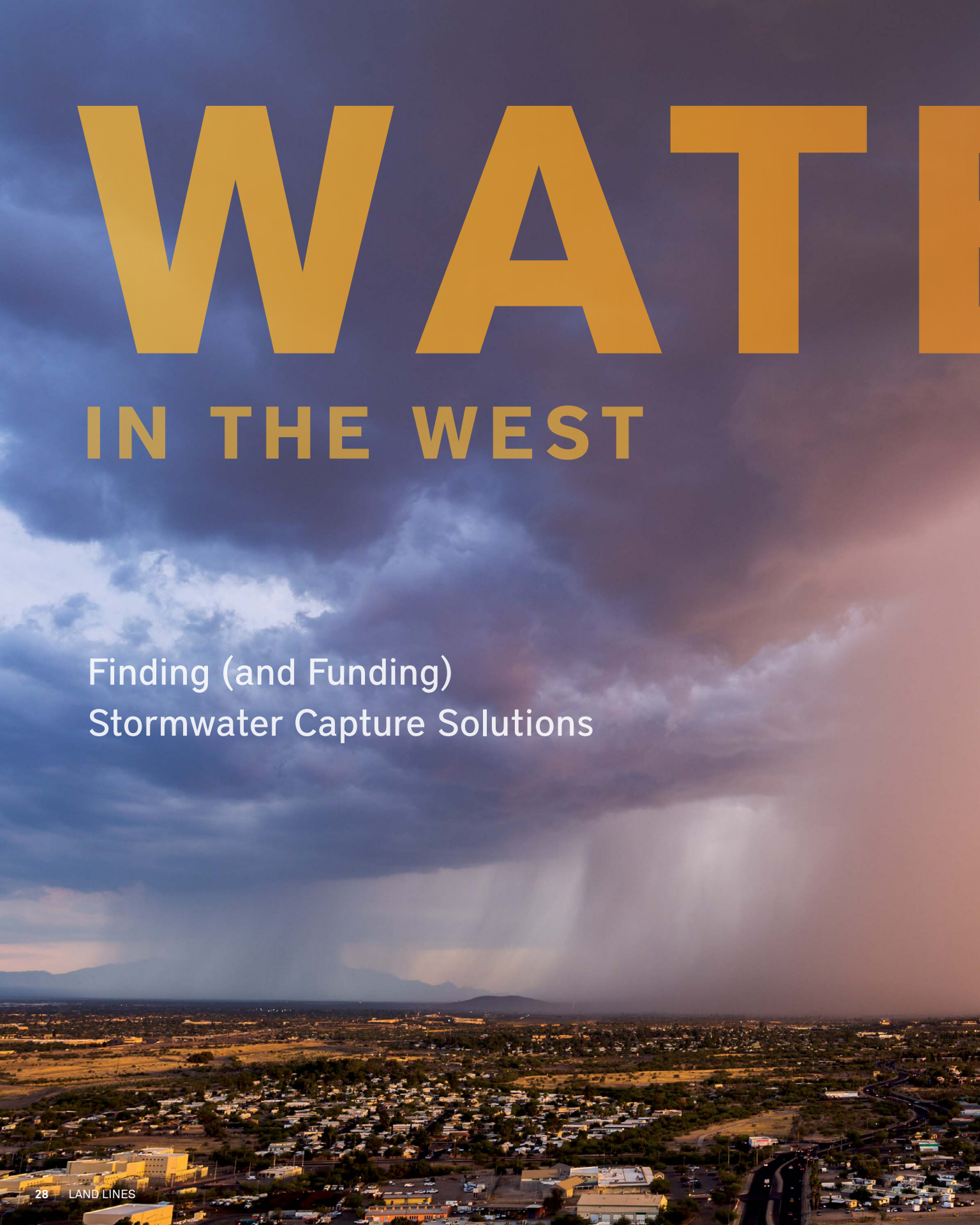
WATE

IN THE WEST

Finding (and Funding)
Stormwater Capture Solutions



By Meg Wilcox

AFTER SEVERAL HOURS of gentle rain in Tucson, water clogs the streets of the modest Palo Verde neighborhood. Traffic chokes a major intersection where an emergency vehicle's flashing red and blue lights signal to cars to detour around a swamped section of road. Rivulets rush along the curbs of side streets, creating pools of water that geyser when cars plough through.

Less than a mile away, at the nonprofit Watershed Management Group's Living Lab and Learning Center, the story is different. Here, a series of tiered, vegetated basins—shallow depressions filled with mesquite trees, brittlebrush, and other native plants—act like sponges, diverting and absorbing the rainwater running down the street. The center's pervious parking lot easily absorbs the light winter precipitation, and downspouts channel the rain drumming on the center's roof into a 10,000-gallon underground storage tank.

Stooping to check the meter on the tank's lid, Lisa Shipek, executive director of Watershed Management Group (WMG), looks pleased. "Five hundred more gallons and it's full. Then it overflows over there," she says, pointing to an adjacent series of rain gardens pulsing with desert life. Prickly pear cacti and giant sacaton grass intermingle with canyon hackberry, desert willow, and velvet mesquite, all native shade trees; pollinator plants like the yellow-flowered and piney smelling creosote, hopseed, and vibrant red chuparosa also populate the gardens.

Straightening to survey the carefully landscaped center—which serves as a demonstration site for the sustainable solutions WMG promotes throughout the desert Southwest—Shipek says proudly, "all of our water needs, including indoor use, are provided by the rainwater we harvest." In this desert city, which receives an average of 12 inches of rainfall a year, finding ways to capture and reuse that water is increasingly important.

Thunderstorm over Tucson, Arizona. Credit: John Sirlin via Getty Images.

The cities of Los Angeles and Tucson both rely on the Colorado River for part of their water supply. Credit: U.S. Bureau of Reclamation.

- Colorado River Basin hydrologic boundary
- Adjacent areas in the United States that receive Colorado River water
- Aqueduct
- River
- Dam

Like other cities across the U.S. West, Tucson is feeling the dual squeeze of climate change and rapid growth. The population of the Tucson metro area, now close to one million, is expected to expand 30 percent by 2050. This is increasing demand for water, even as hotter temperatures and drought diminish supply. When storms come, they are increasingly severe, posing serious flood risks. In response, Tucson and other cities are investing in low-impact development, working with nature to manage stormwater as close to its source as possible.

This type of approach yields multiple benefits, including improving water quality and mitigating flooding, creating green spaces that provide habitat and urgently needed shade, and boosting local water supplies. Tucson's water department has invested $2.4 million in rebates for some 2,000 customers who've installed rain-collecting cisterns or "earthworks" (e.g., vegetated basins and rain gardens) since 2013.

Green infrastructure and **low-impact development** are terms for a nature-based stormwater management method that uses vegetation, soils, permeable pavement, and other elements to absorb and redirect water and to create healthier urban environments.

The rebate program financed half of the $30,000 cost of WMG's underground storage tank, and is among many efforts taken by the city in recent years to promote green infrastructure.

Nearly 500 miles away, in coastal Los Angeles, similar funding mechanisms are changing the landscape of a much larger city. Four million inhabitants strong, Los Angeles boasts one of the country's largest public water systems; like many other cities in the region, it depends in part on the Colorado River for drinking water. With that resource increasingly vulnerable to shortages, the city is looking for more reliable sources of water close to home.

Both cities have led the way on green infrastructure in the West with their comprehensive approaches and investments. When cities invest in projects with measurable local results, their actions can help make the entire region more resilient, says Paula Randolph, associate director at the Lincoln Institute of Land Policy's Babbitt Center for Land and Water Policy.

"The benefit of green infrastructure in the West is twofold," observes Randolph. "One is to capture water and try to keep it in place, let it percolate back into aquifers [for local use]. Two is to sustain the flow of the region's rivers. If there's enough water in an aquifer, if you keep it high enough, you can keep a river flowing."

Tucson: Shifting the Water Supply Equation

Until the 1990s, Tucson relied entirely on groundwater for its water supply. Decades of over pumping led the city to turn to Colorado River supplies via the Central Arizona Project (CAP), an aqueduct system that pipes Colorado River water from its input at Lake Havasu to municipalities and water districts spanning some 330 miles across the state.

Today the city relies on CAP water to recharge its groundwater aquifers, with CAP providing 85 percent of Tucson's supply. Source groundwater contributes only six percent. The remainder comes from reclaimed wastewater that's used for non-potable needs such as irrigation—or for recharging the ephemeral rivers that traverse the city and flow primarily during the monsoon rains each summer, or after other major rain events.

But the Colorado River is an increasingly stressed resource. It provides water to 40 million people and four million acres of irrigated agriculture throughout the West. U.S. Geological Survey scientists predict that the river could lose a quarter of its flow in the next 30 years as climate change shrinks snowpack at the headwaters and increasing temperatures further decrease streamflows (USGS 2020).

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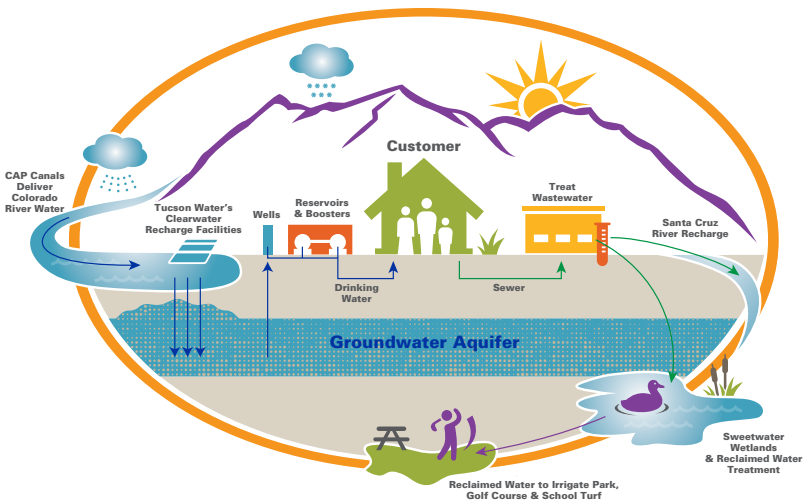
"We are at a crossroads with the Colorado River, and Arizona is in the hot seat because we have taken and will continue to take significant cuts," warns Randolph. That's because Central Arizona has the most junior water rights of the Colorado River basin. As Arizona plans for a drier future and cutbacks of its allotment, as agreed to under the 2019 Drought Contingency Plan between the seven basin states and Mexico, Tucson officials are looking to augment local supplies (USBR 2019).

James MacAdam, superintendent of Tucson Water Public Information & Conservation, says that today the city views stormwater as a significant resource for Tucson's future. "One of the paradigm shifts at Tucson Water is that we now count [stormwater] as a water source in our planning. That's changed in the past five years."



In Tucson, officials are working to augment local water supplies and reduce their reliance on the increasingly stressed Colorado River. Credit: Tucson Water.

Pima County Regional Flood Control District, in fact, estimates that Tucson's stormwater capture potential is roughly 35,000 acre-feet per year, or one-third of the volume Tucson Water delivers today to its 730,000 customers.

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Flood Control District Civil Engineering Manager Evan Canfield says the city has prioritized the benefits stormwater capture could provide. "For the Tucson region, addressing water scarcity and increasing resilience—planting trees in water harvesting basins to help with shade and cooling—are the core benefits that we're looking for," he says. "Water quality concerns are the padding."

There are also real financial benefits at stake: Autocase cloud-based software developed by the Pima Association of Governments shows that every dollar invested in green stormwater infrastructure returns two to four dollars in benefits, including flood risk reduction, property value uplift, and heat mortality risk reduction (Parker 2018).

Over the past decade, the Flood Control District has installed and maintains more than a dozen large projects in the city, such as the $11 million Kino Environmental Restoration Project, which captures stormwater from 17.7 square miles of urban watershed and directs it into more than 100 acres of wetlands and recreational area, while providing up to 114 million gallons annually for landscape irrigation at an adjacent sports complex.

Now Tucson is poised to tap deeper into its stormwater potential. It's passed a number of related measures, including the 2013 Green Streets Policy, requiring the incorporation of green infrastructure into all publicly funded roadway projects; the 2013 Low Impact Development Ordinance, requiring new commercial development to capture the first half-inch of rainwater; and the 2008 first-in-the-nation Commercial Water Harvesting Ordinance, requiring commercial developments to meet 50 percent of their landscaping water needs with harvested rainwater.

Tucson relies on networks of recharge basins located west of the city to manage most of its annual allocation of Colorado River water. Credit: Tucson Water.

Visitors to the Watershed Management Group's Living Lab and Learning Center in Tucson peer into the 10,000-gallon underground cistern the organization uses to capture and store rainwater. Credit: Watershed Management Group, watershedmg.org.

The sum of these measures, says MacAdam of Tucson Water, means that "any time we're building a road or a parking lot, or rebuilding our public and private infrastructure, we now design it in a water-literate way. When Parks is redoing a park, they're incorporating intelligent management of stormwater; when Streets is building a street, they do it in a way that intelligently incorporates and manages stormwater, and so on."

The city recently enacted a novel green stormwater infrastructure fund to help expand and maintain high-priority public projects. The fund will raise about $3 million annually through a small charge on residents' water bills, estimated to cost the average homeowner about $1.04 per month, according to MacAdam. The city has identified 86 potential sites for such projects—many in lower-income neighborhoods that are prone to flooding and searing temperatures of up to 117 degrees in the summer—at a cost of $31 million.

The fund "gets us started," says Catlow Shipek, a driving force behind the local green infrastructure movement who cofounded Watershed Management Group with Lisa, his wife, and is now its policy and technical director. "It's very focused on maintenance because there's currently no dedicated funding for that." The fund, he says, will also help "capitalize on new projects and leverage other departments and agencies to do more."

MacAdam says the fund's approach is to add elements to capital works projects being built through the Parks and Connections Bond, passed in 2018, which allocated $225 million for building bike boulevards, constructing greenways, and fixing up parks. When an old parking lot is being ripped up and replaced, for example, the city will create new basins and curb cuts to channel water into rain gardens that it will plant with native trees and shrubs. The fund will also seek to piggyback off flood control projects.

"When Flood Control buys a vacant lot to bring water off a flooding street in a neighborhood, we can use our funds," MacAdam explained. "They pay for land acquisition and digging the deep basin, and we pay for smaller basins to add vegetation and create a more functional landscape for the neighborhood, and to maintain that landscape over time."

The importance of adding tree cover to the city cannot be overstated, says Randolph. "It's a health issue and a disparity issue," because the hottest parts of Tucson are typically in socially and economically disadvantaged neighborhoods.

"Tucson has done some very innovative things that are not the norm throughout the West, or in Arizona," she adds. "In essence, they've created a master plan where water touches all lives and ecosystems. All of the things they're doing with rainwater harvesting, the rebates, the fund, mean less groundwater pumping, which allows natural systems to flourish and grow."

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Los Angeles: Seeing Stormwater as a Resource

Los Angeles is 10 to 15 degrees cooler on average than Tucson in the summer, though temperatures can vary by as much as 20 degrees across its different microclimates, from beach to hills to hot, flat inland. Lush vegetation in some of the wealthier and cooler seaside communities may give the impression that water is not a concern, but that's not the case.

Like Tucson, Los Angeles receives just 12 inches of rainfall per year. And like Arizona, California faces major water challenges, with climate change intensifying drought while population growth puts pressure on limited supplies. Some California communities are still recovering from the last drought that wrung the state dry from 2012 to 2016. Meanwhile, legacy agricultural pollution in the Central Valley has left one million residents without reliable access to safe drinking water, and the state is just beginning to rein in decades of groundwater overuse through its 2014 Sustainable Groundwater Management Act, which targets critically overdrafted basins.

In Los Angeles, the Department of Water and Power (LADWP) serves four million residents over a 472 square-mile area, supplying more than 520,000 acre-feet of water per year. That supply is largely imported through three aqueduct systems. The California Aqueduct delivers water from the Sacramento-San Joaquin Delta, 444 miles to the north; water is pumped over the Tehachapi mountains and stored for distribution in Pyramid Lake and Castaic Lake north of the city. The Colorado River Aqueduct carries water 244 miles across the Mojave Desert and Imperial Valley from its origins at Lake Havasu, the same source that feeds the Central Arizona Project.

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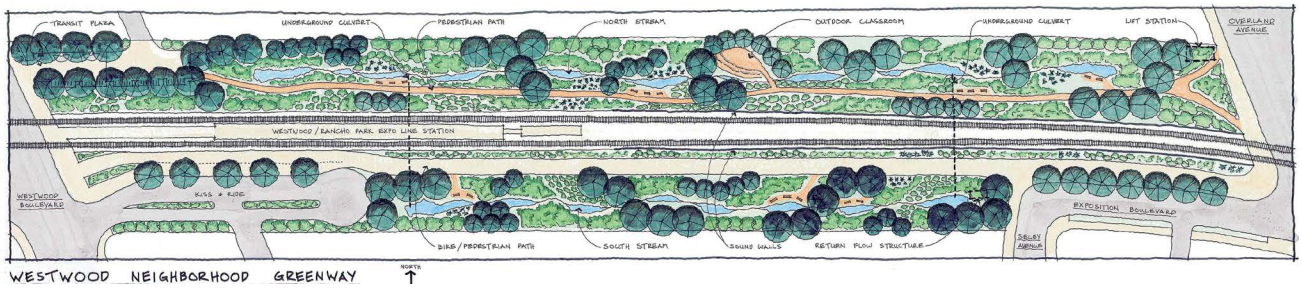
A California pumping plant sends Colorado River water uphill on its long journey to Los Angeles. Credit: NNehring via iStock.

That water is stored in Lake Mathews, about 60 miles southeast of the city. The final aqueduct, the Los Angeles, delivers water from the Owens River Valley in the eastern Sierra Nevada mountains. That system includes a series of eight dams and reservoirs along the 300-mile route. Within the city limits, another nine reservoirs and 110 storage tanks allow for controlled release when water is needed.

Just 14 percent of Los Angeles water comes from local supplies. Under LA's Green New Deal, the city's 2019 sustainability plan, local leaders plan to turn that balance on its head, shifting the contribution from local water supplies—groundwater, recycled wastewater, stormwater, and water conservation—to a whopping 71 percent of its total supply by 2035 (City of Los Angeles 2019). While some southern California cities, like Huntington Beach and San Diego, are turning to desalination—that is, converting ocean water into drinking water—Los Angeles is opting out of this costly, energy-intensive approach, which also harms marine life.

"We want to be more reliable and sustainable on the local level and not depend so much on imported water supply," says Art Castro, manager of watershed management at LADWP. "Climate studies show there's going to be a lot less snow and a lot more rain. That means we'll have less time to capture that snow melt . . . and with less snow and more stormwater, we're not going to have that luxury to store water." It's one of the reasons the city wants to become more self-reliant, says Castro, adding, "the system was built for storage."

Los Angeles is already recharging or capturing 74,000 acre-feet of stormwater per year, primarily through centralized projects like football field-sized spreading grounds and detention basins. Spreading grounds, akin to bottomless cups, are large, sandy basins that overlie an aquifer and allow for rapid infiltration. Water captured in Los Angeles' spreading grounds eventually percolates down some 200 to 400 feet to aquifers in the San Fernando Basin, according to Castro.



The Westwood Neighborhood Greenway, now under construction, is one of several projects funded by Proposition O, which authorized Los Angeles to spend up to $500 million to prevent and remove water pollution. Credit: Westwood Greenway.

A Stormwater Capture Master Plan, published in 2015, lays out how the city can double the amount of stormwater it captures, through projects both large and small (LADWP 2015). Decentralized projects on city streets, in alleys, and on residential properties are a critical component of Los Angeles' stormwater management plans, which address both water quantity and water quality. Stormwater running off city streets eventually makes its way to the Pacific Ocean via the Los Angeles River, polluting some Southern California beaches.

"We have to capture, clean, and infiltrate, if possible, the water moving through a green street system," says Eileen Alduenda, director of the nonprofit Council for Watershed Health, which has played a critical role in the green infrastructure movement in Los Angeles. Alduenda envisions a proliferation of rainwater retention features—like permeable parking lots and driveways, curb cuts, and drought-tolerant landscaping—throughout the city's streets and alleyways, working together to reduce the flow of stormwater to the sea.

Los Angeles County has financed dozens of projects under Proposition O, a funding mechanism that passed in 2004. Projects range from stormwater retention features in public parks and recreation areas to infiltration galleries, catch basins, bioswales, and other structures built into rights of way on residential streets.

A low-impact development ordinance, requiring developers to capture a certain amount of rain (in this case the first three-quarters of an inch) to reduce stormwater runoff, went into effect in Los Angeles in 2012 and is helping spur such decentralized green infrastructure projects throughout the city. Los Angeles County has financed dozens of projects under Proposition O, a funding mechanism that passed in 2004. Projects range from stormwater retention features in public parks and recreation areas to infiltration galleries, catch basins, bioswales, and other structures built into rights of way on residential streets.

This year, new funds will be available for stormwater capture and treatment through Measure W, the 2018 Safe Clean Water Act, a parcel tax projected to raise $300 million per year. The measure allows funds to go toward operation and maintenance (O&M) costs. Having such funds available is critically important, according to Daniel Berger, director of community greening at TreePeople, a local nonprofit that promotes tree planting, rainwater harvesting, and low-impact development.

"One of the largest objections [to implementing green infrastructure] from a government perspective has been the long-term O&M costs, which are certainly higher than for gray infrastructure and are often hard to find dedicated funding for," Berger says. "Measure W is an absolute game changer, an opportunity to really scale things up."

The Value of Nonprofit Participation

In Los Angeles, nonprofit organizations including TreePeople, the Council for Watershed Health, and Heal the Bay were instrumental in getting green alternatives on the city's stormwater management agenda. The Council for Watershed Health and TreePeople collaborated with LADWP and the U.S. Bureau of Reclamation on a three-part study of the potential for groundwater recharge from stormwater infiltration. TreePeople also partnered with LADWP on the 2015 Stormwater Capture Management Plan.

The Council for Watershed Health developed a training program for the City's Native Green Gardener program, a workforce development effort focused on training day laborers how to manage landscapes with unfamiliar native plants and how to maintain and clean features like curb cuts. The Council also managed the city's first large-scale neighborhood project to use green infrastructure for stormwater management, Elmer Avenue in Sun Valley, a low-income neighborhood that regularly flooded.

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"Elmer Ave became a demonstration for not only how you do this technically, but also how you collaborate amongst agencies to ensure you're getting multiple benefits out of any project," says Alduenda. Los Angeles' Green Streets Committee, which was instituted by former Los Angeles Public Works Commissioner Paula Daniels to coordinate work among all of the involved agencies, was vital to the process, she added. "It was a place where folks who were working on Green Streets projects could talk about issues they were encountering. Inconsistences between departments, or process barriers, could get worked out."

The Elmer Avenue Retrofit Project in the Sun Valley area of Los Angeles saw state, federal, and nonprofit partners come together to transform a streetscape, adding water-management features such as rain barrels and drought-tolerant native plants. Credit: Council for Watershed Health.

The corner of Ninth Avenue and University Boulevard in Tucson in 1996, left, and in 2016. Residents installed curb cuts and native plants. Credit: Reproduced with permission from *Rainwater Harvesting for Drylands and Beyond* by Brad Lancaster.

Daniels created the committee in 2007 when she saw the need for a culture shift within the city's Engineering, Sanitation, Parks and Recreation, and Street Services bureaus charged with developing green infrastructure projects. The bureaus were staffed with engineers, not landscape architects, said Daniels, so the expertise they brought to the job was about mechanical solutions. Daniels invited middle managers, rather than bureau heads, and gave staff the opportunity to "kick the tires on an idea," to talk among themselves and teach each other. She invited their peers from cities with strong green infrastructure programs, like Santa Monica and Portland, to show what was possible.

Nonprofits, says Daniels, were an essential part of that mix. "Nonprofits do a really good job at data collection, extracting the necessary analytics," she says. Their involvement in the first green street project led by the city, on Riverdale Avenue, helped "prove out the assumption that it would improve water quality, and that all the water flow would be managed [as required]."

Nonprofits have also played a key role in Tucson, where organizations and engaged citizens have led the way. Tucson water experts credit permaculture enthusiast and author Brad Lancaster with kickstarting the rain harvesting movement in the 1990s, when he created the first intentional curb cut, which was illegal at the time. Lancaster sliced out a piece of curb and placed a vegetated basin behind it to capture the water running down his Tucson street.

For its part, WMG created the first-ever green infrastructure planning manual for desert cities (WMG 2017). Catlow Shipek says the group identified the need for a how-to manual with practices, schematics, and maintenance information when it discovered that key stakeholders—engineers, city departments, and neighborhoods—weren't speaking the same language. The manual helped create that common language and facilitated better collaboration.

MacAdam confirms that citizens, neighborhood groups, and nonprofits have gotten the city where it is today on low-impact development. "It was decades of continual and concerted action by people, the grassroots," he says. "As a city, we want to take that and build on it, improve it and professionalize it, and make it part of our infrastructure."

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A Solution with Multiple Benefits

One of the challenges Tucson Water has faced in advancing low-impact development is that it doesn't pencil out from a water savings or flood control perspective alone. If you look at these elements in isolation, the costs exceed the benefits, according to MacAdam. Tucson will continue to invest in traditional gray infrastructure for flood control, but MacAdam points out that the low-impact approach "can improve a lot of things: how we do flood control, how we manage our water supplies, how we build our streets to provide multiple public benefits, air quality, water quality, shade and resiliency."

Berger of TreePeople agrees. "No one could argue with a straight face that nature-based solutions will be your most effective from a flood control perspective exclusively," he said. But, like MacAdam, he believes that if you take into account the multiple benefits, "nature-based solutions will rise to the top as the preferred solution in many cases."

Both Tucson and Los Angeles can point to proof that investments in low-impact development pay off in multiple ways. But the economics of urban water management are likely to get more complex, not less, as development and climate change continue to accelerate. "Water is only going to get more expensive," says Randolph. "Each city has to invest in solutions that will keep them vibrant for years to come, and that don't pit people against each other when water prices begin to rise. Tucson and LA are making good decisions for their communities. They're tackling the problem head on."

Meg Wilcox is an environmental journalist covering climate change and water, environmental health, and sustainable food systems. Her work has appeared in *The Boston Globe*, *Scientific American*, *Next City*, PRI, and other outlets.

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