

Aggregate Base Course for Permeable Pavements and Bioretention

Pervious Portland Cement Concrete Pavement and Sidewalk

Porous Asphalt Pavement

Pervious Unit Pavers

Geosynthetics for Stormwater Management

Bioretention, Planting, Lawn and Sand Based Structural Soils

C.XX. AGGREGATE BASE COURSE FOR PERMEABLE PAVEMENT AND BIORETENTION

This S.P. supplements 209.

(A) DESCRIPTION

This item shall consist of constructing base courses for permeable pavements and bioretention facilities to the specified depths on a prepared foundation conforming to the lines, grades and cross sections shown in the contract documents. Base courses may include reservoir layer, storage layer, choker layer, filter layer, and other layers included in the Contract Documents. Except as herein stated, all requirements specified for 209 are applicable to this specification.

(B) SUBMITTALS

Submit documentation of materials prior to construction as follows:

1. Material Source - Certificate
2. Cleanliness – Certification that stone is double-washed per Section (J) herein.
3. Properties:
 - a. Gradation
 - b. Smoothness
 - c. Percentage of Wear
4. Sample: Prior to production and delivery of aggregates, take at least one (1) initial sample in accordance with ASTM D75. Collect each sample by taking three (3) incremental samples at random from source material to make a composite sample of not less than 50 pounds. Repeat sampling procedure when source of material is changed or when deficiencies or variations from specified grading of materials are found in testing.

(C) MATERIALS

Coarse aggregate shall be of the types designated in the Contract Documents, and shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel, conforming to the gradations in Table 1 and shall also meet the following:

1. Be double-washed, sufficient to remove dust and other coatings; and
2. Be free from clay balls, organic matter, and other deleterious substances

Reservoir/storage layer shall also meet the following:

1. Maximum percentage of wear of 30% as determined by AASHTO T96.

2. Minimum 75% by mass (weight) of the material coarser than the No. 4 sieve with at least two (2) fractured faces, and 90% shall have one or more fractured faces as determined by ASTM D5821;
3. Have not more than 5% of flat or elongated pieces (>5:1) as specified in ASTM D4791;
4. Material shall have a California bearing ratio (CBR) of at least thirty (30) as determined by laboratory test on a four (4) day soaked sample in accordance with ASTM D1883; Compact the specimen in accordance with ASTM D1557, Method B or C.

Table 1: Gradation for Base Courses

Pavement Reservoir Layer	Choker Layer for Permeable Pavements	Filter Layer	Bioretention Storage/Drainage Layer
No. 2 or No. 3 Stone per Standard Specification Table 803.09-02	No. 57 Stone per Standard Specification Table 803.09-02	No. 8 Stone per Standard Specification Table 803.09-02	No. 57 Stone per Standard Specification Table 803.09-02

(D) PREPARATION OF GRADE

Excavation and sub-grade preparation to the lines and grades shown on the Contract Documents shall follow the requirements of 209, except as stated herein.

1. Sub-grade shall not be compacted for installations where contract documents specify a minimum infiltration rate for the sub-grade.
2. For soft or yielding soils in locations specifying a minimum infiltration rate for the sub-grade, Contractor shall install geogrid in accordance with contract documents. Geotextile fabric shall not be used in these situations.
3. Where no minimum infiltration rate is specified for the sub-grade, Contractor shall be allowed to perform subgrade compaction, and can utilize geotextile fabric or impermeable liners as specified in the Contract Documents.
4. Where erosion of sub-grade has caused accumulation of fine materials and/or surface ponding, this material shall be removed with light equipment and the underlying soils scarified to a minimum additional depth of 6 inches with a rake and a tracked vehicle used in combination, or equivalent.
5. Construction equipment shall not be allowed on the subgrade, except as noted above.

(E) HAULING

1. Hauling of aggregates shall be accomplished in accordance with the requirements of 209.
2. Trucks meeting the same cleanliness requirements of the double washed materials shall be used during hauling. Trucks shall be inspected and cleaned prior to each use.

(F) LIMITATIONS ON PLACING

Do not install aggregate base course when rainfall or other weather conditions will detrimentally affect the quality of the work.

(G) PLACING, SHAPING AND COMPACTING

1. Upon completion of sub-grade work, the Engineer shall be notified and shall inspect the sub-grade before the Contractor continues installation. Owner or Engineer shall have the option to perform infiltration testing on the subgrade to verify minimum infiltration rates, at the Contractor's expense where specified on the contract documents.
2. Any accumulation of debris or sediment which takes place after approval of sub-grade shall be removed prior to installation continuing at no extra cost.
3. Place geosynthetics, impermeable liner, pipe, and aggregate as required on the contract documents immediately after approval of sub-grade in accordance with the standards specifications and the DDOT specification "Geosynthetic Fabric for Stormwater Facilities".
4. Do not dump aggregate base course in piles, but evenly spread and place aggregate on the prepared sub-grade in layers of uniform thickness without segregation. Where the base course is constructed in more than one layer, clean previously constructed layers of loose and foreign matter prior to placing subsequent layers.
5. Moisten and lightly compact each lift of aggregate with a roller, keeping equipment movement over exposed sub-grades to a minimum. Roll each lift between 4 and 6 passes. If a required depth of aggregate in a lift exceeds ten (10) inches, the aggregate layer shall be compacted in ten (10) inch lifts.
6. Make adjustments in placing procedures or equipment to obtain true grades, to minimize segregation and degradation, to reduce or increase water content, and to insure a satisfactory aggregate base course.

(H) FINISHING

1. **Geosynthetics along Edges** – Geotextile fabric or impermeable liners, or both, shall be used along the edges or sides of aggregate base course materials for permeable pavement and bioretention as specified in the contract documents. Following placement of an aggregate base course, and at the conclusion of each day’s work, the geotextile or impermeable liner, or both, shall be folded back and secured to protect from sediment washout along all bed edges. At least a two foot (2’) strip shall be used to protect stone from adjacent bare soil. This edge strip shall remain in place until all bare soils contiguous to beds are stabilized and fully vegetated or until the wearing surface for the permeable pavement has been placed.
2. **Unfinished Edges Of Base Course** – In fill conditions, place earth or other approved materials along any unfinished edges of the base course in such quantity that it will compact to the thickness of the aggregate base course being constructed. In each operation, allow at least a two (2) foot width of the shoulder along all unfinished edges to be rolled and compacted simultaneously with the rolling and compacting of each layer of aggregate.

(I) SAMPLING

1. **Aggregates at the Source** – See section (B).
2. **During Construction** - Take at least one (1) random sample during construction from each 500 tons of placed aggregate base course material, but not less than one (1) random sample per day's work, in accordance with ASTM D 75. Collect each sample by taking three (3) incremental samples at random locations from the placed material to make a composite sample by weight of not less than 50 pounds.
3. **Sample Identification** - Place each sample in a clean container, securely fastened to prevent loss of material. Tag each sample for identification and with the following information:

Contract No. _____

Sample No. _____ Quality _____

Date of Sample _____

Sampler _____

Source _____

Intended Use _____

For Testing _____

4. **Repeat Sampling** – Repeat the above sampling when a material source is changed or when unacceptable deficiencies or variations from a specified gradation of materials is found in testing.

(J) TESTING

Testing responsibilities will be performed by the Contractor's testing agency at the Contractor's expense. Testing may also be performed by DDOT. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered nor shall it obligate the owner for final acceptance at any time. Submit all Test Reports to the Engineer.

1. **Cleanliness** – Prior to any work, the Contractor shall provide a written certification from their suppliers that each material provided for an aggregate base course in permeable pavement has been double washed, and all fines have been removed from the material. Trucks used for hauling the material shall also be thoroughly washed to remove fine material and other deleterious materials.
2. **Gradation** - Test each sample of aggregate base course material for gradation in accordance with ASTM C 136 and with the sampling described in Section (I).
3. **Thickness**– Measure each 100 square yards of each layer of aggregate base course placement. Make depth measurements by test holes, at least 3 inches in diameter, through the base course. Where base course deficiency is more than ½ inch, correct by scarifying, adding mixture of proper gradation, re-blading, and re-compacting. Where the measured thickness is more than ½ inch thicker than indicated, consider it as the indicated thickness plus ½ inch for determining the average. The average thickness is the average of the depth measurements for the entire area, and shall not under-run the thickness indicated in the Contract Documents without written approval from the Engineer.

(K) PROTECTION

Protection work will be performed by the Contractor at the Contractor's expense.

1. As construction is completed, maintain and protect the aggregate base course, except where a portion of the succeeding course is under construction thereon. Maintenance includes drainage, rolling, shaping, and watering, as necessary, to maintain the course in proper condition. Correct deficiencies in thickness, composition, and construction which develop during the maintenance, to conform to the requirements specified herein. Maintain sufficient moisture by light sprinkling with water at the surface to prevent a dusty condition.
2. Finishing along the edges of the permeable pavement for protection during construction shall be as described in Section (G) until the site is fully stabilized, at which time excess geotextile fabrics and impermeable liners can be cut back to the pavement edges.
3. In addition, runoff onto an aggregate base course shall be minimized until the site is fully stabilized. Diversion ditches or other approved types of erosion and sediment control measures shall be placed at the toe of slopes which are adjacent to permeable pavement and bioretention areas, to prevent sediment from washing into areas

aggregate base course at all times during and after construction. Any sediment accumulation into the aggregate base course shall be removed immediately by cleaning or replacement of the aggregate by the Contractor at no cost to the owner.

(L) MEASUREMENT AND PAYMENT

The unit of measure for Aggregate Base Course for Permeable Pavement or Bioretention will be the cubic yard for each course/type of material. The actual number of cubic yards measured complete in place will be paid for the contract unit price per cubic yard, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the work as specified herein. Payment will also include all subgrade preparation and testing necessary to achieve the required placement.

C. XXX PERVIOUS PORTLAND CEMENT CONCRETE PAVEMENT AND SIDEWALK

This S.P. supplements 501 and 608.01.

C.xxx.1. DESCRIPTION

This work shall consist of constructing pervious Portland cement concrete roadway pavements, alleys, sidewalks, or trails on a prepared sub-grade in accordance with these special provisions and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Chief Engineer.

The pervious concrete pavements and sidewalks shall consist of a mixture of Portland cement, aggregate, water, admixtures and other ingredients as may be specified. Except as herein stated, the requirements specified for DDOT Standard Specifications 501 Portland Cement Concrete Pavement and 608.01 Portland Cement Concrete Sidewalk and Driveway are applicable to this S.P.

C.xxx.2. REFERENCES

ACI 522R-10 Report on Pervious Concrete

ACI 522.1-08 Specifications for Pervious Concrete Pavement

ACI 211.3R - Guide for Selecting Proportions for No-Slump Concrete

ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C94 - Standard Specification for Ready-Mixed Concrete

ASTM C150 – Standard Specification for Portland Cement

ASTM C595 - Standard Specification for Blended Hydraulic Cements

ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete

ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction

ASTM C1116 – Standard Specification for Fiber Reinforced Concrete

ASTM C1688 - Standard Test Method for Density and Void Content of Freshly Mixed Pervious Concrete

ASTM C1701 - Standard Test Method for Infiltration Rate of In Place Pervious Concrete

ASTM C1754 - Standard Test Method for Density and Void Content of Hardened Pervious Concrete

ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete

ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction

ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

NRMCA – National Ready Mix Concrete Association

C.xxx.3. MATERIALS

A. Portland Cement shall be:

1. Type I or II conforming to AASHTO M85 or ASTM C150; or
2. Type IP or IS conforming to ASTM C595.

B. Aggregate

1. Maximum coarse aggregate size shall be No. 8.
2. Coarse and fine aggregate conforming to Sections 803.02 and 803.01 of the DDOT Standard Specifications shall be double-washed. Washing shall be sufficient to remove dust and other coatings.

C. Admixtures – Water reducing, hydration stabilizers, air entrainment, and other admixtures conforming to DDOT Specifications shall be allowed in the mix design.

D. Fibers – Reinforcing fibers conforming to DDOT Specifications and ASTM C1116 shall be allowed in the mix design.

E. Pigments – Pigments conforming to ASTM C979 shall be allowed in the mix design.

F. Joint Material – Filler for expansion joints shall be in accordance with Section 807.01 of the DDOT Standard Specifications.

C.xxx.4. PROPORTIONING

Comply with ASTM C94 and develop a concrete mix design meeting the following requirements in accordance with ACI 211.3R, Appendix 6:

A. Concrete shall achieve a minimum infiltration rate of 60 inches/hour (30 gallons/hour in a 12 inch diameter cylinder). Testing shall be in accordance with ASTM 1701.

B. Concrete shall meet a minimum compressive strength when specified in the Contract Documents.

C. A combined coarse and fine aggregates gradation shall be provided and material passing the #4 sieve shall be between 4% and 7%.

D. Mix Water: Mix water quantity shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. Mix water

yielding a cement paste with a dull-dry appearance has insufficient water for hydration. Insufficient water results in inconsistency in the mix and poor bond strength between aggregate particles. High water content results in the paste reducing or eliminating the void system required for porosity.

C.xxx.5. SUBMITTALS

A. Contractor Qualifications

1. At the time of bid submission, Contractor shall submit the name and qualifications of the pervious concrete installer, providing written evidence of the following:
 - (i) Employment of one (1) NRMCA certified Pervious Concrete Craftsman who shall be on site, overseeing each placement crew, during all concrete placement; or
 - (ii) Employment of at least two (2) NRMCA certified Pervious Concrete Installers who shall be on site, overseeing each placement crew, during all concrete placement.
2. Not later than fourteen (14) days before construction of pervious concrete, Contractor shall furnish evidence of employment of at least three (3) certified Pervious Concrete Technicians who will perform the pervious concrete construction.

B. Testing Agency – Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of the proposed testing agency meeting the requirements of Section 15 of this S.P.

C. Concrete Producer Qualifications – Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of an NRMCA certified plant that will produce and provide pervious concrete.

D. Concrete Mix Design – Not later than thirty-five (35) days before construction of pervious concrete, Contractor shall furnish:

1. A proposed mix design with proportions of materials for acceptance as described in section 4 of this S.P. or otherwise specified in Contract Documents. The data shall include unit weight, void ratio, and strength.
2. Samples of individual concrete materials contained in the mix design for sampling and testing of material prior to use, in accordance with Section 106.02 of the DDOT Standard Specifications.

E. Product Sample (Test Panel) – At least fifteen (15) days before construction of pervious concrete, and following the Chief Engineer’s acceptance of the mix design, Contractor shall provide a sample of the product (test panel) in accordance with section 6 of this S.P.

C.xxx.6. TEST PANEL

- A. Contractor shall provide a minimum of one (1) test panel for acceptance. Place, joint and cure the test panel, a minimum of 275 square feet in size or as specified in the Contract Documents, at the required project thickness to demonstrate that in-place void contents, unit weights, and infiltration rates can be met and to demonstrate effective jointing that does not compromise the cured concrete integrity.
- B. **Test Panel Infiltration:** Test panels shall be tested for infiltration in accordance with ASTM C1701.
- C. **Test Panel Cores:** Test panels shall have three (3) cores, each six (6) inches in diameter, taken from the panel a minimum of seven (7) days after placement of the pervious concrete. At least one core shall be taken within six (6) inches of a contraction joint. The cores shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened core samples shall be used to determine thickness in accordance with ASTM C42. After thickness determination, the cores shall be trimmed and measured for unit weight in a saturated condition and void content in accordance with ASTM C1754.
- D. **Test Panel Acceptance:** Satisfactory test panels will be determined by:
 - 1. Infiltration rate of at least 60 inches per hour.
 - 2. Compacted thickness within 1/4" of the specified thickness.
 - 3. Void Content \pm three (3) percent of the design void content.
 - 4. Unit weight \pm five (5) pounds per cubic foot of the design unit weight.

If test panels meet the above mentioned requirements, they can be left in-place and included in the completed work. If test panels do not meet the above mentioned requirements, they shall be removed and disposed of in an approved manner, and replaced with an acceptable test panel at the contractor's expense.

C.xxx.7. PREPARATION OF GRADE

- A. Sub-Grade Preparation – Shall be in accordance with Special Provision “Aggregate Base Course for Permeable Pavements and Bioretention”.
- B. Base Materials – Shall be in accordance with Special Provision “Aggregate Base Course for Permeable Pavements and Bioretention”.

C.xxx.8. HANDLING, MEASURING AND BATCHING MATERIALS

Pervious concrete shall be transported from batching plant 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. Each truck should not haul more than two (2) loads before being cycled to another type of concrete, unless a stabilizing hydration agent is used in the pervious concrete mix design or if DDOT determines that there is no significant concrete build-up in the concrete mixer after delivery of each load.

C.xxx.9. MIXING CONCRETE

- A. Concrete shall be mixed for a minimum of one (1) minute after introduction of all materials into the mixer. Truck mixers shall be operated at the speed designated by the concrete producer for at least 75 to 100 revolutions of the drum.
- B. Concrete mixing shall comply with ASTM C94 except that discharge shall be completed within sixty (60) minutes after the introduction of mix water to the cement. This time can be increased to ninety (90) minutes when utilizing a hydration stabilizer. Further water addition is permitted at the point of discharge provided the design water/cement ratio is not exceeded.

C.xxx.10. LIMITATIONS ON MIXING AND PLACING

Do not install pervious concrete when ambient temperature is below 40°F or above 90°F, or when ambient temperature is forecasted to be below 40°F or above 90°F at any time during the seven (7) days following placement, unless otherwise permitted in writing by the Chief Engineer.

C.xxx.11. PLACING AND CONSOLIDATING CONCRETE

- A. **Pre-Placement Conference** - A mandatory pre-placement conference will take place at least seven (7) days prior to installation of work and shall include at a minimum engineer, inspector, general contractor, pervious concrete contractor, concrete supplier, and field testing agency.
- B. Wet the base materials or sub-grade immediately prior to concrete placement.
- C. Deposit concrete directly from the transporting equipment onto the base materials or sub-grade, as appropriate.
- D. **Discharge:** Each truckload shall be visually inspected for moisture consistency prior to discharge. Water addition shall not be permitted at the point of discharge to obtain the required mixture consistency and truckloads lacking the required moisture consistency shall be rejected as determined by the inspector. Discharge shall be a continuous operation and shall be completed as quickly as possible. Concrete shall be deposited as close to its final position as practical and such that discharged concrete is incorporated into previously placed and plastic concrete. If consolidation occurs during concrete discharge, placement shall be halted, the mixture shall be addressed, and the consolidated portion removed and replaced immediately.

- E. Other methods of discharging the concrete may be used when specified in the Contract Documents or as allowed by the Chief Engineer.
- F. Spread the concrete using a come-along, short-handle square ended shovel or rake, or similar equipment.
- G. Rolling compaction shall be achieved using a motorized or hydraulically actuated, rotating, weighted tube screed that spans the width of the section placed and exerts a minimum vertical pressure of 10 psi on the concrete. Alternatively a steel pipe roller meeting the same criteria may be used.
- H. Plate compaction is not recommended, but may be necessary in small areas. When necessary, a standard soil plate compactor with a base area of at least two square feet that exerts a minimum pressure of 10 psi on the concrete through a $\frac{3}{4}$ inch minimum plywood cover shall be used.
- I. Cross rolling shall be performed using a roller specifically designed to smooth and compact pervious concrete. Lawn rollers are not allowed.
- J. Foot-traffic shall not be allowed on fresh concrete.

C.xxx.12. STRIKE-OFF, CONSOLIDATION AND FINISHING

- A. Strike off concrete between forms using a form riding paving machine, vibrating screed, or roller screed.
- B. Do not use steel trowels or power finishing equipment.
- C. Final surface texture shall be achieved by finishing the fresh concrete using a full-width steel roller that provides a minimum compactive pressure to achieve the required tolerances.
- D. Hand tools shall be used to finish the concrete along the slab edges immediately adjacent to forms.
- E. Other methods of producing final surface texture may be permitted when specified in the Contract Documents or approved by the engineer.

C.xxx.13. CURING

- A. Begin curing within twenty (20) minutes of concrete discharge unless longer working time is approved by the Chief Engineer.
- B. **Curing Material:**
 - 1. The pavement surface shall be entirely covered with a minimum six (6) mil thick polyethylene sheet in accordance with Section 501.17(C) of the DDOT Standard Specifications. Sheeting shall be cut to a minimum of the full lane

width and pavement shall remain covered for at least seven (7) uninterrupted days.

2. Alternate curing materials may be used as approved by the Chief Engineer.
- C. Curing sheets shall be secured and kept secure at all times without using dirt.
- D. **Hot Weather Curing:** A fog shall be sprayed above the surface, before covering, when required due to hot weather conditions. Equipment must include fog nozzles that atomize water using air pressure to create a fog blanket over the slab.
- E. **Cold Weather Curing:** Curing shall be in accordance with DDOT Standard Specification.

C.xxx.14. JOINTS

- A. Contraction joints shall be installed at locations and spacing shown in the Contract Documents at one-quarter ($\frac{1}{4}$) the depth of the thickness or a maximum of one and a half ($1\frac{1}{2}$) inches for roadway and alley pavements, and at one-half inch ($\frac{1}{2}$ "') for sidewalks and trails. Allowable methods for joint placement, as directed by the Chief Engineer, include:
1. **Rolled Joints** - shall be formed in plastic concrete using a steel pipe roller to which a beveled fin with the required diameter to achieve the joint depth has been attached around the circumference of the roller. Rolled joints are formed immediately after roller compaction and before curing. Sidewalks and trails shall have rolled joints.
 2. **Sawed joints** - shall be constructed as soon as the pervious pavement can be sawed without raveling the sawed edge and before initial cracking occurs, using a wet saw or an early-entry saw. Sawed joints shall typically be constructed between 24 hours and 48 hours after concrete placement, depending on site conditions. At no time during the sawing process shall more pavement surface be exposed than that needed for sawing. Any dust or slurry generated during sawing shall be immediately removed during the sawing operation.
- B. Construction joints shall be installed at locations and spacing shown in the Contract Documents and whenever concrete placement is suspended for a sufficient length of time that concrete may begin to harden.
- C. Expansion joints shall be installed when pervious concrete will abut existing concrete slabs or other structures such as walls, footings, columns, catch basins, stairs, light poles, and other points of restraint.
- D. To reduce raveling at joints, or where pervious concrete meets impervious pavement, finishing may be necessary in accordance with Section 12, Item D of this S.P.

C.xxx.15. TESTING

Testing responsibilities will be performed by the testing agency at the Contractor's expense. Concrete materials and operations may also be tested and inspected by the owner as work progresses. Use of testing services will not relieve Contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered later nor shall it obligate the Engineer for final acceptance at any time.

A. Testing Agency: Agencies that perform testing services on concrete shall be AASHTO accredited per AASHTO R18 and meet the requirements of ASTM C1077. Testing agencies performing the testing shall also have experience in testing pervious concrete and shall be accepted by the Engineer before performing any work. Field tests of concrete shall be made by an individual certified as an NRMCA Certified Pervious Concrete Technician, who is also an ACI Concrete Field Testing Technician, Grade 1 in accordance with ACI CPI.

B. Testing Procedure:

1. Conduct tests in accordance with ASTM C1688 at the beginning of each pervious concrete placement operation for each batch, or for every 50 cubic yards (maximum), or a minimum of one test for each day's placement, to verify fresh density and void content.
2. A minimum of seven (7) days following each placement, three (3) cores, six (6) inches in diameter, shall be taken. The cores shall be measured for thickness, void content and unit weight determined using the methods described in section 6 of this S.P. Test Panels. Satisfactory test panels will be determined by:
 - (i) Compacted thickness $+3/4''$, $-1/4''$ of the specified thickness.
 - (ii) Void Content \pm three (3) percent of the design void content.
 - (iii) Unit weight \pm five (5) pounds per cubic foot of the design unit weight.

If pervious concrete fails to meet the above requirements, the Chief Engineer shall make a determination of acceptance, rejection, or acceptance at a reduced price, per Section 501.15 paragraph (A) of the DDOT Standard Specifications.

3. The infiltration of the pavement surface shall be tested in accordance with ASTM C1701. All applied water shall infiltrate directly without puddle formation or surface runoff, and the testing shall be observed by DDOT. A minimum infiltration rate of 60 inches per hour shall be achieved.
4. Submit all test results to the Chief Engineer.
5. Cores holes shall be filled with standard concrete.

C.xxx.16. OPENING TO TRAFFIC

Both vehicular traffic and pedestrian traffic shall be excluded from pervious concrete pavement after the placement of curing materials as follows:

- 7 days for pedestrian traffic on sidewalks or pavements
- 14 days for vehicular traffic on alleys
- As determined by Chief Engineer for vehicular traffic on roadways, but not less than 14 days.

C.xxx.17. TOLERANCES

Pavement must be mechanically swept and finished before testing for compliance with tolerances. Construct pavement to comply with the tolerances of Section 501.23 of the DDOT Standard Specifications and the following:

- Thicknesses: + 3/4 inch; - 1/4 inch; refer to Section 501.23 of the DDOT Standard Specification for disposition on pavement with average thickness which is less than the thickness by more than 1/8 inch.
- Elevation: + or - 1/2 inch
- Contraction joint depth: +1/4 inch, -0 inch

C.xxx.18. MEASUREMENT AND PAYMENT

The unit of measure for Pervious PCC Pavement or Sidewalk will be the square yard at the specified thickness. The actual number of square yards, complete in place measured along the surface, will be paid for at the contract unit price per square yard, or adjusted unit price per square yard if required under Section 501.23 of the DDOT Standard Specifications, which payment will be full compensation for furnishing, hauling, and placing all materials, including formwork, concrete work, joints, expansion joint materials, waterproofing, load transfer devices, impervious material, sealing of joints and curing. Payment for will include all costs for furnishing all materials, labor, tools, equipment and incidentals to complete the work.

XXX. POROUS ASPHALT PAVEMENT

This S.P. supplements 401.

(A) DESCRIPTION

This work shall consist of constructing a porous asphalt pavement on a prepared sub-grade in accordance with these special provisions and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Chief Engineer.

The porous asphalt pavement shall consist of a mixture of aggregates, bituminous binder material including polymer modified asphalt, fibers, mineral filler, anti-strip additives, and other optional additives as may be specified. Except as herein stated, the requirements specified for 401 are applicable to this S.P..

(B) REFERENCES

AASHTO T96 - Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact

AASHTO T209 - Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

AASHTO T275 - Standard Method of Test for Bulk Specific Gravity of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens

AASHTO T283 - Standard Method of Test for Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage

ASTM D3203 - Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

ASTM D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

ASTM D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

ASTM D6390 - Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures

ASTM D6752 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

NAPA IS-115 - Open-Graded Asphalt Friction Courses, Design, Construction & Maintenance

NAPA IS-131 - Porous Asphalt Pavements for Stormwater Management

NAPA – National Asphalt Pavement Association

(C) MATERIALS

The materials for porous asphalt pavement shall meet the requirements of Section 802 and the following:

1. Performance graded asphalt binder (PGAB) meeting Section 802.2 shall be polymer modified with either styrene butadiene rubber (SBR) or styrene butadiene styrene (SBS) per Contract Documents.
2. Coarse aggregate shall be that part of the aggregate retained on the No. 8 sieve and shall consist of clean, tough, durable fragments of crushed stone, or crushed gravel of uniform quality. Coarse aggregate shall:
 - a. Have a percentage of wear as determined by AASHTO T96 of not more than 30 percent;
 - b. Have at least 75% by mass (weight) of the material coarser than the No. 4 sieve with at least two (2) fractured faces, and 90% shall have one or more fractured faces as determined by ASTM D5821;
 - c. Have not more than 5% of flat or elongated pieces (>5:1) as specified in ASTM D4791;
 - d. Be double-washed, sufficient to remove dust and other coatings; and
 - e. Be free from clay balls, organic matter, and other deleterious substances.
3. Additives such as cellulose or mineral filler, or anti-strip additives, shall be included when stipulated in the Contract Documents or as allowed by the Chief Engineer.

(D) COMPOSITION OF THE MIXTURES

The Contractor shall develop for approval a job mix formula for proportioning of each type of porous asphalt pavement proposed for use as specified in the Contract Documents (surface, leveling, base, or other) in accordance with 818 and the following:

1. The percent of bituminous material shall be between 6% and 6.5%, based on the total weight of the pavement. The lower limit is to assure adequately thick layers of asphalt around the aggregate, and the upper limit is to prevent the mix from draining asphalt during transport.
2. Fines in the job mix formula shall have no more than 5% passing the 1/4" sieve, and no more than 1% passing the #200 sieve.
3. Retained Tensile Strength (AASHTO T283) shall be > 80 %.
4. Mix design shall result in pavement that accepts 60 inches/hour (30 gallons per hour in a 12 inch diameter ring). Testing shall be in accordance with ASTM D6390.

5. Air void content shall be calculated from the bulk SG and maximum theoretical SG (AASHTO T209) using ASTM D3203. Bulk specific gravity (SG) shall be calculated using AASHTO T275 (paraffin wax) or ASTM D6752 (automatic vacuum sealing).

(E) SUBMITTALS

1. **Contractor Qualifications** - At the time of bid submission, Contractor shall submit the name and qualifications of the porous asphalt installer, providing written evidence of project experience and proficiency in successfully completing porous asphalt pavement construction including a minimum of three (3) completed projects, total square footage to exceed the project quantities with owner information, addresses of each project, and the following:
 - (i) Job mix designs used;
 - (ii) In-Situ pavement test results; and
2. **Testing Agency** – Within 7 days of notice to proceed, Contractor shall furnish the name and location of a third-party QA Inspection Agency with experience in testing porous asphalt, who will oversee and document mix production. Use of testing services will not relieve the contractor of the responsibility to furnish materials and construction in full compliance with the Contract.
3. **Producer Qualifications** – Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of an asphalt plant that is DDOT certified and will produce and provide porous asphalt.
 - a. Job Mix Designs – At least thirty (30) days before construction, Contractor shall furnish job mix designs for the porous asphalt, which shall include at a minimum all mix design parameters described in section (D).
 - b. Material Sources: Submit a list of materials proposed for work under this Section including the name and address of all material sources and all bituminous mixing plants.
 - c. Certificates: Submit certificates, signed by the material sources and the relevant subcontractors, stating that the materials meet or exceed the specified requirements.
 - d. Samples: Submit samples of all materials for review and approval by the Engineer.

Table 1 – Certification Requirements

Material*	Properties to be reported on Certificate**
binder PGAB	certification
coarse aggregate	gradation, wear, fracture faces (fractured and elongated)
fine aggregate	gradation
Silicone, when applicable	manufacturer's certification
Fibers, when applicable	manufacturer's certification
Mineral filler, when applicable	manufacturer's certification

* Samples of each material shall be submitted to the Chief Engineer. Samples must be in sufficient volume to perform tests for each material.

** At a minimum; more material properties may be required per Contract Documents.

4. **Product Sample (Test Panel)** – At least fifteen (15) days before construction of porous asphalt, and following the Chief Engineer’s acceptance of the mix design, Contractor shall provide a sample of the product (test panel) in accordance with section (F) of this S.P.
5. **Test Results** – Testing agency shall provide in-situ pavement test results.

(F) TEST PANEL

1. Contractor shall provide a minimum of one test panel for acceptance. Place and compact one test panel, a minimum of 275 square feet in size or as specified in the Contract Documents, at the required project thickness to demonstrate to the engineer’s satisfaction that in-place void contents, unit weights, and infiltration rates can be met.
2. **Test Panel Testing:** Test panels shall have three (3) 1’ x 1’ slab samples taken from the panel a minimum of twenty four (24) hours after placement of the porous asphalt. The test panels shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened samples shall be used to determine thickness. After thickness determination, the cores shall be trimmed as needed and measured for unit weight and void content.
3. **Test Panel Acceptance:** Satisfactory test panels will be determined by:
 - a. Infiltration rate of at least 60 inches per hour.
 - b. Compacted thickness within 1/4” of the specified thickness.
 - c. Void Content ± three (3) percent of the design void content.

- d. Unit weight \pm five (5) pounds per cubic foot of the design unit weight.

If test panels meet the above mentioned requirements, they can be left in-place and included in the completed work. If test panels do not meet the above mentioned requirements, they shall be removed and disposed of in an approved manner, and replaced with an acceptable test panel at the contractor's expense.

(G) WEATHER AND SEASONAL RESTRICTIONS

Comply with Section 401.04 and the following:

1. The ambient air temperature during the past 24 hours shall be above 50°F
2. The asphalt laying temperature should be within 10°F of the compactive temperature in the approved job mix design.

(H) HAULING OF ASPHALTIC MATERIALS

1. The asphalt shall be transported in clean vehicles with tight, smooth dump beds that have been sprayed with a non-petroleum release agent or soap solution to prevent the mixture from adhering to the dump beds. Mineral filler, fine aggregate, slag dust, and similar materials shall not be used to dust truck beds.
2. The open graded mix shall be covered during transport to protect the mix from weather and to minimize mix cooling and prevent lumps. Long hauls, particularly those in excess of 25 miles may result in separation of the mix and its rejection, and are not recommended.

(I) PREPARATION OF GRADE

1. **Sub-Grade Preparation** – Shall be in accordance with the special provision “Aggregate Base for Permeable Concrete Pavement and Bioretention”.
2. **Base Materials** – Shall be in accordance with the special provision “Aggregate Base for Permeable Concrete Pavement and Bioretention”.

(J) SPREADING AND FINISHING

1. **Pre-Placement Conference** - A mandatory pre-placement conference will take place at least seven (7) days prior to installation of work and shall include at a minimum engineer, inspector, superintendent, asphalt installer, and QA inspector.
2. Contact surfaces such as curbing, gutters, and manholes shall be painted with a thin, uniform coat of Type RS-1 emulsified asphalt immediately before the asphalt mixture is placed against them.

3. Place the asphalt using self propelled paving equipment meeting Section 904, with an activated screed or strike-off assembly capable of being heated if necessary, and capable of spreading and finishing the mixture without segregation. Track pavers are recommended.
4. The use of water to cool the pavement is prohibited.
5. Place lifts no more than 24 hours after each previous lift to minimize the use of tack coats. Tack coats will only be allowed if required by the Contract Documents or approved by the Engineer.
6. The finished surface shall be of a uniform texture and evenness, and shall not show any indication of tearing, shoving, or pulling of the pavement during placement.

(K) COMPACTION OF POROUS ASPHALT

1. Roll the asphalt using a two-axle tandem roller when it is cool enough to withstand the roller without displacement of the asphalt, and using rollers sufficient to compact the asphalt without crushing the aggregate or compromising the required void content and infiltration rates.
2. The number, mass (weight), and type of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Generally one breakdown roller will be needed for each paver used in the spreading operation.
 - a) Breakdown rolling shall occur when the mix temperature is between 275 and 325°F.
 - b) Intermediate rolling shall occur when the mix temperature is between 200 and 275°F.
 - c) Finish rolling shall occur when the mix temperature is between 150 and 200°F.
3. Unless otherwise specified, the longitudinal joints shall be rolled first. Next, the Contractor shall begin rolling at the low side of the pavement and shall proceed toward the center or high side with lapped rolling parallel to the centerline.
4. Roll until all roller marks are gone however avoid excessive rolling which could reduce the infiltration capabilities of the asphalt.
5. To prevent adhesion of the mixture to the rolls, rolls shall be kept moist with clean water or water mixed with very small quantities of detergent or other approved materials. Excess liquid will not be permitted.
6. Along forms, curbs, headers, walls, and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot or lightly oiled hand tampers, smoothing irons or with mechanical tampers. On depressed areas, either a trench roller

- or cleated compression strips may be used under the roller to transmit compression to the depressed area.
7. Rollers will not be stopped or parked on the freshly placed mixture; Foot-traffic shall not be allowed on fresh asphalt for at least 24-hours.
 8. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh hot mixture. The mixture shall be compacted to conform to the surrounding area with segregation. Any area showing deficiencies shall be replaced at the Contractor's expense.

(L) JOINTS

1. Joints between old and new pavements or between successive days work shall be made to ensure a thorough and continuous bond between the old and new mixtures. Whenever the spreading process is interrupted long enough for the mixture to attain its initial stability, the paver shall be removed from the mat and a joint constructed.
2. Butt joints shall be formed by cutting the pavement in a vertical plane at right angles to the centerline, at locations approved by the Engineer. The Engineer will determine locations by using a straightedge at least 16 feet long. The butt joint shall be thoroughly coated with Type RS-1 emulsified asphalt just prior to depositing the pavement mixture when paving resumes.
3. Tapered joints shall not be allowed. Longitudinal joints that have become cold shall be coated with Type RS-1 emulsified asphalt before the adjacent mat is placed. If directed by the Engineer, joints shall be cut back to a clean vertical edge prior to applying the Type RS-1 emulsified asphalt.

(M) PAVEMENT SAMPLES

The Contractor shall cut 6" diameter core samples from the compacted pavement for testing within 24 hours of placement. Samples of the mixture shall be taken for the full depth of the course.

(N) TESTING

1. **Quality Assurance (QA) Inspector**
 - a. The Contractor shall provide at the Contractors' sole expense and the Engineer's approval a third-party QA Inspector to oversee and document mix production. All mix testing results during production shall be submitted to the QA Inspector.
 - b. The QC plan may be altered at the discretion of the Engineer and based on written recommendations from the QA.

- c. For small batch production, the Engineer may also modify or eliminate some testing requirements in the QC plan.

2. During Production

- a. The Contractor shall sample, test and evaluate the mix in accordance with the methods and minimum frequencies in the Table 2. Test results shall be delivered to the Chief Engineer.

Table 2: QC/QA testing requirements during production

Test	Minimum Frequency	Test Method
Temperature in Trucks Prior to leaving Plant	Six times per day	--
Gradation	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T30
Binder Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	AASHTO T164
Air Void Content	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	ASTM D6752
Flow Rate	Greater of either (a) 1 per 500 tons, (b) 2 per day, or (c) 3 per job	ASTM D6390

- b. Testing of the temperature, binder content, air void content, and flow rate shall be within the limits set by these specifications.
- c. Testing of the gradation shall vary from the approved design mix by more than the tolerances in Table 3.

Table 3: QC/QA testing tolerances during production

Sieve Size	Percent Passing
0.75	---
0.50	± 6.0
0.375	± 6.0
No. 4	± 5.0
No. 8	± 4.0
No. 200	± 2.0
% PGAB	+ 0.4, - 0.2

- d. Should the asphalt fail to meet all testing requirements initially, production modifications shall be made until the porous asphalt mix is within required tolerances. After the corrective action has been taken the resulting mix will be sampled and tested again at the Contractor’s expense.
- e. If the re-sampled asphalt fails to meet all testing requirements again, the Engineer will be immediately informed and provided with the test results. The Engineer may determine that it is in the best interest of project that production is ceased at that time. The Contractor will be responsible for all costs associated with the inability of the asphalt plant to meet all testing requirements.

3. Following Placement

- a. The full permeability of the pavement surface shall be tested prior to final acceptance in accordance with ASTM D6390.
- b. Test in-place base and surface course for compliance with requirements for thickness, void content and unit weight as described above by using 1’ x 1’ slab samples. Repair or remove and replace unacceptable work as directed by the Engineer at the Contractor’s cost.
- c. Surface Smoothness: Test finished surface for smoothness using a 10 foot straightedge applied parallel with and at right angles to the centerline of the paved area. Surface will not be accepted if gaps or ridges exceed 3/16 of an inch. The smoothness requirements specified herein apply only to the top lift of each layer, when asphalt is constructed in more than one lift.
- d. QC/QA requirements during paving are summarized in Table 4.

Table 4. QC/QA requirements during paving.

Activity Schedule	Frequency	Tolerance
Inspect truck beds for pooling (draindown)	every truck	NA
Take surface temp. behind joint heater	each pull	6°C (10°F) of compaction temp
Test surface smoothness & positive drainage with a 10 ft straightedge	After compaction	4.5 mm (3/16")
Hose test with at least 5 gpm water	after compaction	immediate infiltration, no puddling

(O) PROTECTION OF ASPHALTIC PAVEMENT

Minimum times prior to opening pavement to traffic are as follows:

- After pavement has been permitted to cool to below 100 °F for all traffic, and;
- 24 hours for pedestrian traffic, and;
- 48 hours for vehicular traffic.

The Contractor shall protect the porous asphalt from severe weather conditions and contamination by dust, dirt, mud or other fine grained material or sediment. The asphalt shall be protected by an approved method from the time of placement until final acceptance of the project. Any damage to the porous asphalt caused by the contractor's equipment shall be repaired by the contractor at no cost to the owner. Any portion of the porous asphalt that becomes contaminated to the extent that drainage is reduced or inhibited shall be removed and replaced at no expense to the owner.

(P) MEASUREMENT AND PAYMENT

The unit of measure for Porous Asphalt Pavement will be tons. The number of tons will be the actual number of tons complete in place, as weighed on approved truck scales. The Chief Engineer will deduct the weight of all material lost, wasted, damaged, rejected or applied in excess of the Engineer's direction or contrary to these specifications. The number of tons of Porous Asphalt Pavement class specified, as measured, will be paid at the contract unit price per ton, which payment will be full compensation for furnishing, hauling, and placing all materials and for furnishing all equipment, tools, labor and incidentals necessary to complete the work as specified herein.

C.XXX. PERMEABLE UNIT PAVERS

(A) DESCRIPTION

This work shall consist of constructing permeable unit pavers on a prepared sub-grade in accordance with these specifications and in conformity with the lines, grades, thicknesses and typical sections shown in the contract documents or as directed by the Chief Engineer.

The permeable unit pavers shall consist of a combination of unit pavers and aggregate for the joints and bedding layer, to form an integrated, structural wearing surface when compacted.

(B) REFERENCES

ASTM C67 – Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile

ASTM C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

ASTM C150 – Standard Specification for Portland Cement

ASTM C418 - Standard Test Method for Abrasion Resistance of Concrete by Sandblasting

ASTM C595 - Standard Specification for Blended Hydraulic Cements

ASTM C936 – Solid Concrete Interlocking Paving Units

ASTM C979 – Standard Specification for Pigments for Integrally Colored Concrete

ICPI – Interlocking Concrete Pavement Institute

PICP – Permeable Interlocking Concrete Pavers

(C) MATERIALS

Materials shall be approved in accordance with Section 106 requirements, and as described below.

1. All unit pavers shall meet surface requirements of the latest Americans with Disabilities Act (ADA) requirements and accessibility guidelines.
2. Unit pavers shall be of the type, style, color, and other details as described in the Contract Documents and in accordance with all manufacturer's recommendations for the selected unit paver system.
3. **Concrete Unit Pavers:** The material and fabrication for the unit pavers shall meet or exceed the requirements of ASTM C936 "Solid Concrete Interlocking Paving Units."
 - a. Portland cement: ASTM C150, Type 1.
 - b. Aggregate: Normal weight ASTM C33.
 - c. Pigments: ASTM C979 and as specified in the Contract Documents.

- d. Other constituents: Previously established by test or experience as suitable for use in concrete, in compliance with applicable ASTM standards or as otherwise approved by the Engineer
- e. Paver physical properties:
 - (i) Provide only sound units free of defects that would allow proper placing of units to achieve the specified pavement strength and performance.
 - (ii) Compressive strength: ASTM C140, when delivered to the project site, average compressive strength of not less than 8,000 psi, with no individual unit less than 7,200 psi.
 - (iii) Absorption: ASTM C140, average absorption not greater than 5%, with no individual unit greater than 7%.
 - (iv) Resistance to freezing and thawing: ASTM C67, with no breakage and not greater than 1% loss in dry mass of any individual unit after 50 cycles of freezing and thawing.
 - (v) Abrasion resistance: ASTM C418, maximum volume loss of 0.915 cubic inches / 7.75 sq. in. Average thickness loss of no more than 0.118” (3 mm) due to abrasion testing.
 - (vi) Dimension tolerances: Length +/- 1/16”, Height +/- 1/8”
- 4. **Other Material Unit Pavers:** Clay, brick, or other alternate materials shall be utilized as called for in the Contract Documents and shall meet physical properties described above in 3(e), unless otherwise specified in Contract Documents.
- 5. **Bedding and Joints:** AASHTO #8 aggregate or similar, as directed by the Contract Documents and in accordance with DDOT Special Provision for Aggregate Base Course for Permeable Pavement and Bioretention.

(D) SUBMITTALS

Contractor shall submit drawings and documentation as required in this specification and obtain written acceptance of submittals before using the materials or methods requiring approval.

- 1. **Contractor Qualifications** – At the time of bid submission, Contractor shall:
 - a. Submit the name and qualifications of the installer, providing written evidence of project experience and proficiency in successfully completing permeable unit paver construction including a minimum of three (3) completed projects, total square footage to exceed the project quantities with owner information, addresses and a sample of the product used, or photographs and details as to the product type and style including the manufacturer’s mold assembly with patterns, dimensions, all edge details and radii, spacer bars, and the mold head or shoe; and

- b. Submit written evidence of an Installer who will be onsite at all times during the unit paver installation, with a current certificate from the ICPI Installer Certification Program and a record of completion from the PICP Specialist Course, or
 - c. Submit written evidence that the Contractor will obtain the service of a consultant who has the required certifications and who will be on site at all times during the unit paver installation, acting as the installer for the project.
2. **Testing Agency** – Within seven (7) days after notice to proceed, the Contractor shall submit the name and location of a third party QA testing agency with experience in testing permeable interlocking unit pavements, who will oversee and document production and assembly. Use of testing services will not relieve contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
3. **Producer Qualifications** – Within seven (7) days after notice to proceed, the Contractor shall furnish the name and location of the plant that will produce the unit pavers.
 - a. Product Information: The plant shall provide product information including all material sources and all manufacturers’ recommendations that are relevant to the project.
 - b. Certifications: The plant shall provide current certifications, signed by the material sources as relevant, stating that the materials will meet or exceed all specified requirements.
 - c. Samples: The plant shall provide three (3) samples of unit pavers.
4. **Test Panels** – At least fifteen (15) days before construction of permeable interlocking unit pavers, and following the engineer’s acceptance of the qualifications described above, the Contractor shall provide a minimum of one (1) test panel for acceptance. Place, joint and cure the test panel, to be a minimum of 275 square feet in size or as specified in the Contract Documents, at the required project thickness to demonstrate to the engineer’s satisfaction that the unit pavers and design flow rates are acceptable, and that a satisfactory pavement can be installed at the site location. Testing shall be in accordance with Section (G).
5. **Test Reports** - Submit test reports certifying compliance with all material and physical requirements stated herein. All tests shall have been conducted not more than twelve (12) months before manufacturing of the unit pavers.

(E) PREPARATION OF GRADE

1. **Sub-Grade Preparation** – Shall be in accordance with DDOT Special Provision for Aggregate Base Course for Permeable Pavement and Bioretention.
2. **Base Materials** – Shall be in accordance with DDOT Special Provision for Aggregate Base Course for Permeable Pavement and Bioretention.

3. **Edge Restraints** - Install all edge restraints of the types, locations and dimensions shown on the Contract Documents and at the lines and grades required. Permeable pavement shall not be allowed without edge restraints around the entire perimeter without the written approval of the Engineer.
4. **Protection** - Shall be in accordance with DDOT Special Provision for Aggregate Base Course for Permeable Pavement and Bioretention.

(F) INSTALLATION

1. Pre-Placement Conference - A mandatory pre-installation conference will take place at least two (2) weeks prior to installation of the unit pavers and shall include at a minimum engineer, inspector, general contractor, permeable unit paver installer, manufacturer, and field testing agency.
2. Install base materials in accordance with the DDOT Special Provision for Aggregate Base Course for Permeable Pavement and Bioretention
3. Moisten, spread and screed aggregate bedding material and fill any voids left by screed rails. Do not roll or compact the bedding material prior to placing unit pavers.
4. Lay the unit pavers in the type, style, pattern, dimensions, and locations with joint widths as recommended by the Manufacturer and shown on the Contract Documents. Maintain consistent and uniform patterns for the entire pavement area.
5. Fill gaps at the edges of the paved area with cut units. Cut pavers subject to vehicular traffic shall be no smaller than 1/3 of a whole unit and shall have no sharp edges. Patterns shall be maintained to the extent possible in placing cut units to fill gaps in the pattern. Stagger blocks to avoid running bond or other straight joints or seams in the pattern.
6. Fill the openings and joints with ASTM #8 aggregate. Sweep excess aggregate from the surface.
7. Compact and seat the unit pavers into the bedding material using a low amplitude, 75-90 Hz plate compactor capable of at least 5,000 lbf centrifugal compaction force. This will require at least two (2) passes with the plate compactor over the entire surface.
8. Apply additional ASTM #8 aggregate to the openings and joints as needed, filling them in completely, then remove excess aggregate by sweeping, and make at least two (2) more passes with the plate compactor over the entire surface.
9. All unit pavers within six (6) feet of the laying face must be fully compacted at the completion of each day's work.

(G) TESTING

Testing responsibilities will be performed by the Contractor's testing agency or the Manufacturer at the Contractor's expense, as described below. Testing may also be performed by the owner as work progresses. Failure to detect defective work or materials

early will not prevent rejection if a defect is discovered nor shall it obligate the owner for final acceptance at any time.

1. **Manufacturer's Testing** – Testing of the materials to demonstrate compliance with the requirements of 623.02 shall be the combined responsibility of the Contractor and the manufacturer. Test results shall be approved by the Engineer in advance of the construction work.
2. **Smoothness Testing** - Test finished unit paver system with a 10 foot straightedge, applied parallel with and at right angles to the center line of the paved area. Correct deviations in the surface in excess of one-half (1/2) inch by removing the unit pavers as necessary and then loosening, adding or removing material, re-shaping, watering, and re-compacting. The smoothness requirements specified herein apply only to the top lift of each layer, when base course is constructed in more than one lift.
3. **Infiltration Testing** - The full permeability of the pavement surface shall be tested prior to final acceptance by application of clean water at least 5 gallons per minute, using a hose or other distribution device. Water used for the test shall be clean, free of suspended solids and deleterious liquids. All applied water shall infiltrate directly without large puddle formation or surface runoff, and the testing shall be observed by the Engineer. A minimum flow rate of 60 inches per hour is required.

(H) PROTECTION

1. As construction is completed, maintain and protect the permeable pavement. Correct deficiencies in thickness, composition, construction, and smoothness, which develop during the maintenance, to conform to the requirements specified herein.
2. Finishing along the edges of the permeable pavement for protection during construction shall be until the site is fully stabilized, at which time excess filter fabric and impermeable liners can be cut back to the pavement edges.
3. In addition, runoff onto permeable pavement shall be minimized until the site is fully stabilized as described in the Contract Documents. Diversion ditches or other approved types of erosion and sediment control measures shall be placed at the toe of slopes which are adjacent to permeable pavement, to prevent sediment from washing into pavement areas at all times during and after construction. Any sediment accumulation onto the permeable pavement shall be removed immediately by cleaning or replacement of the aggregate by the Contractor at no cost to the owner.

(I) MEASUREMENT AND PAYMENT

The unit of measure for Permeable Unit Pavers will be in square yards for the type(s) specified in the Contract Documents. The actual number of square yards complete in place will be paid for at the contract unit price per square yard, or adjusted unit price per square yard, which payment includes unit pavers, bedding material, and joint filler, complete and in place. Payment will include costs for furnishing all materials, labor, tools, equipment and incidentals to complete the work.

C.XXX GEOSYNTHETICS FOR STORMWATER MANAGEMENT

This S.P. supplements the Standard Specifications.

C.XXX.1. DESCRIPTION

This work consists of supplying and installing various geosynthetics for use in stormwater management, including the following:

- a. Geotextile, Class 1: a geotextile fabric for use in applications where there is a high risk of damage during construction due to construction equipment or dumped aggregates, including due to its use at the bottom of stormwater management facilities.
- b. Geotextile, Class 2: a geotextile fabric for use in applications where there is little to average risk of damage during construction due to construction equipment or dumped aggregates, including use on the sides of stormwater management facilities.
- c. Geogrid: a geosynthetic with woven bands of synthetic material with large apertures for use in applications where the underlying soils are weak or yielding.

If the following soil conditions are encountered when installing permeable pavement facilities, geogrid in accordance with this provision may be utilized in lieu of removal of soil and replacement with select backfill, as approved by DDOT:

- unstable or highly erodible soils,
 - weak soils,
 - gap graded soils,
 - alternative sand / silt laminated soils,
 - dispersive clays, and / or rock flour
- d. Waterproofing Membrane: material that is used to prevent infiltration and contain stormwater within the facility by lining the sides and bottom.

C.XXX.2. MATERIALS

- a. Geotextile: Class 1 and Class 2 geotextiles for stormwater management shall meet the requirements of AASHTO M-288 and Sections 213.02 and 822.09 of the DDOT specifications, as applicable.
 - The permeability of the geotextile fabric should also be at least an order of magnitude higher (10x) the soil sub-grade permeability for stormwater management facilities used as infiltration practices.
- b. Geogrid: Shall meet the requirements of AASHTO M-288 and Section 213.02 of the DDOT specifications, unless otherwise specified in the contract documents.

- c. Waterproofing Membrane: shall meet the requirements of Section 822.10 of the DDOT specifications.

C.XXX.3. SUBMITTALS AND TESTING

- A. Product Data: Submit most recent printed information from manufacturer for:
1. Type and Source of Materials
 2. Qualifications of Manufacturer
 - Manufacturer shall have a minimum of five (5) years of experience supplying geotextile materials for stormwater applications.
 - Submit Manufacturer name, address, telephone and fax numbers, and contact name.
 - Submit certification that Manufacturer is able to provide sufficient quantities of materials for the entire project.
 3. Geotextile Material per Table 213.02 (A)
 - Weight, ounces per square foot
 - Grab Strength, pounds force
 - Puncture Strength, pounds force
 - Trapezoidal Tear Strength, pounds force
 - Permittivity, as a function of permeability, /sec
 - Minimum Apparent Opening Size, millimeters
 - Elongation at Failure, %
 - Ultraviolet stability, % strength retained after 500 hours
 4. Geogrid Material per Table 213.02 (B)
 - Weight, ounces per square foot
 - Strength at 5% Strain, pounds per foot
 - Minimum Opening Size, inches
 - Maximum Opening Size, inches
 - Ultimate Tensile Strength, pounds per foot
 - Junction Strength, pounds force
 - Ultraviolet stability, % strength retained after 500 hours
 5. Waterproofing Membrane per Section 822.10
 - Weight, ounces per square foot
 - Thickness, mils

- Grab Tensile Strength, pounds force
 - Puncture Strength, pounds force
 - Pliability, unaffected at specified testing requirements
- B. Product Samples: Along with product data, submit representative samples to DDOT for review and approval. Do not order materials until DDOT has approved. Delivered materials shall match the approved samples.
- C. Soil Tests: Submit certification that the geotextile has at least an order of magnitude (10x) higher permeability than the soil subgrade permeability as specified in the Contract Documents for infiltration practices.

C.XXX.4. DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle packaged materials in strict compliance with all manufacturer's instructions and recommendations. Keep a record of all deliveries along with corresponding package labels.
- B. Minimize exposure to ultraviolet (UV) degradation by keeping geotextile materials out of direct sunlight at all times. Protect all materials from weather, damage, injury and theft.
- C. Sequence deliveries to avoid delays and UV exposure.

C.XXX.5. PRE-INSTALLATION EXAMINATION AND PREPARATION

- A. Pre-Installation Examination: Prior to beginning work, the Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify DDOT in writing of all deficiencies and conditions detrimental to the proper completion of this work. This includes:
1. The subgrade is at incorrect depths, lines, and dimensions for installing the geotextile fabrics.
 2. Overly wet conditions do not exist and are not anticipated to occur during installation, as they will contaminate the geotextiles.
 3. Construction debris is not present within the placement area which may damage the geotextiles, and work is sequenced to avoid construction traffic on the exposed geotextiles at any time.
- B. By beginning work, the Contractor accepts the previous work and site conditions.

C.XXX.6. PLACEMENT

- A. The Contractor shall not place any geotextile, geogrid or waterproofing membrane until all work in adjacent areas is complete and approved by DDOT.
- B. Material shall be cut and fit to the dimensions shown on the plans with a minimal amount of seams, and with excess materials removed and disposed of properly. Clean and straight cuts are required to the line and grade of the plans.

- C. Geosynthetics shall be placed on the prepared surface of the stormwater practice parallel to the longest side of the practice, and without dragging it across the grade. Wrinkles and folds shall be removed by stretching and pinning.
- D. Securing pins or staples for geotextile fabric shall have a minimum length of 10 inches and shall be designed to securely hold the geotextile fabric in place during construction. Waterproofing membrane shall be held in place by backfilling or other means without puncturing the material. Other methods of pinning can also be used as allowed by the Chief Engineer.
- E. Geotextiles shall be overlapped by a minimum of 3 feet at roll edges and ends. Roll edges, ends and overlaps shall be secured a minimum of 5 feet on center or sewed in accordance with Section 213.02 (C).
- F. Geotextiles shall be folded or cut and overlapped in the direction of the turn for all curves. Folds, as well as edges, ends, and overlaps shall be pinned a minimum of 5 feet on center or sewed in accordance with Section 213.02 (C).
- G. Waterproofing membrane shall be glued continuously at seams in accordance with all manufacturers' recommendations including any required overlap. Folds shall also be secured and pulled taught.

C.XXX.7. PROTECTION

- A. Protect newly placed geosynthetics from damage during construction, and protect them from ultraviolet (UV) degradation at all times.
- B. Construction traffic on exposed geosynthetic materials is strictly prohibited.
- C. After beginning work, coordinate activities with other work so that there is no disturbance or damage from traffic or other construction activities subsequent to placement.
- D. Any damaged geotextile, geogrid, or waterproofing membrane shall be repaired or replaced immediately upon discovery of the damage, to the satisfaction of the Engineer, at the Contractor's expense.

C.XXX.8. EXCESS MATERIALS

Unused material exposed to ultraviolet (UV) degradation or otherwise damaged shall also be disposed of properly.

C.XXX.9. MEASUREMENT AND PAYMENT

The unit of measure for geosynthetics will be square yards (SY). The number of square yards will be the actual number of square yards complete in place, which will include furnishing, transporting, handling, installing, and testing the geosynthetics as well as all seams, overlaps, staking, embedment, and protection measures.

C.xx BIORETENTION, PLANT BED, LAWN AND SAND BASED STRUCTURAL SOILS

This Special Provision supplements the Standard Specifications.

C.xx.1. DESCRIPTION

This work consists of supplying, testing, amending, mixing and installing various planting soil categories for use in stormwater management and horticultural plantings, covering the following:

- a. Planting Soil shall refer to Bioretention Soil, Plant Bed Soil, Lawn Soil and/or Sand-Based Structural Soil.
- b. Bioretention Soil: soil blend for use in stormwater bioretention facilities.
- c. Plant Bed Soil: planting medium for trees, shrubs, and groundcovers in Plant Beds
- d. Lawn Soil: planting medium for lawn areas
- e. Sand Based Structural Soil: soil blend for trees where planting soils are beneath paved surfaces and horticultural subsoil.

C.xx.2. MATERIALS

A. GENERAL

1. Soils mixtures are composed of a blend of three base components: base loam, organic material and sand. The Soil Supplier is responsible for locating and obtaining approval of sources for base loam, organic material and sand that meet the Specification requirements. The Soil Supplier is responsible for mixing the components. Approximate mixing ratios are as specified herein, but may require adjustment, depending on the characteristics of the final base materials.
2. Base Components
 - a. Base Loam: a natural A-horizon growing medium free from admixtures.
 - b. Organic Material or Compost: a fully decomposed yard waste organic material.
 - c. Sand: uniformly-graded medium to coarse sand.
3. Soil medium materials shall fulfill the requirements as specified and be tested to confirm the specified characteristics.

B. BASE LOAM

1. Base Loam shall be natural A-horizon topsoil free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots or other objectionable, extraneous matter or debris. Base Loam shall also be free of quack-grass rhizomes, Agropyron Repens, and the nut-like tubers of nutgrass, Cyperus Esculentus, and all other primary noxious weeds. Base Loam shall not be delivered or used for planting while in a frozen or muddy condition. Base Loam for mixing shall conform to the following grain size distribution for material passing the #10 sieve:

<u>U.S. Sieve Size Number</u>	<u>Percent Passing</u>	
	<u>Minimum</u>	<u>Maximum</u>
10	---	100
18	85	100
35	70	95
60	54	85
140	42	68
270	36	60
0.002mm	3	12

2. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample. Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition. The organic content shall be between 3.0 and 6.0 percent by weight. Base Loam shall have a well-developed and stable crumb structure.
3. Unless otherwise recommended by the Soil Supplier's Soil Scientist: Cation Exchange Capacity shall be not less than 12 and Soluble Salts shall be not more than 2,000 ppm/2.0 mmhos/cm.

C. COARSE SAND

1. Sand for blending, protection layer above filter fabrics, and drainage below planting soils shall be uniformly graded medium to coarse sand consisting of clean, inert, rounded to sub-angular grains of quartz or other durable rock free from loam or clay, mica, surface coatings and deleterious materials with the following gradation for material passing the #10 sieve.

<u>U.S. Sieve Size Number</u>	<u>Percent Passing</u>	
	<u>Minimum</u>	<u>Maximum</u>
10	100	--
18	60	80
35	25	45
60	8	20
140	0	8
270	0	3
0.002mm	0	0.5

2. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.0 or less ($D70/D20 < 3.0$). Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition.
3. Coarse sand shall be non-calcitic and shall not be derived from serpentine. pH shall be less than 7.5.

D. ORGANIC AMENDMENT (COMPOST)

1. Organic Matter for amending planting soils shall be a stable, humus-like material produced from the aerobic decomposition and curing of leaf and yard waste composted for a minimum of one year (12 months). The leaf and yard waste compost shall be free of debris such as plastics, metal, concrete or other debris. The leaf and yard waste compost shall be free of stones larger than 1/2", larger branches and roots. Wood chips over 1" in length or diameter shall be removed by screening. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests.
 - a. The ratio of carbon to nitrogen shall be in the range of 12:1 to 25:1.
 - b. Stability shall be assessed by the Solvita procedure. Protocols are specified by the Solvita manual (version 4.0). The compost must achieve a maturity index of 6 or more as measured by the Solvita scale. Stability tests shall be conducted by a DDOT approved lab.
 - c. Pathogens/Metals/Vector Attraction reduction shall meet 40 CFR Part 503 rule, Table 3, page 9392, Vol. 58 No. 32, (for applications to soils with human activity).

- d. Organic Content shall be at least 20 percent (dry weight). One hundred percent of the material shall pass a 3/8-inch (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Organic content shall be determined by weight loss on ignition for particles passing a number 10 sieve.
- e. pH: The pH shall be between 6.5 to 7.2 as determined from a 1:1 soil-distilled water suspension using a glass electrode pH meter American Society of Agronomy Methods of Soil Analysis.
- f. Salinity: Electrical conductivity of a one to five soil to water ratio extract shall not exceed 2.5 mmhos/cm (dS/m).
- g. The compost shall be screened to 1/2 inch maximum particle size and shall contain not more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.
- h. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Magnesium, Iron, Manganese, Lead, Soluble Salts, Cation Exchange Capacity, soil reaction (pH), and buffer pH. The Soil Supplier's Soil Scientist shall provide a recommendation as to the suitability of the compost based on review of the test results.

E. SOIL ADDITIVES

1. Ground Limestone: dolomitic limestone and contain not less than 50 percent of total carbonates and 25 percent total magnesium with a neutralizing value of at least 100 percent. Material shall be ground to such fineness that 40 percent will pass 100 mesh U.S. standard sieve and 98 percent will pass through 20 mesh U.S. standard sieve.
2. Acidulant for adjustment of planting soils pH shall be commercial grade sulfur, ferrous sulfate, or aluminum sulfate for horticultural use that are unadulterated. Acidulants shall be delivered in unopened containers with the name of the manufacturer, material, analysis and net weight appearing on each container.
3. Fertilizer: slow-release granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in a composition as recommended by the Soil Testing Laboratory.
4. Use of peat moss is prohibited.

C.xx.3. SUBMITTALS AND TESTING

A. Critical Path Processing - Soils Testing Report Submittals.

The Contractor is responsible for recognizing that these project materials warrant timely and serious attention, that the testing process to achieve approved materials shall be considered a lead time item, and that under no circumstance shall failure to comply with all specification requirements be an excuse for a delay or for expedient substitution of unacceptable material(s).

B. Sources for Soil Components and Soil Mixes: Within seven (7) days after notice to proceed, submit information identifying sources for soil components and the firm responsible for mixing of soil mixes:

1. Soil mix supplier shall have a minimum of five years experience at supplying custom planting soil mixes.
2. Submit supplier name, address, telephone and fax numbers and contact name.
3. Submit certification that accepted supplier is able to provide sufficient quantities of materials and mixes for the entire project.

C. Testing Agency: Within seven (7) days after notice to proceed, Contractor shall furnish the name and location of the proposed testing agency. Agency proposed for testing of horticultural soils shall be an approved member of the Performance Assessment Program (PAP) administered by the North American Proficiency Testing (NAPT) Oversight Committee. The Testing agency shall be accepted by the Chief Engineer.

D. Product Data: No later than 30 days prior to planned soil construction, submit most recent printed information from manufacturer for:

1. Organic Material: identify the material(s) from of which is it composed and identify the location where material was composted.
2. Fertilizers
3. Ground Limestone
4. Sulfur

E. Samples and Test Reports: Submit representative samples and reports to the Chief Engineer and the Testing Agency as described herein for approval. Delivered materials shall closely match the approved samples.

1. Submit 1 gallon soil samples and horticultural soil test reports in two phases.
 - a. Planting Soil Base Components:
 - Base Loam

- Organic Amendment (Compost)
- Sand

Submit samples of above to the Testing Agency. Submit soil testing reports to Chief Engineer no later than 21 days prior to planned soil construction.

- b. Only after approval of base components, submit soil blend mixes / mediums for approval. Mixing and batching of soil mediums in the same manner as bulk soils will be prepared for delivery to site, and shall include:

- Bioretention Soil
- Plant Bed Soil
- Lawn Soil
- Sand-Based Structural Soil

Submit samples of above to the Testing Agency. Submit duplicate samples and soil testing reports to Chief Engineer no later than 14 days prior to planned soil construction.

- c. Samples of each soil type delivered to the site shall taken and tested for conformance with the Specification Requirements. Submit duplicate samples and soil testing reports to Chief Engineer.

2. Soil Sampling Method: Sampling shall be done by the Soil Supplier. Samples shall be representative of the material to be brought to the site. Each sample shall be a Composite Sample, which consists of 5 separate sub-samples taken from a minimum of (5) different locations at each source and mixed together to make the test sample.

3. Test Reports shall be certified and shall cover the items below. All reports must be from recent analyses, less than 90 days old, and represent materials that are available for delivery to the site.

- a. Mechanical gradation (sieve analysis) shall be performed and compared to the USDA Soil Classification System.
- b. The silt and clay content shall be determined by a Hydrometer Test of soil passing the #270 sieve. Percent clay (0.002 mm) shall be reported separately in addition to silt (ASTM D-422-63, hydrometer method).
- c. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium Magnesium, Aluminum, Manganese, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

Tests shall be conducted in accordance with Recommended Soil Testing Procedures for the Northeastern United States, Current Edition, Northeastern Regional Publication No. 493; Agricultural Experiment Stations of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia. Tests include the following:

- a. Test for soil Organic Matter by loss of weight on ignition, as described in Northeastern Regional Publication No. 493.
 - b. Test for soil CEC by exchangeable acidity method as described in Northeastern Regional Publication No. 493.
 - c. Test for soil Soluble Salts shall be by the 1:2 (v:v) soil:water Extract Method as described in Northeastern Regional Publication No. 493.
 - d. Test for Buffer pH by the SMP method as described in Northeastern Regional Publication No. 493.
 - e. Certified reports on analyses from producers of composted organic materials are required. Analyses will include all tests for criteria specified herein.
 - f. Density Tests: ASTM D 2922-01: Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). ASTM D698 Test Method For Laboratory Compaction Characteristics Of Soil Using Standard Effort.
 - Contractor shall perform In-place density tests at a rate of one test per 2,000 square feet for each type of material placed.
 - g. Test data and recommendations for soil amendments including but not limited to: nitrogen, phosphorus, potassium and limestone
- F. Certificates: No later than 7 days prior to planned soil construction, submit certification that soil blend components and soil mediums meet applicable environmental standards of the District of Columbia.

C.xx.4. PROPORTIONING

Soil Supplier shall uniformly mix ingredients on an approved hard surface area or with soil blending equipment. Soils and Organic Amendment shall be maintained moist, not wet, during mixing. Amendments shall not be added unless approved to extent and quantity by the owner and additional tests have been conducted to verify type and quantity of amendment is acceptable. Percentages of components, unless

otherwise noted, will be established upon completion of individual test results for components of the various mixes.

After component percentages are determined by the Soil Supplier's Soil Scientist, each planting soil medium shall be tested for physical and chemical analysis.

A. BIORETENTION SOIL

Bioretention Soil shall consist of a blend of approximately 55% by volume Coarse Sand, 20% by volume Base Loam and 25% by volume of Organic Amendment. The components shall be blended to create a uniform mixture that meets the following criteria. Percentages will be adjusted as necessary to achieve a final the following grain size distribution and criteria below for material passing the #10 sieve:

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	100	-
18	68	95
35	38	65
60	22	37
140	15	22
270	12	14
0.002mm	1	4

1. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
2. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 4.5 or less ($D70/D20 < 4.5$).
3. The final mix shall have a saturated hydraulic conductivity of not less than 4.0 inches per hour according to test procedure ASTM D5856-95 (2000) when compacted to a minimum of 86 percent Standard Proctor ASTM D698.
4. Organic content shall be between 3.0 and 4.0 percent.
5. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 7; P-Index shall be between 10 and 30; and Soluble Salts shall be less than 500 ppm/0.5 mmhos/cm.

B. PLANT BED SOIL

Base Loam, Sand and Compost, each as specified above, shall be combined in an approximately equal parts by volume Sand, Base Loam and Compost to

create a uniform blend which meets the following requirements. Percentages will be adjusted as necessary to achieve a final the following grain size distribution and criteria below for material passing the #10 sieve:

U.S. Sieve Size Number	% Passing by Weight	
	Minimum	Maximum
10	100	-
18	80	95
35	56	80
60	32	56
140	23	32
270	19	23
0.002 mm	2.5	8

1. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
2. Saturated hydraulic conductivity of the mix: not less than 3 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 84% Standard Proctor, ASTM 698.
3. Organic content: between 5.0 and 6.5 percent by weight.
4. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 10; and Soluble Salts shall be less than 2,000 ppm/2.0 mmhos/cm.

C. LAWN SOIL

Base Loam, Sand and Compost, each as specified above, shall be combined in an approximate mix ratio of 45% by volume Sand to 30 % by volume Base Loam to 25% by volume Compost to create a uniform blend which meets the following requirements.

Percentages will be adjusted as necessary to achieve a final the following grain size distribution and criteria below for material passing the #10 sieve:

U.S. Sieve Size Number	% Passing by Weight	
	Minimum	Maximum
10	100	-
18	80	95
35	56	80
60	30	56
140	18	30
270	15	18
0.002 mm	2.5	6

1. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
2. The ratio of the particle size for 80% passing (D80) to the particle size for 30% passing (D30) shall be 6.0 or less ($D80/D30 < 6.0$).
3. Saturated hydraulic conductivity of the mix: not less than 4 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 86% Standard Proctor, ASTM 698.
4. Organic content: between 4.0 and 5.0 percent by weight. Compost shall be added as necessary to meet minimum organic content requirement.
5. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 8; and Soluble Salts shall be less than 1,000 ppm/1.0 mmhos/cm

D. SAND-BASED STRUCTURAL SOIL

Sand-Based Structural Soil shall consist of a blend of approximately 60% by volume Coarse Sand, 15% by volume Base Loam and 25% by volume Organic Amendment. The components shall be blended to create a uniform mixture. Percentages will be adjusted as necessary to achieve a final the following grain size distribution and criteria below for material passing the #10 sieve:

U.S. Sieve Size No.	Percent Passing	
	Minimum	Maximum
10	100	-
18	68	90
35	38	63
60	18	39
140	10	18
270	8	10
0.002mm	1	4

1. Maximum size shall be one inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
2. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.2 or less ($D70/D20 < 3.2$).
3. The final mix shall have a saturated hydraulic conductivity of not less than 6.0 inches per hour according to test procedure ASTM D5856-95 (2000) when compacted to a minimum of 94 percent Standard Proctor ASTM D698.
4. Organic content shall be between 2.5 and 3.5 percent.

5. Unless otherwise specified or recommended by the Soil Supplier's Soil Scientist: pH shall be between 6.5 and 7.2; CEC shall be a minimum of 6; and Soluble Salts shall be less than 500 ppm/0.5 mmhos/cm.

C.xx.5. PREPARATION AND MIXING OF PLANTING SOIL MIXES

Preparation, amendment, and mixing of the planting soil shall be performed at the Soil Supplier location. The following procedure shall be followed:

- A. Soil shall be amended to meet pH requirements and horticultural deficiencies as determined by the Testing Agency.
- B. Examine soil and remove foreign materials, stones and organic debris over 1/2" in size.
- C. Correct deficiencies in soil as directed by horticultural soil test results. If lime is to be added, it shall be mixed with dry soil before fertilizer is added and mixed.
- D. Planting soil mixtures shall be produced with equipment that blends together each component in a thorough and uniform manner.
- E. Preparation and mixing shall be accomplished when the soil moisture content is less than field capacity and at a moisture content approved by the DDOT and Soil Scientist.
- F. Incorporate pre-plant fertilizer as directed.

C.xx.6. DELIVERY, STORAGE AND HANDLING

- A. Material shall not be handled or hauled when it is wet, as after a heavy rainfall or is frozen. Soil shall be handled only when the moisture content is less than at field capacity. DDOT or the Soil Scientist shall be consulted to determine if the soil is too wet to handle. Stockpiles shall be covered during wet weather.
- B. Contractor shall store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.

C.xx.7. PRE-INSTALLATION EXAMINATION AND PREPARATION

- A. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

- B. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify DDOT in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the DDOT and Soil Scientist.
- C. Examination of Conditions: Prior to the start of soil placement existing conditions shall be reviewed. Any deficiencies shall be noted and related to the DDOT in writing prior to acceptance of the subgrade by the Landscape Contractor. Deficiencies include, but shall not be limited to the following:
 - 1. Construction debris present within the planting areas.
 - 2. The subgrade is at incorrect depths for installing the designed soil profile and/or drainage layer.
 - 3. Incomplete irrigation and/or subsurface drainage installation.

C.xx.8. SUBGRADE PREPARATION

- A. Coordinate the following scarification work to eliminate subgrade compaction resultant from Construction Operations when located in lawn and planting areas.
 - 1. General Site Subgrade Compaction Mitigation for all planting areas that are not heavily compacted:
 - a. Immediately prior to placing any Planting Soil or any drainage materials beneath planting soils, the entire subgrade shall be loosened to a minimum depth of 3-inches using the teeth of a backhoe or other suitable equipment.
 - b. After the subgrade soils have been loosened, re-compressed and inspected, remove any stones or debris 6” or greater and dispose off of the project site. Do not bury large stones or debris.
 - 2. Subgrade Inspection and Percolation Testing:
 - a. After subgrade levels have been reached the Contractor shall carry out percolation tests according to the following procedures at locations shown on the plans.
 - b. If directed by DDOT, percolation tests shall be performed to confirm subsoil infiltration rates according to the following test

procedures. Utilize perforated canisters or buckets seven to ten inches in diameter and a minimum of six inches high.

- 1) A test hole shall be hand dug at the soil horizon to be tested approximately one-inch larger than the diameter of the test canister and approximately six inches deep. The sides of the test hole shall not be smoothed.
 - 2) Place one-half inch of clean coarse sand in the bottom of the hole and place the canister firmly into the hole. The space around the canister shall then be filled with coarse sand. Tamp the coarse sand to firmly fill any void space around the test canister.
 - 3) Fill the canister with water to the soil horizon level and allow to drain until approximately one inch of water remains, or a minimum of 1 hour.
 - 4) Refill the canister to the soil horizon level. After the water level drops approximately one inch, start the test. Record time versus water level as the water level drops. The percolation rate is the length of time for the water level to drop per inch. The field scientist shall record the rate of percolation for a minimum of two hours or until the water level has dropped a minimum of three inches after the start of measurements.
- c. If the prepared subgrade fails to infiltrate water at the minimum rate, infiltration pits or subsurface drainage systems may be required, as directed by DDOT.
- B. After the subgrade has been approved, Planting Soils or drainage materials may be spread by using a wide track bulldozer size D-5 or smaller or may be dumped and spread with the bucket of a backhoe from the edge of the loosened area. No rubber-tired equipment or heavy equipment except for a small bulldozer shall pass over the subsoils (subgrade) after they have been loosened and recompressed. If the Contractor plans to utilize such areas for any use of heavy equipment, this work should be carried out prior to beginning the process of loosening soils or filling in that area.

C.xx.9. PREPARATION OF SOILS

- A. Soil Moisture Content- The contractor or soil supplier shall not work soil when moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in the air or that clods will not break readily, nor when it is frozen. Apply water, if necessary, to bring soil to an optimum moisture content for tilling and planting.

1. Field Tests
 - a. Form soil in palm of hand, if soil retains shape and crumbles upon touching, the soil may be worked.
 - b. If the soil will not retain shape it is too dry and should not be worked.
 - c. If the soil retains shape and will not crumble, it is too wet and should not be worked.
 - d. If the soil glistens or free water is present after lightly patting the sample, the soil is too wet and should not be worked.

C.xx.10. PLACEMENT OF DRAINAGE MATERIALS AND SOIL LAYERS

A. Preparation for Placement of Planting Soils

1. Notify DDOT of soil placement operations at least seven calendar days prior to the beginning of work.
2. Prevent compacting soils by beginning work in corner, against walls, or the center of isolated beds, and progressing outwards towards borders.
3. Never move or work Planting Soils when wet or frozen.
4. Place barricades as required to prevent compaction of planting soil from vehicles, equipment, or pedestrian traffic.

B. General Placement Requirements

1. Planting Soils or drainage materials may be spread by using a wide track bulldozer size D-5 or smaller or may be dumped and spread with the bucket of a backhoe from the edge of the loosened area. No rubber-tired equipment or heavy equipment except for a small bulldozer shall pass over the subsoils (subgrade) after they have been loosened and recompressed. If the Contractor plans to utilize such areas for any use of heavy equipment, this work should be carried out prior to beginning the process of loosening soils or filling in that area.
2. Place and spread Planting Soils in layers as specified to a thickness greater than required such that after settlement,
3. The surface area of each lift, including the subgrade after it has been compacted, shall be scarified by raking immediately prior to placing the next lift.
4. Place and spread topmost layers of planting medium to the thickness such that, after settlement, finished grades conform to the lines, grades and elevations shown on the Drawings. Ensure proper drainage in an uninterrupted pattern free of hollows and pockets.

- C. In accordance with the Contract Document and Detail Drawings, proceed with placement of base materials as follows:
 - 1. Where geosynthetics are required per the contract plans, place geosynthetic layers in accordance with DDOT approved specification for Geosynthetics for Stormwater Management.
 - 2. Where subsurface storage is required, place sand or stone layer as shown on the drawings in accordance with DDOT approved specification for Aggregate Base Course for Permeable Pavement and Bioretention.
 - 3. Where subsurface drainage is required, install in accordance with DDOT specifications.

- D. Place Bioretention Soil as follows:
 - 1. Bioswales: Place and spread in lifts not greater than twelve inches and compact each layer to a density of 85% plus or minus 2% of Standard Proctor.
 - 2. Bioretention Soil beneath Suspended Pavements: Place and spread in lifts not greater than twelve inches and compact each layer to a density of 80% plus or minus 2% of Standard Proctor.
 - 3. Other Bioretention: Place and spread in lifts not greater than twelve inches and compact each layer to a density of 83% plus or minus 2% of Standard Proctor.

- E. Place and spread Planting Bed Soil in lifts not greater than twelve inches and compact to a density of 82% plus or minus 2% of Standard Proctor Maximum Dry Density.

- F. Place and spread Lawn Soil in lifts not greater than twelve inches and compact to a density of 86% plus or minus 2% of Standard Proctor Maximum Dry Density.

- G. Place Sand Based Structural Soil as follows:
 - 1. Beneath Pavements: Spread in lifts not greater than eight inches and compact with a minimum of two passes of vibratory compaction equipment to a density of 95% plus or minus 1% of Standard Proctor.
 - 2. As Horticultural Subsoil: Spread in lifts not greater than twelve inches and compact to a density of 85% plus or minus 1% of Standard Proctor

C.xx.11. PROTECTION

- A. Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials from other work.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace material to a depth as directed by the DDOT and Soil Scientist; reshape and re-compact at optimum moisture content to the required density.
- C. Where settling occurs, before final acceptance or during the warranty period, remove finish surfacing, backfill with additional approved soil, compact to specified rates, and restore any disturbed areas to a condition acceptable to the Owner.

C.xx.12. COORDINATION AND EXCESS MATERIALS

- A. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
- B. Excess Planting Soil Mixtures and Materials: Remove excess planting mediums and materials from the site.

C.xx.13. POST-INSTALLATION TESTING

In-place density testing shall be performed by the Contractor at a rate of 1 per 2000 square feet for each type of material placed. The standard test for surface and subsurface density shall be ASTM D 2922-01: Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

C.xx.14. MEASUREMENT AND PAYMENT

- A. Bioretention Soil, planting bed soil, lawn soil and sand-based structural soil each will be measured in cubic yards complete in place.
- B. Payment will be made at the respective contract unit price per cubic yard, which payment will include preparing areas to receive the soil, furnishing, transporting, installing and testing the soil mixtures including all amendments, and all labor, tools, equipment and incidentals necessary to complete the work.