Retrofitting stormwater retention on headwater streets: hydrologic effects of catchment-scale green infrastructure
Green infrastructure
(aka low impact development, distributed stormwater management, source control)

Goal: disconnect impervious surfaces from sewer or stream to maintain pre-development hydrograph and water balance
Retrofitting stormwater controls

Already urbanized watersheds may require distributed approaches.

Parma, Ohio: Fully developed since 1950s
How effectively can green infrastructure mitigate urban stormflow?

- What effects do street scale green infrastructure investments including, rain gardens, street side bioretention, and rain barrels have on peak and total stormflows?
- What are the human dimensions of the story?

Parma, Ohio
West Creek (tributary to Cuyahoga) 35% impervious

Klusner Ave.
55.5% impervious
37 Rain Barrels
7 Rain Gardens
16 Bioretention
12.5% homeowner participation

Parkhaven Dr.
26.4% impervious
21 Rain Barrels
3 Rain Gardens
7 Bioretention
32.2% homeowner participation
April 2012
Monitoring Began

May 2013
Phase 1
12 street side bioretention
(10 with underdrains)
22 rain barrels
2 rain gardens

October 2012
Pre-Treatment 1 Monitoring Began

Late Summer 2013
Pre-Treatment 2
Residents hooked up to sanitary sewers
Road repaved with new curbs

April 2014
Phase 2
4 street side bioretention
(no underdrains)
15 rain barrels
5 rain gardens

July 2014
Phase 2
7 street side bioretention
21 rain barrels
3 rain gardens
GI substantially reduced total stormflow.


Figure 4
Why is Phase 2 so much better?
No Underdrains

http://www.dceservices.org/kiosk/bioretention-gardens
GI reduces peak flows in bigger storms...

Peak flows decreased 33%

Figure 2.

Slight design & construction differences matter.

Phase 1

Phase 1

Phase 2
Lag Time Analysis Shows Value of Underdrained GI

Centroid lag-to-peak
- Time from the centroid of precipitation to the peak of discharge ($T_{LPC}$)

Compare Control to Treatment Street: $C_{LPC} - T_{LPC}$
- 0 if streets peak at same time

Adding GI with underdrains slowed down flow. Adding GI without underdrains didn’t.

Lower TI, higher GI street

Did road repairs offset the effect of the GI?
Or did the GI not work?

Scaling up to a (bigger) watershed

- 0.1% of watershed affected by this $300,000 project.
- 12 – 30% homeowner participation, even with incentives.
- Resident opinions sharply divided.
- Open question about long term performance.
How effectively can green infrastructure mitigate urban stormflow?

• Reductions in stormflow volumes & peak flows can be significant for street-scale green infrastructure retrofits.

• Need to achieve big hydrologic changes at street-scale and apply over large areas to see watershed-scale effects.

Real barriers to green infrastructure effectiveness may be humans.