IPMA – QA/QC Division

MEMORANDUM

TO: Meredith Upchurch,
Program Manager
AWI / Stormwater Management -
LID Team

FROM: Wasi U. Khan, P.E.
Chief, QA/QC Division

CC: Carmen Franks,
Project Engineer
AWI/Stormwater Management -
LID Team

RE: RIVERSMART
(RiverSmart Washington & Chevy Chase
Green Alley Construction)

Contract No: None selected

Submittal No.: C23-2

DATE 3/20/2014

As requested through your submittal C.23-2 received March 20, 2014 this office has reviewed the information for Type 2 Pavers to be used at the referenced project. Based on the information submitted, our comments are listed below:

Eagle Bay Hardscape products- Type II Permeable Interlocking Concrete paver (PICP) for parking Lane, L –Shaped size: 4-5 inches width on the short end 8-10
inches, length on the long end 3-3.5 inches in thickness, color light gray conforms to SP C. 23 Item 608992 of the Construction Documents. It is therefore acceptable for its intended use.

Prior to installation upon delivery to the project site, the Engineer should check the manufacturer’s certificate of compliance for infiltration rate, unit pavers style, size, and color.

The contractor shall follow the manufacturer's recommendations for storage, handling, surface preparation and installation procedures.

This office approves the above mentioned material provided that materials delivered to the project site conform to the contract documents.

DDOT QA/QC Division
A. Ladipoh 03/29/14
ATTENTION:  MEREDITH UPCHURCH

SPECIFICATION SECTION 608 - PERVIOUS PAVERS

DATE 3/14/2014

SUBMITTAL NO.: 608992-480-0

CONTRACT LINE # 480

BID ITEM # (S) 608992 - TYPE II PAVER

DESCRIPTION AQUA-BRIC PICP

SUPPLIER EAGLE BAY HARDSCAPE PRODUCTS

MANUFACTURER EAGLE BAY HARDSCAPE PRODUCTS

DISTRICT OF COLUMBIA DDOT TEAM REVIEW / COMMENTS

- [ ] Approved
- [X] Approved as Corrected
- [ ] Corrections Necessary
- [ ] Information Only
- [ ] Rejected

Need to follow placement instructions for stone storage areas as given in special provisions. Color: Use Blue Ridge.

SUBMITTAL PREPARED BY: Patricia Chandler

PROJECT MANAGER
FEATURES

- Available with our signature Permavision finish that produces a rich color, distinctive texture, and wear-resistant surface
- Accommodates surface infiltration of a minimum of 100 inches of rain per hour
- Palletized layers patterned to accommodate efficient mechanical or manual installation
- Full perimeter 5 mm joint and 9 mm void “Joint/Void System” (meets Americans with Disabilities Act)
- Provides the 3 disciplines of “Interlock”
- Hidden paver spacer bars for maximum aesthetics
- 3 ⅛” for commercial applications
- Pallet includes half sizes
1. Eagle Bay® PICP Systems accommodate a wide variety of stormwater management objectives due to flexibility of Pavement Design, Storage Quantity Capacities, and Water Quality Treatment.

2. Runoff reduction of up to 100%, depending on project design parameters.

3. Provides both Channel Protection and FloodMitigation.


5. Allows for retention and storage of stormwater for possible reuse for irrigation or other non-potable applications.

6. Reduces non-point-source pollutants in stormwater, thereby mitigating impact on surrounding surface waters, and may lessen or eliminate downstream flooding and stream bank erosion.

7. Minimizes impact and stress on existing stormwater or combined stormwater and sewer systems through reduced peak discharges.

8. The multi-purpose Permeable Pavement enhances land-use planning and leads to more efficient use of available land for greater economic value, especially in high-density urban areas. Utilizing the storage capacity of the PICP System below the pavement wearing surface, as opposed to above ground storage ponds or the deep excavation required by below grade confined space systems, accomplishes this goal.

9. May decrease project cost by reducing or eliminating drainage and retention/detention systems.

10. May reduce cost of compliance with stormwater regulatory requirements and lower Municipal or State utility / stormwater fees.

11. Solar Reflectivity Index compliance will reduce heat island effect and thermal loading of surrounding surface and/or outflow waters when Eagle Bay’s SRI-Compliant colors are specified.

12. Accommodates pavement design to provide both mechanical stability and structural integrity for a variety of traffic loads, including Secondary Roadways, Light and Heavy Duty traffic requirements.

**CROSS SECTION DETAIL**

**TYP. NO. 8 OR NO. 9 AGGREGATE IN JOINTS/VOIDS**

**EAGLE BAY PICPS: MINIMUM DEPTH 3 1/8"**

**BEDDING COURSE: DEPTH 1 1/8" - 2"**

**NO. 57 STONE OPEN-GRADED BASE: DEPTH 4"**

**NO. 2 OR 3 STONE SUBBASE: DEPTH MINIMUM 6"**

**OPTIONAL PERFORATED UNDERDRAIN**

**SOIL SUBGRADE — ZERO SLOPE**
Friday, February 15, 2013

Filterra® Bioretention Systems
11352 Virginia Precast Road
Ashland, VA 23005

Mr. Chris French,

Please find attached the results of the surface infiltration test conducted on the permeable interlocking concrete paver (PICP) portion of the Filterra BioPave™ in Fayetteville, North Carolina on Wednesday, February 13, 2013. The mean infiltration rate of three locations, with three replicates per location, is 3,440 mm h\(^{-1}\) (135 in h\(^{-1}\)) as determined by ASTM C 1701/C (“Standard Test Method for Infiltration Rate of In Place Pervious Concrete”).

Please feel free to contact me to review and discuss these results. My office phone number is (919) 515-8595. You can contact me via e-mail at arander5@ncsu.edu.

Sincerely,

Andrew R. Anderson, E.I.T.
Extension Associate,
Biological & Agricultural Engineering
North Carolina State University

cc: Mindy Hills, Jodi Mills
METHOD

To determine the infiltration rate of the permeable pavement at the Amtrak Station in Fayetteville, North Carolina (472 Hay Street), ASTM Method C-17071 (Standard Test Method for Infiltration Rate of Pervious Concrete) was performed.

The objective of the test was to quantify the infiltration rate at the start of monitoring (February 2013) of a recently built permeable interlocking concrete paver lot. The parking lot was constructed in September 2013 and subsequent infiltration tests will be performed in August 2013, February 2014 and at the completion of monitoring.

Three locations were tested to represent the entire parking lot: a parking area, an edge of the permeable pavement and the center of the traffic lane. The temperature of the water was recorded for mass conversion. The infiltration ring was secured to the pavement with non-staining plumber’s putty and care was taken to fill in between the interlocking pavers. All three locations were pre-wetted with a weight of 8.0 lb (3.60 kg) of water to determine whether the test should use 8 lb (3.60 kg) or 40.0 lb (18.00 kg) of water. Since all test locations drained the pre-wetting volume in more than 30 seconds, the test was performed with the smaller of the two volumes. The time to drain the 8.0 lb (3.60 kg) of water while maintaining a head between 10-15 mm of the bottom of the infiltration ring was recorded. The test was repeated at each location three times. Equation 1 was used to determine the infiltration rate.

\[
I = \frac{KM}{D^2 \cdot t}
\]

where
- \( I \) = infiltration rate, mm/h (in/hr)
- \( K \) = 4 583 666 000 (SI) or 126 780 (English)
- \( M \) = mass of infiltrated water, kg (lb)
- \( D \) = inside diameter of infiltration ring, mm (in)
- \( t \) = time required for measured amount of water to infiltrate concrete.

Figure 1. Infiltration ring fixed to permeable pavement with plumber’s putty (left). Testing location 3 in center of driving lane (right).
RESULTS

Table 1 summarizes the average infiltration rate at each location. The overall average was computed to be 136 in/h. (3450 mm/h). The attached sheet includes all other intermittent recorded data and description of locations.

Table 1. Summary of Infiltration Rates.

<table>
<thead>
<tr>
<th>Location</th>
<th>Average Infiltration Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>in/h (mm/h)</td>
</tr>
<tr>
<td>1</td>
<td>135 (3420)</td>
</tr>
<tr>
<td>2</td>
<td>158 (4017)</td>
</tr>
<tr>
<td>3</td>
<td>115 (2923)</td>
</tr>
<tr>
<td>Overall</td>
<td>135 (3440)</td>
</tr>
</tbody>
</table>
C1701/C1707M: Standard Test Method for Infiltration Rate of Pervious Concrete Data Sheet

Test performed by: Andrew Anderson and Alessandra Smolek
Date: 2/13/13
Age of PICP tested: 5 months
Amount of rain during last event: 0.3" (7.62 mm)
Temperature of water: 60.0° F (15.6° C)
Inside diameter of infiltration ring: 11.82" (300 mm)

<table>
<thead>
<tr>
<th>ID #</th>
<th>Location Description</th>
<th>$t_{\text{wet}}$</th>
<th>Weight of infiltrated water</th>
<th>$t$</th>
<th>Infiltration rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td></td>
<td>$s$</td>
<td>$\text{lb (kg)}$</td>
<td>$s$</td>
<td>$\text{in/h}$</td>
</tr>
<tr>
<td>1a</td>
<td>NW corner of handicap parking spot, under tree, 1.8 ft from edge of curb, 12.0 ft from east edge of permeable pavement</td>
<td>41.5</td>
<td>7.92 (3.60)</td>
<td>55.2</td>
<td>130 (3320)</td>
</tr>
<tr>
<td>1b</td>
<td>1.8 ft from edge of curb, 12.0 ft from east edge of permeable pavement</td>
<td></td>
<td>7.92 (3.60)</td>
<td>54.6</td>
<td>131 (3360)</td>
</tr>
<tr>
<td>1c</td>
<td>1.8 ft from edge of curb, 12.0 ft from east edge of permeable pavement</td>
<td></td>
<td>7.92 (3.60)</td>
<td>51.2</td>
<td>140 (3580)</td>
</tr>
<tr>
<td>2a</td>
<td>1.3 ft north of south edge and 2.2 ft east of west edge of permeable pavement</td>
<td>37.3</td>
<td>7.92 (3.60)</td>
<td>45.4</td>
<td>158 (4040)</td>
</tr>
<tr>
<td>2b</td>
<td>1.3 ft north of south edge and 2.2 ft east of west edge of permeable pavement</td>
<td></td>
<td>7.92 (3.60)</td>
<td>47.8</td>
<td>150 (3840)</td>
</tr>
<tr>
<td>2c</td>
<td></td>
<td></td>
<td>7.92 (3.60)</td>
<td>44.0</td>
<td>163 (4170)</td>
</tr>
<tr>
<td>3a</td>
<td>5.1 ft east of west edge of permeable pavement and 12.4 ft west of center of east diagonal edge of permeable pavement</td>
<td>44.4</td>
<td>7.92 (3.60)</td>
<td>62.8</td>
<td>115 (2920)</td>
</tr>
<tr>
<td>3b</td>
<td>12.4 ft west of center of east diagonal edge of permeable pavement</td>
<td></td>
<td>7.92 (3.60)</td>
<td>64.7</td>
<td>111 (2830)</td>
</tr>
<tr>
<td>3c</td>
<td>5.1 ft east of west edge of permeable pavement and 12.4 ft west of center of east diagonal edge of permeable pavement</td>
<td></td>
<td>7.92 (3.60)</td>
<td>60.7</td>
<td>119 (3020)</td>
</tr>
</tbody>
</table>
Paver Details

Solid Colors

Kanawha  Buff  Slate  Sahara

Blended Colors

Blue Ridge  Chesapeake  Crimson

Finishes

Chamfered  Antiqued  Textured  Cobble

Old Dominion Collection

Jefferson  Richmond  Shenandoah  Bull Run

Permavision™

Color protection for lasting elegance

• Smoother surface
• Abrasion resistant
• Prevents fading
• Removes blemishes
• Minimizes stone particles
• Lifetime transferable warranty
A. All interlocking paving stones shall comply with the quality specifications for solid concrete interlocking paving units as required per ASTM C 936.

2. *Aggregates*: Conform to ASTM C 33 for normal weight concrete aggregate (no expanded shale or lightweight aggregate) except that grading requirements shall not necessarily apply.
4. *Other Constituents*: Air-entraining admixtures, integral water repellents and finely ground silica shall have a proven record of performance and shall conform to the relevant ASTM standards.
5. *Compressive Strength*: At the time of delivery to the work site, the average compressive strength of the pavers shall not be less than 8,000 psi, with no individual unit less than 7,200 psi. Testing procedures shall be in accordance with ASTM C 140 specifications.
6. *Absorption*: The average absorption shall not be greater than five percent (5%), with no individual unit result greater than seven percent (7%) per ASTM C 140 specifications.
7. *Resistance to Freezing and Thawing*: The manufacturer shall satisfy the purchaser by laboratory testing that the paving units have adequate resistance to freezing and thawing per ASTM C 67-83 specifications. The specimens shall have no breakage and not greater than one percent (1%) loss in dry weight of any individual unit when subjected to 50 cycles of freezing and thawing.
8. *Dimensional Tolerances*: Pavers shall be prismatic in plan and formed with straight, uniform edges. The tolerance for the flat portions of the sides shall not exceed 1/32" as measured with a steel straight edge. “Slumped” pavers exceeding this tolerance will be rejected. The
length, width and thickness of the paving stones shall meet the allowable tolerances specified in ASTM C 936.

9. **Color:** Monochromatic colors from standard range of colors and/or natural gray.

10. No paver shall be used for this project which has been manufactured in a mold that exceeds the mold life specified in the Method Statement, without written approval of the installer and owner.

11. The measurement across a cluster for any mold shall not increase more than ½” for the entirety of the use of the mold for this project.

### 2.02 VISUAL INSPECTION

All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. Minor cracks incidental to the usual methods of manufacture, or minor chipping resulting from customary methods of handling in shipment, delivery and installation, shall not be deemed grounds for rejection.

### 2.03 AGGREGATE MATERIALS

A. **Bedding Course and Void Filler Aggregate**

The bedding course and void filler aggregate shall be free of organics and soluble salts, or other contaminants likely to cause efflorescence. The grading requirement shall be in compliance with the following gradation chart.

| ASTM Sieve Size Percent Passing (by weight) |
|---|---|
| 1/2 inch 100 – 100 |
| 3/8 inch 94 – 100 |
| ¼ inch 39 – 94 |
| No. 4 23 – 39 |
B. Base Course Aggregate
The base course aggregate shall consist of open-graded stone and meet the following gradation chart.

<table>
<thead>
<tr>
<th>ASTM Sieve Size</th>
<th>Percent Passing (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch</td>
<td>100 – 100</td>
</tr>
<tr>
<td>1 inch</td>
<td>90 – 100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>48 – 90</td>
</tr>
<tr>
<td>½ inch</td>
<td>27 – 48</td>
</tr>
<tr>
<td>¼ inch</td>
<td>12 – 27</td>
</tr>
<tr>
<td>No. 40</td>
<td>12 – 27</td>
</tr>
</tbody>
</table>

C. Sub-Base Course Aggregate

The sub-base course aggregate shall consist of open-graded stone and meet the following gradation chart.

<table>
<thead>
<tr>
<th>ASTM Sieve Size</th>
<th>Percent Passing (by weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inch</td>
<td>100 – 100</td>
</tr>
<tr>
<td>3 inch</td>
<td>80 – 100</td>
</tr>
<tr>
<td>2-1/2 inch</td>
<td>50 – 80</td>
</tr>
<tr>
<td>2 inch</td>
<td>20 – 50</td>
</tr>
<tr>
<td>1-1/2 inch</td>
<td>5 - 20</td>
</tr>
<tr>
<td>1 inch</td>
<td>0 – 5</td>
</tr>
</tbody>
</table>

PART 3 – EXECUTION

3.01 – SUBGRADE

The installer shall verify that the subgrade has been shaped and compacted in
conformance to the lines, grades and cross-sections shown on the plans, to
provide for the construction of the Bio-Aquifer Storm System pavement structure.
Site grades can be raised to the design subgrade elevation using clean native earth
fill (free of deleterious material). This fill should be placed in lifts not exceeding
six inches (6”) and compacted to a minimum of ninety-five percent (95%)
Standard Proctor density. The final subgrade profile should be uniformly
compacted to a minimum of ninety-eight percent (98%) Standard Proctor density
and proof-rolled to delineate soft areas. Removing the unstable soil and replacing
with clean, dry compacted earth fill shall be performed to repair these areas.
The requirements to include sub-drains in the pavement design would depend on
the subgrade soil conditions. It is recommended that an experienced, qualified
geotechnical engineer determine the requirements for sub-drains. If required, the
sub-drain pipe shall consist of a four-inch (4”) diameter PVC perforated pipe
wrapped with filter fabric. The pipe would be placed at subgrade elevation and
surrounded with a minimum of four inches (4”) of approved open-graded stone.
The sub-drain shall drain into a catch basin or other frost-free positive outlet.

3.02 – PLACEMENT OF SUB-BASE COURSE

The thickness of the sub-base course layer will depend upon the subgrade soil
conditions and the anticipated traffic loadings. It is recommended that a site
assessment be carried out by an experienced, qualified geotechnical engineer to
determine the requirements of the base course.
The base course shall consist of a minimum thickness of twelve inches (12”) and
be compacted using a vibratory smooth-drum roller.
Minimum Sub-Base Compaction requirements: (frequencies of 1,800 and 2,160 vibrations
per minute (vpm) across an 84-in. (213 cm) operating width. The smooth-drum roller generates
53,100 lbs. (24,086 kg) of centrifugal force in high amplitude and 38,250 lbs.
It shall be installed in lifts not to exceed six inches (6”). Upon completion of the sub-
base course installation, the area shall be proof-rolled using a heavy rubber-tired
vehicle (such
as a loaded tandem truck) to identify any areas requiring additional compaction.
The sub-base course shall be installed to the elevation and cross-section per the plan documents.

3.03 – PLACEMENT OF BASE COURSE

The base course shall consist of a thickness of four inches (4”), placed in one lift, and be compacted using a vibratory smooth-drum roller. ** (same compaction equipment as sub-base) The base course shall be installed to the elevation and cross-section per the plan documents.

3.04 – PLACEMENT OF BEDDING COURSE

The bedding course shall be spread loose in a uniform layer to give a depth after compaction of the paving units of about two inches (2”). The contractor shall screed the bedding course using either an approved mechanical screed beam apparatus or by the use of screed guides and boards. The screeded bedding aggregate shall not be subjected to any traffic by either mechanical equipment or pedestrian use prior to the installation of the paver units. The voids left after the removal of the screed rails shall be filled with loose aggregate as the paver bedding course proceeds.

3.05 – PLACEMENT OF Eagle Bay USA Aqua Bric Type 4 “L” PAVERS

All edge restraints shall be constructed as shown on the plans and in place prior to the installation of the pavers. Poured-in-place concrete curbs are recommended for the Bio-Aquifer Storm System. The pavers shall be installed in approximately the order in which they were manufactured. No cluster shall be installed next to a cluster that was manufactured more than 1,000 cycles before or after.
Lay pavers in the pattern as shown on the drawings. Lay pavers away from the existing laying face or edge restraint in such a manner as to ensure that the pattern remains square. Chalk lines shall be used upon the bedding course to maintain straight joint lines. Joint spacing between pavers shall be between 1/8" and ¼"; however, the joint width may need to be increased to 3/8" (if necessary) to maintain straight joint lines. Lines and grades shown on the plans shall be established and maintained during the installation of the wearing course.

Pavers shall be cut using a table-mounted masonry saw. Block splitting shall not be permitted. All cut faces shall be vertical. Dry cutting of the pavers shall be performed utilizing a dust collection system.

Once the pavers have been placed upon the bedding course and all cut pavers have been inserted to provide a full and complete surface, inspect the pavers for damaged units and remove and replace those units. Once all pattern lines have been straightened, the void filler shall then be placed into the paver openings to the top of the chamfer on the pavers and the surface swept broom clean.

The pavement surface shall be compacted to achieve consolidation of the bedding course and paving stones and brought to design levels and profiles by two passes of a suitable plate compactor. Compaction of the pavers shall be accomplished by the use of a vibratory plate compactor capable of a minimum of 4,500 pounds of compaction force. No compaction shall be permitted within three feet (3’) of unrestrained edges of the pavement.

After compaction, inspect the pavers for damaged units and remove and replace those units. On completion of vibration after void filling, the surface tolerances shall be plus or minus ½” from finish levels. The pavers shall be flush to ¼” above edge restraints.

Additional void filler material shall be swept in the paver voids to within ½” from the bottom of the chamfer on the paving stones. Upon completion, the wearing course surface shall be swept clean of all excess materials. Remove from the site all surplus materials, equipment and debris resulting from these operations.
Dear Patricia,

We are pleased to submit our request for the use of Eagle Bay USA Aqua Bric Type 4 “L” permeable paver for approval on the above reference project.

The Eagle Bay USA Aqua Bric Type 4 “L” Shape provides the following Value Added physical properties as illustrated in the following benefits and features:

1. **A Joint/Void System** - providing the 3 disciplines of “True Interlock”; Rotational, Horizontal, and Vertical movement reduction. These properties provide a smooth, uniform pavement that exceeds the requirements of the Americans with Disabilities Act.
2. Individually the Joint provides:
   a. A mono column of stone for the mechanical connection of the individual concrete block paving stones.
   b. This is accomplished as the 5mm Joint allows a mechanical connection of the #8 setting bed ensuring true “interlock”.
3. Individually the Void provides additional infiltration in an easily maintained opening.
   a. The 9mm Void allows rapid water removal through the surface, reducing or eliminating stormwater runoff.
4. The “L” Shape facilitates interlock enhancing stabilization and load transfer. In addition, this Shape exhibits an inherent Herringbone Pattern.

Collectively, the above listed physical properties combine to provide a multipurpose wearing surface allowing the desired stormwater runoff reduction, while providing physical properties resulting in both mechanical and structural integrity.

Respectfully,

Don Tapley
Technical Sales Specialist
Eagle Bay USA
1231 Willis Road
Richmond Virginia 23237