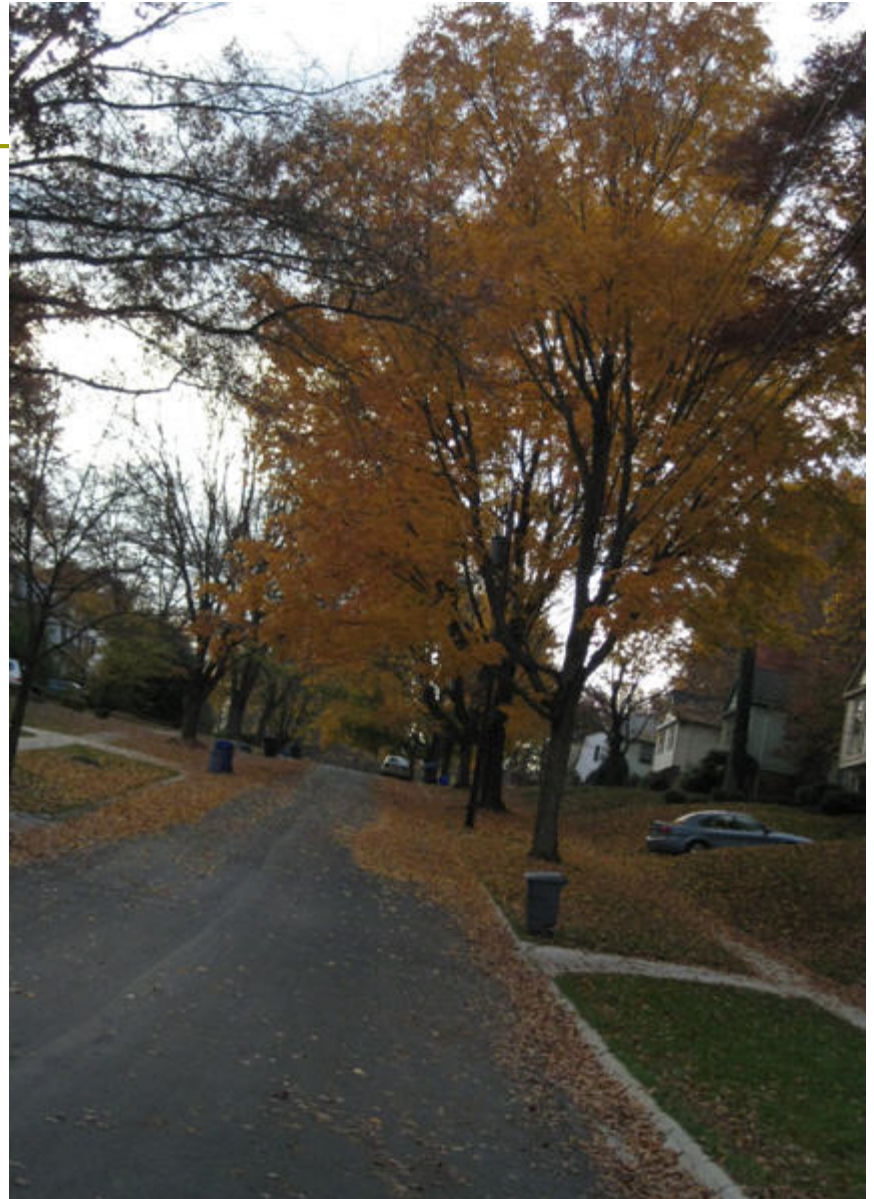


Bioretention and Permeable Pavement Maintenance

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-
- ▣ Trees are a form of LID.













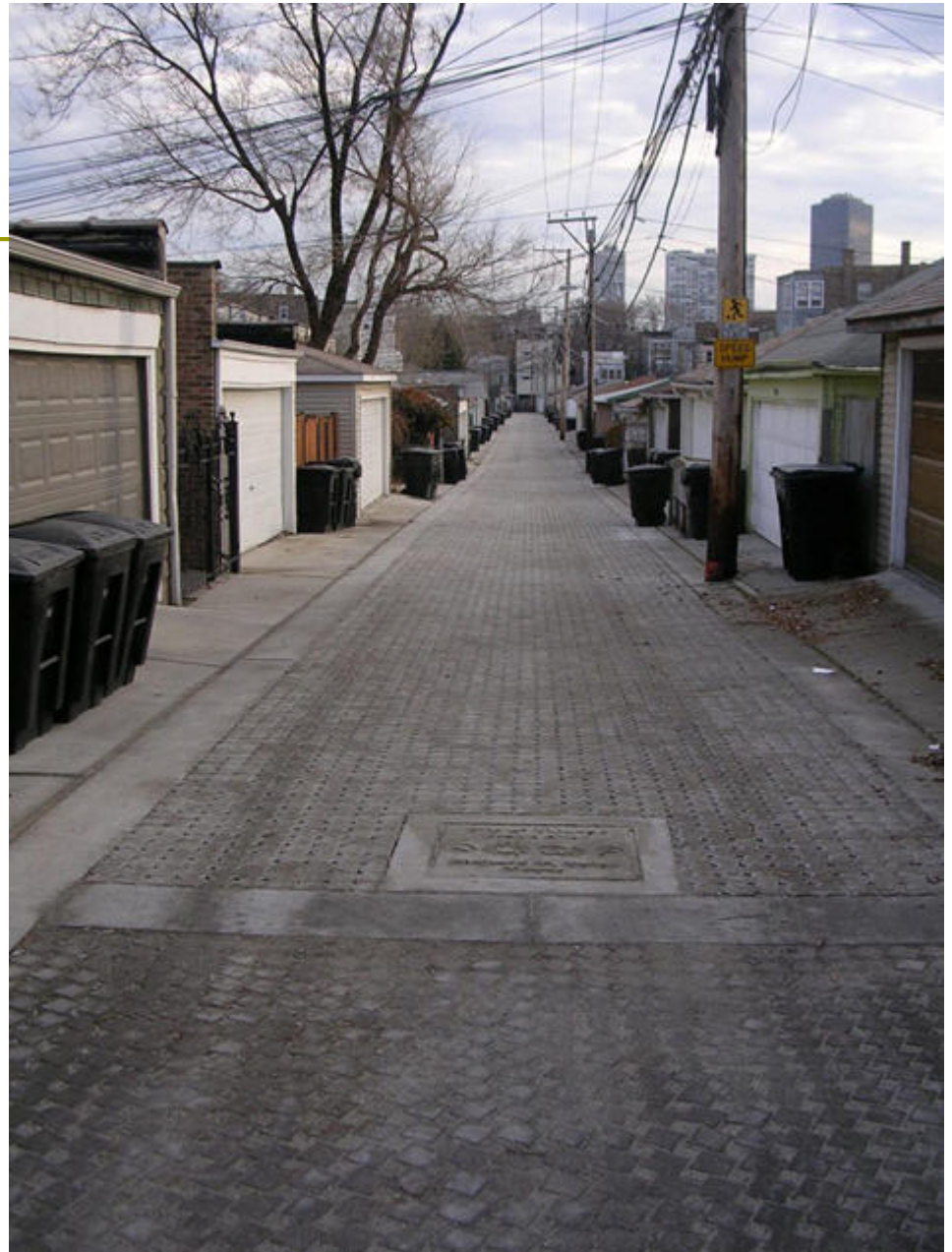








▣ Chicago Alleys Project



Anatomy of a Green Street

Pedestrian friendly

1000 cf soil volume for
street tree tree boxes

Landscape areas

Permeable sidewalks

Transit oriented

Shielded,
Energy efficient street fixtures

Recycled materials used

Mature Street Trees

Compost amended soils

Permeable pavement in
parking lane

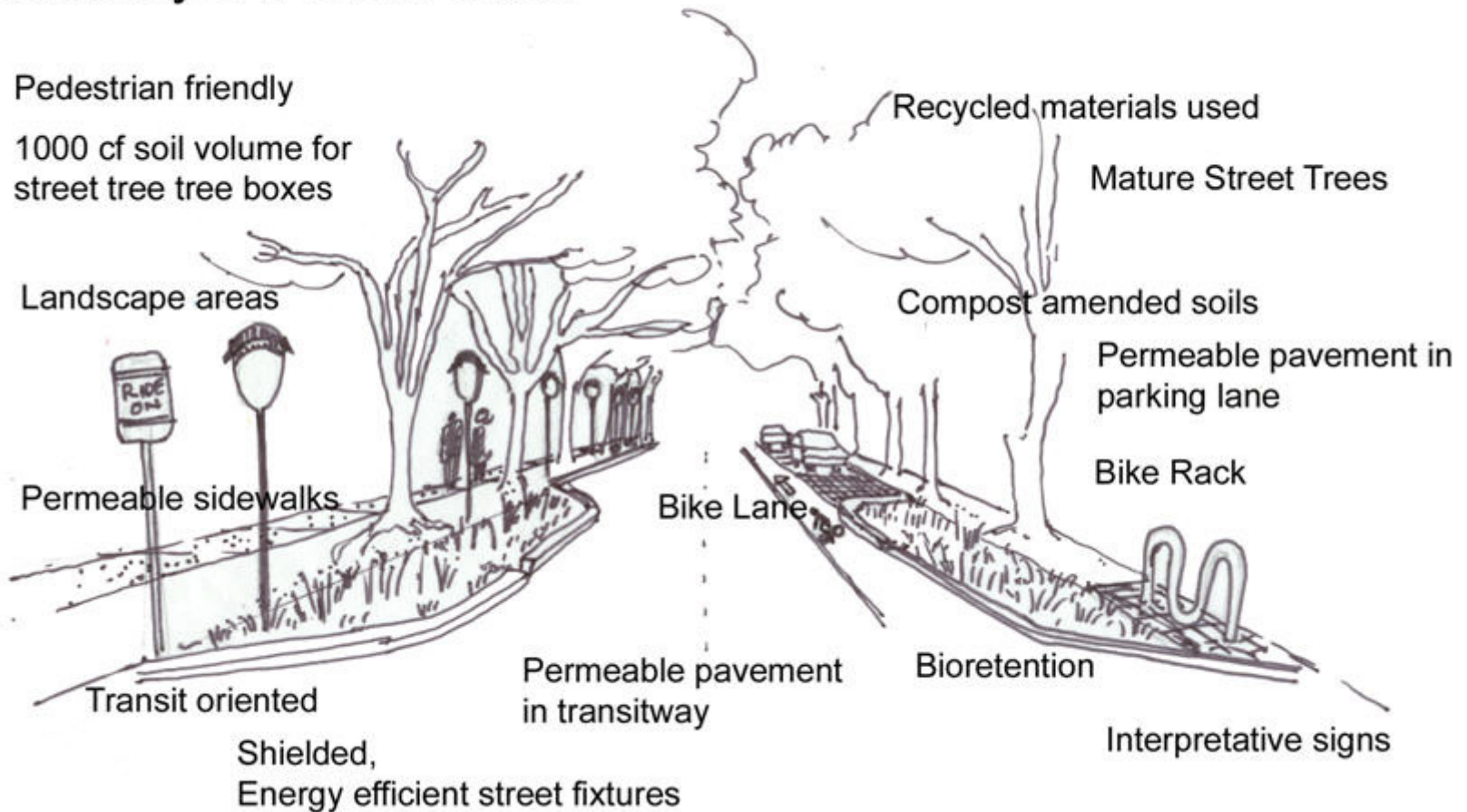
Bike Rack

Bike Lane

Permeable pavement
in transitway

Bioretention

Interpretative signs



Prince George's County, MD



"We Bring Engineering to Life"

Bioretention is Low Maintenance...

...but not *NO* maintenance



Most common cause of bioretention failure....



**BIORETENTION IS *NOT* A
SEDIMENT BASIN!!!**

Chapel Hill, NC

I. Slow Distributed Inflow

Internal Erosion from poor water delivery



Curb cut



Rip rap



Gravel verges and grass filter strips = Treatment train



Bioretention Forebays



II. Clogging

Clogging Causes

- ❑ Berm erosion into mulch and media
- ❑ Unstable catchment
- ❑ Unmaintained forebay
- ❑ Media mix is wrong!



Asphalt Generates Sediment



Clogging

- ❑ Media chosen for **specific porosity**
- ❑ Fines occupy pore space in media
- ❑ Reduces infiltration rate significantly (**goal = 1 in/hr rainfall event**)
- ❑ Useful lifespan of bioretention found to be limited by clogging (Li and Davis, 2008)



Key Maintenance Test

- Visit site within 24 hours of 1 inch rain event (avg 11-12 /yr)
- If water is still ponded site has clogged
- Action needed
- Do this once or twice per year



Unclogging

- ❑ Excavate top 5-20 cm
- ❑ Replace with clean media
- ❑ May need deeper if severe failure occurs
- ❑ Can be expensive \$\$\$



Remove mulch, move plants, dig out clogged soil



III. Trash Removal

- ❑ Unsightly, poor aesthetics
- ❑ Safe harbor for mosquitos
- ❑ Can clog drawdown
- ❑ Takes up volume in forebay



Fort Bragg, NC

IV. Overflow Structure Maintenance

- ❑ Urban areas, overflow structure *can* be matter of **public safety**
- ❑ Certain outlets more apt to clog than others
- ❑ Private firms specialize in outlet maintenance on SCMs

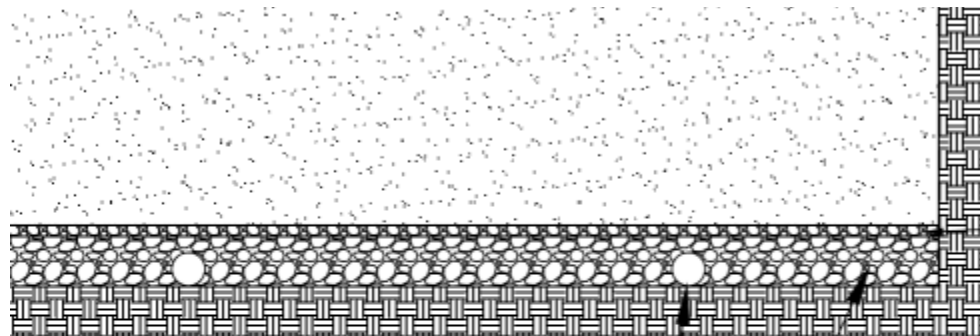


Clogged outlet



V. Underdrain Maintenance?

- ❑ Surprisingly uncommon
- ❑ Clogging potential: filter fabric vs choking stone
- ❑ Cleanouts make it easy



Fill Soil Media: 85 – 88% Washed Sand 8 – 12% Fines (Silt + Clay) 3 – 5% Organic Matter	
Washed Sand	2 to 4 inches
Choking Stone (typically #8 or #89 washed)	2 inches
Washed #57 stone or similar, and underdrain pipe.	6 to 8 inches
In-situ soil	

2" ASTM NO. 8 STONE

4" DIA. CORRUGATED PERFORATED HDPE PIPE

WASHED 57 STONE
ENVELOPE

Underdrain Cleanouts

Bad



Better



VI. Plant Selection



- ❑ Plant palette has grown as BR soils have improved
- ❑ Natives are good
- ❑ Avoid invasives and 'spreaders'

Plant Density



Keep it open!

Maintenance Trigger: Plant replacement

- Replace dead plants ASAP with more tolerant plants or plant new plants on higher ground in the bioretention bed

Vegetation Maintenance



Fort Bragg, NC

Vegetation Maintenance

❑ Irrigate

- 2 to 3 days for first few months

❑ Once established, should sustain themselves

❑ Vegetation selection is key here

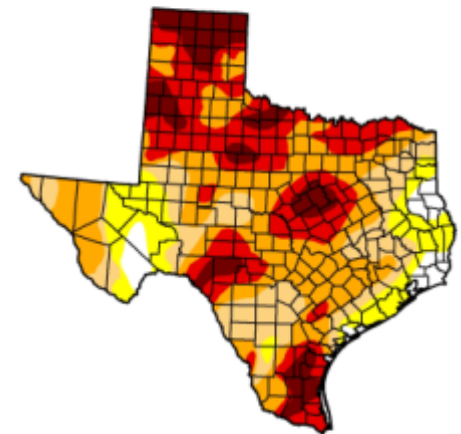
❑ Droughts

U.S. Drought Monitor Texas

January 8, 2013
Valid 7 a.m. EST

	Drought Conditions (Percent Area)					
	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	4.29	95.71	83.78	65.85	34.79	11.41
Last Week (01/01/2013 map)	3.04	96.96	87.00	65.39	35.03	11.96
3 Months Ago (10/06/2012 map)	16.50	83.50	65.38	31.79	15.88	3.23
Start of Calendar Year (01/01/2013 map)	3.04	96.96	87.00	65.39	35.03	11.96
Start of Water Year (09/25/2012 map)	9.13	90.87	78.73	57.41	24.91	5.18
One Year Ago (01/03/2012 map)	0.01	99.99	97.83	84.81	67.32	32.40

Intensity:



The Drought Monitor focuses on broad-scale conditions.
Local conditions may vary. See accompanying text summary
for forecast statements.

<http://droughtmonitor.unl.edu>



Released Thursday, January 10, 2013
David Simeral, Western Regional Climate Center

Importantly...

Think *clean water*, not *lush*



Vegetation Maintenance



**1 to 2
times/yr**

VII. Mulching: Benefits

- ❑ Prevents weeds from sprouting
- ❑ Adds organic matter, active zone for microorganisms
- ❑ Conserves moisture during dry periods
- ❑ Cools soil
- ❑ Attractive



Mulching

- ❑ Use double or triple-shredded hardwood
- ❑ Renew if needed due to oxidation or discoloration
- ❑ Do not over-mulch and fill water storage pool with mulch
- ❑ “Hot Spots”



Bioretention Maintenance Task Schedule

Task	Frequency	Maintenance Notes
PRUNING	1 – 2 times/yr	Nutrients in runoff often cause bioretention vegetation to flourish
MOWING	2 – 12 times/yr	Frequency depends upon location and desired aesthetic appeal
MULCH REMOVAL	Once every 2 – 3yrs	Mulch accumulation reduces available water storage volume. Removal of mulch also increases infil. rate
WATERING	Once every 2 -3 days for first few months. Seldom after establishment	During droughts, watering after initial year may be needed
FERTILIZATION	Once initially	
REMOVE AND REPLACE DEAD PLANTS	Once per year	>10% of plants may die, survival rates increase over time
MISCELLANEOUS	Monthly	Trash collection, spot weeding, removing mulch from overflow

Permeable Pavement Design Steps

- ❑ 1. Siting and feasibility
- ❑ 2. Pavement course
- ❑ 3. Discuss PP with owner
- ❑ 4. Layout site drainage system
- ❑ 5. In-situ soil testing
- ❑ 6. Infiltration vs. detention system
- ❑ 7. Subgrade grading design
- ❑ 8. Depth of aggregate base
- ❑ 9. Safe conveyance of 10-yr storm
- ❑ 10. Observation wells
- ❑ 11. Membranes
- ❑ 12. Edge restraints

Step 1: Siting and Feasibility

- ❑ Constraints with:
 - Seasonal high water table
 - Site slope
 - Buffers and setbacks
 - Stormwater hotspots
 - Redevelopment sites
 - Proximity to water supply wells





Stormwater hotspots

Vehicle maintenance/fueling areas
Public works yards
Trucking & distribution centers
“Heavy” industries
Airport maintenance areas
Railroads and bulk shipping
Solid waste facilities
Wastewater treatment plants
Scrap yards



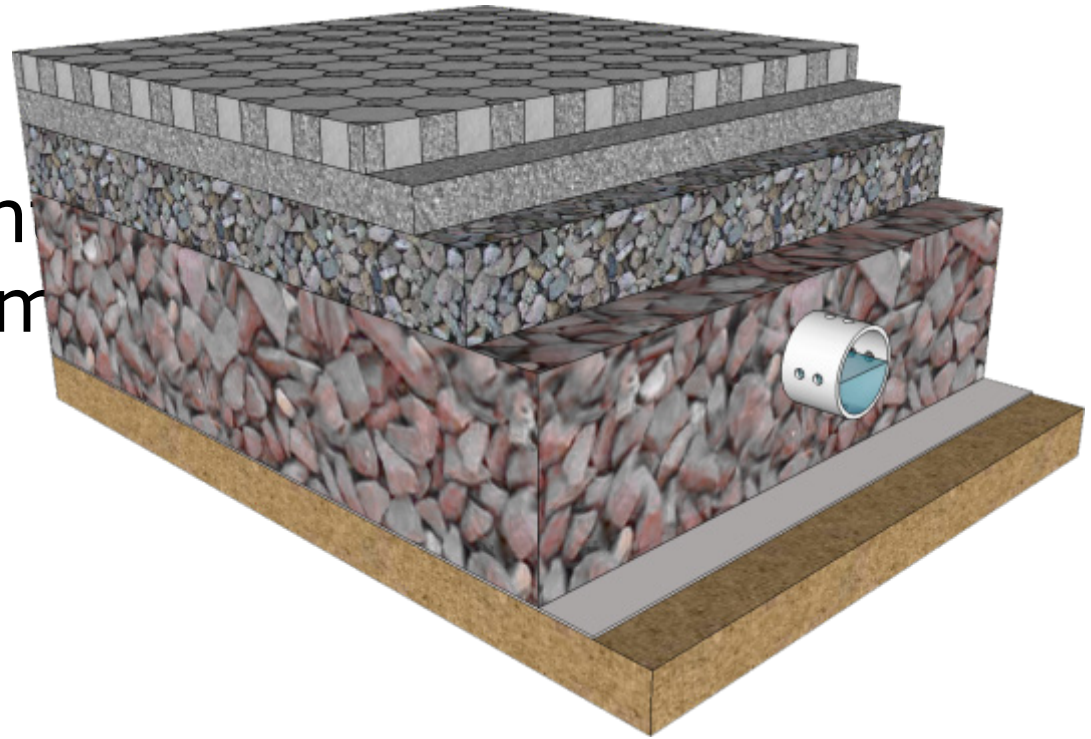
Structural Calculations

- 2 main functions
 - Support Expected Weight of Vehicles (Structural)
 - Store & Infiltrate a design volume of water (Hydrologic)



Factor 2: Design Precip Depth

- ❑ 90% Rainfall Volume?
 - ~1 inch
- ❑ Pre-Development Infiltration Volume
 - 0.33-1 inch
- ❑ Moderate ARI storm (e.g., 2-, 10-yr)
- ❑ Infrequent ARI storm (25-, 50- yr)



If not maintained, “permeable”
pavement can become Impervious



Permeable Pavement Maintenance: Clean the Catchment - Street Sweeper



Permeable Pavement - Clean the Catchment: Blowing



Permeable Pavement Maintenance: Sweeper/Vacuum Truck

- ❑ Different Types of Sweepers for Different Types of Permeable Pavements:
- ❑ Mechanical Sweeper vs. Regenerative Air Sweeper vs. Vacuum Sweeper



Permeable pavement weed control

- ❑ Systemic herbicides like Roundup - Preferred
- ❑ Flame weed killers – LP gas fueled – Be careful. Could ignite Concrete!



Grassed Permeable Pavement

You might have to mow it!



Permeable Pavement Maintenance Tasks and Schedule

<u>TASK</u>	<u>SCHEDULE</u>
Inspect Lot for Clogging	Semi-annual to Quarterly
Street sweeping and vacuuming	Per inspection results
Gravel replacement	Post-Vacuuming
Oil and grease cleaning	As needed per clientele
Avoidance of landscape debris (grass clippings, leaves)	Each landscape maintenance
Spray/ _{Flame} Weeds and Moss with Herbicides	Monthly during growing season
Adjoining land and watershed stabilization	Keep watch

Questions?

