Smart Surfaces Policy Guidance: Mitigating Extreme Heat and Managing Stormwater with Trees

2025

SMART SURFACES COALITION

smartsurfacescoalition.org

Image sources top to bottom:
Cambridge Day
Nature Conservancy
Rapid Transition Alliance

About The Smart Surfaces Coalition

The Smart Surfaces Coalition is a 501(c)(3) non-profit organization made up of more than 40 leading national and international organizations with a shared commitment to creating cooler, healthier, and more resilient cities by cost-effectively reducing the impacts of extreme urban heat and flooding. Smart Surfaces—reflective, porous, and green urban surfaces along with trees and solar PV—can cut peak summer temperatures by 5°F or more, decrease flood risk, slow climate change, and improve public health, with the greatest improvements in low-income neighborhoods and communities of color.

ADDITIONAL RESOURCES AVAILABLE ONLINE AT
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Tree canopy delivers a host of benefits in an urban environment by counteracting the vast expanses of dark-colored pavement that dominate cities. Trees provide shade, cooler air via evapotranspiration, decreased heat-related illnesses and deaths, improved air quality that can reduce respiratory diseases, carbon sequestration, reduced stormwater runoff, and can restore critical habitat for birds, insects, and small mammals.

Trees also play a critical role in the Smart Surfaces framework. Smart Surfaces are technologies and design strategies that mitigate the effects of dark and impervious surfaces and climate change in urban environments—especially extreme heat, stormwater flooding, and poor air quality. Smart Surfaces include green infrastructure (e.g., trees, rain gardens, urban meadows, green roofs), reflective surfaces (e.g., “cool” roofs, walls, and pavements), porous and permeable pavements, solar PV, urban meadows and other “natural” areas, and combinations of these surfaces. Together, these strategies and technologies can deliver massive health, financial, and resilience benefits, making cities more prosperous and livable.

The sections that follow outline concepts and approaches to supporting a healthy urban canopy. Because there are already many tools that provide model language for how tree policy can be shaped, these guidelines focus on the concepts rather than recommending use of specific language. The recommendations below serve as a menu of options from which policy makers and advocates can draw to shape policy in their own jurisdictions. These may not be replicable in exactly the same way in every jurisdiction without adapting to the unique legal requirements applicable to a given place—anyone using this guide should consult with appropriate legal advisers to ensure policies pursued are consistent with applicable law.

The policy recommendations are further described in the memo that follows this checklist.

Tree Policy Recommendations

Recommendation		Examples	Related Resources
1	Draw on existing resources to develop the basic structure of a tree protection ordinance.	Morton Arboretum's ordinance builder tool with sample components and language from existing ordinances: Protection ordinance language Preservation ordinance language	Center for Watershed Protection, Making Your Community Forest Friendly: A Worksheet for Review of Municipal Codes and Ordinances Georgia Tree Council, Getting Started: 12 Steps to Writing an Effective Tree Ordinance The Green Infrastructure Center, Trees and Stormwater Codes and Ordinances tool King County, WA, Guide to Developing Effective Urban Tree Regulations on Private Property
2	Use the purpose and intent section of a tree ordinance to thoroughly describe the full range of benefits that trees provide.	Columbus, OH Utica, NY	Vibrant Cities Lab, What urban tree canopy can do for your neighbors
3	Maximize the role that trees can play in enhancing equity and health by prioritizing planting trees in low-canopy areas within the city.	Goals by neighborhood: Cambridge, MA Grand Rapids, MI Goals by land use type: Lake Forest Park, WA Chesapeake, VA Athens-Clarke County, GA	USDA Forest Service, Climate Adaptation Actions for Urban Forests and Human Health American Forests, Tree Equity Score
4	Create overlay zones or districts on top of base zoning to further enhance tree protection in targeted areas.	Washington, D.C. Salem, VA	Casey Trees, Citizen Advocate Handbook: A Guide to Successful Tree Advocacy in the Nation's Capital

Recommendation		Examples	Related Resources
5	Develop a diverse array of incentives to encourage voluntary tree preservation beyond minimum requirements.	Lakewood, WA Erie, CO Saint Michael, MN	PlanIT Geo, Private Tree Ordinance 101 Trees for Life Oregon, Invisible Incentive to Preserve Large Trees
6	Design parking lot landscaping rules to prioritize the inclusion of trees.	Boxborough, MA (p. 8) Sacramento, CA	Montgomery County Planning Commission, Shading Parking Lots Boston Metropolitan Area Planning Council, Strategies to Strengthen Tree Protections
7	Address financing needs for long-term maintenance.	Oakland, California (p. 98)	The Nature Conservancy's report Funding Trees for Health

Advanced Tree Policy Strategies

Recommendation		Examples	Related Resources
8	Establish no net loss goals for specific census tracts, wards, or other city subdivisions.	North Las Vegas, NV (p. 5) Tukwila, WA (p. EN-19)	University of Florida's Institute of Food and Agricultural Sciences, Urban Forest Management: A Primer to Strategic Planning for Municipal Governments The United States Conference of Mayors, Protecting and Developing the Urban Tree Canopy
9	Tether off-site mitigation programs or in-lieu payment options to lower canopy areas or areas with particular heat island mitigation needs.	Charlotte, NC (p. 16) Burien, WA Seattle, WA	McDonald RI, Biswas T, Sachar C, Housman I, Boucher TM, Balk D, et al. (2021), The tree cover and temperature disparity in US urbanized areas American Council for an Energy-Efficient Economy, Community-Wide Summary of Heat Island Mitigation Policies and Programs
10	Define a root protection zone to protect large trees within and adjacent to development projects.	Baltimore, MD (p. 56 and p. 69) Lexington County, SC (p. 4 and p. 8)	Penn State Extension, A Guide to Preserving Trees in Development Projects *(The tree protection fencing recommended in this source is fencing at a 1-foot radius from tree for every 1 inch of DBH, but best practice would be fencing 1.5 feet for every 1 inch of DBH)* The Conversation, Save the trees: Never-ending construction in cities threatens the urban forest

Recommendation		Examples	Related Resources
11	Publish clear guidance on avoiding damage to trees from infrastructure work and, to the extent possible, require utilities to follow that guidance.	Palo Alto, CA New York City, NY San Antonio, TX	Conservation Law Foundation, Advancing Climate Resilience and Health through Urban Forestry Smart Cities Dive, How Arborists can Work with Developers to Preserve Green Infrastructure Under Pressure
12	Explore partnerships with healthcare organizations or public health agencies could support urban forestry as a public health intervention.	Louisville, KY Phoenix, AZ Oakland, CA	American Public Health Association's Extreme Heat Resource Hub National Institute of Environmental Health Sciences' Climate Change and Human Health Literature Portal
13	Design tree policy to restore and protect biodiversity.	San Francisco, CA New York, NY	Northern Institute of Applied Climate Science's Climate Change Adaptation Resources. ArboristNow's Urban Biodiversity: A 2024 Guide to Planting Trees in Cities
14	Include tree planting soil protections	Washington, DC Asheville, NC Brockton, MA	Tree People and Accelerate Resilience L.A, Urban Soil Management for Climate Resilience DeepRoot, Recommended Soil Volume for Urban Trees
15	Involve urban forestry professionals early in planning processes.	Palo Alto, CA New York, NY	International Society of Arboriculture, Best Management Practices - Managing Trees During Construction, Third Edition (2023)

Detailed Policy Recommendations

Recommendation 1: Draw on existing resources to develop the basic structure of a tree protection ordinance.

Online tools and publications are available to provide helpful starting points for assembling a tree policy or ordinance. Some publications offer guides to important tree concepts, such as determining what kinds of protections existing trees will enjoy, setting requirements for placing new trees, designating what city departments or officials will be responsible for implementation, and who has enforcement authority. Every city is different, so it is critically important to consider how examples and models can be adapted to the unique needs of a particular place. With that in mind, good starting points include these resources:

- North Carolina State University Extension's publication *Developing Successful Tree Ordinances*

- Morton Arboretum's ordinance builder tools for tree protection (focused on trees on a city's own property) and tree preservation (addressing trees on private property during development) each of which describes entry-level and advanced components.

Recommendation 2: Use the purpose and intent section of a tree ordinance to thoroughly describe the full range of benefits that trees provide.

Cities could use the purpose or intent section of their tree protection or preservation ordinances to detail the benefits associated with expanding the urban tree canopy. In addition to the beautification and stormwater management benefits that cities typically include in a purpose and intent section, cities could describe how trees provide shade, cooler air via evapotranspiration, improved air and water quality, carbon sequestration, and critical habitat for birds, insects, and small mammals.

- The purpose and intent section of the public tree code in Columbus, Ohio (Chapter 912.00 Purpose and Intent) establishes the value of public trees as part of the city's infrastructure and recognizes that trees on public and private property are part of the city's collective urban forest. This tree code states that the urban forest in Columbus filters pollution from the air, sequesters carbon dioxide, absorbs and filters pollution from stormwater runoff, cools the environment and helps reduce urban heat island impacts, reduces energy consumption by shielding structures from harsh winds and sun, lowers crime rates, and provides habitat for birds and wildlife.

- The purpose and intent of the City of Utica, New York's tree ordinance is to "promote the growth and health of the City's urban canopy ensuring biodiversity, sustainability, equity, an

aesthetically pleasing environment, and carbon sequestration to combat climate change; [and] combat the urban heat island effect..." (see § 2.17.26).

Recommendation 3: Maximize the role that trees can play in enhancing equity and health by prioritizing planting trees in low-canopy areas within the city.

Low-income communities and communities of color often have fewer trees, leading to disproportionately higher rates of heat-related illnesses and chronic conditions. Strategically planting trees in those areas is an opportunity to advance health equity.

Studies consistently show that communities of color experience disproportionately severe impacts of extreme heat.[1] Data from the EPA indicate that people aged sixty-five and older are much more likely than others to die from heat-related cardiovascular causes.[2] And people with chronic illnesses are more vulnerable to the effects of extreme heat.[3] Tree canopy can help. It reduces heat-related illnesses and deaths, particularly in vulnerable populations. It also improves air quality, reducing respiratory diseases like asthma and Chronic Obstructive Pulmonary Disease (COPD). Access to trees and green spaces supports human well-being and mental health, including reduced stress, anxiety, and depression. When integrated into traffic-calming measures, trees can also support safer roads for pedestrians, cyclists, and drivers. And increased physical activity and social cohesion in tree-lined neighborhoods has been shown to lead to better overall community health.[4]

In some cases, urban tree planting can also contribute to an increase in property values that may play a role in displacing residents from their neighborhoods or community. Cities at risk of experiencing green gentrification can incorporate greater community involvement in the planning of proposed projects, and coordinate across departments to integrate anti-displacement strategies in their work.

Tackling specific areas that have been historically under-invested can increase health equity and improve health outcomes, while meeting the city's overall canopy goals in an equitable way. Prioritizing planting in this way can take the form of setting specific percentage targets applied by ward, census block, or other division; or, a city could set a minimum cover that must be maintained by zoning type. The Green Infrastructure Center's Trees and Stormwater Codes and

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[1] *See, for example,* Risto Conte Keivabu et al., *Racial Disparities in Deaths Related to Extreme Temperatures in the United States*, 7 ONE EARTH 1630 (2024), https://www.sciencedirect.com/science/article/pii/S2590332224004238#sec3; New York City Dep't of Health and Mental Hygiene, *Epi Data Tables* (Aug. 2014), https://www.nyc.gov/assets/doh/downloads/pdf/epi/datatable47.pdf.

[2] U.S. Environmental Protection Agency, *Climate Change Indicators: Heat-Related Deaths*, https://perma.cc/NXK5-TTRL.

[3] Centers for Disease Control, *People at Increased Risk for Heat-Related Illness*, https://perma.cc/B7ZC-PTZP.

[4] Jared M. Ulmer et al., *Multiple Health Benefits of Urban Tree Canopy: The Mounting Evidence for a Green Prescription*, 42 HEALTH & PLACE 54 (2016), https://www.fs.usda.gov/pnw/pubs/journals/pnw_2016_ulmer001.pdf.

Ordinances tool recommends to municipalities that the minimum tree canopy coverage by zoning type be enforced with the use of fees and tree plantings if canopy levels fall below requirements.

- Cambridge, Massachusetts, for example, describes neighborhood-specific canopy goals in its 2019 Urban Forest Master Plan Preliminary Report (Table 6.5).

- In its Urban Forestry Master Plan, Columbus, Ohio distinguishes tree canopy coverage by neighborhood. It notes low canopy areas of a neighborhood to be prioritized for planting to use resources most effectively (see pages 128, 129, and 131).

- The City of Bellingham, Washington's 10-year implementation plan (contained within its draft Urban Forest Plan) includes the action to "develop a capital 'streetscape adaptation' strategy to retrofit trees and pervious surfaces into low tree equity blocks" to ensure low-equity tree areas are prioritized in the expansion of the urban forest (p. 58).

- Lake Forest Park, Washington's code sets tree canopy coverage goals by land use types and lot sizes identified through the city's zoning, such as single-family and multi-family residential and commercial (see § 16.14.070, Table 2).

- The City of Atlanta prioritizes tree plantings in heat islands in its city code (at § 158.103.(h)(1) p. 28).

Recommendation 4: Create overlay zones or districts on top of base zoning to further enhance tree protection in targeted areas.

Cities may be able to designate specific areas—including ones that cut across a range of land-uses—that set different rules for tree protection or preservation. Doing so could be an additional way of achieving better health and equity outcomes in specific areas, but may also tackle other environmental goals, like managing particular types of terrain to minimize erosion. Georgetown Climate Center's resource on resilience districts provides an overview of considerations when creating zones like these, and examples of this approach exist in several cities.

- City code for the District of Columbia includes, for example, a Tree and Slope Protection Overlay District to enable planners to "preserve and enhance the park-like setting of designated neighborhoods adjacent to streams or parks" with unique requirements in targeted areas.

- Salem, Virginia similarly provides for an Urban Forest Overlay District within which additional tree-related requirements apply beyond what the underlying zoning requires.

Recommendation 5: Develop a diverse array of incentives to encourage voluntary tree preservation beyond minimum requirements.

Cities can complement tree protection minimums with incentives to encourage property owners to take further action. The specific incentives appropriate in a particular place will vary but may include height bonuses for above-minimum tree preservation or planting, flexibility on design standards, reduced (or eliminated) parking minimums, or altered setback distances.

- The City of Lakewood, Washington's code, at § 18A.70.320(J), provides a varied menu of incentives connected to tree preservation goals, while taking tree equity goals into account.

- The City of Erie, Colorado permits a 5-20% reduction in the number of parking spaces required on the site for the preservation of existing native and specimen tree cover and vegetation beyond what is already required (§ 10.6.2(C)(8)). The City of Saint Michael, Minnesota's code (section § 94.21) permits building setbacks, lot configuration, shared driveways and variance in right-of-way and width of paving to allow for tree preservation.

- Portland, OR's zoning code (at § 33.120.210(D)) allows developers to transfer development rights to another site they own, or to sell the rights to another developer for protecting trees. By saving a healthy tree at least twelve inches in diameter from removal on one site, a developer can increase the floor area permitted at another site by 1,000 square feet or more, depending on the size of tree preserved and the site receiving the transfer.

Recommendation 6: Design parking lot landscaping rules to prioritize the inclusion of trees.

Cities can increase tree canopy by setting landscaping standards for surface parking lots that require planting and maintaining trees or setting parking space maximums to reduce impervious surface. Metrics for how many trees are planted can be based on a ratio of trees to parking spaces.

- Boxborough, Massachusetts, for example, requires two shade trees for every five parking spaces. That requirement is in § 4.4(4) of the city's site plan approval regulations. As an alternative, cities can set requirements for how much of a parking lot must be shaded (either initially or as of a certain date after construction).

- Sacramento, California has taken a different approach, requiring that at least 50% of the parking surface be shaded within 15 years of planting (§ 17.612.040(B) of the city code).

Recommendation 7: Address financing needs for long-term maintenance.

Cities can help ensure that tree canopy endures for the long term by building long-term maintenance strategies into their policy. The specific strategies appropriate in a particular place will vary but may include raising funds through taxes or exactions on specific properties, issuing bonds, charging fees on permit reviews, or allowing payments in-lieu of some tree requirements. Cities can also make options explicit in planning documents.

- Oakland, California's 2024 Urban Forest Plan, for example, describes funding pathways the city is pursing, along with examples from cities that have pursued similar funding streams.

Advanced Tree Policy Strategies

The strategies in this section are ways that cities can demonstrate leadership and accelerate community tree benefits. As with the previous approaches, the advanced strategies may not be suitable for every jurisdiction.

Recommendation 8: Establish no net loss goals for specific census tracts, wards, or other city subdivisions.

Policies that call for no net loss of trees across a whole city can result in replacement trees being located far from the lost tree, or even for being concentrated in wealthier neighborhoods at the expense of underinvested communities. Cities can combat this outcome by defining a narrower area within which the planting of trees to achieve no net loss occurs. For example, cities can set expectations on proximity, or target boundaries at a census tract, neighborhood, or individual lot level.

- Decatur, Georgia's tree ordinance provides that when removing a tree would reduce canopy coverage below the prescribed threshold of 45%, that tree must be replaced so the property still achieves that threshold of tree cover.

- The City of North Las Vegas' Urban Forestry and Tree Protection chapter in its code of ordinances provides a "No Net Loss Canopy Coverage" provision to maintain or increase canopy percentages with one-for-one tree replacement. The code stipulates that "replacements should take place as close as possible to the original location, ideally within the same ward where the tree is located."

- Tukwila, Washington's 2024-2044 Comprehensive Plan pairs its goal to increase the city's overall total canopy coverage and use of native species by 2034, with the goal of "No Net Loss of canopy cover in individual zoning categories, or environmentally critical areas and open space" (p. EN-19).

Recommendation 9: Tether off-site mitigation programs or in-lieu payment options to lower canopy areas or areas with particular heat island mitigation needs.

Where cities allow developers to meet tree protection requirements with off-site tree planting or preservation, the policy could direct off-site mitigation to priority areas. Low canopy or high-heat areas within a city could be designated as sole or priority off-site mitigation locations

- Charlotte, North Carolina's Tree Protection Manual, for example, specifies that off-site mitigation must take place in certain areas, and that "[t]o be considered, alternative locations should address one or more tree canopy-related equity and/or environmental justice issues such as: < 35% tree canopy coverage or urban heat island impacts."

- One of the objectives of the fee-in-lieu program established by the city of Burien, WA is to support tree equity. Its city code, at § 19.26.100(5)(C), indicates "fee-in-lieu monies may also be used for off-site replacement plantings at city-owned parks, public street rights-of-way, Highline School District properties within the city limits, and neighborhoods identified in the Green Burien Partnership Urban Forest Stewardship Plan in need of tree equity as determined by the Director."

Recommendation 10: Define a root protection zone to protect large trees within and adjacent to development projects.

Policies can be developed to protect trees in danger of construction project damage. For example, cities can establish protective areas around mature trees and require precautions to avoid damaging tree roots. This strategy is particularly valuable when tree trunks are located outside of a permitted construction area.

- Resources from the North Carolina Urban Forest Council, among others, provide helpful guidance for designing a root protection area.

- The Green Infrastructure Center's (GIC) Trees and Stormwater Codes and Ordinances tool recommends that municipalities require and enforce the placement of tree protection fencing during construction on public and private property to protect the critical root zone. The rule of thumb advised by GIC is to place fencing around the tree at a distance of 1.5 feet away from the tree for every 1-inch of tree's diameter at breast height (DBH). A fencing radius of 1.5 foot for every 1-inch DBH is also supported by research.

Recommendation 11: Publish clear guidance on avoiding damage to trees from infrastructure work and, to the extent possible, require utilities to follow that guidance.

Cities can encourage or require utilities and other partners to follow protective practices when conducting infrastructure work. For clarity, cities can publish guidance and communicate expectations for how work performed near trees should take place. For example, a city could require consultation with an International Society of Arboriculture certified arborist and compliance with industry standards (ANSI A300 and ANSI Z133), which provide simple specifications that ensure tree protection. The extent to which cities can impose enforceable requirements on utilities operating within the city varies, but in nearly any jurisdiction a city can establish guidelines that describe how work ought to be performed and work with utilities to encourage following those guidelines.

- Both New York City and San Antonio, Texas provide examples of guidance for utilities working near trees.

Recommendation 12: Explore partnerships with healthcare organizations or public health agencies.

A large number of studies have demonstrated a clear link between urban forestry and public health.[5] Their consensus indicates that cities, public health agencies, and other organizations focused on public health have an opportunity to consider urban forestry programs as viable interventions to improve human health, particularly in areas that suffer from low tree canopy. Cities are increasingly making health a fundamental goal of their urban forestry management planning. Long-term forestry goals can include partnerships between community members focused on improving health outcomes.

- Oakland, California's recent urban forest plan explicitly names as strategies to "support urban forestry initiatives led by partners," and to provide "opportunities for community participation in the urban forest."

- Phoenix, Arizona's draft shade plan announces that "[T]he vision, strategies, and actions in the Shade Phoenix Plan are also informed by and will be implemented with valued partnerships with local, regional, and national organizations."

- Louisville, Kentucky's Green Heart Louisville study is exploring the connection between urban greening strategies and community health.

[5] Kathleen L. Wolf, *Urban Trees and Human Health: A Scoping Review*, 17 INT'L J. ENV'T RES. & PUBLIC HEATH 4371 (2020), https://pmc.ncbi.nlm.nih.gov/articles/PMC7345658/#sec6-ijerph-17-04371.

Recommendation 13: Design tree policy to restore and protect biodiversity.

Selecting an appropriate mix of native and near-native trees well-adapted to anticipate expected changes in the local climate can help ensure the urban forest is resilient and provide critical habitat for animals and insects that depend on tree canopy. These strategies can also be complemented by programs to proactively remove invasive species.

- In 2018, the San Francisco Board of Supervisors approved a resolution establishing a citywide biodiversity policy that builds on the city's commitment to "maintain, and monitor robust and interconnected … urban forests so that they support a diverse web of life, and mitigate climate change impacts to rare species and communities."

- Similarly, in the Natural Areas Conservancy's forest management plan for New York City (developed in partnership with NYC Parks) emphasizes biodiversity opportunities and challenges that the city's urban forest faces: "Despite a high percentage of native trees in the canopy, native species are less prevalent in the midstory and understory layers. Invasive herbaceous species are common … and can prevent native seedlings from reaching the canopy, affecting ecosystem composition and function."

Recommendation 14: Include tree planting soil protections.

Inadequate soil volume is the most limiting factor for tree growth on developed sites. Requiring and providing minimum soil volumes is the most effective way to ensure successful tree growth. Relatedly, Silva Cells can provide an avenue for cities to provide a healthy growing medium for trees where compacted soil and the needs for hardscapes around a tree would otherwise limit tree growth.

- Washington, D.C., for example, in Chapter 47.7 if its Department of Transportation Green Infrastructure Standards, has created standards for minimum soil volume that trees of various sizes will require, which provides a template other cities could borrow.

- Silva Cells that protect tree roots are incorporated into Asheville, NC's Transportation Design Standards to provide a consistent form for using the technology.

- Similarly, Brockton, MA's draft form based code (§ 10.2.1.g) would give "Green Score" points for structural soil systems including Silva Cells.

Recommendation 15: Involve urban forestry professionals early in planning processes.

Consulting arborists and/or urban foresters in project planning, from scoping onward (and especially during site assessment) can ensure that valuable trees are identified and preserved.

This early planning work can eliminate unnecessary mitigation planning and maximize return on investment in tree preservation. The International Society of Arboriculture provides best management practices for managing trees during site development and construction.

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For more information about policies in this this document, questions about replicating these in other jurisdictions, for research on how effective policies are or how Smart Surfaces work, or for any other needs related to Smart Surfaces policy, please visit our City Policy Help Desk at https://smartsurfacespolicy.org/contact/.