# Current research and development activities in the area of Green Infrastructure

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# Programmatic Context

This work is a part of ongoing Safe and Sustainable Water Resources research (4.1) under the general theme of "Integration of green and grey infrastructure for US communities that operate combined sewer systems".

# Take home message

- Green infrastructure, in any form, is NOT a one-size-fits-all proposition
- Know your landscape and management objectives
- Take appropriate data to understand site prospects and limitations
- Use data to guide planning and implementation
- *Give the concept of Green Infrastructure a fighting chance!*

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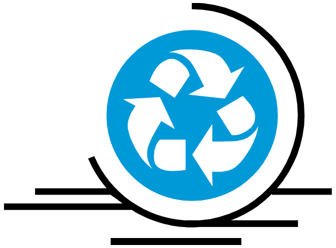
# Sustainability

- Sustainability is built on the foundations of social equity, economic stability, and environmental integrity
- In the case of Green Infrastructure (GI), is it sustainable?
- Only if everyone has equal access to GI that has a cost-effective life cycle, and that fulfills environmental performance objectives
- Landscape-specific data may help design and implement effective GI



# What is Green Infrastructure?

- Green Infrastructure (GI) includes:
  - Plant-soil systems (rain gardens, swales) that infiltrate, transpire, store, and redistribute water volume and provide contaminant filtration and other ecosystem services
  - Engineered structures designed to catch/store rain water or runoff in green roofs, cisterns, etc.
  - In the classical sense, GI should be contiguous, interconnected across landscapes

# What is Green Infrastructure?

- Potential for different or perhaps less-onerous life-cycle costs compared to grey
- Provide ecosystem services (are we getting services from plant-soil systems as they are?)
- Community benefits from increased, visible green space, re-purposing vacant properties, etc…
- Match oversupply of runoff vol. with oversupply of vacant land

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# A lot of assumptions for infiltration-type GI

Assumed rainfall pattern

X

**Assumed Soil Characteristics taken from coarse survey data**

→

How much infiltration capacity? Drainage?

How much runoff volume?

Uncertainty multiplies throughout these processes

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# A practical problem

"While (county) soil surveys may be useful in urbanized areas for general properties, it is likely that the soil beneath the surface is highly disturbed, mixed, and probably compacted. *I would hope that a design involving infiltration would not use native soil properties from soil surveys……"*

Taken from an NPS-INFO discussion started by RA McLaughlin, Professor/Extension Specialist, Soil Science Department, North Carolina State University)

# Why endure the impacts of poorly-sited GI?

- A study of rain garden performance in MN (Asleson et al. 2009, JAWRA) found that rain garden failure was attributed to:
  - Hydric soils
  - Compacted subsoils
  - Insufficient drainage
- These rain gardens could have been designed to succeed, or put elsewhere, but only **if** the actual field conditions had been accounted for, prior to installation

# How do we manage risk?

- **By making actual measurements in the field**!
- The nature and hydrology of urban soils is largely unknown, so we've set up an assessment protocol, and set up transects across parks, vacant lots
- Evaluate taxonomy, hydrology, fertility of soils:

i. <u>Soil taxonomy</u> – the way that the soil is layered and colored offers clues to characteristic wetness, drainage of soils (use Geoprobe to take cores)

ii. Make <u>field measurements of hydraulic conductivity</u> (surface and sub-surface)

iii. <u>Soil chemistry</u> – standard agronomic measures (N,P, K, C, pH, CEC, etc.)

# What does this data do for prospective GI implementation?

- Prevents installation of GI in an “impossible” area
- Quantifies the value of interaction between GI and the surrounding soils
- For areas where drainage is poor and space allows, this data provides a basis for experimenting with using native soils for infiltration, detention, and storage capacity
- Design drainage architecture that can be “throttled down” or partially closed off, an acceptable way to regulate the interaction between bioretention and the surrounding soils

# It’s all tied together

We apply this data to understanding how urban vacant areas, and their underlying soil ecosystem, can be used to:

See soils as natural resources that can be leveraged toward the provision of additional ecosystem services,

Manage urban stormwater volumes and possibly correct sewer malfunctions,

Visualize how vacant lots may be best reutilized

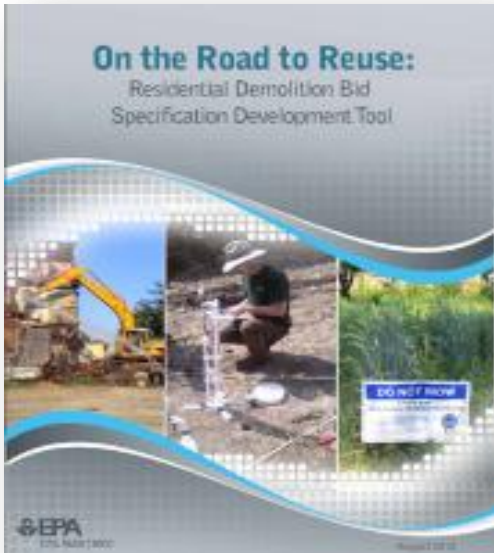
# Paying twice to get the parcel in shape for GI is not a sustainable process (!)

# Let’s use the demolition process as a first step toward GI

## On the Road to Reuse:

**Residential Demolition**

Bid Specification Development Tool




August 20, 2013:

**Detroit to receive $52.2M in Federal funds to demolish abandoned buildings**

# Passive GI

Urban soil surveys – hydrologic assessments are an opportunity to explore what sorts of services may be provided by passive GI in different soil orders (thus far: Cleveland, Cincinnati, Detroit, Omaha, Phoenix, New Orleans)

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# Detroit, 2013

- Over a two-week period in May-June 2013, we assessed Detroit MI soils in 26 vacant lots and 5 city parks (east-west)
- No soil surveys had ever been conducted in Wayne County MI
- We selected from a list of vacant sites provided by the Michigan Land Bank, and worked with the City of Detroit to gain access to five parks
- Took cores to 5m and assessed hydrology at surface, ~1.3m

# Some results – Detroit MI

- Refusal (an index of burid debris) ranged 27 - 45% within a given site
- Soil fill depth ~ 1.2m,
- $K_{unsat}$ (infil. Rate) ~1 cm $hr^{-1}$
- Drainage rate (subsurface $K_{sat}$) ranged between 2-15 cm $hr^{-1}$

***These conditions support…***

# Passive GI representation in Detroit vacant neighborhoods 1.

# Range of conditions in Detroit vacant lots 2.

# Range of conditions in Detroit vacant lots 3.

# Range of conditions in Detroit vacant lots 4.

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# Conclusions

- Use actual field data to manage risk in the planning, modeling, and design process preceding GI implementation
- Next steps: how does intentional and passive GI fit in to the local hydrologic cycle? Is there return flow, or are we actually pulling water out of the CSS?
- Monitor end product GI – no one design is perfect, no installation is right on “spec”, make sure it works, and use monitoring data to guide operation and modification

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# References


- Asleson, et al., Performance Assessment of Rain Gardens, J. Am. Water Resources Assoc., vol. 45, No. 4, 1019-1031
- Residential demolition and its impact on vacant lot hydrology: implications for the management of stormwater and sewer system overflows. 2014. **WD Shuster**, S Dadio, P Drohan, R Losco, and J Shaffer. Landscape and Urban Planning. http://dx.doi.org/10.1016/j.landurbplan.2014.02.003

# Thank you for your time

With thanks to the cities and citizens that we have worked with in the course of conducting these assessments

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