

Tree Benefits, Tools for Tree Conservation & State Policy Challenges

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Presentation by Green Infrastructure Center

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The Green Infrastructure Center (GIC) is a nonprofit organization that helps communities evaluate green assets and manage them to maximize ecology, economy and culture.

We do this by:

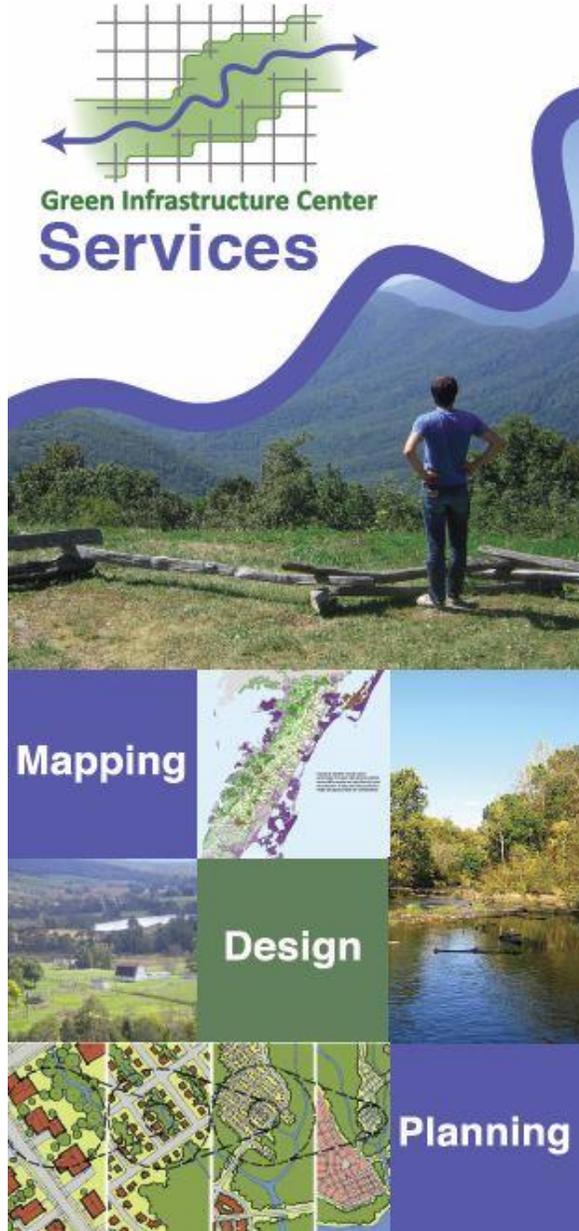
Building landscape models

Teaching courses and workshops

Research into new methodologies

Helping communities create strategies

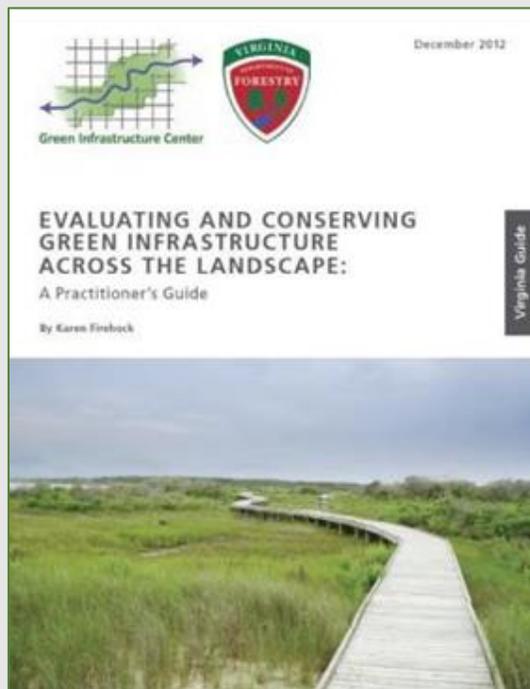
www.gicinc.org



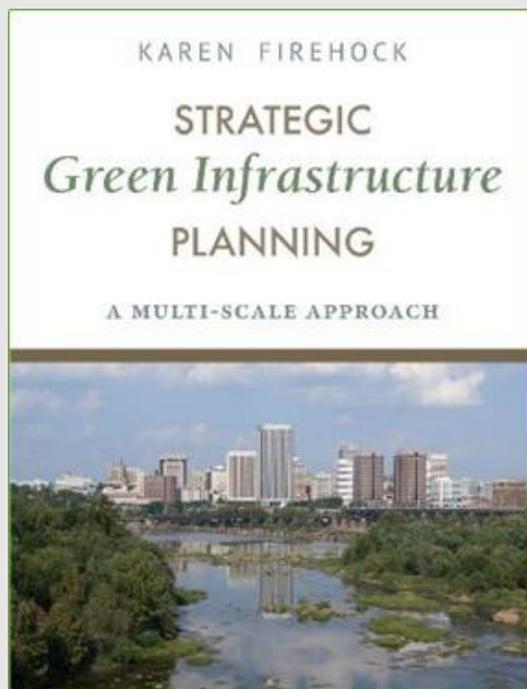


studies on how to plan and implement green infrastructure strategies in communities.

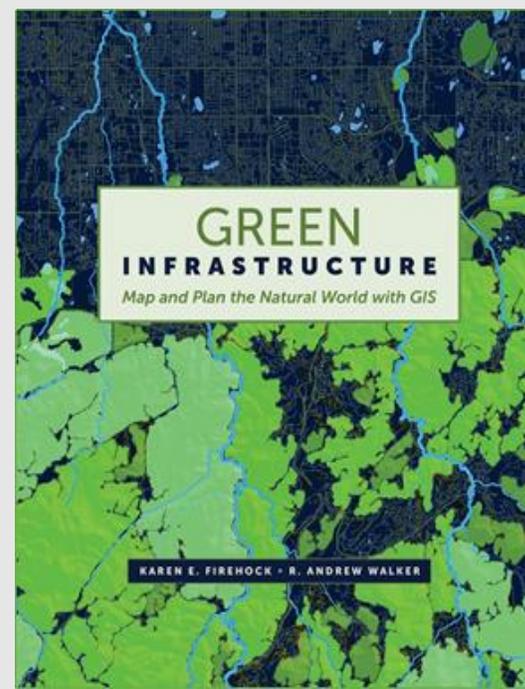
Additionally there are numerous **free tools** and other resources available through our website: www.gicinc.org



VA guide: \$free from GIC



National guide: book sellers



Advanced GIS users guide to mapping: book sellers



GIC's Newest Project

Resilient Coastal

Forests: A study of all the factors that influence forest health, longevity, uses and extent! We are looking at Fire, Pests, Storm Surges, Zoning, Development Pressures etc. – what is happening to our forests and what can we do to better protect them for the future? In VA, SC, and GA! Three year project begun in 2019. We are developing a plan and model process that can be followed in the south and beyond!





Trees: the original green infrastructure!

Trees give us cleaner air, shade, beauty and stormwater benefits at a cost that is far cheaper than engineered systems!



Estimates for the amount of water a typical street tree can intercept in its crown, range from 760 gallons to 4000 gallons per tree per year, depending on species.

Estimate the value of a tree in your yard with itreemytree

<https://mytree.itreetools.org/#/>



Benefits of Trees and Forests

- Preserving biodiversity and wildlife habitat.
- Conserving working lands such as farms and forests, that contribute to the economy.
- Protecting and preserving water quality and supply.
- Providing cost-effective stormwater management and hazard mitigation.
- Improving public health, quality of life and recreation networks.

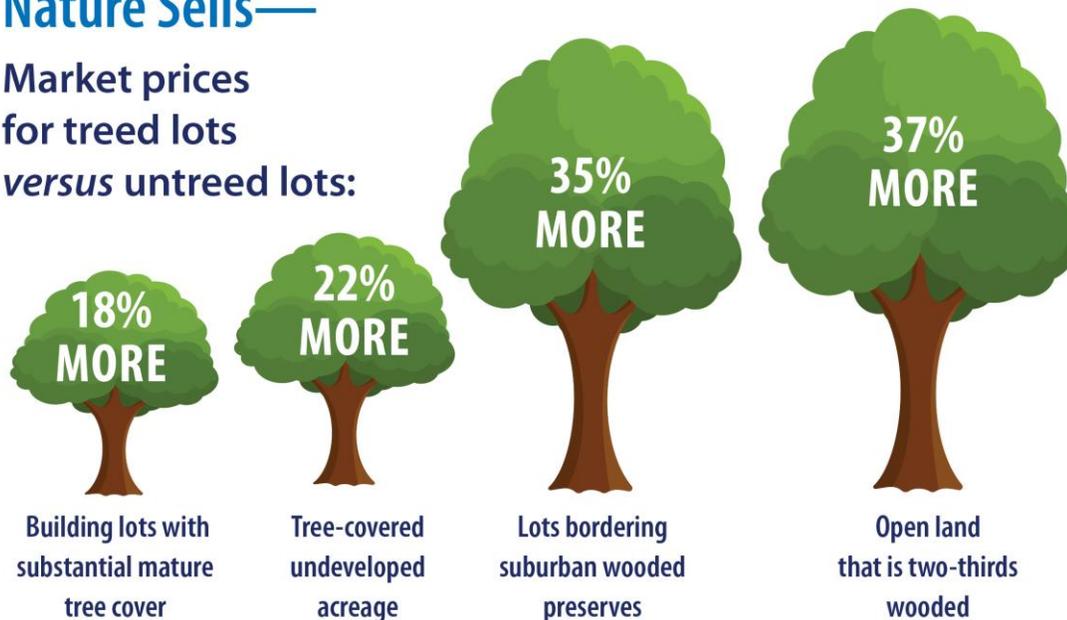


Trees add value to neighborhoods

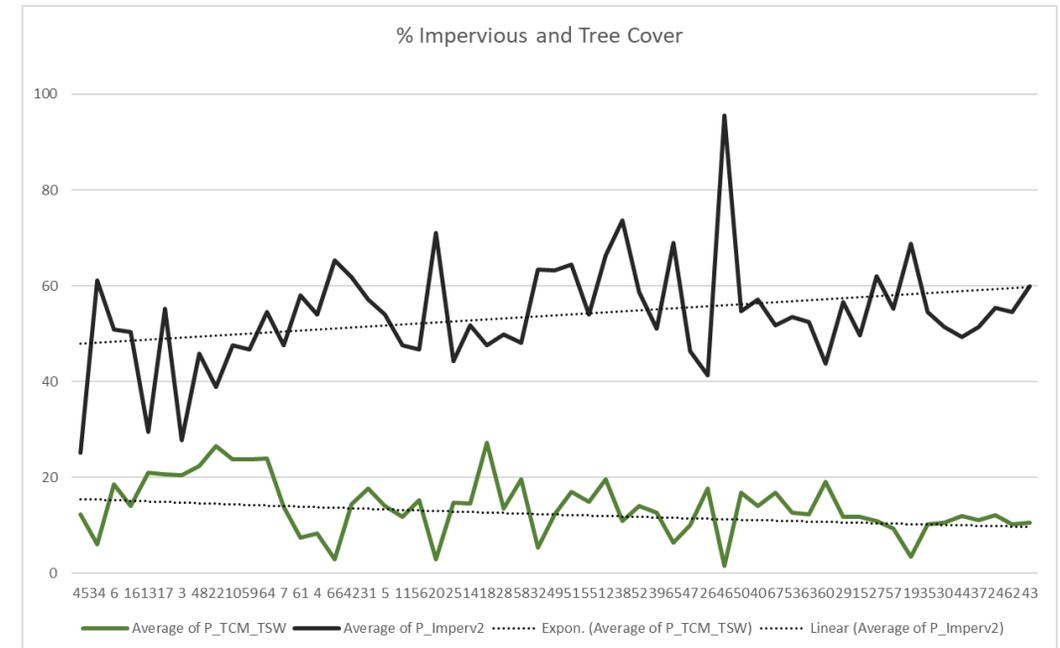
Trees add value to properties, in improved real estate values, savings on air conditioning costs, lower heat island and even sequestering carbon!

Nature Sells—

Market prices for treed lots versus untreed lots:



Source: Kathleen Wolf, 2007, *City Trees and Property Values*.



Decreases in tree canopy correlate to increased urban heating. Areas under trees are often 12 degrees cooler and neighborhoods are cooler too!

VA is losing trees to land conversion, storms, age and other causes.

If the statement from VA is true... "We will develop more land in the next 40 years than the past 400" this likely means tree loss.

And, while total acreage is important, the quality and intactness of these forests also matters. According to the USFS: Forest fragmentation remains the greatest threat to southern forests.

Our trees are in trouble!



Urban and suburban tree canopy cover is trending downwards nationwide at a rate of about 175,000 acres per year – around 36 million trees annually. (Nowak and Greenfield 2018)



USDA Forest Service funded GIC to partner with 6 states to demonstrate how cities can utilize trees for stormwater management.

A partnership between **USDA Forest Service, state forestry agencies** and the **GIC** developed to implement the project.

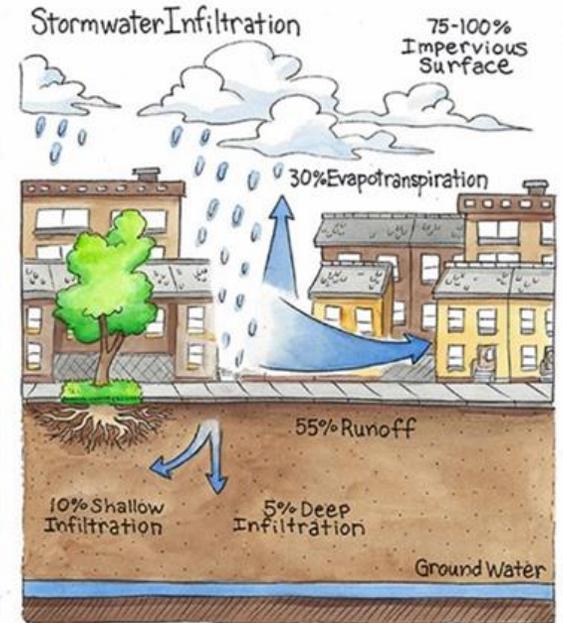
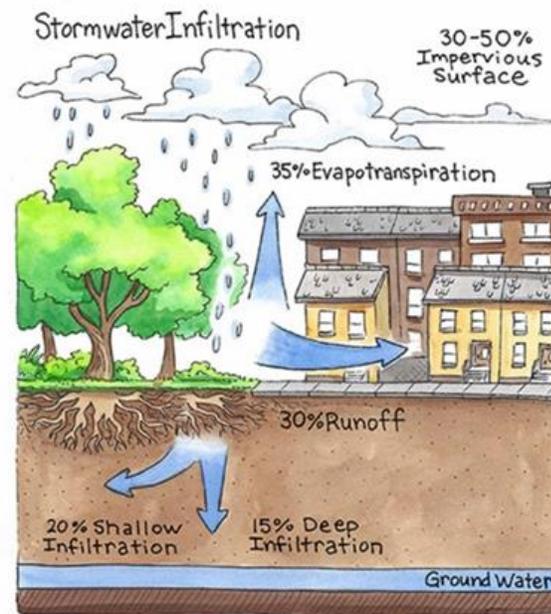
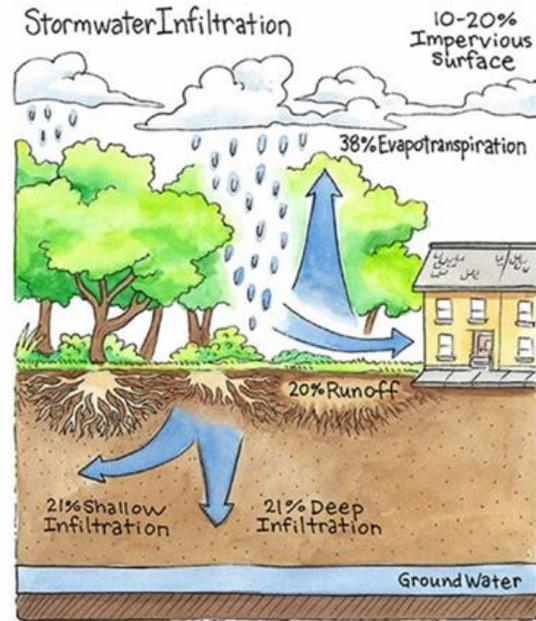
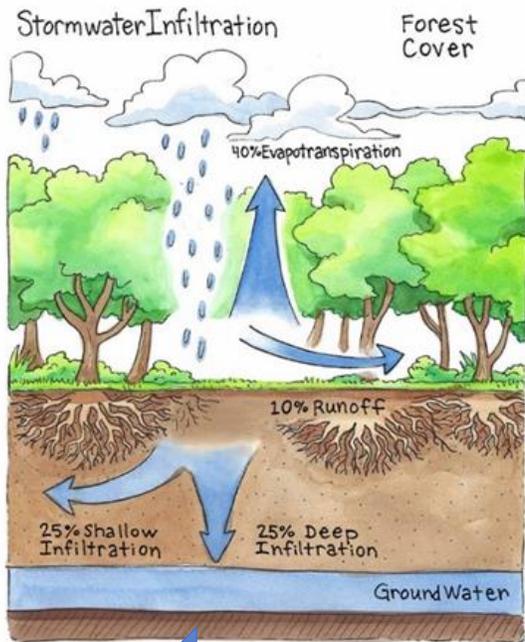
Virginia: Norfolk, Harrisonburg and Lynchburg

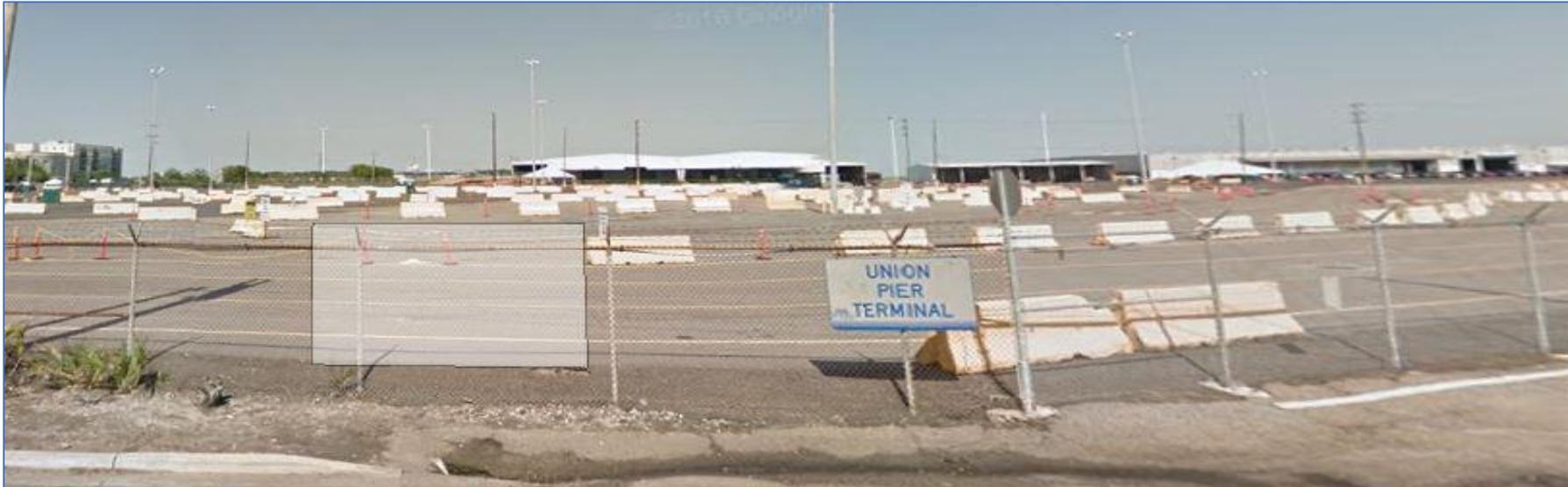


Urban flooding

6 southern states:
SC, NC, GA, FL, AL, VA

As land cover changes, so does stormwater runoff ...





This parking lot could be retrofitted so we get less of this ...



One acre of pavement releases 36 times more runoff than a forest.

During a rainfall event of one inch, one acre of forest will release 750 gallons of runoff, while a parking lot will release 27,000 gallons.

(PennState Extension).



Flooding



Forestry Work Group Study

Tree canopy works to reduce the proportion of precipitation that becomes stream and surface flow, also known as *water yield*.

We used a modified water yield equation that changes the SCS model by adding a canopy interception term (C_i), as suggested by Hynicka and Divers resulting in:

$$R = \frac{(P - C_i - I_a)^2}{(P - C_i - I_a) + S}$$

Where R is runoff

P is precipitation

I_a is the initial abstraction,

S is the potential maximum retention after runoff begins for subject land cover.

($S = 1000/CN - 10$)

Recommendations of the Expert Panel to Define BMP Effectiveness for Urban Tree Canopy Expansion

Karen Cappiella, Sally Claggett, Keith Cline, Susan Day, Michael Galvin, Peter MacDonagh,
Jessica Sanders, Thomas Whitlow, Qingfu Xiao



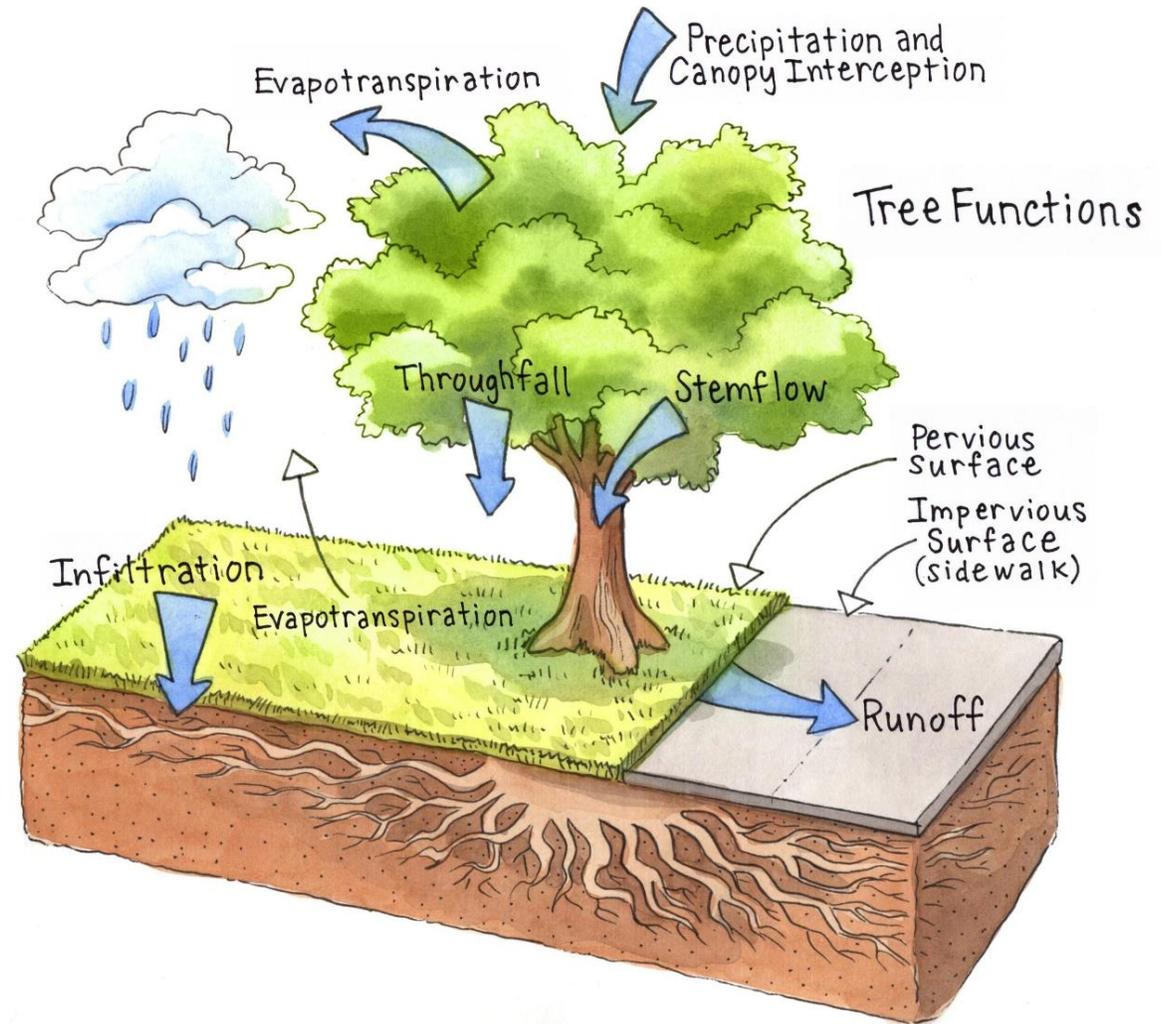
Accepted conditionally by Forestry Work Group, June 23, 2016
Approved by Watershed Technical Work Group, DATE TBD
Final Approval by Water Quality Goal Implementation Team, DATE TBD

Prepared by
Neely L. Law, PhD, Center for Watershed Protection, Expert Panel Chair
Jeremy Hanson, Virginia Tech, Expert Panel Coordinator



Urban Tree Canopy and Water

- 20%+ of annual rainfall retained in crown (Xiao et al., 2000)
- Delays runoff up to 3.7 hours
-  infiltration capacity of soils
- One tree can soak up 700 to 4000 gallons water annually depending on the age and species!





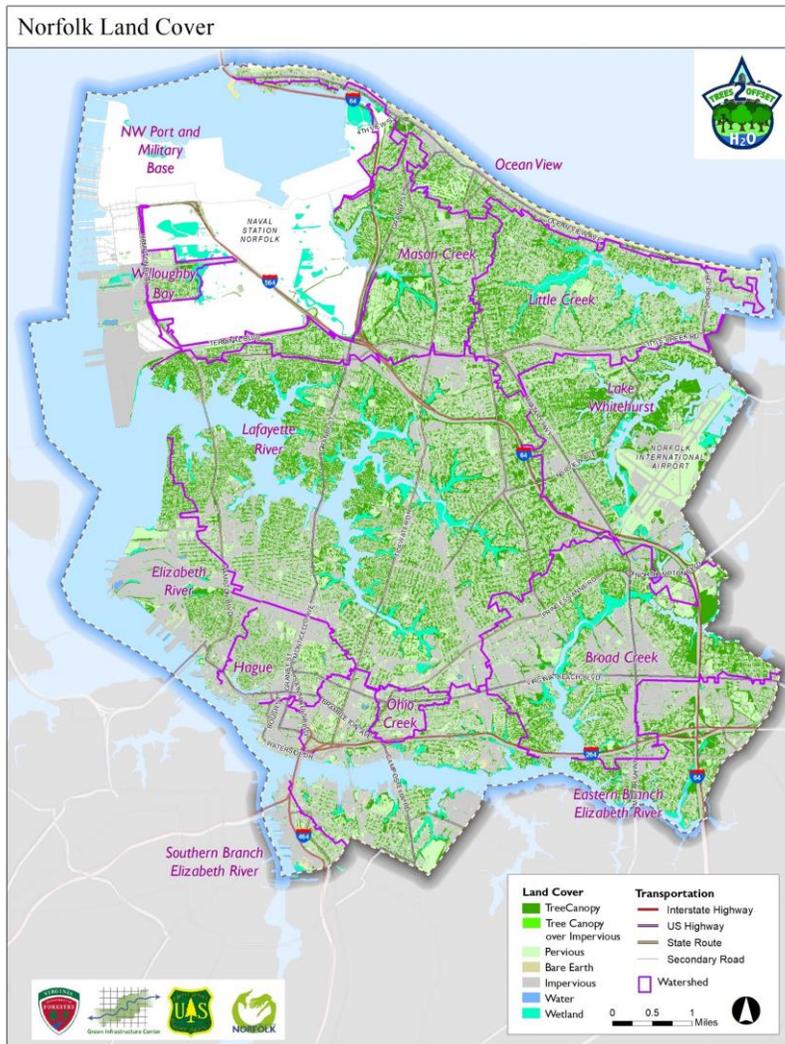
Project Goals

This project's purpose was to show the role that trees play in soaking up stormwater. GIC helped each city with strategies to map, evaluate, protect and restore its urban forests for improved stormwater management and clean water.



Flooding on Greenwood Drive in Lynchburg, VA

Urban forests are a vital tool in managing and reducing runoff.



Tree Over Parking Lot



Tree Over Street



Tree Over Lawn



Tree Over Natural Forest Cover

Trees take up more or less water depending on their settings so GIC created high resolution 1 meter x 1 meter maps to account for conditions of the urban forest.



The GIC's stormwater calculator uses land cover and soils to model the benefit of maintaining or increasing urban canopy.

Harrisonburg, Virginia, USA* Urban Tree Canopy Stormwater Model version July 2, 2019																			
methodology is based upon the NRCS TR-55 method for small urban watersheds. It is used to provide better estimates using GIC's high-resolution land cover and modeling of potential canopy area.																			
 																			
TOTALS		26.6%	38.4%	7.9	5.7	1.6	34.8%	Variable					Variable						
Statistic by Drainage Basin (current settings)		Current Tree Cover		Current Impervious Cover		Tree H ₂ O Capture		Increased H ₂ O w/xx% tree loss		Added H ₂ O Capture w/xx% PPA		Tree Cover Goal		Pick an Event	Pick a loss scenario	Converted Land	Canopy Added	Enter % to be planted	
		%		million gallons		million gallons		million gallons		%		Event	% UTC loss	% FOS Loss	% Imperv	PCA	PPA	% of Land	% of PPA
1	Blacks Run	24.9%	41.6%	6.2	4.31	1.25	33%	1 yr / 24 hour	10%	10%	40%	40.9%	15.9%	8.0%	50%				
2	Cooks Creek	33.4%	23.3%	1.1	0.91	0.21	43%	1 yr / 24 hour	10%	10%	40%	53.2%	19.8%	9.9%	50%				
3	Dry Fork	37.1%	23.4%	0.5	0.37	0.06	45%	1 yr / 24 hour	10%	10%	40%	53.7%	16.6%	8.3%	50%				
4	Linville Creek	21.1%	44.4%	0.1	0.04	0.02	29%	1 yr / 24 hour	10%	10%	40%	36.4%	15.3%	7.6%	50%				
5	Mill Creek-North River	36.5%	34.2%	0.1	0.07	0.01	45%	1 yr / 24 hour	10%	10%	40%	53.5%	17.0%	8.5%	50%				
6	Town of Keezletown-Cub Run	61.0%	0.7%	0.0	0.02	0.00	77%	1 yr / 24 hour	10%	10%	40%	93.9%	32.9%	16.5%	50%				



The GIC's stormwater calculator also calculates changes in pollution loading from one land use to the next.

Stormwater Model version April 22, 2019

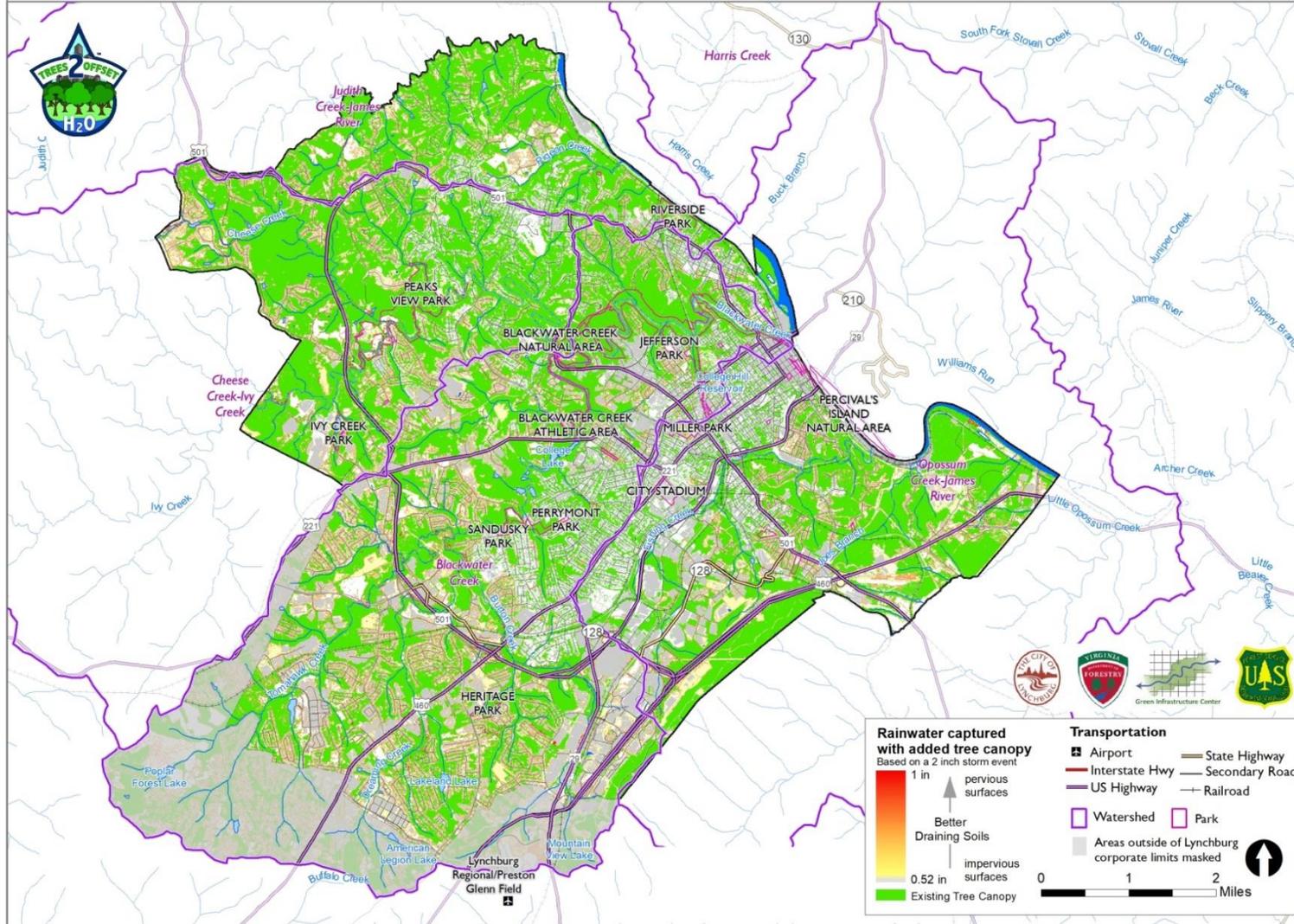
Canopy Stormwater Model estimates stormwater runoff yields for current and potential land cover. The CS TR-55 method for small urban watersheds. It is used to provide better estimates using GIC's high-resolution potential canopy area.



Current Settings			Variable										Pollution by Drainage Basin (current settings)									
Increased H ₂ O w/xx% tree loss	Added H ₂ O Capture w/xx% PPA	Tree Cover Goal	Pick an Event	Pick a loss scenario		Converted Land	Canopy Added	Enter % to be planted	Non-Point Pollution by Drainage Basin (current settings)													
million gallons	million gallons	%	Event	% UTC loss	% FOS Loss	% Imperv	PCA	PPA	% of Land	% of PPA	N lbs/yr	N (%)	P lbs/yr	P (%)	SED t/yr	SED (%)	N lbs/yr	N (%)	P lbs/yr	P (%)	SED t/yr	SED (%)
101.9	851.3	55.2%									4809	8	371	10	774	17	-2236	-4	-85	-3	-191	-5
5.25	0.82	59%	1 yr / 24 hour	10%	10%	40%	66.0%	14.6%	7.3%	50%	4,323	9	337	11	656	16	-1,900	-4	-75	-3	-168	-5
7.26	0.88	58%	1 yr / 24 hour	10%	10%	40%	64.7%	12.6%	6.3%	50%	5,752	9	443	12	937	20	-2,428	-4	-91	-3	-202	-5
5.70	0.85	49%	1 yr / 24 hour	10%	10%	40%	55.0%	11.3%	5.7%	50%	4,674	7	352	9	856	17	-2,617	-4	-99	-3	-213	-5
0.83	0.11	37%	1 yr / 24 hour	10%	10%	40%	44.0%	13.5%	6.7%	50%	628	4	46	6	130	10	-606	-4	-25	-4	-52	-5
1.11	0.25	36%	1 yr / 24 hour	10%	10%	40%	44.3%	17.0%	8.5%	50%	783	4	61	5	121	5	-1,206	-6	-49	-4	-111	-5
1.58	0.04	68%	1 yr / 24 hour	10%	10%	40%	73.5%	10.7%	5.4%	50%	1,091	12	85	11	160	10	-21	0	0	0	0	0
1.89	0.22	62%	1 yr / 24 hour	10%	10%	40%	70.4%	16.4%	8.2%	50%	1,510	10	115	12	263	17	-469	-3	-20	-2	-39	-6
0.51	0.08	66%	1 yr / 24 hour	10%	10%	40%	73.9%	15.6%	7.8%	50%	437	11	34	13	72	30	-128	-4	-5	-2	-11	-7
0.21	0.04	70%	1 yr / 24 hour	10%	10%	40%	80.1%	19.7%	9.9%	50%	175	11	13	13	29	31	-56	-4	-2	-3	-5	-8
3.28	0.48	48%	1 yr / 24 hour	10%	10%	40%	54.3%	13.2%	6.6%	50%	2,529	7	193	9	435	15	-1,717	-5	-67	-3	-148	-6



Lynchburg Optimal Tree Planting Locations for Stormwater Infiltration



Data can be translated into maps~

All planting areas are not created equal.

Optimal Tree Planting Location



Virginia needs to revise outdated laws and expand the tools that localities can use. Many decisions affecting trees happen locally.

GIC has a Codes and Ordinances Tool for cities and towns that covers all the ordinances you should have in place to:

- 1) Reduce Impervious surfaces and
- 2) Improve, expand and enhance urban forest management



Local Review: What to Look For in City and Town Codes! TSW Codes, Ordinances & Practices Tool

	A	B	C	D	E	F	G	H	I	J
1	Trees and Stormwater Codes, Ordinances, and Practices Audit									
2	TREE CARE AND PROTECTION									
3	Understanding the codes and ordinances that impact individual trees paints a picture for impacts on the urban tree canopy as a whole. This includes information about tree protection									
4	requirements, tree care practices and requirements on tree planting.									
5				Presently of Jacksonville Comm		GIC Comments	Source	What to Look For	Score	Potential
6	Tree Protection									
7		Are other kinds of tree protection allowed/enforced (e.g. root pruning, mulch mats, aeration)?	No	In ord, not enforced.				Create root pruning, mulch matting, and aeration matting details. Require the inclusion of these details on all development plans. Inspect the site for adequate tree protection mechanism installation before any further work is permitted on-site. If all details are required and construction may not proceed on-site until tree protection device inspections have been completed, apply one point. If details are required but inspections are not required or details are not required and	0	1
8		Is there a penalty or planting requirement for removing a certain number of DBH inches in trees?	No		(Need to get a permit to remove protected trees.)			Set minimum canopy levels by zoning area. Incite a fine or planting requirement when tree removals exceed set levels. Municipalities using a fine or planting requirement when tree canopy coverage is lowered beyond set levels score one point. Municipalities not using a fine or planting requirement when canopy coverage is lowered	0	1
9		Are developers permitted to clear lot line to lot line? Are there incentives to not do this?	Yes, allowed		Must request an exemption to cut a protected tree. (Instead, require a minimum DBH inches per acre remain on site). From Comp Plan "The City shall encourage landowners and developers to protect or preserve Environmentally Sensitive Lands within developments, where feasible. Developers will be informed, through development review processes, and provided options for preservation of these areas." How often are exemptions to cut protected trees granted?	Sec. 656.1205 Zoning Code		Implement discouragements to the practice of lot line to lot line clearing. Municipalities employing effective discouragements for the practice of lot line to lot line clearing score one point. Municipalities not employing effective discouragements for the practice of lot line to lot line clearing score zero points.	0	1

Example code: Reduce parking space requirements and increase parking lot perviousness.



Add bioswales to capture runoff



Add permeable pavers in parking spaces – this is at a Walmart!

- Some parking lots have excess spaces and therefore excess impervious surfaces and more stormwater runoff. Establish parking maximums (not just minimums).
- Require tree planting in parking lots and use adequate soil volumes and tree care/bonding.
- Use Low Impact Development (LID) technology to increase parking lot perviousness, provide more shade, and increase parking lot attractiveness.

Conduct land cover assessment every 4 to 5 years.



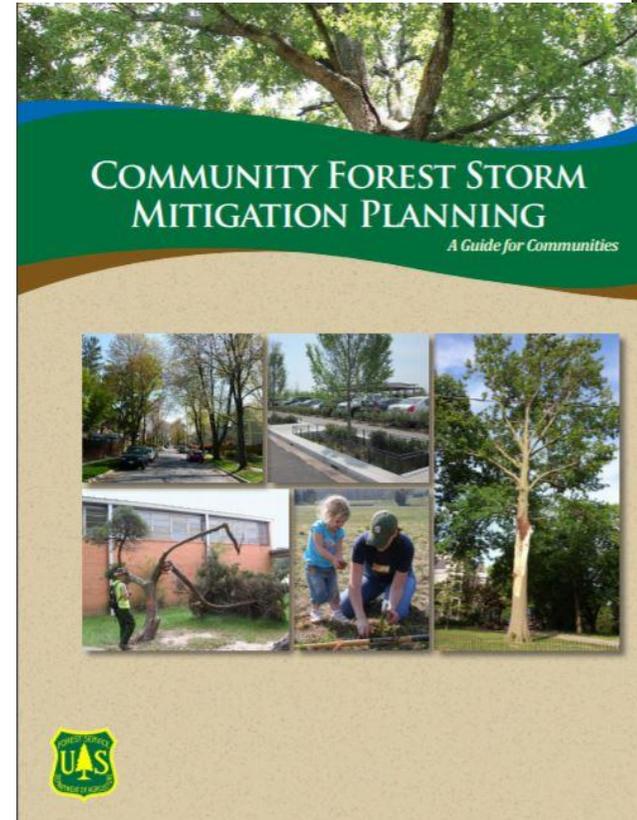
Compare tree canopy levels over time.

Understand where tree loss is occurring and take mitigation steps. We developed a budgeting tool for cities to calculate the cost of tree planting using the data from a canopy map!

Develop a forestry emergency response plan.

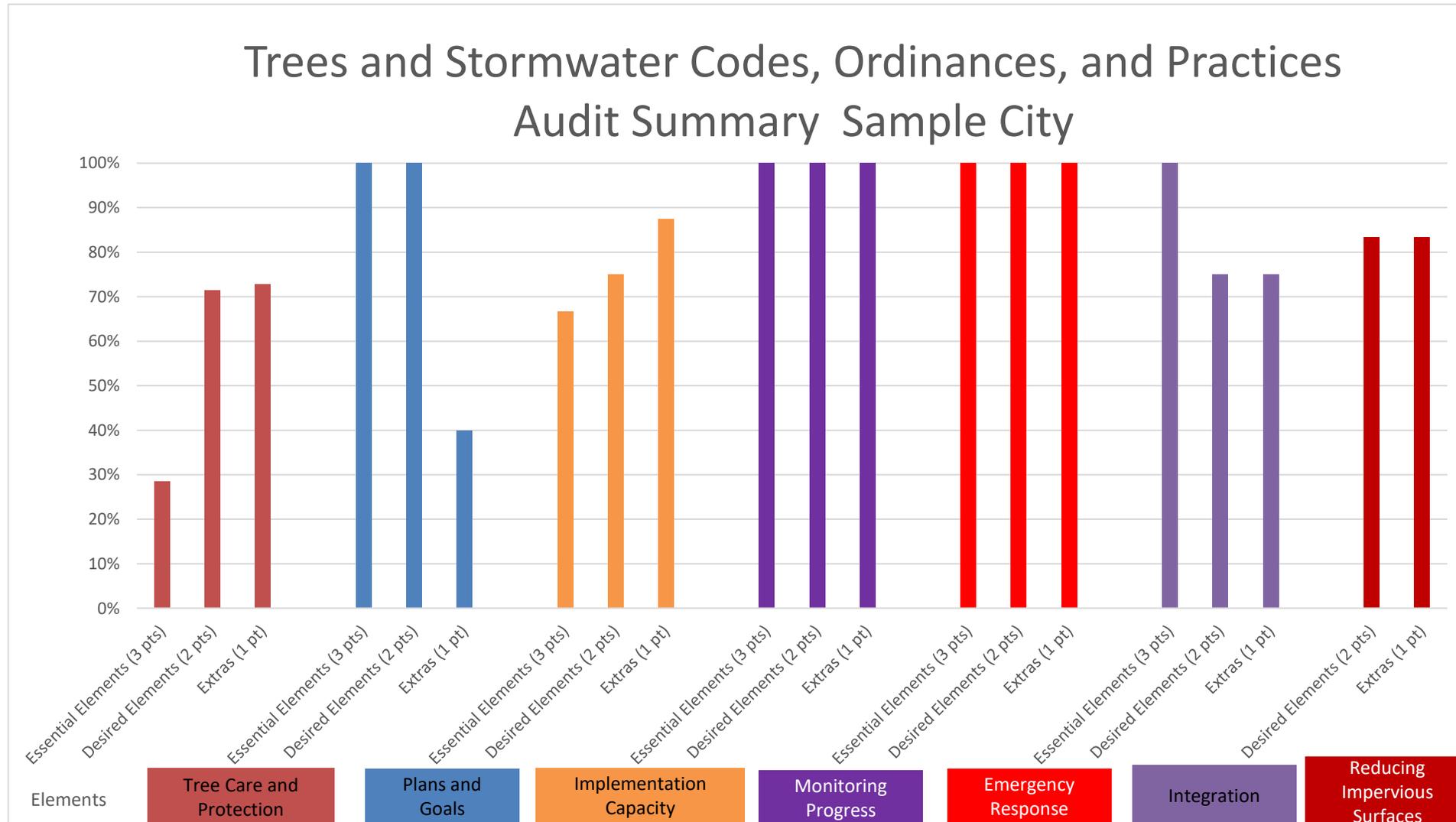
Municipalities typically plan well for the removal of vegetation and debris directly following a storm. However, much less foresight is typically put into replanting after a storm.

A forestry emergency response plan addresses funding and timelines for replanting following a storm. Contracts can be set up ahead of time – before a hurricane – to save on delays and get better pricing too! We have updated Virginia's storm planning guide (with permission).





A summary shows what to improve!



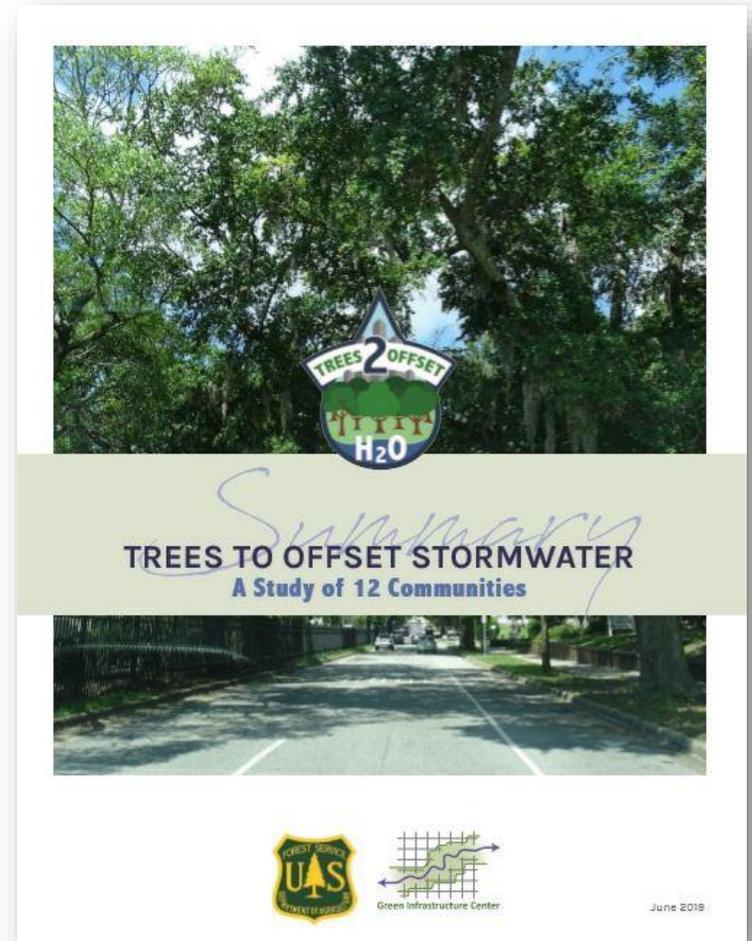
Each municipality gets a score by priority and topic.



Products you can use Trees and Stormwater

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

- ✓ **Trees and Stormwater Codes Ordinances and Practices Audit Tool:** Anyone can fill it out and a city can self-score!
- ✓ **Trees and Stormwater Calculator Tool:** Requires tree canopy map and adding in data such as roads, buildings etc. Then plantable area can be calculated and data can be added to the calculator spreadsheet. Technical instructions for GIS on line!
- ✓ **Case Studies** – get them on line!
- ✓ A **final summary report**, on line too, provides key findings.
- ✓ We **continue to follow up** on implementation!



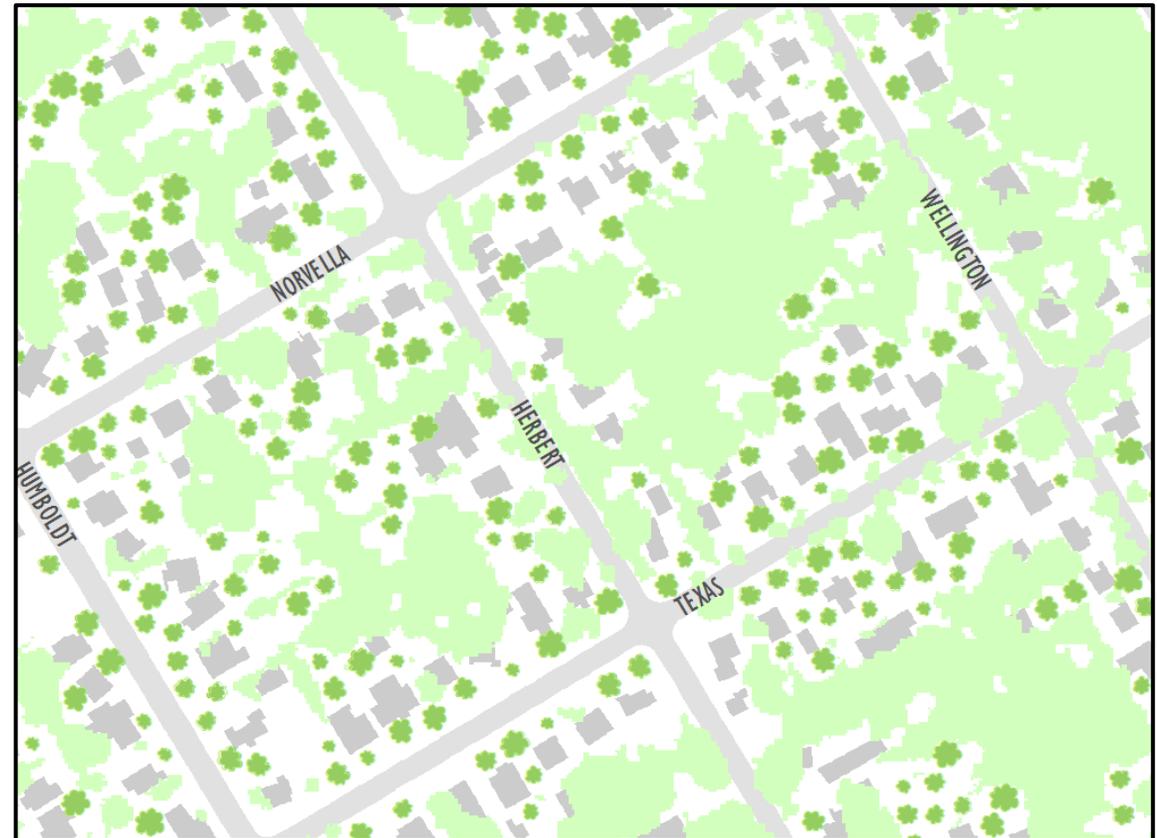
Key Strategy: Plant trees on private lands

Individuals actions can make a big impact! Example for the City of Norfolk:

- ~**47,500** parcels with single family homes
- ~**31,000** of these have room for at least 1 tree
- If everyone planted a single tree, they would intercept **62 million gallons** of rainwater every year (1.5 million bathtubs!)

So organize plantings in your community and encourage them at city parks, along streets ...everywhere!

There are legislative tools that can encourage more of this...let's look at some!



Each tree icon represents a possible tree planting location that avoids buildings, underground utilities, and other infrastructure. Tree spacing is 30 feet.

Virginia's State Policies: Legislative Needs for Trees

#1: Tree Replacement Ordinance

- Sets max tree canopy coverage by zoning to replace trees lost during development.
- Some localities offer bonus credits for leaving mature trees on site to achieve tree cover percentages.

Benefits:

- Prevent urban canopy loss or maintain canopy cover.
- Requires developers mitigate losses to the urban tree canopy.

Challenges:

- Prevents setting more expansive canopy standards: Caps canopy at 20% residential, 14% PUD, and 10% commercial.
- Site's mature trees can be sacrificed as long as new tree plantings meet required canopy.

#1: Tree Replacement Ordinance Cont'd

Limitations:

- ❑ Only Planning District 8 can enact higher canopy standards. HB 1624 proposed to change but was continued to Cities and Towns Committee. Now overall workgroup to study tree code needs
- ❑ Localities restricted to 20-year timeline for developers to achieve cover requirements (with few exceptions). One tabled proposal was to require achievement of canopy cover replacement by 10-years.
- ❑ Limited to Ches Bay jurisdictions or population > 75 people sq. mile

Recommendation: Remove canopy caps, and allow all localities to set their own canopy percentages by zoning class. Remove density per sq. mi restriction.

#2: Tree Banking

Allows cities to meet tree canopy standards off site (when cannot be met onsite). In planning District 8, non-profit groups can be used to plant trees, even on private property.

Benefits:

- Flexibility to plant new trees off site to meet canopy requirements while still maintaining tree cover.

Challenges:

- Can result in forest or tree cover being disaggregated across the landscape.
- Could result in plantings only on public lands or rights-of-way or, there may not be enough public planting space.
- May discourage large tree preservation on site.
- No authority to plant outside jurisdiction or consider landscape scale (i.e. watersheds).

#2 Tree Banking cont'd

Limitations:

- Developers can claim hardships to avoid tree replacement.
- § 15.2-961 tree planting funds restricted to local government (not for NGOs).
- For § 15.2-961.1 apply only to Planning District 8: Tree canopy fund expenditures limited to the same non-attainment area in which they were generated.

Recommendation: Allow all Planning Districts to use NGOs to plant. Encourage replacement of acres of forest (not just individual trees).



#3: Trees as Nutrient Credits

2005: originally point source (PS) pollution trading; 2009: Trading between PS and agricultural non-point sources (NPS).

Changing from forested to non-forested state requires mitigation.

Credits based on Ches Bay Model's NPS calculations.

Trading areas within 8-digit HUC watershed or adjacent watershed.

Benefits:

- A variety of nutrient best management practices can be used and reforested land permanently protected.

#3: Trees as Nutrient Credits

Challenges/Limitations:

- Only ag land eligible for credits; this limits incentive to preserve existing forests.
- Urban lands not eligible for credit trading.
- Only considers land cover status prior to July 1, 2005.
- Reforestation criteria are minimal (can plant monoculture) and no way to verify no net loss of forest cover.

Recommendation: Need to incentivize maintaining forest cover – provide a system to credit keeping land forested.

#4: Cluster (and Conservation) Development Ordinance

EXAMPLE
CLUSTER



#4 Cluster (and Conservation) Development Ordinance

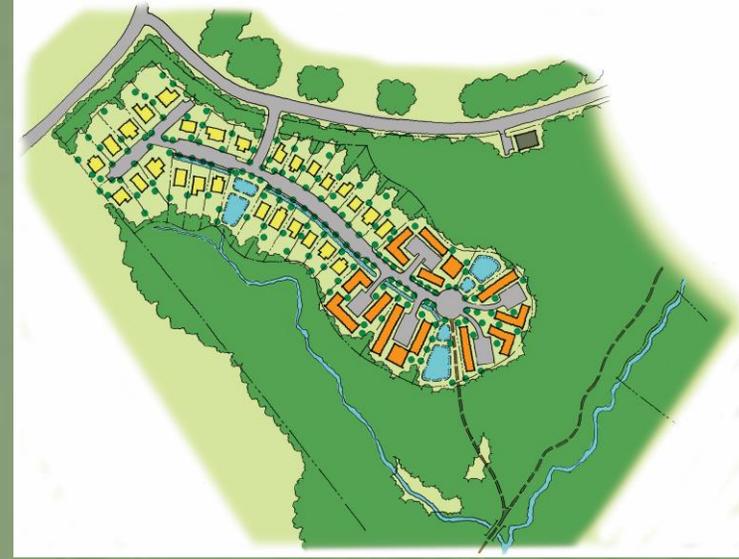
Cluster development maintains development density, but allows changing lot sizes (smaller) to preserve some area as “open space”.

Benefits:

- In urban areas, protects sensitive environmental resources while creating more compact development patterns that also provide efficiencies for infrastructure delivery.
- In rural areas, it helps landowners realize some development value while conserving agricultural and forested lands.

Challenges:

- Permitting process can take longer than a “by right” development.
- Does not fully protect rural lands from sprawl.



#4 Cluster (and Conservation) Development Ordinance Cont'd

Limitations:

- Only for jurisdictions with >10% growth (Census) so mostly does not apply.
- Prohibits requiring
 - Prior site assessment or resource map of open space to determine conservation value.
 - Special resource areas or open space exclusions from density area calculations.
 - Access pathways from developed areas to open space areas
- Open space can be disturbed (e.g. put a stormwater pond in it).
- Localities exempted from new regs if had cluster ord. before 2004.

Recommendation: Strike all prohibitions on listing open spaces and site evaluations. Allow any VA locality to adopt this. Consider simply going back to the prior regulation!

#5 Trees as Best Management Practices (BMPs)

Background: Individual trees not currently considered a best management practice (BMP) for managing stormwater. DEQ will report on new options in November.

Benefits:

- ☐ Trees reduce the amount of stormwater runoff by capturing precipitation and infiltrating it onsite & evapotranspiration, thus reducing flooding and recharging groundwater.

#5 Trees as Best Management Practices (BMPs) cont'd

Challenges:

- ❑ Quantifying standard volume for credits is difficult: variables include tree species, size, location/soils where tree is planted, etc.
- ❑ Time lag for compliance if new, young trees planted for credit (versus mature tree) benefits.

Limitations: Only existing forest cover can be counted as stormwater management.

Recommendations: Committee has been convened to address this. The concern is that they may not have time to complete this work in just a few months.

Trees as Best Management Practices (BMPs)

Trees can be used in concert with existing BMPs such as this bioswale with a tree planted in it. Often, bioswales with trees don't get additional credits from adding a tree. But they should!

A state work group will start soon to tackle questions of trees as BMPs.



Other places use trees as a site scale BMP...

- ❑ Center for Watershed Protection has tools to calculate vol. runoff reductions per tree: <https://www.cwp.org/making-urban-trees-count/>
- ❑ Pine Lake, GA: 10 gallons of water credit per inch of the diameter at breast height (DBH) for preserving existing trees under 12" DBH, and 20 gallons of credit per inch of DBH for preserving existing trees over 12" DBH.
- ❑ Washington D.C.: 20 cubic feet for each preserved tree, and 10 cubic feet for each planted tree. Trees planted as part of BMP, e.g. bioswale get 10 cubic feet water credit.
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6134866/>
- ❑ Portland: 'tree credit' can be used to offset 10 percent of a site's impervious surface as stormwater management and they also use trees in BMPs. <https://www.portlandoregon.gov/bes/article/582102>>



Larger landscape credits for trees as a BMP ...

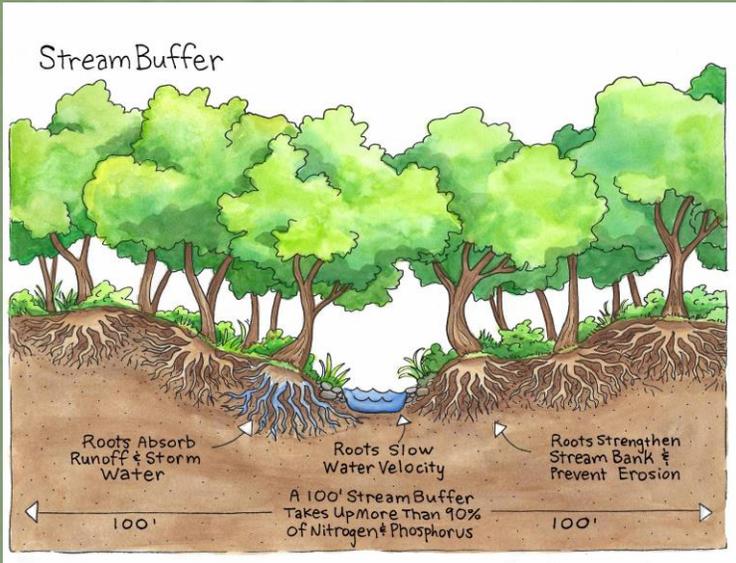
The Chesapeake Bay Program (CBP) developed BMPs for Chesapeake Bay Watershed Phase III Watershed Improvement Plan (WIP) targets.

Credit based on type of planting:

- Urban Canopy Expansion: 300 newly planted trees = 1 acre of urban tree canopy expansion.
- Urban Forest Planting: Converting turf grass to trees and must have contiguous planting and maintenance plan.
- Urban Forest Buffer: Contiguous planting of 100' to 35'

To get credit to remove N, P, Sed = trees planted/300 * reduction coefficient.

Jurisdiction	BMP	Nitrogen Average reduction per acre, Edge of tide (lbs/ac)	Phosphorus Average reduction per acre, Edge of tide (lbs/ac)	Sediment Average reduction per acre, Edge of tide (lbs/ac)
Virginia	Forest buffer	8.77	1.61	854
	Forest planting	7.33	1.16	451
	Tree planting - canopy	1.82	0.15	223



The Chesapeake Bay's Watershed Implementation Plan (WIP) for VA is tasked with meeting ambitious goals for reductions in Nitrogen, Phosphorus and Sediment by 2025. Establishment of new riparian buffers is an essential BMP intended to help reach this target.

We hope to assist VA DOF with determining a process to better evaluate and track how and where buffers are established and to improve landowner outreach.

One unmet need is the # of trees available to buy and plant. Some estimates have shown we may need several tens of millions of new trees! This number may be 10 fold higher than what is currently available from the state or private nurseries. We need to rapidly ramp up tree planting and funding this work.



Discussion?



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