Strawperson Research Needs

Roundtable on Urban Ecohydrology Science and Practice
July 24, 2012

Introduction

- Participants provided answers to several discussion questions
  - existing knowledge, knowledge gaps, types of studies needed, facilities available for research, etc.
  - first in writing then a one hour conference call
- I compiled these results but this is NOT a consensus document
- It is a strawperson
  - Intended to start discussion

Existing Research: Water Quantity

- Understand how soil properties relate to runoff volume reduction, evapotranspiration in green roof and rain garden
- Sizing of infrastructure vs. catchment area
  - Amount of runoff reduction achieved
  - Extent of evapotranspiration
  - Importance of tree guards
  - We think we know how to size it but lots based on rules of thumb that may not be optimized and may depend on temperature, soil type, etc.
    - 6 inch rule of thumb for rain garden was a good guess but should not be etched in stone
- Burnsville, MN, 2 streets one with and one without
  - In aggregate it works
  - But which component contributed what? Could we do better?

Existing Research: Benefits

- Good understanding of the valuation of benefits
- BUT quantifying impacts on ecosystem services is still needed

Existing Research: Quality

- The Center for Watershed Protection research on the nutrient flux from leaves to receiving waters.
  - practices that capture leaf material (e.g., storm drain nets) are as cost effective in removing nutrients as upstream green infrastructure (e.g., Bioretention).
  - Tremendous nutrient fluxes from water and wastewater infrastructure (leaky pipes)
- Microbial ecology of processes is not well understood

State of Knowledge

- Moving beyond pilot studies toward implementation
- No textbook, but moving rapidly toward standardization
  - Gold standard approach, Need to think about tradeoffs, what is absolutely necessary
- Design manuals are beginning to appear but no consensus across cities
  - NYC has bioswale design manual
  - Philly has plant mix manual for bioswale
  - Seattle has procedure for design process
  - This may be fine as different cities have different goals
    - CSO cities vs. water quality cities
- Perhaps too rigid standards already
  - Uniformity for mass production and standardized performance estimates for regulatory compliance

Research Gaps: Performance

- Understanding of soil performance and plant performance
  - Engineered soils have potential as they are more consistent
  - But long term performance of engineered soil mixes is not clear
  - How site conditions affect performance?
    - Soil saturation, distribution of pervious and impervious, soil quality, microbial communities, age of installation, temperature, and rainfall patterns
- Are our performance estimates overly conservative?

Research Gaps: Plant performance

- Plant selection for improved performance
  - Good at picking plants, picking for survival
  - Are there plants that provide more benefits?
  - Grass will do more than tree for soil porosity but tree will give more leaf area
- Tree canopy should be given credit
  - Need research to quantify benefit
- Better understanding of evaporation
  - How well do standard hydrology algorithms work in engineered systems?

Gaps: Flow

- Using old antiquated peak flow measurements when we should monitor flow as a continuous variable
  - How will system perform under a series of storms?
  - Develop a risk-based approach to designing for multiple storm events

Gaps: Quality

- Nitrogen flux
- Microbial ecology of nutrient cycling

Gaps: Long term effectiveness

- How will infrastructure perform over time?
  - Compaction, nutrient dynamics
  - May diminish over time, loss of organic matter
- How will climate change affect performance?
- What maintenance is needed? What designs need less maintenance to maintain performance?

Gaps: Social Science

- Will people like them?
  - “Weedy”?
- What incentives are needed to foster adoption by homeowners?
- How will people treat them?
  - Mow them over?

Gaps: Climate Change

- What is resilience of plants used with green infrastructure under climate change scenarios?

Gaps: System Dynamics

- Important interactions may exist but are not well studied
- Habitat, role in promoting urban biodiversity
- We did not discuss this in detailed but noted it as an issue for future discussions

Gaps: Hydraulics

- How to design so that they capture as much water as possible?
  - We have designs but are they optimal?
- Can technologies be used with fractured bedrock?
- Impact on groundwater
- “Plant hydrology” and impacts on system
- Soil porosity over time
- Sediment behavior in these systems

Types of studies needed: Observational

- Monitor first generation and try to back out which design configurations are successful in which contexts
  - Improve next generation of designs
  - Need to build first generation with monitoring built into design
  - Compare “design details”
    - Inlets, soils, etc. over time

Types of studies: Watershed scale

- Sewer flow before and after, with and without intervention
  - Like Burnsville, MN street study?
- Nutrient budgets
- Long term

Types of Studies: Small scale

- Instrumented street
  - learn more about unit processes, how much does a tree remove,
  - Reductionist, small sites to allow for intensive monitoring, understand components, keep whole thing on a small and manageable scale
  - Observe green roofs in combination with bioswales
  - Sensors, smart fields, nursuries, nutrients and water management
- Better to study small in some cases due to logistical challenges of large sites

Types of studies: Trial plots

- Understand performance of different plants in context of green infrastructure
- Current fundamental knowledge provides educated guesses but we need lots of trial plots, to gain knowledge in context
- Need to dig them up to learn?

Decisions that could benefit from information?

- Design details
  - Inlets
    - What clogging may occur and how to avoid it
  - How to design to minimize maintenance
  - Plant and soil choices
- What is the cost effectiveness using triple bottom line accounting?
  - BUT benefits are considered well researched
- Improve risk management, avoid overly restrictive regulatory practices due to risk aversion,
  - Restriction in where they can be located and what you can do may not be justified
    - “Need to make sure we are protected against back to back hurricanes”

Sites available for performance studies

- Pilot project happening everywhere
  - EPA Edison, NJ and test beds across country
  - NYC, Philly, Syracuse,
- Drexel is monitoring 15ish sites
  - A few more on the way
- Villanova sites can serve as test bed
  - 15 rain gardens on campus, porous pavement, green roof, infiltration trench
  - instrumented with rain gages, flow measurement, some soil moisture monitors, flow and water quality
  - Stormwater wetland

Data sharing and collaboration

- Among researchers
  - Need to equitably share credit, protect students' intellectual contributions
- Researchers and practitioners
  - Researchers will want time, controls, monitoring, etc.
  - Cities may have varying levels of comfort with sharing performance data
- Takes a lot of work to share data
  - Need to get data on a common basis, QA/QC issues
  - But can be done!