GREAT ADAPTATIONS

How Two Smaller Legacy Cities Are Embracing Green Infrastructure

By Cyrus Moulton

AS RAIN SHEETED across the 150,000-square-foot roof of a transit facility in one of the most flood-prone neighborhoods in Worcester, Massachusetts, things looked ominous. But instead of posing a threat, that stormwater slithered into a jumble of purple coneflower, Joe Pye weed, Russian sage, and other flood- and drought-tolerant plants growing between the complex and nearby Quinsigamond Avenue.

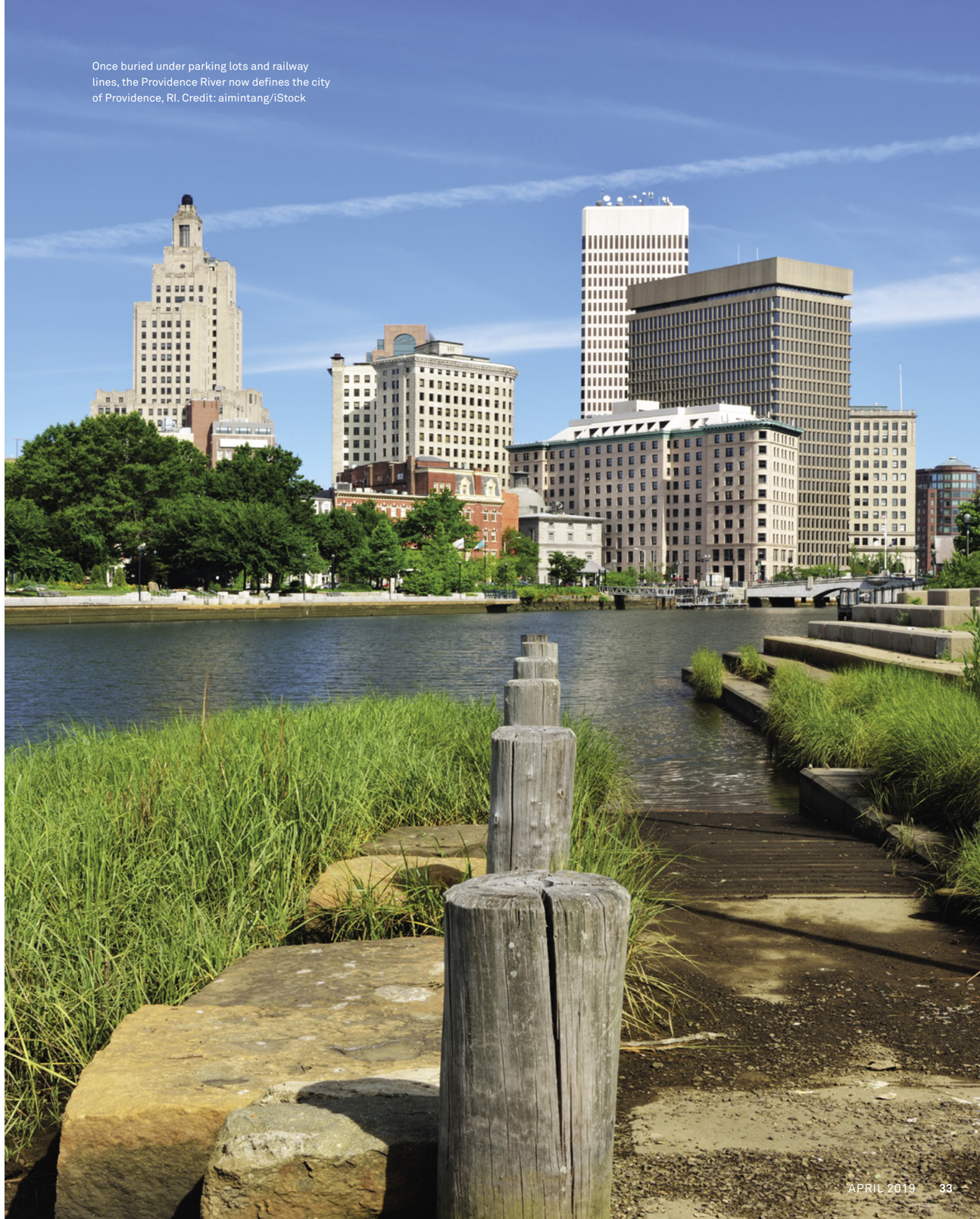
The transit facility, built on a remediated brownfield, represents a $90 million investment for this small city. Green infrastructure elements like that rain-absorbing bioswale were considered a must, according to William Lehtola, chair of the Worcester Regional Transit Authority Advisory Board: "We want to provide the best possible environment for the city and our customers and employees," he said. "Not just in our buses, but in our facilities too."

As smaller legacy cities like Worcester and nearby Providence, Rhode Island, continue the grueling work of rebounding from the severe economic and population losses suffered since their manufacturing heydays, the green approach is gaining traction. Despite challenges ranging from financial constraints to deteriorating infrastructure, many legacy cities have realized that investing in—and, in some cases, mandating—green infrastructure yields multiple benefits. Projects such as rain gardens, bioswales, urban farming, and tree planting, whether introduced on a small scale or implemented citywide, are an effective way to revitalize public spaces, manage stormwater, improve public health, and deal with the impacts of climate change, from increased heat to floods.

"Green infrastructure can address multiple challenges, and provide amenities as well," says Professor Robert Ryan, chair of the Landscape Architecture and Regional Planning Department at the University of Massachusetts, Amherst. Ryan has led courses on greening legacy cities including Worcester. "Cities like Worcester and Providence are the ideal place for this approach."

Cultivating this shift isn't always simple. While new environmental codes, regulations, and awareness have increased the frequency of green infrastructure projects, they still often coexist with structures and streetscapes from an earlier era, when nearby waterways were de facto sewers, and pavement was the go-to choice for urban improvements.

As legacy cities across the country implement green infrastructure projects and strategies, they are coping with an important reality: They cannot just create themselves anew. They can, however, adapt and evolve.



Once buried under parking lots and railway lines, the Providence River now defines the city of Providence, RI. Credit: aimintang/iStock

Green infrastructure can be an effective way to revitalize public spaces, manage stormwater, improve public health, and deal with the impacts of climate change . . . Cultivating this shift isn't always simple.

A New Lease on Life in New England

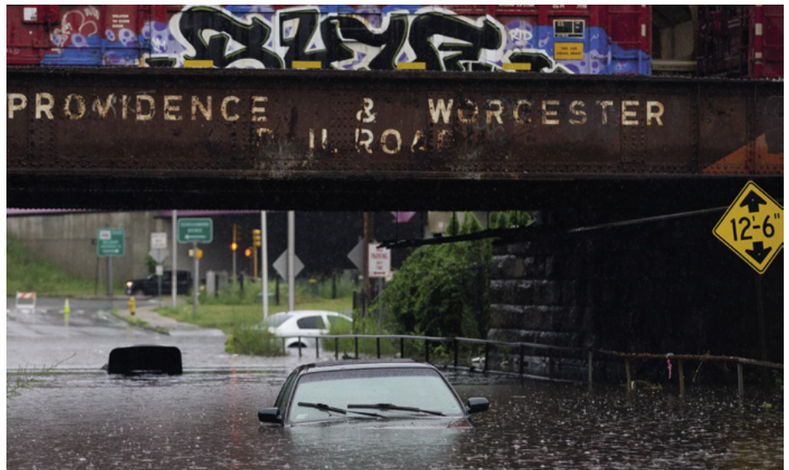
Located in a hilly area of central Massachusetts, Worcester is home to an estimated 185,000 people. Its population peaked at 203,486 in 1950 and dipped to about 161,000 by 1980.

Worcester was always the economic hub for surrounding Worcester County. But it earned the moniker "Heart of the Commonwealth" thanks to connections with Boston (via railroad in 1835) and with Providence (via the Blackstone Canal in 1828 and the Providence & Worcester Railroad in the late 1840s), which made it an increasingly important industrial and transportation hub. It became known for its machine tools, wire products, and power looms.

Providence, perched on the banks of the Providence River at the head of Narragansett Bay, has followed a similar path, albeit in a different setting. The coastal city is home to approximately 180,000 people. That's up from a twentieth-century low of 156,000 in 1980, but far smaller than the peak of more than 253,000 in 1940. The state capital, Providence became a manufacturing powerhouse after the Revolutionary War, with factories churning out goods such as jewelry, textiles, silverware, and machinery, and shipping them from its port. At one point, it was one of the wealthiest cities in the country.

In both cities, the industrial activity and the population eventually declined and, coupled with suburbanization, left hollowed-out sections of formerly vibrant urban cores (see Figure 1). But, as is the case with many legacy cities, people have slowly rediscovered the assets these communities offer. As Alan Mallach and Lavea Brachman explain in the Lincoln Institute report *Regenerating America's Legacy Cities*, these assets include downtown employment bases, stable neighborhoods, multimodal transportation networks, colleges and universities, local businesses, historic buildings and areas, and facilities for arts, culture, and entertainment (Mallach 2013).

Providence, for instance, is home to Brown University, the Rhode Island School of Design, the University of Rhode Island, and Johnson & Wales. Worcester is home to more than a dozen institutions of higher learning including Clark University, College of the Holy Cross, Worcester Polytechnic Institute, and University of Massachusetts Medical School. Both cities have major hospitals and performance venues. And both cities have revitalized their downtowns with signature projects.



Cars navigate heavy flooding under an aging Providence & Worcester Railroad bridge in Worcester in July 2018. Credit: Matthew Healey

Figure 1

Providence and Worcester Population Trends, Key Industries, and Land and Water Area

	Current population	Population 1900	Peak population	Population 1980	Key Industries	Land Area	Water Area
Providence	180,000	175,597	253,000 (1940)	156,000	jewelry, textiles, silverware, machinery	18.45 sq. mi.	2.17 sq. mi.
Worcester	185,000	118,421	203,486 (1950)	161,000	machine tools, wire products, power looms	37.36 sq. mi.	1.09 sq. m.

Source: World Population Review

Providence successfully rebranded itself as an arts and cultural hub beginning in the 1990s. In a massive green infrastructure effort, the city unearthed the Providence River, formed by the confluence of the Woonasquatucket and Moshassuck rivers, which had long been buried under parking lots and railroad tracks, and lined the banks with parks and pedestrian-only walkways. ("The river has to be an integral part of the city," said then-Mayor Vincent "Buddy" Cianci Jr. "Don't cover it, don't block it, don't pollute it. Celebrate it and use it.") The massive effort changed the character of the downtown, which soon began to draw new development projects—including ambitious renovations of vacant mill buildings—as well as new residents and businesses.

Worcester is replacing its failing downtown mall with the $565 million, mixed-use CitySquare redevelopment, reconnecting the central business district with other burgeoning parts of the city such as Washington Square—the home of the renovated Union Station—the restaurants of Shrewsbury Street, and the hip Canal District. In fact, Worcester was deemed "high performing" among cities of its size in the Lincoln Institute report *Revitalizing America's Smaller Legacy Cities* (Hollingsworth 2017). Factors cited in this designation included its proximity to Boston and easy access via commuter rail; leaders who have the energy and skills to revitalize the city; and the CitySquare project. Providence was not included in either Lincoln Institute report, but its revitalization efforts have been heralded by organizations from the American Planning Association to *The New York Times*.

Although this momentum is promising, climate change complicates everything. In the Northeast, climate change is associated with more frequent extreme weather events including heavy rainfall and flooding, droughts, warmer air and water temperatures, changing circulation patterns in the ocean (and related impacts on weather and fisheries), and sea-level rise. Providence is positioned to see flooding and damage from more intense Nor'easters and hurricanes that slam into its shores; a climate report prepared in Worcester nods to predicted impacts including "increased temperatures, more extreme heat days, and changing precipitation patterns."

"Some degree of climate change is inevitable—there's literally nothing we can do about it now," said Edward R. Carr, professor of international development, community, and environment at Clark University in Worcester. "The question is, how much can we deal with it, and what is that going to look like."

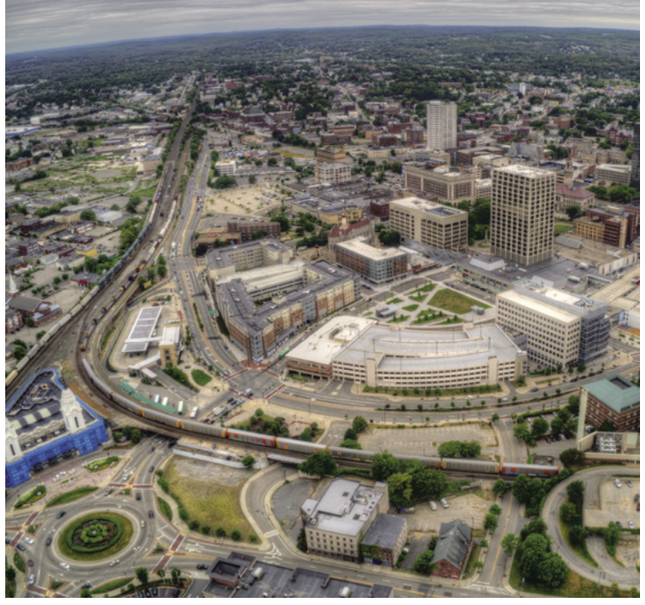
Where Revitalization and Preparedness Meet

"The most fundamental rationale for thinking about green infrastructure is to come up with uses for a massive accumulation of vacant lots, so it will not be a blight and hopefully will [have] a positive effect on the neighborhood," said Alan Mallach. "Historically, a lot of people had the theory that a vacant lot was worthless unless you built something on it. But that's changing. There are a number of ways you can take a vacant lot and make it valuable to the community, whether for recreation, to produce fresh food, address sewer overflow. There are ways to address vacant lots that don't require building new housing or office buildings."

As legacy cities assess such land use opportunities, they sometimes lack the political or economic power to engineer effective solutions. But there's one area in which legacy cities have an advantage: They are seeking to reinvent themselves as healthier, more appealing places to live, so they are often more willing to embrace novel and creative projects. This will be helpful in the era of climate change, says Amy Cotter, associate director of Urban Programs at the Lincoln Institute.

"If you think about ways we could prepare legacy cities to play key roles in a future where climate change is affecting large population centers, green infrastructure could be both a revitalization strategy and a climate preparedness strategy," said Cotter. "It can also help places revitalize and deal with what otherwise would be the blight of vacant property."

Larger legacy cities across the country have embraced a suite of options with these goals in mind. In Detroit, a comprehensive green infrastructure effort has led to a citywide sprouting of green roofs, rain gardens, and a "green alley" program in which native plants and permeable pavers replace urban debris and concrete in previously neglected alleyways. In Cleveland, the regional sewer district manages a green infrastructure grants program, and ambitious plans are coming together for a park that will occupy



An aerial view of Worcester, Massachusetts. Credit: Jacob Boomsma/Shutterstock

20 acres of formerly industrial waterfront along the Cuyahoga River. Philadelphia is investing approximately $2.4 billion in public funds over 25 years to do everything from provide rain barrels to create urban wetlands in order to reduce combined sewer overflow.

Smaller legacy cities with populations under 200,000 don't always garner headlines, or have the resources and capacity to undertake such large projects, but many are making similar efforts. Worcester and Providence demonstrate how smaller legacy cities—one coastal, one inland—are relying on green infrastructure to help them rebound from the challenges of the last century and prepare for the uncertainties of the decades ahead.

"Not only does green infrastructure act as an environmentally friendly alternative to traditional stormwater systems, it can help protect us from climate impacts like urban heat island and coastal erosion, and be used in streetscape design to make our roads safer for cyclists and pedestrians," said Leah Bamberger, the city of Providence's director of sustainability. "Providence is a forward-thinking city, and green infrastructure is an opportunity to invest in green jobs while building a healthier, thriving community."

Finding Stormwater Solutions

In the last 80 years, Rhode Island and southern New England have experienced a doubling of flood frequency and an increase in the magnitude of flood events, according to the report *Resilient Rhody: An Actionable Vision for Addressing the Impacts of Climate Change in Rhode Island* (State of Rhode Island 2018). Unfortunately, the region's infrastructure isn't up to the challenge.

"Much of the state's stormwater infrastructure was built at least 75 years ago and was designed for less intense storms," the *Resilient Rhody* report says. "Climate change further challenges the capacity and performance of these drainage systems."

Carr says the same is true of the Worcester area, noting that the "infrastructure here is simply not built to handle . . . what is becoming normal."

"Climate adaptation is very specific to place," says Ryan of the University of Massachusetts, who coedited *Planning for Climate Change: A Reader in Green Infrastructure and Sustainable Design for Resilient Cities*, published by Routledge. "For these particular cities, and for any legacy city, the question is how do they accommodate the extra water that comes with sea-level rise and increased precipitation." Pointing out that neighborhood development patterns have tended to stem from the historic location of worker housing near riverside mills and factories, Ryan says flooding raises equity issues too: "How do cities protect the vulnerable populations in those low-lying areas?"

With this array of concerns in mind, public and private entities are taking action. The Green Infrastructure Coalition in Rhode Island—made up of more than 40 nonprofit organizations, city planners, architects, elected officials, and others—works to promote green infrastructure projects as one way to reduce stormwater problems such as flooding and pollution.

The coalition hires local crews to install green infrastructure projects, such as a bioswale in a local park, a green roof, or a rain garden, and trains public works employees and other involved parties on maintenance. "It's small projects right now, but it seems that the need and appetite for this is growing," said John Berard, Rhode Island state director of Clean Water Action, which acts as the project organizer for the coalition. "We're seeing it get more and more prevalent as storms get worse, and cities are realizing that stormwater is a really important piece for managing a city effectively."

Meanwhile, the city of Worcester has put policies in place that help ensure sound stormwater management. The city regulates runoff near wetlands and catch basins that drain directly to wetlands or water resource areas. Additionally, all development and redevelopment must have no net increase in runoff rates, often leading to on-site stormwater management systems for large developments.

The city also aggressively protects land within its watershed to improve the quality of its drinking water and offset some of the land lost to development, according to Phil Guerin, director of water and sewer operations for the city.

But Guerin noted that the built-up nature of Worcester, as well as the geology of the city, makes it difficult to decrease the amount of impervious surfaces. "There are lots of areas with shallow bedrock, a shallow water table, and it's a pretty built-up city," Guerin said.

At a Green Infrastructure Coalition project in Providence, bilingual signs explain how green roofs reduce flooding. Credit: Dot Campbell, Woonasquatucket River Watershed Council

Combating the Urban Heat Island Effect

A few years ago, scientists from NASA set out to understand the difference between surface temperatures in the cities of the Northeast and surrounding rural areas. Their research revealed that surface temperatures in the cities were an average of 13 to 16 degrees hotter than surrounding areas over a three-year period. In Providence, surface temperatures are about 21.9 degrees warmer than the surrounding countryside (NASA 2010). The compact size of Providence contributed to this heat island effect, which is caused by buildings retaining heat and urban infrastructure such as pavement.

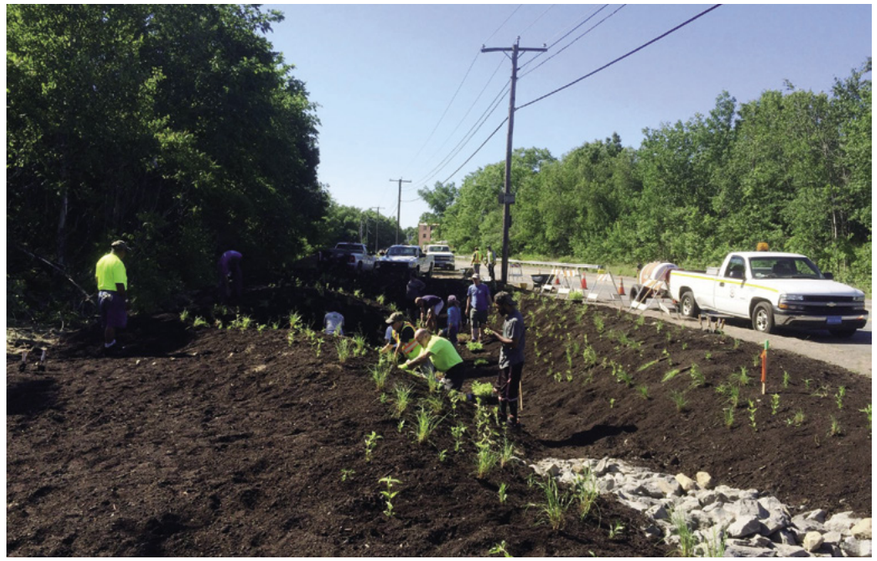
When it comes to combating the heat island effect, the answer is clear, says Carr of Clark University: "Trees, trees, trees. There are tons of studies that urban tree cover makes a tremendous difference in lowering temperatures, improving air quality, and—to some extent—helping with flooding."

According to the U.S. Department of Agriculture, a healthy, 100-foot-tall tree can take 11,000 gallons of water from the soil and release it into the air again in a single growing season.

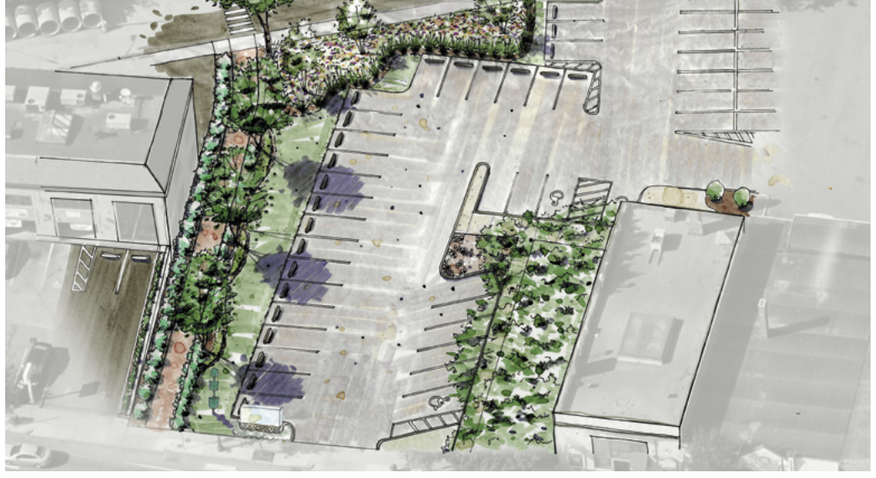
In 1907, the city of Providence recorded approximately 50,000 street trees, according to the local nonprofit Providence Neighborhood Planting Program (PNPP). The city currently has just half that amount—approximately 25,500 street trees—according to the sustainability dashboard on the City of Providence Sustainability website. A citywide tree inventory is underway.

In its Trees 2020 plan, Providence aims to increase the tree canopy 30 percent by 2020 and plant 200 trees annually. The city has partnered with PNPP, offering grants for tree planting and providing the curb cuts, tree pit, and trees for free. In addition, PNPP and the city offer the Providence Citizen Foresters program, which provides technical training focused on the care of young urban trees. PNPP has cofunded the planting of more than 13,000 street trees with more than 620 neighborhood groups since 1989.

"If people are engaged and want the tree, they're more likely to care for it and nurture it," said Bamberger. "You can plant the trees all day long, but if there's no one there to care for them and nurture them, they're not going to last long."



Volunteers helped the Worcester Department of Public Works and Parks install a rain garden along a busy road in the northeast section of the city. Credit: Worcester DPW



A project in Providence's Olneyville neighborhood will transform a paved bank parking lot, adding plantings to help absorb stormwater and incorporating a path to a nearby bikeway. Credit: Fuss & O'Neill for RIDOT, courtesy of Woonasquatucket River Watershed Council

Ryan echoes that sentiment, drawing from research he has been involved with on community gardens in Boston and Providence. "You often have outside groups come to cities and neighborhoods saying how wonderful green infrastructure is, but unless a community wants it—and wants to maintain it—it doesn't sustain itself so well over time," he says. "Green infrastructure needs to be both top-down and bottom-up. A bottom-up approach seems to have longer-term impact in terms of stewardship and making projects work."

In Worcester, a robust tree-planting effort grew into a statewide success story. In 2008, the discovery of the invasive Asian longhorned beetle (ALB) in Worcester led to a massive eradication effort that would fell 35,000 trees in a 110-square-mile quarantine area in the city and adjacent towns. (Four years later, students at Clark University began studying the impact of the tree loss, noting that the heat island effect had increased in a neighborhood that had lost its trees, as did heating and air conditioning bills.)

An ambitious replanting effort known as the Worcester Tree Initiative kicked off in 2009, with the city and state Department of Conservation and Recreation (DCR) partnering to plant 30,000 trees in just five years in private yards, in parks, and along streets. The program recruits neighborhood tree stewards to care for and monitor the trees, and runs a Young Adult Forester program in the summer for at-risk youth.

The partnership has been so successful that the DCR has expanded it to other cities in Massachusetts through its Greening the Gateway Cities Initiative. This program is concentrated in areas within cities with lower tree canopy, older housing, and a larger renter population. DCR works with local nonprofits and hires local crews to plant trees for environmental benefits and energy efficiency. The program is currently active in Brockton, Chelsea, Chicopee, Fall River, Haverhill, Holyoke, Lawrence, Leominster, Lynn, New Bedford, Pittsfield, Quincy, Revere, and Springfield.

"The model was established in ALB areas and is now a successful model across the state," said Ken Gooch, director of the DCR's Forest Health Program. "We've planted thousands and thousands of trees."

Facing Challenges

The city of Worcester's zoning ordinance requires that trees be planted around the perimeter of parking areas abutting a street, park, or residential property and serving more than three residential dwellings. Additionally, interior tree plantings are required in surface lots with more than 16 spaces and the state's Complete Streets Policy, enacted in March 2018, specifically calls out trees as an important part of the public street, noted Stephen Rolle, assistant chief development officer for the city.

But some neighborhoods are less amenable to trees, as utilities, power lines, and sidewalks on narrow streets compete for space. There are

simply fewer places to plant trees in built-up cities, particularly the large shade trees providing the most environmental benefits. Urban rain gardens or bioswales often have to compete for space with utilities and parking areas too.

"There is valuable paved space downtown, and people are hesitant to let that parking space go to put in bioswales or street trees," said Berard of the Green Infrastructure Coalition.

Rolle notes another challenge: low-intensity development is sometimes perceived as more expensive, because of installation costs or maintenance requirements. But "there's quite a bit of evidence suggesting that the benefits of such improvements overall outweigh the costs," he says. "It can be cheaper to pave it, but that doesn't make it the right choice."

Part of the Green Infrastructure Coalition's advocacy includes support for a stormwater enterprise fund with a utility fee. Property owners pay into this fund based on the amount of impervious surface on their land, with the funds dedicated to projects including green infrastructure. But Berard admitted it's a tough sell. "As a policy solution, it's pretty much accepted to be the best way to fund programs," he said. "But it's politically unpalatable."

As the two cities look ahead, more plans are taking shape. Worcester is engaged in a citywide master plan process that will consider adaptations to climate change. The city also received a $100,000 grant in 2018 to prepare a citywide climate change vulnerability assessment.

The Water and Sewer department is also developing a long-term plan to prioritize investments in water, wastewater, and stormwater infrastructure over the next 50 years, giving the department an opportunity to look at increasing stormwater capability through green infrastructure.

Meanwhile, the city of Providence has been updating its Hazard Mitigation Plan, with a major focus on climate preparedness, said Bamberger. As climate change bears down, she says, thinking ahead and planting the seeds for a greener city will be the key to vitality.

"If you only have a day to prepare, you have [fewer] options . . . You may only get to batten down the hatches," Bamberger said. "We do have some time to think strategically as to how we need to respond to these impacts. Integrating nature into urban design and supporting the natural systems we depend on is critical to creating a climate-resilient city."

Cyrus Moulton is a reporter for the *Worcester Telegram & Gazette*, where he covers urban and environmental issues, health, utilities, and transportation.

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