Permeable Pavements Panel Discussion
Thoughts from the Field

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Benefits of Permeable Pavements

1. Reduce runoff
   - Pollutants
   - Flooding
   - CSOs
2. Recharge groundwater
3. Preserve surface land & trees
4. Reduce thermal impacts
5. Reduce hydroplaning
6. Reduce salt use and ice build up

Why are we still afraid to use them?

Source ICPI
The List goes on..
We have needed some better information-Standardization

- Details
- Specifications
- Terminology
- Materials
- Testing Methods
- Long-term data on performance
- Cost data
- Best practices - installation, construction, maintenance
- Resources and References - clearinghouse
Mostly heard about Failures...
Now we are hearing about successes.....

Success - White Sox stadium, Chicago
-150,000 sf PICP parking
- Saving about $400,000 (underground storage chambers not required)
Source: David Smith ICPI
But still on the learning curve for many projects… anecdotal notes from the field…

**Porous Asphalt (PA)**

- Difficult to place if specification calls for two small lifts
- May be small / specialty batch and difficult to get sample tested prior to placement
- Surface should be protected from infiltration, sediment drag on and use during curing, preferably 7 days
- Similar practices for surface placement as standard pavement

Source: Bethany Eisenberg, VHB
Pervious Concrete (PC)

- Precast panels - no curing time and can be removed for cleaning
- When properly placed and cured & no/minimal salt expected 30 years
- Issues with Mix and Placement in some locations
- Deicers result in structural degradation
- Variable thickness depending on anticipated traffic load
Permeable Interlocking Concrete Pavement (PICP)

- More costly – but is a precast product with no curing time
- Standard paver thickness for all applications
- Mechanical or hand installation
- Consider extent of utilities (if expecting frequent removal and replacement

Source: ICPI
Grid Pavement

- Concrete or plastic material, needs edging and a bedding course
- Not for heavy loads or continuous use
- Typically filled with small aggregate (ASTM No. 8 or 89 stone) or topsoil and grass

Source: Geosyntec

Source: VHB
Materials
When and where to use – specifications

- Geotextiles
- Geogrids
- Geomembranes

Source: Keville
Utility Coordination

- Consult local for necessary setbacks
- Design modifications in field may be acceptable

Source: VHB
Maintenance - Infiltration Testing

- Vacuum Sweeping 1 to 2 times/year typically sufficient
- Inspections may lead to increased or decreased frequency
- Infiltration testing of pavement surface practical (ASTM C1701)
Resources Emerging and Advancing Everyday
ASCE Permeable Pavement Technical Committee Book

- Standardization for Industry
- Explains hydrologic & structural design components
- Checklists:
  - Design
  - Construction
  - Maintenance
    (recommendations for success)
- Outlines for Specifications
- Identify Research Needs

Source: VHB
Vanasse Hangen Brustlin, Inc. 2015
What do we even call them? Pervious, permeable, infiltrating

- Porous asphalt (PA)
- Pervious concrete (PC)
- Permeable interlocking concrete pavement (PICP)
- Grid pavement (plastic or concrete)

These are pavement surfaces

*Slide Prepared by VHB for ASCE Permeable Pavement Webinar*
This is a Permeable Pavement System

Figure 1-3
Generic permeable pavement cross-section
Source: © Vanasse Hangen Brustlin, Inc. (VHB)
Checklist: Chapter 1 – Introduction and Design Considerations Common To All Permeable Pavements

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Chapter 1: Introduction and Design Considerations Common To All Permeable Pavements

SUMMARY CHECKLIST

Design Considerations Common To All Permeable Pavements

1. REGULATION (Check Requirements and Guidelines)
   a. Does the local regulatory agency allow permeable pavements? If not, who can authorize approval?
   b. Are they prohibited in certain areas, such as groundwater recharge zones, karst geology and fill sites?
   c. Are there credits offered to stormwater utility fees, permitting fees or reduced site development costs for using permeable pavements?
   d. Are there regulatory hydrologic control or water quality requirements associated with the use of permeable pavements?
   e. Are there water quality control requirements specific to permeable pavement use?
   f. Are there specific design guidelines or specifications mandated under applicable federal, state or local regulations?

2. SITE (Identify Site Conditions)
   a. Groundwater Elevation—The bottom of the permeable pavement base should be at least 60 cm (2 ft) above the seasonal high groundwater level within the soil subgrade.
   b. Groundwater Supply—Locate nearby groundwater supply wells or recharge wells. Wellhead protection—a common requirement—is that permeable pavement should not be used for road or parking surfaces within two years of travel to wellhead protection areas.
   c. Bedrock—Locate bedrock elevations and/or karst geology. Bedrock directly under the permeable pavement base may require the use of an impermeable liner around the base to prevent direct seepage into groundwater supplies.
   d. Soil Properties—Determine soil type and physical properties:
      • Soil Classification—From soil borings or test pits on the site.
      • Soils Present—Identification/estimated elevation of aquifer or low-permeability soils if present.
      • Load Bearing Capacity—Estimate the bearing capacity of the underlying soils (CBR, K-value or resilient modulus) and determine the soil support value. Determine requirements for intended vehicular traffic use.
      • Soil Compaction—Specify soil compaction requirements. If the underlying soils have a low California Bearing Ratio (CBR) (or soaking CBR), they may need to be compacted to at least 95% of standard Proctor density, which reduces their infiltration rate.
      • Soil Permeability—Identify Soil Permeability (Hydraulic Conductivity Rate, K) and rate to be used for design, check with local requirements/regulations on methodologies and guidelines. For larger projects with adequate budgets, it may be advantageous to compact the soil subgrade in a test pit or pits and then measure permeability. Identify low permeability soils and constraints.
      • Soil/Groundwater Contamination—Research/Identify the presence of any soil or groundwater contamination and how it may affect design. Permeable pavements should not be used in areas of groundwater/solids contamination without an underdrain above the liner.
   e. Rainfall—Evaluate regional rainfall and estimate how frequently the pavement will be inundated and how quickly the pavement drains based on the ability of the underlying soils to infiltrate water.
Chapter 8: Maintenance Checklists

CHECKLIST 3

Annual Permeable Pavements Inspection

1. RUN-ON/TRACK IN
   - Check all areas around permeable pavement perimeter for signs of sediment non-concurrent sediments tracked in from adjacent properties or roads.
   - Mitigation action: Implement mitigation methods appropriate to reduce runoff or tracked sediments.

2. VEGETATION/SOILS/SLOPES
   - Inspect vegetation around permeable pavement perimeter for coverage, quality and soil stability, especially areas that slope towards the pavement.
   - Mitigation action: Stabilize all soils and replant grass or groundcover as needed. Ground covers are typically preferred over mulch. Replace dead or unhealthy vegetation intended for stabilization. Incorporate compost amendments into soils that will be re-vegetated to assist with moisture retention, permeation and/or long-term health. If possible, relocate soil stockpiles to impermeable pavements. Otherwise, cover stockpiles with plastic barrier between permeable pavements and stockpiles.
   - Inspect pavement for presence of unintended vegetation, which can affect infiltration and indicate excess sediment accumulation in areas.
   - Mitigation action: Vegetation should be removed manually. Avoid use of herbicides, which can be transported into unintended environments (e.g., subsurface, groundwater or surface waters via drainage.
   - Inspect grid pavements for grass coverage, soil or aggregate erosion, scour and unwanted growth.
   - Mitigation action: Replant soil or aggregate. Re-seed bare soil areas as needed. Fertilize grass in the spring and fall. Limit applications if runoff may carry nutrients into nearby waters.

3. ORGANIC MATTER BUILD UP
   - Inspect for excess build up of organic materials or other debris (thick tree leaves, mulch from adjacent areas, etc).
   - Mitigation action: Systemic affected areas and consider alternative methods of vegetated cover/pest control or adjust slopes to reduce pavement build up.

4. UNDERDRAINS/OUTFALLS/MONITORING WELLS/CLEAN OUTS
   - Check that underdrains, outfalls and other flow paths allow for unobstructed water flow.
   - Check monitoring wells (inspection port) for standing water levels following a major storm.
   - Mitigation action: Address clogged pipes via cleanouts. Clean outfalls and remove any obstructions. Check monitoring wells for adequate storage recovery.

This information is a suggested framework for a checklist and should not be considered an exhaustive or complete list of all items that should be reviewed. A full and detailed plan from a competent professional in the field should be sought for the specific application of any and all materials included in this report.

Source: VHB
Vanasse Hangen Brustlin, Inc. 2014
Appendix A: Common Concerns Regarding Permeable Pavements Fact Sheet

- Clogging
- Costs
- Maintenance
- Cold climate
- Durability
- Soil constraints
- Groundwater constraints
- Spills
- Slopes

Source: VHB
Vanasse Hangen Brustlin, Inc. 2015
Pavement Construction

- Design and Construction Checklists - Permeable Pavements

**CHECKLIST 2**

**Recommendations for Permeable Pavement Construction Procedures (continued)**

4. INSTALLATION (continued)

- b. Sediment management
  - Protect temporary soil stockpiles
  - Ensure no sediment enters the project contributing drainage area

- c. Soil subgrade
  - Ensure soils, subgrades, and fill are suitable
  - Confirm soil compaction as needed
  - Confirm no groundwater seepage or suction drainage may be present

- d. Grouting
  - Confirm grouting
  - Ensure no cracks, slabs, or voids are present

5. GEOTEXTILE (if specified)

- Confirm the following:
  a. Meets specifications
  b. Placement and down slope over to specifications and drawings
  c. Sides of excavation covered
  d. No tears or holes
  e. No wrinkles—Folded taught and

6. IMPERVIOUS LINER (if specified)

- Confirm the following:
  a. Meets specifications
  b. Placement, shop or field welds

7. DRAIN PIPES/OBSERVATIONS

- Confirm the following:
  a. Size, perforations, locations, and
  b. Varying elevation of overflow pipes

8. SUBBASE, BASE, BEDDING

- Confirm the following:
  a. Sieve analysis—From quarry or
  b. Spread (not dumped)—With a

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Chapter 1: Design Considerations Common To All Permeable Pavements

**CHECKLIST 2**

**Recommendations for Permeable Pavement Construction Procedures**

1. COMPLETED SOILS TESTING

- a. Verify that soils tests indicated in the specifications have been completed. Note any changes to proposed use, materials or design that may have been made or need to be made as a result of the specified soils tests.

2. CONDUCTED PRE-CONSTRUCTION MEETING

- a. As outlined in Checklist 1: Design Considerations Common To All Permeable Pavements Summary—Confirm that specifications are clear and review each of the items listed below with emphasis in materials testing, avoiding unspecified soil compaction to the subgrade and proper installation of erosion and sediment control per Best Management Practices.

3. SITE INSPECTION PRIOR TO INSTALLATION

- a. Site walk—Walk through the site with project engineer, geotechnical engineer and builder/contractor/subcontractor to review erosion and sediment control plan/stormwater pollution prevention plan (SWPPP).
- b. Construction sequence—Determine when the permeable pavement is to be built in project construction sequence. Determine measures for protection and/or surface cleaning if needed depending on sequence.
- c. Aggregate storage—Identify storage location for aggregate material, which typically includes identifying an impervious surface or an area covered with a geotextile to ensure no soils mix enter the aggregate during storage.
- d. Access routes—Identify access routes for delivery and construction vehicles, and ensure permeable pavement will have no or very little traffic.
- e. Vehicle tire/track washing station—Identify location and maintenance requirements (if specified in erosion and sediment plan (SWPPP).
- f. Foundation walls—Identify specifications and design for how the foundation is protected from water stored in the system (i.e., undrain, liners, system below foundation elevation, etc.). Confirm with geotechnical engineer.
- g. Water supply—Confirm that the pavement system is at least 30 m (100 ft) from municipal water supply wells.

4. INSTALLATION

- a. Excavation
  - Utilities are located and marked by local service
  - Excavated areas are marked with paint and/or stakes
  - Excavation size and location conforms to plans
  - Storage and disposal of excavated soil areas are defined, adhered to, and provide protection the of the permeable pavement placement location
  - The subgrade has been prepared at the correct design elevation
  - Keep wheeled vehicles off the pervious subgrade