

# Seattle Permits

— part of a multi-departmental City of Seattle series on getting a permit

## PERMEABLE PAVEMENT IN THE RIGHT-OF-WAY

Effective Date 5/30/2010

The 2009 Seattle Stormwater Code will introduce new requirements for stormwater management. The new code requires all Single-family residential projects and all other projects with 7,000 square feet or more of land disturbing activity or 2,000 square feet or more of new plus replaced impervious surface to implement green stormwater infrastructure (GSI) to infiltrate, disperse, and retain drainage water onsite to the maximum extent feasible. GSI includes bioretention, permeable pavement, and green roofs.

In addition, the Department of Planning and Development, updated the Green Factor Standards in 2009. The Green Factor is a landscape requirement designed to increase the quantity and quality of planted areas in Seattle while allowing flexibility for developers and designers to meet development standards. It currently applies to new development in commercial and neighborhood commercial zones outside of downtown, and is proposed for multifamily residential zones and the South Downtown planning area.

Permit applicants in affected zones must demonstrate that their projects meet the Green Factor by using the Green Factor Score Sheet. The scoring system is designed to encourage permeable paving, green roofs, vegetated walls, preservation of existing trees, and layering of vegetation along streets and other areas visible to the public.

Because the revised Stormwater Code and the updated Green Factor requirements promote the use of GSI both on private property and within the City of Seattle Right of Way, SDOT has incorporated design guidelines for GSI in the current version of the City of Seattle Right-of-Way Improvement Manual (ROW IM).

This Client Assistance Memo provides additional information for permeable paving in the Right-of-Way. It includes:

- the approved permeable pavement wearing courses for ROW applications,
- the siting requirements for permeable pavement, and
- SDOT's permitting review process for GSI.

Additional design guidelines can be found in the ROWIM Manual - Section 6.4 Natural Drainage Systems.

### PERMEABLE PAVING WEARING COURSE APPROVED LIST

Permeable Cement Concrete is currently the only acceptable permeable pavement that is approved only as a walking surface in the ROW. Additionally, permeable cement concrete is the only approved material that may be used to meet stormwater code requirements.

Permeable pavement is not approved for use as a driving surface, including driveways and parking lanes. Permeable pavement will also not be approved within the footprint or landings of accessible ramps.

Excluding designated walking surfaces within the ROW, all other permeable pavement types identified in the GSI permeable pavement table will be considered for approval. The table can be found at:

[http://www.seattle.gov/util/stellent/groups/public/@spu/@usm/documents/webcontent/spu02\\_019966.pdf](http://www.seattle.gov/util/stellent/groups/public/@spu/@usm/documents/webcontent/spu02_019966.pdf)

However, these types of permeable pavements will not be approved to meet Stormwater code requirements.

The approved specifications for permeable cement concrete are provided in *Attachment A*. Other

[www.seattle.gov/transportation](http://www.seattle.gov/transportation)



materials are currently under review by SDOT and will be included in this CAM as soon as they are approved for use in the Right of Way as a designated walking surface.

### **SITING REQUIREMENTS FOR PERMEABLE PAVING**

The following siting considerations should be made when determining if Permeable Paving is a suitable material:

- Area of installation – The City requires that the area of installation must be at least 2,000 square feet or one block frontage, whichever is less.
- Longitudinal Slope – the longitudinal slope must not exceed 5%
- Existing Trees and Tree Canopy – In areas with mature trees the root zone must be considered. Retention of tree roots necessary to support the health and future growth of the tree may dictate the limits of the paved area as well as the drainage capacity for permeable paving. Additionally, areas shaded by trees may be limited to a specific type of permeable paving or may be considered unsuitable altogether.

### **SDOT STREET USE PERMITTING REQUIREMENTS**

All GSI infrastructure (including permeable pavement) installed in the right of way as a Stormwater Code requirement or for Green Factor Credits, must obtain a SDOT Street Improvement Permit prior to construction. Refer to CAM 2200 for information regarding the SDOT Street Improvement Permitting Process. Permeable paving requires 60% Complete SIP approval. Refer to CAM 2211 and CAM 2213 for requirements to obtain 60% Complete SIP approval.

The following Specifications have been approved by SDOT for use of the placement of Permeable Cement Concrete Sidewalks. These Specifications should be used in conjunction with the City of Seattle, Standard Specifications and Plans for Municipal Construction, 2008 Edition.

## **SECTION 5-06           POROUS CEMENT CONCRETE (GSP 09-30-09)**

### **5-06.1 DESCRIPTION**

Section 5-06 describes work consisting of constructing porous cementitious sidewalk and walkway applications including excavation, subgrade preparation, geotextile, and aggregate discharge subbase, that shall allow surface water to permeate through the porous surface into the supporting materials to allow infiltration or detention of surface waters,

### **5-06.2 MATERIALS**

Materials shall meet the requirements of the following Sections:

Portland Cement and Pozzolans	9-01
Fine Aggregate for Portland Cement Concrete	9-03.1(2)
Aggregates for Porous Pavements	9-03.1(4)
Crushed Gravel (Mineral Aggregate)	9-03.11
Premolded Joint Filler for Through, Construction and Expansion Joints	9-04.1(2)
Concrete Curing Materials, and Mixes Incorporating Pozzolans and Admixtures	9-23
Water	9-25
Construction Geotextiles	9-37

Portland cement shall be Type II, Type IP, or Type I (SM). Blended hydraulic cement shall conform to the requirements of Section 9-01.2(4).

Allowable Pozzolans:

1. Fly ash, if used, shall be Class F as specified in Section 9-01.6(1).
2. Ground granulated blast furnace slag, if used, shall be as specified in Section 9-01.6(2).
3. Silica fume shall not be allowed.

See Sections 9-01.6 and 9-23.9 for additional constraints.

Fine aggregate for porous concrete shall be Class 1 as specified in Section 9-03.1(2).

Coarse aggregates for porous concrete shall conform to the requirements of Section 9-03.1(3).

Aggregates for the discharge subbase gravel shall meet the requirements of mineral aggregate Type 24 or substitute material approved by the Engineer.

Premolded joint filler for isolation joints shall conform to the requirements of Section 9-04.1(2).

Curing materials shall be sheet materials as specified in Section 9-23.1.

Hydration stabilizing admixtures shall meet the requirements of ASTM C494, Type B or Type D.

Microfibers shall conform to the requirements of ASTM C 1116, Type III and shall be ½ inch in length.

Unless otherwise specified or shown on the Drawings, geotextile shall be nonwoven and shall meet the requirements of Tables 1 and 2 of Section 9-37.2 for Moderate Survivability and Class C.

### **5-06.3 CONSTRUCTION REQUIREMENTS**

#### **5-06.3(1) POROUS CONCRETE MIX DESIGN**

The Contractor shall propose a mix design for porous concrete and shall submit the mix design to the Engineer for acceptance prior to constructing the Test Section. Porous concrete shall not be placed in the Test Section without a mix design that has been reviewed and accepted by the Engineer.

##### **5-06.3(1)A MIX DESIGN CRITERIA AND PROCEDURES**

The Contractor shall include the following elements and results of the described procedures in the proposed mix design:

1. The cementitious content, including pozzolans if used, shall be a minimum of 500 pounds per cubic yard, calculated as portland cement (cement plus cement substituted for).
2. The mix shall incorporate a hydration stabilizing admixture.
3. The mix shall incorporate ½ inch microfibers at a rate of 1.5 pounds per cubic yard.
4. The mix shall be designed to have a total void content greater than 15 percent and less than 30 percent, in place, as constructed. Void content of the mix shall be determined from a minimum three (3) samples of four (4) inch diameter core samples from a finished test section of the proposed mix design using the following methods:

##### **5-06.3(1) A1 VOID CONTENT OF THE MIX; LAB TEST:**

Determine the bulk specific gravity ( $G_B$ ) of the core using the method described in ASTM D1188. Core samples shall be trimmed to 4-1/2 inches in depth to provide increased uniformity of test results. Trimming shall be squared and from the bottom of each pavement core samples.

Dry the core samples at a temperature not to exceed 65 C (150° F) until a constant mass ( $\pm 0.1\%$ ) is obtained and allow to cool to ambient temperature. Remove paraffin coating from core samples.

Weigh the core and record weight to the nearest 0.1 g.

Use the pycnometer apparatus as described in ASTM D2041.

Place core samples in calibrated pycnometer and cover completely with water. If the core sample is too large to be placed into the pycnometer, it may be broken into pieces and placed into the pycnometer together or the pieces may be evaluated separately.

Place the lid on pycnometer and fasten it on a mechanical agitation device.

Turn on the agitation device and slowly apply a vacuum to the pycnometer until the vacuum reaches  $3.7 \pm 0.3$  kPa ( $27.5 \pm 2.5$  mm Hg). The vacuum should be reached in less than 2 minutes.

After the vacuum is achieved, maintain vacuum and agitation for a period of  $15 \pm 2$  minutes.

Slowly release the vacuum and determine the weight of the sample and pycnometer as described in paragraph 9.5.1 or paragraph 9.5.2 in ASTM 2041.

Calculate specific gravity ( $G_{mm}$ ) as described in paragraph 10.1.1 or paragraph 10.1.2 in ASTM 2041, as appropriate.

If multiple procedures are run for separate pieces of the core, the weighted average of all of the runs will be the specific gravity ( $G_{mm}$ ) of the core as a whole.

$$G_{mm} = \frac{\text{sum}(G_{mm1} \times W_{t1} + G_{mm2} \times W_{t2} + \dots + G_{mmi} \times W_{ti})}{W_{t_{total}}}$$

The percentage of air voids will be calculated as:

$$\text{Voids} = \frac{G_{mm} - G_B}{G_{mm}} \times 100\%$$

Where:

V = Voids in the Sample (%)

$G_{mm}$  = Specific Gravity of the Core Material Less Air Voids

$G_B$  = Bulk Specific Gravity of the Core as determined by ASTM D1188

This Void Content lab Test information shall be part of the Mix Design submittal.

#### **5-06.3(1) A2 VOID CONTENT OF THE MIX; TEST SECTION:**

The test section will not be accepted unless each of the cores has a void content between 15 and 30 percent.

Porous concrete mix shall also have an infiltration rate equal to or greater than 100 inches per hour, in place, as constructed. The locations for conducting the infiltration tests shall be determined by the Engineer and tests shall be conducted in the presence of the Engineer. Coordinate and schedule inspections with the Engineer a minimum of five (5) Working Days in advance. The infiltration rate shall be measured in the following manner:

Place a cylinder with an inside diameter between 16 and 19 inches, and sufficient height to hold five (5) gallons of water, on the finished pavement and seal the mating surfaces with plumbers putty. (Schedule 40 PVC pipe with at nominal diameter of 18 to 20 inches, cut 18 inches in length, will make a satisfactory testing cylinder). The plumbers putty shall be suitable for the matting materials.

Fill cylinder with four (4) gallons of water in 2 seconds or less.

When all of the water has been poured into the cylinder, measure the time in seconds until the water in the cylinder has drained.

Calculate the infiltration rate using the following equation:

$$R = \frac{3,326,760}{AT}$$

Where:

R = Infiltration Rate (in/hr)

A = Cross Sectional Area of Cylinder (in<sup>2</sup>)

T = Time to Empty Cylinder (s)

The amount of water added to the mix shall be carefully controlled such that the aggregates are well coated with paste and the paste has a sheen without separating from the aggregates. The water / cement ratio shall be between 0.27 and 0.35, as required. An indicator that a proper amount of water has been added, is the mix can be formed into a ball without crumbling or the paste flowing into the void space.

Fine aggregate may be added to the mix, but shall not exceed three (3) cubic feet per cubic yard. No more than 25 percent of portland cement in the mix, by weight, may be replaced by fly ash, ground granulated blast furnace slag, or a combination of both.

#### **5-06.3(1)B JOB MIX FORMULA (JMF)**

Once accepted by the Engineer, the mix design shall become the Job Mix Formula (JMF) and shall not be modified in any way. The JMF shall be determined from information submitted under Section 5-06.3(2) and from results of Test Section testing as described in Section 5-06.3(7)B. The JMF shall include the following:

1. Batch weights of all constituents.
2. Portland cement type and brand.
3. Pozzolan type and source.
4. Microfiber brand.
5. Admixture type and brand.
6. Aggregate source(s) and gradation(s).
7. Fresh density of the porous concrete.
8. Unit weight of the hardened porous concrete.

Modifications to the JMF will not be allowed and any modified mix placed in the Work will be rejected. Proposed modifications to the JMF shall be submitted as a new mix design and shall require a new test section to validate the proposed mix design and determine the new JMF. If accepted by the Engineer, the new mix design shall become the JMF. Only one (1) JMF shall be valid at any time. Admixture dosages may be modified as needed to maintain mix properties.

#### **5-06.3(2) SUBMITTALS**

In accordance to section 1-05.3, the Contractor shall submit the following items to the Engineer for acceptance prior to placing any porous concrete pavement or test section:

The source of all materials proposed for use in constructing porous concrete sidewalks.

1. Batch weights for all constituents of one (1) cubic yard of the proposed porous concrete mix.
2. The specific gravity (SSD) of all aggregates to be used in the proposed porous concrete mix.
3. The proposed gradation of coarse and fine (if used) aggregates used in porous concrete.
4. The designed volume in cubic feet of 1(one) cubic yard of the proposed porous concrete mix.
5. The target voids content of the cured proposed cured porous concrete mix.
6. The design water / cement ratio of the proposed mix design.
7. The fresh density of the proposed porous concrete mixture as determined using the jiggling procedure outlined in ASTM C29. The proposed gradation of aggregates to be used in the discharge subbase gravel.
8. Catalogue cuts for all proposed admixtures and geotextiles.
9. Chemical analyses of the portland cement and pozzolans, if used, for the current lot to be used in the production of the proposed porous concrete mix. The Contractor shall maintain this submittal throughout the duration of the project as lots change.

10. Manufacturer certification(s) that the current lot of portland cement and pozzolans, if used, conform to the requirements of Section 5-06.2. The Contractor shall maintain this submittal throughout the duration of the project as lots change.
11. Current certification by the National Ready Mix Concrete Association (NRMCA) for the batch plant to be used in the production of porous concrete.
12. Current certifications by the NRMCA for the trucks to be used in transporting porous concrete from the batch plant to the point of placement.
13. Current certifications by the NRMCA for the Contractor's personnel who will be installing sidewalk for "Pervious Concrete Installer" and "Pervious Concrete Technician", as applicable.

### **5-06.3(3) EQUIPMENT**

The Contractor shall provide all equipment necessary for handling materials and performing all parts of the Work.

Vibrators shall not be used for placement of porous concrete.

### **5-06.3(3)A BATCHING PLANT**

Porous concrete shall be mixed in a batch plant meeting the provisions of Section 6-02.3(3)A.

### **5-06.3(3)B MIXER TRUCKS**

Porous concrete shall be transported to the location of placement by a rolling drum mixer truck with current (within 12 months) certification by the NRMCA. Non-agitating trucks shall not be used for the transport of porous concrete.

### **5-06.3(3)C SIDE FORMS**

Porous concrete sidewalks shall be constructed using side forms. Slip form paving will not be allowed. Forms for porous concrete sidewalks shall be made of steel or wood and shall be in good condition, clean and be capable of being anchored in place so that they will be true to grade, line and slope. Forms that are bent, warped, unclean or otherwise deemed inadequate by the Engineer, shall not be used. If porous concrete is to be placed against a curb or other existing structure, the curb or structure shall be used as a side form for the porous concrete sidewalk paving.

Prior to inspection by the Engineer, the Contractor shall inspect all forms for line, grade and slope. No porous concrete shall be placed until the forms are inspected and accepted by the Engineer.

### **5-06.3(3)D FINISHING EQUIPMENT**

Finishing equipment for porous concrete sidewalk paving shall be designed for the intended work, shall be clean and in good operating condition.

Vibrating screeds shall not be used for striking off the porous concrete. Equipment used for striking off the porous concrete shall leave a smooth surface at the planned grades and shall not cause excess paste to be left on, or drawn to, the surface. The strike off apparatus shall be set up to allow the forms to be overfilled by  $\frac{1}{2}$  to  $\frac{3}{4}$  inch, or as necessary, to allow for compaction of the porous concrete to grade.

If rollers are used to compact, the rollers shall be of sufficient weight and width to compact the porous concrete to grade without marring the surface. Rollers used for compacting porous concrete shall not cause the surface to close or otherwise clog and shall produce a surface that is free of ridges or other imperfections. Rollers used for producing contraction joints shall be designed and manufactured for the purpose, shall have sufficient weight to produce the joint and shall not otherwise damage or mar the surface.

Tamps, hand finishing equipment and tools for joints shall be in good repair and adequate for the intended use.

### **5-06.3(3)E JOINT SAWING EQUIPMENT**

Equipment for sawing joints in porous concrete sidewalks shall be power driven concrete saws. Concrete saws shall not tear, spall or otherwise damage the porous concrete. The Contractor shall maintain concrete saws in good operating condition and shall keep an adequate supply of blades on hand. Measures to collect dust and slurry during sawcutting operations shall be implemented by the Contractor. There shall be an adequate number of concrete saws and equipment on the project so that sawing may occur at a rate to prevent random cracking of the porous concrete sidewalk; including contingency in the event of a breakdown.

### **5-06.3(3)F SMOOTHNESS TESTING EQUIPMENT**

The Contractor shall provide a 10-foot straight edge to be used for measuring the profile of the porous concrete sidewalk. The straight edge device shall be designed so that it may be easily moved from location to location without marring the surface of the freshly compacted porous concrete. The Engineer shall accept the 10-foot straight edge prior to placing porous concrete.

### **5-06.3(4) MEASURING AND BATCHING MATERIALS**

Measuring and batching materials for porous concrete sidewalks shall conform to the requirements of Section 5-05.3(4).

### **5-06.3(4)A ACCEPTANCE**

For acceptance, porous concrete sidewalk will be divided into lots. A single lot shall be represented by the lesser of: one (1) day's production or 50 cubic yards of porous concrete in place. Where more than one lot is established in a day's production, should the last lot be less than 25 cubic yards in size it shall be incorporated into the previous lot; where 25 cubic yards or greater, is shall become another lot. Where the Contractor has more than one crew placing porous concrete, lots shall be associated with each crew. Porous concrete placed by different crews may not be aggregated to produce a lot. Acceptance shall be on a lot by lot basis. Acceptance of a lot of porous concrete sidewalk will be based on the following criteria:



1. **Grade:** Porous concrete sidewalk shall be true to planned grades plus or minus ½ inch and shall not deviate from grade more than ¼ inch in ten (10) feet. Where abutting existing facilities such as sidewalks, walkway, curbs, driveways or other pavements, the porous concrete sidewalk will be flush and provide a transition that will not deviate in more than ¼ inch in ten (10) feet.
2. **Line:** Porous concrete sidewalk margins shall be true to planned lines plus or minus ½ inch at any point.
3. **Slope:** Porous concrete sidewalk shall be sloped as shown on the Drawings. Slope shall be consistent to within 1/4 inch in ten (10) feet.
4. **Conformance to JMF:** The porous concrete used shall conform to the JMF within the limits as set forth in Section 6-02.3(4)C and as determined from the accepted test panel.
5. **Thickness:** Three (3) core samples of, four (4) inches in diameter shall be taken from each lot for acceptance in accordance with ASTM C42. Implement measures to collect slurry and debris during coring operation in order to avoid sealing adjacent pavement. Each Core Sample shall be equal to the minimum section dept or more as specified in the Drawings. After core's length and diameter is measured, trim cores to uniform depth as specified in this section for determining the weight. Core holes shall be filled with concrete meeting the JMF and shall match adjacent pavement color, texture and grade.
6. **Unit Weight:** The unit weight of each core sample taken for acceptance shall be determined using the method described previously in this section. The unit weight of the core sample for each lot shall be within eight (8) pounds per cubic foot of the unit weight as accepted in the JMF.
7. **Infiltration Rate:** The infiltration rate of each lot shall be tested at three (3) random locations within the lot as described in Section 5-06.3(1)A. The average of all three (3) tests shall be greater than 100 inches per hour.
8. **Fresh Density:** The fresh density as measured using the jiggling procedure outlined in ASTM C29 at the point of placement shall be within or equal to five (5) pounds per cubic foot of the fresh density indicated by the JMF.
9. **Manufacturer's Certificate of Compliance:** Each load of porous concrete transported to the location of placement shall have an original Manufacturer's Certificate of Compliance as specified in Section 6-02.3(4)B delivered with the load. Photocopies, carbon copies or facsimiles are not acceptable.
10. **Appearance:** Each lot of finished porous concrete sidewalk shall be inspected for appearance by the Engineer. The porous concrete sidewalk shall have a consistent surface texture, shall have no more than five (5) percent of the surface area within each panel (joint to joint) filled with paste, shall not be raveled, shall be free of ridges or other surface imperfections, shall have joints that are in the specified location and are constructed per specification, and shall be free of cracks.

Quality Assurance Testing: Before final acceptance by the Engineer, the Contractor shall pressure wash the porous concrete sidewalk. Pressure washing shall be provided and completed by using portable washer equipment working at a minimum of 3000psi at 1.0 gpm. The nozzle shall be held a maximum of three (3) inches off the concrete surface. The Contractor shall pressure test three (3) locations per lot or as determined by the Engineer. Any sections of porous concrete that breaks up, ravel, or does not infiltrate shall be removed and replaced with acceptable porous concrete to the nearest joints. The Engineer will determine the acceptability of the concrete after pressure washing.

The Contractor shall decide, after placing the porous concrete, when to perform the quality assurance testing for the acceptance.

#### **5-06.3(4)B REJECTION**

Porous concrete sidewalk that does not meet the acceptance criteria put forth in Section 5-06.3(4)A will be rejected by the Engineer on a lot by lot basis. At the discretion of the Engineer, a localized area of porous

concrete sidewalk not meeting the requirements of items 1, 2, 3 and 8 of Section 5-06.3(4)A may be broken into a subplot bounded by planned joints.

Porous concrete sidewalk that has been rejected by the Engineer, or the Contractor, shall be removed and replaced at no additional cost to the Owner.

#### **5-06.3(5) MIXING POROUS CONCRETE**

Porous concrete shall be batched and centrally mixed at a semi-automatic or automatic batching plant with a current (within 2 years) certification from the NRMCA. Porous concrete shall not be shrink mixed or transit mixed.

The mixing time, after all materials have been delivered to the drum, shall not be less than 50 seconds or more than 90 seconds. The porous concrete aggregates shall be uniformly coated with paste and shall be of the required consistency. After mixing, the porous concrete shall be delivered to a truck meeting the requirements of Section 5-06.3(3)B for transport to the job site. Porous concrete shall be placed no more than 90 minutes from the time water is added to the cement. Porous concrete shall not be retempered.

#### **5-06.3(5)A LIMITATIONS OF MIXING POROUS CONCRETE**

Porous concrete shall not be mixed, placed, compacted or finished when the natural light is inadequate, as determined by the Engineer, unless an adequate and accepted lighting system is in operation.

Mixing and placing porous concrete shall only occur when the ambient air temperature, as measured in the shade away from artificial heat sources, is greater than 40°F and less than 80°F.

The temperature of porous concrete shall not be less than 50°F when placed and shall at no time be greater than 90°F.

Porous concrete shall not be mixed with frozen aggregates.

#### **5-06.3(6) AGGREGATE DISCHARGE SUBBASE**

Porous concrete sidewalk shall be constructed on an aggregate discharge subbase over the prepared subgrade. The aggregate discharge subbase shall be constructed to the lines, grades and thickness shown on the Drawings. Aggregate discharge subbase shall be as specified in section 5-06.2

Aggregate discharge subbase material shall be placed over the preplaced geotextile as specified. Geotextile shall be as specified in section 5-06.2. Aggregate discharge subbase shall be placed in lifts not to exceed 12 inches uncompacted. The aggregate discharge subbase shall be compacted to the satisfaction of the Engineer. The compaction equipment shall be of sufficient weight and dimensions so as not to break or degrade the aggregate. In areas that are not accessible to equipment, other mechanical means may be used to compact the aggregate discharge subbase. Equipment used for compaction of the aggregate discharge subbase shall be accepted by the Engineer prior to use.

The aggregate discharge subbase shall be true to grade and slope plus or minus 0.5 inches after compaction. Where the grade is low, the surface of the aggregate discharge subbase shall be scarified to a depth of two (2) inches, additional material added and recompact. If there are high areas, the material shall be removed and the area recompact.

The Contractor shall take care to protect the aggregate discharge subbase from damage and contamination. Damage to the aggregate discharge subbase shall be repaired to the satisfaction of the Engineer at no additional cost. Contaminated aggregate discharge subbase shall be removed and replaced to limits as

determined by the Engineer. The aggregate discharge subbase shall be inspected and accepted by the Engineer prior to placing any porous concrete sidewalk.

### **5-06.3(6) SUBGRADE PREPARATION**

Subgrade for porous concrete sidewalk shall be excavated, graded and compacted as specified in Section 8-14.3(2) except that the subgrade shall be compacted to a relative density of 92 percent of optimum density of the subgrade soil as determined by ASTM D 698. Prior to placing the geotextile fabric, the surface of the subgrade shall be scarified to a depth of ¼ to ½ inch. Once scarified, materials or equipment shall not be stored or permitted within the prepared subgrade area so as to avoid re-compaction of the scarified areas and diminishing the infiltration rate of the subgrade.

Geotextile shall be placed on the prepared subgrade prior to placing aggregate discharge subbase as shown in the Drawings. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer. Overlaps of the geotextile shall be a minimum 1 foot or to the manufactures recommendation, whichever is greater.

### **5-06.3(7) PLACING, SPREADING, AND COMPACTING POROUS CONCRETE**

Standard methods of placing, spreading, and compacting shall be as described herein. However, the contractor may submit for review and approval by the Engineer, alternative methods of work that deviate from the standard methods described in this specification. Such methods shall be demonstrated through the Test Section trial and will require final acceptance by the Engineer. Alternate methods that are rejected through the Test Section will be discontinued. Methods described in this specification shall be used.

#### **5-06.3(7)A CONTRACTOR'S QUALIFICATIONS**

The Contractor shall employ no less than one (1) NRMCA certified Pervious Concrete Craftsman who shall be on site, overseeing each placement crew during all porous concrete placement, or the Contractor shall employ no less than three (3) NRMCA certified Pervious Concrete Installers, who shall be on site working as members of each placement crew during all porous concrete placement, or the Contractor shall employ no less than three (3) NRMCA certified Pervious Concrete Technicians and one (1) Pervious Concrete Installer, who shall be on site working as members of each placement crew during all concrete placement unless otherwise specified. For those crews having personnel with NRMCA certified Pervious Concrete Technician certifications, the placement crew shall also successfully pass a Performance Evaluation required under NRMCA Pervious Concrete Installer certification.

The porous cement concrete sidewalk test section installed at the project site may be utilized as the “mock-up” placement required for the NRMCA “mock-up” Performance Evaluation exam for Pervious Concrete Installer certification. If the “mock up” placement installed for NRMCA certification does not meet the project specifications, the “mock up” placement shall be removed at the Contractor’s expense and a new porous concrete sidewalk test section shall be installed, tested and submitted for acceptance.

Documentation of NRMCA certifications for the Contractor’s personnel shall be submitted per Section 5-06.3(2) prior to proceeding with production placement of the porous concrete sidewalks.

If, in the opinion of the Engineer, personnel used for installing porous concrete sidewalk are unqualified, inattentive to quality, or unsafe, they shall be removed or reassigned from installation of porous concrete sidewalk at the written request of the Engineer.

#### **5-06.3(7)B TEST SECTION**

Production placement of porous concrete shall not occur until the Contractor has completed a test section of porous concrete sidewalk that meets all of the acceptance criteria herein and is accepted by the Engineer. The Contractor should allow time in his schedule for the construction and acceptance of the test section.

The Contractor shall construct a test section of porous concrete sidewalk with a minimum area of 225 square feet. The width of the test section shall be equal to the nominal width of the sidewalk to be placed. The test section shall be equivalent and representative of the production porous concrete sidewalk in all aspects including subbase depth and preparation. The Engineer shall observe and accept each element of porous concrete sidewalk construction. Construction and evaluation of the test section will occur as follows:

Notify the Engineer at least ten (10) Working Days before installing porous concrete sidewalk test section

Coordinate the location of the test section with the Engineer.

Install the test section in accordance with the Specifications and Drawings.

Notify the Engineer when each element of the test section is ready for inspection.

Remove, replace, and dispose of any unsatisfactory portions of test section as determined by the Engineer and at no additional cost.

Failure to install acceptable test sections of porous concrete will indicate an unqualified installer.

Production sections of this Work shall not be placed until achieving a complete test section that fully complies with the Drawings and Specifications and has written acceptance issued by the Engineer.

The completed test section shall be used to validate the porous concrete mix design and establish the JMF. Three (3), four (4) inch, cores shall be cut in accordance with ASTM C42 and these cores will be used to validate the mix design under the design criteria set forth in Section 5-06.3(1)A and the acceptance criteria of 5-06.3(4)A. The average unit weight of the cores as determined by ASTM D1188 shall be within eight (8) pounds per cubic foot of the average of the three (3) cores. The average unit weight of the cores shall be the unit weight used for the JMF. Core holes shall be filled with concrete meeting the proposed JMF and shall match adjacent pavement color, texture and grade.

Three (3) infiltration tests will be conducted in the test section for acceptance. Each of the infiltration tests shall meet the minimum infiltration rate requirement noted in Section 5-06.3(1)A.

The completed and accepted test section shall be maintained and protected throughout the duration of the Work and may not be demolished and disposed of without written permission from the Engineer. If the test section is incorporated into the Work, it shall remain in place accepted as a single lot.

### **5-06.3(7)C PLACING, SPREADING AND COMPACTING**

Prior to placing porous concrete, the Engineer will inspect and accept all formwork and subbase/subgrade. All surfaces that will contact the finished porous concrete shall be damp with no standing water. Porous concrete shall not be placed on standing water or frozen materials.

Porous concrete sidewalk shall be placed on the prepared subbase as close to its final position as possible in a continuous operation so as to minimize evaporation. Where necessary, the porous concrete may be spread with square edged shovels or rakes prior to strike off. The porous concrete shall be struck off or screeded to a depth sufficient to allow for compaction to grade. Porous concrete shall be placed in a single lift.

Contractor's personnel shall take care to avoid foot traffic in the porous concrete to prevent non-uniform compaction and to keep contaminating material from the mix. Foot traffic on fresh concrete shall not be allowed after it has been struck off.

Within 20 minutes of discharge from the truck, the concrete shall be compacted, finished and covered for curing. The compacted effort shall be sufficient to compact the fresh porous concrete to grade, not draw excessive paste to the surface and to leave a smooth finish. In areas where the roller cannot be brought to bear, hand tamping, or other methods accepted by the Engineer, may be used to compact the porous concrete. Edges and plastic formed joints shall be finished by hand tooling with a ½ inch radius edging tool. Defects shall be repaired immediately.

Porous concrete shall be placed continuously. Where placement has been halted for a period of 15 minutes, a header shall be placed between the forms and a construction joint formed. Construction Joint shall be located at the same spacing of where a contraction joint would be. The porous concrete shall be compacted and finished to the header before placement may continue. Upon resuming placement, the header may be carefully removed and a construction joint formed at that location. Any sloughing or sagging of the previously placed porous concrete at the header location shall be corrected prior to placing new porous concrete against the joint.

### **5-06.3(8) JOINTS**

Joints shall be of three (3) types: construction, contraction, isolation. Construction joints shall be formed at the end of a day's work or when necessary to stop production for any reason. Contraction joints shall be used to control random cracking. And, isolation joints shall be used where the porous concrete abuts existing facilities or where shown on the Drawings. Wherever possible, the angle between intersecting joint shall be between 80 and 100 degrees.

#### **5-06.3(8)A CONSTRUCTION JOINTS**

Construction joints shall be located as near as possible to the location of a planned contraction or isolation joint. Construction joints are to be formed by placing a header between the forms, at right angles, to the full depth of the finished porous concrete, and set to the height of the forms. Porous concrete shall be placed against the header and compacted and finished as normal, including edging. Upon resuming paving, the header shall be carefully removed and new porous concrete placed directly against the existing porous concrete. The new porous concrete shall be compacted and finished against the hardened porous concrete as if it were a form. If an isolation joint is planned at this location, then the premolded joint filler shall be placed against the existing porous concrete and the new porous concrete shall be placed against the premolded joint filler. The joint shall be tooled on both sides of the premolded joint filler.

#### **5-06.3(8)B CONTRACTION JOINTS**

Contraction joints shall be placed every 20 feet unless otherwise shown on the Drawings. Contraction joints shall have a depth of 1/3 the thickness of the porous concrete and have a width of no more than 1/8 inch. Contraction joints may be formed in the plastic concrete using a roller designed for this purpose or by other methods accepted by the Engineer. Plastic formed contraction joints shall be tooled on both sides of the joint with a radius of ½ inch.

At the option of the Contractor, contraction joints may be saw cut after the porous concrete has hardened. If saw cutting the contraction joints, saw cutting shall occur as soon as the concrete is sufficiently cured so that it may be cut without raveling or dislodging aggregate from the finished surface. Measures to collect dust and slurry during sawcutting operations shall be implemented by the Contractor. To minimize drying, curing materials shall be removed only as needed to make cuts and shall be replaced immediately after cutting.

#### **5-06.3(8)C ISOLATION JOINTS**

Isolation joints shall be placed where the porous concrete abuts existing structures or where shown on the Drawings. Isolation joints shall continue through the depth of the porous concrete using a 3/8 inch premolded joint filler. Isolation joints may be formed by inserting the premolded joint filler into the plastic

concrete or by forming a construction joint and affixing the premolded joint filler against one side of the joint and placing fresh porous concrete against it. Isolation joints and filler shall be flush with the surrounding porous concrete and shall not deviate from the acceptance criteria for smoothness as shown in Section 5-06.3(4)A. The edges of the porous concrete on either side of the premolded joint filler shall be hand tooled with a ½ inch radius.

**5-06.3(9) RESERVED**

**5-06.3(10) RESERVED**

**5-06.3(11) RESERVED**

**5-06.3(12) SURFACE SMOOTHNESS**

The surface of the porous concrete sidewalk will be checked immediately after compaction for grade and slope using the 10 foot straightedge specified in Section 5-06.3(3)F. Where the surface is found to be out of specification as determined by the criteria specified in Section 5-06.3(4)A, it shall be immediately corrected by recompacting, removing excess porous concrete, or by adding porous concrete; as necessary.

If it is necessary to correct grade or slope by removing excess porous concrete, the surface shall be recompacted and the edges retooled. If the grade or slope is to be corrected by the addition of porous concrete, the surface shall be lightly scarified and the new material added. The surface shall be recompacted to grade and the edges retooled. Any corrections to the surface shall occur before the porous concrete has set or has dried. Porous concrete sidewalk that is out of specification with regard to grade or slope will be rejected to the nearest joints.

Porous concrete sidewalk that has been corrected shall not be distinguishable from the adjacent, undisturbed porous concrete sidewalk. If in the opinion of the Engineer, the corrected porous concrete sidewalk is distinguishable from the adjacent Work, the repaired area will be rejected to the nearest joints.

**5-06.3(13) CURING**

Immediately after the porous concrete sidewalk has been compacted and checked for grade and slope, the sheet curing material as specified in Section 9-23.1 shall be applied. If the surface appears dry, lightly mist the surface with water prior to applying the sheet curing material. The sheet curing materials shall be fixed in place by method(s) that shall not damage the porous concrete sidewalk and is accepted by the Engineer. The porous concrete shall be placed, struck off, finished and the curing materials in place within twenty (20) minutes of the time the porous concrete is discharged from the truck. This time may be shortened if conditions exist that promote excessive drying. Forms and sheet curing material(s) shall remain in place for a minimum of ten (10) Days.

With the exception of saw cutting equipment, all traffic shall be kept off the porous concrete sidewalk during the curing period. For saw cutting contraction joints, only the amount of sheet curing material necessary to accomplish the saw cutting shall be removed and the surface of the exposed porous concrete sidewalk shall be kept moist for the entire duration of the exposure.

Any testing for acceptance shall not occur until the end of the curing period.

**5-06.3(14) RESERVED**

**5-06.3(15) RESERVED**

**5-06.3(16) PROTECTION OF POROUS CONCRETE SIDEWALK**

As part of the Stormwater Pollution Prevention Plan (SWPPP), rain runoff, surface water of any kind and sediment shall be prevented from entering the area of porous pavement construction, including excavation, until the porous concrete application has cured and the adjacent areas that sheet flow/drain onto the porous pavement are permanently stabilized from erosion and plantings are established. Once pavement is placed, protective covers shall continually be maintained until adjacent areas are permanently stabilized and pavement has been accepted.

The Contractor shall take every precaution to protect the porous concrete sidewalk from damage, including the introduction of foreign materials to the surface, throughout the course of the work. Porous concrete sidewalk that is damaged or has been adversely impacted by the introduction of foreign materials shall be rejected and replaced to the nearest joint.

**5-06.3(17) RESERVED**

**5-06.4 MEASUREMENT**

Bid items of Work completed pursuant to the Contract will be measured as provided in Section 1-09.1, Measurement of Quantities, unless otherwise provided for by individual measurement paragraphs herein this Section.

Measurement for “Porous Concrete Sidewalk” will be by the square yard for the surface of porous concrete walk placed. Deduction will be made for blocked out areas, castings or other discontinuities in the sidewalk nine (9) square feet or larger.

**5-06.5 PAYMENT**

Compensation for the cost necessary to complete the work described in Section 5-06 will be made at the bid item prices Bid only for the Bid items listed or referenced as follows:

“**Porous Concrete Sidewalk**”, per square yard.

The Bid Item price for “Porous Concrete Sidewalk” shall include all costs for the work required to construct the porous concrete sidewalk as specified in this section, including but not limited to; performing mix designs, testing, excavation, and subgrade preparation; and, furnishing and installing geotextile, aggregate discharge subbase, and porous concrete.

Payment of the volume of earthwork involved in excavating Material above the top surface of the sidewalk will be made in accordance with Section 2-03.5 “Common Excavation” as defined in Section 2-03.1(2).

**9-03.1(4) COARSE AGGREGATES FOR POROUS CONCRETE (GSP 09-17-09)**

**9-03.1(4)A GENERAL**

Aggregate for porous concrete shall meet the requirements of Sections 9-03.1(3)A, 9-03.1(3)B and 9-03.1(3)C.

**9-03.1(4)B GRADING**

Aggregate for porous concrete shall conform to one of the following gradations

% - Total percent passing	AGGREGATE GRADATION	
	AASHTO No. 8 size	

by weight	aggregate gradation			
Sieve Size	Min.	Max.		
1/2" Square	100%	---		
3/8" Square	85%	100%		
U.S. No. 4	10%	30%		
U.S. No. 8	0%	10%		
U.S. No. 16	0%	5%		
U.S. No. 50	---	---		
U.S. No. 200	0%	0.5%		

In individual tests, a variation of four (4) percent under the minimum percentages or over the maximum percentages will be allowed on sieves size No. 16 and larger. For sieves smaller than No. 16, the maximum percentage passing shall not exceed the limits shown for any single test. The average of three successive tests shall be within the percentages stated above. Coarse aggregate shall contain no pieces larger than two (2) times the maximum sieve size for the specified grading measured along the line of greatest dimension.

Acceptance of grading and quality of the aggregate will be based on samples taken from stockpiles at the concrete plant. The exact point of acceptance will be determined in the field by the Engineer.

When the Engineer accepts, the porous concrete aggregate may be blended from other sizes if:

The resulting aggregate meets all requirements for the specified grading;

Each size used makes up at least five (5) percent of the blend;

The Contractor supplies the Engineer with the gradation for the proposed sizes, along with their proper proportions before producing the aggregate. If the aggregate comes from commercial sources, the Contractor shall supply this information and have it accepted before proportioning and mixing the concrete.