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Greening the Way

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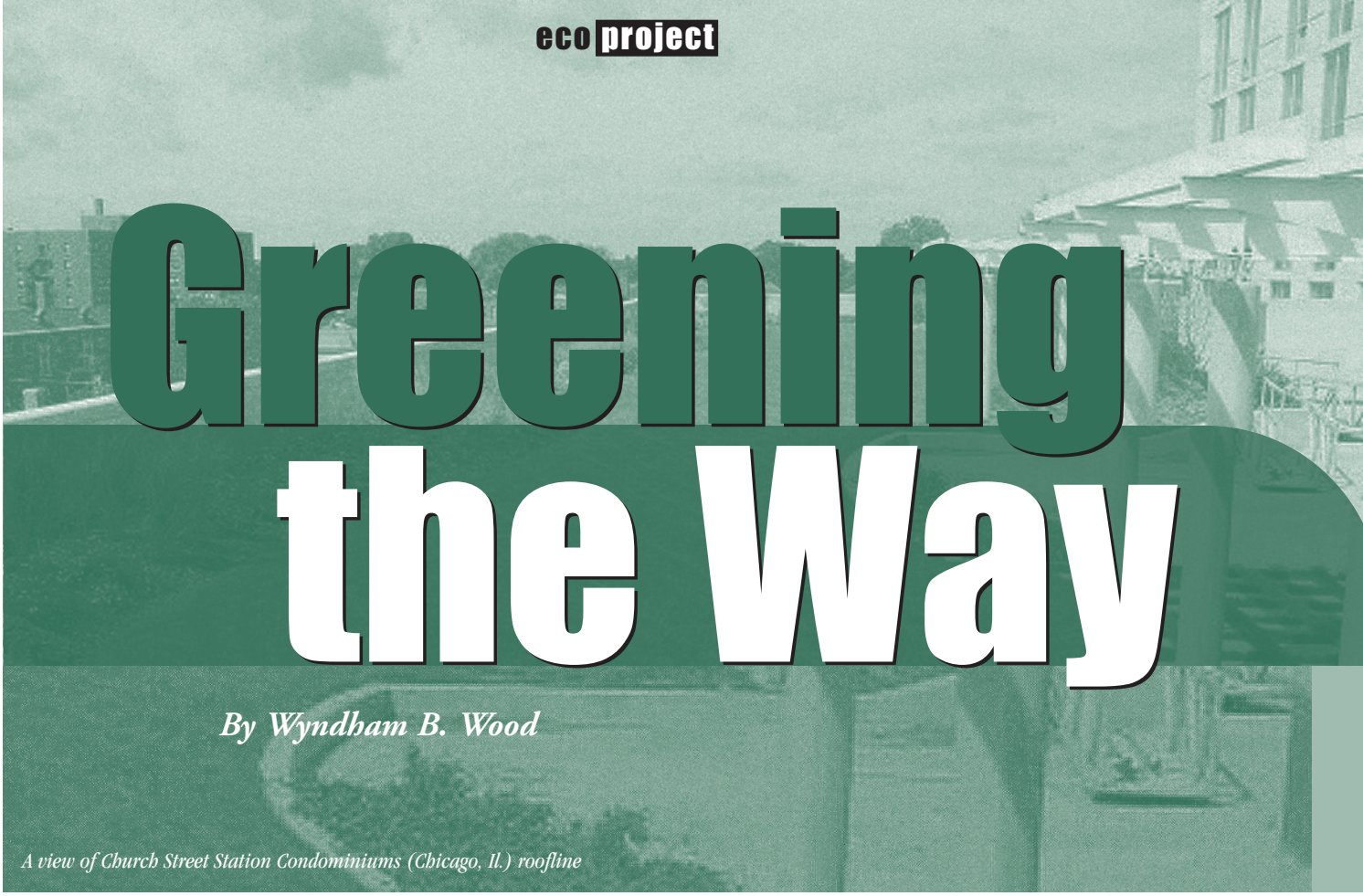
Greening the Way

By Wyndham B. Wood



A view of Church Street Station Condominiums (Chicago, Il.) roofline

Garden roofs, also known as green (or eco) roofs, are an exciting trend in the A/E industry, showing up on projects around the country, including the Seattle Civic Center, Latter-day Saints Conference Center (Salt Lake City), and The Gap Headquarters (San Bruno, Calif.).

Though some may view it as an emerging trend, green roofs have a long and established history. Our Babylonian ancestors installed elaborate vegetated roofs in the terraced structures of the Hanging Gardens of Babylon, built around 500 B.C., which is considered one of the Seven Wonders of the World. Early 20th century installations include New York City's Rockefeller Center (1930s), Frank Lloyd Wright's Guggenheim Museum (1950s) and Madison Square Garden (1920s).

Like so many technologies, green roof engineering has vastly improved over time, allowing the industry to migrate to more modern garden roofs. And in fact, our condensed, gridlocked cities could use it. Viewed from above, most highly populated areas bare testament to the imbalanced environment we function in every day, an environment dominated by concrete, steel and asphalt with barely a hint of green.

In Europe, particularly Germany, where garden roof technology has been in place for well over 50 years, "naked roofs" like the black-topped ones to which we're accustomed, are viewed as environmental, financial and aesthetic liabilities due to the burden they place on municipal storm water systems and energy resources. Even roofs on industrial structures in Germany are often planted with colorful, low maintenance sedums.

Reclaiming the Fifth Elevation

Increasingly here in the United States, that same push to reclaim what some call the fifth elevation – our roofs – is taking hold. And garden roof technology is making that easier, with lighter weight

systems that can outlast conventional black roofs by decades.

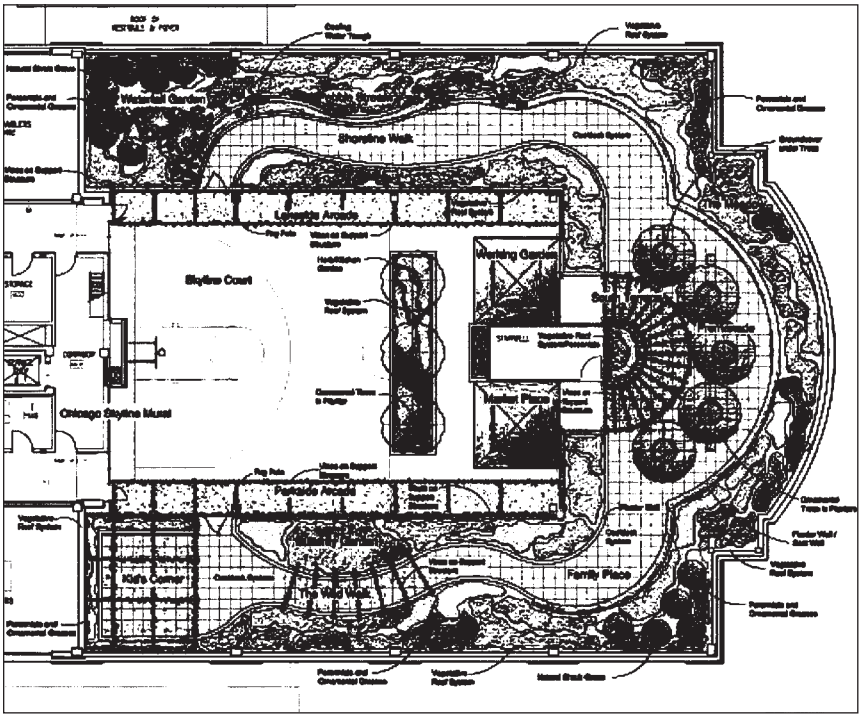
The base of the garden roof is one of the most critical components of a quality system – the waterproofing, ideally a seamless rubberized asphalt waterproof membrane. Fluid-applied products are applied directly to the structural substrate, creating a tight bond that has no seams – a configuration especially well suited to a saturated environment like a garden roof.

Some manufacturers also offer green roof systems with modified bitumen, or mod bit, sheet waterproofing, which is installed above the insulation. Though used frequently for blacktop roofs, some question the viability of placing so many seams under a vegetated roof, which requires the constant presence of moisture. Any water that seeps through the seams between the mod bit sheets will eventually find its way down to the substrate, producing leaks whose origins are difficult to pinpoint and expensive to repair.

Above the waterproofing, garden roof components vary by manufacturer and by project. Typically, a root barrier is installed above the waterproofing to protect it from penetration by aggressive roots. Above that, there is a water drainage/retention system – an area that has benefited enormously from technological innovation over the past 40 years. More modern garden roofs use fabricated drainage components, which drain excess water to drains at 50 percent of the weight of the heavy pea gravel used in older green roof systems. Because those components also retain water for the roots to "drink up", they also create a more hospitable environment for roots to flourish.

The Church Street Station Condominiums Green Roof Project in Chicago, Il.

This technology accommodates different types of garden roofs, commonly referred to as extensive and intensive. Extensive garden roofs are low maintenance non-recreational roofs with lower soil depths, usually planted with hardy, colorful sedums. While most garden roofs benefit from irrigation during the first year of establishment, extensive roofs often do not require long-term irrigation systems. Intensive roofs have deeper soil beds, and can accommodate a vast range of vegetation, including large bushes and trees, which do need regular maintenance. Intensive garden roofs also can be used as recreational areas – walking parks, golf courses and soccer fields among them.



Schwab Rehabilitation Hospital and Care Network Green Roof Project schematic.

System Benefits

Whatever the improvements in technology, however, the inclusion of a garden roof in any given project often boils down to a simple question – how will a vegetated roof benefit the owner and/or building? The answer is simple, though multifaceted.

Although first costs can be higher for garden roofs, short- and longer-term owners reap the rewards in several different ways. Early on in a building's life cycle, the owner profits from increased property values, and, in the case of Intensive garden roofs, added useable

Aerial view of resort.

space. Owners can often charge higher rents, particularly when a garden roof is accessible to tenants, or visible from interior spaces.

Long-term owners like The Gap, the City of Seattle and Schwab also gain from improved building performance and long-term efficiency of the structure overall. The soil layer of the garden roof performs several important functions: it insulates the interior from temperature extremes, thereby reducing heating and cooling demand; minimizes noise transmission to create a more peaceful and productive environment; and acts as its own safeguard, providing a thick protective layer that prevents mechanical damage to the waterproofing membrane below it.

And there are other advantages that make garden roofs solid investments, though in less obvious ways. In high-stress environments like corporate headquarters, for instance, employees can visit a garden roof to take a break from the daily grind, which may improve their health and decrease employee absenteeism, saving companies thousands of dollars annually. Health care patients at facilities like the Schwab Rehabilitation Hospital in Chicago also may go home earlier thanks, in part, to rooftop "healing gardens". Those earlier checkout dates enable facilities to take in more patients each year.

The Urban Roast

Some of the best-publicized benefits, however, are those that have a larger impact on the municipality and natural environment that surround the structure. A garden roof directly addresses two major environmental issues that are quickly becoming listed on many cities' Top 10 concerns –the urban heat island effect and storm water management.

The urban heat island effect, which describes the two to eight degree Fahrenheit rise in ambient temperature in cities since the early 1940's, is plaguing cities like Salt Lake City, Atlanta, Los Angeles and many others. Because hotter cities require more power, mostly for cooling, temperature spikes have added annual power costs of approximately $40 billion. Studies have attributed these higher temperatures to the heat-absorbing dark hard surfaces (asphalt paving, blacktop roofs, etc.) that dominate the urban landscape. Computer simulation and other research methods have exposed a lucrative cost/benefit ratio to lowering city temperatures by five degrees Fahrenheit; this reduction could result in annual energy savings of $100 million annually. Since urban heat island patterns are remarkably similar from city to city, except for minor variations in geographical and climatological features, these figures are attracting international attention.

Heat is also conducive to smog, which can exacerbate such health conditions as asthma. Because cooler ambient temperatures lessen smog, reversing the urban heat island effect could also lower health care expenditures. In such cities as Los Angeles, where smog is dangerously dense, lowering the ambient urban temperature by five degrees Fahrenheit could cut related health costs by $360 million.

Cooling the cities would also decrease the rate at which pollutants (nitrogen oxides and evaporative organic compounds, specifically) embed into ozone, which is the principal cause of smog. The overall effect would be cooler, cleaner air and less need for energy-hungry air conditioning.

Minimizing urban heat islands is achieved most effectively by increasing the amount of green space in cities. Evapotranspiration, defined as the loss of water from the soil both by evaporation and by transpiration from plant growth, can also cool the surrounding air, which helps lessen demand for cooling (and fossil fuels, as a result) and mitigate smog. Because roofs are available, open spaces that occupy countless miles of space in any urban core, garden roofs are being heralded as an important solution to the urban heat island problem.

Running Off the Roof

Compounding the push toward garden roofs is another major issue – storm water management, which, in some cities, is causing potentially irreversible damage to regional ecosystems. Because storm water must be channeled, purified, and detained within enormous systems, it is a financial and logistical burden on cities around the globe.

If improperly handled and purified, storm water contaminated with pollutants from city streets and other sources is channeled to natural bodies of water. As these pollutants build up, local ecosystems are harmed, often seriously. In the Pacific Northwest, for example, salmon have suffered in recent years because the waterways they inhabit could barely support life.

In areas where the industries like salmon are paramount, the ecosystem's troubles quickly turn into our own. In the Pacific

Northwest, for example, the salmon industry feeds people, as well as the regional economy. Any contaminated storm water that harms the salmon quickly turns up on the plates, budgets and agendas of businessmen, politicians, city bureaucrats, environmentalists, fishermen and local residents alike.

Garden roofs are a convenient and productive way to use storm water run-off. Not only does the vegetation need storm water to sustain its own life, the industry's current water retention/drainage technology is designed to store additional water for the plants to dip into during drier months. So, between the soil and other components, some garden roofs can retain as much as 90 percent of the water that falls on it. If these types of garden roofs were installed on large percentages of any given city's commercial roof acreage, cities could drastically reduce their storm water management expenditures.

And in fact, forward-thinking cities like Portland, Ore., are getting serious about using garden roofs to solve the storm water management problem. In March 2001, Portland implemented its FAR, or Floor-to-Area ratio, incentive program. FAR rewards private developers that include garden roofs into their buildings with additional square footage. For instance, a private developer who installs a garden roof on 10 percent to 30 percent of the total roof area earns an additional square foot of floor area for every square foot of garden roof. That ratio improves as the percentage of space dedicated to a garden roof increases. Cities like Seattle and Chicago are looking at implementing similar policies.

LEED™-ing the Way

Further encouraging cities to increase the square footage of garden roofs is the United States Green Building Council's Leadership in Energy & Environmental Design, or LEED™, guidelines. The first widely recognized definition of "green building," LEED assigns credits according to specific criteria in areas like Sustainable Sites, Water Efficiency and Materials & Resources.

Cities like Portland, Seattle, and Vancouver, British Columbia, are looking to LEED as a basis for future green building policy. Because garden roofs that use modern water drainage/retention technology can qualify for 10+ LEED credits, owners looking to achieve LEED certification, whether to meet local policy standards, or for its marketing value, will benefit from their garden roof through LEED credits as well.

Educating Green

Though the case for garden roofs is a strong one, there remains a fair amount of education needed to inform owners, contractors, architects and engineers about designing one. Vegetated roofs require additional forethought early in the planning process. Factors including those listed below should be considered early in the design process.

- **Design Intent:** What is the purpose of this garden roof? Will it be pedestrian accessible? If so, the system will need to be intensive, requiring regular maintenance and a structure that can support the additional weight.
- **Waterproofing:** Because this is a buried application that won't be easy to repair or replace, the waterproofing membrane should have a proven performance record in garden roof applications over many years. The membrane should last the life of the building, be fully bonded to the substrate (no seams for water to seep through), and be installed by experienced subcontractors. Perhaps most importantly, the entire system, from waterproofing membrane through growing medium (engineered soil), should be warranted by a single-source manufacturer for at least 10 years.
- **Structural Capacity:** Although garden roof system weights have been reduced by 50 percent thanks to lightweight water drainage/retention components, garden roofs can add weight, so the structure needs to be designed for additional loading.
- **Water Drainage/Retention:** This is critical to sustain plant life over time. The drainage/retention element should reproduce basic elements of natural ground, drain off excess water to prevent fungus growth and root rot, retain water for plants to "drink up" over time, and provide adequate aeration for the root zone.

Split-level view of the Greenwich Academy Project in Greenwich, CT.

- **Wind Loading:** Like any roof, a garden roof must be able to withstand wind speeds. While ASTM is currently developing standards that will address wind loading for garden roofs specifically, there are a host of other standards that provide guidelines about wind loading – among them, FLL Guidelines, Factory Mutual, American National Standards Institute (ANSI). An experienced garden roof manufacturer should also be able to offer wind loading guidelines.
- **Fire Resistance:** Like wind loading, fire resistance guidelines are available from individual manufacturers, the Underwriters Laboratory (UL), the International Conference of Building Officials (ICBO) and FLL. Again, an experienced garden roof manufacturer should have its own guidelines and certifications.
- **Slope:** Typical garden roofs systems are designed for a maximum slope of two inches in 12 inches. Extensive systems may be able to handle steeper slopes, though battens and restraints may be required for loose-laid components. Also, steeper garden roofs may require soil erosion control measures.
- **Detailing:** Vegetation-free zones should be installed at all roof flashings, drains, joints, etc. V-F zones are hardscape areas – typically gravel or architectural pavers – installed in a strip measuring 18 inches wide. Standard protected membrane roof drains with extension collar and clamping ring can be used in shallower extensive roofs, while inspection chambers are recommended for drains in deeper intensive garden roofs.
- **Maintenance:** While extensive systems require minimal maintenance – some as little as one annual weeding/watering – intensive systems require regular maintenance including mowing, weeding, watering and fertilizing.

Dirt: A Four-letter Word

Due to the unique nature of the application, garden roofs require special growing media – ideally, engineered soil that is tailored to each specific application. Ordinary ground soil – dirt, essentially – is very heavy due to its high clay content. On a garden roof, this material compacts, and holds excessive moisture, preventing aeration at the root zone and creating an environment hospitable to fungus and root rot.

Soil engineered for a garden roof is much lighter in weight than ordinary ground soil, usually a blend of a lightweight mineral like expanded shale, or pumice, sand and organic matter. The overall mixture should demonstrate a balanced pH, drain well and be capable of holding nutrients and moisture.

Increasingly, reputable manufacturers are coming up with their own soil blends, engineered for extensive and intensive garden roofs in different climates. And, due to the specialization required for garden roofs, many manufacturers also now have soil and plant experts on staff or available to A/E professionals planning one of their garden roofs.

Plant Selection

A well-designed garden roof, one that can sustain itself over time, should adhere to the principles of good ecological design. Appropriate plant selection is an important part of this process. Vegetation should be chosen first and foremost for its ability to mimic the surrounding landscape's structure, function and diversity; withstand the harsh conditions of a roof; and thrive in the local climate. Garden roof vegetation should be sustainable, not reliant on fertilizers, irrigation or maintenance.

Plant diversity is important to a garden roof's long-term potential. To maximize seasonality, early and late flowering species should be planted, along with annuals and long-lived perennials. Mixing in shallow-rooted wildflowers with deeper fibrous-rooted grass-like vegetation helps to encourage long-term plant viability.

Using these general guidelines, specific plant choices should be determined by several factors. Garden roof vegetation needs to be resistant to direct radiation, drought, frost and strong wind conditions. Often, native plant palettes offer the most favorable options, species that are regenerative and self-sustaining in the local climate.

The Future Is Looking Green

City workers in Seattle, hospital patients in Chicago, boarding school students and teachers in Greenwich, Conn., -- these are just a few of the groups benefiting from the thousands of garden roofs being installed on commercial structures across the country. And many more will feel the positive effects in the years to come, as garden roofs assume an increasingly larger place on our buildings, in our construction documents and city policies. It's an exciting movement, one that will help clean our air and water, improve our quality of life and reintroduce some much-needed balance into our cityscapes. ■

Wyndham B. Wood has worked in the sustainable building industry for the past seven years, focusing on garden roofs and the LEED(TM) green rating system. Among her other published pieces on the topic is "Cool Roofs," printed in Earthpledge's Sustainable Architecture White Papers.