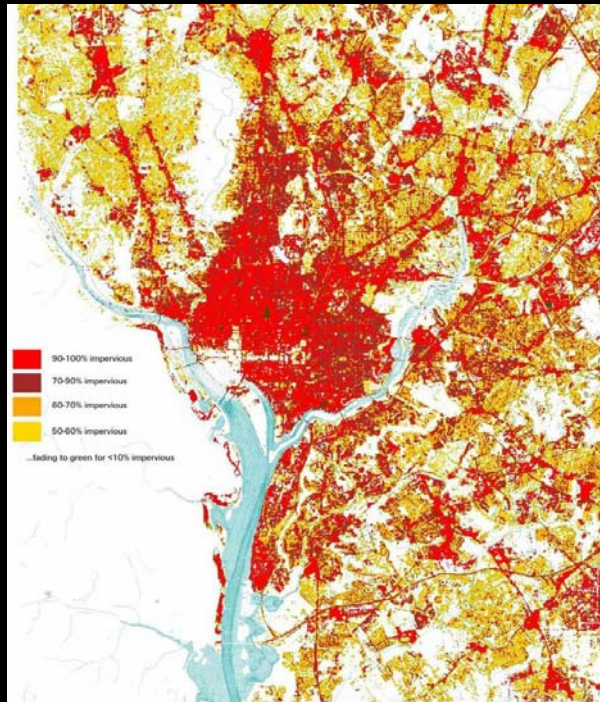


# green streets



San Antonio, Texas  
February 17-18, 2009  
Chris Kloss  
[www.lowimpactdevelopment.org](http://www.lowimpactdevelopment.org)





# typical pollutants

Examples of Stormwater Pollutants Typical of Roads.<sup>1,2</sup>

Pollutant	Source	Effects
Trash	---	Physical damage to aquatic animals and fish, release of poisonous substances
Sediment/solids	Construction, unpaved areas	Increased turbidity, increased transport of soil bound pollutants, negative effects on aquatic organisms reproduction and function
Metals <ul style="list-style-type: none"> <li>▪ Copper</li> <li>▪ Zinc</li> <li>▪ Lead</li> <li>▪ Arsenic</li> </ul>	<ul style="list-style-type: none"> <li>▪ Vehicle brake pads</li> <li>▪ Vehicle tires, motor oil</li> <li>▪ Vehicle emissions and engines</li> <li>▪ Vehicle emissions, brake linings, automotive fluids</li> </ul>	Toxic to aquatic organisms and can accumulate in sediments and fish tissues
Organics associated with petroleum (e.g., PAHs)	Vehicle emissions, automotive fluids, gas stations	Toxic to aquatic organisms
Nutrients	Vehicle emissions, atmospheric deposition	Promotes eutrophication and depleted dissolved oxygen concentrations

<sup>1</sup> National Cooperative Highway Research Program, *Evaluation of Best Management Practices and Low Impact Development for Highway Runoff Control*, National Academy of Sciences – National Research Council, 2006.  
<sup>2</sup> *Pollutants Commonly Found in Stormwater Runoff*, <http://www.stormwaterauthority.org/pollutants/default.aspx> (accessed July 2008).



# runoff from roads & parking lots

- [roads and parking lots] constitute as much as 70 percent of total impervious cover in ultra-urban landscapes, and as much as 80 percent of the directly connected impervious cover.
- roads tend to capture and export more stormwater pollutants than other land covers in these highly impervious areas, especially in regions of the country having mostly small rainfall events.

National Research Council, *Urban Stormwater Management in the United States*, October 2008.



# typical road functions

1. move cars

2. move water to pipes





## green streets

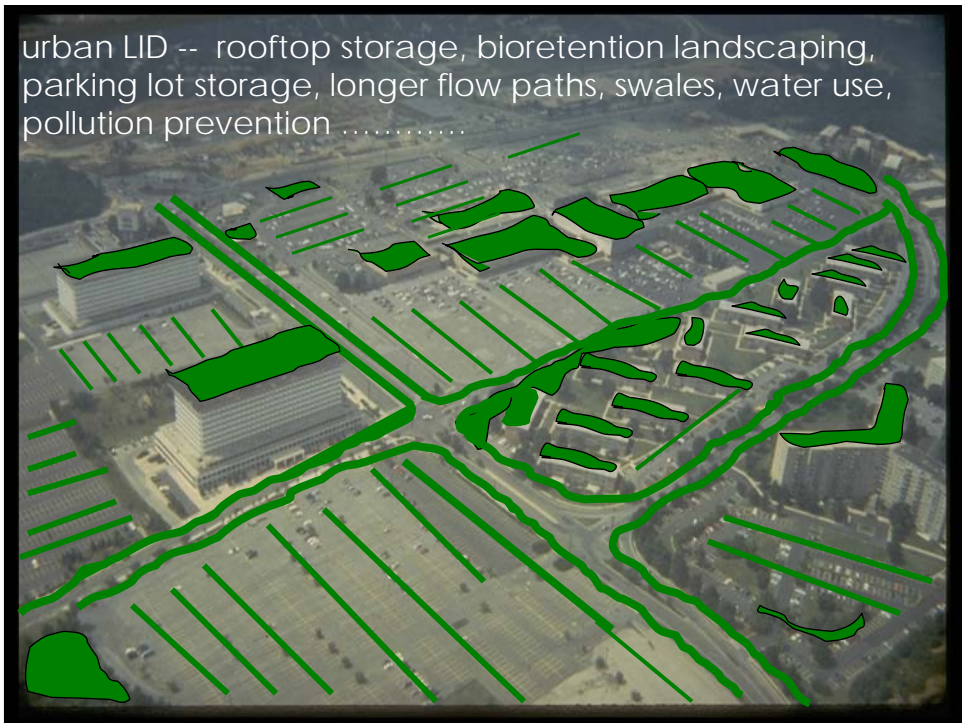
- mimic local hydrology prior to development
- provide multiple benefits
  - stormwater management and volume reductions
  - key link in green infrastructure network
  - aesthetic enhancement
  - improved local air quality by intercepting airborne particulates and providing shade
  - enhanced economic development
  - improved pedestrian experience

WERF livable communities: <http://www.werf.org/livablecommunities/>





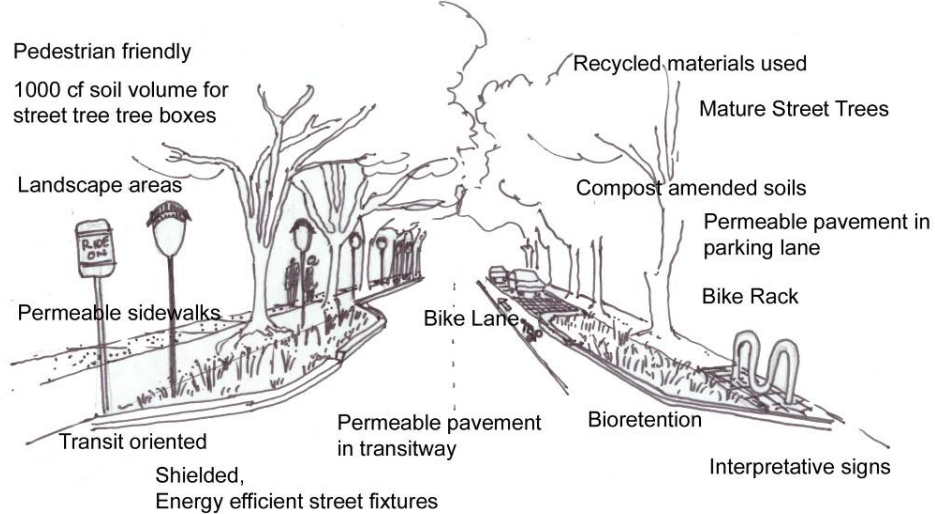
urban LID -- rooftop storage, bioretention landscaping, parking lot storage, longer flow paths, swales, water use, pollution prevention .....

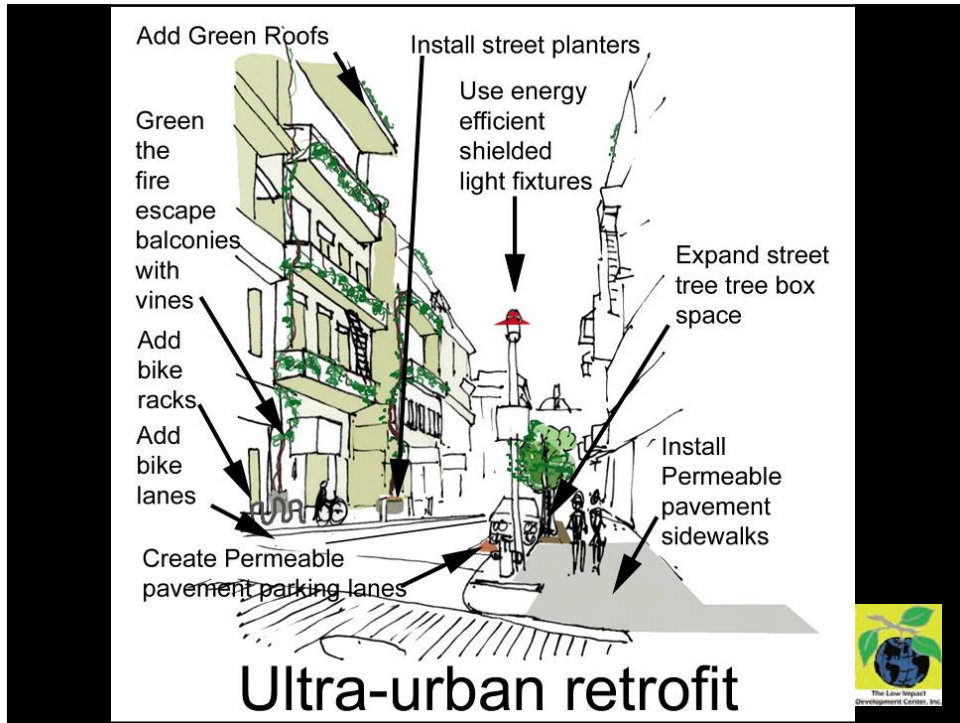




## multi-function / multi-benefit

### Anatomy of a Green Street





## importance of stormwater retention

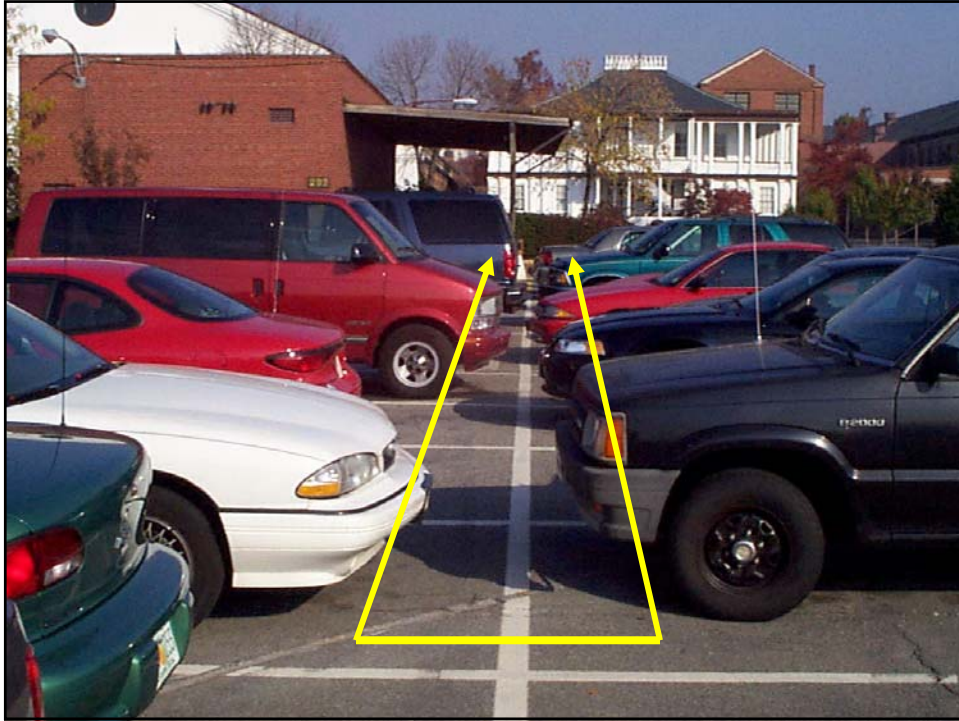
Runoff Volume and Pollutant Load from One-Acre Parking Lot with Treatment and Meadow for a One-Inch Rain Event.

Land Use	Pollutant	Concentration (mg/L)	% Removal	Effluent Concentration (mg/L)	Runoff Volume (gal)	Pollutant Load (lbs)
Paved Parking Lot with Treatment	TSS	130	80	26	25,800	5.6
Meadow		25	0	25	1,600	0.34

Thomas R. Schueler and Heather K. Holland, *The Importance of Imperviousness: Article 1 from The Practice of Watershed Protection*, The Center for Watershed Protection, 2000.  
 Wisconsin Department of Natural Resources, *Impact of Redevelopment on TSS Loads*, Runoff Management.







brownfields and unknown conditions









## permeable pavers



source: ICPI





## vancouver, british columbia

- uses naturalized streetscapes, infiltration bulges and country lanes to manage stormwater from roadways.
- more than 30 green roofs installed in the city.
- first SEA street design projected to reduce annual runoff 90%.



country lane. photo courtesy of city of vancouver greenways program.



## vancouver, british columbia (cont.)



crown street during construction. photo courtesy of city of vancouver greenways program.



## vancouver, british columbia (cont.)



infiltration bulge. *photo courtesy of city of vancouver greenways program.*



## vancouver, british columbia (cont.)



infiltration bulge. *photo courtesy of city of vancouver greenways program.*



## vancouver, british columbia (cont.)

- the city has integrated its LID program with its greenways program, which was designed to create green city corridors and improve pedestrian access and safety throughout the city.
- community groups donate time to maintain vegetated areas that manage stormwater



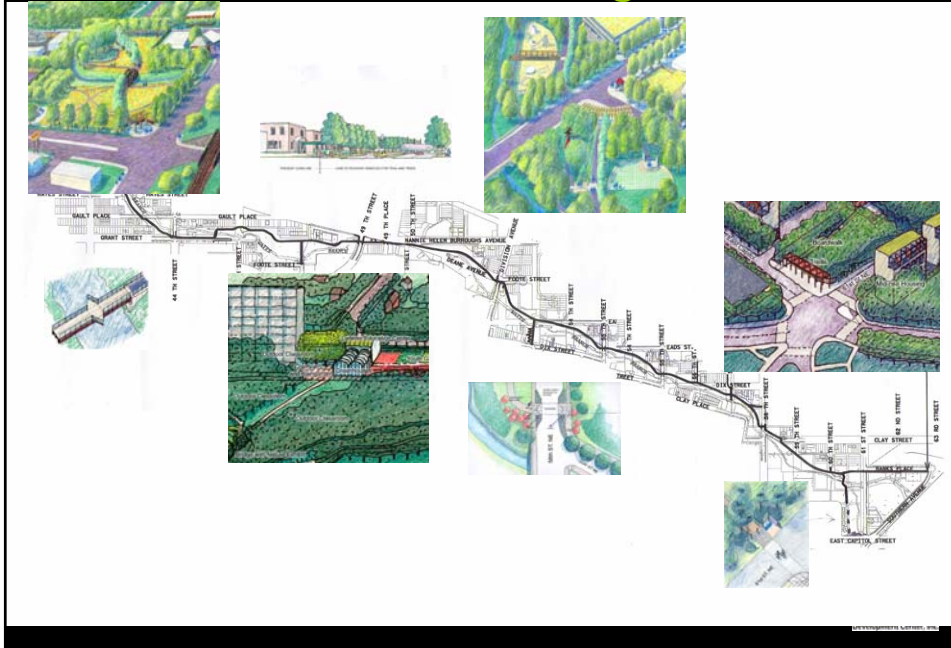
greenway. photo courtesy of city of vancouver greenways program.



rain garden in commercial parking lot



# nannie helen burroughs, dc



## Nannie Helen Burroughs Avenue Great Street LID Toolbox Stormwater solutions which support sustainable urban design



### Bioslope

- Add green infrastructure
- Links to other BMPs
- Improve water quality
- Reduce runoff volume
- Reduce erosion tendency
- Requires periodic aeration & compost amendment

•Possible Locations:  
•40' Street across corridor



### Bioswale

- Linear bio-retention feature, may mimic natural stream channel form
- Reduces runoff volume as water is conveyed
- Removes stormwater pollutants
- Links with other BMPs
- Provides green infrastructure link and habitat
- Planting design conforms to aesthetic design goals for urban design

•Possible Locations:  
•Minors and MB Intersection, SE Corner  
•4th Street, South of 4th  
•4th Street, South of Gault



### Bioretention Cell

- Green infrastructure link
- Reduces runoff volume
- Removes pollutants
- Links to other BMPs
- Provides habitat
- Provides aesthetic character definition

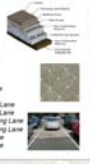
•Possible Locations:  
•Minors and MB Intersection, SE Corner  
•4th Street, South of 4th, Alley to Gault PI  
•4th Street, N Side of 4th, Gault PI to end of 4th  
•4th Street, N Bus Stop Bump Out  
•4th Street, S Bus Stop Bump Out  
•4th Street, N Bus Stop Bump Out  
•5th to 5 1/2 Street, N Sidewalk Buffer Area  
•5th to 5 1/2 Street, S Sidewalk Buffer Area  
•5 1/2 to Division, N Sidewalk  
•5 1/2 to Division, S Sidewalk  
•Near Eastern Ave, DC Welcome Sign



### Permeable Pavers

- Community development tool
- Reduces runoff volume
- Removes pollutants
- Reduces urban heat island
- Aesthetic enhancement of area, many color options
- ADA compliant pavement

•Possible Locations:  
•4th Street, Sidewalk between N slope  
•4th Street, End  
•Gault PI to 4th, N Designated Parking Lane  
•4th to 4th Street, N Designated Parking Lane  
•4th to 4th Street, S Designated Parking Lane  
•4th to 5th, N Designated Parking Lane  
•4th to 5th, S Designated Parking Lane  
•4th Street, Traversal



### Vegetated Filter Strip

- Filters pollutants from stormwater
- Provides stream and roadway buffering
- Links with other BMPs
- Reduces Soil amendments

•Possible Locations:  
•Gault to 4th, Median  
•4th to 4th Street, Median  
•4th Street, Traffic Circle  
•5th to 5 1/2 Street, Median  
•5 1/2 Street to Division, N Sidewalk  
•Division to 5th Street, Median



### Street Trees

- Reduces runoff volume
- Removes stormwater pollutants
- Reduces urban heat island
- Promotes pedestrian use of streets
- Links community via canopy

•Possible Locations:  
•All along the MB Corridor



Nannie Helen Burroughs Ave. is a neighborhood street with "green" practices that builds on its history and park-like context with great access to Watts Branch trail and the Kenilworth Aquatic gardens.

For additional information, please contact:  
District Department of Transportation (DDOT) 64 New York Avenue,  
Al Shaker, PE Ward 7 & 8 Program Manager (202) 671-6712 or al.shaker@dc.gov

The Low Impact Development Center  
www.lowimpactdevelopment.org

# mid-atlantic bioretention



capital hill rain garden – washington, dc



# bioretention for drier climates



bioswales in california.



# xeriscape



native texas plants for xeriscaping.

[http://www.ci.austin.tx.us/greengarden/award\\_wagontrain.htm](http://www.ci.austin.tx.us/greengarden/award_wagontrain.htm)



# permeable pavements



permeable asphalt and permeable pavers in california.



# permeable pavements



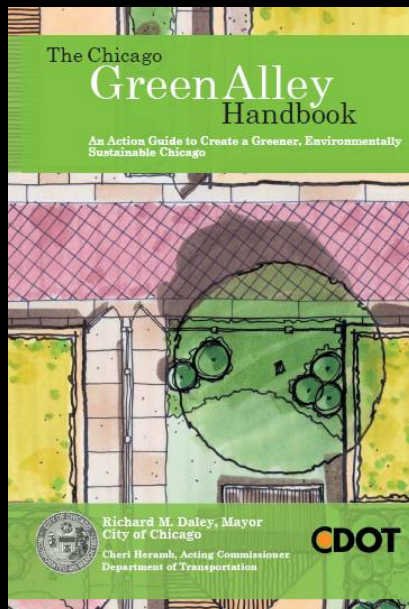
permeable concrete – webb bridge park,  
alpharetta, georgia.



ada compliant interlocking concrete  
paver blocks. portland, oregon.



# green alleys handbook



# chicago green alleys

- pilot projects address stormwater, urban heat island, recycled materials, energy efficiency and light pollution.
- transformed from a source to a sink.
- early pilot alley retain the volume of a 3-inch, 1-hour event.
- created a market for permeable concrete - \$145/yd to \$45/yd one year later (regular concrete \$50/yd).



high albedo concrete and permeable concrete trench in chicago alley. photo courtesy of abby hall, u.s. epa.



## Anacostia Waterfront

Transportation Architecture Design Standards



District of Columbia  
District Department of Transportation  
Infrastructure Project Management Administration



## anacostia river redevelopment

- stormwater standard requires on-site retention of the first inch of rainfall & water quality treatment for up to the two-year storm volume.
- transportation standards identify green infrastructure options for right of ways.



award winning barracks row.

