

Tools and Resources for Integrating Trees in Green Infrastructure



JENNIFER GULICK

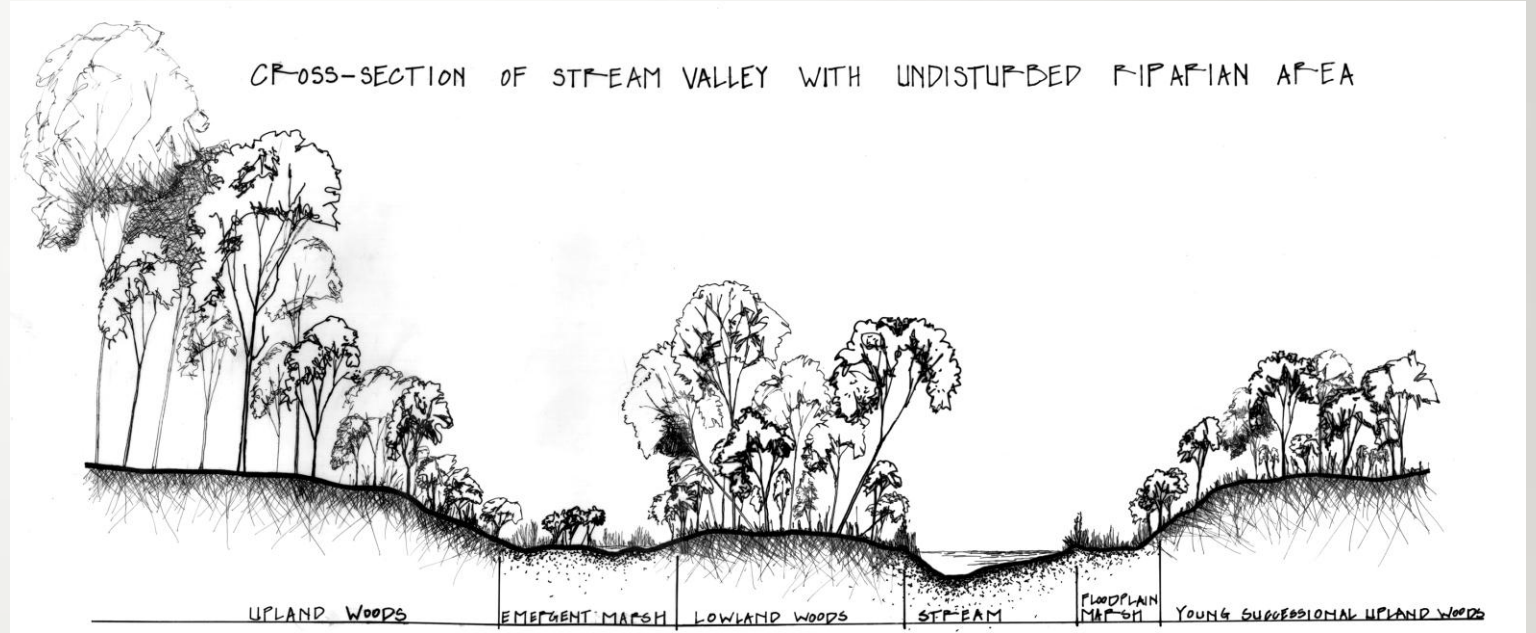
URBAN CANOPY WORKS, LLC



You Can't
Fight
Mother
Nature

So, work WITH
Mother Nature
instead!



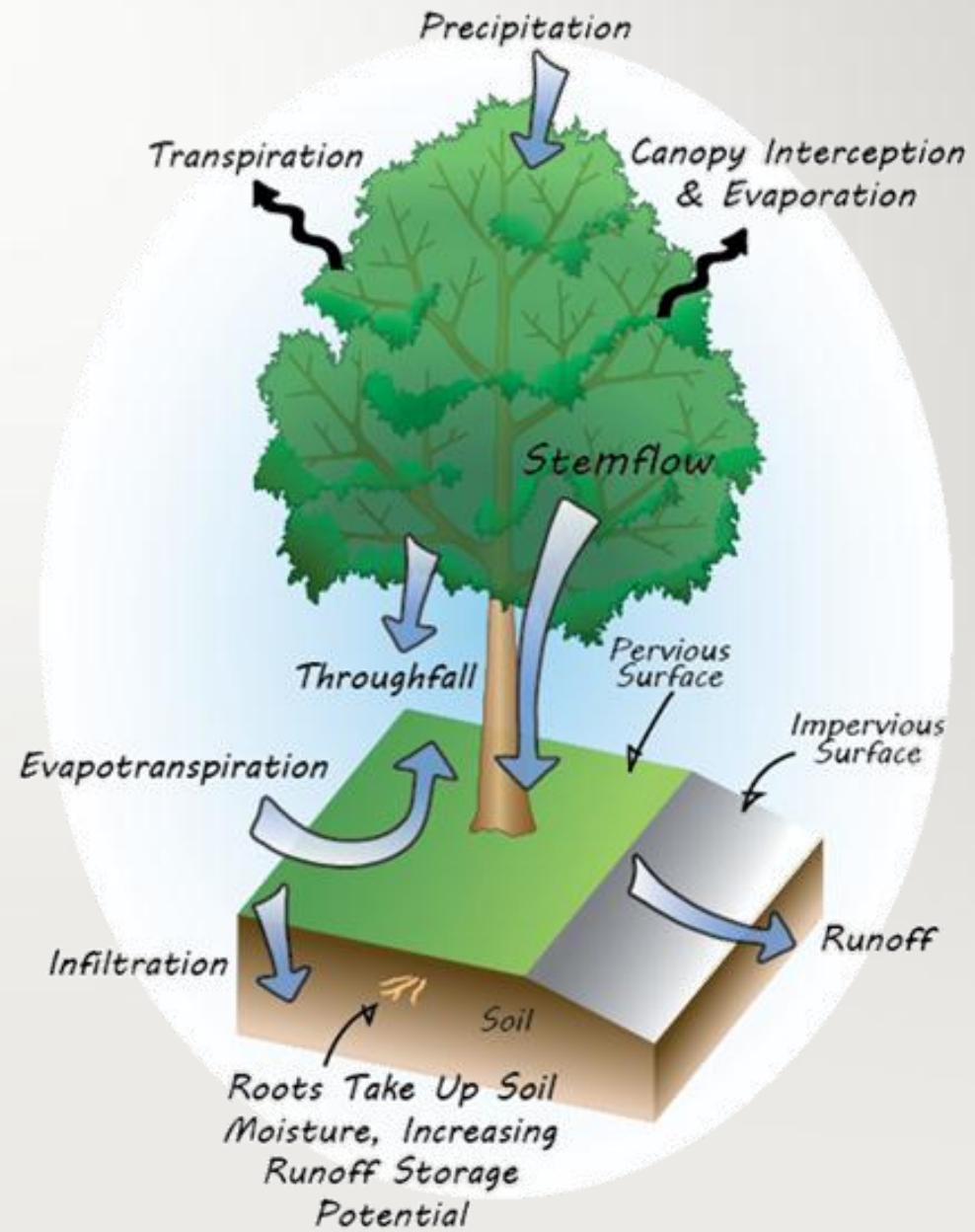


Mimic Nature

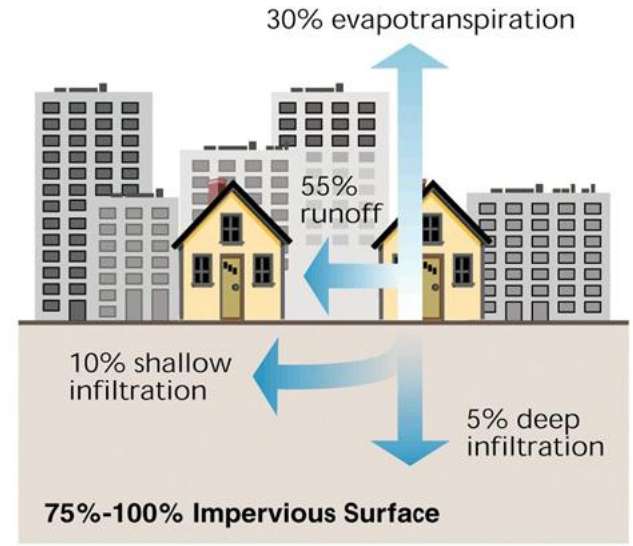
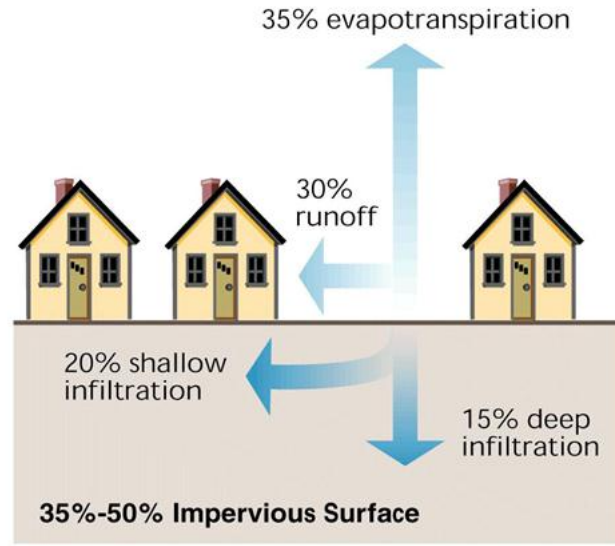
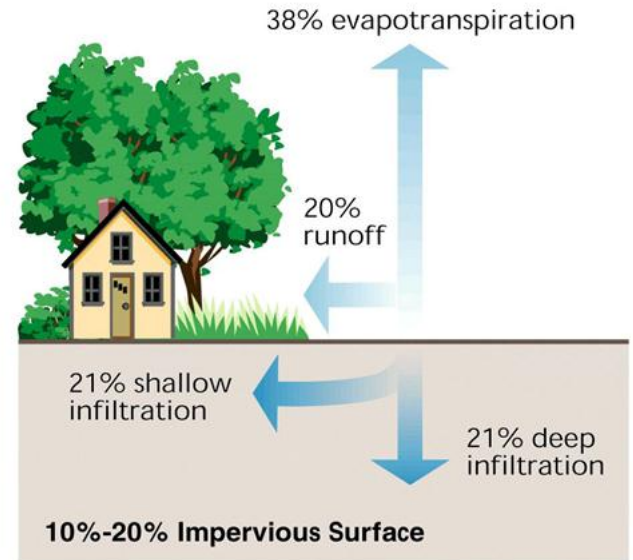
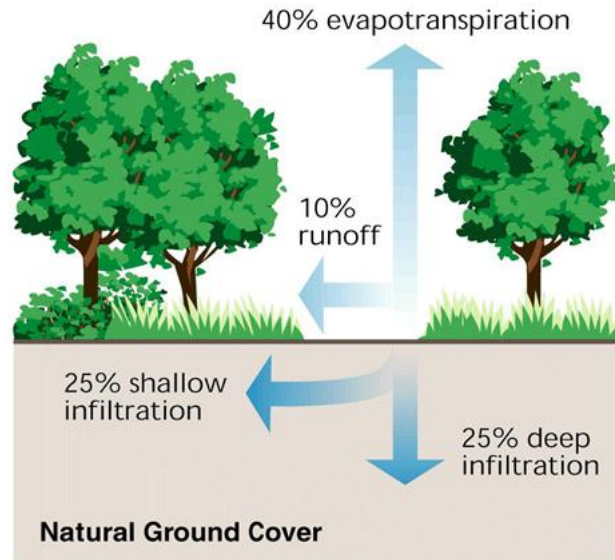
Fact:

**A single oak tree
can absorb
40,000 gallons of
stormwater
annually.**

(USGS)



Effects of Development



Trees Work!

- We have the **SCIENCE** to prove it

- We have the **PROJECTS** to prove it



i-Tree Tools

A Suite of USDA Forest Service Urban and Community Forestry Analysis and Benefits Assessment Software:



- ✓ State-of-the-Art
- ✓ Peer-Reviewed
- ✓ Free of Charge to the Public
- ✓ Easy to Implement
- ✓ For Communities of All Sizes
- ✓ Promote and Strengthen Urban and Community Forestry Management Efforts





Trees contribute positively to stormwater management

Year Completed	<i>i-Tree Reference City</i>	Number of Trees Studied	Annual Stormwater Benefits (dollars)	Rainfall Intercepted Annually by Trees (million gallons)
2006	Albuquerque, N.M.	4,586	\$55,833	11.1
2005	Berkeley, Calif.	36,485	\$215,645	53.9
2004	Bismarck, N.D.	17,821	\$496,227	7.1
2007	Boise, Idaho	23,262	\$96,238	19.2
2005	Boulder, Colo.	25,281	\$357,255	44.9
2006	Charleston, S.C.	15,244	\$171,406	28.3
2005	Charlotte, N.C.	85,146	\$2,077,393	209.5
2004	Cheyenne, Wyo.	17,010	\$55,301	5.7
2003	Fort Collins, Colo.	31,000	\$403,597	37.4
2005	Glendale, Ariz.	21,480	\$18,198	1.0
2007	Honolulu, Hawaii	235,800	\$350,104	35.0
2008	Indianapolis, Ind.	117,525	\$1,977,467	318.9
2005	Minneapolis, Minn.	198,633	\$9,071,809	334.8
2007	New York City, N.Y.	592,130	\$35,628,220	890.6
2009	Orlando, Fla.	68,211	\$539,151	283.7
2003	San Francisco, Calif.	2,625	\$466,554	99.2
2001	Santa Monica, Calif.	29,229	\$110,784	3.2

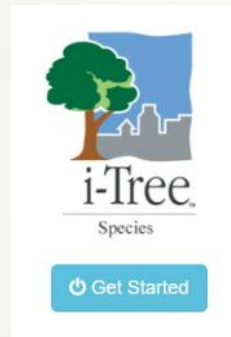
U.S. Forest Service's i-Tree Tools

(www.itreetools.com)

Each year DC's trees filter 44,274,580 cubic feet of water equating to about \$779 million per year. That is equal to about 500 Olympic size swimming pools.

SPECIES NAME	NUMBER OF TREES	AVOIDED RUNOFF VALUE (\$/YR)
 TULIP TREE	110,911	\$117,343,848
 AMERICAN ELM	47,844	\$64,098,587
 COMMON CRAPEMYRTLE	104,387	\$39,919,104
 AMERICAN BEECH	387,101	\$98,547,221

i-Tree Species



Species are selected based on three types of information:

1. **Hardiness** – as determined by state and city.
2. **Mature height** – user specified minimum and maximum heights.
3. **Environmental factors** – ranked from 0 to 10:
 - o Air pollution removal
 - o Air temperature reduction
 - o Ultraviolet radiation reduction
 - o Carbon storage
 - o Pollen allergenicity
 - o Building energy conservation
 - o Wind reduction
 - o Stream flow reduction (storm water management)

Air Pollutant Removal (0-10 importance)

Rank each of the following environmental services from 0 to 10 on how important these tree services are to you. 0 = not important; 10 = highly important.

Pollutant Removal

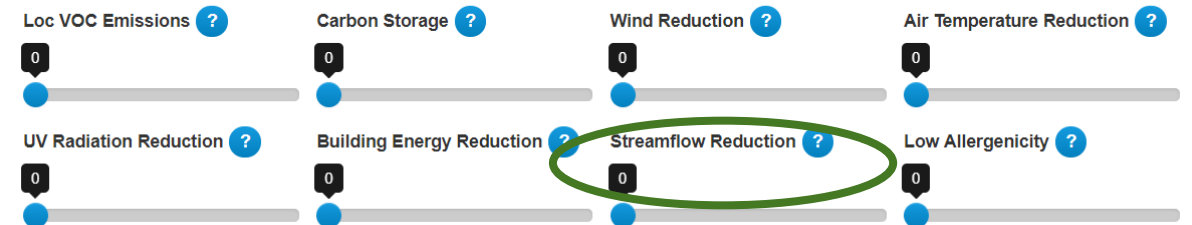
Overall Specific

Overall Rate ?



- Select Overall to consider the overall air pollutant removal impact of any tree (weights five pollutants based on the estimated effect of each pollutant).
- If you wish to rank the pollutants individually, select Specific to see a list of five pollutants.
- Ranking sliders: 10 is most important while choosing 0 means the pollutant will not be considered during species selection.

Other Functions (0-10 importance)



i-Tree Design



i-Tree Design v6.0

7178 Tippenhauer Rd, Newport, KY 41076, USA

[Start Over](#)
[Save Progress](#)
[About](#)

Get started with these easy steps:

1. Draw Structures

2. Place Trees

Describe your tree:

- Tree species: (Lower Midwest region)
Elm, American
- Tree diameter: 2 Inches
or circumference: 6.3
- Tree condition: Excellent
- Tree exposure to sunlight: Full sun

To place a tree:

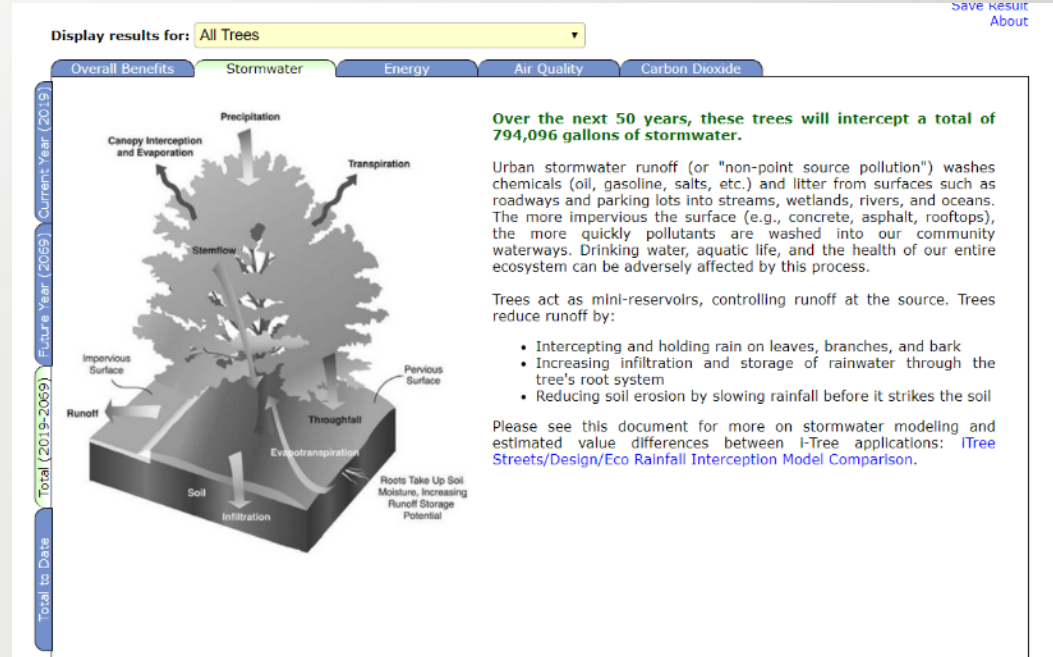
- Drag this icon to the location on the map where you would like to place your tree.
- Repeat to place additional trees.
- Hover over any tree you have placed on the map to display its benefits.

Model the tree(s) future crown growth over time:

[Model Crown Growth](#)



Map data ©2019 Google Imagery ©2019, DigitalGlobe, U.S. Geological Survey, USDA Farm Service Agency | Terms of Use
Lat: 38.98826
Lng: -84.45573



Trees and Stormwater

A Guide for Local Decision Makers

www.treesandstormwater.org



The natural solution is the best solution

Trees intercept rainfall and help increase infiltration and the ability of soil to store water. By retaining water in their canopy – even for a short time – trees can disperse precipitation over a longer time period and reduce velocity of the water when it does fall.

The Guide

- It Works!
- Return on Investment
- Regionally relevant case studies
- Create a customizable report to inform and base decisions



www.treesandstormwater.org

Introductory Video





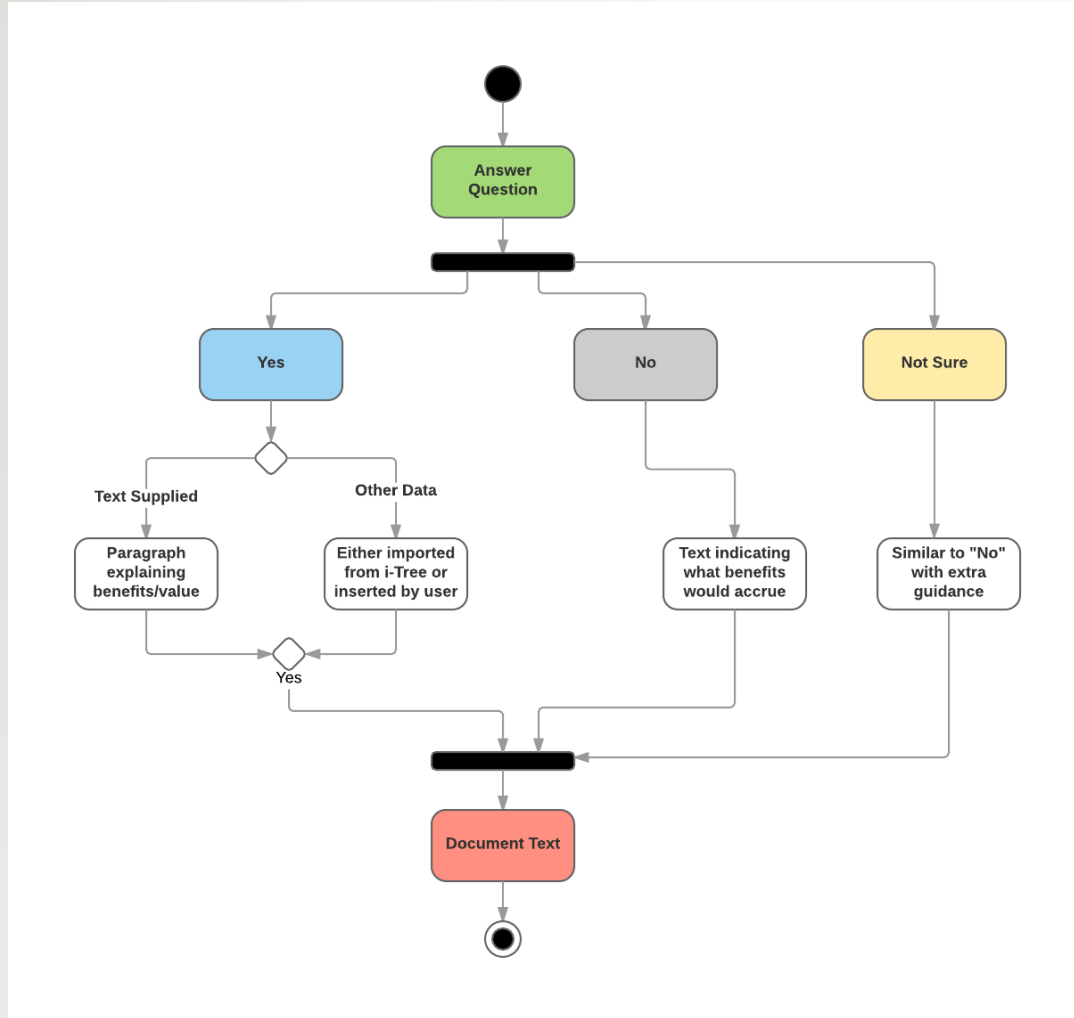
Why Build a Document?

- Because you want to learn about stormwater management and trees
- Because you want someone else to learn the same thing
- Because adding trees to new development and redevelopment initiatives and save money and create healthier, more livable neighborhoods.

Think of this as both a learning and teaching tool ... and a way to stimulate policymakers



How Does it Work?





So What is It?

A detailed questionnaire which enables you to characterize your community, and how it manages its trees.

Our current urban tree canopy covers this % of our community:	Type Here:
I can't locate these figures and/or to my knowledge, they don't exist:	■
Does your community maintain an inventory of street-side and road-side trees:	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Not Sure
Has a comprehensive plan ["comp" plan] been adopted for your community?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Not Sure
If yes, are there specific provisions that deal with <u>your</u> community's water resources?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Not Sure
If there <u>are</u> provisions that deal with water resources, do they call for use of green infrastructure to help implement the plan?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Not Sure
Is your community part of a regional planning organization?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Sure

Urban Forests in Your Community

Many communities already have urban forestry projects and programs underway. In this section, we'll ask you to describe – to the best of your ability – the extent of your **urban forest** [link to definition]. Often expressed as **urban tree canopy**, these numbers may be available from your community's urban forester or arborist, or from your state forestry agency's urban forestry coordinator. Likewise, you may find them by searching online.

Our current urban tree canopy covers this % of our community:

I can't locate these figures and/or to my knowledge, they don't exist:

Does your community maintain an inventory of street-side and road-side trees: Yes No Not Sure

To the best of your knowledge, is your urban tree canopy distributed through all neighborhoods in your community? Yes No Not Sure

Take 20 Minutes to Find Out About Your Urban Forest: Where It Is, and What It Does!
[Link to I Tree Landscape](#)
Download results to your user library.

The Value of Urban Forestry

Trees in neighborhoods provide many vital benefits that aren't well-known or even acknowledged. And the value of these benefits far outweighs the cost of managing the trees that deliver them.

Tell us what benefits you'd like to explore – and that others in your community need to know about. We'll add a brief description to your case statement for each of the benefits you mark.

For Stormwater Management	[✓] if Interested
Interception	
Infiltration	
Pollution Reduction	
Evapotranspiration	
Soil Conditions [macropores]	
Flood Control	

The Value of Urban Forestry

Benefits to the Public	[✓] if Interested
Air quality	
Public health	
Children's health and well-being	
Energy conservation	
Carbon sequestration	
Mitigating urban heat island	
Vibrant business districts	
Safer, healthier and more cohesive neighborhoods	
Other [Type]	
Other [Type]	

The Answers



Why It's Important to Know Your Canopy Cover. Trees have long been deemed an essential part of the urban landscape. At the end of the 19th century, advocates praised the cooling, calming effect of trees and noted that their interlocked canopy created healthier neighborhoods. By the late 20th century and into the 21st we learned how to measure and quantify these benefits and more, and to assess their monetary value to the community.

If No or Not Sure, ADD: Because we need to know where to start – and more important, what we stand to gain – we should develop at least a rough estimate of both the extent of our tree canopy and the services it provides to our residents.

Street Tree Inventory. A street tree inventory enables us to plan periodic inspections, check for pests and disease, remove hazardous trees and reduce liability.

If No or Not Sure, ADD: Without one, we're stuck in a reactive mode, fixing problems as they're reported – often spending more to accomplish less.



Excerpts from a “Built Document



Region:

Great Lakes:

This region is characterized by cold winters and warm to hot humid summers. Heavy precipitation can fall anytime of the year but occurs most often in the spring and summer. Snow is common in the winter with heavy accumulations in the northern portions of the region especially the narrow bands on the eastern south eastern shores of the great lakes. This region is home to the world's largest supply of liquid fresh water. Precipitation range 30 – 50 inches annually.

Urban Forestry in Your Community

With our urban forestry master plan, we can identify the benefits we get from trees, and make certain that these benefits are equitably distributed. Developing an urban forestry master plan can assure we maximize the benefits from our urban forests, expand them to areas that need more trees, and focus our resources – now and in the future – on sustaining our forests, not reacting to threats.

An urban forestry master plan would help identify opportunities to assure healthy trees on both public and private lands, and assure that the community [including the owners] accrue all the benefits these trees deliver – energy savings, stormwater management, cleaner air, and others.

- Covers all sections
- Text correlated to answers from questionnaire
- Can be edited off-line
- Images, maps, charts and tables can be added
- Exportable



What's Covered

Urban Forestry in Your Community

The Value of Urban Forestry

Characteristics of Your Urban Forests

Private Land Policies in Place in Your Community

Demonstrating How Urban Forestry Helps Manage Stormwater

- Exemplary projects, including schematics
- Case studies
- Flow reduction calculators
- Creating coalitions
- Common barriers and solutions
- Funding

Partnerships are the key to success

Trees & Stormwater (beta)

KNOW YOUR COMMUNITY

IMPLEMENT

MONITOR AND MAINTAIN

RESOURCE LIBRARY

DOCUMENT BUILDER



Finding and Recruiting Allies

You can't do it alone. To make yours a tree-rich community, you'll need to find and recruit allies from other municipal departments, community leaders, and the public itself. ☺



Engaging and Motivating Stakeholders

To achieve green infrastructure and tree canopy goals, you must influence what residents, businesses, and institutions do on their own property. ☺

The Guide Has Resources for You

KNOW YOUR COMMUNITY ▾ IMPLEMENT ▾ MONITOR AND MAINTAIN ▾ RESOURCE LIBRARY DOCUMENT BUILDER



Case Studies

- Community Engagement** (8)
- General Guidance** (23)
- Innovative Design** (4)
- Modeling Impacts** (4)
- Multi Agency Alignment** (7)
- Plans** (35)
- Public Private Partnerships** (3)
- Use of Available Technologies** (8)
- Zoning, Ordinances, Regulations, Incentives** (7)

Stormwater Impact

- Best Management Practice** (10)
- Fact Sheet** (7)
- General Guidance** (18)
- Tools & Calculators** (12)
- Tree Selection** (6)
- Useful Approaches** (10)

Case Studies & Stormwater Impacts

Project Design

- Examples** (15)
- Fact Sheet** (12)
- General** (13)
- Manuals** (19)
- Tools** (11)
- Tools & Calculators** (2)
- Tree Selection** (7)

CoBenefits

- Air Quality** (3)
- All** (12)
- Community** (3)
- Economic** (4)
- Education** (3)
- Public Health** (7)
- Urban Heat Island** (3)
- Water Quality** (6)

Project Design & Co-Benefits

Public Policies & Planning Resources

Public Policies

- Best Management Practices** (8)
- Community Engagement** (4)
- General Guidance** (28)
- Manuals** (3)
- Model Ordinance** (16)
- Plans** (6)
- Tools** (2)
- Zoning, Ordinances, Regulations, Incentives** (8)

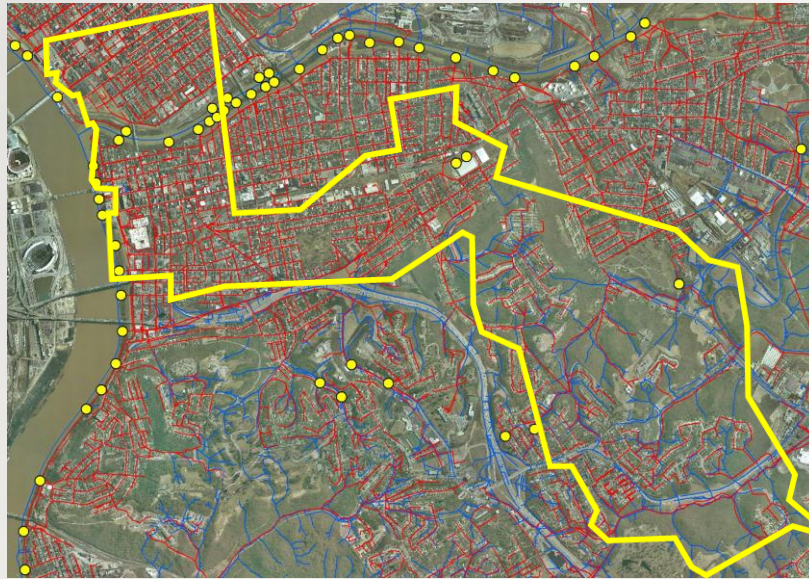
Resource Library Examples



Case Study – Covington, Kentucky



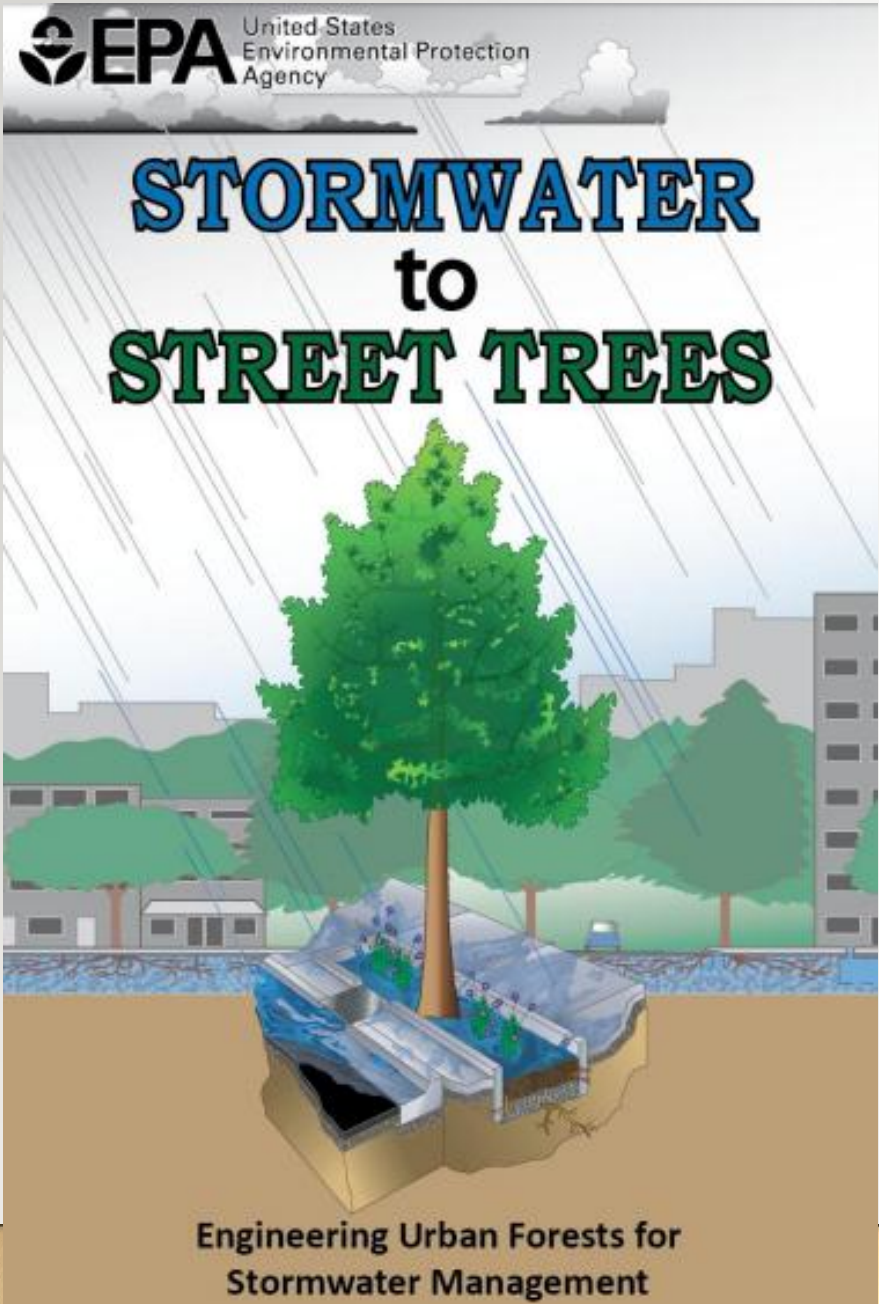
- **SANITATION DISTRICT NO. 1**
- **I-75 TERRACED REFORESTATION**



EXISTING LAND COVER

- Open space
- Grass
- Ground cover
- Tree cover
- Impervious





Trees in Urban Redevelopment

Regulations and Ordinances

915.02.D Tree Protection and Replacement

The Zoning Administrator shall require the protection and preservation of trees with a diameter of twelve (12) inches or more, measured at a point four (4) feet above grade. If said trees are removed during site preparation or development, they shall be replaced, at a minimum, equal to the combined total diameter of removed trees. Diameter measurements shall be taken at a point four (4) feet above grade.

Purpose. The purpose of this Article is to promote and protect public health, safety, and general welfare of citizens by improving the environmental conditions impacted by the built environment through the effective protection of and use of trees to accomplish the following:

- *Stormwater Impact.* Reduce stormwater impacts and costs associated with the movement of earth, flooding, erosion, expansion of impervious surface areas, and removal of vegetation.



Chapter 2. Tree Canopy Coverage Standards

Tree Canopy Defined. The tree canopy in Pittsburgh is defined as the topmost layer of leaves, branches, and stems comprising the crowns of trees as defined in **(Article x - Tree Ordinance)**.

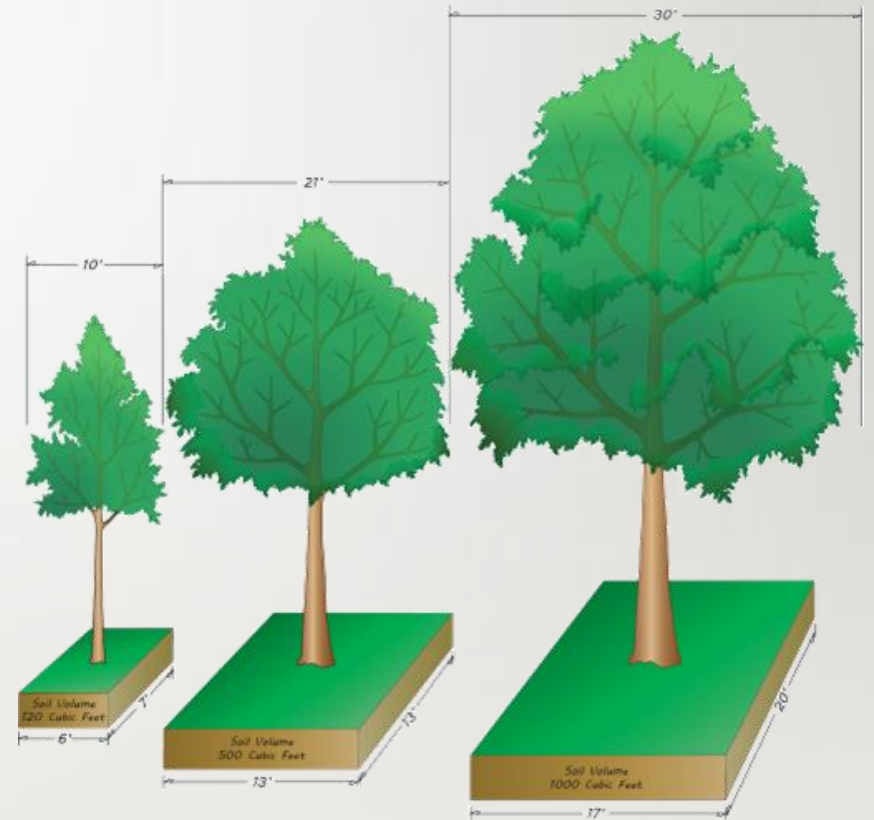
Tree Canopy Cover Measurement. The current and future total tree canopy cover throughout the City of Pittsburgh and the total within each zoning district shall be calculated on a regular basis by the Department of Public Works or its agent.

Minimum Canopy Coverage Standards. The city desires to maintain the maximum practical tree canopy cover across all land uses within the city’s jurisdiction. When canopy removal is subject to the provisions of this Section, the following minimum tree canopy coverage percentages are required within the zoning lot boundaries and can be inclusive of public right-of-way:

Land Use and Zoning	Minimum Canopy Coverage
Low Density Single-Family Residential	50%
Low Density Single-Family Residential	40%
Low Density Single- and Two-Family Residential	30%
Medium and High Density Single- and Two-Family Residential	20%
Medium Density Multi-Family Residential	40%
High Density Multi-Family Residential	30%
Commercial	30%
Institutional	40%
Mixed Use	40%
Downtown and Business Districts	15%



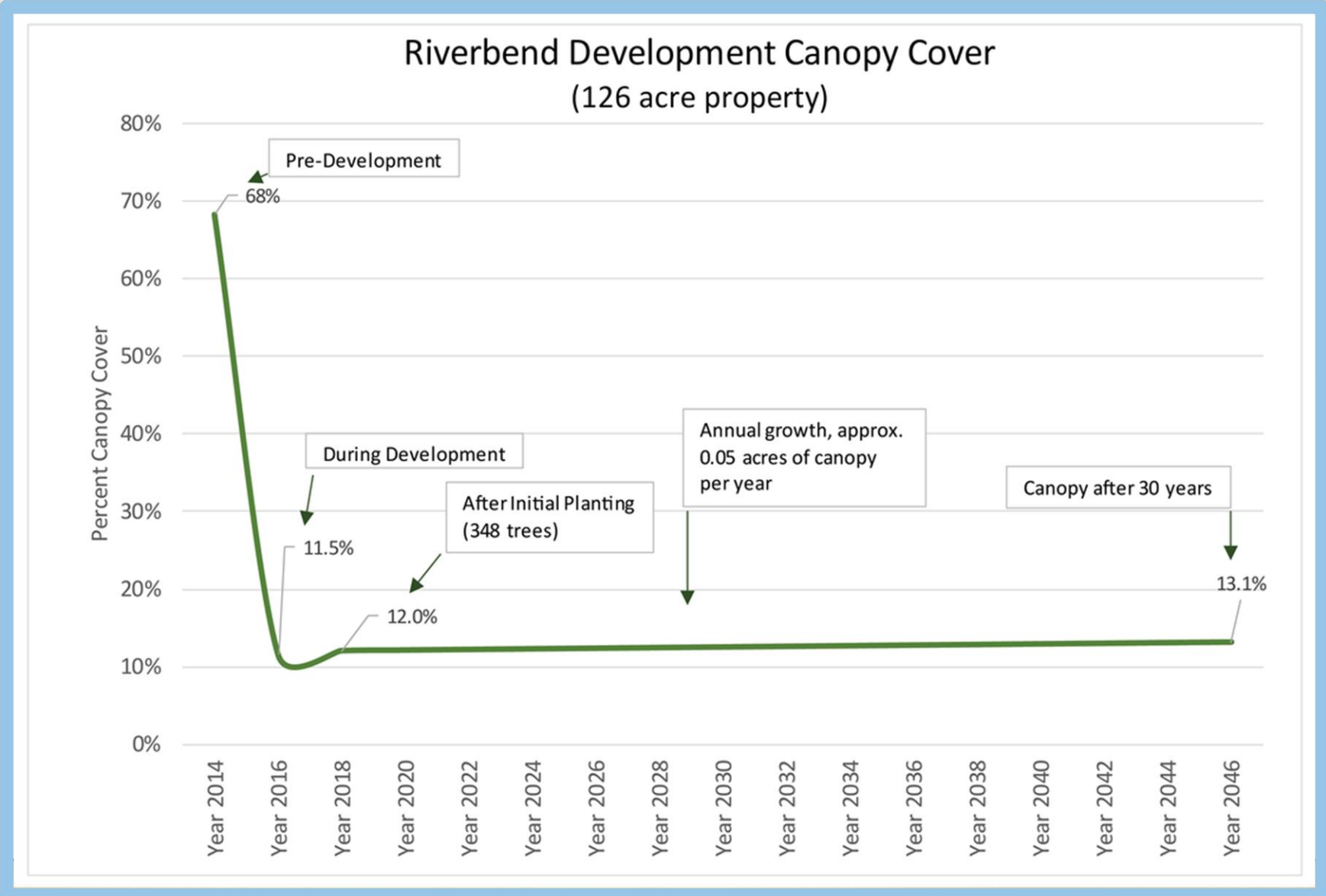
Trees are a great tool for communities.....



.....if they are preserved.

Size matters!

Why we need to protect trees -----



Urban Forests in Watershed Plans

- “Efforts should be focused to preserve and protect high quality forested areas where features are present that significantly contribute to protecting water quality and quantity.”



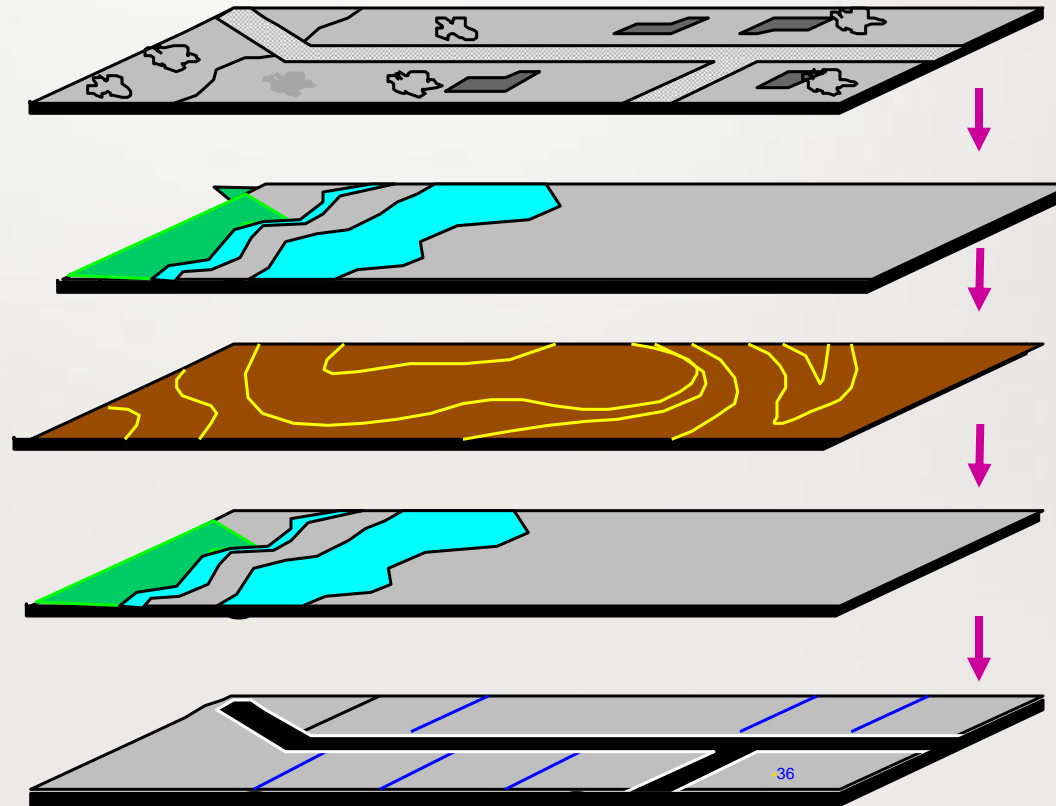
■ **Forests First: Water Wins!**



Critical Areas Identification

- Using GIS tools to identify forests most valuable for protecting watersheds.

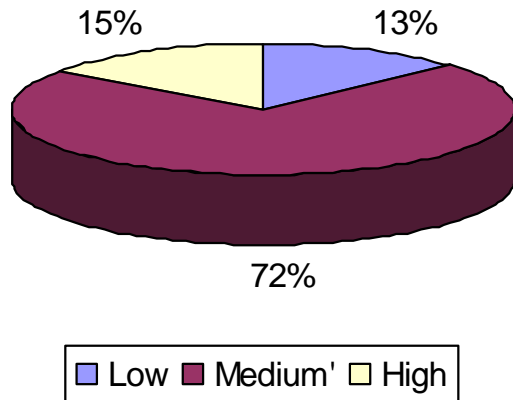
- Forest Cover
- Floodplain
- Steep Slopes
- Riparian Corridor
- Impervious Surface
- Runoff Potential



Critical Areas for Protection

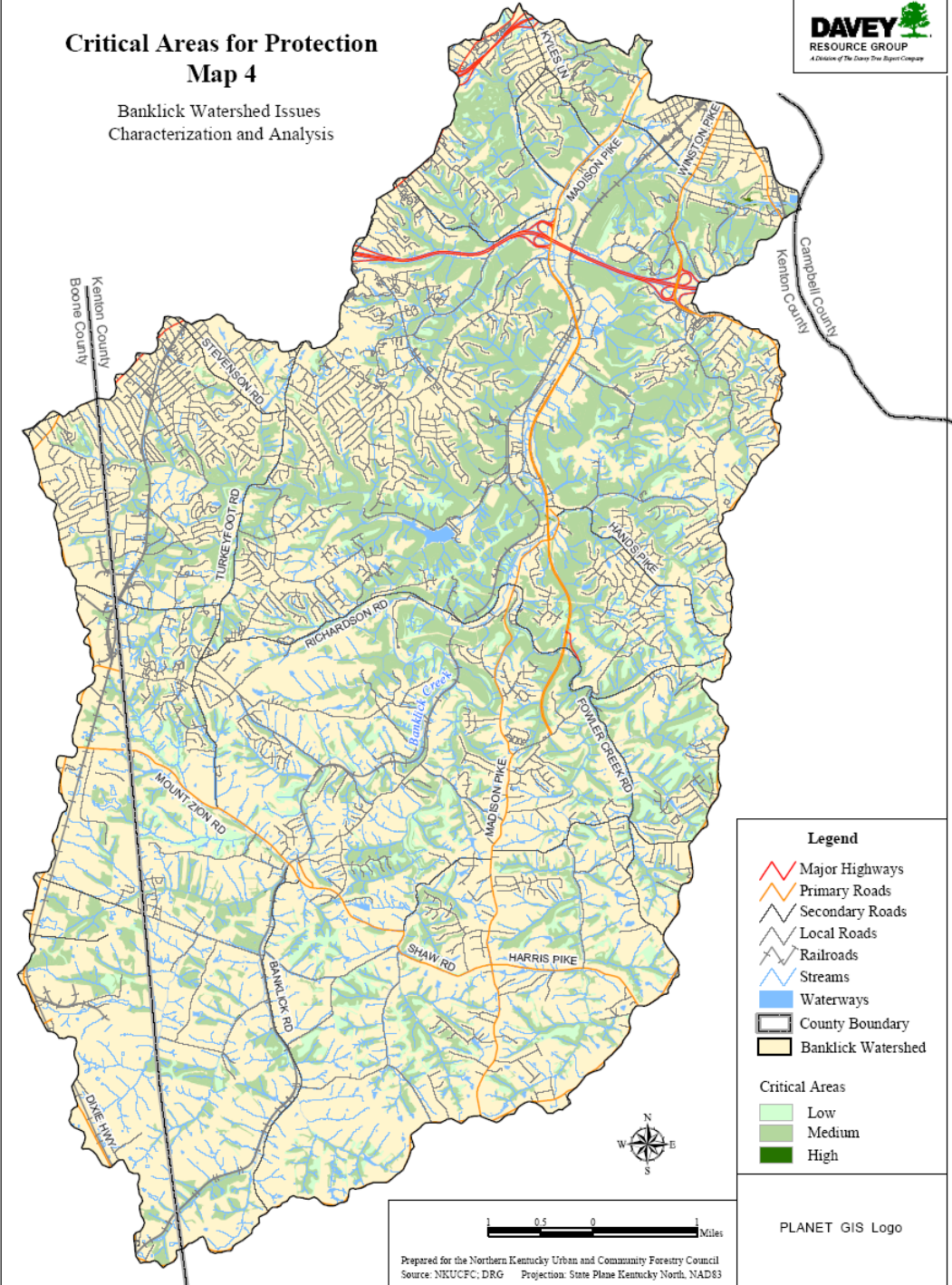
- Total = 12,188 acres
- 33% of entire watershed

Critical Areas for Protection



Critical Areas for Protection Map 4

Banklick Watershed Issues
Characterization and Analysis



Urban Forest Management/Master Plans

CHARLOTTE
URBAN FOREST MASTER PLAN
2017

[HOME](#) [ACTION STEPS](#) [PARTNERS](#) [GET INVOLVED](#) [FULL REPORT](#) [ABOUT](#)



PRESERVING AND ENHANCING CHARLOTTE'S URBAN FOREST

Charlotte Urban Forest Master Plan 2017

Cool New Tool!

Tree Species Selection for Green Infrastructure



Issue 1.1/2018

A Guide for Specifiers

Written by:
Dr Andrew Hirons and Dr Henrik Sjöman



Primary Project Funder



Academic Partners



Guidance Sponsors



Introduction

Authors and Acknowledgements



Foreword



Chapter 1:

Interpreting this guidance



Chapter 2:

The principles of tree selection for green infrastructure



Chapter 3:

Enhancing ecosystem services of green infrastructure through tree selection



The Tree Profiles

Key to Profiles



Alphabetical Index



The Profiles:



Tree Selector:



- Use potential



- Mature size



- Crown form



- Crown density



- Environmental tolerance



- Ornamental qualities



Bibliography



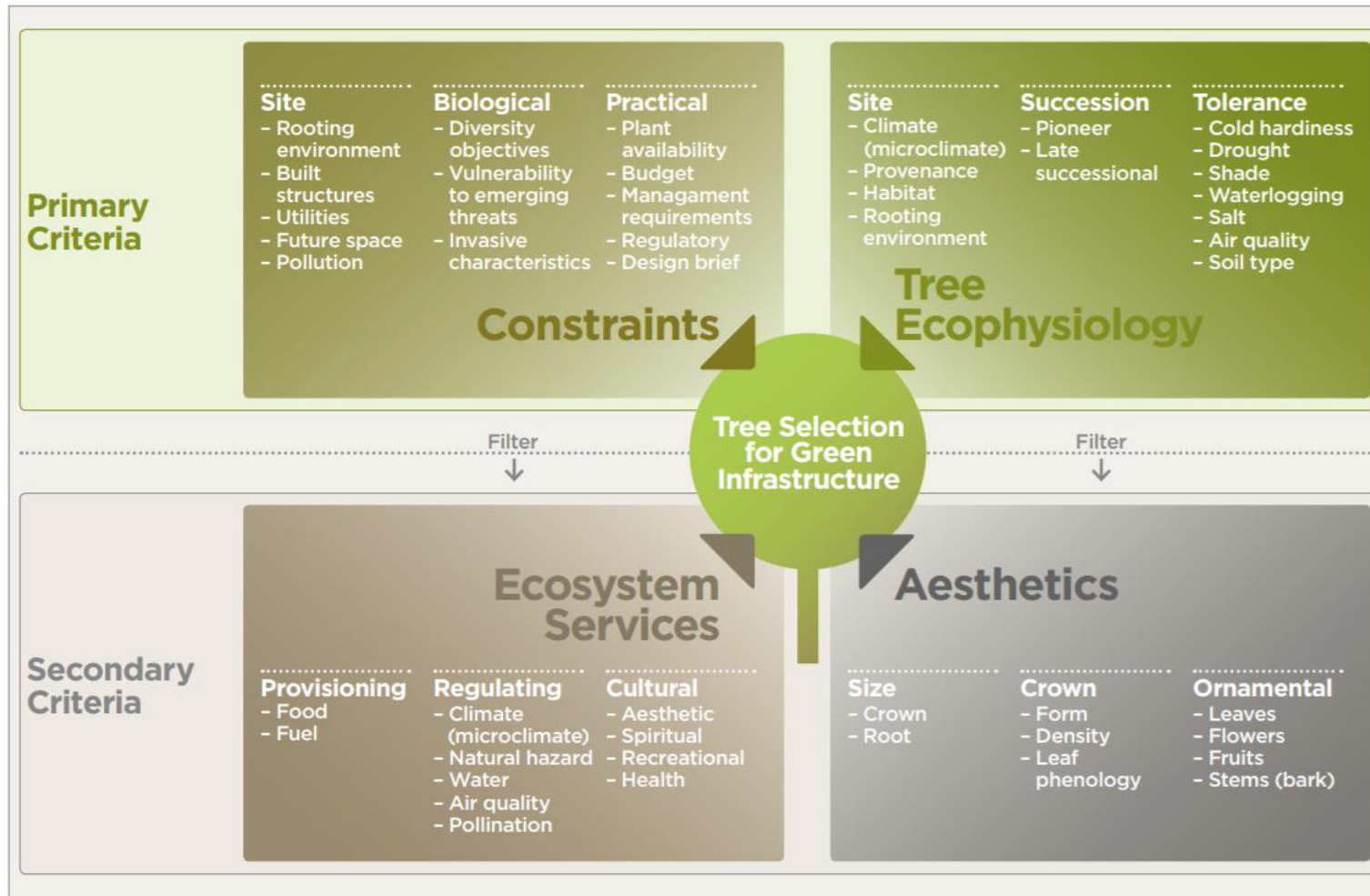


Figure 1 Factors to consider for effective tree selection.

Adapted from Johnston and Hirons (2014)

Green Infrastructure Center Tools

Stormwater Calculator Example

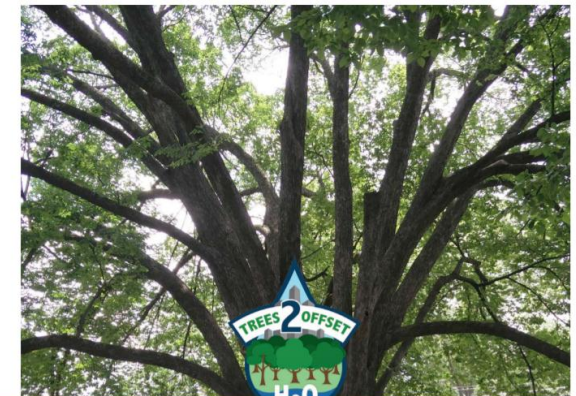
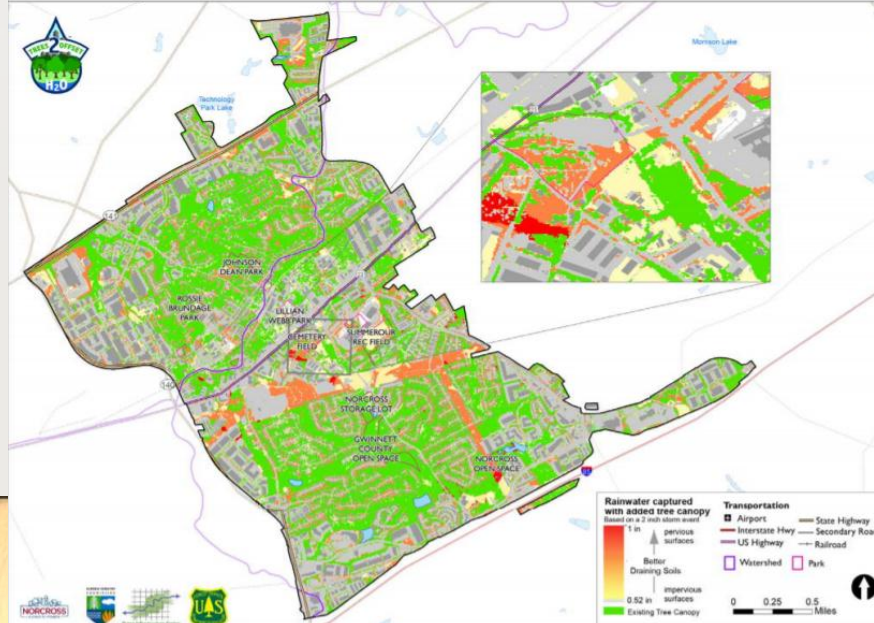
Potential Landcover - Increased Tree Cover

	acres	%	Runoff / acre (cf)	Capture M gallons
Bare Earth	1,314	1.2%	168	
Forested open space	36,467	33.9%	3,106	4,121
Forested wetland	24,902	23.1%	2,229	2,886
Impervious	1,177	1.1%	171	
Pervious	4,726	4.4%	422	
Trees over pervious	23,603	21.9%	2,160	2,744
Trees over Impervious	15	0.0%	2	2
Water	4,383	4.1%	665	
Wetlands	11,048	10.3%	1,677	
totals	107,635		10,601	9,752

Percent tree canopy **max 92.2%** Goal % **69% <- Set Goal!**
 Percent Impervious **1.3%** **1,719** Increased H2O Captured million gallons

http://www.gicinc.org/trees_stormwater.htm

Norcross Optimal Tree Planting Locations for Stormwater Infiltration



Norcross
TREES TO OFFSET STORMWATER
 Case Study 06: City of Norcross, Georgia

The Swiss Army Knife of Natural Resources



Un-muddy the Waters Through Education



Questions?

