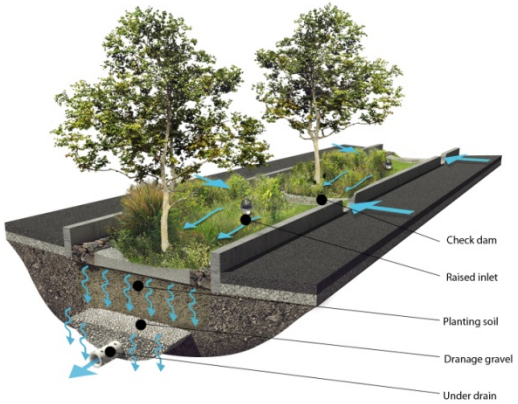
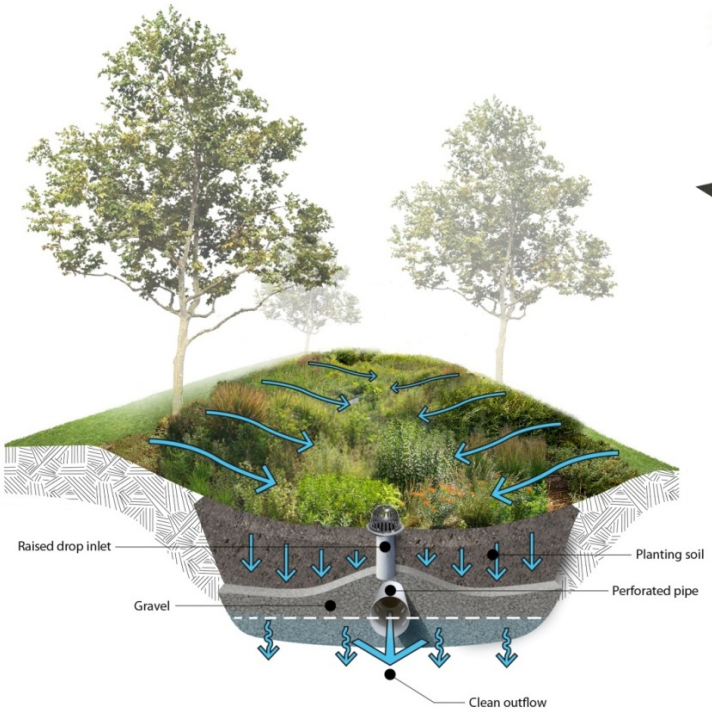
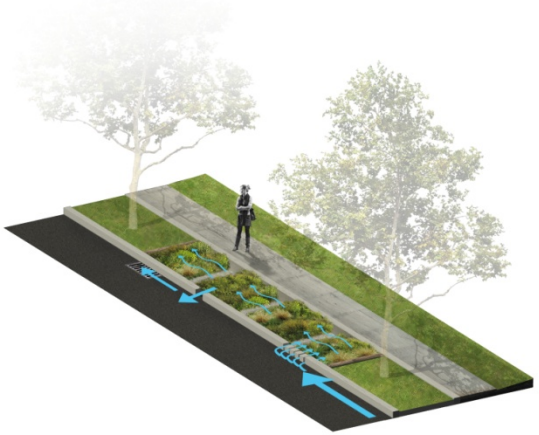
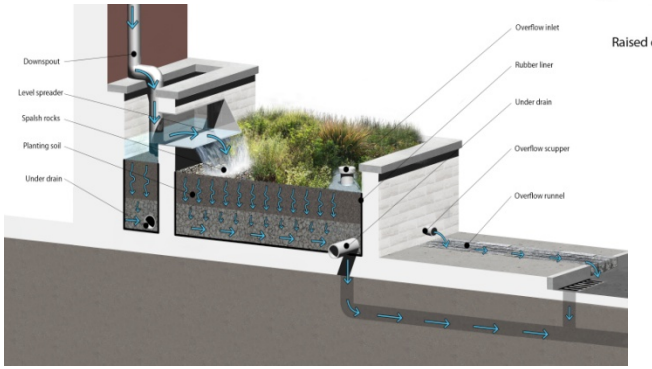
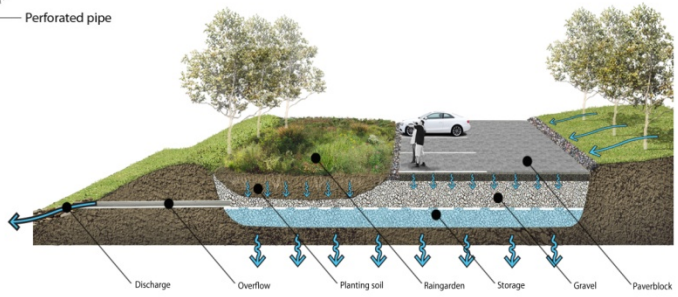
CENTER FOR GREEN INFRASTUCTURE AND STORMWATER MANAGEMENT











CENTER FOR GREEN INFRASTUCTURE AND STORMWATER MANAGEMENT

Barriers to Adoption of Green Infrastructural Solutions

Lead Investigator: Dr. Barbara Gray
Team Members – Dr. Stuart Echols, Mr. Matt Royer, Professor Brian Orland, Dr. Richard Ready

Project Objectives

To understand the cognitive and institutional barriers that currently prevent the adoption of innovative green infrastructure solutions for stormwater management, and to identify ways in which those barriers can be overcome, research will focus on institutional stakeholders in three Pennsylvania counties with high urban loadings of pollutants and high vulnerability to future urban land conversion in the Pennsylvania portion of the Chesapeake Watershed.

Barriers to Adoption of Green Infrastructural Solutions

Lead Investigator: Dr. Barbara Gray

Cognitive Barriers or Frames

Frames shape how we view an issue of problem.

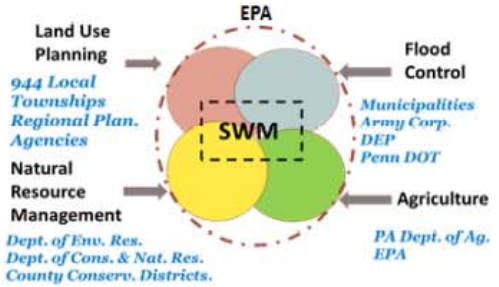
People use frames to define a problem what to do about it

Frames reflect deep-seated values and justify actions

Stakeholders Frame Storm Water Management As:

Institutional Barriers

- **Institutional barriers:** Impediments to change that result from laws, institutional rules, cultural practices & resource allocations
- **Conflicting regulatory objectives & priorities among regulatory agencies**



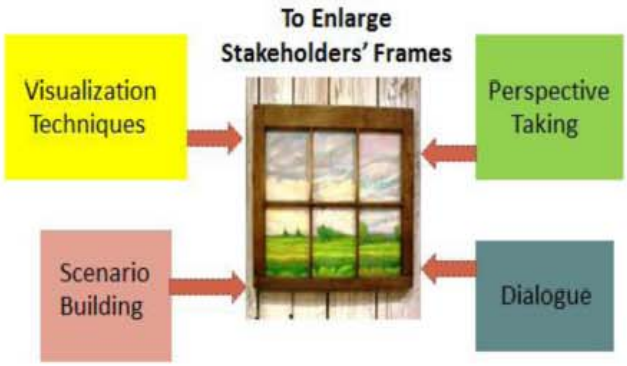
Institutional Barriers

- **Institutional barriers =** Impediments to change that result from laws, institutional rules, cultural practices & resource allocations
- **Too many townships (944)**
- **Conflicting regulatory objectives & priorities among agencies**
  - Conflicts with existing local ordinances
  - Difficulties getting BMPs approved
  - Responsibility for future maintenance is ambiguous
- **Differing views on regulatory effectiveness**
  - Regs OK, but not enforced
  - Regs are too lenient
  - Agriculture and landscapers are difficult to regulate
- **Practical problems with implementing regs**
  - Guidance for MS4 permitting is missing
  - Unfunded mandates

Technical Barriers to Using GI

- **Technical nature** of SWM makes it difficult to plan for (e.g., changes in plantings)
- Very **contrived system—not** typical of natural world
- **Requires retrofit** to provide detention, conveyance and infiltration in built areas
- Future **maintenance** is problematic
- **Users** are **not knowledgeable** about maintenance & fear liability

Project's Future Educational Efforts



CENTER FOR GREEN INFRASTUCTURE AND STORMWATER MANAGEMENT

Green Infrastructure Design and Visualization

Lead Investigator: Brian Orland

Team Members – Dr. Stuart Echols, Dr. Richard Ready, Dr. James Shortle, Abhinandan Bera, Yau-Huo Shr

Project Objectives

Investigate two tightly-coupled roles for human perception in decision-making regarding stormwater management. First, the role of computer-delivered information, visual and verbal, in motivating the adoption of stormwater management practices. Second, the role of visualization as a component of choice models and other survey-based means of eliciting values for the non-commodity attributes of stormwater practices—the contribution of design to aesthetics and sense of place

This research is funded by U.S. EPA - Science To Achieve Results (STAR) Program
Grant # R835142

Green Infrastructure Design and Visualization

Lead Investigator: Brian Orland

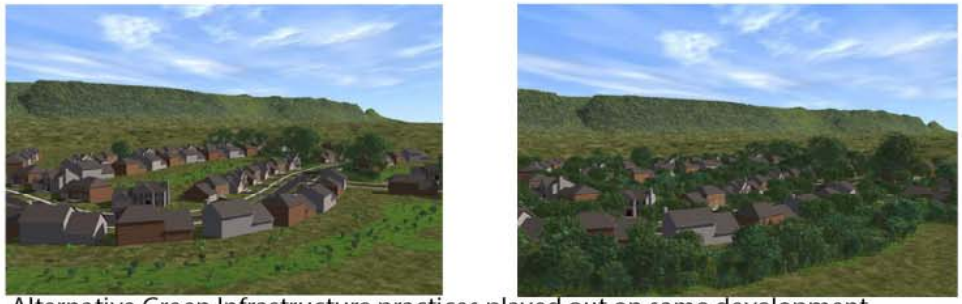
Potential aids to Green Infrastructure adoption include:

+ That green infrastructure might improve upon present conditions, and
+ That effective green infrastructure can be formal or naturalistic, more or less biodiverse

People might be better motivated if they could see what the future might hold

+ To weigh the potential positive and negative effects of change, and
+ To ensure all interests are addressed fairly

People are better motivated if they knew what the future might hold



Alternative Green Infrastructure practices played out on same development

We lean on our visual senses to understand our world:

+ We use our vision extensively to "see" and evaluate the existing situation
+ We project "in our mind's eye" where and how change might occur
+ We "envision"—the possible good and bad outcomes of change
+ We show expected changes—so stakeholders see the same "vision"
+ We watch carefully—to "see" that changes happen as promised

Visualizations can represent:

+ Visual amenity values
+ Intermittent stream flow
+ Short-term standing water
+ Alternate best practices
+ Cultural values
+ Ecosystem services
+ Biodiversity
+ Alternate design strategies

Structures vs. naturalistic plantings

Management vs. biodiversity

CENTER FOR GREEN INFRASTUCTURE AND STORMWATER MANAGEMENT

Hydrologic Water Quality Modeling and Practitioners Survey

Lead Investigators: Dr. Chris Duffy, Dr. Shirley Clark
Team Members – Dr. Stuart Echols, Dr. James Shortle, Dr. Richard Ready, L. Shu Grad Student

Project Objectives

Create a high resolution, spatially explicit watershed model to test the relative performance of local green infrastructure practices at a both large and small scales using future climate-landuse-landcover scenarios for the impact and efficiency of green infrastructure on the overall watershed.

Improve the understand the professionsl design and technical barriers to implement green infrastructure and provide tools to decision-makers to help designers uvercome these barriers.

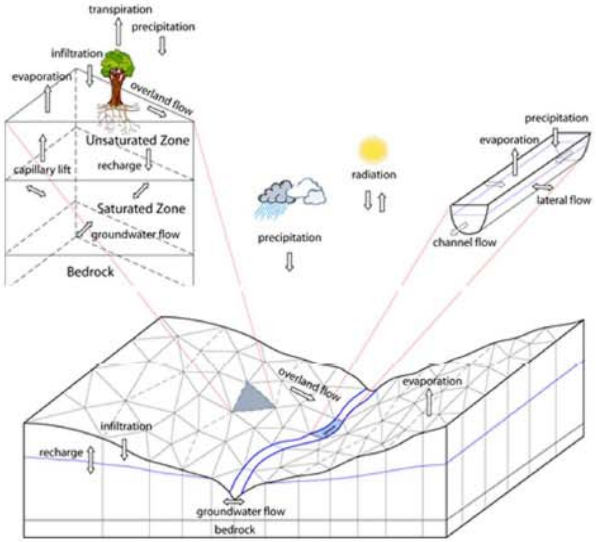
Hydrologic Water Quality Modeling and Practitioners Survey

Lead Investigators: Dr. Chris Duffy, Dr. Shirley Clark

A Multi-Scale Modeling Strategy for Water Resources In the Urban-Suburban Watershed

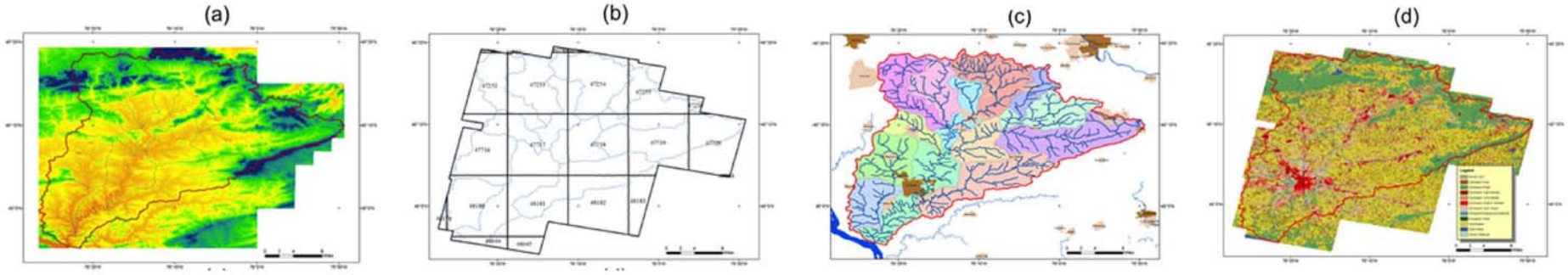
PIHM: The Penn State Integrated Hydrologic Model

Implement physically-based, multi-scale model for water, solute and energy budgets in complex lanscapes
Provide reliable water, solute, sediment, and energy budgets
Estimate recharge, soil moisture change, infiltration, and direct runoff for climate and landuse patterns
Evaluate the impact of green infrastructure on urban watersheds
Assess impact of soil compaction
Provide a scientific basis for the next generation of predictive tools for water resource managers



Date Tools

GIS - Geographic Information System
TIN - Domain Decomposition: Triangular Irregular Net
FVM - Finite Volume Method
PDE - Partial Differential Equations
ODE - Ordinary Differential Equations
PDAE - Differential-Algebraic Equations



The data resources are derived from our new watershed data service, HydroTerre (www.hydroterre.psu.edu). The service hosts on-demand geospatial data for soils (SSURGO, USDA), geology (PASDA), landuse-land-cover (NLCD), climate (NLDAS-2, NOAA), terrain model (USGS, NED).

CENTER FOR GREEN INFRASTUCTURE AND STORMWATER MANAGEMENT

Non-hydrological Benefits and Citizen Preference

Lead Investigator: Dr. Richard Ready

Team Members – Dr. Stuart Echols, Professor Brian Orland, Dr. Barbara Gray, Dr. Stuart Echols, Dr. James Shortle, Dr. Chris Duffy

Project Objectives

Measure residents' attitudes toward and preferences over nonhydrological aspects of green stormwater management, including the various ways that stormwater managment can affect the built and natural landscape, and to measure residents' willingness to pay for changes in attributes of the landscape that can be affected by green stormwater management approaches.

Non-hydrological Benefits and Citizen Preference

Lead Investigator: Dr. Richard Ready

Suppose that you were considering moving to a new home in a new neighborhood. Perhaps you are changing jobs, or you simply want a different place to live. Other than the home itself and how much it costs, what would be the most important things you would think about when choosing a new neighborhood? Please check one circle for each row.

	Not at all Important	Somewhat Unimportant	Neither Important nor Unimportant	Somewhat Important	Extremely Important
Close to places to shop	○	○	○	○	○
Restaurants nearby	○	○	○	○	○
Close to work or school	○	○	○	○	○
Good schools	○	○	○	○	○
Low crime, safe	○	○	○	○	○
Playgrounds, ballfields, tennis courts, etc	○	○	○	○	○
Natural areas	○	○	○	○	○

BACK Continue

0% 100%

If you had a choice between these two neighborhoods, which neighborhood would you prefer to live in?
Click on the box under the neighborhood you prefer.

Neighborhood A

Diversity in Species	Medium
Standing Water	Always
Percentage of Green Space Mowed	30%
Annual Homeowner Association Fee	$50

Please select the circle below if you prefer this neighborhood ○

Neighborhood B

Diversity in Species	Low
Standing Water	Never
Percentage of Green Space Mowed	100%
Annual Homeowner Association Fee	$100

Please select the circle below if you prefer this neighborhood ○

BACK Continue

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If you had a choice between these two neighborhoods, which neighborhood would you prefer to live in?
Click on the circle under the neighborhood you prefer.

Neighborhood A ○

Neighborhood B ○

Now suppose you have identified two possible neighborhoods that look like the one you just chose. On each of the following pages, you will see pictures of two neighborhoods, and you will be asked which neighborhood you would rather live in.

These neighborhoods are similar in terms of how close they are to your work, how close they are to shopping and restaurants, the quality of the schools, and every other thing that you care about. The only difference between the neighborhoods is how the green space in the neighborhood is designed. Also, each neighborhood has a neighborhood association that maintains the green space. If you live in the neighborhood, you have to pay an annual fee to the neighborhood association. If you rent your home, the neighborhood association is included in your rent, so a higher fee means a higher rent.

Below is the overhead view of the neighborhoods you just chose with highlighted green space, so that you can see where the green space is located relative to the houses.

BACK Continue

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Example screen shots of on-line computer-based choice model survey instrument for targeted community groups

CENTER FOR GREEN INFRASTUCTURE AND STORMWATER MANAGEMENT

Public Engagement and Outreach

Lead Investigator: Matt Royer
Team Members – Dr. Stuart Echols, Dr. Barbara Gray

Project Objectives

- Ensure research involves decision makers and communities within the target region.
- Develop expert inpit within the target region in an advisory capacity to ensure regional relevance of project.
- Work with public to frame issues, barriers, and potential solutions, disseminate outcomes and research results, to help decision makers achieve better implementation of green infrastructure in Pennsylvania.
- Achieve broad external engagement and outreach of research results and project outcomes to a wider citizen audience through the Center's website.

Public Engagement and Outreach

Lead Investigator: Matt Royer

The **Community Partners Council** is the stakeholder advisory committee for the Center. Members represent a diversity of stormwater decision makers and stakeholders within the target region. The CPC provides advice and guidance ensuring that research is transferable and relevant to decision makers.

John Bingham East Hempfield Township (Lancaster Co.)
Matt Bonanno, P.E. HRG, Inc.
Andrew Gavin Susquehanna River Basin Commission
Michael LaSala LandStudies, Inc.
Steve Letavic Londonderry Township (Dauphin Co.)
Fritz Schroeder Lancaster County Conservancy
Shiela Warluft North Lebanon Township (Lebanon Co.)

The **Science Advisory Committee** is a group of professionals that guide the center on programmatic matters and priorities for research, integration, outreach, and engagement. They also evaluate the merits of project activities to ensure that the program stays true to its mission, to capitalize on recent scientific advances, and is responsive to the needs of key stakeholders.

Harry Campbell, Chesapeake Bay Foundation
Ken Murin, PA DEP
Michelle Adams, Meliora Design
Kelly Gutshall, LandStudies, Inc.
Paul Leisnham, Ph.D., University of Maryland

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