Building Climate Resiliency with Green Infrastructure

Tuesday, July 22, 2014
1:00 – 2:30pm EST

Speakers:

- **Beth Sawin**, Climate Interactive
- **Alan Cohn**, NYC Department of Environmental Protection
- **Mikelle Adgate,** NYC Department of Environmental Protection
- **Carolina Griggs,** NYC Department of Environmental Protection

Sponsored by U.S. EPA Office of Wastewater Management

Logistics

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  - Call **GoToWebinar** support:[800 263-6317], and give conference ID# 733268065

Webcast Agenda

- **Introduction**
- **The Green Infrastructure Decision Support Tool**
  Elizabeth Sawin
- **Green Infrastructure and Climate Change in New York City**
  Alan Cohn, Mikelle Adgate, & Carolina Griggs
- **Q&A session**
- **Wrap up**

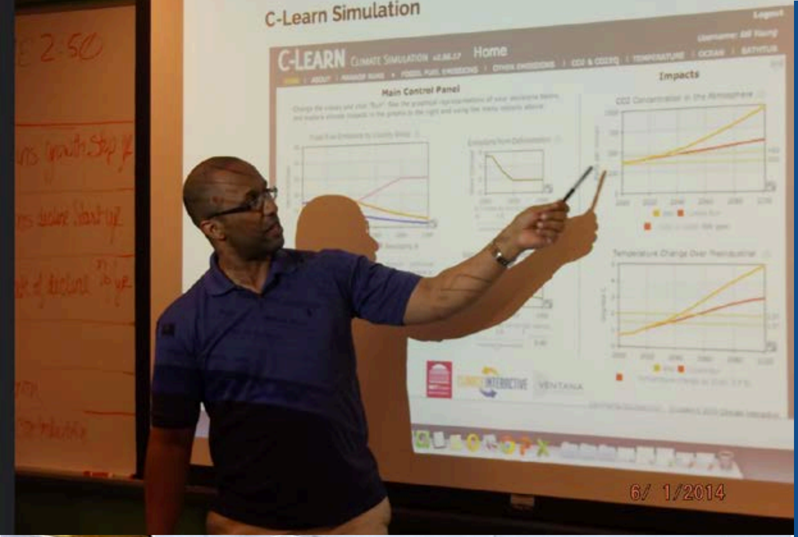
Now to our speakers!

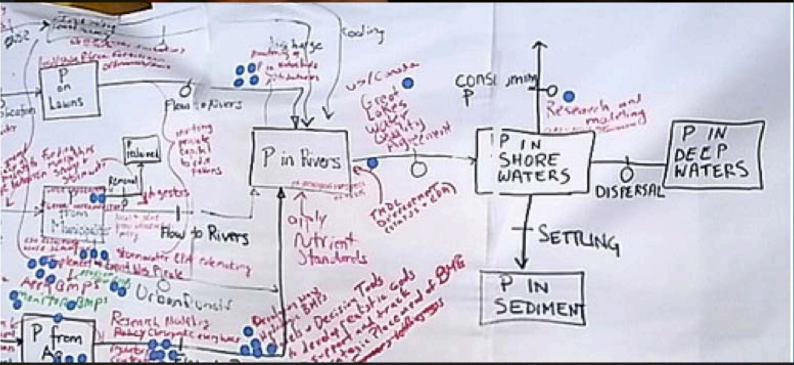
The Green Infrastructure Decision Support Tool

22 July 2014

Dr. Elizabeth Sawin

EPA Green Infrastructure Webcast Series





CLIMATE INTERACTIVE

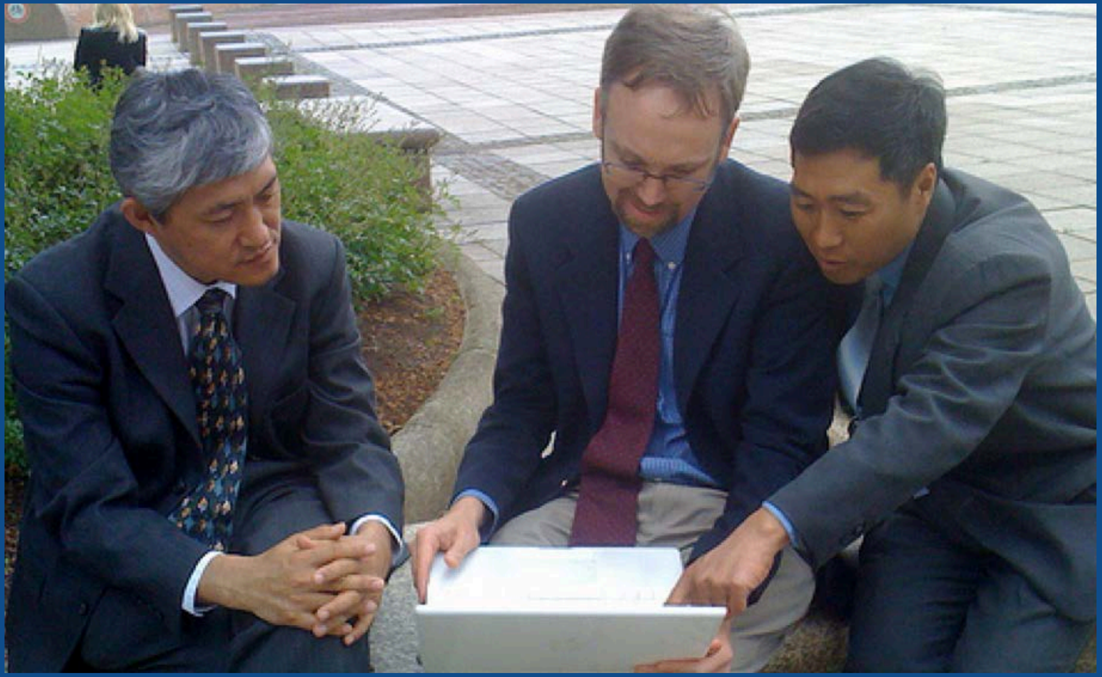
Helping people see what works to address our biggest climate challenges:

- clean energy
- food and water
- resilience

www.ClimateInteractive.org

Seeing what works --

Fast, interactive computer simulation to support learning and cooperation.



People need ways to see what they might accomplish together.

Why a Green Infrastructure simulation?

People need ways to ask ‘what if’ questions about the future before they invest time and money.

All impacted groups need to have a voice in infrastructure decisions

Why a Green Infrastructure simulation?

People need ways to prioritize which approaches will deliver the most benefit for investment of time and money.

Pilot project in Milwaukee, Wisconsin

CLIMATE INTERACTIVE

Pontifex CONSULTING

MMSD PARTNERS FOR A CLEANER ENVIRONMENT

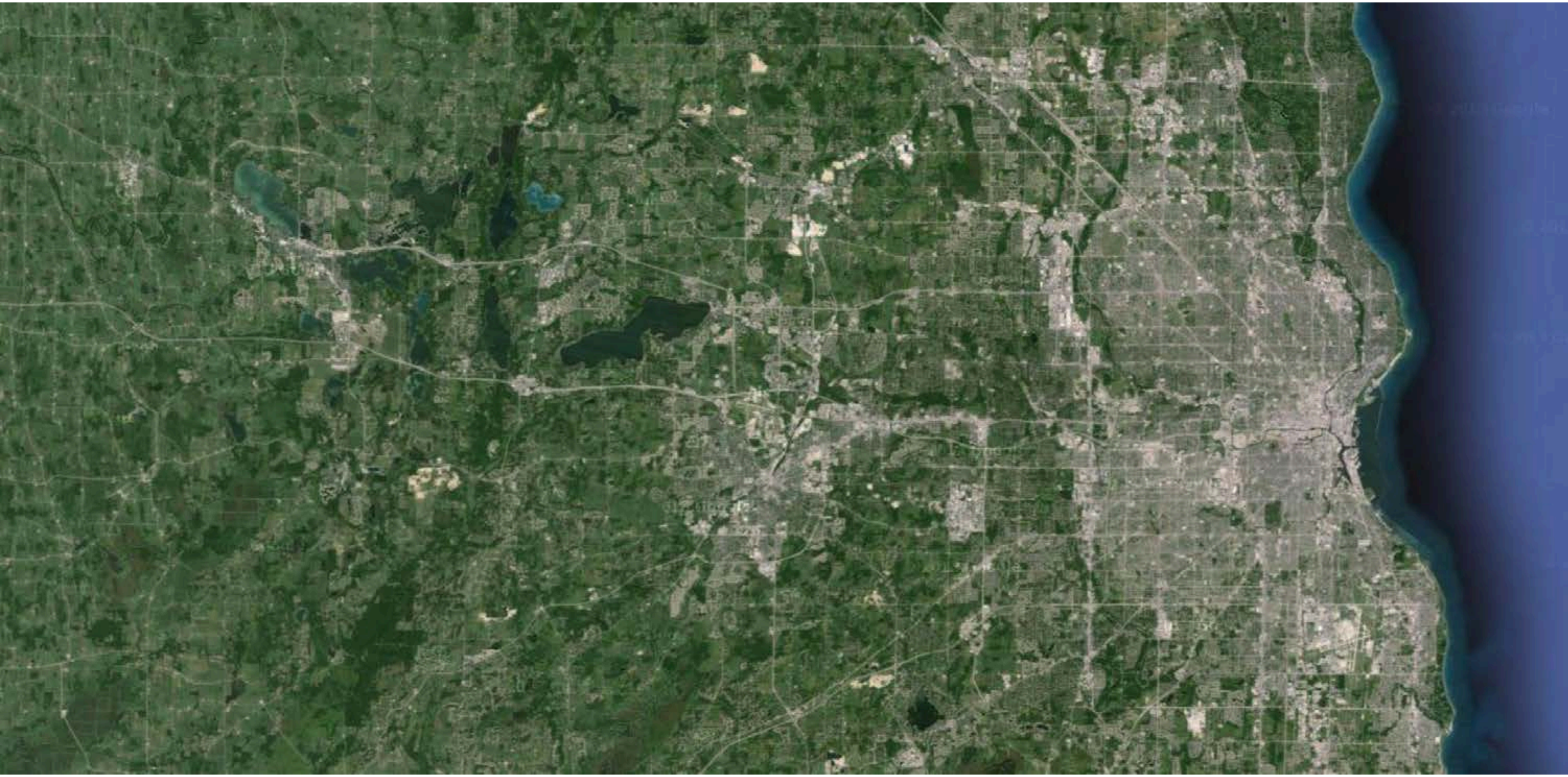
Sixteenth Street COMMUNITY HEALTH CENTERS

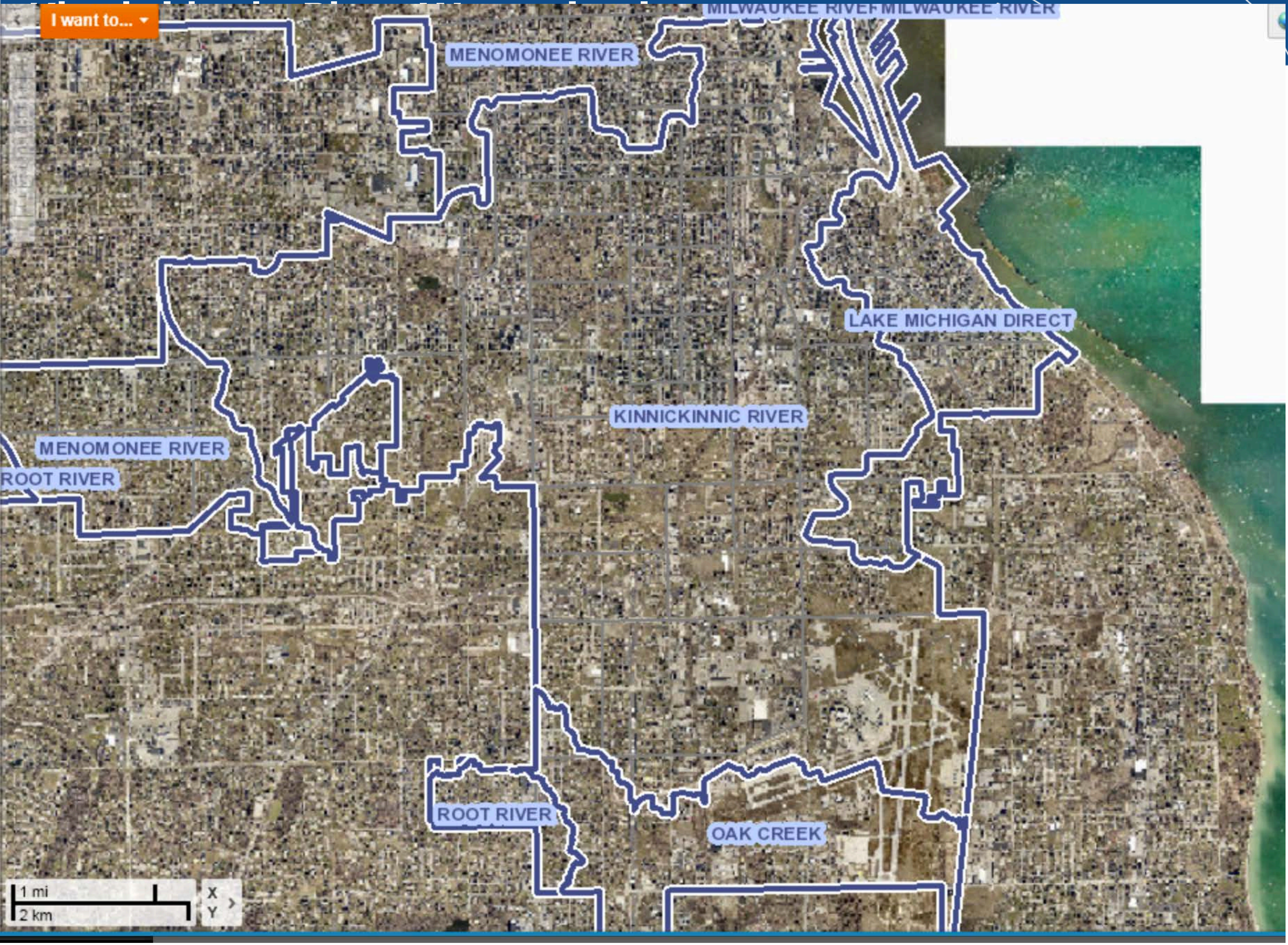
SURDNA ANDRUS

Fund for Lake Michigan

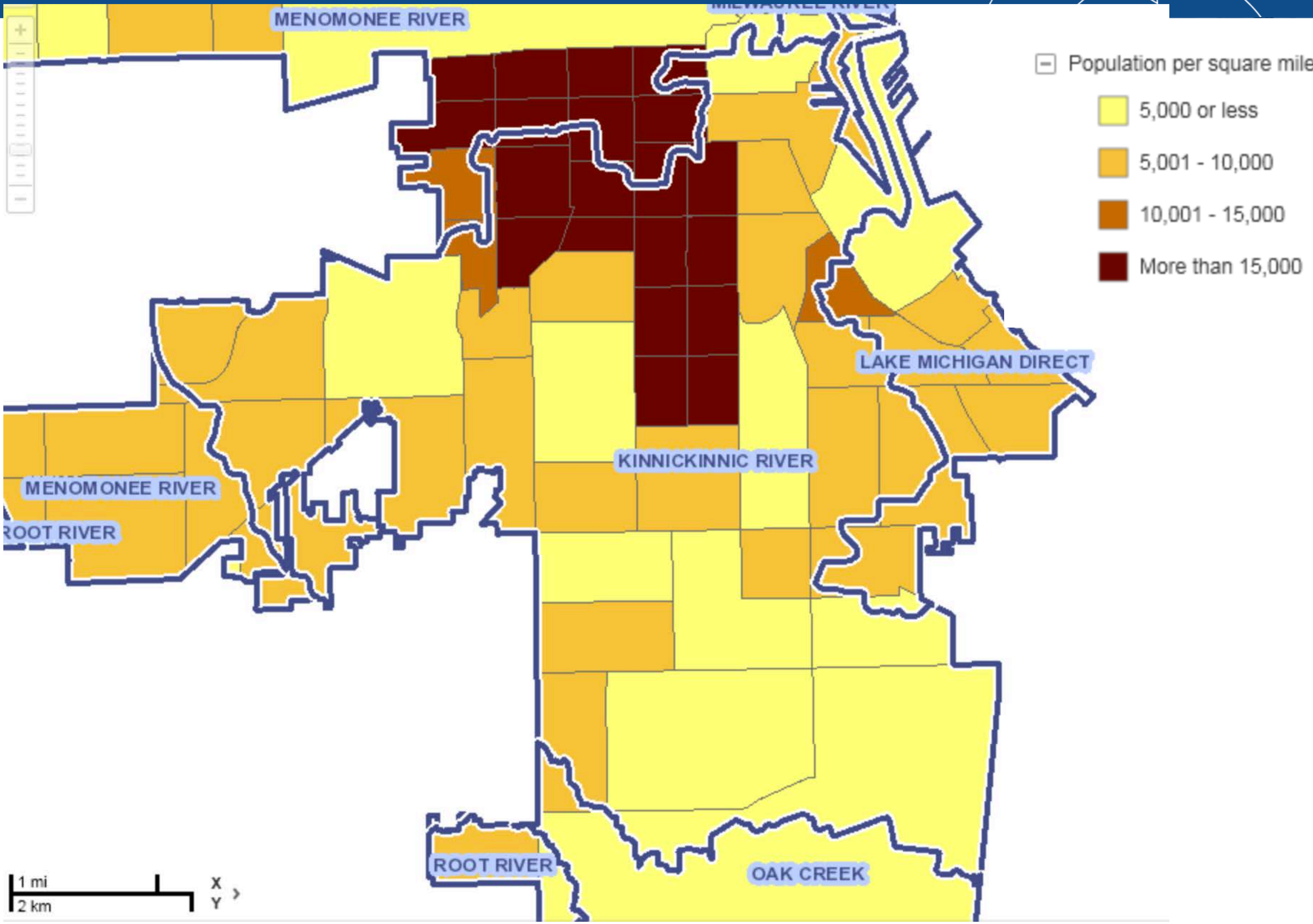
Roy A Hunt Foundation

Kinnickinnic River Watershed





Source: Map Milwaukee Portal



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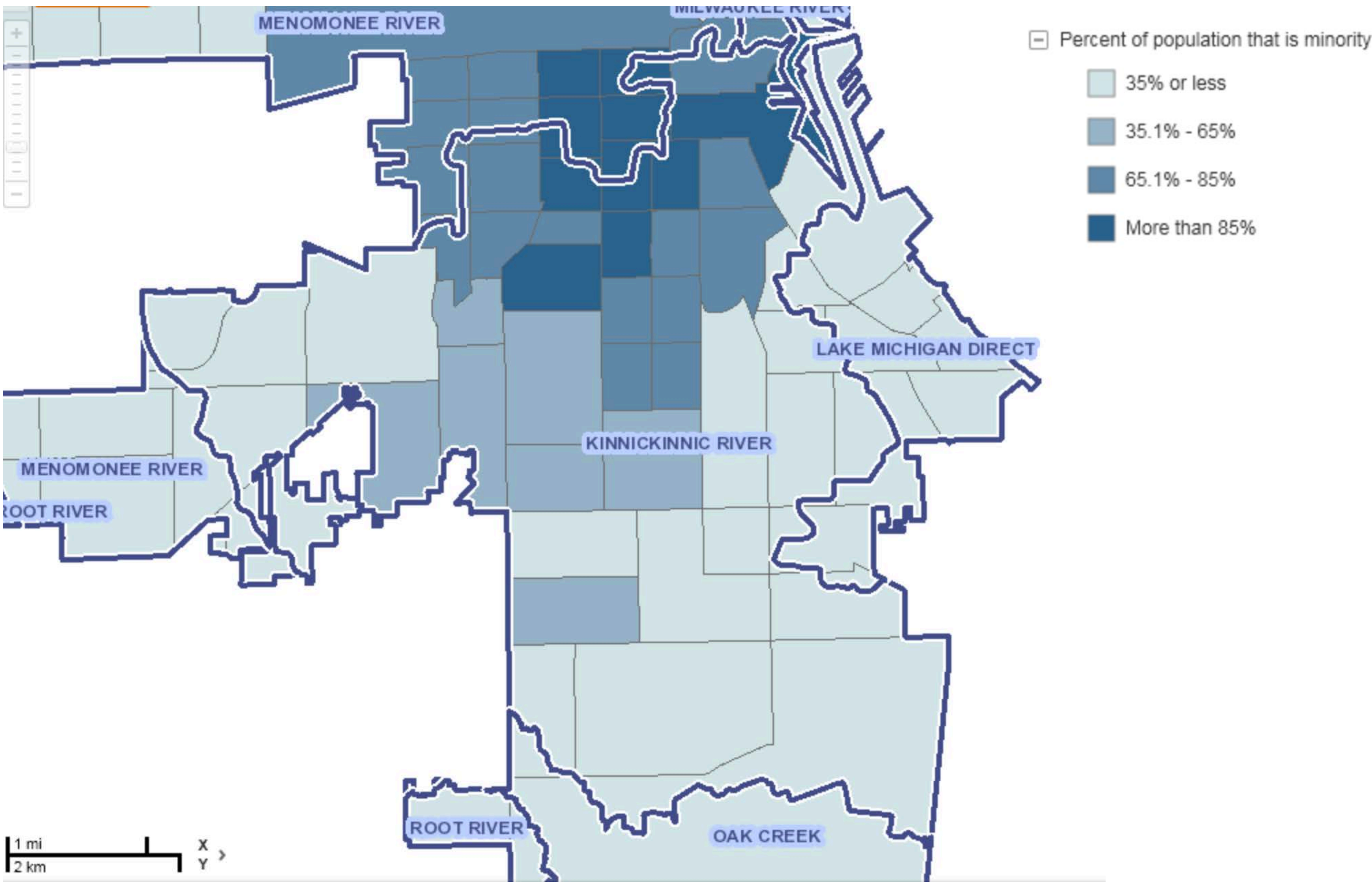


Source: Map Milwaukee Portal

Iterative Approach

Input so far from

- Milwaukee Metropolitan Sewerage District
- City of Milwaukee Dept. of Public Works
- City of Milwaukee Office of Environmental Sustainability
- Milwaukee Riverkeeper
- Wisconsin Voices
- 16th Street Community Health Center
- Gateway Milwaukee
- Citizen Action
- Brico Foundation
- Fund for Lake Michigan
- Joyce Foundation
- University of Wisconsin Madison
- Sweetwater
- University of Wisconsin Milwaukee
- American Rivers

Simulation structure

Investment
Green vs. grey
8 types of green

Support for GI
Residents
Commercial
Local government

Capacity
Green
Grey

Precipitation
Frequency
Intensity

GI effectiveness
Seasonality
Effectiveness

CSOs
Volume
Number

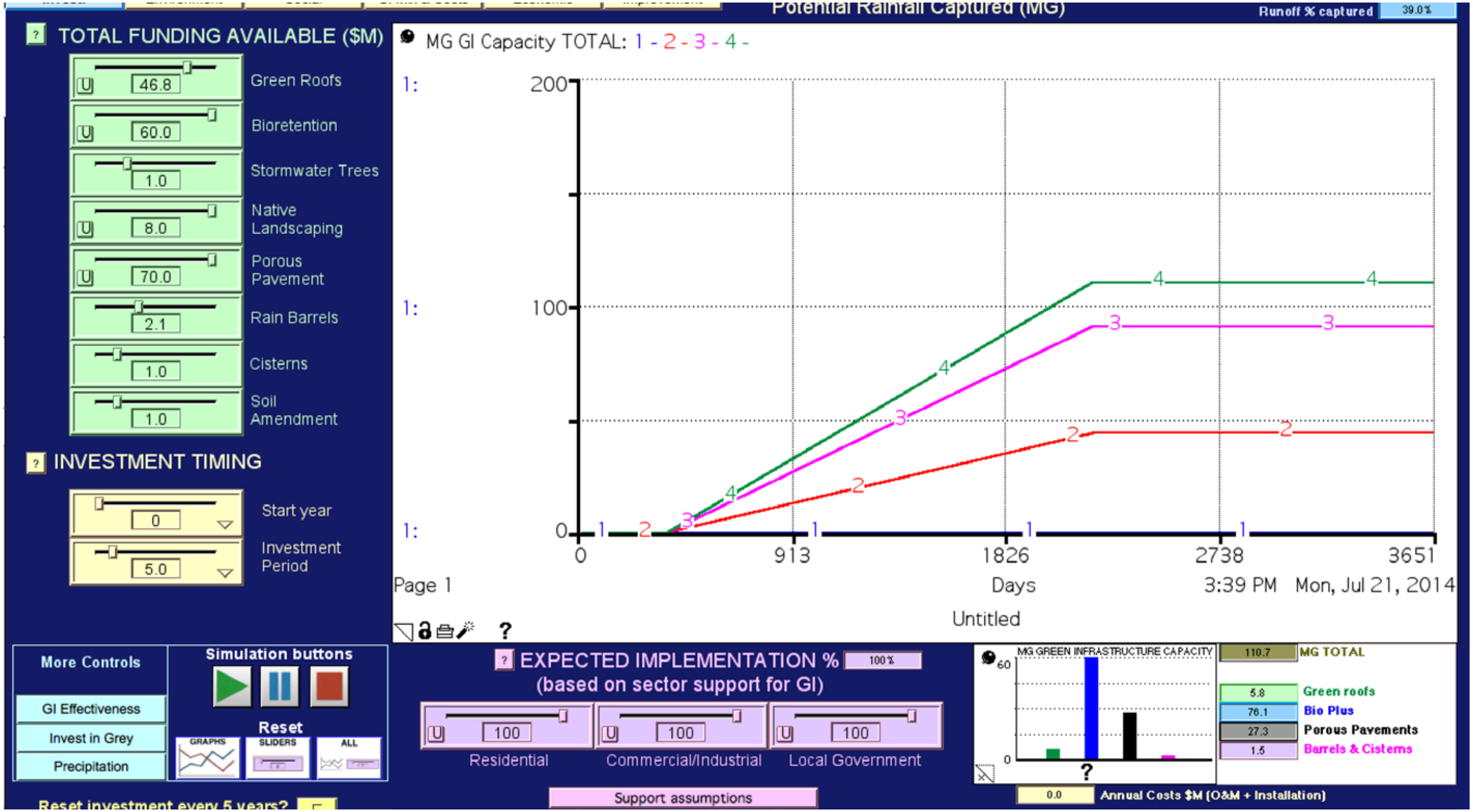
Economic
New jobs
Property values
O & M costs

Environment
Water quality
Energy savings

Social
Basement backups
Beach closures
Heat island effect
Bad air days

Demo

Differing Green Investment



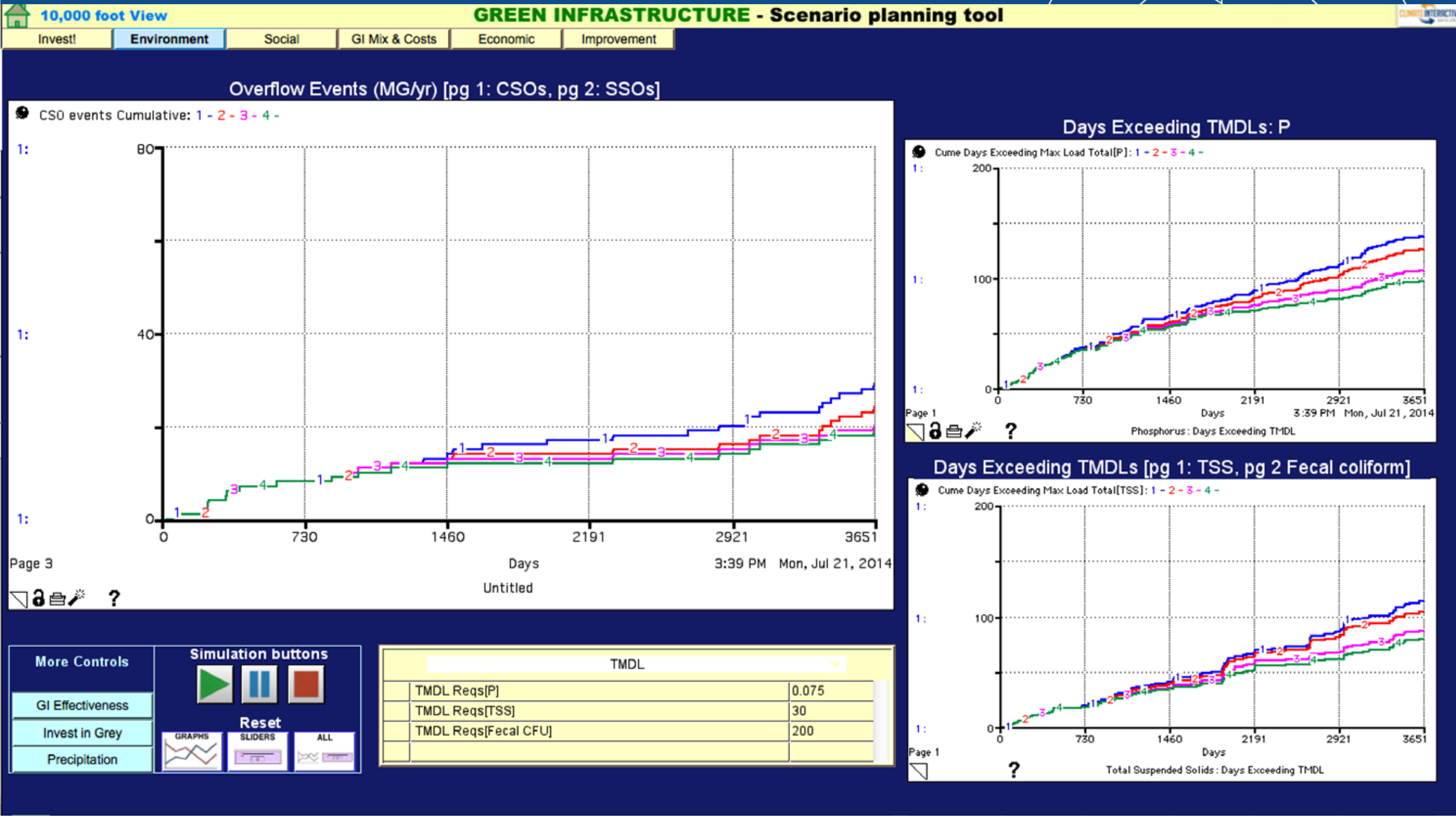
1 – no investment

2- Partial Green

3 – Full Green

4- Full Green – with more bioretention and porous pavement

Environment Outputs



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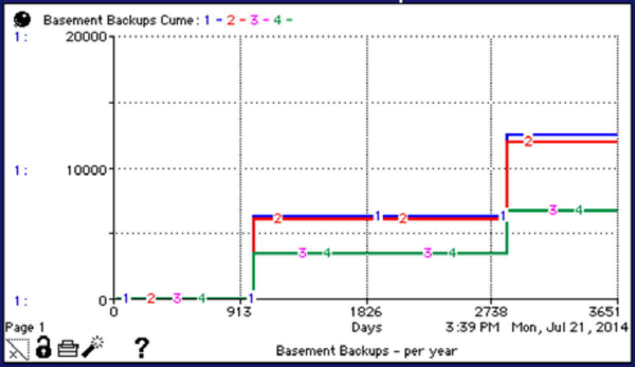
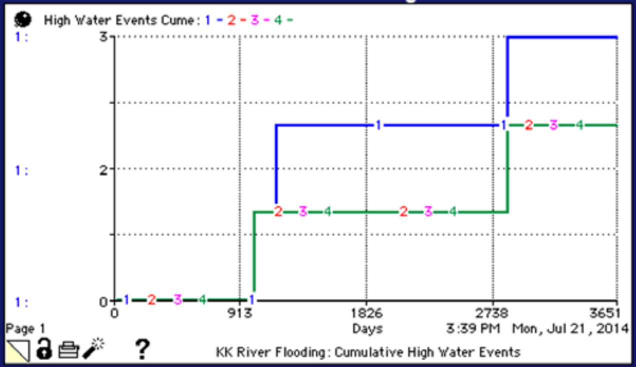
Social Outputs

Invest! | Environment | Social | GI Mix & Costs | Economic | Improvement

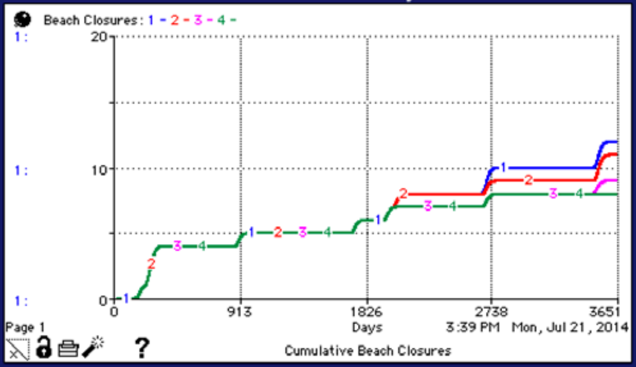
Basement Back Ups

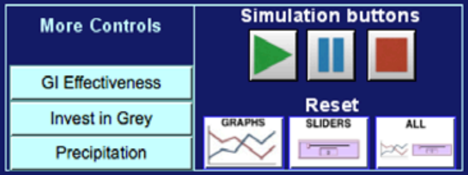


KK River Flooding

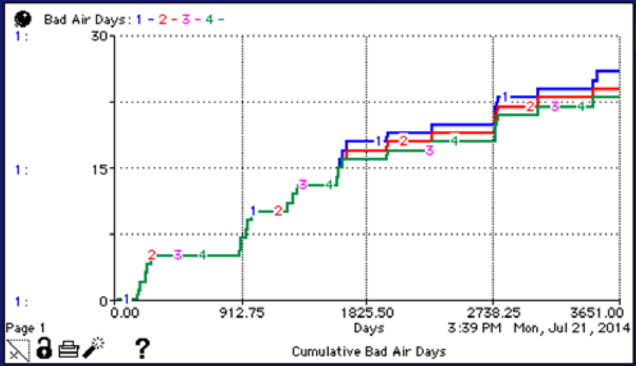


Beach Closure Days

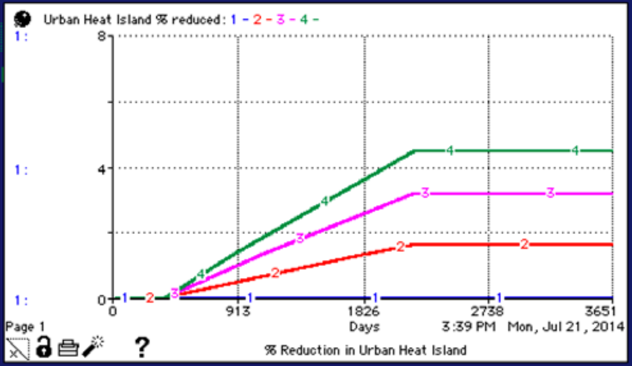




Bad Air Days



Heat Island Effect



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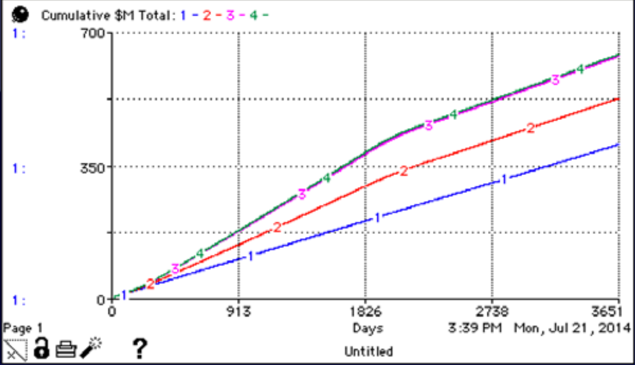
Economic Outputs

10,000 foot View

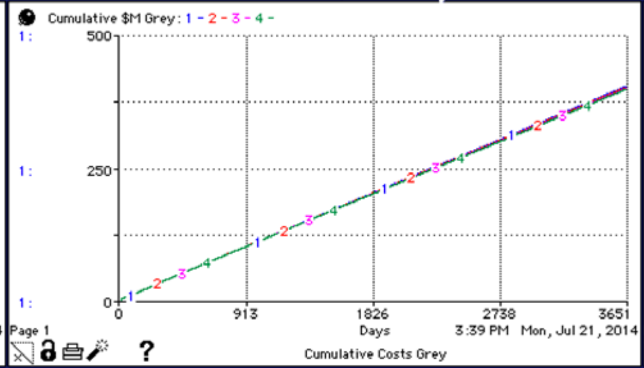
GREEN INFRASTRUCTURE - Scenario planning tool

Invest! | Environment | Social | GI Mix & Costs | Economic | Improvement

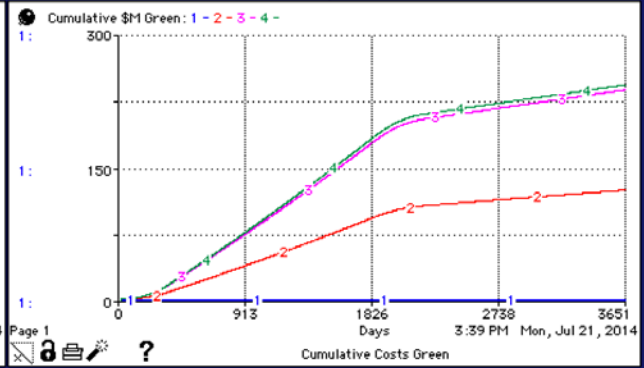
Cumulative $M – Total $M



Cumulative $M – Grey



Cumulative $M – Green



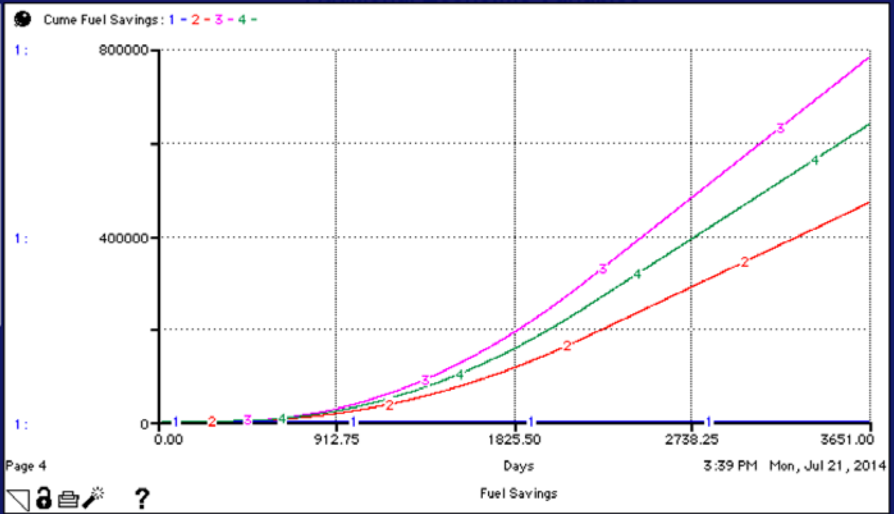
SPREADSHEETS

3:39 PM 7/21/14 — Table 3 (Untitled Table)

Days	0	365	730	1095	1460	1825	2190	2555	2920	3285	Final
Cume Total Costs (Millions)	$0	$60	$139	$219	$302	$385	$451	$499	$547	$595	$643
Cume Total Costs Grey (Millions)	$0	$41	$82	$121	$161	$201	$241	$280	$319	$359	$398
Cume Total Costs GI (Millions)	$0	$19	$58	$98	$140	$184	$211	$219	$227	$236	$244

More details

Additional Economic Variables



pg 1: Green Jobs – Installation & O&M
pg 2: Grey Jobs – Installation & O&M
pg 4: Fuel Savings
pg 5: Property Values

More Controls

GI Effectiveness

Invest in Grey

Precipitation

Simulation buttons

Reset

GRAPHS | SLIDERS | ALL

1 – no investment

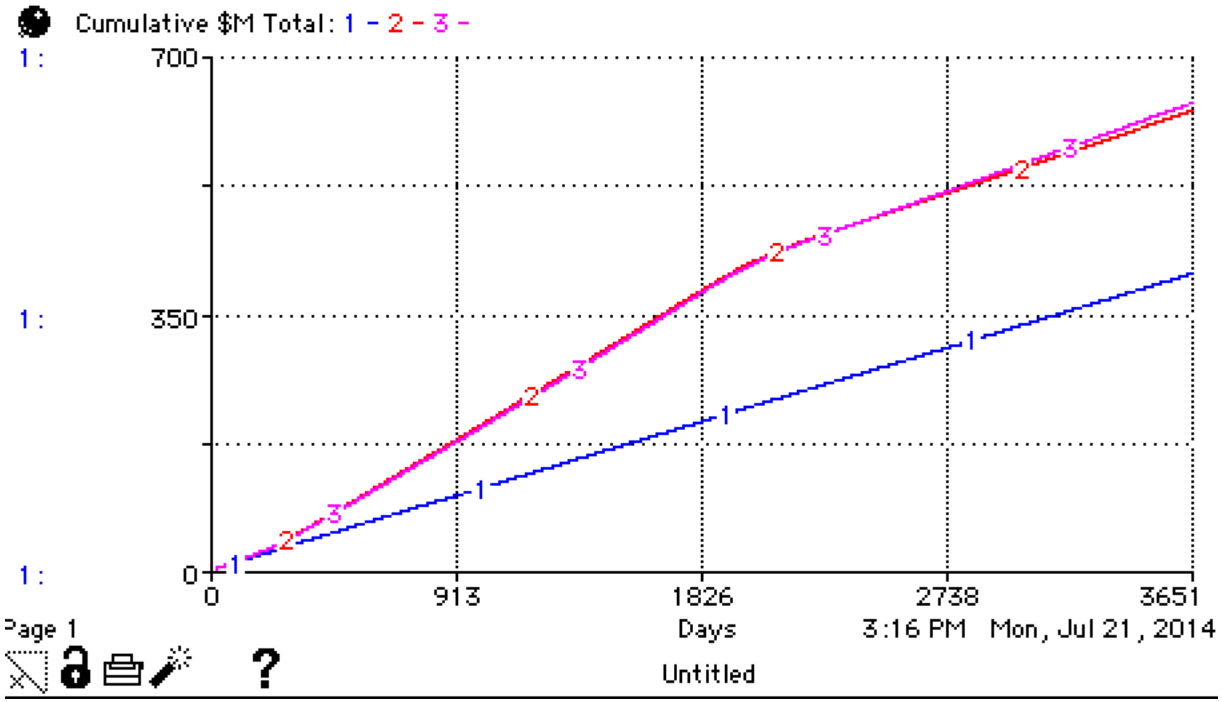
2- Partial Green

3 – Full Green

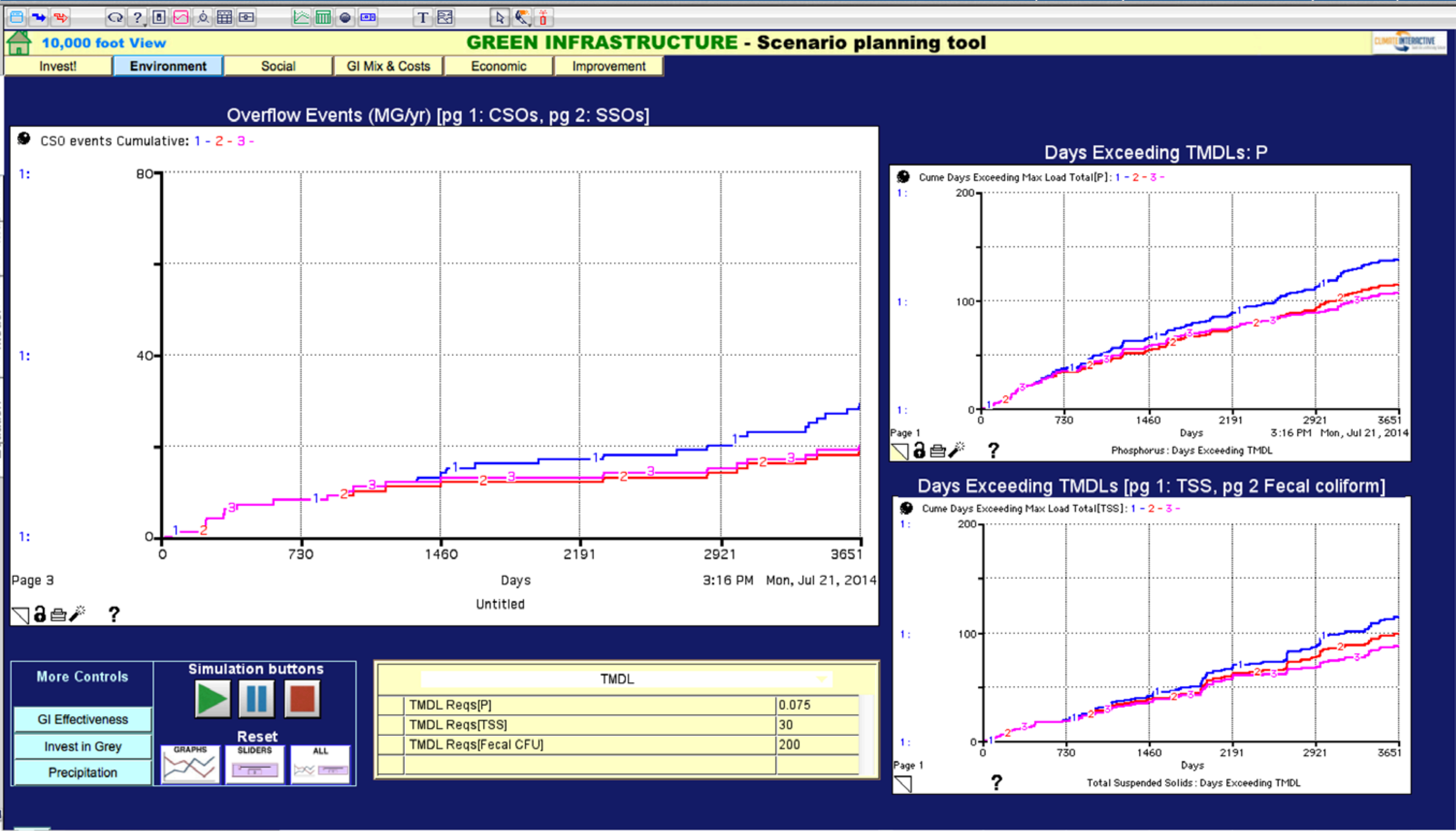
4- Full Green – with more bioretention and porous pavement

Grey, Green or No Investment

1 – no investment
2- Grey
3 - Green



Environment Outputs



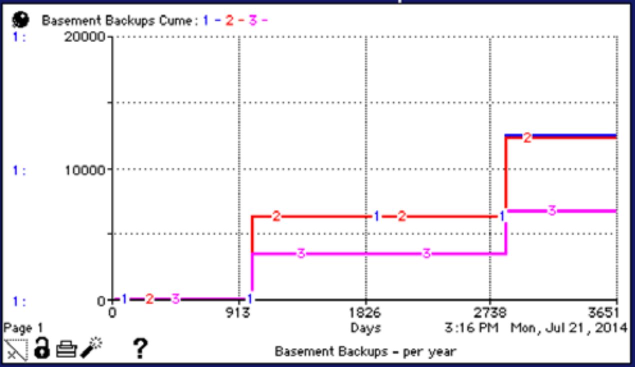
1 – no investment

2- Grey

3 - Green

Social Outputs

Basement Back Ups



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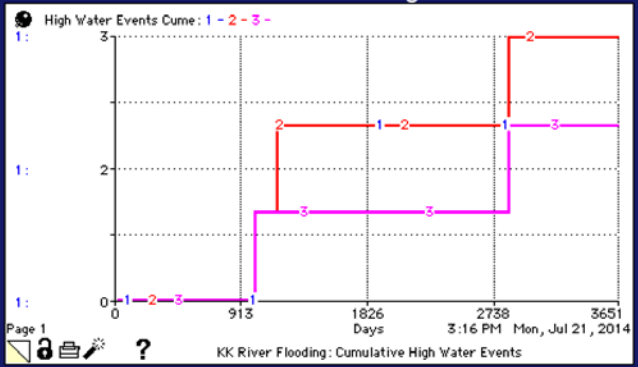
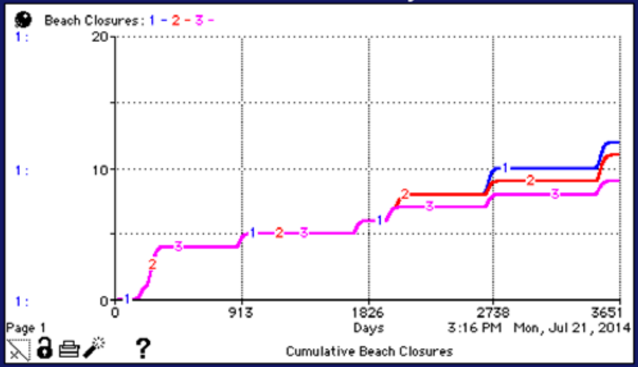


Beach Closure Days



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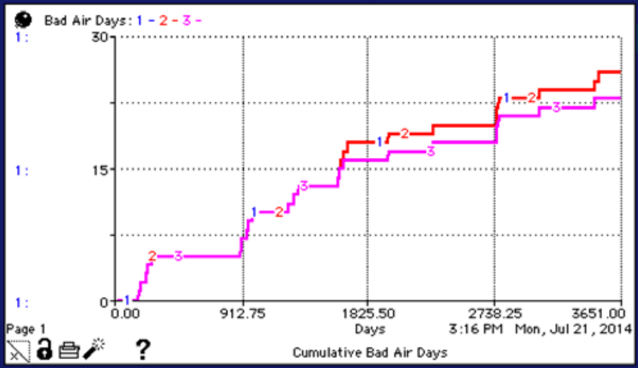

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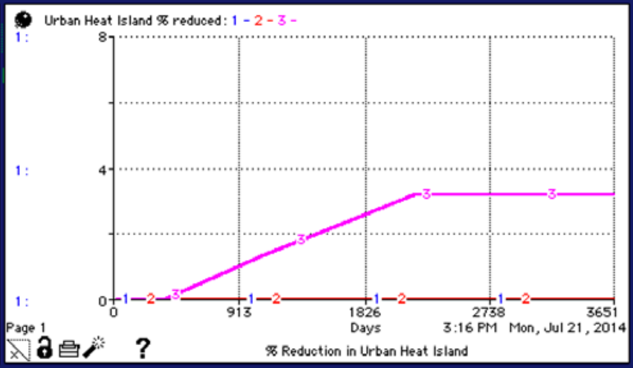
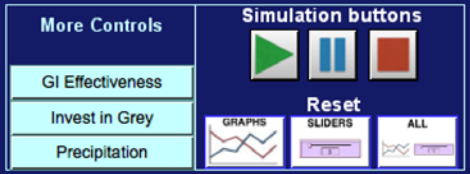


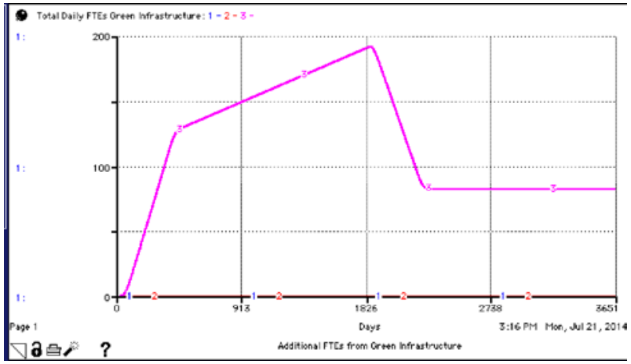


1 – no investment

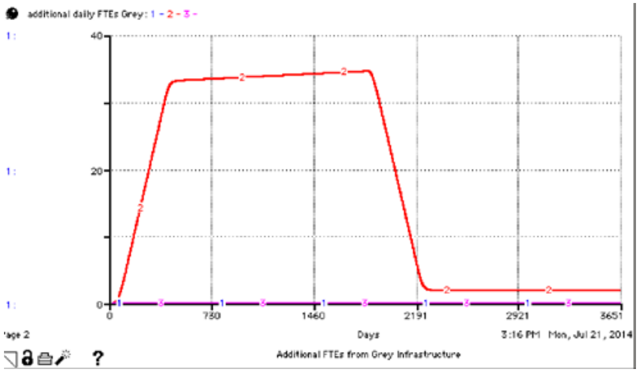
2- Grey

3 - Green

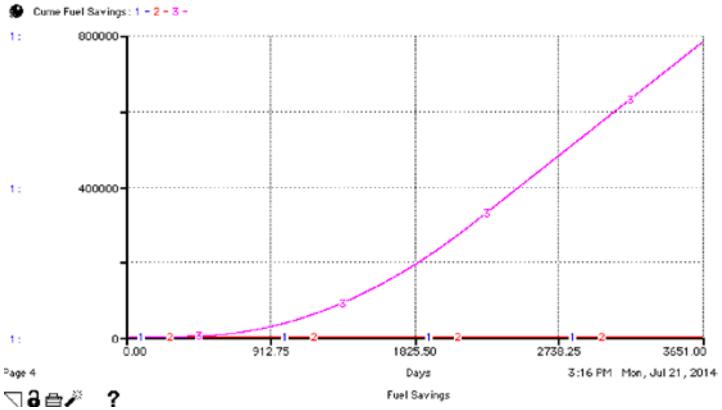
Jobs Green



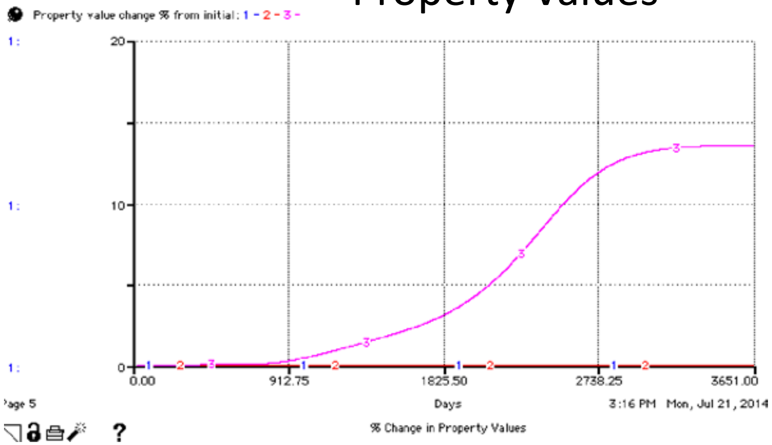
Jobs Grey



Cumulative Energy Savings



Property Values

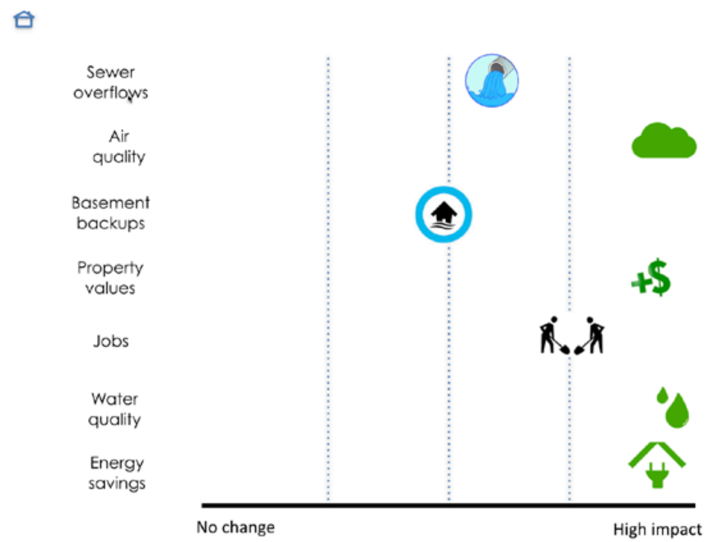


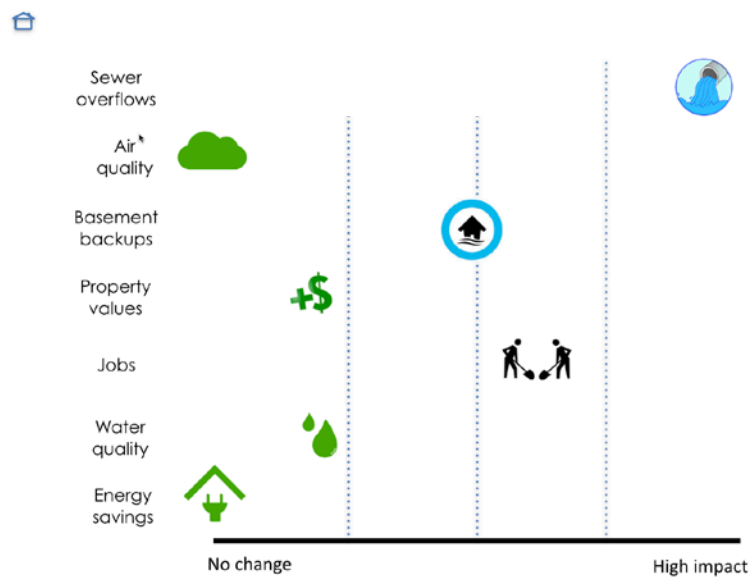
1 – no investment
2- Grey
3 - Green

2014-2015: 1st goal

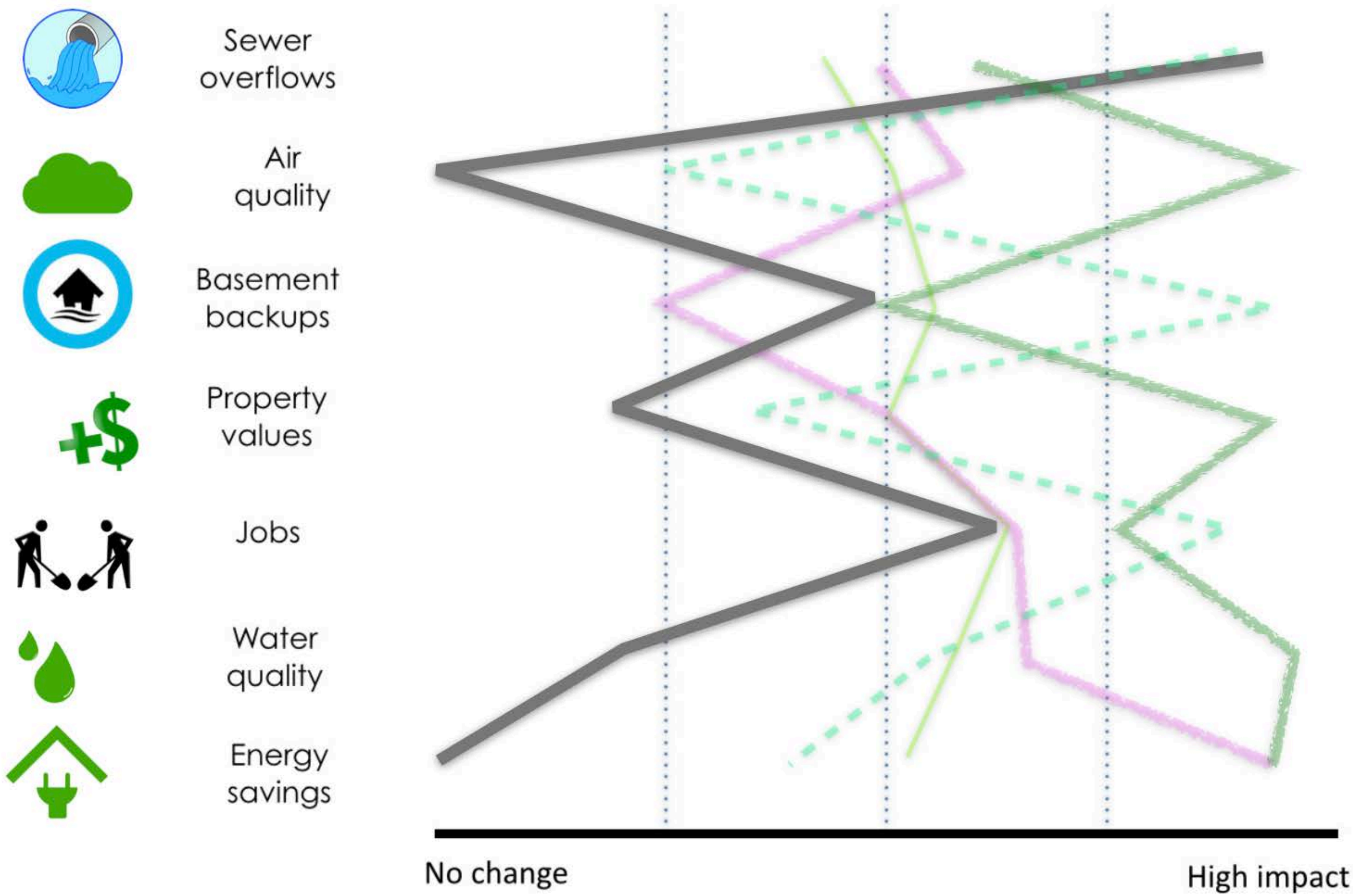
1. **Develop a simple, less graph-intensive interface**

In development – ‘at a glance’ output





In development – 'at a glance' output



2014-2015: 2nd goal

1. Develop a simple, less graph-intensive interface
2. **Support local organizations in catalyzing a wave of GI investment in Milwaukee**

Catalyzing GI investment in Milwaukee

- Local partners – 16th Street Community Health Centers and Milwaukee Metropolitan Sewerage District
  - 6 municipalities, county, business groups, neighborhood associations, non-profits
  - Simulation will help citizens and leaders see what is possible and build a shared vision for their communities
  - Complemented with technical and planning expertise, site visits, information sharing
  - Vision of an implementation fund at the end of the project

1. Develop a simple, less graph-intensive interface
2. Support local organizations in catalyzing a wave of GI investment in Milwaukee
3. **Making insights from the simulation useful around the country, and making customized versions for other cities**

Sharing insights and customized tools around the US

- Late fall/early winter – an online learning community of GI advocates from municipalities, regional agencies, and community groups
- Meeting via webinar, a few hours per month
- Our offers
  - More time with the Milwaukee tool, understanding the generalizable insights
  - Access to the Milwaukee tool and support in using it
  - For 2-4 cities willing to invest more time, the offer of more detailed consultation to customize the Milwaukee tool for other regions.

- How you can help
  - Sign up if you'd like to be informed of call for applications to the learning network
    - http://www.climateinteractive.org/infrastructure-community/
- Let us know if your network or professional associations might like to partner with us or co-host these learning sessions.

Thank You!

esawin@climateinteractive.org

www.ClimateInteractive.org

To receive notification about our online learning community:

http://www.climateinteractive.org/infrastructure-community/

Environmental Protection

Green Infrastructure and Climate Change in New York City

Alan Cohn
Director, Climate & Water Quality

Mikelle Adgate
Project Manager, Green Infrastructure Partnerships

Carolina Griggs
Deputy Director, Planning, Projections
& Demand Management

Agenda

- Introduction to DEP
  - Water and Wastewater Systems
  - Planning for Climate Change
- The NYC Green Infrastructure Plan and Program
- Quantifying Local Co-Benefits of Green Infrastructure

A Brief Introduction to DEP

- DEP provides more than 1 billion gallons of water each day to more than 9 million residents, including 8 million in NYC.

- NYC remains one of only five large cities in the United States that is not required to filter its drinking water.

A Brief Introduction to DEP

- Approximately 7,400 miles of sewer lines take wastewater to 14 treatment plants.
- DEP also manages stormwater throughout the City, and ensures that the City's facilities comply with the Clean Water Act and other federal, state and local rules.

Planning for Climate Change

DEP is planning for climate change, from reducing greenhouse gas emissions to preparing for the impacts of extreme weather to drinking water and wastewater infrastructure.

Apr. 2007

May 2008

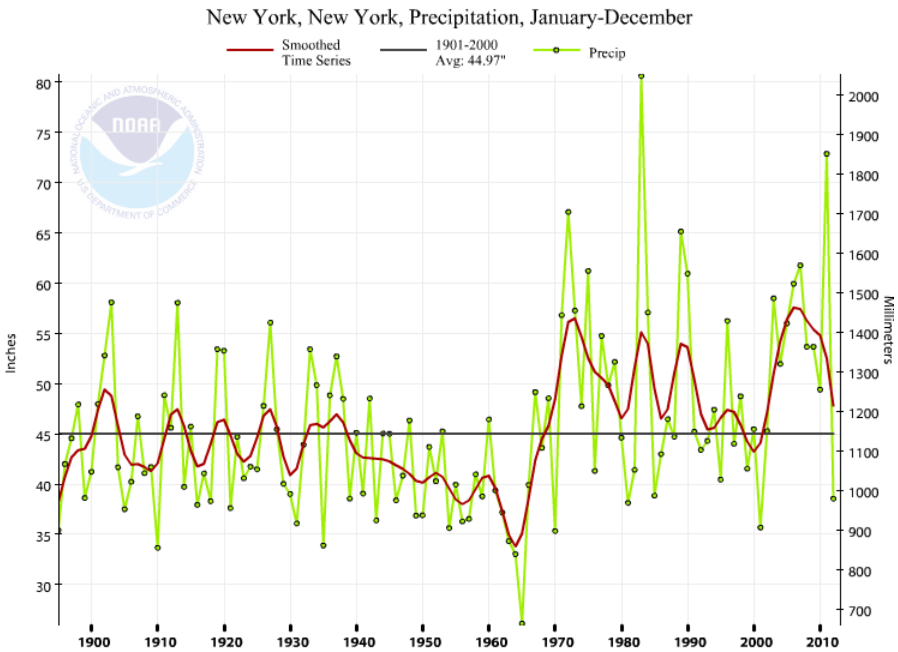
Feb. 2011

Oct. 2012

Jun. 2013

Oct 2013

Recorded Data



Climate Projections

Projected Climate Change (Mean annual changes)		
	25th to 75th percentile	90th percentile
Air temperature		
2020s	+2 to 3 deg F	+3 deg F
2050s	+4 to 5.5 deg F	+6.5 def F
Precipitation		
2020s	0 to +10 percent	+10 percent
2050s	+5 to 10 percent	+15 percent
Sea level rise		
2020s	4 to 8 inches	11 inches
2050s	11 to 24 inches	30 inches

New York City Panel on Climate Change.
Climate Risk Information 2013.

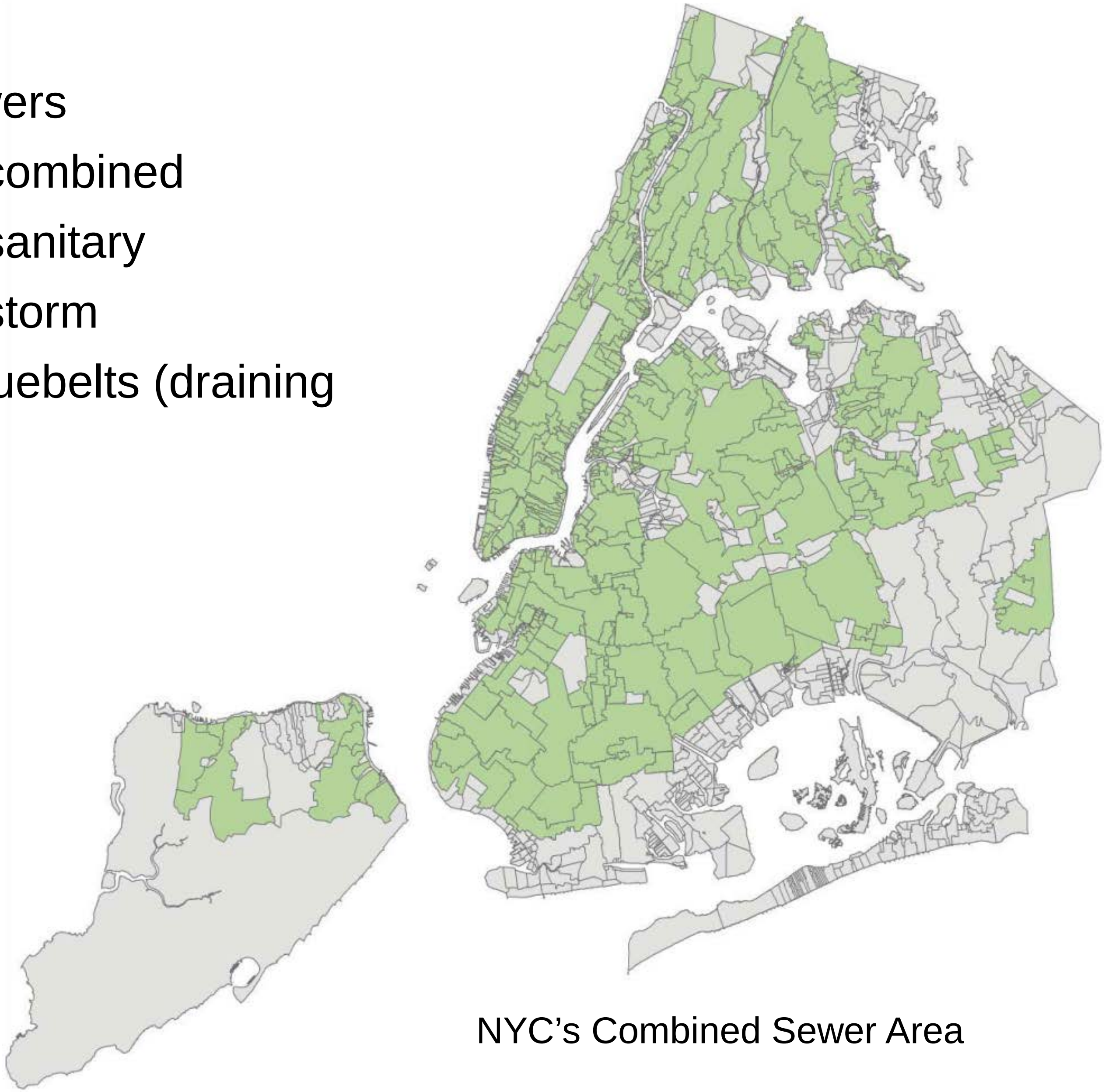
Environmental Protection

The NYC Green Infrastructure Plan and Program

NYC's Combined and Separate Sewers

- 7,400 miles of sewers
  - o 3,337 miles of combined
  - o 2,271 miles of sanitary
  - o 1,801 miles of storm
  - o 400 acres of Bluebelts (draining 14,500 acres)

**Above statistics in process of being updated*



NYC's Combined Sewer Area

Water Quality in New York City

= does not meet water quality standards

75% of Harbor meets pathogen standards for swimming

19% meets standards for boating, fishing

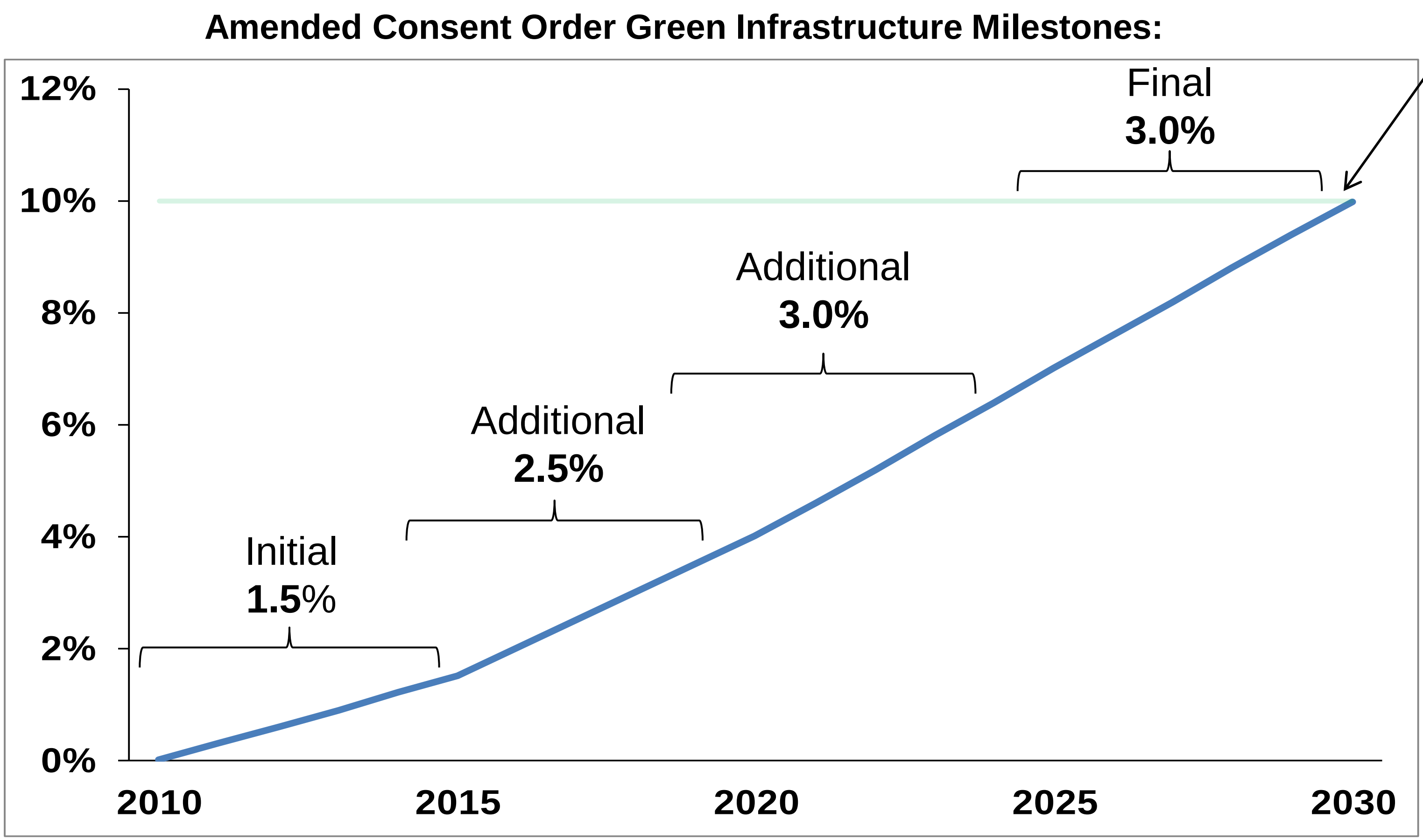
7% of our Harbor is made up of tributaries that do not meet secondary contact standards

A Sustainable, Hybrid Approach to CSOs

1. Build cost-effective grey infrastructure
2. Optimize the existing wastewater system
3. Control runoff from 10% of impervious surfaces through green infrastructure and other source controls
4. Institutionalize adaptive management, model impacts, measure CSOs, and monitor water quality
5. Sustain stakeholder engagement

2012 Amended CSO Consent Order

- March 2012 - DEP signed Amended Consent Order with New York State Department of Environmental Conservation
- Among other grey projects, the Order ensures green infrastructure investments over 20 years to manage combined sewer overflows (CSO)



GOAL: Manage 1 inch of runoff on 10% of impervious surfaces in combined sewer areas

GI Program Overview

Overview: Over $700 million budgeted in the 10 year capital plan

1. **Right of Way GI Design/Construction:**
   - Area-wide implementation of Bioswales and Stormwater Greenstreets
   - Adding GI to scope of existing capital highway and sewer projects

2. Public Property Retrofits:
- School yards, playgrounds, public housing, parkland, parking lots

3. Green Infrastructure Grant Program:
- $11.5 million committed for 29 projects over 3 grant cycles

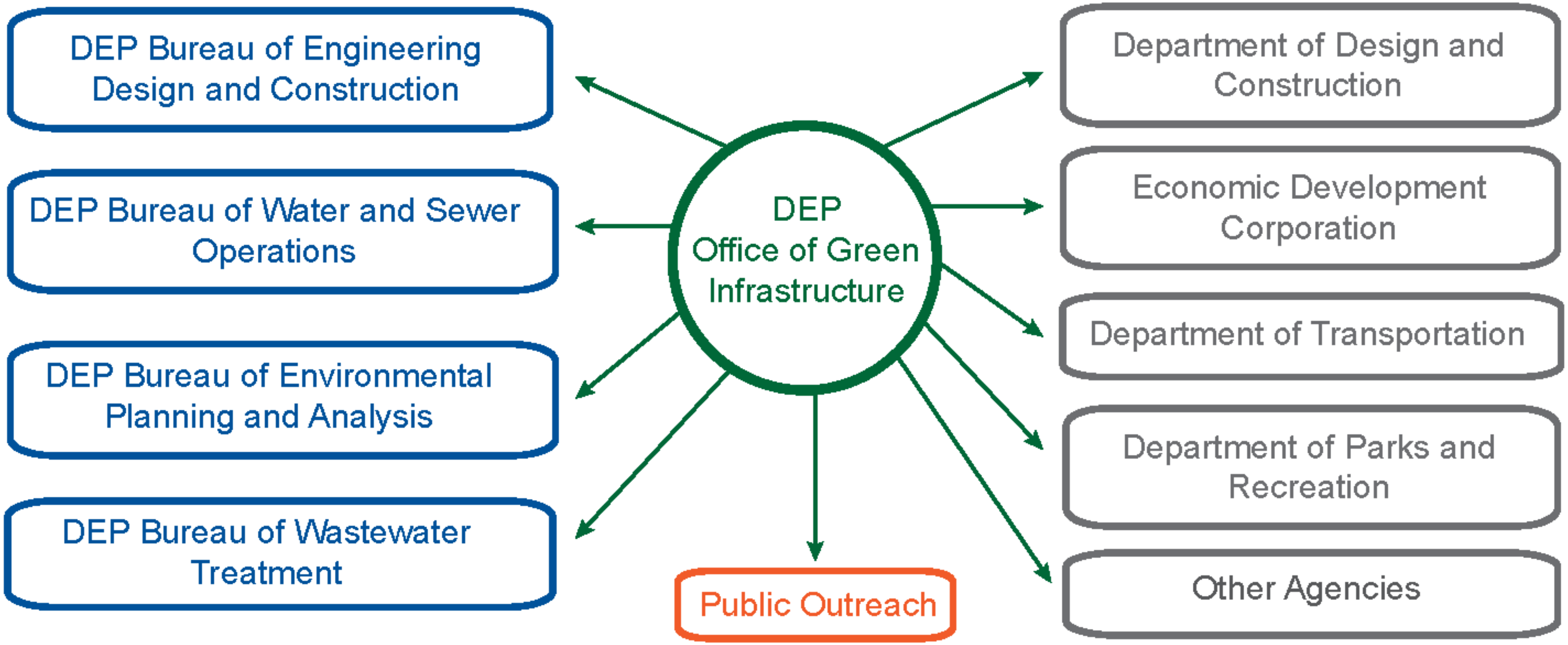
4. Neighborhood Demonstration Areas

5. Research and Development Program

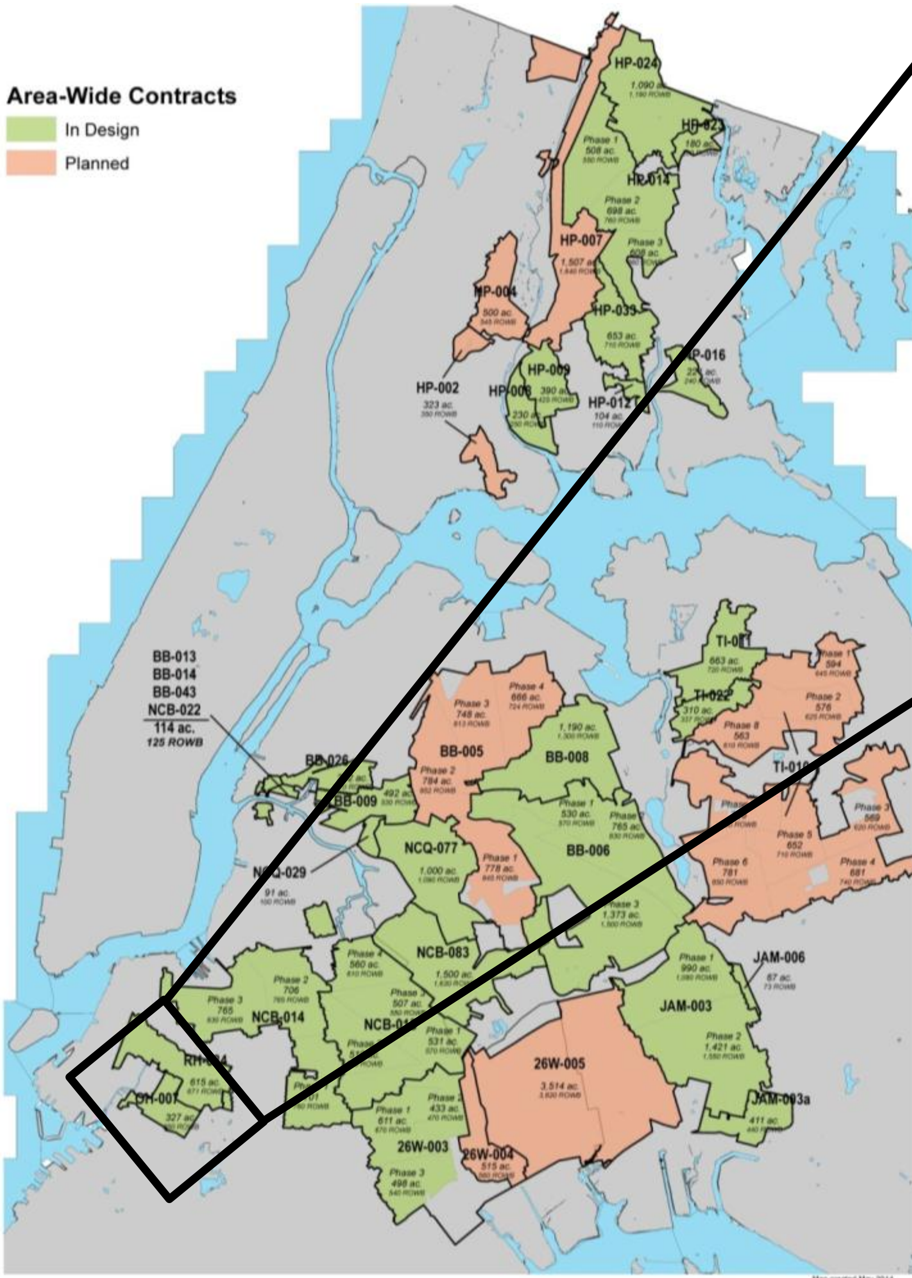
6. O&M/Asset Management Program

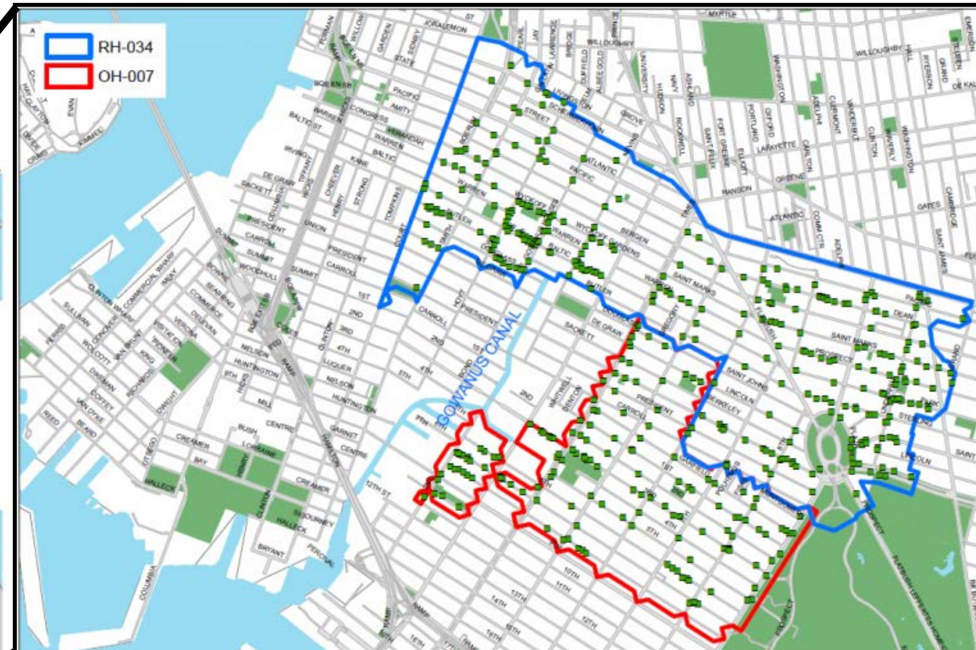
7. Outreach and Engagement Program

Interagency Program Coordination



Area-Wide GI Implementation





EXAMPLE

Preliminary Sites

The Area-wide approach allows OGI to:

- Focus resources on specific outfall tributary areas
- Saturate these areas with as much GI as possible
- Achieve efficiencies in design and construction

Right-of-way Green Infrastructure

Public Property Retrofits

PS 261 (Boerum Hill / Cobble Hill, Brooklyn)

Green Infrastructure Grant Program

NYC Environmental Protection

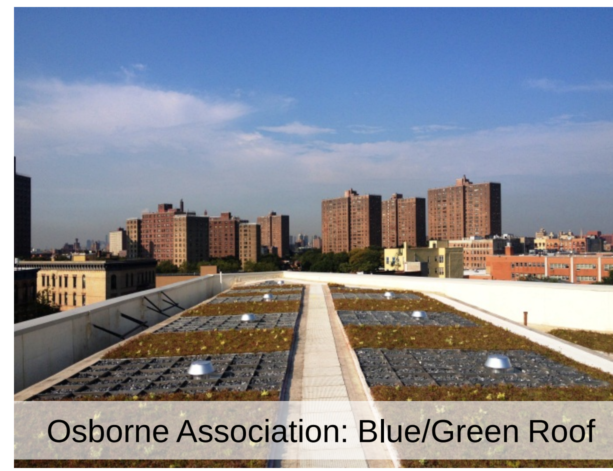

Brooklyn Navy Yard: Rooftop Farm


Queens College: Rain Garden/Pavers


Bishop Loughlin: Green Roof

Lenox Hill House: Green Roof


NYRP: Rain Garden/Pavers


Osborne Association: Blue/Green Roof

Maintenance of Green Infrastructure

ROW Maintenance:

- Through FY2015 DEP will fund new Greenstreets crews to maintain all green infrastructure in the right of way.
- Maintenance MOU clearly defines roles and responsibilities for ROW installations for DEP/DOT/DPR.

Onsite Maintenance:

- Project specific maintenance agreements are developed with each partnering agency.

Quantifying Local Co-Benefits of Green Infrastructure

Green Infrastructure Co-Benefits Study

NYC Environmental Protection

This preliminary study analyzed the following benefits:

- Carbon Sequestration
- Urban Heat Island Mitigation
- Reduced Energy Demand
- Improved Ecosystem Services
- Improved Air Quality
- Improved Quality of Life
- Reduced Treatment Needs
- Green Jobs

For the following green infrastructure practices:

- Right of way bioswales
- Green streets
- Large bioretention
- Porous Pavement
- Constructed Wetland
- Green Roof
- Blue Roof

Using the following analyses:

- NYC pilot monitoring
- Literature review
- Life Cycle Analysis

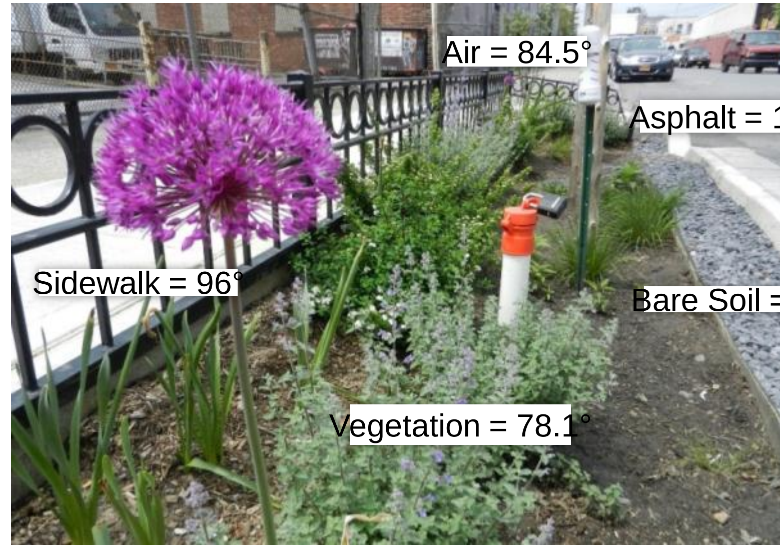
Pilot Monitoring

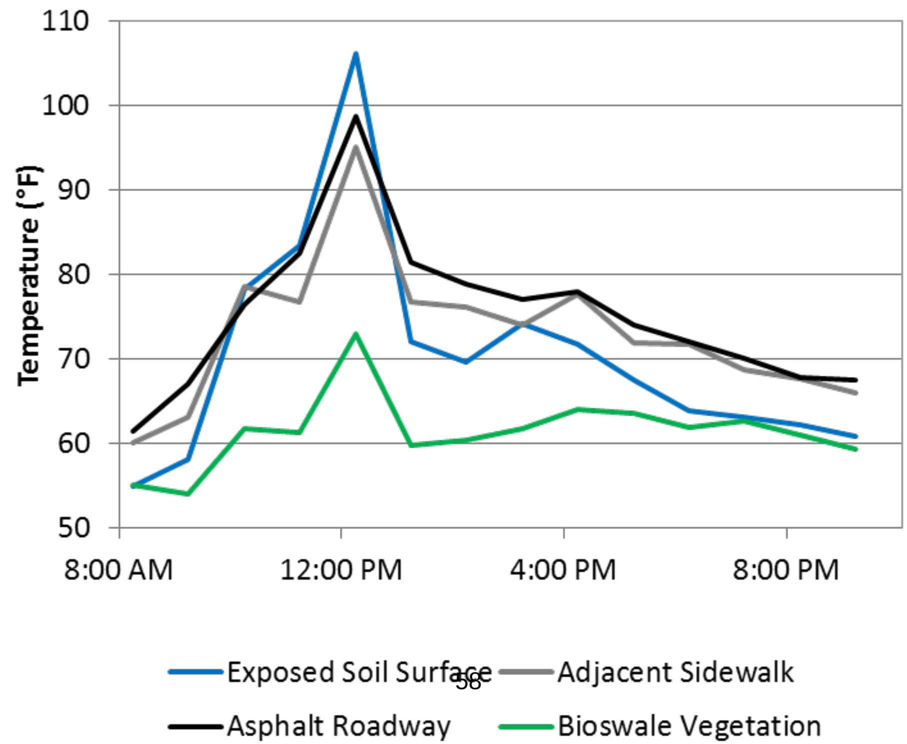
- Practices evaluated: Right of way bioswales, blue roofs, green roofs, large bioretention, porous pavement, wetland

- Preliminary results confirm that green infrastructure surfaces generally cooler than nearby pavement

    - o Vegetation surfaces >10°F cooler than adjacent sidewalk and asphalt

- High temperature of bare soils illustrates importance of vegetation coverage





Literature Review Summary

	Co-Benefit	Findings from Literature Review
ENVIRONMENTAL	Carbon Sequestration	• Methods to correlate vegetation coverage to CO_2 sequestration rates
ENVIRONMENTAL	Urban heat island mitigation	• UHI reduction through increases in albedo and vegetation coverage • Cooling impacts from urban trees • Modeled city-wide temperature reductions from large scale vegetation implementation
ENVIRONMENTAL	Reduced energy demand in buildings	• Energy savings associated with shading from urban trees • Energy savings associated with insulating effects of green roofs
ENVIRONMENTAL	Ecosystem services	• Correlation between pollinators, bloom density, and specific vegetation • Correlation between wildlife and presence of green space corridors • Habitat potential provided by green infrastructure
SOCIAL	Improved air quality	• Air pollutant removal rates for vegetation • Economic value of better public health from reduced pollution
SOCIAL	Improved quality of life	• Non quantitative benefits
ECONOMIC	Reduced stormwater treatment demand	• Reduced stormwater treatment costs at wastewater treatment plants based on GI stormwater retention • Chemical and energy savings at waste water treatment plants
ECONOMIC	Green jobs	• From federal infrastructure investment estimates and engineer estimates

Life Cycle Analysis Inputs

NYC Environmental Protection

20'x5' bioswale with tree			**Conversion Factors:**		
			$1ft^3$ =	28316.8466	cm^3
Case Study: NYC Standard Bioswale			1 in =	1000	mils
Technology: NYC Standard Bioswale with 2 curb cuts and 1 tree			1 ft =	12	in
Manufacturer:			$1ft^3$ =	1728	in^3
Installer:			1 ton =	2000	lb
Lifespan: Assume 25 years					
INPUTS ARE FOR 1 bioswale					

Stage	Description	Data/Assumptions	Calculations	Units	LCA Description
M	Excavation of sand for engineered soil	Quantity: 2'x20'x'5', minus gabion in soil (3'x1'x2'), 80% of engineered soil	155	ft3	Sand, at mine
	Transport of sand to site		30	miles	Operation, lorry 3.5-16t, fleet average/RER U
	Manufacturing of geotextile over stone bed	Quantity: 20'x5' + 2*20'x2' + 2*5'x2'	3.77	kg	Polypropylene
	Transport of geotextile		50	miles	Operation, van <3,5t/RER U
	Production of concrete for pour in place	Quantity: 6 flags (5'x5'x4"), curb (length of bioswale plus 2 flags on either side x 8" wide x 18" deep), header (3 sides of bioswale (30lf) x 6"x15"), aprons (2*46"x18"x8")	6930.8	kg	Concrete, not reinforced

Life Cycle Analysis Environmental Impact Metrics

Environmental Protection

Impact2002 Impact Units
Carcinogens (kg C2H3Cl)
Non-carcinogens(kg C2H3Cl)
Respiratory Inorganics (kg PM2.5 eq)
Ionizing radiation (Bq C-14 eq)
Ozone layer depletion (kg CFC-11 eq)
Respiratory organics (kg C2H4 eq)
Aquatic ecotoxicity (kg TEG water)
Terrestrial ecotoxicity (kg TEG soil)
Terrestrial acid/nutri (kg SO2 eq)
Land occupation (m2org.arable)
Aquatic acidification (kg SO2 eq)
Aquatic eutrophication (kg PO4 P-lim)
Global warming (kg CO2 eq)
Non-renewable energy (MJ primary)
Mineral extraction (MJ surplus)

Cost and Benefit Comparison Tool - Beta

NYC Environmental Protection

NYC Green Infrastructure Cost-Benefit Comparison Tool

ROW Bioswales | Large Bioretention | Porous Pavement | Constructed Wetland | Green Roof | Blue Roof | Tool Setup

Co-Benefits

- Carbon Sequestration
- Urban Heat Island Mitigation
- Reduced Energy Demand
- Improved Ecosystem Services
- Improved Air Quality
- Improved Quality of Life
- Increased Property Value
- Reduced Treatment Needs
- Green Jobs

Co-Benefit Details

Urban Heat Island Mitigation

Description:

Thermal properties of common urban surfaces can lead to warmer air temperatures. By using natural surfaces that are cooler and reflect more solar radiation, green infrastructure can help reduce urban heat island impacts.

Literature:

Higher surface albedos are reported in the literature for vegetation and soil surfaces than materials like asphalt pavement. These higher albedos mean less heat is being captured by these materials.

Details

NYC Monitoring:

Infrared thermometer measurements confirmed that vegetation surfaces were cooler than bare soil and surrounding pavements. Air temperature reductions may not be consistently evident due to other site-specific factors.

Details

Calculator Inputs

Save Name: ROWB 1

50	ROWB Footprint (ft^2)
2000	Managed Impervious Area (ft^2)
25	Anticipated Lifespan (yrs)
75	Shrub and Herbaceous Cover (%)
10	Tree Canopy Coverage (%)
>75%	Flowering Vegetation
100%	Native Vegetation
2-10	Plant Species
Corner Park	Visible Greenspace
Accessible	GI Accessibility
Unknown	Community District

Unknown/General

Calculate

Calculator Outputs

Total | Per ft^2 GI | Per ft^2 Man. | Per Gal.

Geographic need: High Low

Environmental

37,400	Gallons Managed (gal/yr)
180	CO2 Produced (lb/yr)
707	Carbon Sequestered (lb/yr)
4.36	Inferred CO2 Reduction (lb/yr)
2.14	Ozone Removed (lb/yr)
1.91	PM10 Removed (lb/yr)
1.73	NO2 Removed (lb/yr)
1.00	SO2 Removed (lb/yr)
0.51	CO Removed (lb/yr)
86 %	Urban Heat Island Potential
79 %	Ecosystem Services Score

Ecosystem Score Detail

High	Pollinator Support
High	Native Habitat Support
Medium	Biodiversity Support
Med-High	Green Corridor Support

Social

Save/Open Mode | Compare Mode | Help Enabled | Tutorial

Saved for Comparison: ☑ ROWB 1 ☑ ROWB 1 ☐ ROWB1 ☐ ROWB1 ☐ ROWB1 ☐ ROWB1 ☐ ROWB1 ☐ ROWB1 ☐ ROWB1 ☐ ROWB1

View Comparison

Conclusion

Green Infrastructure, an adaptive management framework that promotes flexibility and leverages co-benefits, is a crucial element of New York City's resiliency programs.

PlaNYC: A Stonger, More Resilient New York

nyc.gov/**resiliency**

2013 Green Infrastructure Annual Report

nyc.gov/**greeninfrastructure**

NYC Wastewater Resiliency Plan

nyc.gov/dep/**climatechange**

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