



# Green Infrastructure and Stormwater Utility Credit Design *for Sustainability*

Olivia Odom Green, Ruben Kertesz,  
Lewis Rossman, William Shuster

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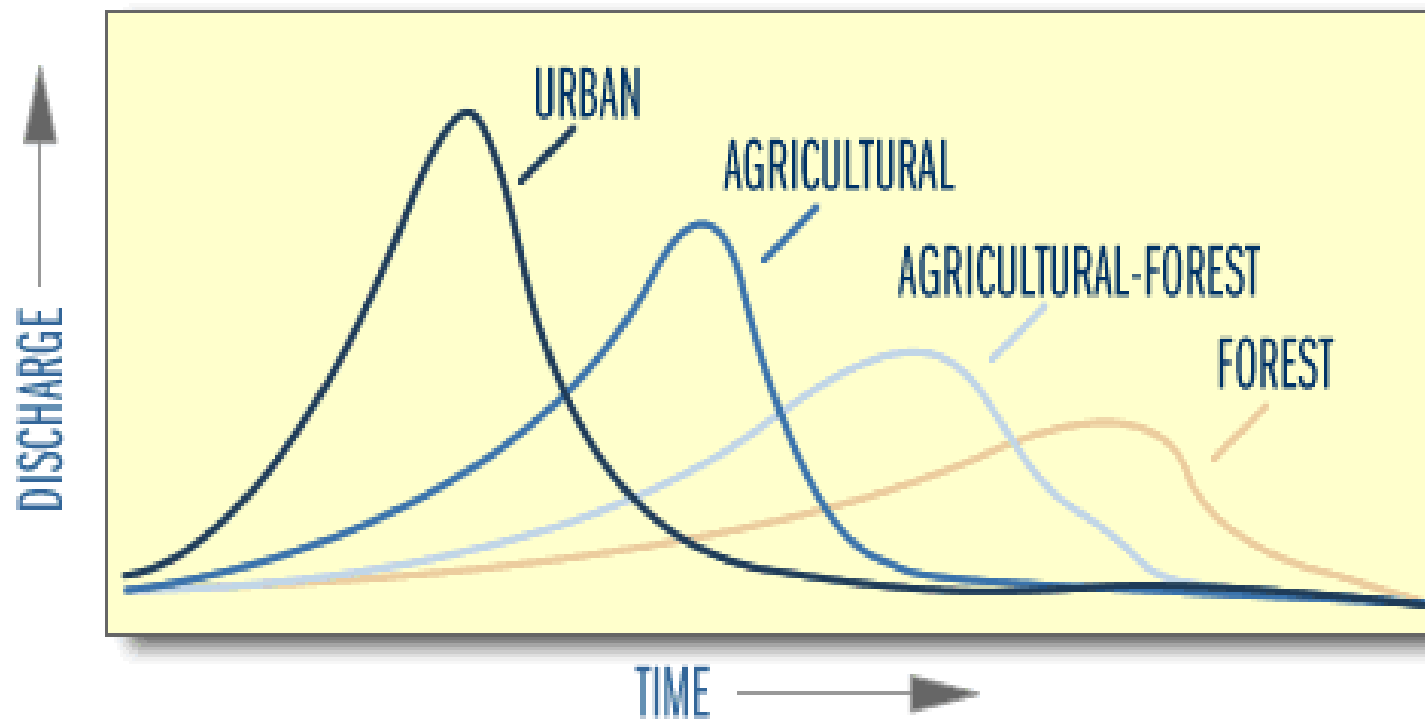


# Presentation Outline

- Urban Stormwater
- Stormwater Utilities
  - Policy trends, jurisprudence
- Credit programs
  - Citizen stormwater management
  - Economic, social, hydrologic components
- General findings and next steps

# Urban Stormwater: “Urban Slobber”

## STORMWATER DISCHARGES FROM VARIOUS LAND COVERS



Credit: Water on the Web

Urban stream syndrome: flashy hydrographs, increased contaminant loads, altered morphology, etc.

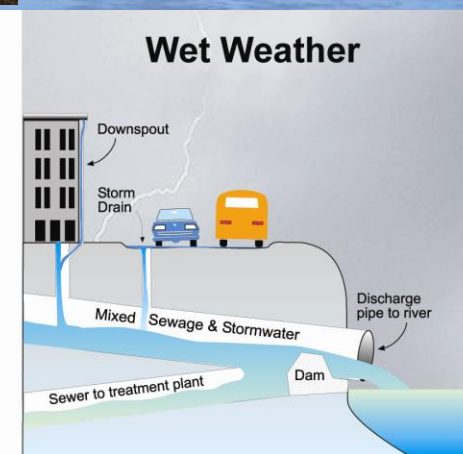
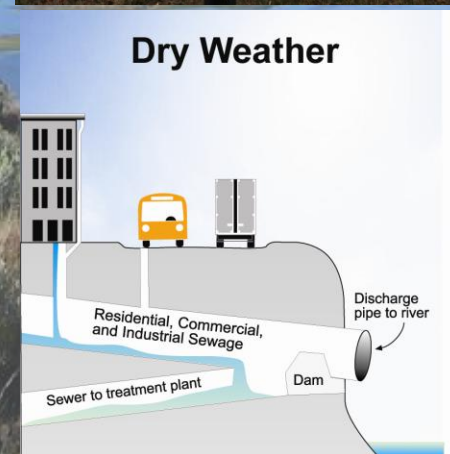


# Urban Stormwater Infrastructure: Capture and Convey Disconnects SW from H<sub>2</sub>O cycle

Municipal  
Separate Storm  
Sewer Systems  
(MS<sub>4</sub>)



Combined  
Storm Sewer  
Systems





# Urban Stormwater Management: Regulatory Pressure

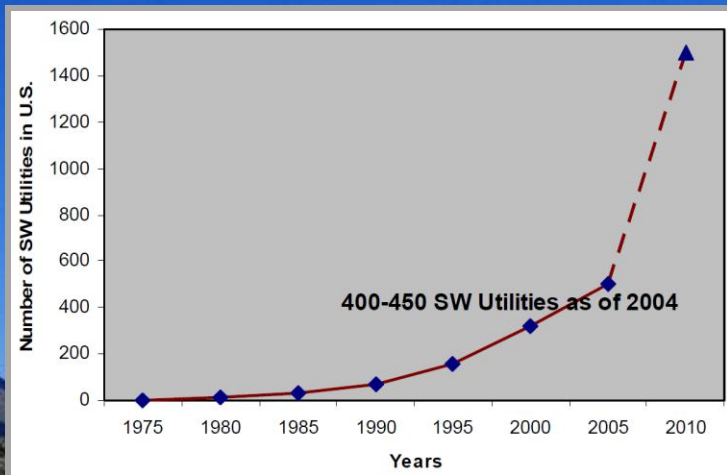


- NPDES- Phase I & II MS<sub>4</sub>- control pollution to maximum extent practicable
  - 6 minimum control measures
- CSOs- Consent decrees, long term control plans
- Age of infrastructure

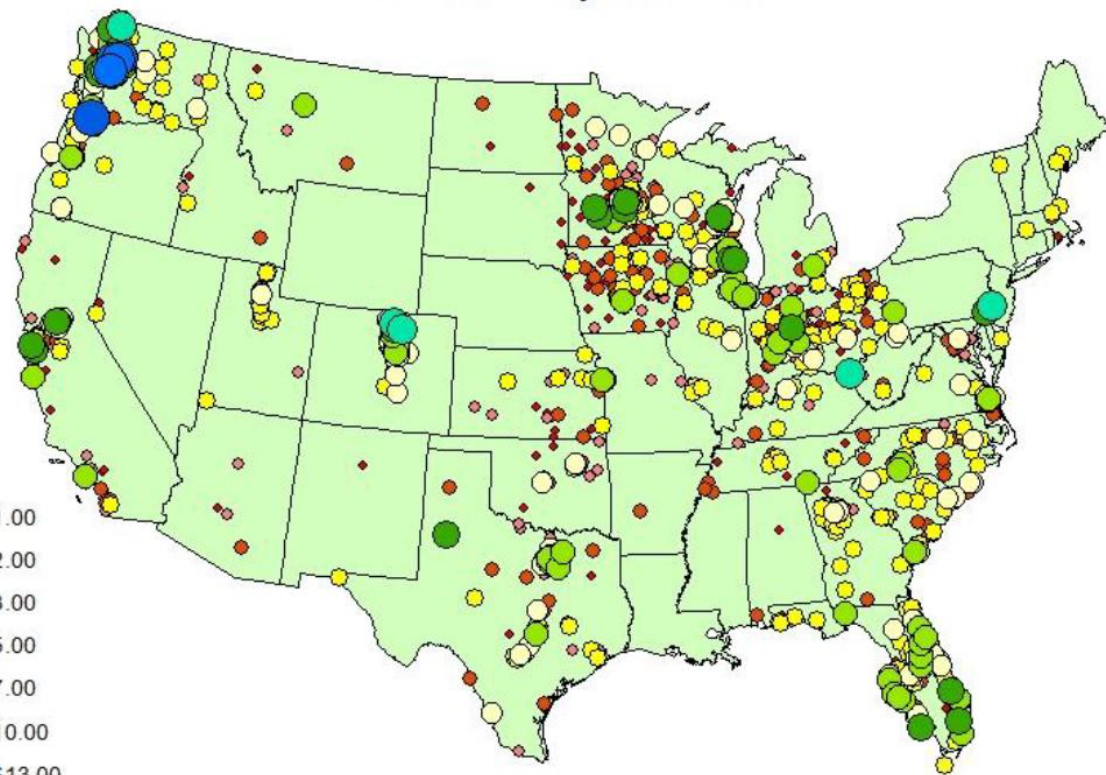


# Stormwater Utilities:

## a stable, dedicated funding source



Stormwater Utility Fees 2012



Western Kentucky University Stormwater Utility Survey 2012

New England Environmental Finance Center 2005

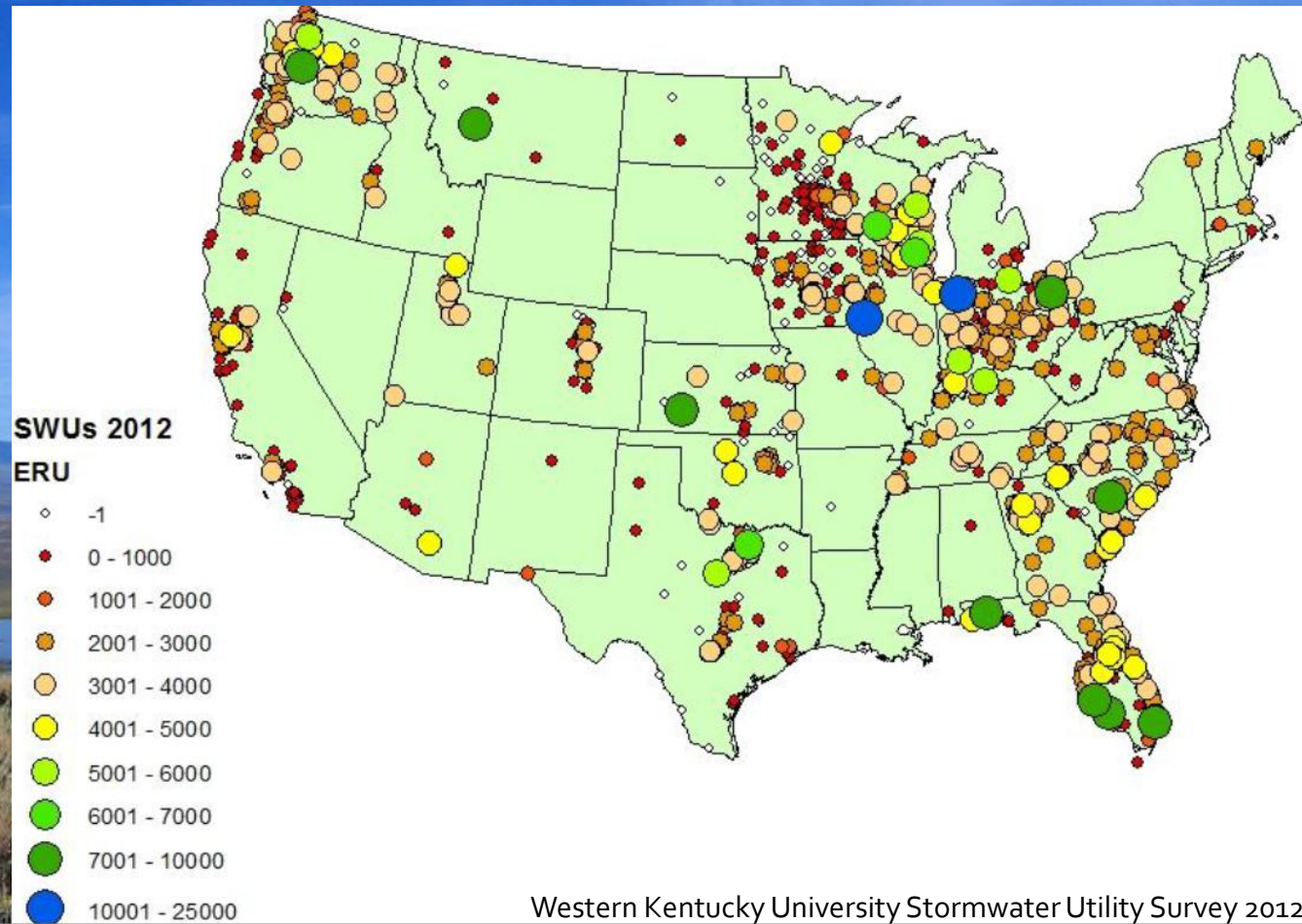
- Fee charged per IA
- ~1300 identified
- Avg SFR fee= \$4.20/mnth
- Median= \$3.65
- St. Deviation= \$2.60
- No correlation to politics, affluence, tax burden
- Product of state law (NB, MD, CA, AL)



# Equivalent Residential Unit Model

## average IA of SFR

- average ERU: 2970 sq ft
- std dev: 1512 sq ft
- Footprints (not total sq ft), architectural trends
- Roofs only, in some cases
  - Administratively burdensome
- SFRs: pay 1 ERU, tiered, actual
  - Resources for groundtruthing
- nSFRs: pay # ERU, actual



Western Kentucky University Stormwater Utility Survey 2012

- If ERU is inaccurate, fees are not proportional
  - If  $ERU > \text{actual av SFR IA}$ , then nSFR pay lower proportion of SW revenues and SFR pay more



# SW Utility Fee: Economics and Social Justice

## Stable, dedicated funding source

- Separate enterprise fund
  - SW revenues fund SW projects
  - Not general fund
    - Competing needs, variable revenue
- Pigouvian tax
- Equitable, non ad valorem
  - Charged based on your contribution to problem
- No exemptions
  - including federal properties
    - CWA § 313 (2011 amendment)



# SW Utility Jurisprudence

## Constitutional Authority: Fee v Tax

- Authority to charge fees that:
  - bear substantial relationship to cost of providing specific service
    - e.g., revenues ~ SW expenditures
  - are apportioned reasonably
    - e.g., ERU accurately reflects impervious area
  - provide ability to reduce fee
    - e.g., reducing IA, onsite treatment
  - are not subject to liens for failure to pay



- Most challenges upheld utility as “fee” (38/67); some overturned (14/67);
  - but see *DeKalb County, GA, v. United States* (Jan 28, 2013 , Fed. Cl.)
    - retroactive charges at issue, not “fee v tax”
    - on appeal, County asking for narrow ruling (DC Cir) CWA §313
- Some repealed (4) – Colorado Springs, Birmingham, Nampa (ID), Cumberland Co (NC)
  - Maryland counties- Anne Arundel mayoral veto, Harford 90% discount, Fredrick 1¢



# Stormwater Utility Credits

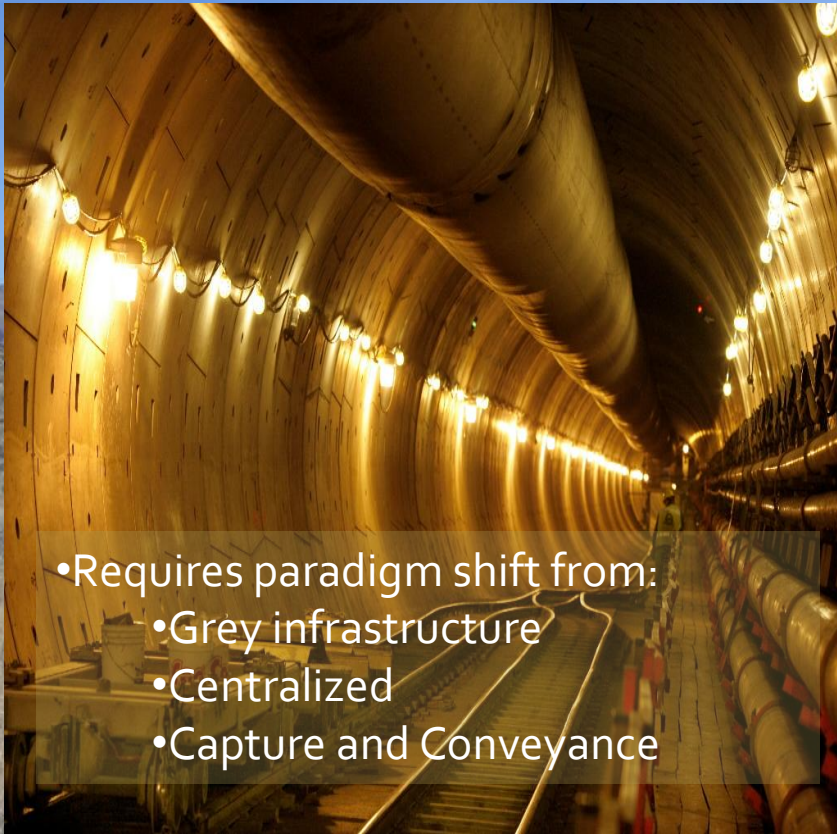
- Discount for reducing runoff
  - *Curb opposition- solution to problem*
  - *Ability to reduce fee may be factor in state law*
- Single family residences & rain gardens
- Efficacy & Sustainability:
  - Economy
    - Financial incentives
    - Municipal finance
  - Community
    - Outreach & Accessibility
  - Environment
    - Hydrology





# Single Family Residences: GI Requires Decentralized Approach

## Physical Capital: Capture & Convey



- Requires paradigm shift from:
  - Grey infrastructure
  - Centralized
  - Capture and Conveyance

Credit: Motoya Nakamura/The Oregonian

## Natural Capital: Decentralized, in situ treatment



- Reconnect SW to Hydro Cycle
- Decentralized
- Access to private property
  - Especially SFR, no regulatory mechanism otherwise
- Citizen SW Management



# Economics of GI on Private Property:

## Minimal Financial Incentives Necessary

### Shepherd Creek Watershed (Cincinnati)

	2007	2008	Total
Rain gardens			
Number of bids	57	37	94
Minimum bid	\$0.00	\$0.00	\$0.00
Maximum bid	\$500.00	\$1,000.00	\$1,000.00
Mean bid	\$58.16	\$88.54	\$70.12
Mean bid excluding max	\$50.27	\$63.22	\$60.12
Number of \$0 bids	30	16	46
Percent \$0 bids	52.6	43.2	48.9
Rain barrels			
Number of bids	63	45	106
Average number of barrels per bid	1.9	1.7	1.8
Minimum bid (per barrel)	\$0.00	\$0.00	\$0.00
Maximum bid (per barrel)	\$500.00	\$250.00	\$500.00
Mean bid (per barrel)	\$32.06	\$44.30	\$36.44
Mean bid excluding max (per barrel)	\$24.51	\$34.74	\$32.03
Number of \$0 bids	38	20	58
Percent \$0 bids	60.3	44.4	54.7

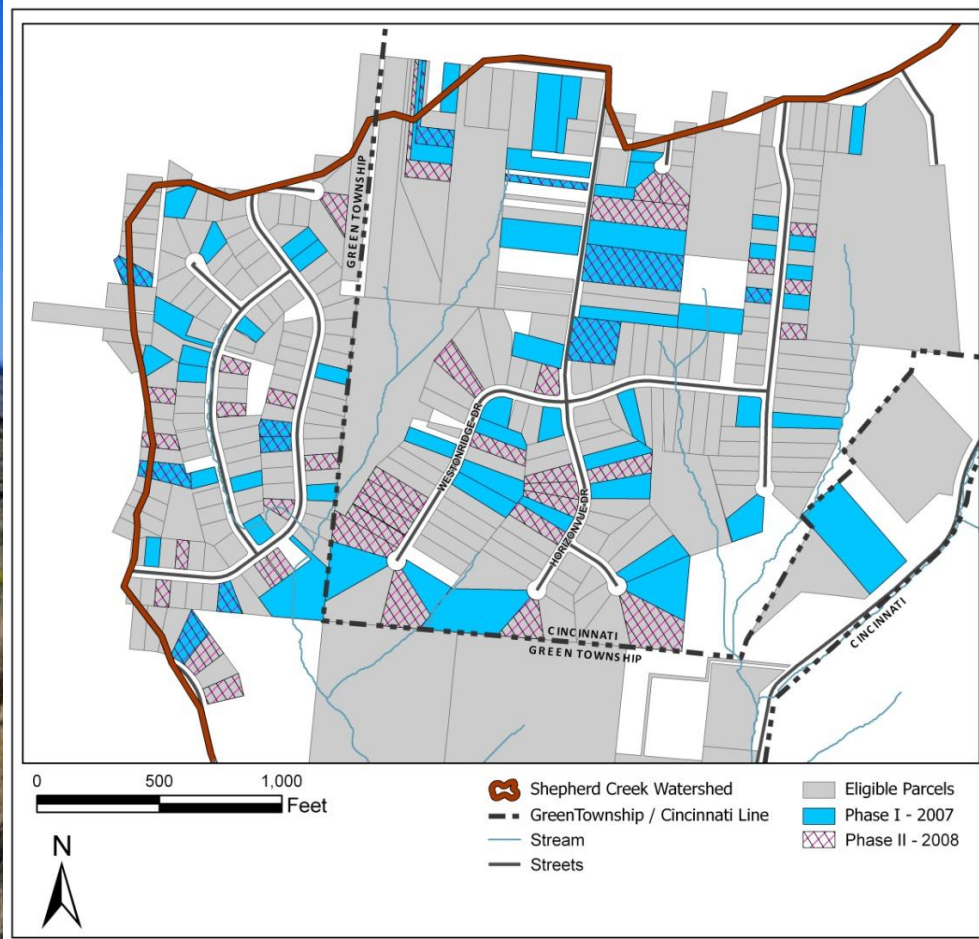
Roughly half of residents required \$0 to turn a portion of their private property into a public good.

• More similar to discount + rebate model

Thurston, H. W., et al. (2010). "Using a reverse auction to promote household level stormwater control." *Environmental Science & Policy* 13(5): 405-414.



# Social Capital of GI on Private Property: Social Networks and Contagion Shepherd Creek Watershed (Cincinnati)



Hesitant, reluctant neighbors enrolled in 2<sup>nd</sup> year

- Perhaps after witnessing neighbors' positive experience

- Social network
- Social contagion

- Intangibles- culture of residential SW management
- Cultural capital



# Stormwater Utility Credits

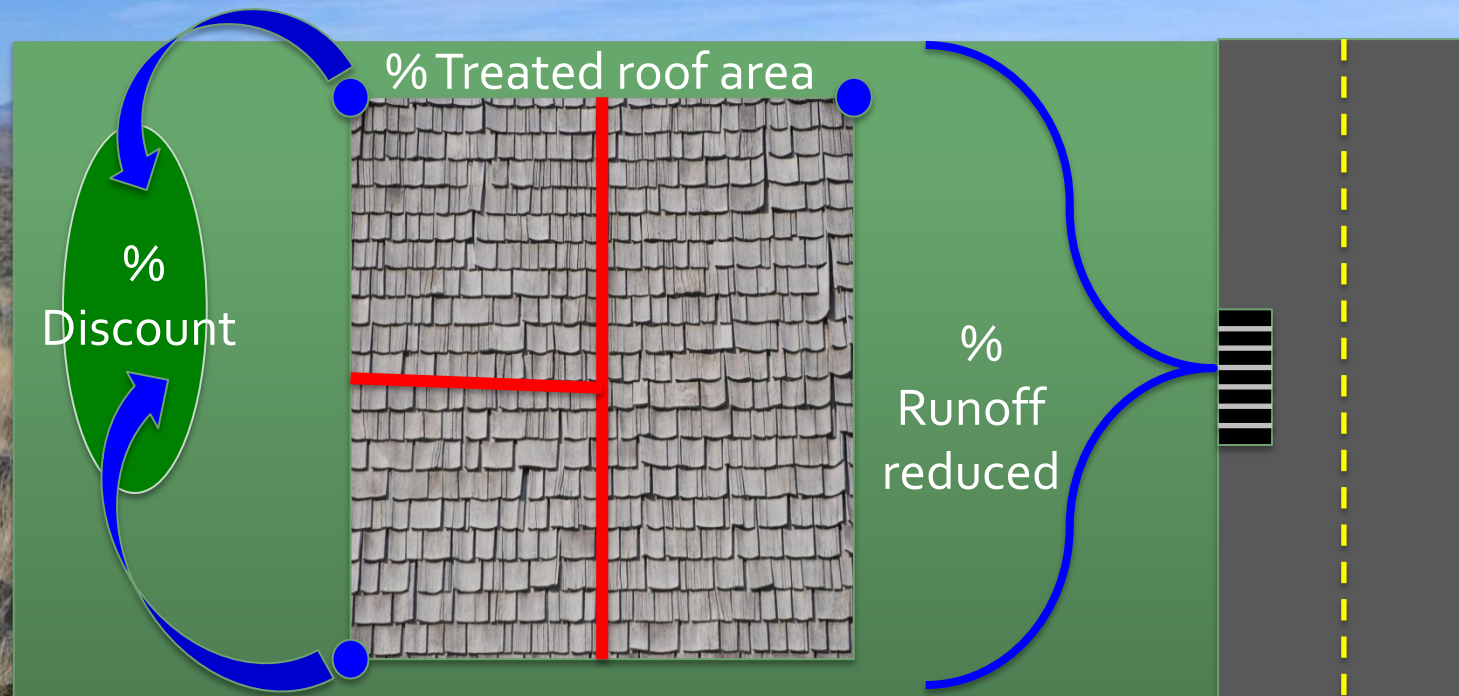
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  - Environment
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# Hydrologic Research Question

- Treating % of impervious area, results in % discount and % runoff reduction
  - Treated IA and Discount % are products of administrative rules
  - % Runoff reduced is modeled

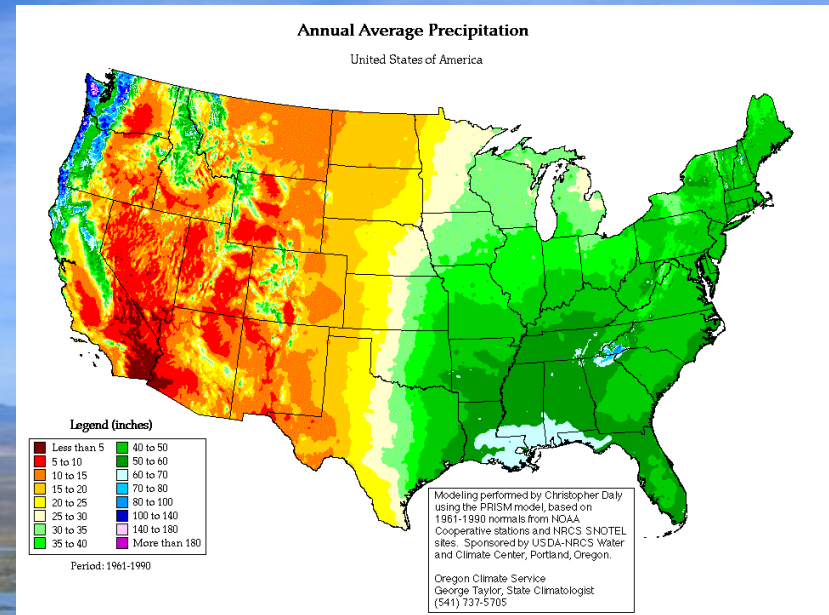




# Hydrologic Efficacy: Rationale for study design

- Regional Conditions

- Soil
  - Conductivity
  - Type
- Precipitation



- Site-specific Conditions

- Slope
- Soil
- Pervious area: Impervious area



# Method

- Identify programs
  - Bioretention (raingardens) for single family residences
- Model runoff pre vs post-treatment
  - Follow instructions for designing/installing raingarden
  - Vary site conditions
  - Compare reduction in annual runoff between all factors
- Compare reduction in runoff to financial discount



# EPA Stormwater Calculator: pretreatment

Overview

Location

Soil Group

Conductivity

Slope

Rainfall

Evaporation

Land Cover

LID Controls

Runoff Results

Land Cover Distribution:

% Forest

0

% Meadow

0

% Lawn

33

% Desert

0

% Impervious

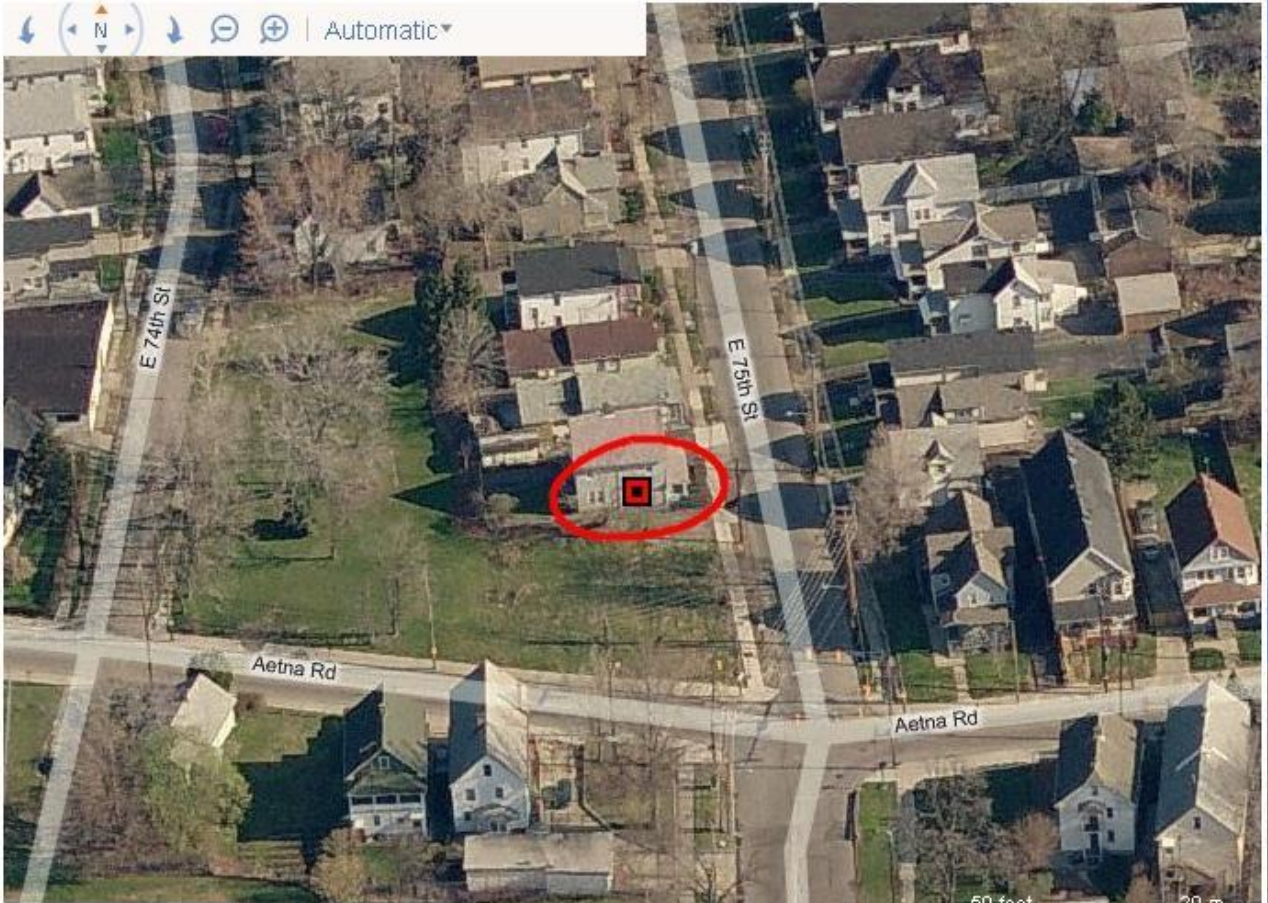
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Land cover affects the amount of rainfall captured on vegetation or in natural depressions and determines surface roughness.

Enter the percentage of the site's area covered by each type of pervious surface. The remaining area is considered to be impervious (roofs, sidewalks, streets, parking lots, etc.).

N

Automatic



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# EPA Stormwater Calculator: treatment

Overview

Location

Soil Group

Conductivity

Slope

Rainfall

Evaporation

Land Cover

LID Controls

Runoff Results

% of Impervious Area Treated By:

Disconnection

0

Rain Harvesting

0

Rain Gardens

50

Green Roofs

0

Street Planters

0

Infiltration Basins

0

Porous Pavement

0

LID controls are landscaping practices designed to retain stormwater on site.

Enter the percent of the site's impervious area treated by a listed LID practice.

Click a practice to learn more about it or to change its design parameters.

Design Storm Depth (in)

0.00

4th

bing

E 74th St

E 75th St

Aetna Rd

Aetna Rd

50 feet

20 m

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# Adjusted Parameters

Utility	Slope %	Garden Depth (in.)	Soil*	Conductivity* (in/hr)	% Roof Treated	% Impervious Area
Portland	5, 10	6, 12	a, c	2, 0.25	66, 100	33, 66
Cleveland (NEORSD)	4, 6, 10	f(slope)	sand (a), silt (c), clay (d)	1.4, 0.57, 0.06	25, 100	25, 50, 75
Ft. Myers	2, 5	6, 12	a, b	5, 1.5	10, 100	33, 66

- Soil conductivity is related to soil type by USDA NRCS National Engineering Handbook: Part 630 Hydrology
  - except for Portland, where 2 in/hr is minimum infiltration rate for credit.
  - Ft Myers shows higher required infiltration rate for each soil type due to proximity of water table to the ground surface:



# Portland, Oregon

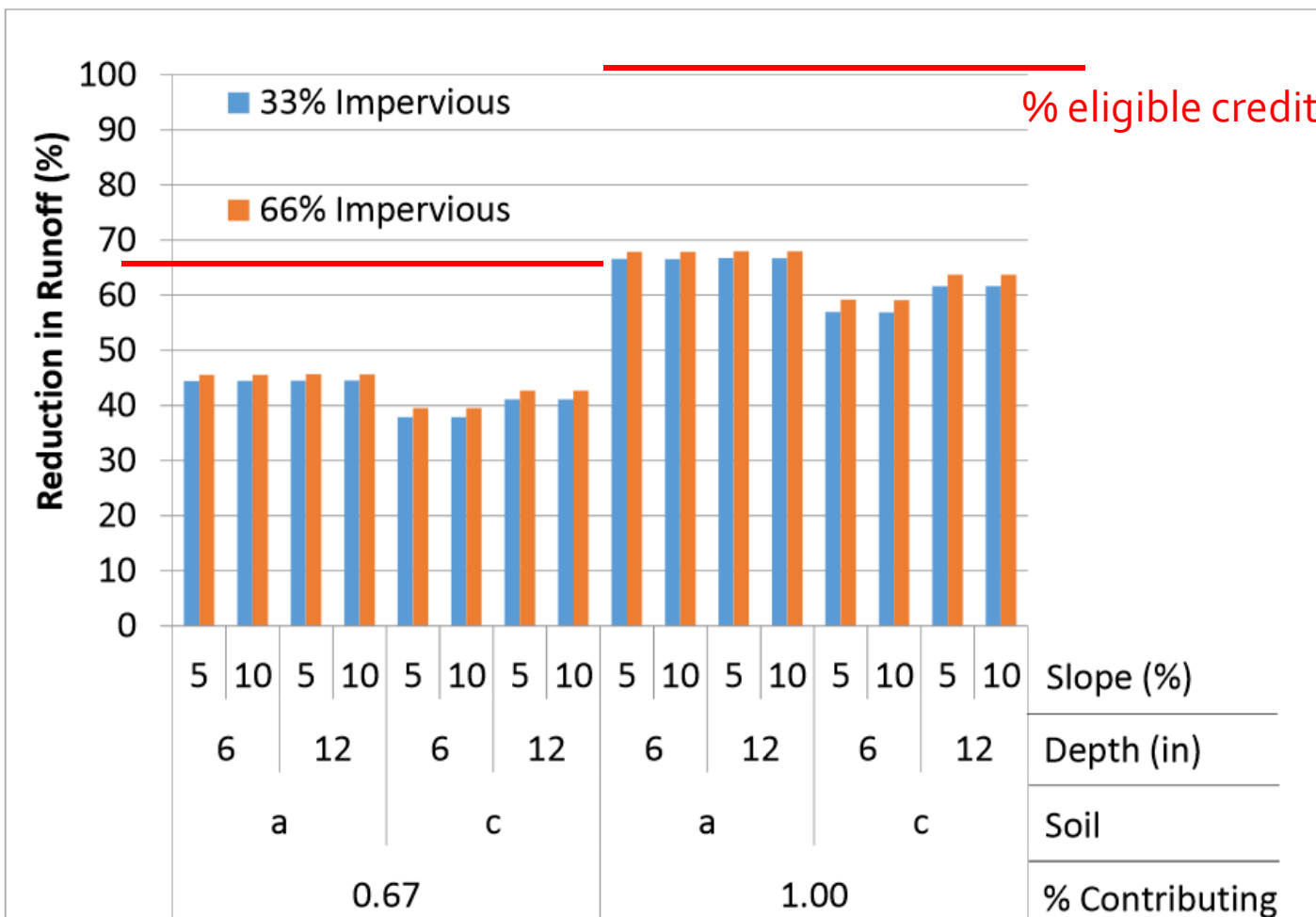


- Max eligible credit:
  - 100% Onsite fee for full treatment of roof
  - 67% Onsite fee for “partial treatment”
- Hydrology:
  - “How to manage stormwater: Rain Gardens”
  - Specifies area equal to 9% of treated IA
- Social:
  - High accessibility- workshops, fee maps, manual
  - Though steep areas not eligible
- Economics:
  - High rate (\$22.37/month)=moderate discount incentive (\$7.83)



# Portland

## Hydrologic and Economic Results





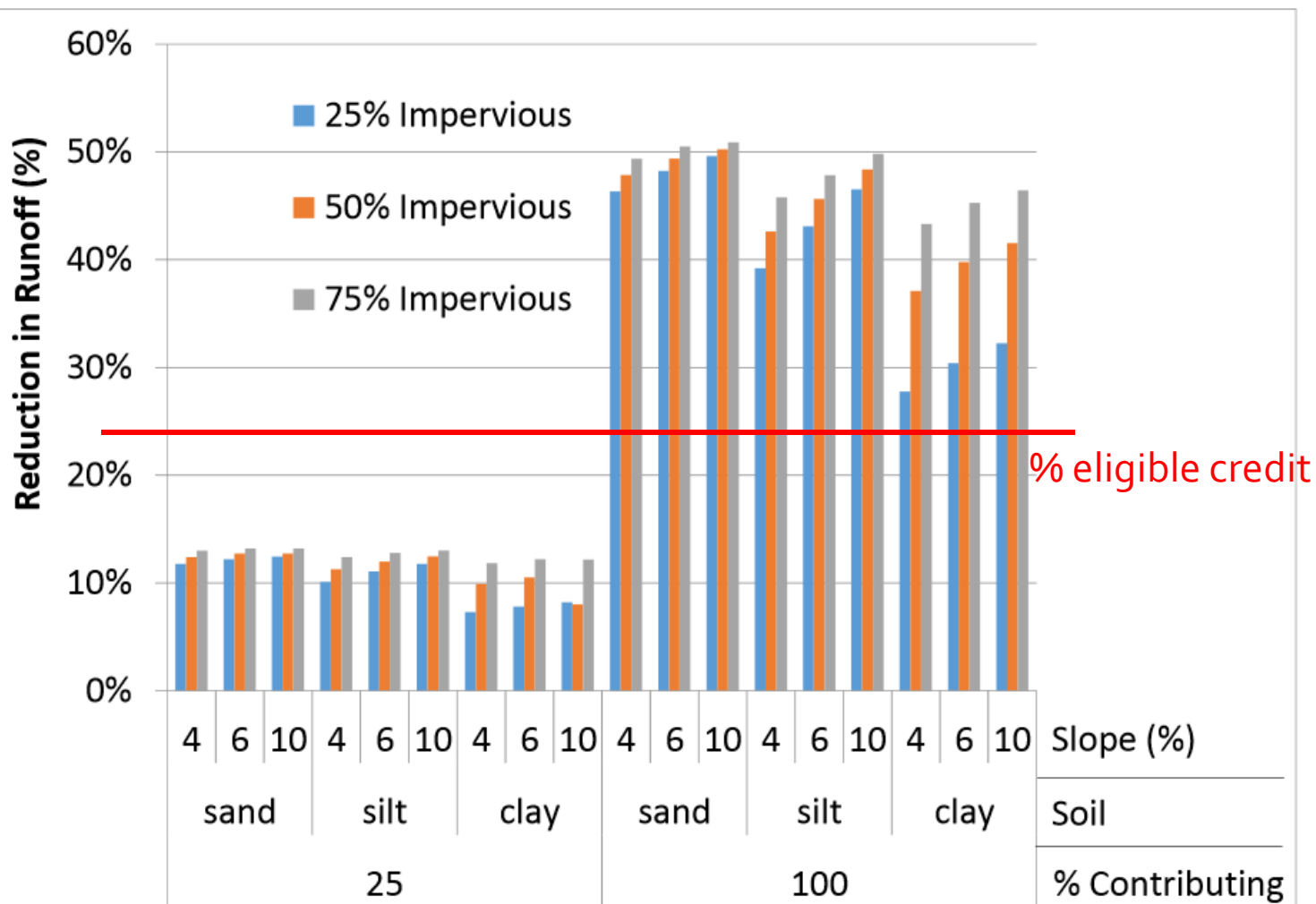
# Cleveland (NEORSD)

- Max eligible credit:
  - 25% Individual Residential Property Credit
    - Flat reduction for 25% (min) roof treatment
- Hydrology:
  - “Raingarden Manual for Homeowners”
    - f(sand, silt, clay)
    - f(raingarden depth [slope])
- Social:
  - High accessibility- fee maps, residential specific manual
  - Must dedicate 25% of SW expenditures to source municipality
    - Cost sharing for local projects
  - Education credit for SW curriculum
- Economics:
  - low rate (\$5.05/month)=low discount incentive (\$1.26)



# Cleveland

## Hydrologic and Economic Results



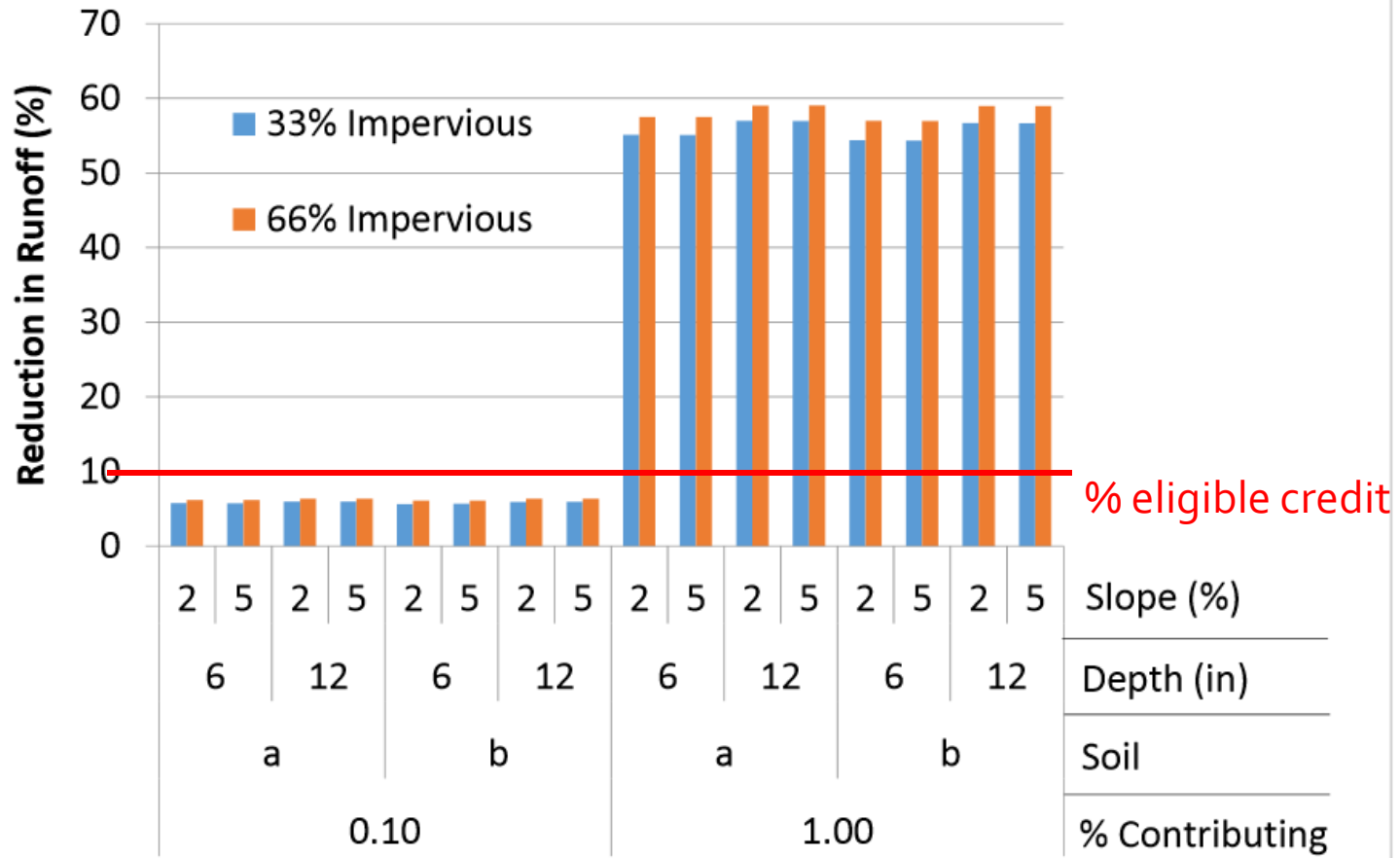


# Ft. Myers

- Max Credit:
  - 10% flat for rain garden
- Hydrology:
  - No manual; industry standards for area, depths
- Social:
  - Low accessibility
    - Limited outreach
    - Requires PE approval
- Economics:
  - Low rate (\$5.76/month)= low discount incentive (57¢)



# Ft. Myers





# General Findings

- Hydrology
  - Prominent factors
    - % captured roof area, Soil
  - Less prominent factors
    - Slope, Depth, Site imperviousness
- Social
  - Outreach varies
  - Jurisprudence indicates value of strong outreach
    - emphasize co-benefits of green infrastructure & SW management
- Economics
  - % runoff reduced v. % discount
    - Efficiency based on perspective
      - Even a windfall to a citizen ( $\% \text{ discount} > \% \text{ runoff reduction}$ ) may be efficient to municipality
      - Especially when goodwill, social contagion considered



# Questions

- Law, policy
  - Olivia Green
    - [green.olivia@epa.gov](mailto:green.olivia@epa.gov)
- Hydrologic analysis
  - Ruben Kertesz
    - [kertesz.ruben@epa.gov](mailto:kertesz.ruben@epa.gov)
- Stormwater Calculator
  - Lewis Rossman
    - [rossman.lewis@epa.gov](mailto:rossman.lewis@epa.gov)