Life-cycle cost analysis & capital spending

Application: green infrastructure, City of New York

April 8, 2014

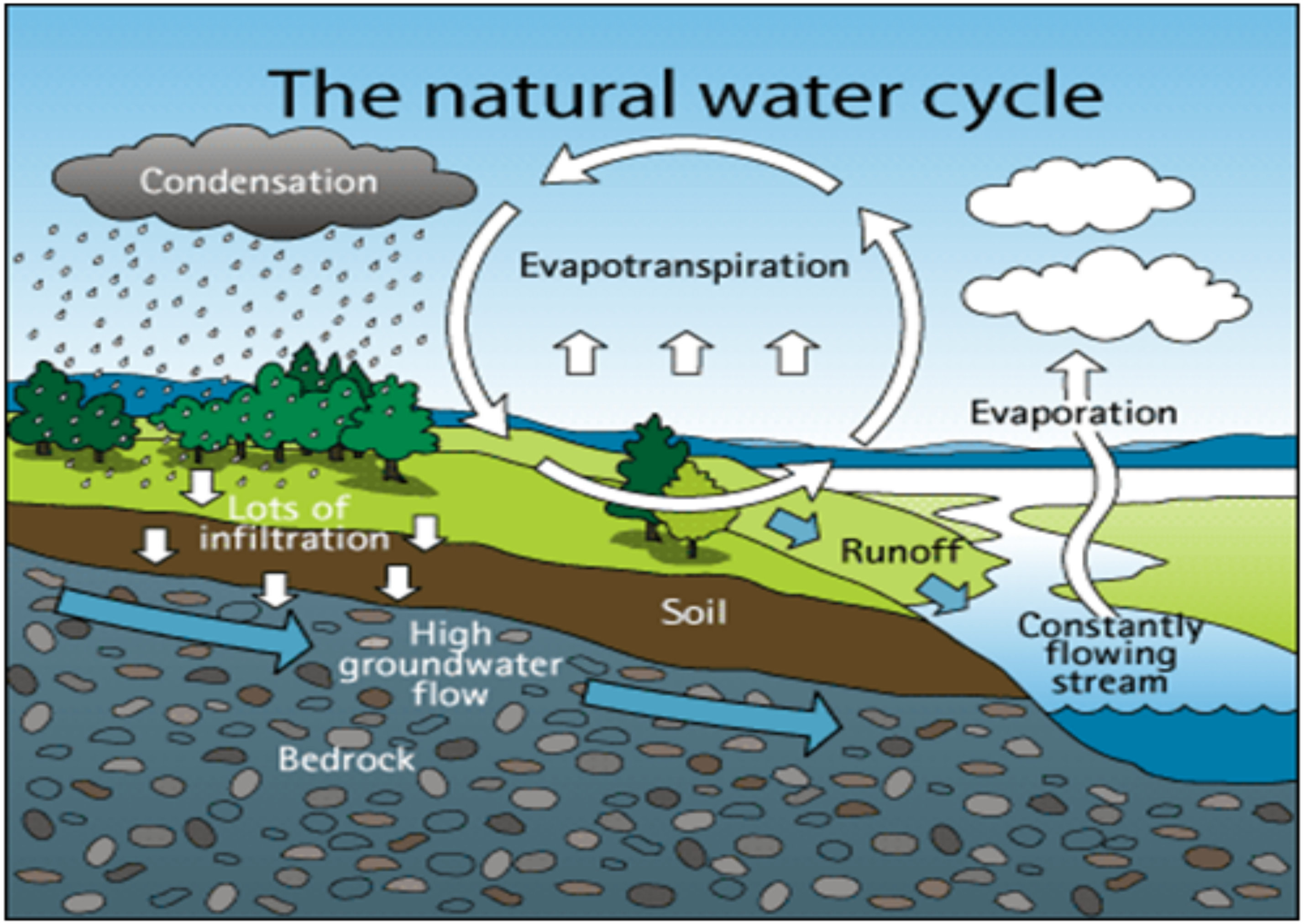
Objective

This project employs the principles of life-cycle cost analysis to evaluate projects at the City of New York.

- *LCC: method of evaluating costs over a project's lifetime.*
- *Accounts for all costs of acquiring and owning buildings, infrastructure or other physical capital.*
- *Discounts and aggregates cost components over time to a single present day value.*
- *Helps compare alternatives that fulfill similar needs.*

… applied to green infrastructure in NYC

Green infrastructure diverts storm water from sewers and returns it to the natural water cycle.



Background: manage storm water

The City faces the long-term challenge of improving water management by, to the extent possible, keeping runoff out of the sewers during major storms.

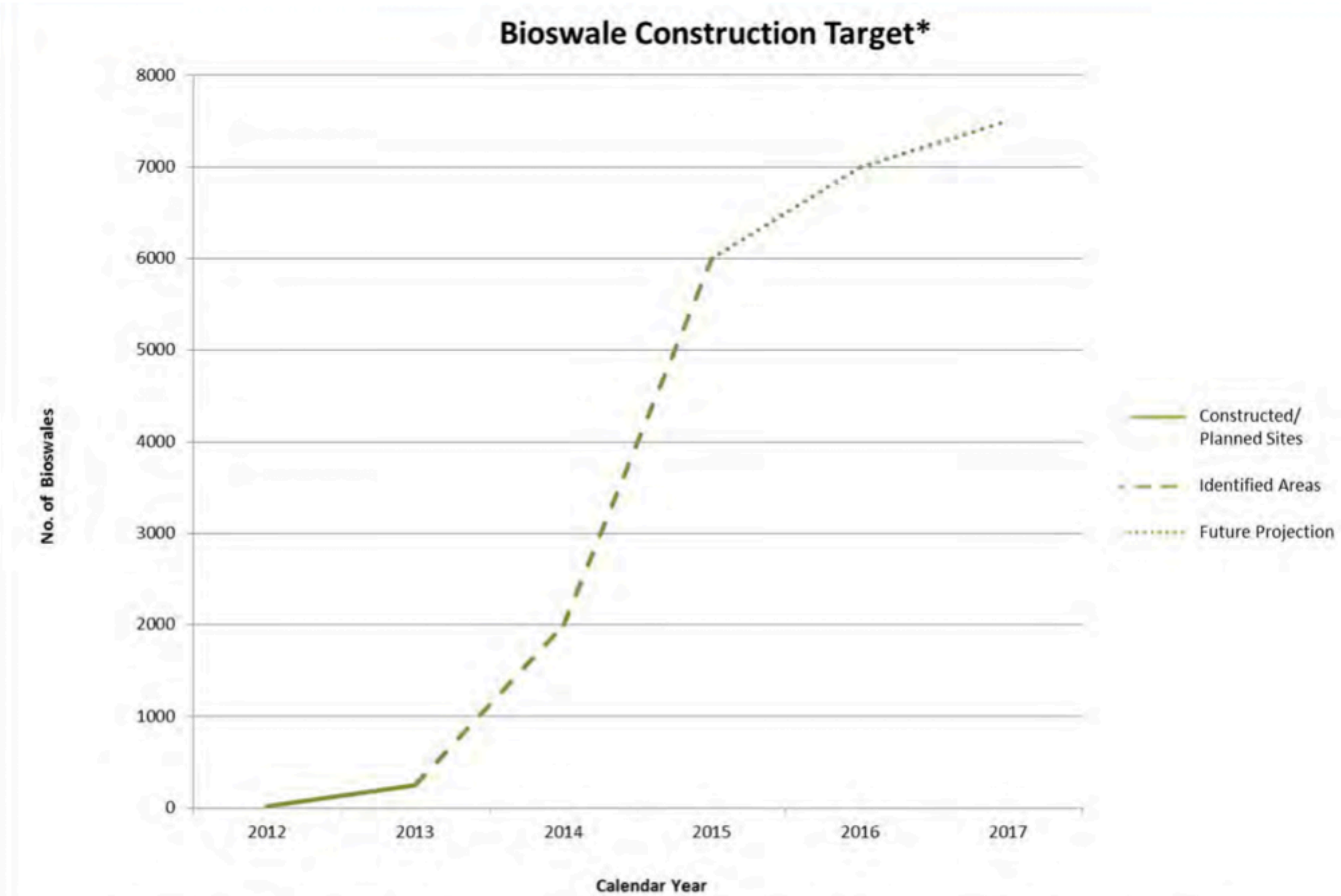
The City must better manage storm water.

Public offices published a Green Infrastructure Plan in 2010.*

- *Major goal: reduce pressure on combined sewer-storm water system.*
- *Approach includes grey infrastructure and green infrastructure.*

* The City wants to capture the first inch of rainfall on impervious area within combined sewer watersheds during storms.

Background: bioswales and New York City



Background: permeable (porous) pavement

Background: Town + Gown program

Research projects facilitate partnerships between academics and practitioners to investigate potential changes to practices and policies.

Relevant projects

Geographic information systems

State University of New York – Buffalo, 2013

Investigated technical problems when applying life-cycle cost analysis to the City of New York.

Incorporating life-cycle cost analysis

New York University, 2011

A holistic look at one department's effort to employ life-cycle cost analysis.

Outside Town + Gown:

Life-cycle costing & green infrastructure

Columbia University, 2012

Matchmaking project regarding the City of New York and permeable (porous) pavement.

Background: LCC, discounting


COMPREHENSIVE PAVEMENT DESIGN MANUAL

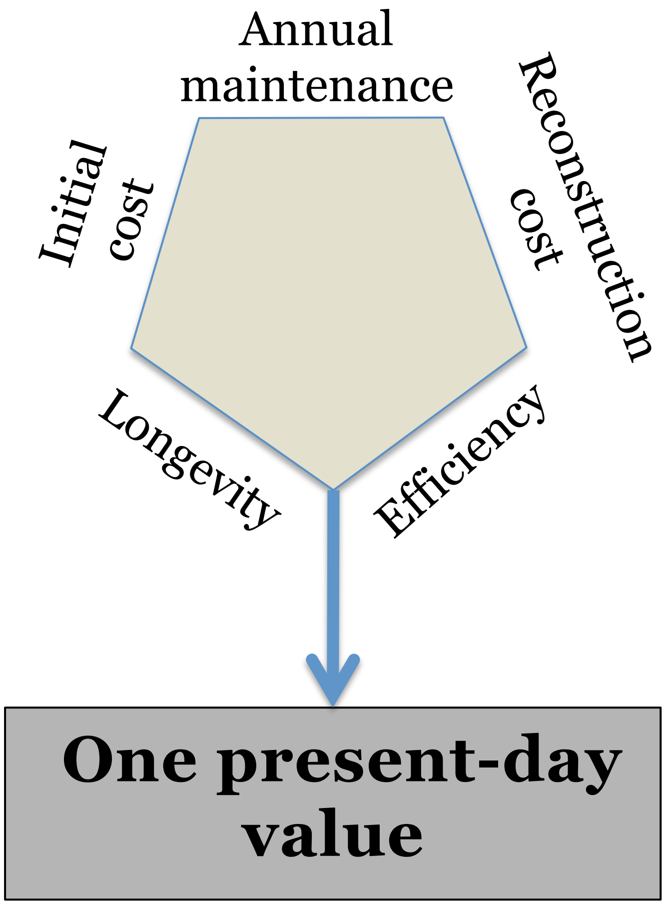
Design Division &
Technical Services Division

New York State Department of Transportation

This project looked to New York State Department of Transportation's Comprehensive Pavement Design Manual, which describes established practices regarding life-cycle costing and capital design.

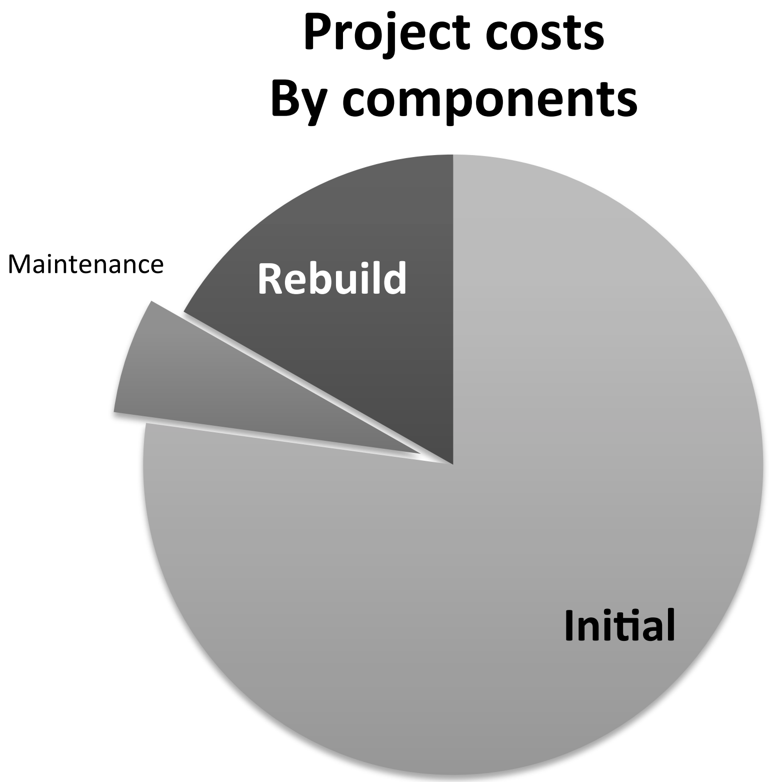
Functions

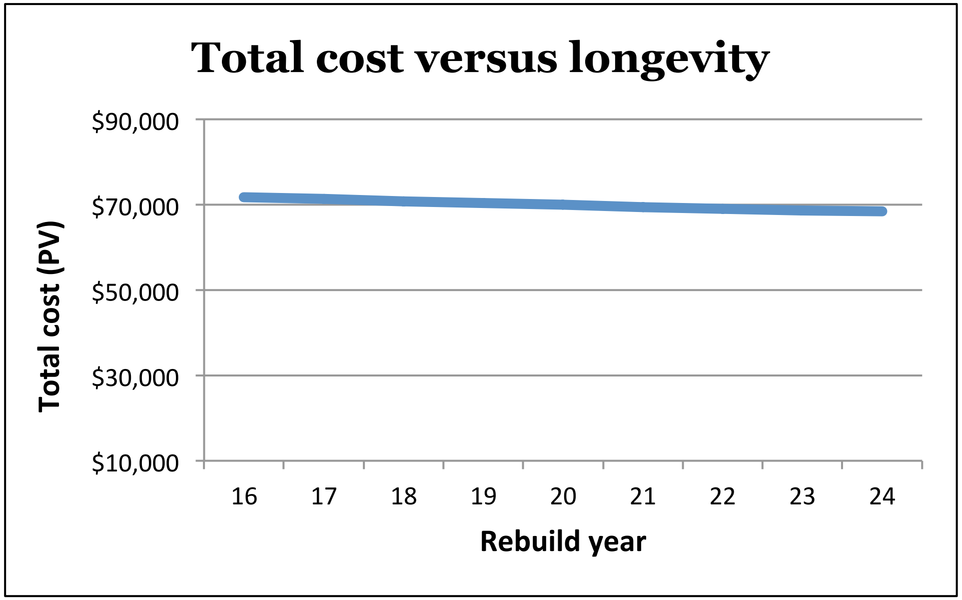
Model relies on discounting — a central tool in economic analysis— to combine projects' upfront and future costs into single, present-day estimates.



Functions

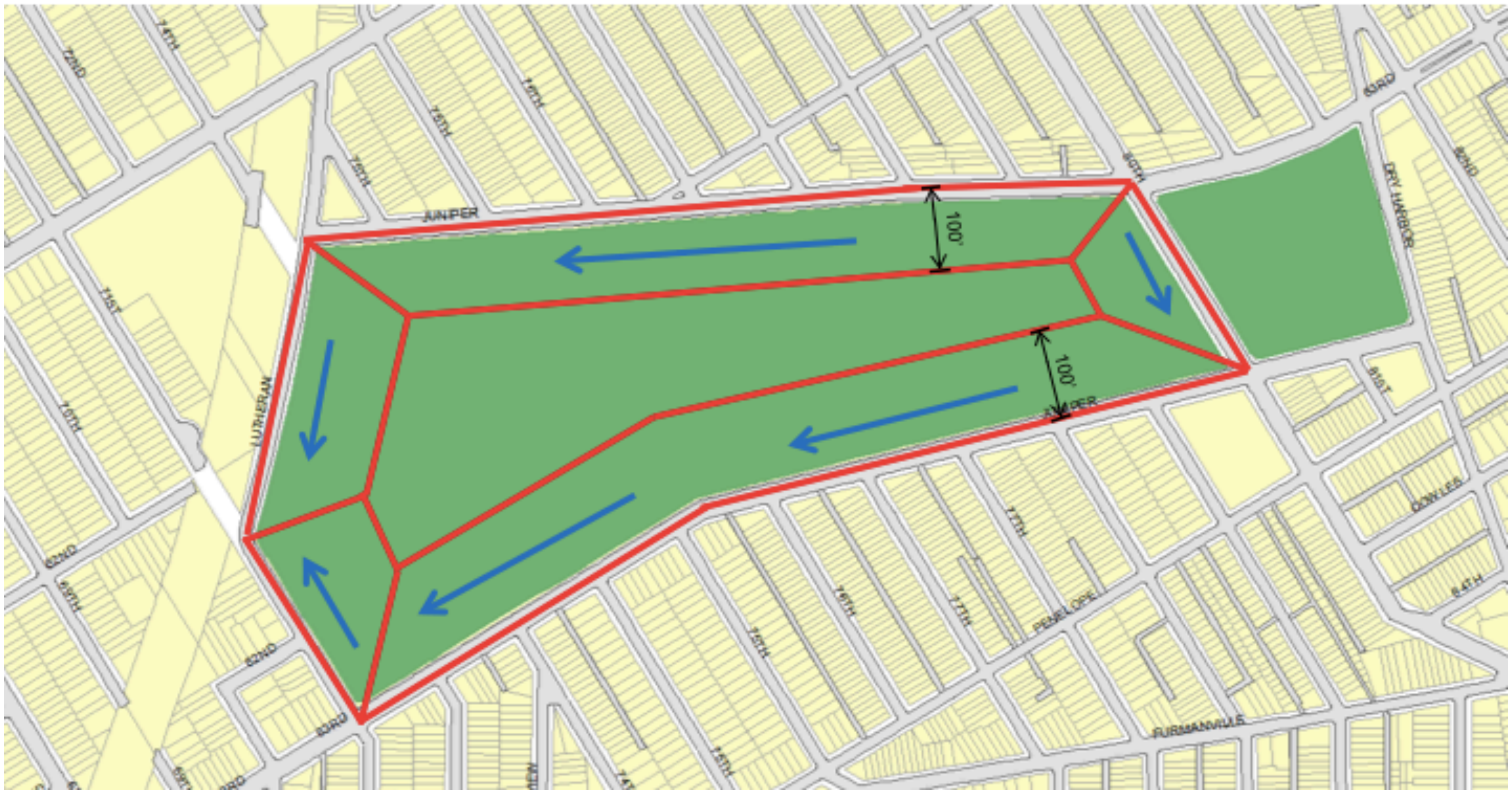
Model allows for intra-project analysis and inter-project comparisons. For example, it displays the dominance of initial construction costs in total cost calculations and considers total cost's sensitivity to individual cost components.





Design and instructions

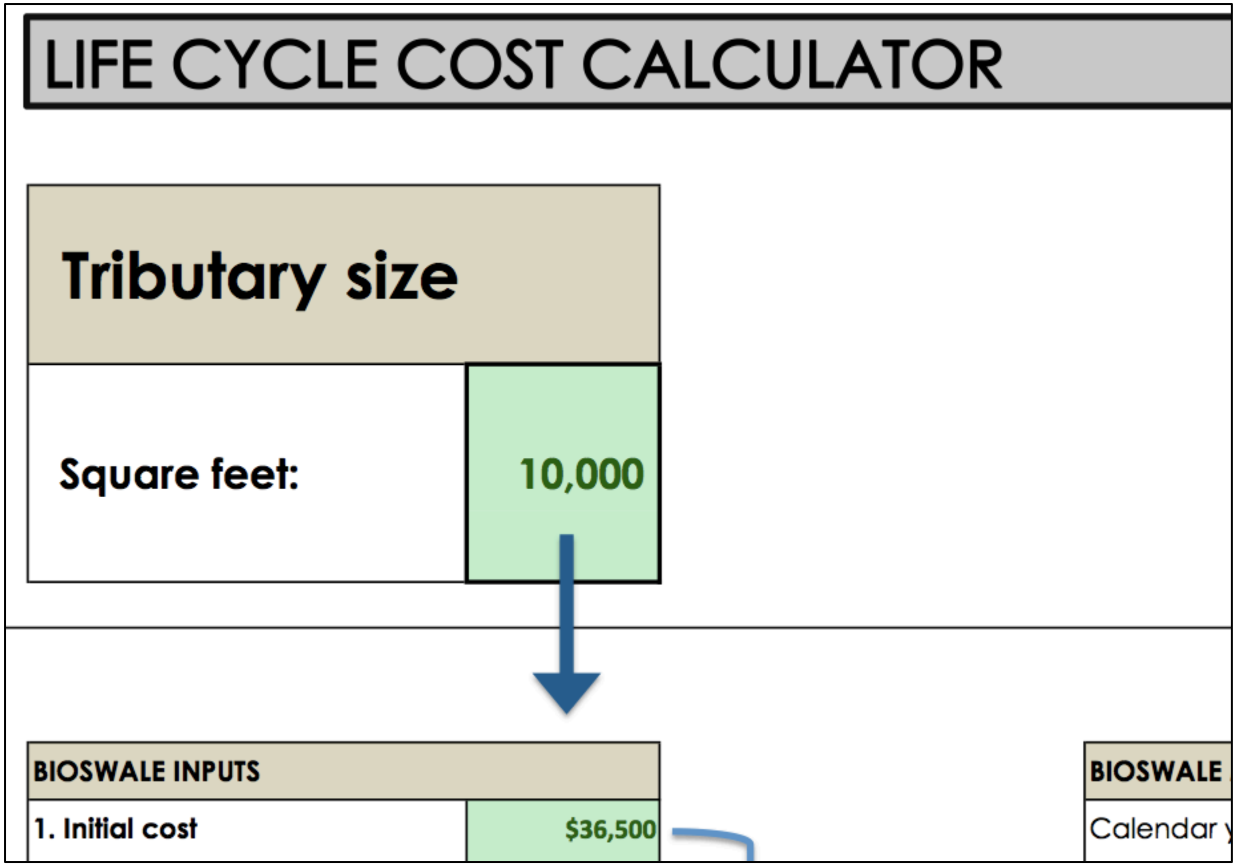
Agencies appear to size green infrastructure to fit specific tributaries, or catchment areas. The tributary size is a key input in this model.



- From NYC DEP's tributary drainage analysis procedure (PDF)

Design and instructions

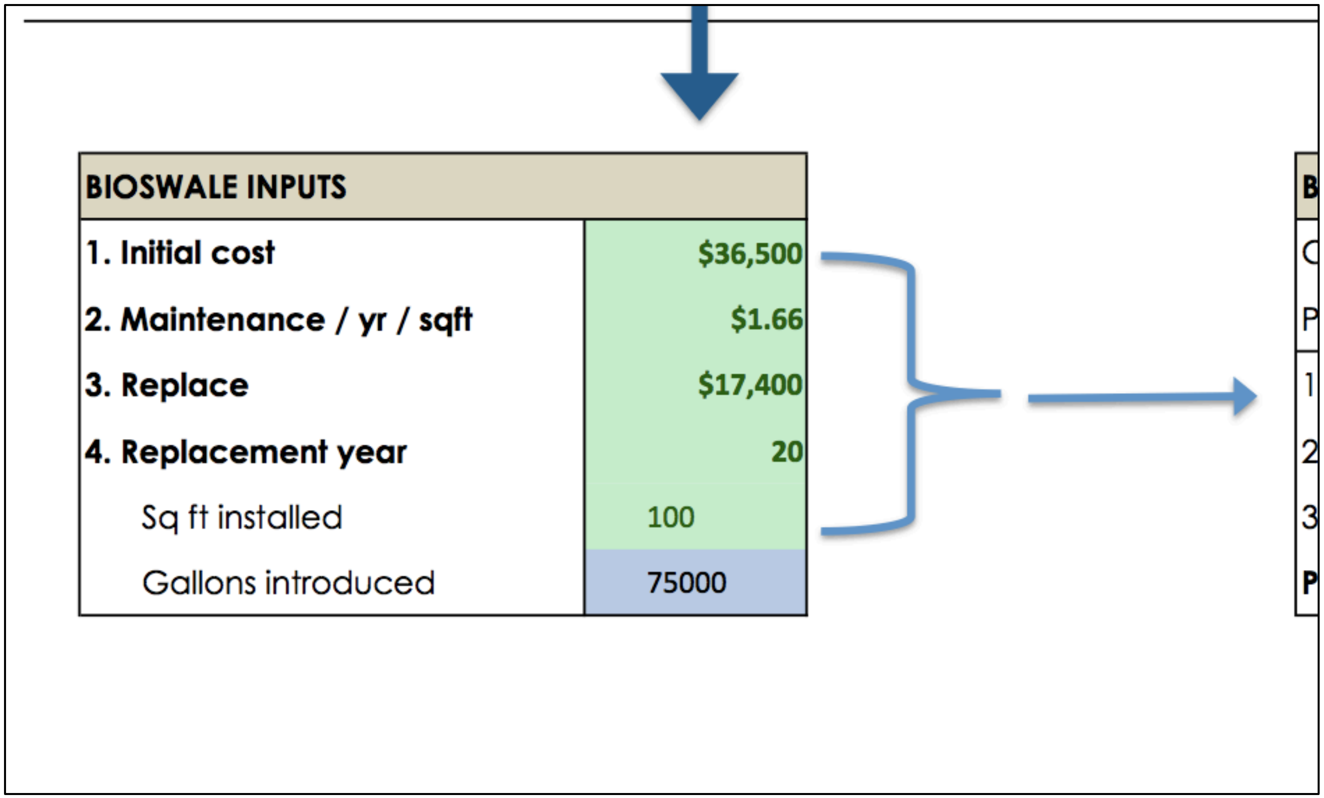
The model populates (updates) automatically when a user changes the size of the catchment area being considered.



- From the model's "MAIN: TOTAL COST" sheet

Design and instructions

… it also adjusts when the user updates any cost component — initial cost, maintenance, reconstruction costs, and installation lifespan.



BIOSWALE INPUTS	
1. Initial cost	$36,500
2. Maintenance / yr / sqft	$1.66
3. Replace	$17,400
4. Replacement year	20
Sq ft installed	100
Gallons introduced	75000

The model is designed for agencies to use!

Public value

This model is designed to provide real value to the City's budget, transportation, environmental protection, and design and construction teams.

Direct value

- *Reinforce traditional capital analysis with more holistic perspective*
- *Help City understand capital, operating costs associated with alternatives*

Indirect value

- *Supports interagency collaboration*
- *Buttresses City's commitment to transparency*

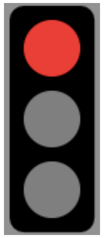
Data collection and limitations

Limits in data collection:

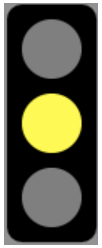
- *Some data, particularly re: pavement, was slim*
- *Result: analysis and results remain <u>conceptual</u>*
- *Model, however, is not conceptual and can be used*

Rating system: data quality

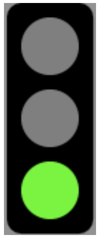
- Red light = suspect to errors



- Yellow light = researched, not yet concrete



- Green light = researched, trustworthy



Data collection and limitations

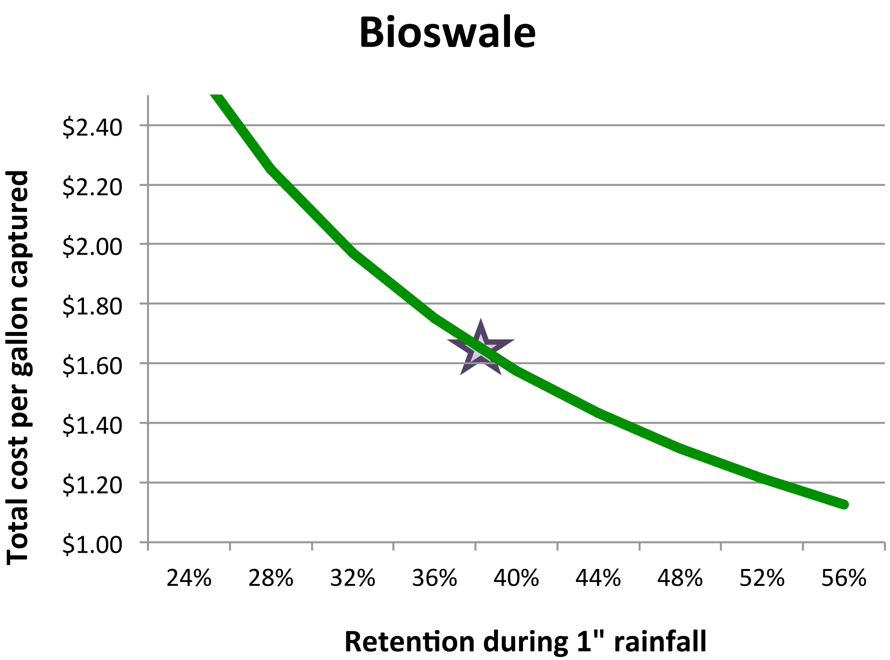
The model's first analysis (mine) applied data collected in late 2013 to two conceptual green infrastructure projects envisioned at the same site.

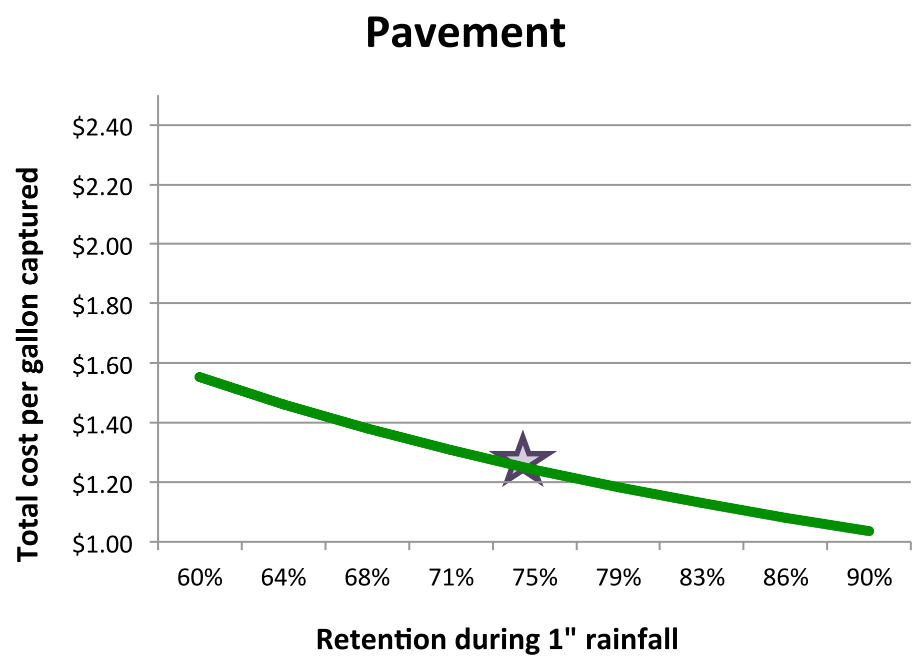
Bioswale cost component	Estimate	Validity
Initial cost	$36,500	
Annual maintenance	$1.66/sq ft/year	
Longevity and reconstruction cost	20 years, $17,500	
Efficiency	**40 percent**	

Pavement cost component	Estimate	Validity
Initial cost	$58,000	
Annual maintenance	$0.40/sq ft/year	
Longevity and reconstruction cost	20 years, $17,500	
Efficiency	**75 percent**	

Findings

Initial costs, efficiency are bigger determinants of total project cost than maintenance, longevity or reconstruction cost. Below: cost per gallon captured & installation efficiency.





City agencies can, using established initial cost estimates and reasonable assumptions for efficiency, compare projects.

Next steps

Agencies work together, develop most efficient and cost-effective green infrastructure: the public's best interest.

1 Incorporate historical weather data

Important regarding efficiency

2 Account for major external benefits

Particularly for bioswales

Existing software should make this quite manageable

3 Collaborate

Share data and, when data isn't concrete, use best numbers available

Thank you!

More specifically, thanks to:

NYC Department of Design and Construction
NYC Department of Environmental Protection
NYC Department of Transportation
NYC Department of Parks and Recreation
NYC Office of Management and Budget
Port Authority of New York and New Jersey
NYS Department of Transportation
Columbia University | SIPA
Columbia Engineering (SEAS)
City of Portland Bureau of Environmental Services
… and others too numerous to mention