Richmond Cool Kit

Cooling Strategies for Heat Resilience in the City of Richmond, VA

City of Richmond RVAgreen 2050

City of Richmond Established 1737 — Office of Sustainability

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We are all the leaves of one tree
We are all the waves of one sea

— *Thich Nhat Hanh*

Acknowledgements

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City Advisory Group

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Department of General Services
Department of Parks and Recreation
Department of Planning and Development Review
Department of Public Utilities
Department of Public Works
Office of Emergency Management
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Office of Housing and Community Development
Office of Sustainability

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Bike Walk RVA
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Groundwork RVA
James River Association
PlanRVA
Richmond & Henrico Health District
RVA Rapid Transit
Science Museum of Virginia
Southside ReLeaf

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Message from Mayor Danny

Dear Fellow Richmonders,

I am excited to share the Richmond Cool Kit, a first-of-its-kind resource for integrating heat mitigation into City projects and making Richmond a cooler, more heat-resilient city. Innovative tools like these support a **thriving city government that gets things done** and helps to ensure equitable access to safe, comfortable public spaces for all Richmonders.

As a public health practitioner, I know that extreme heat poses a real threat to our daily lives. Extreme heat is deadlier than hurricanes, floods, and tornadoes combined and the impacts are disproportionately felt across our City, with some zip codes experiencing vastly different average temperatures, urban tree canopies, and in some cases up to a 20-year difference in life expectancy. Cooling down communities is not only a chance to right past wrongs, it means fostering better long-term health outcomes and building climate resilience for future generations.

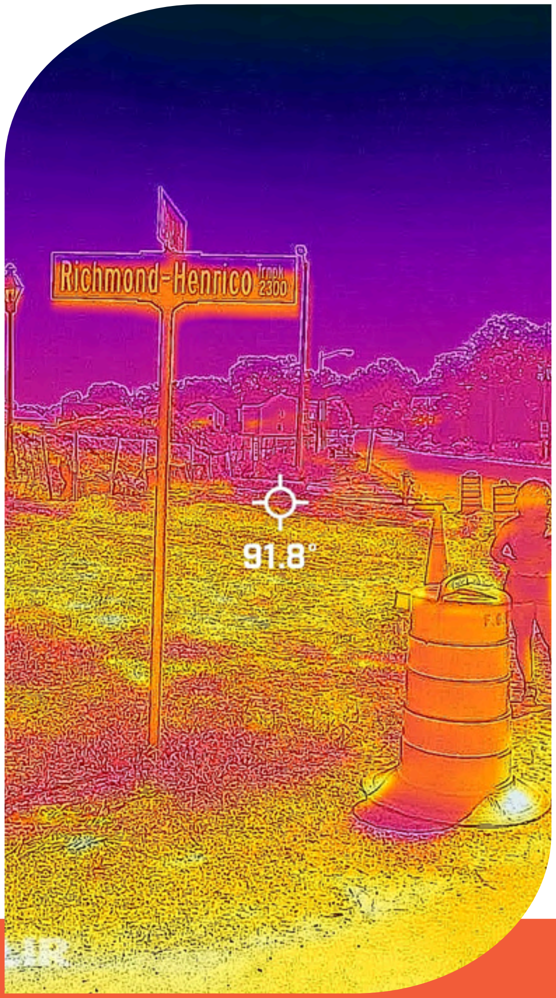
The cooling strategies laid out in the Richmond Cool Kit will be used by City staff on projects large and small to reduce urban heat and make safer, cooler neighborhoods. Whether through tree plantings, built shade, smart surfaces, or depaving, we can address our climate challenges head-on, protecting lives, and saving taxpayer dollars through sustainable design.

By working with stakeholders across the city and the region to implement the Cool Kit strategies, we can prepare for a hotter future by building heat resilience today. **Together, we can create a thriving and sustainable built environment that is planned for future generations.**

Danny TK Avula MD, MPH

Mayor of Richmond

Overview



The **Richmond Cool Kit** lays out twenty-five evidence-based cooling strategies that can reduce surface temperatures in urban and suburban communities across the City of Richmond. These strategies can be applied to publicly-owned properties, the public right-of-way, and privately-owned spaces. The Cool Kit is designed to support the work of City of Richmond employees as they plan, build, and maintain our built environment. These cooling strategies will protect our natural environment, enhance connectivity, and improve public health and safety.

The Cool Kit is also a resource for the public. Community members can apply these strategies to their homes, businesses, and in their communities to reduce heat risk.

Together, we can reduce urban heat in our communities and ensure that all Richmonders, regardless of their identity or neighborhood, thrive in a climate-resilient and climate-neutral community.

Vision

The Richmond Cool Kit establishes a shared understanding of the causes and impacts of urban heat while outlining cooling strategies that can reduce surface temperatures and promote community resilience to extreme heat and flooding. This document proposes four priority resilience goals:

1. Cool neighborhoods, homes, and businesses
2. Cool walking, biking, and transit infrastructure
3. Cool community spaces, parks, libraries, and schools
4. Increase climate resilience and well-being for all Richmonders

Strategic Plans

The City and its regional partners have developed several strategic plans which form the foundation for this document. Refer to the **Strategic Plans and Guides** section on page 33 to learn more.

Fact Base

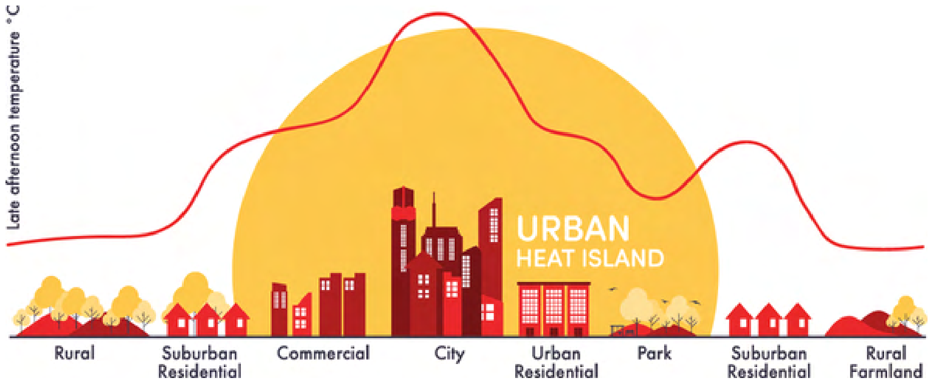
Urban heat is complex. Refer to the **Fact Base** on page 34 to find heat plans from peer cities, research studies, reports, and articles that form the basis of this document.

Glossary

Technical terms are used throughout this toolkit. Refer to the **Glossary** on 35 page if you encounter an unfamiliar word.

What Is Urban Heat?

Urban Heat Islands (UHIs) refer to the significantly higher temperatures experienced in urban areas compared to suburban and rural areas. The buildings, streets, and infrastructure that make up our cities are constructed of heat-absorbing materials such as metal, glass, concrete, asphalt, and brick. Our City's natural elements such as plants, animals, and ecosystems help to mitigate the urban heat through shade and evapotranspiration.



Source: World Meteorological Organization (WMO)

What Makes Cities So Hot?

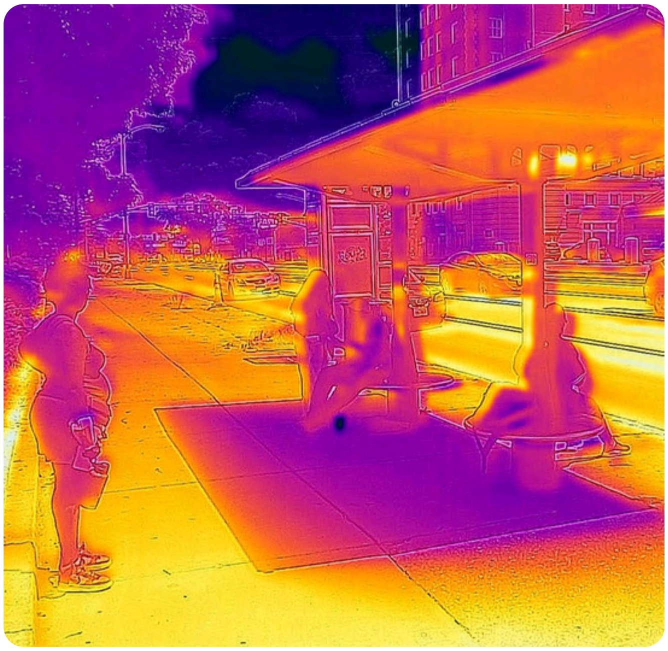
Throughout the day, heat from the sun is absorbed by the built environment, raising surface temperatures across the City. That stored heat is radiated into the surrounding neighborhoods, raising the ambient air temperature of the area. The built environment continues to radiate trapped heat throughout the night, preventing urban spaces from cooling down and posing health risks to City residents.

Sources of Urban Heat:

- Dark, impervious surfaces such as tar roofs, asphalt streets, and paved parking lots.
- Heat-absorbing buildings and infrastructure made of metal, glass, concrete, and brick.
- Lack of vegetation or tree canopy.
- Buildings that block or slow air movement and trap heat.
- Heat released by vehicle engines, air conditioning units, generators, and other sources of wasted heat.

Infrared Imagery

Infrared images are used throughout the Cool Kit to demonstrate temperature differences in the built and natural environment. Cooler surface temperatures appear in **purple hues** and hotter surfaces appear in **yellow hues**.



FLIR Photos acquired by Groundwork USA and Groundwork RVA

What Is Extreme Heat?

The definition of extreme heat can vary, but generally refers to a "heat wave," or a period of sustained heat and humidity with temperatures above 95˚F. While Richmond already experiences extreme heat, climate change is making the problem worse by raising average temperatures, creating more frequent hot days, and more frequent extreme heat events.

What Is Heat Resilience?

Heat resilience refers to the capacity to manage and mitigate the impacts of extreme heat today and tomorrow through intentional planning, clear goals, and active and inclusive participation. Heat resilience has a place in City policies and procedures, development standards, individual habits and practices, and more. Some of the cooling strategies laid out in this plan offer immediate heat relief while others are more holistic and may take years to become truly effective.

Average Daily Max Temp (°F)

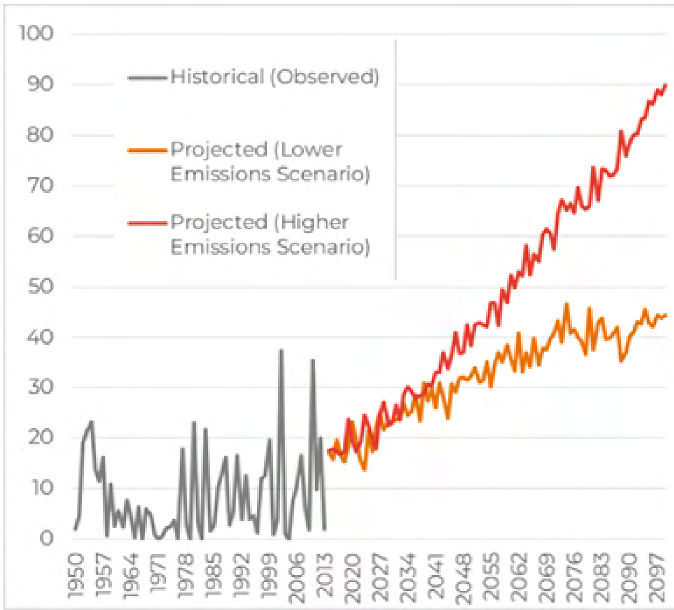


Figure 2. U.S. Climate Resilience Toolkit Climate Explorer, Average Daily Maximum Temp (°F) - Richmond, VA

Average Number of Extreme Heat Days per Year in Richmond, VA (High Emissions Scenario)

Legend

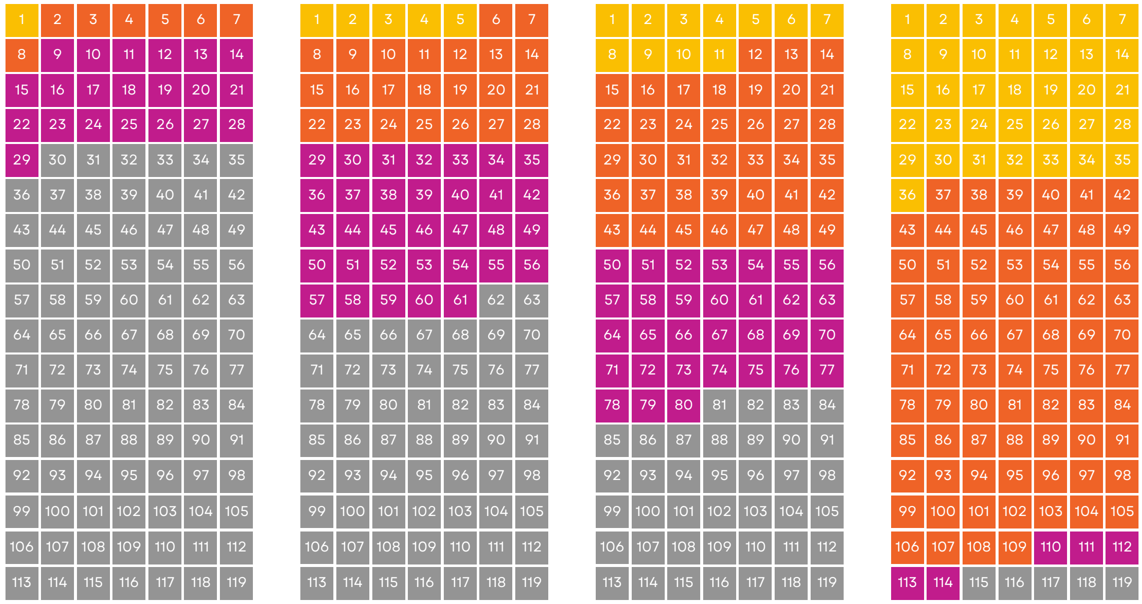
- Annual days >90°F
- Annual days >95°F
- Annual days >100°F

Modeled History 1976 - 2005

Early Century 2015 - 2044

Mid Century 2035 - 2064

Late Century 2070 - 2099



The Daily Impacts of Urban Heat

Urban heat already impacts everyday life for individuals, communities, businesses, infrastructure, and the natural environment across Richmond. As the number of extreme heat events rise due to climate change, outdoor activities like work, sports and recreation, concerts, spectator sports, and school recess are at risk. Targeted heat mitigation will be necessary to ensure community members can safely go about their daily lives.

Heat-Related Illnesses and Public Safety

Urban heat increases the rate of heat-related illnesses like dehydration, heat exhaustion, and heat stroke and aggravates existing health conditions like asthma and heart disease.[1] Urban heat adds stress already vulnerable communities; studies have shown a link between rising temperatures and crime rates.[2]

Public Infrastructure and Energy Grid

Urban heat can stress infrastructure engineered for a 20th century climate. Built elements expand and contract due to heat, which degrades roadways, sidewalks, power lines, and utility equipment.[3] Increased energy demand from higher cooling needs will strain our grid and risk triggering a blackout.[4]

Ecosystem Health, Habitat, and Biodiversity

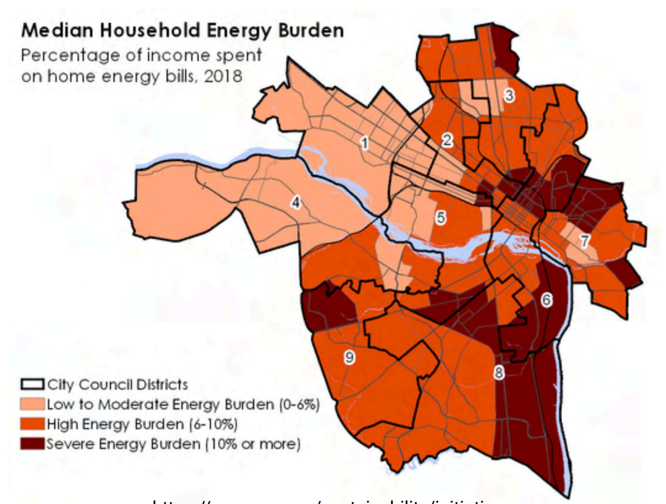
Urban heat poses a threat to local ecosystems by intensifying evaporation and straining plant, animal, and insect populations. By disrupting ecosystems, contributing to drought, and increasing wildfire risk, urban heat threatens the living organisms and natural cycles upon which our lives depend.

Business and Industry

Urban heat impacts local economic activity as customers seek refuge from outdoor businesses, commercial centers, and uncovered spaces. City agencies and industries which rely on outdoor labor, such as construction, trades, landscaping, utilities, and emergency response, may need to alter schedules and protocols to mitigate the dangers of midday heat.

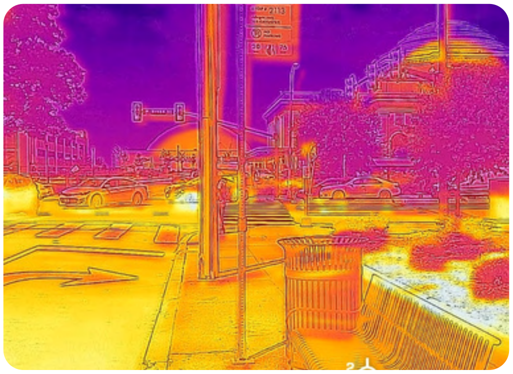
Energy Burden

Energy burden refers to the proportion of a household's income spent on energy bills. A 2020 study on energy burden in Richmond found that the median energy burden of Black households in Richmond is **42% higher** than that of non-Hispanic white households.[5] As temperatures rise and the number of extreme heat days increase, cooling energy demand and energy costs are expected to rise and will pose a growing risk to vulnerable communities. Neighborhoods with high energy burden will benefit the most from targeted heat mitigation efforts.



https://www.rva.gov/sustainability/initiatives

Rising Heat, Rising Inequities

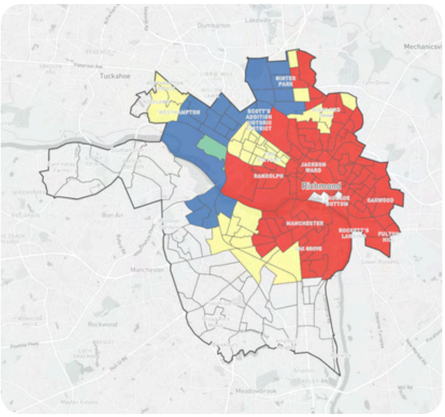


The science and thermometers are clear: Richmond is getting hotter. The increasing heat is not impacting everyone evenly. Richmond's urban landscape reflects a complicated history of formerly racist policies including redlining,[6] highways construction through Black and Brown neighborhoods,[7] urban renewal,[8] and county annexation.[9]

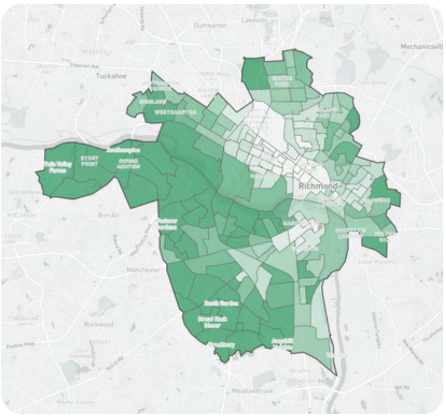
The Richmond of today includes neighborhoods with starkly different tree canopy coverage, ambient air temperatures, public health outcomes, and life expectancy. Investing in cooling strategies equitably allows the City to address past inequities and ensure better outcomes for all Richmonders.

American Forests developed a Tree Equity Score Analyzer (TESA)[10] tool for the City of Richmond which combines demographic data, environmental factors, impervious surface rates, and land use to evaluate disparities in tree coverage and potential for tree planting. Below are three maps from the TESA tool that help to illustrate the connection between redlining policies, tree canopy coverage and the resulting heat disparity.

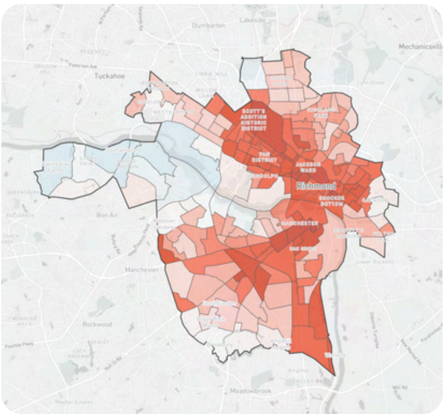
Redlined Neighborhoods
(1937)



Tree Canopy Coverage
(2020)



Heat Disparity
(2022)



Source: Tree Equity Score Analyzer (TESA)

Disproportionate Heat

A 2020 study[11] concluded that past exclusionary zoning can be linked to hotter neighborhood temperatures today. Richmond's legacy of racism has created lasting climate exposure gaps for low-income communities and Black and Brown neighborhoods. This underscores the need for targeted cooling and urban greening in frontline communities.

Disproportionate Impacts

A 2024 study[12] found that approximately 40% of reported EMS responses for heat-related illness occurred within ≈100 meters of a transit stop. It also found that Black residents, people aged 50+, males, and people experiencing homelessness were disproportionately impacted by heat related illnesses. This study highlights the need for targeted heat mitigation at transit stops and other waiting spaces.

Cooling Project Planning Guide

To determine if a project should incorporate cooling strategies, consider the five steps below. These prompts are designed to help project managers weigh the need for cooling, which strategies to incorporate, and how best to integrate them into the overall project.

Step 1: Understand Community Needs

Start with people, not data. Engage the community early to understand their daily routines, gathering spaces, and cooling priorities. Heat mitigation projects succeed when designed with communities, not for them.

Key Questions:

- Where do people gather, wait, and move through the area?
- What are the community's specific cooling needs and preferences?
- How do residents currently cope with extreme heat?

Step 2: Assess Heat Risk and Vulnerability

Map the heat. Use PlanRVA's Extreme Heat storymaps[13] and the Richmond Resilience Assessment[14] to identify:

- Urban Heat Island intensity at your site
- Heat-vulnerable populations nearby
- Current shade coverage and cooling infrastructure

Step 3: Observe How People Use the Space

Study public life patterns. Document when, where, and how people move through and occupy the space:

- Peak usage times and seasons
- Travel routes and gathering spots (e.g., high-traffic sidewalks and bike lanes, long paths without shade)
- Current shade-seeking behaviors (e.g., waiting in the shade of nearby trees or buildings)
- Vulnerable users (e.g, children, elderly, outdoor workers)

Step 4: Select Appropriate Cooling Strategies

Match interventions to community needs and site conditions. Refer to Cooling Project Typologies (pg. 8) and Cooling Strategies (pg. 10) to determine:

- Tree placement and species selection
- Shade structures (sails, canopies, shelters)
- Surface treatments and materials
- Integration with existing infrastructure

Step 5: Design for flexibility and future adaptation.

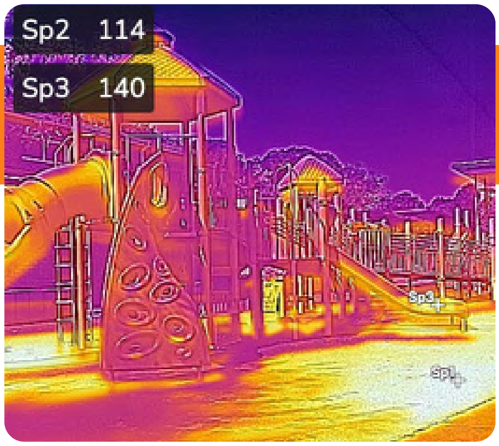
Remember: Effective cooling projects create comfortable public spaces that support daily life while building long-term community resilience. Manage uncertainty by incorporate solutions that will be beneficial regardless of future heat and flood risk. Learn more about adaptive design and risk management through climate-resilient infrastructure here.

Cooling Project Typologies

The sites most in need of cooling are ones in which community members are most exposed to heat. The Richmond Cool Kit identifies three types of public gathering spaces where folks are at the highest risk of heat-related illnesses due to exposure. Refer to the three site typologies when determining cooling strategies will confer the most community benefits.

Hot Spots

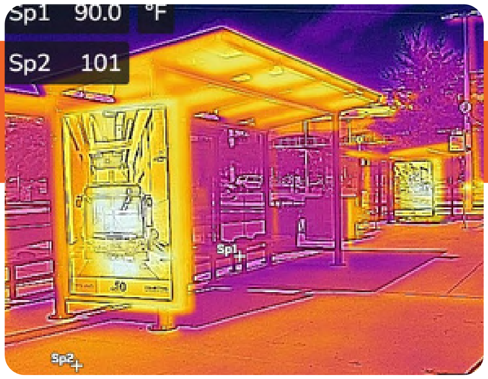
Popular spaces for gathering



- Parks, recreation fields, athletic facilities
- Schools, daycares, and learning centers
- Playgrounds, dog parks, and community gardens
- Outdoor events, markets, and festivals
- Public plazas, outdoor arenas, venues, and stadiums
- Restaurants, breweries, coffeeshops, and business districts

Waiting Spaces

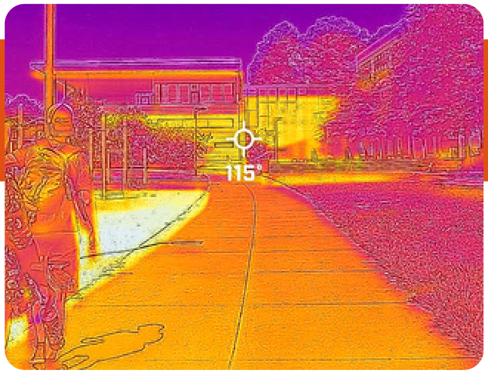
Liminal spaces for pausing or waiting



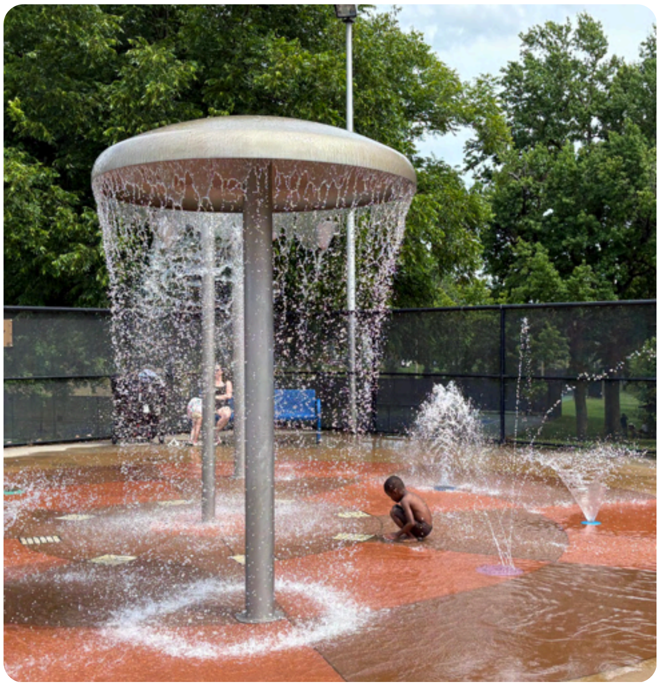
- Transit stops
- Carpool lanes
- Busy intersections

Corridors

Linear spaces used to traverse the City



- Bike lanes, shared use paths, and trails
- Sidewalks and pedestrian bridges
- Alleyways
- Vegetated roundabouts
- Highway on ramps



Cooling Strategies

This toolkit outlines 25 evidence-based cooling strategies that can reduce surface temperatures and mitigate urban heat. These strategies build critical resilience to extreme heat and should be integrated into City capital improvement projects (CIPs) and maintenance projects on publicly-owned properties and the public right-of-way. Community members are encouraged to implement these cooling strategies on privately-owned spaces.

Many of these strategies are expanded on in the Richmond Sustainable Design Standards (SDS). Reference numbers from the SDS are noted alongside relevant strategies.

Urban Greening

Urban Forestry
- Street Trees
- Reforestation
- Pocket Forests

Green Infrastructure
- Bioretention
- Green Buffers
- Turfgrass Conversion

Green Space
- Mini-Parks
- Curbside Parklets

Blue Space
- Water features

Shade

Light Shade
- Lightweight Canopies
- Shade Sails
- Affixed Shade

Heavy Shade
- Shade Walls
- Shade Structures
- Building form

Smart Surfaces

Cool Roofs
- Reflective/Cool Roofs
- Green Roofs
- Solar Roofs
- Combined Roofs

Cool Pavement
- Light Pavement
- Permeable Paving

Cool Infrastructure
- Light-Colored Paints
- Heat-Resistant Materials

Depaving

Surface Removal and Replacement
- Greening
- Placemaking
- Permeable Pavements

Urban Greening


Jefferson Park, Richmond, VA

Photo: Max Posner

Urban greening offers cost-effective solutions for cooling neighborhoods and increasing community resilience to extreme heat and flooding. These interventions cool the built environment in two key ways:

- **Shade** from urban trees keeps surface temperatures low by blocking solar radiation and preventing heat build up.
- **Evapotranspiration** from vegetation lowers ambient air temperatures by releasing water vapor into the air, cooling the surrounding air and ventilating hot air away from the street.

Beyond heat mitigation, urban greening solutions offer multiple co-benefits including: reduced stormwater runoff; dampened noise pollution; improved air quality; carbon sequestration; increased biodiversity; traffic calming; reduced heating and cooling demand; increased property values; and improved physical and mental health.

Urban Greening Strategies:

Urban Forestry

- Street Trees
- Reforestation
- Miyawaki Forests

Green Infrastructure

- Bioretention
- Green Buffers
- Turfgrass Conversion

Green Space

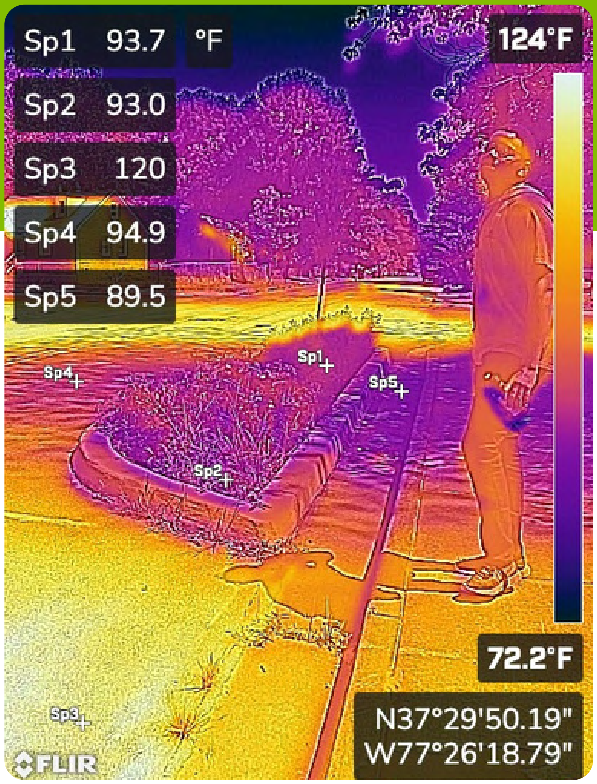
- Mini-Parks
- Curbside Parklets

Blue Space

- Water Features
- Splash pads


Cool the City campaign launch event - Spring 2025, Richmond, VA

Photo: Daniel Klein



From Grey to Green

The thermal image to the right utilizes infrared cameras to visualize the stark difference in surface temperatures between grey infrastructure and green infrastructure. The asphalt in direct sunlight (Sp3) reads 120°F while the shaded and vegetated curb extension (Sp1) reads 94°F. That 26°F difference can have serious health implications for City residents. Converting grey infrastructure to green infrastructure can reduce surface and ambient air temperatures, reduced stormwater runoff, and ensure safe, climate-conscious infrastructure for all residents.

Resources

- Richmond Resilience Assessment Storymap
- Richmond Sustainable Design Standards (SDS)
- Richmond DPU Stormwater Utility Credits
- NACTO Urban Street Stormwater Guide
- Native Plants for Virginia's Capital Region
- Applied Nucleation for Forest Recovery in the Mid-Atlantic
- Virginia Conservation Assistance Program (VCAP)

Decision Making Tools

- Richmond Guide to Greening Multimodal Buffers
- PlanRVA Extreme Heat Storymap
- APA - Planning for Urban Heat Resilience
- Tree Equity Score Analyzer

For Project Team Members

1. Does your project sit within an Urban Heat Island or heat sensitive community?
2. Does your project sit within a flood-prone area?
3. Can your project incorporate more green features such as trees, native landscaping, or bioretention?

1 Urban Forestry

Urban forestry refers to the practice of managing trees and forests within urban areas to promote environmental sustainability, social benefits, and economic growth. Urban trees cool communities through evapotranspiration and shading and are essential infrastructure for heat resilience. A 2023 study found that increasing present-day tree canopy shading of roadways to an average of 50% can reduce the estimated rate of heat mortality between 14% and 27%.[15]

1.1 Street Trees

Street trees are the most cost effective solution for cooling urban streetscapes. Trees require good soil condition and adequate volume to establish healthy roots, as well as ongoing care and maintenance.

Applications: Residential neighborhoods; business districts; school zones; transit stops. **(SDS 5.5.1; SDS 5.6.4)**
Considerations: CIP and maintenance projects should incorporate shade trees, but must include adequate soil volume; intensive watering for the first 2 years after planting; ongoing management plans; consider tree well expansion.

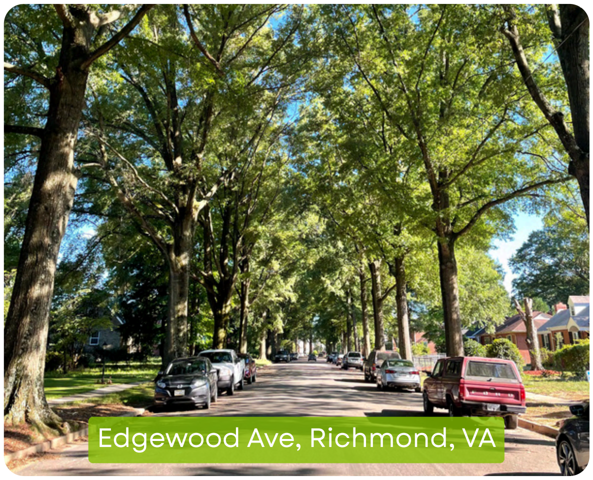


Photo: Daniel Klein

1.2 Reforestation

Planting native trees in underutilized lawns and turfgrass can reduce local temperatures, restore lost habitat, and improve rainwater infiltration while reducing maintenance costs.

Applications: Underutilized turfgrass on City-owned property including parks and schools; difficult-to-maintain areas; slopes; flood-prone areas with poor drainage. **(SDS 5.5.1; SDS 5.6.4)**
Considerations: Invasive species management; sight lines and pedestrian visibility; native species selection.

Photo: Daniel Klein

1.3 Miyawaki Forests

Densely planted pockets of native plants, shrubs, and trees can provide highly-localized cooling and are ideal for high-traffic urban areas, schoolyards, and parks.

Applications: Schoolyards; playgrounds; community centers; parks; highly exposed spaces. **(SDS 5.5.1; SDS 5.6.4)**
Considerations: Intensive short-term care; long-term maintenance plans; sight lines and visibility; community-facing signage for context; screening infrastructure.

Photo: Daniel Klein

2 Green Infrastructure

Green infrastructure refers to natural and semi-natural solutions that reduce stormwater runoff while increasing climate adaptation and urban cooling. As green infrastructure solutions offer both heat and flood mitigation, they are ideal for areas that experience both issues.

2.1 Bioretention

Bioretention refers to landscaped systems that slow down, filter, and retain stormwater in the underlying soil. This reduces stormwater runoff and cools the surrounding area while establishing natural habitats for pollinators. Bioswales and raingardens are examples of bioretention.

Applications: Curb extensions; medians; alleyways; parking lots; flood-prone areas with poor drainage. **(SDS 5.5.1)**
Considerations: Management plans; community-facing informational signage; conflicts with utilities; soil conditions.

East End Branch Library, Richmond, VA

Photo: Justin Doyle

2.2 Green Buffers

Vegetated buffers protect pedestrians and bicyclists from vehicular traffic while providing shade, cooling, stormwater reduction, and increased ventilation. Green buffers allow residents to safely traverse the city year-round.

Applications: Bike lanes; shared-use paths; high-traffic pedestrian zones; sidewalks. **(SDS 5.4.3)**
Considerations: Maintenance and implementation costs; see Richmond Guide to Greening Multimodal Buffers.

Mercer Bike Lane, Seattle, WA

Photo: Seattle Bike Blog

2.3 Turfgrass Conversion

Converting underutilized lawn into low- or no-mow pollinator gardens or urban meadows provides localized cooling, reduces maintenance needs, and established natural habitat.

Applications: Underutilized turfgrass on City-owned property (i.e., parks, schools, etc.); difficult-to-maintain areas; slopes; flood-prone areas with poor drainage; medians. **(SDS 5.5.1; SDS 5.6.4)**
Considerations: Sight lines; native species selection; cues-to-care; invasive species management; litter pickup.

Bellemeade Park, Richmond, VA

Photo: Daniel Klein

3 Green Space

Green space refers to publicly accessible areas with trees, turfgrass, or landscaping. While large public parks can lower the ambient air temperature of adjacent neighborhoods, smaller-scale solutions such as mini-parks and parklets provide both valuable community space and heat respite for City dwellers.

3.1 Mini-Parks

Mini-parks provide residents with localized cooling and climate resilient social infrastructure. Seating, shade, landscaping, and other amenities can make even the smallest parks inviting, comfortable, and cool.

Applications: Residential neighborhoods; business districts, transit stops; enhancing existing triangle parks; underutilized slip lanes; gaps in the 10-minute parks walkshed.
Considerations: Sight lines and visibility, pedestrian access and safety, native species selection, cues to care (including maintaining clean edges), invasive species management, and litter pickup.


Broad St. Pollinator Park, Richmond, VA

Photo: Daniel Klein

3.2 Parklets

Parklets replace street parking with modular or custom designs that create park-like spaces. These provide localized cooling, expand community access to high quality green space, create new social infrastructure, and calm traffic.

Applications: High-pedestrian traffic zones; business districts; high injury streets; underutilized slip lanes.
Considerations: Incorporating permanent or temporary shade structures; benches; plants that enhance resilience; trade-offs with losing 1-2 parking spots (this consideration may be mitigated if pedestrian and bike traffic is encouraged to reduce vehicular traffic).


Leigh St. Parklet, Richmond, VA

Photo: Daniel Klein

4 Blue Space

Blue space refers to public spaces with surface waterbodies (ponds, lakes), watercourses (streams, rivers, canals), or water features (fountains, springs). Blue spaces reduce ambient air temperatures through evaporative cooling and pair well with both natural and built shade. Blue spaces can also function as natural habitat for local ecosystems, recreation amenities, and social gathering spaces.

4.1 Water Features

Public pools, fountains, and natural springs offer localized cooling, community spaces, and urban beautification. Public plazas, mini-parks, and neighborhood gathering spaces in heat islands are prime locations for water feature installation. Outdoor misters are extremely effective at cooling and can be integrated into existing amenities such as benches, transit stops, and park pavilions.[16]

Applications: Parks; underutilized urban spaces; high-pedestrian traffic zones; business districts; plazas and squares.
Considerations: Maintenance and cost; public safety.

Jefferson Park, Richmond, VA

Photo: Daniel Klein

4.2 Splash Pads

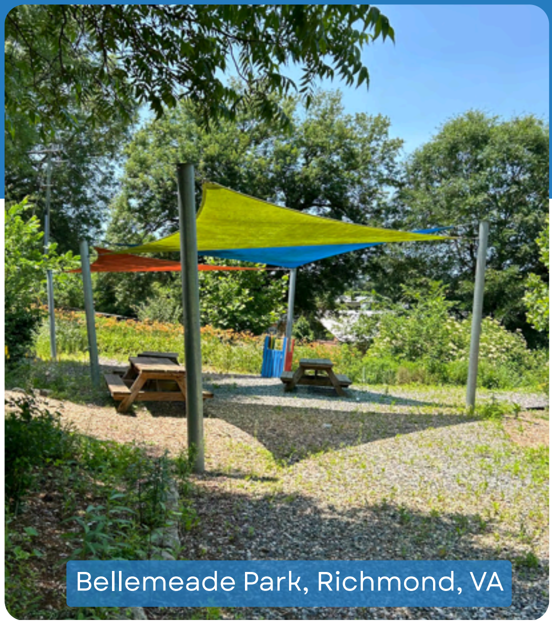
Splash pads offer all the benefits of water features and provide play and recreation space. Some designs are integrated into public plazas and blur the lines between a fountain and a play space. Places with regular pedestrian traffic--such as outdoor markets, venues, and playground--are ideal spaces for splash pads.

Applications: Parks; underutilized urban spaces; high-pedestrian traffic zones; business districts.
Considerations: Maintenance and cost; public safety (See VDH guidance on splash pad safety).[17]

Battery Park Splash Pad, Richmond, VA

Photo: Daniel Klein

Shade



Bellemeade Park, Richmond, VA

Photo: Katie Brown

Shade structures provide critical protection from direct sunlight and inclement weather and are ideal solutions for areas with space or budget constraints. Shade designs can add to the visual interest and character of a structure, neighborhood, or business district while adding heat resilience to existing community spaces.

Lightweight shade options, such as shade sails, are ideal for cooling transit stops with right-of-way constraints. Whereas urban greening solutions take time to establish, shade structures can be installed relatively quickly to offer immediate heat relief.

Built shade structures range in size and cost from free-standing umbrellas to fixed structures with solar arrays that span entire basketball courts. Shade is particularly effective when layered with other cooling strategies, such as shade trees, heat-resistant surface coatings, and permeable surfaces. Thermal heat readings taken at GRTC bus stops by RVA Rapid Transit in 2023 detected a 18^{O}F reduction in surface temperatures at stops with shade structures versus those that are exposed.[18]

Shade Strategies:

Light Shade

- Lightweight Canopies
- Shade Sails
- Affixed Shade

Heavy Shade

- Shade Walls
- Shade Structures
- Building Form

Whole Foods, Richmond, VA

Photo: L.F. Jennings

Reducing Exposure

The infrared image to the right shows an 11°F difference between the 101°F sidewalk in direct sunlight (Sp2) and the 90°F sheltered bus stop bench (Sp1). The Greater Richmond Transit Company (GRTC)'s Essential Transit Infrastructure Plan[19] outlines a goal of installing benches or shelters at 50-75% of all transit stops by 2027. In cases where a full shelter can't fit due to space constraints, more flexible options such as shade sails, shade walls, and affixed shade can provide heat relief for riders. In 2024, RVA Rapid Transit released the Cooling the Commute report[20] outlining the importance of heat mitigation at transit stops.

Resources

- GRTC Essential Transit Infrastructure (ETI) Plan
- 50 Grades of Shade study
- DCR Shade Project Kit of Parts & Design Guidelines
- Shade Phoenix
- Cooling Long Beach
- Shade Lookbook: A Guide to Designing Sun Safety

Decision Making Tools

- PlanRVA Extreme Heat Storymap
- APA - Planning for Urban Heat Resilience
- Urban Design Guidelines
- Shade Map

For Project Team Members

1. Does your project sit within an Urban Heat Island or heat sensitive community?
2. Is your project a waiting space, hot spot, or corridor? (see page 10)
3. Can your project incorporate a shade solution?

5 Light Shade

Light shade solutions are low-cost, widely available, and easily adaptable options for cooling down public and private spaces. These can be installed or removed quickly and are well-suited for small spaces, outdoor events, or for rapid heat response. Light shade is ideal for corridors, such as streetscapes or bike lanes with space constraints or right-of-way conflicts. These options also work well for waiting spaces, such as bus stops that cannot accommodate a bus shelter.

5.1 Lightweight Canopies

Lightweight canopies such as patio umbrellas and canopy tents are low-cost, widely available, mobile, and easy to install. These can be deployed quickly to provide immediate heat relief for short-term needs such as events or emergency response. As canopies lack anchoring to the ground and require weights, they are not a long-term solution.

Applications: Outdoor markets, festivals, and sporting events; public squares and plazas; businesses and food establishments; private residences; outdoor work sites; employee break areas.
Considerations: Limited to short-term or immediate use; feasibility and safety of use during weather events; lack of ground mounting.

Lightweight canopy, Richmond, VA

Photo: Daniel Klein

5.2 Affixed Shade

Awnings and overhangs can be affixed to buildings to cool streetscapes and pedestrian spaces. Affixed shade options are low-cost and offer weather protection for pedestrians, transit riders, and business patrons. Retractable models are available and can be stowed while a business or amenity is closed or during inclement weather.

Applications: High-traffic streetscapes with few overhead conflicts; commercial districts and businesses with outdoor seating; employee break areas.
Considerations: Weatherization; wind rating, permits and engineered designs; maintenance; creating design standards; incentives for private businesses; solar readiness.


Nate’s Bagels, Richmond, VA

Photo: Anna Bon-Harper

5.3 Shade Sails

Shade sails are high-tensile, lightweight shade cloths stretched between wood or metal support structures. Sails vary in shape and size, are often made of canvas, knitted polyethylene, or woven PVC. They are ideal for public or private areas with space restrictions or right-of-way constraints. Shade sails can be installed quickly and provide immediate heat relief. As the sun's UV rays degrade the materials over time, shade sails typically last for around 10 years.

Applications: Waiting spaces such as transit stops and busy pedestrian intersections; community hot spots such as plazas, community gardens, athletic facilities, playgrounds; commercial districts, and businesses; corridors such as high-traffic pedestrian zones, active transportation corridors, trails, shared-use paths, and pedestrian alleys.

Considerations: Weatherization and seasonality; wind rating; material longevity; installation and maintenance by public or private entities; design standards; and, space constraints.

Shade sail at Water St., Richmond, VA

Photo: Daniel Klein

6 Heavy Shade

Heavy shade refers to larger, fixed structures which protect residents from direct sunlight and the elements. Heavy options require more intensive design, engineering, and funding, but are ideal solutions for large public spaces, bus transfer stations, athletic courts, playgrounds, parking lots, and outdoor venues. Fixed shade structures can be fitted with solar panel arrays and are ideal for parking lots with EV charging stations.

6.1 Shade Walls

Shade walls can range from simple trellises for vining plants to more complex green walls. These vertical elements can be strategically positioned to block direct sunlight without the need for complex engineering and have longer lifespans than temporary shade sails. Vertical Greenery Systems (VGSs) are also known as "green walls" or "living walls," and are highly effective at providing both shade and evaporative cooling.

Applications: Parking lots; outdoor recreation and athletic facilities; school yards; streetscapes with limited space; transportation corridors such as bike lanes, shared-use paths, and busy sidewalks.
Considerations: Aesthetic and design standards; orientation to maximize shade; sight lines; maintenance; placemaking.


VMFA, Richmond, VA

Photo: Daniel Klein

6.2 Shade Structures

Shade structures such as gazebos, pavilions, and pergolas provide horizontal shade from direct sunlight, weather protection, and social space for gathering and community events. Prefabricated models are widely available, while custom shade designs can incorporate public art.

Applications: High-pedestrian traffic zones; parks and recreation facilities; community gardens; transit stops unsuitable for bus shelters; spectator areas. **(SDS 5.4.7)**
Considerations: Public seating; smart surfaces to lower surface temperatures; orientation to maximize shade and ventilation; solar readiness; placemaking.


SPARC Park, Richmond, VA

Photo: Daniel Klein

When designing shade into projects, it's important to consider ventilation and air flow which can compound the cooling benefits of any project. Electric fans and misters can be integrated into most heavy shade designs and will improve airflow but require electrical wiring. Solar-ready designs allow for low-cost electric fans without the need for extensive electrical wiring.

6.3 Building Form

Building design and orientation has a dramatic impact on urban temperatures. Buildings with varied facades and overhangs absorb less heat than structures with flat frontages. In certain cases, shade created by nearby buildings can provide the most effective cooling for specific streetscapes.[21] Variation in building heights increase ventilation, which moves hot air up and away from streets.

Applications: Design overlays for new development.
Considerations: Wind tunnels during winter months; expense; limited to new development.

Photo: CoStar

Smart Surfaces

Photo: Irvine Community News & Views (ICNV)

Smart Surfaces refer to a range of technologies that reduce surface temperatures by reflecting sunlight and limiting absorption of solar radiation. Smart surfaces work in two primary ways:

- **Solar Reflectance (SR),** or **"Albedo,"** is the reflectivity of a surface. Light-colored paints and reflective materials do not absorb solar radiation in the same way that dark colored surfaces do, which helps to lower surface temperatures.
- **Evapotranspiration** refers to the process of transferring water from the land into the air. Porous surfaces and permeable pavements encourage evapotranspiration and help to lower both surface and ambient air temperatures.

Smart surface solutions reduce energy demand for cooling, reduce stormwater runoff, and can extend the lifespan of infrastructure. On a typical summer day, a white roof that reflects 80% of sunlight will remain up to 55°F cooler than a gray roof that reflects only 20% of sunlight.[22]

Smart Surface Strategies:

Cool Roofs

- Reflective Roofs (Cool Roofs)
- Green Roofs
- Solar Photovoltaic (PV) Roofs
- Combined Roofs

Cool Pavement

- Light Pavement
- Permeable Paving

Cool Infrastructure

- Light-Colored Paints
- Heat-Resistant Materials

Photo: NYC Cools Roofs

Heat Resilient Recess

The infrared image to the right shows cool surface temperatures in dark purple and hot surface temperatures in yellow. The plastic slide (Sp3) is reading 140^{o}F and poses a serious burn risk to children using the playground. Burns can occur after two minutes of exposure to 125^{o}F surfaces or after just one minute of exposure to 130^{o}F surfaces.[23]

Extreme heat is not only a health risk for students, it also impacts learning ability and outcomes. A 2017 study found that students taking an exam on a 90^{o}F day were nearly 11% less likely to pass than students taking the exam on a 72^{o}F day.[24] Implementing cooling strategies can help to ensure playgrounds, recreation facilities, and school recess remain accessible and heat resilient.

Resources

- EPA Using Cool Roofs to Reduce Heat Islands
- EPA Using Cool Pavements to Reduce Heat Islands
- Cool Roof Rating Council (CRRC)
- CRRC Resource for Home and Building Owners
- Smart Surfaces Coalition
- Smart Surfaces Guide
- NYC Cool Roofs
- Global Cool Cities Pavement Coating Research

Decision Making Tools

- Solar reflectance and temperature
- Energy burden of the neighborhood
- Climate proofing of buildings against excessive heat

For Project Team Members

1. Does your project sit within an Urban Heat Island or heat sensitive community?
2. Is your project a waiting space, hot spot, or corridor? (see page 10)
3. Can your project incorporate smart surface technology?

7 Cool Roofs

Cool roofs utilize various technologies to increase the solar reflectivity of building rooftops to reflect rather than absorb sunlight. Cool roofs can be up to 50^{O}F lower than standard dark roofs.[25] Buildings with cool roofs lower require less cooling thus alleviating strain on the energy grid during peak heat hour. Lower cooling energy demand means lower energy costs for residents and can save high energy burdened households money.

7.1 Reflective Roofs (Cool Roofs)

Reflective roofs utilize light-colored paints and heat-resistant materials to reflect sunlight and reduce surface temperatures. Reflective roofs lower a building's rooftop temperatures and the ambient air temperature of the surrounding area. Most roofs can be resurfaced with white paint (aka "white-topping") or retrofitted with heat-resistant membranes such as TPO, short for Thermoplastic Polyolefin.

Applications: Publicly owned structures; industrial, commercial, and residential buildings; retrofits and new builds; bus shelters; public pavilions. **(SDS 5.7.3)**
Considerations: Slope angle; roof orientation; roof condition.

The Valentine Museum, Richmond, VA

Photo: Daniel Klein

7.2 Solar Photovoltaic (PV) Roofs

Solar panel arrays not only produce clean, renewable energy, they also shade building rooftops and are effective at lowering surface temperatures. Installing solar rooftops add low-carbon, renewable energy to the local energy grid, helping the City reduce its GHG emissions reduction and transition to our clean energy future. Solar roofs can be applied broadly including on solar-ready shade structures in parks or at transit stops or solar canopies for carports, parking lots, and decks.

Applications: Publicly owned structures; industrial, commercial, and residential buildings.
Considerations: Installation costs; maintenance requirements; slope and angle of the roof; roof warranty.

Huguenot High School, Richmond, VA

Photo: Secure Solar Futures

7.3 Green Roofs

Green roofs are roof coverings designed with a layer of drought-resistant plants, a growing medium, a drainage layer, and a waterproof membrane. These roofs lower surface temperatures, reduce stormwater runoff, improve building insulation, and reduce energy demand. Green roofs with public access expand a community's usable green space while passively reducing greenhouse gas emissions and providing habitat for biodiversity.

Applications: Publicly owned structures; industrial, commercial, and residential buildings; retrofits and new builds; bus shelters; public pavilions.
Considerations: Slope angle; roof orientation; roof condition; maintenance; roof warranty

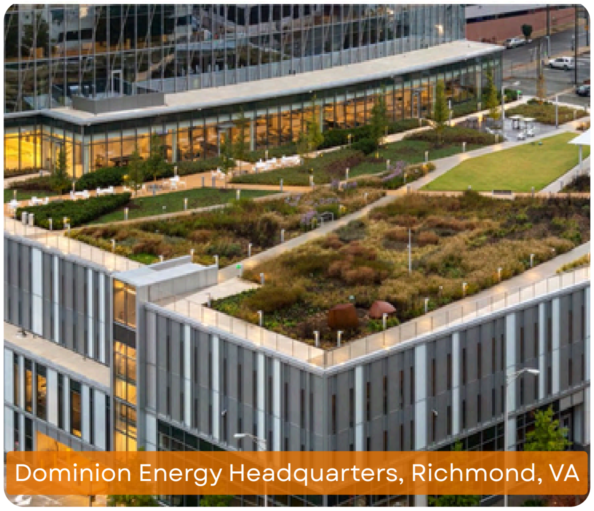

Dominion Energy Headquarters, Richmond, VA

Photo: Landezine International Landscape Award

7.4 Combined roofs

For some roofs, integrating multiple cool roof strategies together can confer the most benefits. For example, installing solar PV panels above a green roof can increases energy efficiency while reducing surface temperatures.


Solar Biodiverse Roof

Photo: Sempergreen

8 Cool Pavement

Similar to cool roofs, **cool pavements** use light-colored-paints and heat-resistant materials to increase solar reflectance. The use of cool pavements can reduce surface temperatures by 50–70°F[26], lowering energy demand for nearby buildings and creating a more comfortable public realm.

8.1 Light Pavement

Light pavements are coated with white or light-colored paints or sealants which increases solar reflectance, reflecting more sunlight, and reducing surface temperatures. Light pavements are more durable and have extended service lives than darker surfaces. This strategy has been found to improve nighttime visibility for pedestrians and drivers while also improving air quality.[27]

Applications: Roadways; parking lots; street murals. Options include asphalt seal coats, chip seals, pavement rejuvenators, white-topping, and light-colored aggregates. **(SDS 5.4.8)**
Considerations: Cool pavements can contribute to increased ambient air temperatures and shouldn't be used in high-pedestrian traffic zones. Street murals are prime opportunities for traffic calming and localized cooling.

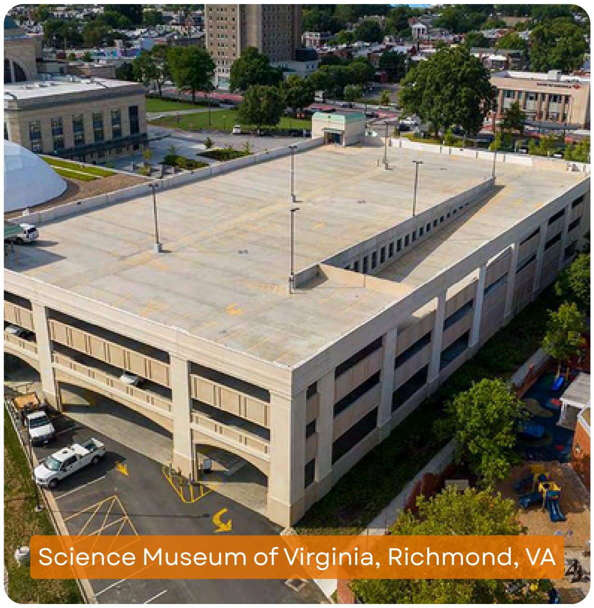

Science Museum of Virginia, Richmond, VA

Photo: S. B. Ballard

8.2 Permeable Paving

Permeable, or pervious, paving falls into two types: modular options like permeable pavers and pour-in-place materials such as permeable asphalt or concrete. Permeable pavements decrease flooding impacts by routing stormwater runoff into temporary storage areas and allowing stormwater to absorb back into the ground. The increased porosity of permeable pavements improves evapotranspiration thereby reducing surface temperatures and cooling the surrounding area.

Applications: Bicycle lanes and shared-use paths; sidewalks and pedestrian walkways; low traffic roadways such as parking lots, road shoulders, carpool lanes, and driveways; green alleys; patios, plazas, and other outdoor gathering spaces. **(SDS 5.4.8; SDS 5.6.6)**
Considerations: Installation costs; maintenance requirements; soil infiltration rate.

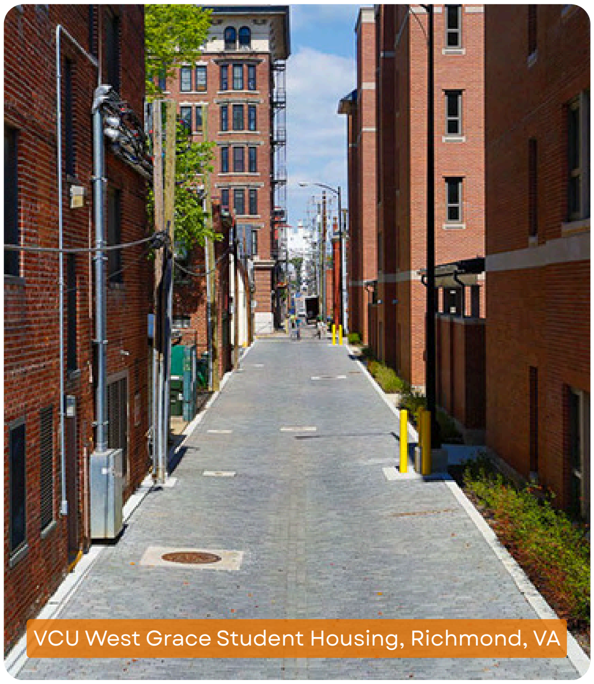

VCU West Grace Student Housing, Richmond, VA

Photo: Timmons Group

9 Cool Infrastructure

Cool infrastructure utilizes light-color paints and heat-resistant materials to reflect sunlight and reduce surface and ambient air temperatures. Strategies can be as simple as painting bus shelters lighter colors or resurfacing parking lots with heat-resistant sealants. Cool surface technology extends the lifespan of critical infrastructure which is otherwise susceptible to extreme heat.

9.1 Light-Colored Paints

Light-colored paints apply not only to streets and roofs but also to public amenities such as public benches, waste receptacles, railings, and bus shelters. Selecting paints or coatings with high solar reflectance will reduce surface temperatures and extend the object lifespan. Public art projects such as traffic calming street murals and wall murals should use paints with higher solar reflectance.

Applications: Building facades, public furnishings; utility infrastructure; light fixtures; waste receptacles; publicly-owned and privately-owned structures.
Considerations: Surface material and condition; maintenance schedule; Public Art Commission and community-engagement for cooling public art projects.

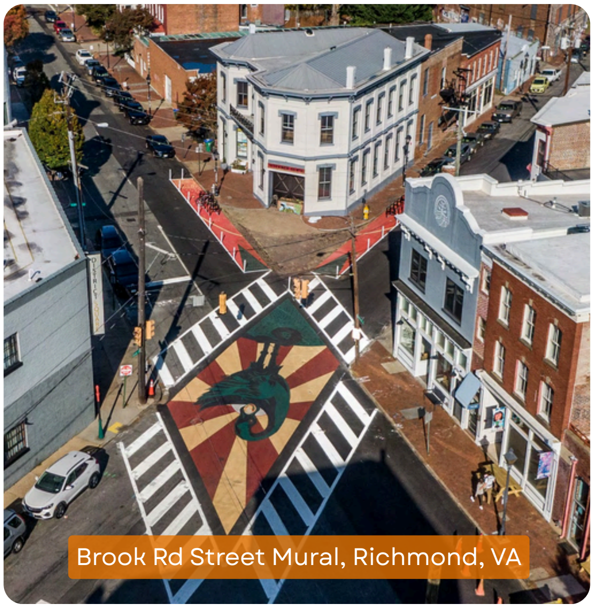

Brook Rd Street Mural, Richmond, VA

Photo: Richmond Biz Sense

9.2 Heat-Resistant Materials

Heat-resistant materials absorb and radiate less heat than traditional materials thus lowering surface temperatures. Incorporating these materials into a design can also extend the material lifespan of buildings and infrastructure. Consider materials when designing projects where community members will be sitting, standing, or gathering nearby. For example, granite, wood, and certain metals conduct heat less effectively than iron, plastic, or brick. Materials with high thermal resistance or low conductivity will feel cooler to the touch and make for smarter infrastructure.

Applications: Building facades, public furnishings; utility infrastructure; light fixtures; waste receptacles; publicly-owned and privately-owned structures.
Considerations: Surface material and condition; maintenance schedule.


VMFA, Richmond, VA

Photo: PBS

Depaving

Depaving refers to the removal and replacement of impervious surfaces such as roadways, sidewalks, and parking lots with green infrastructure, community space, or permeable pavements. This solution offers highly localized urban heat mitigation, stormwater runoff reduction, habitat restoration, traffic calming, community space, and resilience to extreme heat and flood. Depaving is therefore ideal for communities experiencing the compound effects of both heat and flooding.

Depaving requires cross-agency coordination, planning, technical skills and equipment, and ongoing maintenance. After a surface is removed, the highly compacted soil must be amended with compost and biochar and tilled to support healthy plants.

Photo: Todd Lookingbill

Depaving Strategies:

Surface Removal and Replacement

- Greening
- Placemaking
- Permeable pavements

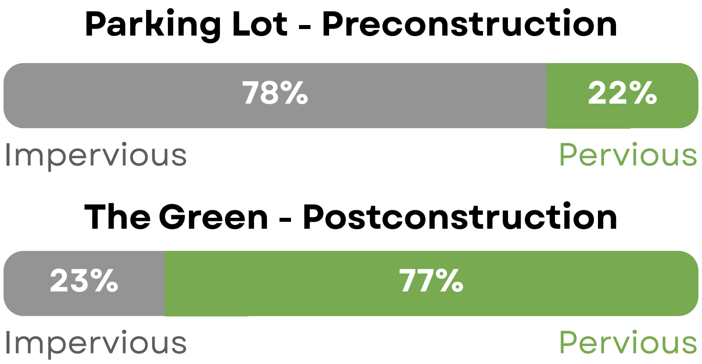
Photo: Andrew Allli

From Parking to Park

In 2023, the Science Museum of Virginia (SMV) completed work on Richmond's largest depaving project to date. The project, referred to as The Green,[28] included depaving a 381-space surface parking, conversion into a 2-acre public park with 150 trees, 900 shrubs, and over 12,000 perennial grasses and native flowers, and the construction of a new 400-space parking deck.

The SMV is located in Greater Scott's Addition, a notable urban heat island, and not only offers community members a place to seek refuge from the heat but also acts as a heat sink for the surrounding neighborhood. The Green is adjacent to a popular Pulse BRT stop on Broad Street further cooling a critical waiting space. In converting a surface parking lot with a park, the SMV demonstrated the efficacy of depaving to reduce surface temperatures, mitigate urban heat, and build heat resilience.

Photo: Science Museum of Virginia



Resources

- DPU Impervious Surface Area by Property
- DPU Green Infrastructure Mapping Tool
- Depave Portland

Decision Making Tools

- EPA Green Infrastructure Modeling Toolkit
- City Of Richmond Depaving SOP

For Project Team Members

1. Does your project sit within an Urban Heat Island or heat sensitive community?
2. Is your project a waiting space, hot spot, or corridor? (see page 10)
3. Is there underutilized impervious surface in or near the project area?
4. Does the project sit within a high flood risk community?

10 Surface Removal and Replacement

Impervious surface removal can be grouped into three categories: greening, placemaking, and permeable pavements. Greening includes replacing impervious surfaces with rain gardens, pollinator gardens, bioswales, or trees. Placemaking integrates greening options with communal elements such as benches, tables, shade structures, or vegetable gardens. Permeable pavement (see pg. 27) retrofits of existing paved surfaces can reduce local heat and flood risk. **(SDS 5.4.8; SDS 5.6.6)**

10.1 Greening

Depaving excess sidewalk squares allows for the creation, expansion, and connection of tree wells while maintaining ADA compliance. Greening bike lane buffers and installing vegetated curb extensions cools streetscapes, encourages active and public transportation, and improves pedestrian safety. Parking lots can be retrofitted with tree wells and bioswales or can totally removed to reduce temperatures depending on a community's current needs.

Applications: Waiting spaces such as transit stops and busy intersections; residential, commercial, and arterial streets; alleyways; high injury network streets; underutilized roadway, slip lanes and overly-wide streets; underutilized parking lots, driveways, and recreational courts; CIP streetscape projects
Considerations: Site feasibility; cost, installation, and maintenance of vegetated swales, stormwater planters, and street trees; stormwater utility credits; ADA compliance; right-of-way conflicts and utilities.

James River Parks System, Richmond, VA

Photo: Katie Brown

10.2 Placemaking

Placemaking refers to the holistic approach to improve the public realm to be accessible, usable, and memorable. Depaving offers a chance to redefine parking lots, paved schoolyards, overly-wide streets, or any other underutilized impervious surface which contributes to urban heat. Installing trees, greenery, public seating, trash cans, and wayfinding signage can convert underused surfaces into meaningful community spaces through participatory co-design.

Applications: Publicly owned properties and buildings; industrial, commercial, and residential buildings.
Considerations: Design; community engagement; installation costs; maintenance requirements;

SMV green, Richmond, VA

Photo: Daniel Klein

10.3 Permeable Pavements

See **Smart Surfaces: 8.2 Permeable Pavements** (pg. 27)

For some streets, parking lots, and sidewalks, simply removing impervious surfaces is not feasible. In those cases, permeable pavements should be integrated into future maintenance or CIP projects to mitigate the urban heat causes by that infrastructure. Parking lanes, alleys, and sidewalks in high heat risk and flood-prone communities can be converted into permeable pavers.

Applications: Bicycle lanes and shared-use paths; sidewalks and pedestrian walkways; low traffic roadways such as parking lots, road shoulders, carpool lanes, and driveways; green alleys; patios, plazas, and other outdoor gathering spaces.
Considerations: Installation costs; maintenance requirements; soil infiltration rate.

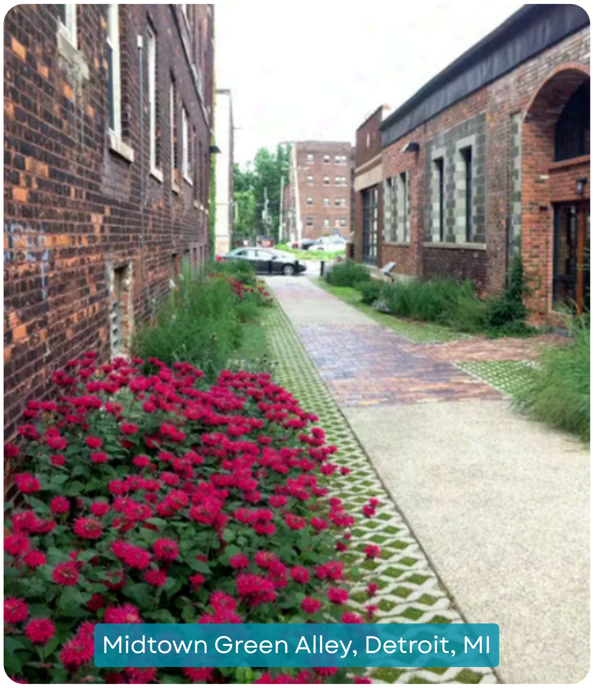

Midtown Green Alley, Detroit, MI

Photo: Sierra Club

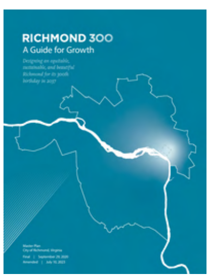
Strategic Plans and Guides

The Richmond Cool Kit is nested within an ecosystem of City-developed plans for future land use, transportation, housing, and growth. These plans include the following:

- Richmond 300: A Guide for Growth
- RVAgreen 2050: Climate Equity Action Plan 2030
- RVA H2O: RVA Clean Water Plan
- Richmond Connects Strategic Multimodal Transportation Plan
- Richmond Sustainable Design Standards
- Richmond Urban Design Guidelines

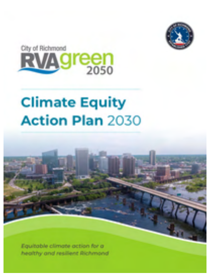
Forthcoming Plans and Policies:

- INSPIRE – Parks Master Plan
- Richmond Urban Forest Master Plan
- Code Refresh



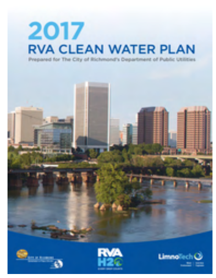
Richmond 300: A Guide for Growth

Objective 17.3 Reduce urban heat, prioritizing areas with a high heat vulnerability index rating. (pg.197)



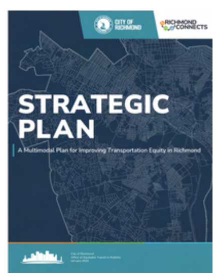
RVAgreen 2050: Climate Equity Action Plan 2030

Action ENV-2.1.i Develop, fund, and implement an urban heat island reduction plan with a focus on vulnerable populations and ecosystems. Include actions such as mandating benches and shade structures at all bus stops and establishing "rubber-stamped" shade structure designs that businesses can build and install in the public right-of-way. (pg.130)



RVA H2O: RVA Clean Water Plan

Objective: Develop green infrastructure, including riparian buffers and removal of impervious surfaces on development, existing development and redevelopment.



Richmond Connects Strategic Plan

INC 10: Sustainability - More Plants MORE PLANTS & EDIBLE LANDSCAPING (10.5) Plant more trees, landscaping, and other green infrastructure along streets throughout the City to create more shade, absorb rainwater, provide food, and improve water quality.

Fact Base

Heat Maps

- Richmond Resilience Assessment
- A Hot Issue: Extreme Heat in Our Communities - PlanRVA

Heat Management Plans and Guides

- Extreme Heat Playbook - US Department of Housing and Urban Development
- Heat Island Related Links - EPA
- Heat Resilience Playbook - City of Austin, TX
- Climate Resilience Toolkit - Boulder, CO
- Heat Mitigation & Adaptation Guidebook - Charlottesville, VA
- Cooling Long Beach - Long Beach, CA
- Shade Phoenix: An Action Plan for Trees and Built Shade
- Cool Corridors Program - Phoenix, AZ
- Keep Cool DC - Washington, D.C.

Research Studies:

- A Heat Emergency: Urban Heat Exposure and Access to Refuge in Richmond, VA (2024)
- Mitigating urban heat along roadways; systematic review of impact and practicability
- The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas (2020)

Reports

- Great parks should not uproot communities green gentrification risk factors and anti-displacement options
- Small Space, Big Impact - Blue Ridge Outdoors

Articles

- The climate crisis: The economic, health, and developmental consequences of extreme heat
- Extreme Heat Is Deadlier Than Hurricanes, Floods and Tornadoes Combined
- Shade Will Make or Break American Cities - The Atlantic
- The Problem with Hot Schools
- How Green Schoolyards Create Economic Value
- We need to prepare our transport systems for heatwaves — here's how

Glossary

Ambient Air Temperature	A measure of the average air temperature in the environment measured with a thermometer or temperature sensor.
Built Environment	The constructed or modified structures that provide people with living, working, and recreational spaces including buildings, roads, sidewalks, parks, schools, work sites, and homes.
Climate Change	Long-term shifts in temperatures and weather patterns primarily due to the burning of fossil fuels like coal, oil and gas which increase heat-trapping greenhouse gas levels in Earth's atmosphere and raise Earth's average surface temperature.
Climate Resilience	The ability to prepare for, recover from, and adapt to the impacts of climate change.
Cool Pavement	Pavements that use light-colored-paints and heat-resistant materials to increase solar reflectance.
Cool Roofs	Various technologies which increase the solar reflectivity of building rooftops to reflect rather than absorb sunlight.
Cues-to-Care	Intentional landscape design and maintenance practices that signal to observers that a space is actively being cared for and maintained.
Evaporative Cooling	A natural process where water changes from liquid to vapor state (evaporation) by absorbing heat energy from its surroundings.
Evapotranspiration	The combined processes (evaporation and transpiration) which move water from the Earth's surface into the atmosphere.
Exclusionary Zoning	The use of zoning ordinances to exclude certain types of land uses from a given community, especially to regulate racial and economic diversity.
Extreme Heat	A period of high heat and humidity with temperatures above 90˚F for at least two to three days.
Fact-Base	A compilation of verified and objective information, data, and information on a specific topic which serves as a shared understanding for decision-making and problem-solving among collaboration partners.
Frontline Communities	Communities that experience the most immediate and worst impacts of climate change and often include Black, Brown, Indigenous, and low-income communities.
Green Infrastructure	A range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters.

Green Wall	A vertical built structure intentionally covered by vegetation, also referred to as Vertical Greenery Systems (VGSs) or “living walls”.
Green Roof	Roof coverings designed with a layer of drought-resistant plants, a growing medium, a drainage layer, and a waterproof membrane
Heat Management	comprehensive efforts undertaken by local governments to protect people and manage the impacts of extreme heat and the urban heat island effect.
Heat Mitigation	Strategies which reduce overall urban temperatures by altering the built environment through cooling strategies.
Heat-Related Illness	A group of ailments that occur when the body natural cooling mechanisms struggle to keep up with heat as a result of exposure to abnormal or prolonged amounts of heat and humidity without relief or adequate fluid intake. Common illnesses include heat cramps, heat exhaustion, or heat stroke.
Heat Sink	A mechanism that absorbs and dissipates unwanted heat.
Median Radiant Temperature	A measure of the combined effect of all the radiant temperatures in an environment and includes heat radiating from nearby surfaces. Also known as “experienced heat.”
Miyawaki Forest	A method of creating dense, native forests in a short amount of time, involving a high density of various native tree and shrub species in specially prepared soil, mimicking the structure of a natural forest.
Natural Environment	all living (biotic) and non-living (abiotic) things occurring naturally, meaning not created or significantly altered by human beings.
Public Right-of-Way	A legally designated path, road, or access area that allows unrestricted movement for the general public, ensuring connectivity across communities and properties.
Slip Lane	A short, one-way lane at a junction that allows traffic to turn onto a cross street without fully entering an intersection.
Smart Surfaces	A range of technologies that reduce surface temperatures by reflecting sunlight and limiting absorption of solar radiation.
Solar Absorptance (SA)	The fraction of sunlight (0 to 1, or 0 percent to 100 percent) that is absorbed by a surface.
Solar Photovoltaic (PV) Roof	A roof covering that includes electricity-generating solar photovoltaic (solar PV) panels.

Glossary

Solar Radiation	Energy emitted by the Sun through electromagnetic waves including including ultraviolet, visible, and infrared light.
Solar Reflectance (SR or "albedo")	The fraction of sunlight (0 to 1, or 0 percent to 100 percent) that is reflected from a surface.
Solar Reflective Index (SRI)	The measure of a material's solar reflectance and thermal emissivity, that is, the ability to reflect solar energy or emit absorbed energy. SRI is used to indicate how hot a material is likely to become.
Streetscape	The visual elements that make up a street, including the road, buildings, sidewalks, landscaping, and other urban features.
Stormwater Runoff	Precipitation, such as rain or melting snow, that flows over land or impervious surfaces (like roads, parking lots, and rooftops) and doesn't soak into the ground.
Surface Temperature	The infrared energy emitted by surfaces warmer than the surroundings. Also known as "radiant heat."
Thermal Comfort	The feeling of being neither too hot nor too cold; influenced by factors like temperature, humidity, air movement, radiant heat, and individual characteristics such as clothing and activity level.
Thermal Emittance (TE)	A material's ability to release previously absorbed energy away from itself.
Thermal Resistance (R-value)	The measure of a material or system's ability to prevent heat from flowing through it. The thermal resistance of a roof can be improved by adding insulation, a radiant barrier, or both.
Thermal Radiation	The transfer of electromagnetic radiation (aka heat), commonly referred to as radiant heat.
Urban Heat Islands (UHIs)	The significantly higher temperatures experienced in urban areas compared to suburban and rural areas due to heat-trapping buildings, streets, and infrastructure.
Urban Tree Canopy	The area of leaves and branches of trees that cover the ground when viewed from above, within a city or urban area.
Urban Meadow	A designed landscape in an urban area that mimics a natural meadow, typically featuring a mix of grasses and wildflowers, and is managed to support biodiversity and provide ecological benefits.
Wasted Heat	Heat generated as a byproduct of inefficiencies in equipment and thermodynamic processes that is not used and is released into the environment.

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