American Concrete Institute®
Advancing concrete knowledge

Sustainability of Concrete Pavement
Part 3 of 3

ACI Fall 2010 Convention
October 24 - 28, Pittsburgh, PA

ACI WEB SESSIONS

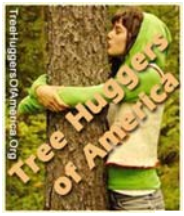
Dr. John Kevern is a nationally recognized expert on pervious concrete. He received his M.S. and Ph.D. degrees from Iowa State University in Civil Engineering Materials with both thesis and dissertation on the durability and application of pervious concrete. He is a member of the pervious concrete committees at ACI, ASCE, and NRMCA. He is also a member of the national transportation research board and sits on various concrete committees. He joined the faculty at the University of Missouri - Kansas City in 2008. Some of his current pervious concrete research topics include pervious concrete roadways for noise reduction and improved skid resistance, using pervious concrete to reduce slip/fall, and using pervious concrete to mitigate the urban heat island.

ACI WEB SESSIONS

Green Streets

ACI Fall 2010 Pittsburgh

John T. Kevern and Liv Haselbach



UMKC

ACI WEB SESSIONS

Green Streets

A Street considering equity of access for the users while balancing the environmental considerations of the selected materials and impacts of the design throughout the entire project lifecycle.

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Green Street Components

- Pedestrian access
- Alternative Modes of Transportation
- Integrating Design
- Better Material Selection Choices
- Integrated Stormwater Management
- Urban Heat Island Effect
- Light Pollution
- Construction Emissions
- Public Education
- Use Regional Materials

ACI WEB SESSIONS

Concrete Uses

See if you can spot all of the ways concrete can be utilized in a green street.

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Improving Access

Clearly Marked Crossings

ADA Compliant Sidewalks and Ramps

David Leopold, Project Manager, Chicago Streetscape and Sustainable Design Program

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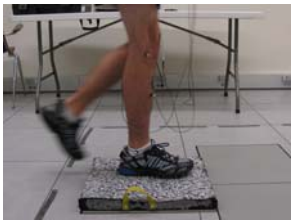
Safer Walking Surfaces

Pervious concrete has less icing, better traction, higher contact pressures



Biomechanical testing on frozen pervious concrete

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Increasing Alternative Transportation

- Relocating bus stops
- Reconstructing ADA compliant bus stop areas

David Leopold, Project Manager Chicago Streetscape and Sustainable Design Program

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Improving Access/Alternative Transportation

Cleveland, OH

Bike lanes, dedicated center bus lanes

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Increasing Alternative Transportation

Curitiba, Brazil

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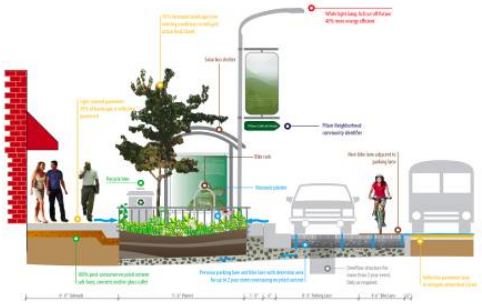
Integrating Design



David Leopold, Project Manager Chicago Streetscape and Sustainable Design Program

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Concrete Material Improvements

- Recycled industrial by-products
- Recycled wash water
- Recycled aggregates
- Photocatalytic cement

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Better Material Choices

- 2 lift pavements, equal cost, better performance, lower environmental impact

An optimized 2 lift with lower cementitious, SCMs, recycled concrete aggregate, etc. can easily reduce the CO_2 by 50%.

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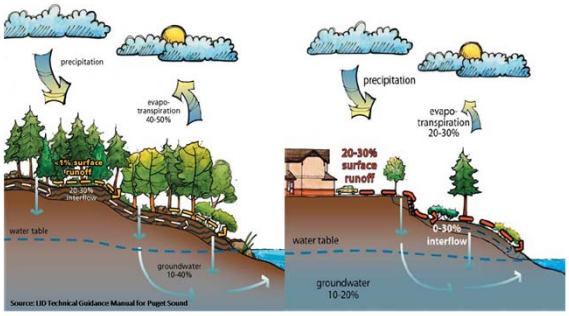
Managing Stormwater



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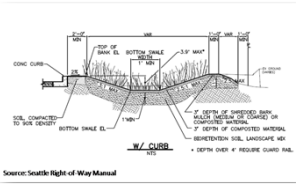
Mimicking Former Site Hydrology

- Storage
- Infiltration and the recharge of ground water
- Evaporation and evapotranspiration
- Detention



Stormwater planter in Kansas City

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Green Street Stormwater Technologies

Curb extensions: Curb extensions are created by carving out portions of the street's parking zones and converting them into landscaped curb areas similar to the parkway

Permeable Pavements: Permeable pavement allows water to infiltrate the ground.

Planters: Planters transform a street's pedestrian zone into attractive and sustainable stormwater management systems.

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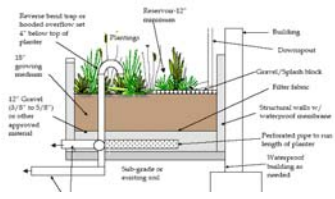
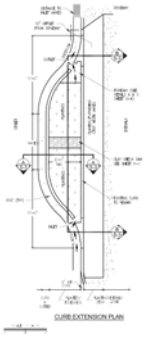
Biotreatment History in the Pacific Northwest

Portland Planter Box details first published in 1998

Bioretention BMPs favored as a means of flow control and pollution control since 2008 (Portland)

Approximately 2,000 flow through planter boxes installed in the City of Portland





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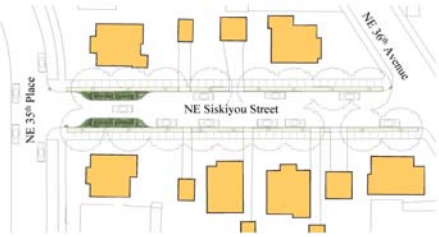
NE Siskiyou Curb Extensions



- Helps with stormwater volume, rate, and quality
- Helps with traffic calming
- Helps with pedestrian safety

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NE Siskiyou

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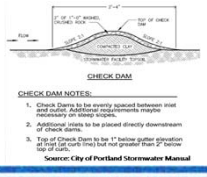

CHECK DAM NOTES:

1. Check Dams to be evenly spaced between inlet and outlet. Additional requirements maybe necessary on steep slopes.
2. Additional inlets to be placed directly downstream of check dams.
3. Top of Check Dam to be 1" below gutter elevation at invert (at curb line) but not greater than 2" below top of curb.

Source: City of Portland Stormwater Manual

CHECK DAM SPACING

Facility Length	Longitudinal Street Slope	# of Check Dams *	Additional Inlets **
30	<=1%	0	None
	>1%	1	None
31 - 50	<=1%	1	None
	>1%	2	1
51 - 70	<=1%	2	1
	>1%	3	2
71-90	<=1%	3	2
	>1%	4	3
91 +	<=1%	4	3
	>1%	5	4

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Bioretention Gone Right

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Biotreatment Construction and Commissioning

- Biotreatment media must be protected from construction runoff
- Compaction should be avoided
  - Material staging
  - Heavy equipment traffic
- Install media as final component
- Block inlets, cover media until construction completed

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Biotreatment Inspection and Maintenance

Inspection and Maintenance Fundamentals

- Remove trash and debris
- Inspect energy dissipation elements
- Restore design percolation rate
- Restore design storage capacity and grade/elevation
- Note areas of deposition and bed channelization
- Restore even mulch and media distribution
- Note flow patterns around inlet and overflow and correct as necessary

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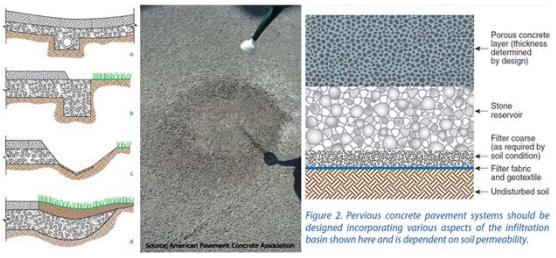
Pervious Concrete



Source: American Pavement Concrete Association

Figure 2. Pervious concrete pavement systems should be designed incorporating various aspects of the infiltration basin shown here and is dependent on soil permeability.

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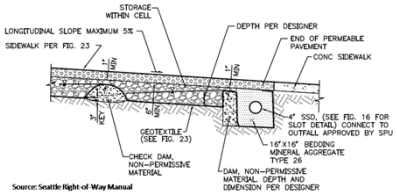

Source: Seattle Right-of-Way Manual

	RESIDENTIAL DRIVEWAY OR PEDESTRIAN ONLY	PRIVATE STREET, PARKING LOT, OR FIRE LANE	PUBLIC STREET
CONCRETE	4"	4"	7"
ASPHALT	2 ½"	3"	6"
PAVERS	2 ⅜"	3 ⅜"	3 ⅜"
ENGINEERING REQ'D	NO	YES	YES
COMPACTION REQ'D	NO	YES	95%

EXHIBIT 2-8
PERVIOUS PAVEMENT REQUIREMENTS FOR TOP LIFT DEPTH, ENGINEERING, AND COMPACTION.

Source: Portland Stormwater Manual

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BMP	Level of Effectiveness: Volume	Peak Discharge	Water Quality	Unit Operation/Process
Lid Practices				
Bioretention	Medium	High	High	Volume Reduction; microbially mediated transformation; uptake and storage, size separation, sorption
Bioslope	Medium	Medium	High	Volume Reduction; microbially mediated transformation; uptake and storage, size separation, sorption
Catch Basin Controls	No Impact	No Impact	Low	Size seperation and exclusion; density, gravity, inertial separation
Gutter Filter	No Impact	Low	Medium	Size Separation and exclusion; physical sorption
Infiltration Trenches/Strips	Medium	Medium	Medium	Volume reduction; size separation and exclusion; chemical sorption processes
Permeable Pavement	High	High	Medium	Volume reduction; size separation and exclusion
Pollution Prevention/Street Sweeping	No Impact	No Impact	Low/Medium	N/A
Surface Sand Filter	Low	Low	Medium	Size separation and exclusion; microbially mediated transformation, sorption
Soil Amendments	Medium	Medium	Medium	Volume reduction; size separation and exclusion; microbially mediated transformation; uptake and storage, sorption
Swales	Medium	Medium	High	Volume reduction; density, gravity, inertial separation, microbially mediated transformation; uptake and storage
Vegetation/Landscaping	High	High	High	Volume reduction; microbially mediated transformation; uptake and storage
Conventional and Innovative BMP's				
Advanced Biological Shystems	Medium	Medium	High	Microbially mediated transformation; uptake and storage
Detention and Retention Ponds	No Impact	High	Low	Flow and volume attenuation; density, gravity, inertial separation; coagulation/flocculation
Disinfection Systems	No Impact	No Impact	Medium	Chemical disinfection
Flocculent/Precipitant Injection	No Impact	No Impact	Medium	coagulation/flocculation
Sedimentation Ponds and Forebays	No Impact	Medium	Low	Flow and volume attenuation; density, gravity, inertial separation
Surface filters (Filter Fabrics)	No Impact	No Impact	Low	Size separation and exclusion

Rankings are qualitative. "High effectiveness" means that one of the BMP's primary functions is to meet that objective. "Medium effectiveness" means that a BMP can partially meet the objective but should be used in conjunction with other BMPs. "Low effectiveness" means that the BMPs contribution to the objective is a byproduct of its other functions, and another decentralized control should be used if that objective is important

Source: Low Impact Development Design Manual for highway Runoff Control

Source: Low Impact Development Design Manual for highway Runoff Control

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Urban Heat Islands

- 6 – 12 °F Hotter in daytime
- Up to 22 °F Hotter at night
- More Smog Occurrences
- High Level of Ground-Level Ozone
- More Frequent Air Quality Alerts
- Increased Health Problems
- Higher Energy Demand

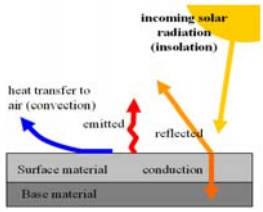

Figure 3. Thermal Behavior of Pavements (EPA 2010)

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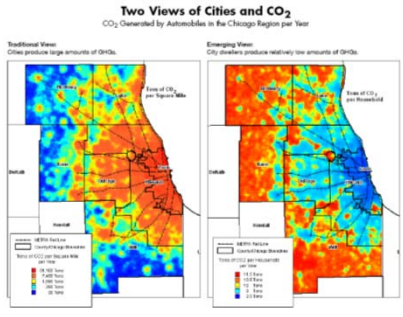
Urban Heat Island



David Leopold, Project Manager Chicago Streetscape and Sustainable Design Program

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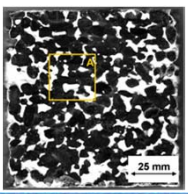
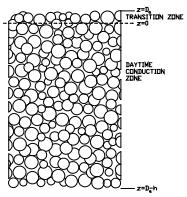
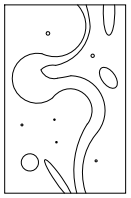
Urban Heat Island Strategies

- Highly reflective surfaces
- Infrared blocking coatings
- Permeable pavements
- Shading
- Vegetation







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Energy Efficient Lighting

- Examples in Chicago achieved 49% reduction in energy use over a streetscape baseline
- Utilize a white light source
- Eliminate light trespass into the night sky

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Construction Emissions

- Use more durable materials
- Use more efficient construction equipment

EPA tier 4 equipment used in mining

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Public Education about Target Pollutants

AUTOMOBILES	HOME	PUBLIC
• Gasoline • Oil • Antifreeze • Car washing	• Toxic chemicals • Paints • Fertilizers and pesticides • Soil erosion	• Littering • Pet waste

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Case Studies – Austin, TX

Scoop the Poop

PRE-PROGRAM (2000)
- 250 TONS PET WASTE PER YEAR INTO WATERSHED

CURRENT (2005)
- 540,000 MUTT MITTS
- REDUCED BY 135,000 LB

Grow Green

BROCHURES PROVIDED TO PARTICIPATING NURSERIES

14 OF 16 SHOWED INCREASED SALES FOR GROW GREEN PLANTS
- 4 SHOWED DECREASED FERTILIZER SALES
- 11 SHOWED INCREASED ORGANIC AND NATURAL FERTILIZER SALES

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Regional Materials

- Less transportation = lower emissions
- LEED, Chicago, Greenroads use 500 miles

Weight/Distance List

ZONE	MATERIAL OR SERVICE	MAXIMUM DISTANCE
7	Ideas	12,429.91 miles
6	Renewable Energy Technologies[26]	9000 miles
5	Assemblies that actively contribute to building performance once installed[34]	3000 miles
4	Consultant Travel[37]	1500 miles
3	Light, low density materials[38]	1000 miles
2	Medium Weight and density materials	500 miles
1	Heavy, high density materials[39]	250 miles

Living Building Challenge Regional Materials

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What's a Green Street?

- Pedestrian access
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For More Information

- Green streets manuals
  - Portland Stormwater Management Manual
  - Seattle Right-of-Way Manual