The purple lovegrass, orange trumpet vine and black-eyed Susan are no longer in bloom at this time of year. Yet one of the most prized installations of the American Society of Landscape Architects (ASLA) is still receiving visitors: the rooftop garden above its headquarters in downtown Washington, DC.

Green roofs, it seems, are sprouting everywhere. And not just for their good looks. The ASLA figures its experimental “urban oasis” slashes its heating bill by 10% in winter months and captures three quarters of all precipitation hitting the roof, substantially reducing runoff into DC’s antiquated sewer system. Moreover, water that does reach the sewer contains fewer pollutants than typical city rainwater, having been filtered through the rooftop vegetation.

But life is not easy up on the roof. “You have the worst extreme conditions,” Kays says. “A lot of wind. Extreme heat events in summer, extreme cold in winter. Basically, you’re trying to grow something that will grow in a semi-arid environment and also grow in a northern, almost frigid-like environment. It’s very wet at times and very dry at times.”

One plant, the water-storing sedum, is a green roof workhorse because it “can hang in a pretty wicked environment,” according to Kurt Horvath, owner of the company Intrinsic Landscaping. His company installs about 50 green roofs a year, ranging from a four-acre installation atop the FedEx sorting facility at O’Hare International Airport to rooftop gardens for environmentally conscious homeowners.

The benefits of vegetated rooftops are so many and so well established that DC aims to achieve 20% green roof coverage by 2020. Just last year, the DC metropolitan area added 1.3 million square feet of rooftop vegetation.

DC is not alone. Both Toronto and Chicago mandate at least some green roof coverage for certain types of new development or redevelopment within the cities. New York City and Portland, OR, offer tax incentives for green roof installations (as does DC). And even mid-size cities, such as Cincinnati, Nashville, and Baltimore, are growing significant green roofs.

Chicago City Hall rooftop garden. Courtesy of Flickr/Wickerfurniture.

Sedum on a green roof in Lancaster, PA. Courtesy of the Chesapeake Bay Program.

Engineering Nature
Yet choosing the right plant species is far from the only consideration. Sedums, cacti, thymes, and other roof-hardy perennials depend upon a carefully engineered environment to survive the harsh conditions stories above street level.

While green roof plantings may recreate desert or prairie landscapes, there is little that is natural below the “ground.” A living roof installation is a multi-layered assembly of materials that are contrived to achieve specific results. From the roof-top up, there is a roof slab for structural support, a layer of insulation, a waterproofing/root barrier membrane, a water storage area (often resembling an egg carton), drainage material, a soil separator membrane, soil, a biodegradable covering to keep the soil from blowing away, and finally plants. Among all of
these materials, it might be easy to take the soil for granted, but the type of soil used is critical for success.

Bruce Dvorak, a professor of landscape architecture and urban planning at Texas A&M University, says, “The soils used on modern green roofs are engineered soils typically categorized as growth media. The soils need to perform the same as soils on the ground, but they must remain stable over time. This means that they need to resist slumping (i.e., excessive settling and compaction), erosion, and nutrient depletion.”

The main components of green roof soils are sand that has been screened to achieve a fairly uniform particle size and expanded aggregates—rock or clay fragments that are heated until they expand, providing greater volume for the same weight. These are supplemented with various organic materials, such as tree bark and other hard plant parts that decompose slowly.

Often, soils are custom blended to support the plant community chosen to populate a green roof garden, using local aggregate materials. In the West, Horvath says, that means pumice. In the Midwest, expanded clays or shale. And in the East, shale, slate, or clay.

“One of the most important properties of green roof media,” Dvorak says, is “the distribution of particle size from sand to small gravel.” Coarse material at the bottom provides air space to store excess water below the root zone. Finer-textured soil at the top provides a favorable environment for plants to take root.

“There is typically very little silt in the media because silt can clog drainages,” Dvorak explains. “Poor drainage can be as much a problem as too porous a media. If the media holds too much water, it can suffocate plants, whereas if the media does not hold enough moisture, the plants can wilt. So, the appropriate distribution of particle size helps to control these factors.”

In fact, green roof soils are strikingly similar to the earth below the turf in high-use, outdoor public spaces. Kays helped design the soil mix used in a 24-acre outdoor events venue in New York City's Central Park. “Up to a million people attend events there,” he says. “We designed it to be able to handle a 10-inch rainstorm three hours before a function.” By the time people arrive for the event, the rainwater has drained away, so no one walks through puddles or mud, and the turf remains intact.

The vast majority of all green roofs in North America have so-called extensive rooftop gardens. The soil is no more than six inches deep and contains little organic matter. “These are fairly dry soils,” Kays says, “that drain readily and hold only limited moisture.” Although extensive gardens can sustain only plants adapted to arid environments, they require little irrigation or other maintenance, making them a popular choice.

Extensive green roof. Photo courtesy of Bruce Dvorak.

Intensive green roofs, in contrast, place a heavier load on the roof and require more human intervention, including irrigation and fertilization. The soil runs at least 12 inches deep, contains more organic matter than an extensive green roof, holds a fair amount of moisture, and can sustain a varied plant community, including shrubs or even small trees. Intensive green roofs generally use a lightweight expanded slate sand media. Even so, because of the extra weight associated with intensive roofs, they are mostly used on new construction, with the weight load factored into a building’s design.

A Green Roof of Your Own?
The green roof movement began in Germany about a hundred years ago, after gravel and sand-blasted roofs became popular in Berlin to prevent the spread of fire in congested urban areas. As luck would have it, the sand and gravel held sufficient moisture to germinate wind-blown seeds that landed on the rooftops.

These spontaneous living roofs attracted the attention of botanists and others, eventually leading to the development of the world’s first green roof guidelines, produced by the German Landscape Development and Landscaping Research Society, commonly known as the FLL guidelines. Although there are various green roof guidelines used in North America, none are as comprehensive as the FLL guidelines.

Dvorak says many U.S. green roof growth media manufacturers base their soil formulations on the FLL guidelines. But he says, “Some regions of the U.S. require modifications to these guidelines to accommodate greater drainage capacity or more water retention.”

What should green roof enthusiasts know before greening their own roof? Two things. First, consult the pros. Dvorak says, “Modular (off-the-shelf) green roof systems exist, but even with these types of systems, experience is necessary.” It is best to use an installer who has at least a five-year record of success with previous projects.

Second, check to see if there are local regulations governing green roof installations in your area. “Shallow green roofs can weigh 20 to 35 pounds per square foot, so structural engineers need to approve plans for construction,” Dvorak says. “Drainage plans need review and design as well, so architects may need to become involved. Landscape architects become involved with more complex projects, looking at the entire green roof system design.”
Today, there are more and more of these projects adapting living roofs for any number of innovative uses.

Horvath, for example, is working on several urban farm projects in the Chicago area. “I don’t know that that’s going to solve the world’s food problems,” he says, “but for local food production and specialty food products, I think that’s a great niche.”

As urban agriculture becomes more popular, some are using their roofs to grow food. Courtesy of Flickr/ramson.

The California Academy of Sciences in San Francisco’s Golden Gate Park has a green roof comprised of several 30-foot rolling hillocks covering 2.5 acres that is an attraction in its own right. Visitors can access an open-air observation terrace for a close-up view of 1.7 million self-propagating native plants—billed as “the densest concentration of native wildflowers in San Francisco”—along with the birds, butterflies, and insects that have discovered the verdant bounty of flora.

The California Academy of Sciences' green roof. Courtesy of Flickr/Judy H.

And the John Deere Werke facility in Mannheim, Germany, has a rooftop wetland system designed to remove phosphates and heavy metals from the plant’s wastewater.

Cleaning the environment, saving energy, supporting wildlife, and growing food—what else can a living roof do? Maybe it can even engender a little more harmony in the world.

Says Horvath, “There was a guy who loved living in the city (of Chicago), and his wife wanted to move out of the city for the family they wanted to start. We built a turf yard on the roof, and everyone was happy.”