Low Impact Development
Permeable Paving
An education initiative funded by the Department of Ecology
June 11, 2013
How to Participate in a Webinar

- chat
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- enter full screen
Low Impact Development
Permeable Paving
An education initiative funded by the Department of Ecology
June 11, 2013
Chat

DEPARTMENT OF ECOLOGY
State of Washington

Low Impact Development
Permeable Paving
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Polling

Low Impact Development

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June 11, 2013
Question Answer Period

Please send questions via Chat throughout the presentation to be answered during the question period at the end of the presentation.
Look for Upcoming Articles In:

B&B

Happy Earth Month!
low impact development

Plus, 2013 NW Flower & Garden Show Picture Review!

NORTHWEST LANDSCAPE PROFESSIONAL

Award Winners: Improved Front Entry
Access In Lake Tapps • Page 10

Nature Green Landscapes Earns 2011 Environmental Landscape Awards Program Gold Award

FM Answers
Employee Handbooks • 5
Distinguish Yourself In Irrigation • 6
Benefits From GC/GFL • 7

WAHLP
Challenge
Low Impact Development

Introduction
Low Impact Development (LID)

Is a design, planning and engineering approach to managing stormwater runoff

LID includes:

- Rain gardens
- Bioretention
- Permeable pavement / pavers
- Green roofs
- Rain water harvesting
- Green walls
Stormwater Runoff

- Impervious Surfaces
  - Roads
  - Roof tops
  - Lawns and landscapes

- Pollutants
  - Oil
  - Heavy metals
  - Phosphorous
  - Silts

- Affected Natural Areas
  - Wetlands
  - Streams
  - Water bodies
Stormwater Runoff Can Lead To:

- Erosion
- Pollution of Soils and Water Bodies
- Sedimentation
- Combined Sewage Overflows
- Loss of Wildlife Habitat
LID principles

Conserve
• trees
• plants
• healthy soils

Minimize
• impervious surfaces
• native vegetation loss
• stormwater runoff
Benefits of LID

- Reduces and slows stormwater runoff
- Protects water quality
- Restores ecosystem services including:
  - Water infiltration
  - Groundwater recharge
  - Pollution interception and filtration
  - CO2 sequestration
  - Protection of habitat for beneficial wildlife

[Image of Hydrologic (water) cycle]
Stormwater is Regulated

- Clean Water Act
- National Pollution Discharge Elimination System (NPDES)
- Washington State Department of Ecology
- Municipal permits
Regulatory Changes are Coming

• Western Washington - LID will be required in new development and re-development
• Eastern Washington - LID allowed
• Deadlines depends on population size
  • Earliest: June 2015
  • Most will adopt by: Dec 2016
  • Latest: June 2018
Give Input

Get in touch with your local officials while regulations are being made:

http://www.mrsc.org/research/research.aspx
Rick Crooks

- Civil Engineer
- Mutual Materials Company
- Director of Business Development
- Nationally respected instructor
Zsofia Pasztor

- Owner of **Innovative Landscape Technologies**
- Certified Professional Horticulturist
- Past president of Sustainable Development Task Force – Snohomish County
- Instructor at Edmonds Community College
Basics of Permeable Pavements

Sponsored by:

Presented by:
Rick Crooks
Outline and Learning Objectives

• Why use permeable pavement?
• Understand the basic components of the three most popular permeable pavement systems:

  *Porous Asphalt*

  *Pervious Concrete*

  *Permeable Interlocking Pavers*

• Understand available system information sources
• Review construction sequencing for each pavement
• Review maintenance requirements
Why Permeable Pavement?

• Part of BMP mix, supports LID
• Conserves space: a functional pavement and a stormwater management facility
• 100% runoff reduction for high frequency storms, can help meet Ecology’s flow control requirement.
Why Permeable Pavement? (cont.)

• Reduce retention/detention, drainage fees
• Together with subgrade soil, permeable pavement systems can help filter and reduce pollution from stormwater.
• Increase groundwater recharge
Determining Subgrade Soil Infiltration

- Soil maps and soil classification systems (NRCS, USCS)
- Conduct on-site infiltration tests
- Use lowest (conservative) values for preliminary design.
Subgrade Infiltration

- Use site tests for accurate information
- Frequency and location based on geotechnical requirements (consult engineer)
Handling sloped sites

Depending on the slope of the project, use check dams to allow runoff to infiltrate into sub-soil.
Porous Asphalt

- Defined as full depth porous material – all materials in the road section are permeable.
- Historically used as porous friction course (PFC) overlay to reduce highway spray and minimizes traffic noise.
- Limited use on local residential projects, more typical on municipal streets.
Arizona SR-87

Slide courtesy Mark Palmer, City of Puyallup
Typical Porous Asphalt Cross-Section

3” POROUS ASPHALT
2” CHOKER COURSE
18” AGGREGATE
DISCHARGE SUBBASE

NOTES:
1. DEPTHS NOTED ARE COMPACTED DEPTHS.

POROUS PAVEMENT NON-WOVEN
GEOTEXTILE AT INTERFACE WITH
AGGREGATE DISCHARGE BASE
(SIDES AND BOTTOM)
SOIL SUBGRADE COMPACTED
TO 92%. SCARIFY TOP 1/4”
OF SURFACE PRIOR TO
PLACEMENT OF GEOTEXTILE.

Porous Asphalt Concrete Pavement

Slide courtesy Mark Palmer, City of Puyallup
Materials and Specifications

- HMA (hot mix asphalt) complies with NAPA specifications for porous applications (polymer additive, 6%-9% asphalt cement binder). Use fibers and anti-stripping agents in binder to reduce drain-down potential.
- Aggregate for wearing course is typically 1/4” to 3/8”, though larger gradations have been used successfully.
- Choker course gradation depends on reservoir course gradation but is typically 3/4” to 1”. Some projects are eliminating (or minimizing) the choker course.
- Reservoir aggregate is 1” to 2” gradation (WSDOT Section 9-03.9(2) permeable ballast).
- All aggregates are durable, crushed and clean with no rounded rock (90-100% fractured face)
Base and Sub-base Aggregates

- Choker course – well-graded, crushed aggregates (no fines).

- Reservoir course – Larger crushed aggregates (no fines).
Industry publication

- National Asphalt Pavement Association (NAPA)
- Order number: IS-131

www.asphaltpaving.org
Porous Asphalt Construction Sequence

Slide courtesy Mark Palmer, City of Puyallup
Porous Asphalt Construction Sequence

Slide courtesy Mark Palmer, City of Puyallup
Examples of Porous Asphalt Installations
Pervious Concrete

- ‘No fines’ concrete creates void structure that allowing for quick drainage of water.
- Rigid pavement structure (different from asphalt or pavers which are flexible pavement systems)

Photo from www.perviouspavement.org
Typical Pervious Concrete Cross-Section

from Stormwater Management Academy, UCF (2007)
Materials and Specifications

• Rigid pavement typically requires less base aggregate than other systems for structure.
• Contractor certification and educational programs help promote proper installations.
• Differences from standard concrete:
  – stiff mix so no slump or strength testing
  – cannot be pumped
  – compact in place with vibratory roller
  – cover with plastic while curing
Industry Resources

• National Ready Mixed Concrete Association
  www.perviouspavement.org

• Puget Sound Concrete Specification Council
  www.theconcretecouncil.org

• Portland Cement Association
  www.cement.org
  “Pervious Concrete Pavements,”
  product code EB302
Pervious Concrete Construction Sequence

from www.perviouspavement.org
Examples of Pervious Concrete Projects
Examples of Pervious Concrete Projects
Examples of Pervious Concrete Projects
Permeable Interlocking Concrete Pavements ("PICP")

- Unlike other systems, the paving stones that comprise the wearing surface of the pavement are not permeable.
- Permeability is achieved through openings in the pavers or the joint spaces between the blocks.
- Structurally, PICP is a flexible pavement (like asphalt)
PICP Cross-Section

- Permeable paver wearing course
- No. 8 aggregate joint fill
- No. 8 aggregate bedding
- No. 57 ‘choke’ course
- No. 2 reservoir course or ‘permeable ballast’
- Geotextile (if required)
Types of PICP
Infiltration Rates --Surface, Joints & Bedding

- Infiltration rate of stone in openings: 300 to 1200+ in./hr
- Open surface area: varies with paver design/pattern, typically from 8% to 18%

Initial surface infiltration calculation:
1,000 in/hr x 12% open area = 120 in/hr
Industry publication

- Interlocking Concrete Pavement Institute (ICPI)
  
  www.icpi.org
Construction

No. 57

No. 2
PICP Installation

- During excavation, do not compact native soil
- Compacted soil is 30% to 90% less permeable than un-compacted soil
Keep delivery trucks off of native soil
Spreading Base Material
Final grading of base material
Compacting base material
Screeding No. 8 stone over No. 57 base
Mechanical placement
Mechanical Installation

Mechanical installation of PICP can decrease construction time 20-80% over manual installation.

*Manual paver installation:*

1,000 – 2,000 sq. ft. per man per day

*Mechanical paver installation:*

3,000 – 10,000 sq. ft. per machine per day
Edge pavers cut and placed, then compacted
Compact before sweeping in aggregate
Filling the openings with No. 8 stone, final compaction
Excess stones removed, then final compaction.
Keep sediment away from the permeable pavement
Partial Exfiltration Design Option

• When subgrade infiltration rates are low (less than 0.25 in/hr), consider ‘partial exfiltration’ design
• Uses perforated pipe ‘under-drains’ to route excess water to outfall

Note: Full flow control credit is not allowed when underdrain systems are utilized.
Design Details

Overflow drain

Drain to grass swale
Maintenance

Annually: overall system performance inspection, check observation well, inspect after major storm, vacuum surface (once, twice, or more) to ensure optimum design life performance

Maintenance checklist (specific to each project)

Model maintenance agreement

Monitor adjacent uses
## Inspection Checklist

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum surface</td>
<td>1 to 2 times annually, adjust for sediment loading</td>
</tr>
<tr>
<td>Replenish aggregate in PICP joints</td>
<td>As needed</td>
</tr>
<tr>
<td>Inspect vegetation surrounding pavement perimeter for cover &amp; stability</td>
<td>Annually, repair/replant as needed</td>
</tr>
<tr>
<td>Check drain outfalls for free flow of water</td>
<td>Annually and/or after a major storm event</td>
</tr>
</tbody>
</table>
New Maintenance Document

A new O & M document is available from Ecology...

Maintenance

Sweeper Effectiveness

Best: Vacuum sweeper (no water)

OK: Regenerative air (broom) sweeper (no water)

Vacuum essential as brush bristles clean ~ ¼ in. into surface
Restoration Maintenance
Other products available

Grid pavement systems using concrete or other materials
Thank You!

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PERMEABLE PAVERS
Some of the visual information for this presentation came from Stewardship Partners; David Hymel; Erica Guttman and Sharon Collman, members of the WSU Extension Faculty.
Soils make or break the system
PERVIOUS CONCRETE
THEY ALSO LOOK GOOD
4 years later
THEY ALSO LOOK GOOD
CONCRETE VERSUS ASPHALT

- Installation issues
- Cost per area
- Durability and longevity
- Lifetime performance
- Look and feel
- Short term and long term effects
- Short term and long term benefits
- Maintenance
- End-of-life solutions
NATURAL STONES
Specs are not created equal

- Check with your jurisdiction
- Things change
- Do not depend on old reference material
Always analyze specs

Design Guidelines for Porous Asphalt with Subsurface Infiltration

RIVERJACKS OPEN INTO RECHARGE BED

POROUS ASPHALT PAVEMENT

UNCOMPACTED SUBGRADE IS CRITICAL FOR PROPER INFILTRATION

FILTER FABRIC LINES THE SUBSURFACE BED

UNIFORMLY GRADED STONE AGGREGATE WITH 40% VOID SPACE FOR STORMWATER STORAGE AND RECHARGE
Creativity goes a long way

- Non-engineered projects
- Using specs for similar size pavers, but use flagstones or recycled concrete
- Deep layer of pea gravel up to 10 inches or more, slows walking, provides more exercise and reduces runoff – terrible as a main walking area
- Near steep areas or on heavy clay lots of organic material with steps
- Any size or shape when it comes to area can be utilized
GRAVEL
What retooling?

I think we finally have the system down.
Material dependent

- May need new tools, new skills, new training, new certification
- Concrete for sure all of the above
- Asphalt new training, certification, skills and some new tools
- Pavers new skills, training, certification helps, no new tools
THE VALUE OF LID

- SPU’s Venema Project estimated LID at $410K per block incl. 50 yr maintenance vs $720K per block
- traditional street design $425K per block
- SEA street design $325K per block
- traditional collector street $520K+ vs. Cascade street $285K
THE VALUE OF LID

- Aesthetics
- Property sales
- Attracting mission driven businesses
- A cost saving
Redefining Beauty

- move away from non-indigenous species
- focus on what occurs in nature
- consider what belongs in our environments
- use less ornamentals
- increase function
- improve habitat quality
Business as usual...or not anymore?

- Networking with other landscape professionals
- Networking with engineers
- Networking with suppliers
- New territory; explore and reassess
- For some solutions – open market; requires investment
- Flexibility, creativity, ability to learn are key
- FOR ME: this is who I am what I believe in so there is no other way. I centered my business around this theme. People only contact me if this is what they want.