

**1) COORDINATION WITH ADJACENT PROJECTS AND COMMUNICATIONS:**

a) Roles/Responsibilities:

- i) The Program Management Consultant (PMC) Team is employed by the City of Dublin in order to manage the interfaces between the projects in association with the City of Dublin Capital Improvements Plan and the Bridge Street District Development. The PMC serves as the point of contact for management of the programs projects. Key interfaces between the projects will involve project shared work limits/overlaps, maintenance of traffic coordination, shared detour routes, private utility coordination, multiple project scope dependencies, multi-project communications, notice of service interruptions, construction timing, and scheduling. The PMC's execution of these program components shall not replace the requirements of each respective contractor's management staff. It is intended to enhance the ability of each project to achieve the individual project goals while minimizing the impact to one another and preserve the intended functions of the existing rights of way.
- ii) The awarded contractor and their subcontractors are required to incorporate the work of the private utility relocations into their CPM Schedule for the project. All payment for required CPM Scheduling Type B shall be included for payment under the referenced pay item found in Miscellaneous, John Shields Parkway, Phase 2. The City of Dublin Specification 108.03 is utilized in conjunction with this pay item. No additional payment is made for schedule coordination with the PMC or the private utility companies. The contractor is required to provide the CPM Schedule file in .xer format using Primavera version 6.0 or later to the PMC as requested and no less than 1 time per month. In addition to the requirements outlined in City of Dublin Specification 108.03, the contractor is required to hold group meetings with the private utility companies and subcontractors in order to develop the projects baseline schedule. The contractor is required to incorporate all work elements associated with John Shields Parkway Phase, 2, and the work associated with the private utility companies identified.
- iii) Cooperation between Contractors: This section is used in conjunction with the City of Dublin CMS specification section 105.07, Cooperation with Utilities and 105.08, Cooperation between contractors. The additional language below is not intended to replace the contents of these sections. In the event

the below contents conflict with the referenced specification sections above, the strictest requirements shall govern.

The contractor is responsible for providing adequate management staff in order to participate in the coordination between the multiple contractors. This may include attendance of interface focused coordination meetings, attendance at progress meetings, and field coordination meetings. Costs associated with the cooperation between contractors shall be included as a cost of managing the project and no separate pay item will be made.

The contractor will be responsible to provide as-built information as requested by the PMC staff or the City of Dublin for the purposes of adequately addressing the project interfaces that may exist. Similarly, field records may also be requested at any time in order to address coordination issues that are identified. The Contractor shall provide all information requested promptly. Costs associated with the cooperation between contractors shall be included as a cost of managing the project and no separate pay item will be made.

## **INSPECTION**

All inspections shall be provided by the City and it will provide inspection staff associated with the installation of the facilities.

## **CPM SCHEDULING**

The contractor and their subcontractors will be required to incorporate the work of the private utility relocations into their CPM Schedule for the project. Payment for all required CPM Scheduling Type B shall be included for payment under the referenced pay item found in Miscellaneous, John Shields Parkway, Phase 2. The City of Dublin Specification 108.03 will be utilized in conjunction with this pay item. No additional payment will be made for schedule coordination with the PMC or the private utility companies. The contractor will be required to provide the CPM Schedule file in .xer format using Primavera version 6.0 or later to the PMC as requested and no less than 1 time per month. In addition to the requirements outlined in City of Dublin Specification 108.03, the contractor will be required to hold group meetings with the private utility companies and subcontractors in order to develop the projects baseline schedule. The contractor is required to incorporate all work elements associated with John Shields Parkway Phase, 2 and the work associated with the private utility

companies identified. The Contractor shall provide a 6-week look ahead schedule within 15 days of the City issuing the notice to proceed for construction. A Full Baseline CPM Schedule shall be submitted within 45 days of the notice to proceed being issued, and updates shall be submitted no less than once a month.

b) Pay item for Type B – CPM Schedule has been included in the John Shields Parkway Phase, 2 plans. Payment for all CPM Scheduling associated with this contract shall be made under this pay item.

c) Construction Administration and Inspection Team

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Construction Contract Administrator  
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d) PMC Contact List

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## **2) PROJECT INTERFACES**

Each individual project will interface with other projects in a different manner depending on the timing of construction activities that are occurring and the Contractor's sequence of construction. The Contractor will be required to communicate with the PMC team on a daily basis to ensure any deviations to the contractor's work plans are being adequately communicated to all contractors and stakeholders with a vested interest in the projects.

- a) Definitions: For the purposes of coordinating the multiple projects and interface types associated with this contract, the following interface types have been defined as follows:
  - i) Shared Project Limits: Shared project limits occur when the work of another contractor is occurring inside the work limits defined in the project documents. This requires the affected contractors to coordinate their work with the PMC and one another. Contractors will be required to provide accommodations for the shared work zone to one another based on the contractor's CPM Schedule and the importance of the work occurring at a given time. The importance to the work will be assessed by the PMC based on the overall program importance to the specific scope being impacted and will consider the specific impacts associated with each project involved. The Contractors of this contract are required to allow access to work by another contractor within the project area where a Shared Project Limit Interface is to occur.
  - ii) Shared MOT Setups: Throughout the course of the project, when a scope of work by another contractor is to be performed adjacent to the work areas associated with this contract. The contractor is required to coordinate the maintenance of traffic setups with the adjacent project and may be required to revise existing maintenance of traffic schemes in order to facilitate the construction of both projects and maintain traffic as planned in the documents.
  - iii) Shared Detour Routes: Throughout the course of the project, the traffic detours that are required for the completion of this work will overlap with the detour routes of other contracts. The contractor is required to provide 3 days prior notice to any traffic maintenance installations in order to allow for adequate evaluation of the existing conditions associated with other detour

routes that are installed. The contractor may be required to revise the maintenance of traffic schemes in order to facilitate the construction of both projects and minimize the length of the project detour routes.

iv) Scope Dependency: A scope dependency interface is where the scope of this contract has a direct relationship with the scope of work being completed by another contractor. Scope dependency interfaces require the contractor to coordinate their work with the contractor performing the work of which the contract scope is dependent on. In situations where this contract's work is dependent on another contractor's work, the contractor will be required to maintain safe work conditions on the project and utilize the CPM schedule to identify the scope dependency interface. The contractor shall make every attempt to complete their work so as not to impede the progress or cause delays associated with the work of others.

b) Coordination Table of Key Interfaces

i) The below table is a summary of the anticipated interfaces with adjacent projects. Detailed descriptions of each interface and the requirements of this contract are found in sections 3, 4, and 5 below.

**SS Table 1.0 PROJECT COORDINATION TABLE**

PROJECT OWNER	PROJECT NAME	PROJECT DESCRIPTION	INTERFACE TYPES			
			SHARED PROJECT LIMITS	SHARED MOT SETUPS	SHARED DETOUR ROUTES	SCOPE DEPENDENCY
CASTO	Tuller Flats Development	Multi-unit apartments North and South of John Shields Parkway from the Western Boundary of the project limits to Future Hobbs Landing	YES	NO	NO	YES
CRAWFORD HOYING	Sanitary Sewer Installation	Site development project consisting of new Sanitary Sewers West of project site	YES	YES	NO	YES
CITY OF DUBLIN	John Shields Parkway Phase 2, Part 1 and 2	This project consists of Waterline and Sanitary Pipe within the same work limits as this contract. Work is anticipated to be completed prior to commencing work of this contract. As built documents will be held by the PMC and made available as necessary to perform the work.	YES	NO	NO	YES
INTERIM COTA PARK AND RIDE	CITY OF DUBLIN / COTA	The interim COTA Park and Ride site is located on the South east corner of the project and is a functional facility that will need to maintain operations during the construction efforts associated with this contract	YES	NO	NO	YES

**3) CITY AND STATE PROJECT COORDINATION**

a) Projects Requiring Coordination

- i) John Shields Parkway Phase 2, Parts 1 & 2

b) Critical Interfaces

- i) Coordination of Site access from the East of the site and material staging may be coordinated with the contractor but is not required. The Contractor shall not be able to access the site from this area if the PMC determines that adverse impacts to an adjacent contractor may occur.

ii) Abandonment of utilities will be occurring on the Byer's Site and may require coordination with the work of this contract.

iii) As Built Details are to be provided including but not limited to final installation of all scope elements and Horizontal/Vertical Controls used during construction

#### **4) DEVELOPER PROJECT COORDINATION**

a) Projects Requiring Coordination

- i) Casto Tuller Flats Development
- ii) Crawford Hoying Sanitary Sewer Installation

b) Critical Interfaces

- (a) Sanitary Manhole Scope Dependencies/Tie In's: The Casto Development will be tying up stream sanitary piping from sanitary structures installed by this contract. The scope dependency will require coordination with the submittals for these structures for the north facing inverts of structures 9 and 10 and coordination with the Casto Development Contractor.
- (b) This project also requires shared project limits with the Casto/Tuller Flats Development. This will require the contractor to identify staging areas for materials and equipment during the preconstruction meeting as well as identify the contractor's intention for accessing the site and material deliveries. Regular Communications with the adjacent Contractors will be facilitated by the PMC team to ensure communications and coordination is taken place as the work of both project progresses.
- (c) The Waterline portion of this scope will be installed as planned to provide future connections by the developer. The 5 locations identified on the plan sheets will need to be identified and communicated with the PMC team and the as-built coordinates will need to be marked in the field and coordinated.
- (d) The Crawford Hoying Sanitary Sewer Installation will be tying into the west elevation of structure 1 installed by this contract. Regular Communications with the adjacent Contractors will be facilitated by the PMC team to ensure communications and coordination is taken place as the work of both project progresses.

## **5) PRIVATE UTILITY PROJECT COORDINATION**

Projects Requiring Coordination: The intent of this section is to inform the contractor of work occurring either within the project limits of, or adjacent to the construction limits outlined in the plan sets. It is the Contractor's responsibility to coordinate their work with the private utilities as required. The utility owner may be required to brace, temporarily support, or relocate their respective utilities so that the proposed improvements can be constructed.

## **5) SERVICE INTERRUPTIONS, OUTAGES, AND MAINTENANCE OF TRAFFIC**

### b) Objectives:

- i) Maintain a safe work zone for all construction personnel as well as pedestrian and vehicular traffic throughout the contract.
- ii) Minimize the length of time an outage/service interruption is to occur and the number of times an outage/service interruption is to occur.
- iii) All work associated with this contract and interfacing projects shall not impede traffic to less than a single lane in all directions at any time.

### c) Requirements:

#### i) Advance Notice and Communications:

(1) Any scheduled interruption to public services associated with this contract requires a minimum 5-day notice provided to the PMC and the City in order to allow for proper consideration of adjacent projects.

(2) Working Restrictions and hours of operation: Any planned work requiring a service interruption or Outage shall be performed at a time of day that is deemed by the City to be the least impactful to the affected parties. All outage/service interruptions require a minimum 5-day notice and written authorization from the PMC or Owner prior to execution.

(3) Unscheduled interruptions shall be communicated immediately to the PMC and the City of Dublin so appropriate action can be taken. Should an incident occur during off hours, the contractor is responsible for initiating their emergency response plan and notifying the PMC and the City in addition to any emergency services that may be necessary to minimize the interruption.

ii) Traffic Maintenance is a critical component of the Bridge Street District Development and the execution of the scope of work in this contract. MOT shall be per the approved plans unless otherwise approved by the City Engineer.

(1) Every effort shall be made by the PMC and the project contractors to ensure safe accessible conditions are maintained everywhere possible. The contractor shall provide a site logistics plan and traffic maintenance plan prior to commencing work. The site logistics plan and maintenance of traffic plans are the responsibility of the contractor and can only be installed on the project until this plan has been submitted and reviewed by the PMC and the City of Dublin. All maintenance of traffic item costs are to be included in the applicable pay item unit costs and no separate pay item will be provided for Maintenance of Traffic. All traffic maintenance shall be completed in accordance with the OMUTCD and applicable City, State, and Local Standards. Traffic must be maintained along Dale Drive at all times in both directions and all MOT must be removed in times when work is not being performed on the project (off hours) or the work zone is not being utilized by the contractor. The contractor shall include restoration in kind for any area damaged by pavement within the right of way as a result of the waterline and sanitary piping installations. This cost shall also be included in the applicable unit prices and no separate payment will be made for restoration work. All restoration work shall conform with city of Dublin standard documents and is subject to approval by the City. The means and methods of restoration in road right of way are at the contractors discretion so long as the installations conform to the standard documents.

(2) In the event another project has captured an area typically utilized for vehicular or pedestrian travel and is in proximity to the permitted work zone, the contractor shall coordinate their work with the existing maintenance of traffic setups to ensure a minimum of 1 lane in all directions is maintained at all times. The contractor(s) may be required to share work limits or maintenance of traffic setups with another project in order to perform the contract work.

(3) Adjacent Property Access shall be maintained at all times. In the event the contract work requires impeding access to an adjacent property, every effort to minimize the disruption to the property access shall be maintained. When the contractors work impedes access to an adjacent property the contractor shall not vacate the area of work until temporary measures for maintaining access are implemented. No separate pay item will be made for temporary measures. All costs associated with installing temporary work to maintain safe access to adjacent properties shall be included in the applicable pay items for the items being installed.

## **7) PERMITS AND RESTRICTIONS**

### a) Tree Clearing

- i) *A United States Fish & Wildlife Service Coordination for Indiana Bat* coordination letter has been processed and clearance received to cut trees in advance of March 31.

### **WORKING HOURS**

All work associated with the project shall be constructed from 7 A.M. to 7 P.M., Monday through Saturday. If the contractor wishes to work on Sunday, a written request must be submitted to the contract administrator for the project, and City approval is required. Requests for Sunday work to be performed shall be made a minimum of 3 calendar days prior.

The Contractor may request modification of these working hours in writing with appropriate explanation and justification for review by the Program Management Consultant and approval by the City Engineer. Any alteration to the working hours above will be evaluated on a case-by-case basis, and must be made with the best interest of the City and local traffic conditions in mind.

### **STORAGE OF EQUIPMENT AND MATERIALS**

No materials, including pipe, shall be stored within twenty (20) feet of any intersecting street or driveway. During non-working hours, storage of equipment shall comply with these same requirements and shall not in any way relieve the Contractor of their legal responsibilities or liabilities for the safety of the public.

### **CONSTRUCTION NOISE**

Any device shall not be operated at any time in such a manner that the noise created substantially exceeds the noise customarily and necessarily attendant to the reasonable and efficient performance of such equipment. All construction activities are subjected to the City of Dublin Noise ordinances.

## 6) PROJECT COMPLETION

<b>SS Table 2.0</b>		
<b>ITEM</b>	<b>SCOPE</b>	<b>Milestone Date Required</b>
Project Substantial Completion	Reference "Section 6, Work schedule, Substantial Completion and Final Completion"	Finish on October 15, 2016
Project Final Completion	Reference Section 6, Final Completion	Finish on November 30, 2016
Interim Cota Site Demolition activity	All work required on the COTA Interim park and ride site shall not be performed until the site is vacated. This is inclusive of demolition activities and storm pipe installations. This site is anticipated to be vacated by September 15, 2016. As such no CPM schedule submission can schedule work in this area prior to this date without authorization from the PMC.	Start on September 16, 2016

- i) Extensions of time will be for calendar days and calculated in accordance with The City of Dublin General Conditions 108.06 except as follows: no extensions of time will be granted for delays in material deliveries (unless such delays are industry wide), labor strikes (unless such strikes are area wide) and inclement weather except in cases of area flooding, blizzard conditions, damaging wind or local tornado damage.

### **WORK SCHEDULE AND FINAL COMPLETION.**

- ii) Substantial Completion for this project is defined as the full functional use of the roadway including all regulatory inspections and testing have been completed. The project final completion date shall be completed by **October 15, 2016**
- iii) Final Completion for this project is defined as the completion of all plantings, demolition, restoration, and all punchlist activities. Are requirements for final completion inclusive of the requirements defined in substantial completion shall be completed by **November 30, 2016**.

## **ITEM 201 -Clearing and Grubbing**

- ii) Any tree trimming, pruning, and protection of trees on the site necessary to perform the contract scope shall be paid for and included under item 201 Clearing and Grubbing. Where work is required inside of existing tree drip lines, the contractor shall use a good faith effort to minimize any damage to the existing trees in order to preserve the trees that remain on the site. All trees not scheduled for removal in the documents are required to be protected and preserved. Stockpiling of materials within the dripline of trees will not be permitted.

## **7) PERMITS AND RESTRICTIONS**

### **TREE CLEARING**

*A United States Fish & Wildlife Service Coordination for Indiana Bat* coordination letter has been processed and clearance received to cut trees in advance of March 31, 2016.

### **NOTICE OF INTENT**

A Notice of Intent (NOI) has been filed with the Ohio Environmental Protection Agency (OEPA). The NOI was filed on December 28, 2015 and the NOI approval is anticipated to be received prior to issuing the notice to proceed.

### **WATERLINE PERMIT TO INSTALL**

A waterline Permit to Install (PTI) is required for the contract. The permit is anticipated to be available on March 15, 2016.

### **SANITARY PERMIT TO INSTALL**

A sanitary Permit to Install (PTI) is not required for the project.

### **EROSION AND SEDIMENT CONTROL**

Ditch erosion protection pay items are included in each bid tabulation for the respective plan sets. The contractor is required to maintain appropriate Storm water pollution prevention within the site limits at all times. No additional payment shall be made should the contractor elect to utilize different means and methods for the temporary erosion and sediment control measures in order to maintain compliance with the City of Dublin and EPA requirements.

Cooperation with the Casto Tuller Flats Development will be necessary as the scope of work associated with this contract and the Development effort are anticipated to occur simultaneously. Maintenance of the erosion and sediment

and erosion control within the work limits is to be provide using as directed quantities identified in the Bid Tab with an \*.

The Contractor will be responsible to sweep the adjacent streets and minimize all track out from the work limits that occurs associated with the project. This will need to be responded to immediately as identified by the PMC Team. All project costs associated with addressing track out and erosion and sediment control other than described above shall be the responsibility of the contractor and be included on applicable line items identified in the scope.

### **FESTIVALS AND CITY EVENTS**

- a. Periodically the City will have community events and festivals that will require consideration for the construction activities associated with this contract. Events not listed may come up periodically that will require additional coordination with the work of this contract and all dates identified are subjected to change. The maintenance of traffic setups accommodate many of the events occurring in the community without further consideration. At a minimum, for the following event dates, the contractor shall ensure the work limits have been cleaned from debris and all construction materials are stored safely and securely. The streets shall be swept 1 day prior and as directed by the project inspection staff throughout the project to maintain the safest construction area possible. Additional work requests may be made by the City for consideration of improved pedestrian walk paths through the construction zone, maintenance of traffic temporary modifications, additional safety barricades, utilization of additional law enforcement officers.

<b>SS Table 4.0 Events Schedule</b>		
<b>Events Schedule</b>		<b>Frequency</b>
St. Patrick's Day Parade	March 12, 2016	Annual
Memorial Day Parade	May 30, 2016	Annual
Memorial Tournament	May 30 – June 5, 2016	Annual
Independence Day Parade	July 4 <sup>th</sup> , 2016	Annual
Dublin Irish Festival	August 5-7, 2016	Annual
Spooktacular	October 15 <sup>th</sup> 2016	Annual
Beggars Night	October 31 <sup>st</sup> 2016	Annual
Veterans Day Ceremony	November 11, 2016	Annual

### **GEOTECHNICAL INFORMATION**

The subsurface exploration report for this project is included in the bid documents. This is intended to provide geotechnical data for bidding purposes. The conditions represented are not a guarantee of conditions to be encountered.

## TEST HOLES

The Contractor is encouraged to dig test holes at the project site prior to making their bid to familiarize themselves with site subsurface conditions. The bidder shall take into account any difficulty they perceive in constructing the project due to rock, ground water, weak soils, topsoil, etc.

The City will issue a permit to proceed with this work. Please contact the Project Manager, Mandy K. Bishop, PE, SI at 614-410-4672.

## ROCK EXCAVATION

Rock may be encountered throughout this project. Payment shall be made under applicable pay items where rock would be encountered when excavation is required to perform the work. No additional payment shall be made for rock excavation.

All excavation shall be considered as unclassified, including rock.

No alternates or deviations shall be permitted from those construction materials shown on the plans. Bidders shall not submit alternates with their bid unless an alternate is explicitly requested.

The City is currently constructing a sanitary sewer and waterline in the roadway alignment. All station references are related to the plans for **Proposed Public Sanitary Sewer for John Shields Parkway, Phase 2 – Part 1**. Based on inspection reports, rock has been encountered at the following locations and elevations:

Station	Elevation of Rock Encountered
0+75.90 (MH# 1)	835.00 +/-
0+85	841.00 +/-
1+74.09 (MH#2)	842.00 +/-
1+75	840.00 +/-
3+00	841.00 +/-

These are snapshots of conditions encountered in the field. Rock may be encountered at other locations and depths. Bidding contractors shall provide for all rock excavation associated with the infrastructure installations using their best judgement and include bid costs in the applicable line items. No separate pay item will be included and no additional compensation will be paid for rock encountered on the project.

## **CONSTRUCTION LAYOUT**

All construction layout stakes for this project shall be provided by the Contractor. All work shall be performed by and under the guidance of an Ohio Professional Surveyor.

## **DEWATERING**

The cost of any dewatering operations required for the construction of the storm sewers, water mains, culverts, and AEP duct systems and vaults, and/or conduits shall be included in the price bid for the various items.

## **CONDUIT END TREATMENT**

Immediately after placement of any conduits, the Contractor shall construct the end treatments required by the plans at both the outlet and inlet ends. This shall include headwalls, flared-end sections, rip-rap, rock channel protection, seeding, etc.

## **MANHOLES, CATCH BASINS AND INLETS**

The contractor will make all final grade adjustments of manhole, catch basin and inlet covers and frame assemblies using injection molded high density polyethylene (HDPE) adjustment rings where practical. These adjustment rings shall be manufactured from polyethylene plastic as identified in ASTM Designation D-1248 (Standard Specification for Polyethylene Plastic Molding and Extrusion Materials). Installation shall be per manufacture's recommendations only. The annular space between the rings and cone basin, the rings, and the rings and cover frame shall be sealed utilizing an approved butyl sealant.

## **SURVEY MONUMENTATION**

The contractor shall carefully preserve bench marks, property corners, reference points, stakes and other survey reference monuments or markers. In cases of

willful or careless destruction, the contractor shall be responsible. Resetting of markers shall be performed by an Ohio Professional Surveyor as approved by the City Engineer at the contractor's expense.

Benchmarks placed by this contract are to be made available for reference to the adjacent contractors working on the site.

**COLUMBUS INDUSTRIAL – 4333 TULLER ROAD**

The right-of-way on this property has not been obtained. Work associated with this parcel is not available shall be scheduled prior to May 15, 2016. The Contractor will be provided written documentation of its availability. This work is approximately between stations 669+50 and 676+50.

**OFFSITE STORM SEWER WORK – SHEET 38**

The work on this sheet and cross referenced sheets 2, 20, 24 and 71 shall be complete within 30 calendar days of initiation of the work. Specifically, the pavement of the shared use path shall be restored in kind and usable by pedestrians and cyclists within 30 calendar days of disturbance. Additionally, the contractor is required to maintain a functional walkway when construction operations are not underway.

## **SECTION 02795 PERVIOUS CONCRETE PAVEMENT WITH DETENTION**

### **PART 1 GENERAL**

#### **1.01 Scope of Work:**

- A. The Work described by this guide addresses the labor, materials and equipment necessary for construction of pervious concrete pavement in conformance with the plans, specifications and other contract documents, for Item Special - Permeable Paver Roadway.

#### **1.02 References:**

- A. American Concrete Institute (ACI)
  - 1. ACI 211.3R "Guide for Selecting Proportions for No- Slump Concrete"
  - 2. ACI 305 "Hot Weather Concreting"
  - 3. ACI 306 "Cold Weather Concreting"
  - 4. ACI 522 "Report on Pervious Concrete"
  - 5. ACI 522.1-13 "Specification for Pervious Concrete Pavement"
  - 6. ACI Flatwork Finisher Certification Program
  - 7. ACI Field Technician Certification Program
- B. American Society for Testing and Materials (ASTM)
  - 1. ASTM C 29 "Test for Bulk Density (Unit Weight) and Voids in Aggregate"
  - 2. ASTM C 33 "Specification for Concrete Aggregates"
  - 3. ASTM C 42 "Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete"
  - 4. ASTM C 94 "Specification for Ready-Mixed Concrete"
  - 5. ASTM C 117 "Test Method for Material Finer than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing"
  - 6. ASTM C 150 "Specification for Portland Cement"
  - 7. ASTM C 172 "Practice for Sampling Freshly Mixed Concrete"

8. ASTM C 260 "Specification for Air-Entraining Admixtures for Concrete"
9. ASTM C 494 "Specification for Chemical Admixtures for Concrete"
10. ASTM C 595 "Specification for Blended Hydraulic Cements"
11. ASTM C 618 "Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete"
12. ASTM C 979 "Specification for Pigments for Integrally Colored Concrete"
13. ASTM C 989 "Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars"
14. ASTM C 1077 "Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation."
15. ASTM C 1116 "Specification for Fiber-Reinforced Concrete"
16. ASTM C 1542 "Standard Test Method for Measuring Length of Concrete Cores"
17. ASTM C 1602 "Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete"
18. ASTM C 1688 "Test Method for Density and Void Content of Freshly Mixed Pervious Concrete"
19. ASTM C 1701 "Test Method for Infiltration Rate of In Place Pervious Concrete"
20. ASTM C 1754 "Standard Test Method for Density and Void Content of Hardened Pervious Concrete"
21. ASTM D 448 "Classification for Sizes of Aggregate for Road and Bridge Construction"
22. ASTM D 1557 "Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>)"
23. ASTM D 1751 "Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)"
24. ASTM D 1752 "Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction"
25. ASTM D 2434 "Test Method for Permeability of Granular Soils (Constant Head)"
26. ASTM D 3385 "Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer"
27. ASTM D 5084 "Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (Falling Head, Method C)"
28. ASTM D 5093 "Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring"
29. ASTM D 6391 "Test Method for Field Measurement of Hydraulic Conductivity Limits of Porous Materials Using Two Stages of Infiltration from a Borehole"

- 30. ASTM D7357 "Specification for Cellulose Fibers for Fiber-Reinforced Concrete"
- 31. ASTM E 329 "Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction"
- C. National Ready Mixed Concrete Association (NRMCA)
  - 1. NRMCA Pervious Concrete Contractor Certification
- D. State of Ohio Department of Transportation (ODOT) Construction and Material Specifications
  - 1. Item 703.02 Aggregate for Portland Cement Concrete

### **1.03 Quality Assurance:**

- A. Qualifications of testing laboratories -The testing laboratory shall have its laboratory equipment and procedures inspected at intervals not to exceed 2 years by a qualified national authority as evidence of its competence to perform the required tests and material designs. Acceptable national authority will include the AASHTO Materials Reference Laboratory (AMRL) or the Cement and Concrete Reference Laboratory (CCRL) as appropriate. In addition, testing machines and equipment must be calibrated annually or more frequently by impartial means using devices of accuracy traceable to the National Bureau of Standards.

Field tests of pervious concrete shall be performed by individuals certified as both an NRMCA Certified Pervious Concrete Technician (or equivalent) and as an ACI Concrete Field Testing Technician – Grade I. In fields other than those covered by the referenced ASTM standards, the testing laboratory shall accept only those assignments which it is able to perform competently by use of its own personnel and equipment. Any work to be subcontracted must be to laboratories meeting the same criteria.

The testing laboratory shall have demonstrated its competence in the applicable fields for a period of not less than 3 years.

The inspection and testing services of the testing laboratory shall be under the direction of a full-time employee registered as a professional engineer in the State of Ohio. The Engineer shall have a minimum of 5 years of professional engineering experience in inspection and testing of concrete construction.

- ### **1.04 Special Equipment:**
- Pervious concrete requires specific equipment for compaction and jointing. The pervious concrete pavement shall be jointed and compacted using the methods listed, or alternatives as demonstrated and

approved by the Architect/Engineer. For example, large installations may warrant mechanized placement techniques.

- A. Rolling compaction shall be achieved using a steel pipe roller or a motorized or hydraulically actuated rotating tube screed that spans the width of the section placed and exerts a vertical pressure of 10 psi (68.95 kPa) to 30 psi (206.85 kPa) on the concrete.
- B. Plate compaction (for small areas) shall be achieved using a standard soil plate compactor that has a base area of at least two square feet and exerts a minimum of 10 psi (69 kPa) vertical pressure on the pavement surface (through a temporary cover of  $\frac{3}{4}$  in. (19 mm) plywood).
- C. When contraction joints are created in pervious pavements, they may be constructed by rolling, forming or sawing. Rolled joints shall be formed using a "pizza cutter roller" to which a beveled fin with a minimum depth of  $\frac{1}{4}$  the thickness of the slab has been welded around the circumference of a steel roller.

**1.05 Submittals: Administrative Requirements, for submittal procedures.**

Prior to commencement of the work the contractor shall submit the following:

- A. Concrete materials:
  - 1. Proposed pervious concrete mixture proportions including all material weights, volumes, design density (unit weight), water-cementitious ratio, and design void content.
  - 2. Aggregate type, source, grading, dry-rodded unit weight, percent passing number 4 sieve and void content.
  - 3. Cement, supplementary cementitious materials, synthetic (polypropylene) or cellulose fibers and chemical admixture manufacturer certifications.
  - 4. Density (unit weight) and void content of proposed freshly mixed pervious concrete mixture per ASTM C 1688. (The fresh density and void content calculated from this procedure will differ from in-place density and void content and is only used to check mixture proportion consistency).
- B. Aggregate base materials: Washed aggregate type, source, grading and void content (percent porosity).
- C. Qualifications: Evidence of qualifications listed under Quality Assurance in Section 1.03 of this guide.
- D. Project details: Specific plans including a jointing plan, details, schedule, construction procedures and quality control plan.
- E. Subcontractors: List all materials suppliers, subcontractors and testing laboratories to be used on the project.

**1.06 Test Panels:** Prior to construction, a test panel shall be placed with the crew meeting the requirement of NRMCA certified personnel per section 1.03 C. and approved by the Architect/Engineer. The Architect/Engineer may waive this requirement based on Contractor qualifications. At Contractor's option, test

panels may be constructed on approved sections of project aggregate detention (or groundwater recharge) layer.

- A. Test panel(s) shall be constructed in accordance with the plans and specifications. Regardless of qualification, the contractor is to place one test panel, consisting of approximately 740 ft<sup>2</sup> (82.5 SY), at the required project thickness, consolidated, jointed and cured using materials, equipment, and personnel proposed for the project, and on the same aggregate base proposed, to demonstrate to the Architect/Engineer's satisfaction that in-place unit weights and infiltration can be achieved and a satisfactory pavement can be installed at the site location. If strength is used in the pavement design, cores from the test panels may be used to confirm that consolidation and infiltration, as well as strength, is consistent with design objectives for the top and bottom of the slab.
- B. Test panel(s) cost and removal, if necessary, shall be included as a line item in the contract proposal and contract. Test panels may be placed at any of the specified pervious concrete pavement locations on the project or at another test site.
- C. Quality: Test panels shall have acceptable surface finish, joint details, thickness, porosity and curing procedures and shall comply with the testing and acceptance standards listed in the Quality Control section of this specification. Test density and void content of fresh concrete for the test panels in accordance with ASTM C 1688. Obtain hardened concrete cores from the test panels in accordance with ASTM C 42 upon completion of the 7-day cure: test core thickness in accordance with ASTM C 1542, and density (unit weight) and void content in accordance with ASTM C 1754.
- D. Satisfactory performance of the test panels shall be determined by:
  1. Fresh concrete results
    - a. Density (unit weight) plus or minus 5 lb/ft<sup>3</sup> (80 kg/m<sup>3</sup>) of the submitted fresh density (unit weight).
  2. Hardened concrete results (average of minimum 3 cores)
    - a. Compacted thickness no less than ¼ in. (6.35 mm) less than specified thickness  $(T_{\text{compacted}} \geq T_{\text{specified}} - \frac{1}{4} \text{ in.}); (T_{\text{compacted}} \geq T_{\text{specified}} - 6.35 \text{ mm})$
    - b. Hardened density (unit weight) plus or minus 5 % of the design density (unit weight).
  3. Infiltration Rate of In-Place Pervious Concrete
    - a. Minimum of 1000 inches per hour
- E. If test panels are found to be unsatisfactory, they shall be removed at the Contractor's expense and disposed of in an approved landfill or recycling

facility. If test panels are found to be satisfactory, they may be left in-place and included in the completed work, at no additional cost to the project.

## **1.07 Project Conditions**

### **A. Weather Limitations**

1. The Contractor shall not place pervious concrete for pavement when the ambient temperature is predicted by the National Weather Service Point Forecast for the jobsite to be 40 °F (4 °C) or lower during the seven days following placement, unless otherwise permitted in writing by the Architect/Engineer.
2. The contractor shall not place pervious concrete for pavement when the ambient temperature is predicted by the National Weather Service Point Forecast for the jobsite to rise above 90 °F (32 °C) during the seven days following placement, unless otherwise permitted in writing by the Architect/Engineer.
3. Pervious concrete pavement shall not be placed on frozen coarse aggregate or subgrade.
4. Evaporation control measures shall be applied from the time of discharge until the pavement is covered with polyethylene sheeting to prevent moisture loss during placement operations (refer to section 2.09).

## **1.08 Pre-paving Conference**

A pre-paving conference with the Architect/Engineer shall be held within one week prior to beginning placing the pervious concrete. The contractor shall have the pervious concrete supplier, the foreman and the entire concrete crew that will form and place the concrete in attendance at this meeting. A qualified representative from ORMCA/Ohio Concrete shall also be in attendance for assistance.

As a guide for the meeting, the document *Checklist for the Concrete Pre-Construction Conference* (available from the National Ready Mixed Concrete Association or the American Society of Concrete Contractors) shall be used to review all requirements of the contract during the meeting. Meeting emphasis shall be on how paving with pervious concrete differs from paving with conventional concrete.

## **PART 2      PRODUCTS**

### **2.01    Curing materials**

- A. Polyethylene sheeting - The primary method of curing pervious concrete shall be the placement of a waterproof covering, consisting of a minimum of 4 mil thick clear polyethylene sheeting.
- B. Other moisture loss control - For prevention of moisture loss prior to the primary method of curing:
  - 1. Monomolecular film (evaporation retardant), SikaFilm by Sika Corporation, EucoBar by Euclid Chemical Co., Confilm by BASF (Master Builders Technologies) or Catexol Cimfilm by Axim Concrete Technologies, or approved equal, applied per manufacturer's instructions.
  - 2. Soybean oil sealer. Note: Soybean oil is gaining recommended for added protection. It reportedly reduces surface color markings from plastic sheeting, may enhance strength and does not reduce porosity.
  - 3. Fogging equipment designed to raise the relative humidity of the ambient air over the slab and reduce evaporation to include fog nozzles that atomize water using air pressure to create a fog blanket over the slab. Note: garden hose nozzles are not sufficient to create fog and may wash paste off the aggregate.

**2.02    Cement:** Portland cement Type I, Type II or V conforming to ASTM C 150 or Portland cement Type IP or IS conforming to ASTM C 595.

### **2.03    Supplementary Cementitious Materials:**

- A. Fly ash conforming to ASTM C 618
- B. Ground Granulated Blast-Furnace Slag conforming to ASTM C 989

### **2.12    Admixtures:**

- A. Air entraining admixtures with ASTM C 260.
- B. Chemical admixtures shall comply with ASTM C 494.
  - 1. Mid-range water reducing admixtures (water reducers) Type A or High Range water reducing admixtures Type F or G are permitted due to low water-cementitious ratios specified for pervious concrete.
  - 2. Extended set control admixtures (hydration stabilizers) meeting requirements of ASTM C 494 Type B Retarding or Type D Water Reducing/Retarding admixtures are recommended to increase concrete placement time or to improve finishing operations. Note: this stabilizer suspends cement hydration by forming a protective barrier around the

cementitious particles, which delays the particles initial set. If this mix heats up in the truck a standard retarder will not prevent premature hydration where the stabilizer will.

3. Viscosity modifying admixtures (VMA's) are permitted to facilitate discharge of the concrete from the truck and placement in the forms.

### **2.13 Fiber Reinforcement:**

- A. Synthetic fiber shall be in accordance to ASTM C 1116 Type III made of polypropylene.
- B. Cellulose fibers shall be in accordance to ASTM C 1116 Type IV made of natural fibers conforming to ASTM D 7357.
- C. Macrosynthetic fibers are gaining acceptance and use in certain areas.

### **2.14 Aggregates for pervious concrete:**

- A. Coarse aggregate shall meet the size and grading requirements as defined in ASTM D 448 (or Standard Sizes of Coarse Aggregate, Table 4, AASHTO Specifications, Part I, 13<sup>th</sup> Ed., 1982 or later) and shall comply with ASTM C 33 and ODOT Item 703.02. Use No.67, No. 7, No. 8, No. 89 or No. 9 unless an alternate size is approved for use based on meeting the project requirements. Data for proposed alternate material shall be submitted for approval per Section 1.05A of this guide. Fine aggregate complying with ASTM C33, if used, shall not exceed 3 ft<sup>3</sup> per yd<sup>3</sup> (0.11 m<sup>3</sup> per 1.0 m<sup>3</sup>).
- B. Larger aggregate sizes may increase porosity but can decrease workability. No. 8 (3/8 in. or 9.5 mm) size coarse aggregate is the common size used in pervious concrete pavements. Well graded aggregates shall be avoided as they may reduce porosity, and may not provide adequate void content.  
Note: Suggested maximum limit when using a number 8 coarse aggregate pervious mix is 15% passing No. 4 sieve (4.75 mm)
  - a. For 5 to 10% passing No. 4 sieve (4.75 mm), add 125 lb/yd<sup>3</sup> (74 kg/m<sup>3</sup>) fine aggregate
  - b. For 0 to 5% passing No. 4 sieve (4.75 mm), add 200 lb/yd<sup>3</sup> (119 kg/m<sup>3</sup>) fine aggregate

**2.15 Water:** Water shall be potable and comply with ASTM C 1602.

**2.16 Mixture Proportions:** The Contractor shall furnish a proposed mix design with all proportions of materials prior to commencement of work. The data shall include densities (unit weights) and void contents determined in accordance with ASTM C

1688 for fresh mixed properties and with ASTM C 1754 for hardened concrete properties of the same proposed mixture. The composition of the proposed concrete mixture shall be submitted to the Architect/Engineer for review and/or approval and shall comply with the following provisions unless an alternative composition is demonstrated to comply with the project requirements. Mixture performance will be affected by properties of the particular materials used. Trial mixtures must be tested to establish proper proportions and determine expected behavior. Concrete producers may have mixture proportions for pervious concrete optimized for performance with local materials by use of available software programs. Appendix 6 of ACI 211.3R provides a guide for pervious concrete mixture proportioning. General mixture proportions are as follows:

- A. Aggregate/cementitious ratio: range of 4:1 to 5:1.
- B. Concrete mixture unit weight: range of 115 lb/ft<sup>3</sup> to 135 lb/ft<sup>3</sup> (1840 kg/m<sup>3</sup> to 2080 kg/m<sup>3</sup>)
- C. Concrete mixture void content: range of 13% to 30%.
- D. Cementitious content: range of 450 lbs/yd<sup>3</sup> to 600 lb/yd<sup>3</sup> (267 kg/m<sup>3</sup> to 356 kg/m<sup>3</sup>), total cementitious content.
- E. Supplementary cementitious content: Fly ash: 25 % maximum; Slag: 25 % maximum, or Combined supplementary cementitious content: 35 % maximum.
- F. Water - cementitious ratio: range from 0.28 to 0.35.
- G. Fiber reinforcement is recommended for added performance:
  - a. Synthetic polypropylene, target 0.1% volume of mixture or range 1 lb/yd<sup>3</sup> to 1.5 lb/yd<sup>3</sup> (0.593 kg/m<sup>3</sup> to 0.890 kg/m<sup>3</sup>)
  - b. Cellulose, range 1.5 lb/yd<sup>3</sup> to 3 lb/yd<sup>3</sup> (0.890 kg/m<sup>3</sup> to 1.78 kg/m<sup>3</sup>)
  - c. Macrosynthetic fibers, range per manufacture's recommendation.
- H. Aggregate content: The bulk volume of aggregate per cubic yard (cubic meter) shall be 27 ft<sup>3</sup> (1 m<sup>3</sup>) when calculated from the dry rodded density (unit weight) determined in accordance with ASTM C29 jigging or rodding procedure.
- I. Admixtures: Admixtures shall be used in accordance with the manufacturer's instructions and recommendations. Dosage of air-entraining admixture shall be a minimum of 2 oz /cwt (130 mL/100kg) of cementitious material.
- J. Mix Water: The quantity of mixing water shall be established to produce a pervious concrete mixture of the desirable workability to facilitate placing, compaction and finishing to the desired surface characteristics. Note: Mix water shall be such that the cement paste displays a wet metallic sheen without causing the paste to flow from the aggregate. (A cement paste with a dull-dry appearance has insufficient mix water for hydration.) Insufficient mix water results in inconsistency in the mix and poor bond strength. Jobsite addition of mix water is permitted to adjust for dry mixtures in concrete transit mixers. Note: High water content results in the paste sealing the void system primarily at the bottom and poor surface bond.

## **PART 3 EXECUTION**

The Architect/Engineer shall be notified at least 24 hours prior to pervious concrete paving work. Careful consideration for the construction sequence is prudent and, to the greatest extent possible, the surrounding earthwork/landscape operations should be completed and stabilized prior to stormwater storage and pervious concrete placements.

### **3.01 Installation**

#### **A. Pervious Concrete Pavement**

##### **1. Pavement Thickness:**

Pavement thickness for all applications (excluding heavy traffic loads) shall be single-course placement 8 in. (203 mm) thick unless otherwise specified in the plans. Pavements for vehicles heavier than single axle service/delivery trucks will require special design thicknesses which may require two-course construction.

Note: Thicknesses greater than 6 in. (152 mm) have been successfully installed with single-course construction, and design has been verified with cores. Cores from a test slab may be used to confirm that consolidation and infiltration in the bottom of the slab is consistent with design objectives. Cores may also be used to determine relative compressive and flexural strengths.

##### **2. Formwork:**

- a. Form materials are permitted to be of wood or steel and shall be the full depth of the pavement. Caution: protect impermeable membranes from puncture or tear when placing forms and form pins. Forms shall be of sufficient strength and stability to support mechanical equipment

without deformation of plan profiles following spreading, strike-off and compaction operations. Forms may have a removable spacer of ½ in. to ¾ in. (13 mm to 19 mm) thickness placed above the depth of pavement. The spacers shall be removed following placement and vibratory strike-off to allow roller compaction. (Removable spacers may not be necessary if other means of strike-off and consolidation are used, such as a hydraulically actuated pipe roller screed.)

- b. The Contractor will be restricted to pavement placement widths of a maximum of 20 ft (6.1 m) [*Note: Parking stall area is typically 19 feet (5.8 m) wide.*], unless the Contractor can demonstrate competence to provide pavement placement widths greater than the maximum specified to the satisfaction of the Architect/Engineer. Large scale mechanized placement of pervious concrete with slipform concrete paving machines, laser screeds or asphalt paving machines may preclude use of fixed forms.
3. Mixing and Hauling:
    - a. Production: Pervious concrete shall be manufactured and delivered in accordance with ASTM C 94.
    - b. Mixing: Mixtures shall be produced in central mixers or in transit (truck) mixers. When concrete is delivered in agitating or non-agitating units, the concrete shall be mixed in the central mixer for a minimum of 1.0 minute or until a homogenous mix is achieved. Concrete mixed in transit mixers shall be mixed at the speed designated as mixing speed by the manufacturer for 75 – 100 revolutions.
    - c. Transportation: The pervious concrete mixture may be transported or mixed on site and discharge of individual loads shall be completed within one (1) hour of the introduction of mix water to the cement. Delivery times may be extended to 90 minutes when a hydration stabilizer is used.
    - d. Discharge: Each truckload shall be visually inspected for consistency of concrete mixture. Water addition shall be permitted at the point of discharge to obtain the required mix consistency, provided a measurable quantity is discharged, and provided no more than half of the batch amount has been discharged. A minimum of 30 revolutions at the manufacturer's designated mixing speed shall be counted following the addition of any water to the mix, prior to further discharge. 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 plastic concrete. If consolidation occurs during concrete discharge, placement shall be halted and wet concrete removed (this may happen towards the end of some loads).
  4. Placing and Finishing:

- a. Prior to placing concrete, the surface of the aggregate detention layer (or recharge bed) shall be soaked and in a wet condition at time of placement. Failure to moisten the aggregate surface will result in a reduction in strength of the pavement.
- b. Concrete may be deposited into the forms by mixer truck chute, conveyor or buggy.
- c. Unless otherwise permitted, the Contractor shall utilize a mechanical vibratory screed to strike off the concrete  $\frac{1}{2}$  in. to  $\frac{3}{4}$  in. (13 mm to 19 mm) above final height, utilizing the form spacers described in Formwork. An alternative method to strike off and compact the concrete is to use a hydraulically actuated pipe roller screed as described under 1.04 Special Equipment. If approved by the Architect/Engineer in writing, the Contractor may place the pervious concrete with either slip form or vibratory form riding equipment with a following compactive unit that will provide a minimum of 10 psi (69 kPa) vertical force to the concrete. Similarly, strike off by hand straightedge may be permitted for sidewalks and other small areas followed by compaction.
- d. Care must be taken to prevent closing the void structure of pervious concrete. After mechanical or other approved strike-off and compaction operation, no other finishing operation will be allowed. Internal vibration shall not be permitted. If vibration, internal or surface applied, is used, it shall be shut off immediately when forward progress is halted for any reason.
- e. Placed concrete shall not be disturbed while in the plastic state. Low spots after the screeding operation shall be over-filled for surface repair and either tamped to desired elevation with hand tampers or passing the screed a second time to correct the elevation.
- f. Following strike-off, remove spacers and compact the concrete to the form level, utilizing a steel roller, a plate compactor on plywood or other method approved by the Architect/Engineer. Longitudinal rolling shall be followed immediately by cross rolling and joint rolling (if specified). Care shall be taken during compaction that sufficient compactive force is achieved without excessively working the concrete surface that might result in sealing off the surface porosity. Rollers may require cleaning and treatment to prevent aggregate pick-up during rolling operations.
- g. Hand tampers and an edging tool with  $\frac{1}{4}$  in. (6 mm) radius shall be used to compact the concrete along the slab edges immediately adjacent to the forms. After compaction, inspection and surface repair, no further finishing shall be performed on the concrete. Surface curing shall begin immediately.

- h. The pervious concrete pavement shall be compacted to the required cross-section and shall not deviate more than +/- 3/8 in. in 10 ft (+/- 9 mm in 3 m) from profile grade.

## 5. Jointing

- a. Joints in pervious pavements can be precluded at the option of the owner, who may, instead, choose to accept or prefer the appearance of random cracking.
- b. Although longer joint spacings may control cracking, for conservative design, contraction (control) joints shall be installed at regular intervals not to exceed 20 ft (6.1 m), and slab length shall not exceed 1.25 times the width of the slab. Transverse contraction joints shall be installed at 1/4 the depth of the thickness of the pavement. These joints can be installed in the plastic concrete or saw cut after the concrete has hardened; in either case, careful attention is necessary to prevent raveling.
- c. Jointing plastic concrete: Joints installed in the plastic concrete may be constructed utilizing a small rolling groover as described in the Special Equipment section of this guide specification. When this option is used it shall be performed immediately after roller compaction with one single pass and prior to curing. Note: Improper use of the rolling groover may cause "de-consolidation" of material within a 2-in. band along either side of the groove joint, and result in raveling under traffic. Rollers may require cleaning and treatment to prevent aggregate pick-up during rolling operations.
- d. Jointing hardened concrete: Saw-cuts shall be made as soon as the pavement has hardened sufficiently to prevent raveling and uncontrolled cracking. [Note: jointing of hardened concrete has successfully occurred after the seven day minimum curing period with minimal to no uncontrolled cracks.] Early entry sawing occurs later with pervious concrete than with conventional concrete. For either method, the curing cover shall be temporarily removed and the surface kept misted to prevent moisture loss during sawing. Sawdust or slurry shall be promptly removed to protect the pervious concrete pores. After sawing, the curing cover shall be securely replaced for the remainder of the curing cycle.
- e. Transverse construction joints: Transverse construction joints shall be installed whenever placing is suspended for 30 minutes or whenever concrete is no longer workable.
- f. Isolation joints: Isolation joints shall be used when abutting fixed vertical structures such as light pole bases, building foundations, etc.
- g. Edging, using a tool with 1/4 in. (6 mm) radius, and additional compaction with hand tamping tools shall be performed along all form

lines and along all isolation joints and construction joints to reduce potential for raveling under traffic.

6. Curing:
  - a. Curing procedures shall begin immediately, no later than 10 minutes, from the time the pervious concrete is discharged from the truck. Placing, finishing and tooled jointing and edging must be completed within the 10-minute window from discharge. The pavement surface shall be covered with a minimum of 6 mil thick clear polyethylene sheet or other approved covering material. Prior to covering, an evaporative reducer shall be sprayed above the surface when required due to ambient conditions (high temperature, high wind, and low humidity). The cover shall overlap all exposed edges and shall be secured (without using dirt or stone) to prevent dislocation due to winds or adjacent traffic conditions. For additional guidance on hot weather concreting, see ACI 305, and for cold weather concreting see ACI 306.
  - b. Immediately after screeding, the surface shall be kept moist and evaporation prevented using a spray applied curing compound and/or evaporation retarder immediately after screeding. Note: The low water/cementitious ratio and high amount of exposed surface of pervious concrete makes it especially susceptible to drying out. Immediately after each transverse jointing the polyethylene sheet curing shall be applied then cross rolling shall be performed.
  - c. The curing cover shall remain securely in place for a minimum of 7 days, uninterrupted. No vehicular traffic shall be permitted on the pavement until curing is complete (7 days) and no truck traffic shall be permitted for at least 14 days. Pedestrian traffic may be permitted on the curing concrete after 24 hours. The Architect/Engineer may permit earlier traffic opening times.
7. Sealing –When pervious concrete is produced with an integral color pigment, a UV resistant, non-yellowing acrylic based sealer per ASTM C 309 shall be lightly broadcast onto the cured pavement surface to brighten and highlight the color pigment without clogging the surface pores of the pervious matrix and disrupting its permeability. Some surface preparation may have to be conducted to prepare the sealer. Subsequent applications of the sealer shall be a part of the maintenance plan and not included in this contract.
8. Quality Control - Concrete:
  - a. The Architect/Engineer shall employ a testing laboratory that conforms to the requirements of ASTM E329 and ASTM C1077. All personnel engaged in concrete testing shall be certified by the American Concrete Institute as ACI Concrete Field Technicians or equivalent.

- b. Traditional concrete testing procedures for strength and slump control are not applicable to this type of pavement material. Procedures to be used per this guide specification include: ASTM C 172, ASTM C 29, ASTM C 42, ASTM C 1688, and ASTM C 1754.
- c. Concrete tests shall be performed for each 50 yd<sup>3</sup> (38 m<sup>3</sup>) or fraction thereof with a minimum of one set of tests for each day's placement.
- d. Sampling - Plastic concrete shall be sampled in accordance with ASTM C 172.
- e. Density (unit weight) – Density (unit weight) of the plastic concrete shall be measured in accordance with ASTM C 1688. The density (unit weight) of the delivered concrete shall be +/- 5 lb/ft<sup>3</sup> (80 kg/m<sup>3</sup>) of the submitted fresh density (unit weight).
- f. Void content - Void content of the plastic concrete shall be calculated as per ASTM C 1688 and compared to the submitted fresh void content. Unless otherwise specified, void content shall be between 13% and 30%. After a minimum of seven (7) days, hardened concrete shall be tested at a rate of one set of three cores per 50 yd<sup>3</sup> (38 m<sup>3</sup>) of concrete placed on one day or fraction thereof. Cores shall be drilled in accordance with ASTM C 42. The cores shall be measured for thickness, void structure and unit weight. Cores shall be taken at minimum 2 ft (0.6 m) away from the edge of placement to ensure a representative sample.
- g. Thickness – Untrimmed hardened core samples shall be used to determine placement thickness. The average of all production cores when measured for length shall not be more than ½ in. (13 mm) less than the specified design thickness.
- h. Core density (unit weight) and void content - The cores shall be tested for average density (unit weight) and void content using ASTM C 140. Density (unit weight) of cores trimmed and tested in the saturated condition, per ASTM C 1754 shall be +/- 5 % of the design unit weight or approved hardened density from the test panels.
- i. Infiltration Rate of In-Place Pervious Concrete – The infiltration rate when tested in accordance with ASTM C1701 shall be a Minimum of 1000 inches per hour.

## 9. Basis of Payment

Pervious concrete pavement shall be paid for based on the square yards or square feet (square meters) of in-place product including materials and labor, thickness, and void content.

## 10. Performance and Inspection/Maintenance

Excessive raveling – At or before 28 days after placement, any areas of excessive surface raveling, as determined by the Architect/Engineer, shall be removed and replaced or repaired by the Contractor, [optional language – a) at the unit price established in the contract; or b) at no additional cost to the project].

Surface drainage – At or before 28 days after placement either the average infiltration rate of multiple locations or the infiltration rate of a determined localized area of the in-place pervious concrete shall be determined per ASTM C 1701. Any areas of insufficient surface porosity, as specified, shall be removed and replaced by the Contractor, at no additional cost to the project.