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Civil Engineering  
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WSU & Puget Sound Partnership Permeable Pavement LID Workshop

**Inspection and Verification**

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Topics of Discussion

- Pre construction
  - Installer Pre-qualifications
- Construction
  - Timing & Sequencing
  - TESC Measures
- Inspection
  - QA Testing
  - Specifics related to various materials
- Remedies for Failing Sites



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Installer Pre-qualifications

- TEST PANEL\***
  - May require multiple test panels
  - If unable to install test panel, recommend they provide at least 3 examples of previous installations by crew done at locations nearby. Include mix design & test results.
- \*Not applicable to porous asphalt
- Installers and Supplier Certification & Experience**
  - Pervious Concrete Installer:
    - 1 NRMCA "Craftsman" or 3 NRMCA "Installers" on crew. Local contact: Bruce Chattin with WACA.
    - No certification? then require contractor to hire a construction consultant with NRMCA Craftsman certification (extensive porous pavement installation experience) to oversee installation.
  - Supplier QC Representative: Examples of 3+? past projects
  - Proprietary Materials: Training by Manufacturer Rep.
  - Porous Asphalt: Minimum 3 past projects (no industry certification)
- Recommend at least 2-3+ persons per crew have experience. Depends on size of project.



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- School in Medina, WA



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La Center Parking Lot, Washington

[www.lcrep.org/fieldguide/examples/permeablepavers.htm](http://www.lcrep.org/fieldguide/examples/permeablepavers.htm)

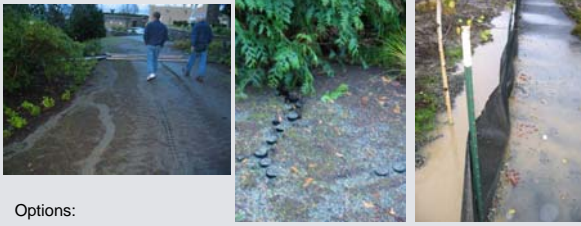
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### Install & Maintain TESC & Flow Diversion Measures



#### Options:

- Timing and Sequencing / Install porous pavement at end of project?
- Cover and seal pavement surface (plastic and geotextile)
- Reroute flow around installed porous pavements until areas are stabilized
- Inform workers and other subcontractors of protection
- Fix: Redo work
- Other?

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### Protect area from other construction activity



Patching due to footprint indentation.



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### Inspectors

- Provide time for Inspector training
- PRE-precon with Inspectors to inform them of special issues related to porous pavement and what it was designed for
- If possible, have Inspectors attend an installation training by manufacturer, industry (NRMCA), etc.
- Provide inspection checklists and discuss design intent with staff
- Several agencies now have standard construction / plan reviewer checklists on their websites

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### General Inspection Checklist – Sample items to include

- ✓ Installer certification
- ✓ Install Test Panel or review previous installations by crew
- ✓ TESC and Flow Diversion in place prior to excavation
- ✓ Material meets specifications and submittal?
  - ✓ Mix Design
  - ✓ Subbase
  - ✓ Geotextile (?)
- ✓ Subgrade free of sediment/fine deposits during construction (perform final 12" excavation until time for placement of full pavement section)
- ✓ Infiltration Testing of exposed subgrade prep
- ✓ Geotextile (if required) overlap and secure
- ✓ Subbase protected from sediment/fines from construction stormwater
- ✓ Placed material protected from construction vehicles
- ✓ TESC and flow diversion being maintained throughout construction until adjacent areas are stabilized

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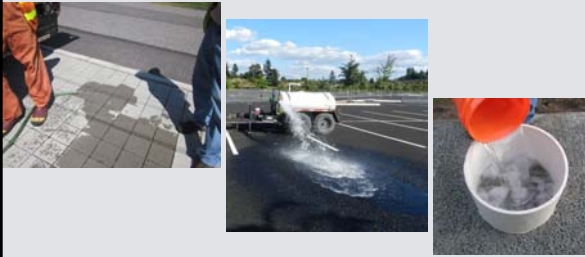
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### General Post Installation QA Testing: Drainage function

- Field Infiltration Tests
  - ~18" cylinder & measure time it takes water to infiltrate
  - ASTM C1701-Standard Test Method for Infiltration Rate of In Place Pervious Concrete
  - Or Pressure wash test, bucket/hose test



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### General Post Installation QA Testing

- Depth of Section (check in field)
- Dry Unit Weight (cores for pervious concrete, ACI 522)
- Refer to previous presentations for specific material



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### Post Installation Observation review of Pervious Concrete and Porous Asphalt

- Uniform Finish vs. Excessive Sealing
- Some factors that affect/cause sealing:
  - Method of installation
  - Mix non-uniform (paste not thoroughly mixed)



Porous Uniform Finish



Porous Non-Uniform Finish

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### Post Installation Observation review of Pervious Concrete and Porous Asphalt

- Uniform Finish vs. Excessive Raveling
- Factors that can affect/cause raveling:
  - Non-continuous protective cover during curing
  - Too Dry Mix (cement concrete)
  - Weather (Temp and Wind)
  - Loading pavement not as intended. (Using as construction entrance)



Pavement was placed early and used as a construction entrance for concrete deliveries.



Pavement being covered immediately as it's being placed to hold moisture in for curing.

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### Pervious Concrete Pavement Joint Inspection



Sawcut joint (~1/5")

- Joints? or no Joints?
- Further spacing? Or follow conventional?
- No dowels or keyways
- Sawcut vs. Tooled joints
  - Pros & cons
- Keep width narrow otherwise can become a maintenance issue
- Pave up to castings vs. concrete pad
- Geotextile in lieu of premolded joint filler.



Too wide tooled joint



Longview, WA public road



Parking lot, Vancouver, WA

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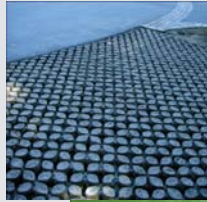
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### Open Celled Paving Grids/Interlocking pavers

- Follow manufacturer testing and installation guidelines
- Plastic Geocells: Staking per manufacturer?
- Prefab interlocking pavers – Right side up?



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### What to do when a problem occurs?

- Identify issue
  - Design?
  - Materials?
  - Installation?
  - Maintenance?
  - Unknown condition?
- Remedies?
  - What are the impacts?
    - Drainage, Safety & Aesthetics
  - Leave as is?
  - Repair ?
  - Extend Warranty?
  - Document for O&M
  - Inform others (designers, manufacturer, industry reps, inspectors, O&M) on lessons learned and update procedures



Above Photo: Used not as intended. Vehicles drove over walkway in park.



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### Achieving success during construction

- Planning
- Preconstruction meeting
- Test Panel Practice
- Qualified & Experienced Crew
- Timing & Sequencing
- Materials meets spec\*
- TESC and Flow Diversion
- Train inspectors/ CA
- Research issues/Lesson learned
- Update inspection checklists & procedures
- Other?



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## Resources (1 of 2)

- American Concrete Institute's Specification for Pervious Concrete Pavement 522.1-13  
<http://www.concrete.org/general/home.asp>
- National Ready Mixed Concrete Association Pervious Concrete Publications [www.nrmca.org](http://www.nrmca.org)
- "Freeze Thaw Resistance of Pervious Concrete," National Ready Mixed Concrete Association, May 2004. [www.nrmca.org](http://www.nrmca.org)
- "Pervious Concrete Contractor Certification," National Ready Mixed Concrete Association, August 2005. [www.nrmca.org](http://www.nrmca.org)
- City of Seattle Department of Planning and Development Client Assistance Memo #515. <http://www.ci.seattle.wa.us/dcd/ Publications/cam/CAM515.pdf>
- LID Technical Guidance Manual for Puget Sound, 2012 [www.psp.wa.gov/LID\\_manual.php](http://www.psp.wa.gov/LID_manual.php)
- Lower Columbia River Field Guide to Water Quality Friendly Development Lower Columbia River Field Guide to Water Quality Friendly Development  
<http://www.lcrgp.org/fieldguide/samples/permeablepavers.htm>
- City of Olympia  
[www.olympiawa.gov/cityutilities/stormwater/scienceandinnovations/porouspavement.htm](http://www.olympiawa.gov/cityutilities/stormwater/scienceandinnovations/porouspavement.htm)
- Delatte, Norbert, Dan Miller of Cleveland State University "Portland Cement Pervious Concrete Pavement: Field performance Investigation on Parking Lot and Roadway pavements, Final Report" to RMC Research & Education, December 1, 2007.
- Dierkes, Carsten, Lothar Kuhlmann, Jaya Kandasamy, George Angelis. Abstract: "Pollution Retention Capability and Maintenance of Permeable Pavements". Presented at Global Solutions for Urban Drainage: 8th International Conference on Urban Drainage, Portland, OR. September 2002.
- Bruce Chattin from Washington Aggregates and Concrete Association, <http://www.washingtonconcrete.org>
- City of Portland 2008 & 2014 Stormwater Management Manual, <http://www.portlandonline.com/bes/index.cfm?c=479528>, <http://www.portlandoregon.gov/bes/64040>

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## Resources (2 of 2)

- Dietz, Michael E. "Low-Impact Development Practices: A Review of Current Research and Recommendations for Future Directions". Springer Science + Business Media B.V. 2007.
- "Porous Pavements," by Bruce K. Ferguson, Taylor & Francis Group, 2005.
- "Pervious Concrete Pavement" by Paul D. Tennis, Michael L. Leming and David J. Akers and Portland Cement Association and National Ready Mixed Concrete Association, 2004.
- "NC State University Permeable Pavement Research: Water Quality, Water Quantity, and Clogging," Eban Z. Bean, EL, PhD Candidate and William F. Hunt, PhD, PE, NWQEP Notes, North Carolina State University, Number 119, November 2005.
- "Long-Term Stormwater Quantity and Quality Performance of Permeable Pavement Systems," by Benjamin O. Brattebo and Derek B. Booth, July 1, 2003, Center for Water and Watershed Studies, Department of Civil and Environmental Engineering, University of Washington at <http://depts.washington.edu/cwss/Research/Reports/permeableparking.pdf>
- La Center Parking Lot, <http://www.uni-groupusa.org/PDF/La%20Center.pdf>
- Pervious pavement in cold climates:  
<http://www.perviouspavement.org/asphalt%20vs.concrete.htm>
- Example checklists & also google the web:  
<http://www.seattle.gov/util/EnvironmentConservation/Projects/DrainageSystem/GreenStormwaterInfrastructure/StormwaterCode/InspectionVerificationProcedures/index.htm>
- Svr Design Company [www.svrdesign.com](http://www.svrdesign.com)

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### Question & Answers

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