other forms of compaction within the porous pavement strategies. CONTRACTOR shall inspect and maintain all sediment control measures protecting both the porous pavement strategies and the entire project site following periods of rainfall or snowmelt.

5. COMPACTION AVOIDANCE

a. Compaction and smearing of the soils beneath the floor and sides of the porous pavement area shall be minimized. During site development, the area dedicated to the porous pavement area shall be cordoned off to prevent access by heavy equipment. Acceptable equipment for constructing the porous pavement strategy includes excavation hoes, light equipment with turf type tires, marsh equipment or wide-track loaders.

b. If compaction occurs at the base of the porous pavement strategy, the soil shall be refractured to a depth of at least 12 inches. Additional base or subbase may be required along with additional compaction of these materials to reduce the risk of surface settlement. CONTRACTOR shall provide OWNER with plan for reducing compaction of over-compacted soils prior to completion of the work for acceptance by OWNER. Refracturing shall not be used by CONTRACTOR in lieu of proper compaction avoidance techniques.

6. SUBGRADE PREPARATION

a. The slope of the subgrade shall be as flat as possible. In no case shall the subgrade slope be greater than 2 percent. A series of aggregate storage reservoir cells can be designed and constructed to prevent seepage through downgradient portions of the permeable pavement surface, if necessary.

7. POST-CONSTRUCTION CLEANING

a. Following substantial completion of the Project, CONTRACTOR and OWNER shall inspect the porous pavement green infrastructure strategy surface. If OWNER determines the surface requires cleaning before final acceptance, CONTRACTOR shall clean the surface of the porous pavement green infrastructure strategy in accordance with industry recommended methods. These methods include items such as regenerative air or vacuum sweeping.

8. NOTIFICATION

a. CONTRACTOR shall notify OWNER following the excavation of porous pavements, prior to installation of underdrains, observation wells, storage layer, base course layer, bedding layer, and porous pavement surface mixture. CONTRACTOR shall only proceed with the installation of these items with approval of the OWNER.

D. PAYMENT

Except as noted otherwise hereinafter payment for the work in this Section will be based on the quantities and unit bid prices for each of the individual bid items for the porous pavement green infrastructure strategy. Payment will be made at the unit prices stated in the Bid. The unit prices shall constitute full compensation for all labor, equipment, materials, and incidentals necessary for the satisfactory completion of the work.

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