



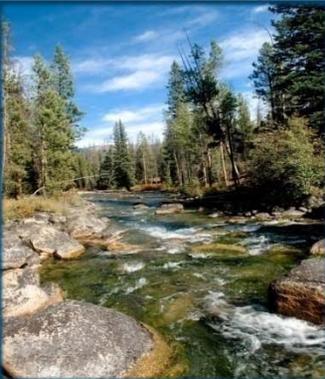
SAFE AND SUSTAINABLE WATER RESOURCES RESEARCH PROGRAM

Green Infrastructure for Stormwater Management

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April 17, 2012



19 April 2012

Why the Interest in Green Infrastructure?

- ASCE assessment of U.S. water infrastructure:
 - Grade of D-
 - Identified investment needs of \$255 billion.
- EPA analysis of wastewater and stormwater infrastructure needs:
 - Nearly \$300 billion of required investment
 - \$60 billion for CSO control
 - \$40 billion for stormwater management

American Society of Civil Engineers, (2010), *Report Card for America's Infrastructure*.

U.S. EPA, (2010), *Clean Watersheds Need Survey: 2008 Report to Congress*, Office of Wastewater Management, EPA 832-F-10-010.



Street flooding after ½" rainfall in Ocean City, NJ, August 9, 2011

Stormwater Management Issues: How did we get here?

- Past development of land has altered natural hydrologic cycle – net runoff instead of net infiltration
- Storm sewer systems were necessary to manage flooding, erosion, basement backups, etc
- Aging water (grey) infrastructure, increased water usage, and demographic changes stress water systems
- Stormwater discharge and combined sewer overflows introduce significant environmental and health risks



- Release of untreated wastewater
- Increased runoff of stormwater
- Water quality degradation (e.g., pathogens, nutrients and resulting algal blooms, chemical contaminants)
- Stream erosion and degradation of aquatic ecosystems



ORD's Research to Further the Agency's Green Infrastructure Agenda

1. Determine integration of green infrastructure in communities
2. Green Infrastructure Best Management Practices (BMP) performance and metrics
3. Green Infrastructure Modeling Tools and Data Inventories

These research activities, explicitly designed to support the GI Agenda, are housed within ORD's Safe and Sustainable Water Resources research program

Determine integration of green infrastructure in communities

Cleveland case study



- ORD and Region 5 “Green Team” proposal (adopted) for an integrated green-gray approach for Cleveland consent decree for CSO control, \$3B with \$42M for GI (8% total volume)
- Adaptive management approach to integrate GI and modify plan over time based on actual conditions and outcomes
- Opportunity to adapt green-gray approach and take advantage of additional GI substitution for gray
- Site-scale monitoring (soils, hydrology) of GI practices at a Cleveland pilot GI project

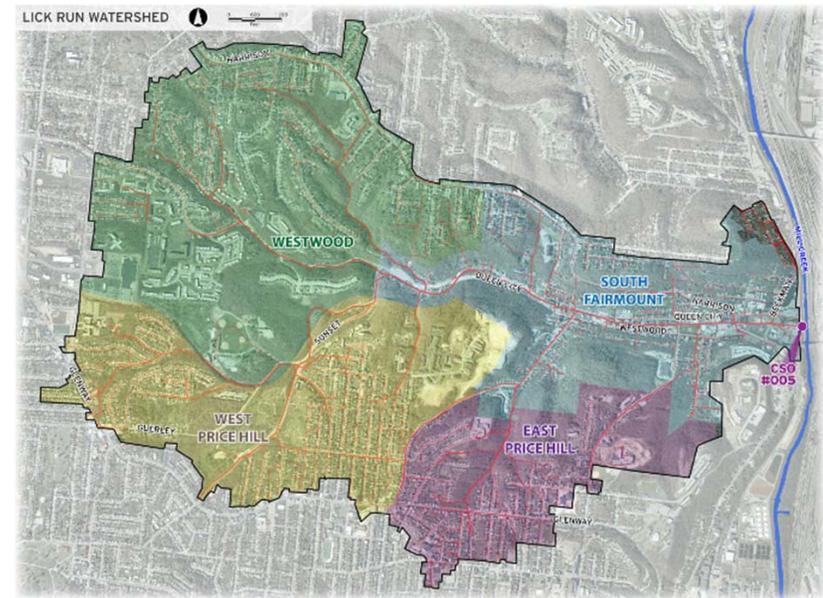
Omaha case study

- Omaha’s consent decree for CSO control relies on grey infrastructure enhancements, \$1.7B
- Numerous GI opportunities under consideration to enhance plan
- Collaboration with ORD under development at their Minne Lusa pilot, where GI practices will be introduced or expanded at several city parks

Determine integration of green infrastructure in communities

Cincinnati case study

- Cincinnati’s consent decree for CSOs (2010) approximately \$2.2B
- If GI pilots in Lick Run watershed are successful in controlling stormwater targets, construction plans for tunnel in Lower Mill Creek could be altered
- ORD monitoring hydrology and water quality at select demonstration projects (e.g., St. Francis Apartments expansive rain gardens, Cincinnati State permeable pavement parking lots)
- Developing baseline data on socio-economic indicators to assess co-benefits



Green Infrastructure Best Management Practices (BMP) performance and metrics

- Monitoring of GI BMPs such as permeable parking lots and rain gardens (O&M, long term performance)
- Field sites are located primarily in the Northeast and Midwest – Combined Sewer Systems (CSS), Green Infrastructure primarily implemented for keeping stormwater out of CSS
- Edison, NJ EPA facility: permeable parking lots, rain gardens
- Cincinnati, OH: rain gardens, stream restoration pilot, EPA facility improvements for stormwater



EPA Facility in Edison, NJ: Porous Asphalt, Porous Concrete, and Pavers



The infiltration rate varies across the three surfaces.

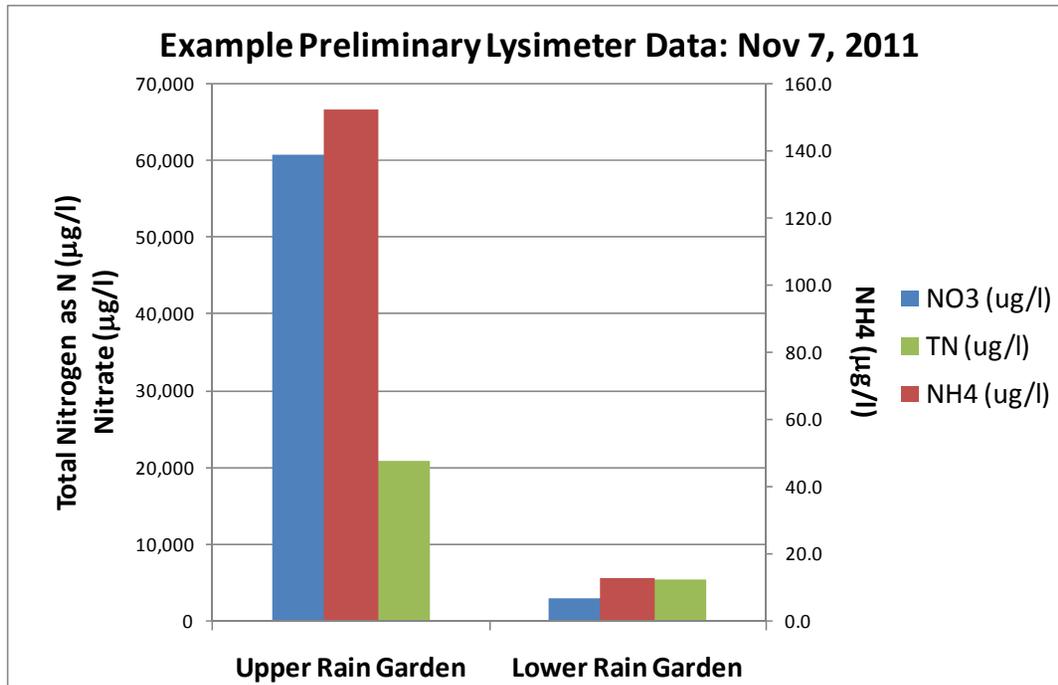


Data through Feb 2012
2-way factorial ANOVA
Concrete data pools both rows

Monitoring of BMP Performance

Rain Gardens

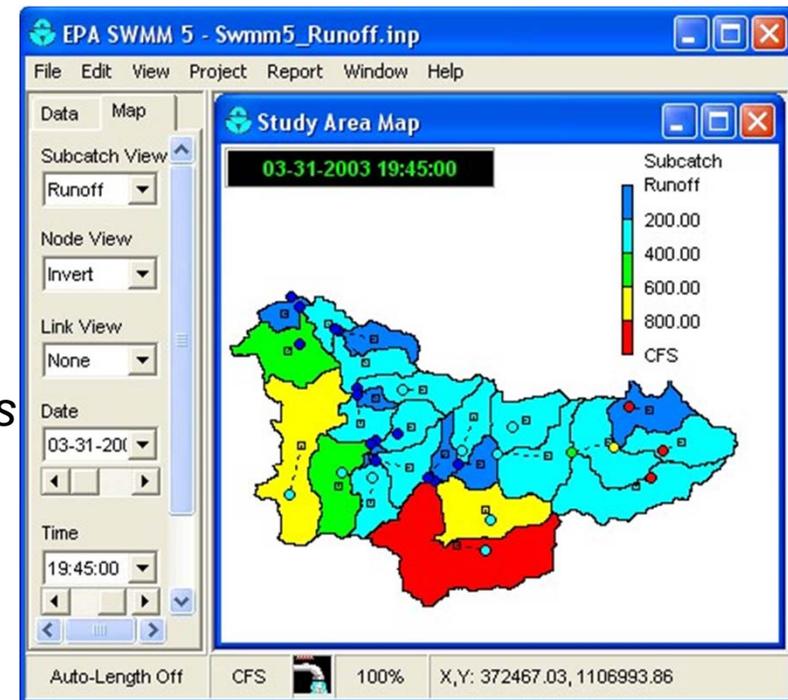
- Example: St. Francis Apartments rain gardens, Cincinnati, OH
- Monitoring put in place during FY11 for hydrology and nutrients



Storm Water Management Model (SWMM)

v.5 with Low Impact Development:

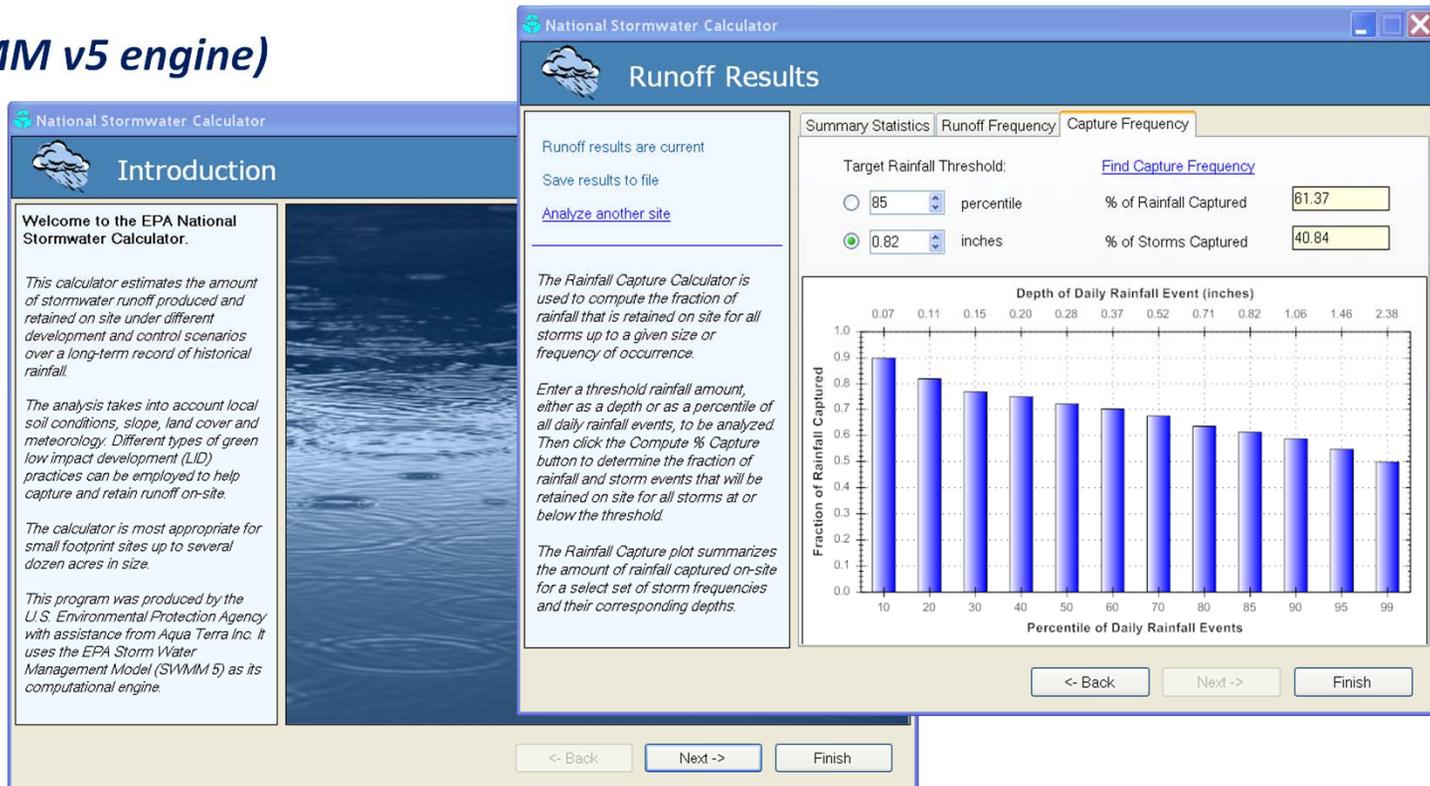
Planning, analysis and design related to stormwater runoff, combined sewers, sanitary sewers, and other drainage systems in urban areas



How would GI BMPs in an urban environment impact stormwater and contaminant runoff and reduce CSO events?

Stormwater Calculator

(note: SWMM v5 engine)



The screenshot shows the National Stormwater Calculator interface. The main window is titled 'Runoff Results' and has three tabs: 'Summary Statistics', 'Runoff Frequency', and 'Capture Frequency'. The 'Capture Frequency' tab is active, showing a 'Target Rainfall Threshold' of 0.82 inches. The results show that 61.37% of rainfall is captured and 40.84% of storms are captured. A bar chart titled 'Depth of Daily Rainfall Event (inches)' shows the fraction of rainfall captured for various percentiles of daily rainfall events. The x-axis represents the percentile of daily rainfall events (10, 20, 30, 40, 50, 60, 70, 80, 85, 90, 95, 99) and the y-axis represents the fraction of rainfall captured (0.0 to 1.0). The bars show a decreasing trend in the fraction of rainfall captured as the percentile increases.

Percentile of Daily Rainfall Events	Depth of Daily Rainfall Event (inches)	Fraction of Rainfall Captured
10	0.07	0.92
20	0.11	0.82
30	0.15	0.78
40	0.20	0.75
50	0.28	0.72
60	0.37	0.68
70	0.52	0.65
80	0.71	0.62
85	0.82	0.60
90	1.06	0.58
95	1.46	0.55
99	2.38	0.52

- Package modeling solutions (e.g., SWMM-LID) into usable tools for engineers and planners

Questions?

