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Volume 2, Number 3

Green Roofs for Healthy Cities Launches  
Green Roof Infrastructure Demonstration Project

On Thursday  
November 7th

INSIDE

Green Roofs  
for Healthy Cities  
Launches Green Roof  
Infrastructure  
Demonstration Project  
PAGE 1

Green  
Infrastructure Monitor  
Roof



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# LIVING ARCHITECTURE MONITOR

A GREEN ROOFS FOR HEALTHY CITIES PUBLICATION

VOLUME 21 / ISSUE 1 / SPRING 2019

understand the technical performance  
of green roofs in the Toronto climate  
and to raise awareness among clients,  
industry representatives and the  
public.”

John McManus, Vice President,  
Flynn Canada Ltd.

There are two sites for the  
demonstration: the City Hall  
podium roof and the East  
Neighbourhood Commu-  
nity Centre. The size of the City Hall  
demonstration site on the podium  
roof is approximately 7,000 square  
feet and the re-roofing and

Green Roof in  
Dearborn, Michigan  
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Spring 2007 / Volume 9, No. 1

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## LIVING ARCHITECTURE MONITOR

# 2019

## ANNIVERSARY ISSUE

## TWENTY YEARS OF GROWING THE INDUSTRY

# SOCIAL BENEFIT ISSUE

**INSIDE:**  
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SCHICKEDANTZ ON  
TWENTY YEARS OF GREEN  
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MAINTENANCE TIPS;  
REVISITING ICONIC CHICAGO  
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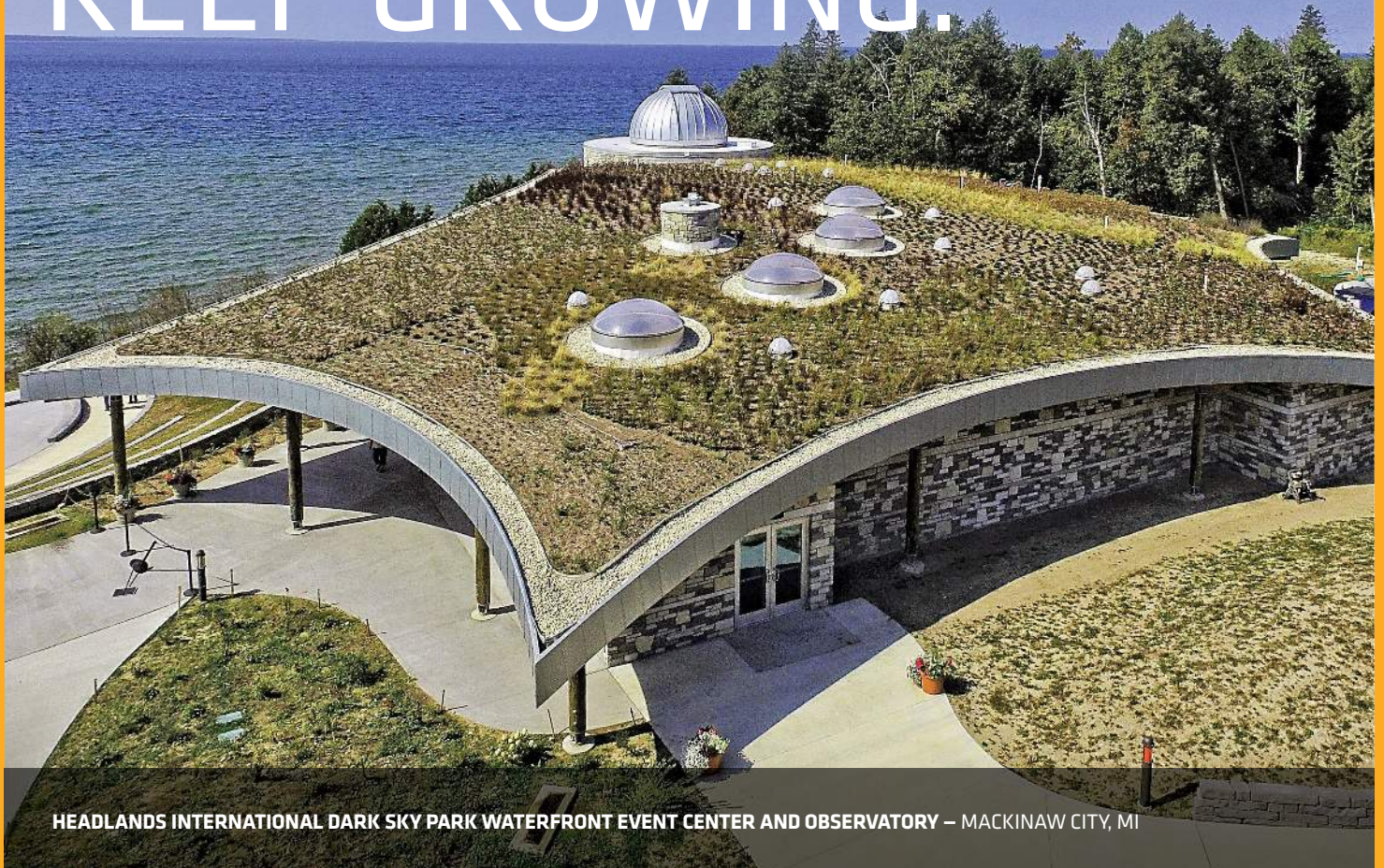


VOLUME 21 ISSUE 1 SUMMER 2019  
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## THE 10TH ANNIVERSARY COMMEMORATIVE ISSUE

New Data on Green Wall Performance  
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10 Years in Review Special Fold-out Section

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ISSUE 1  
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**20<sup>TH</sup>**  
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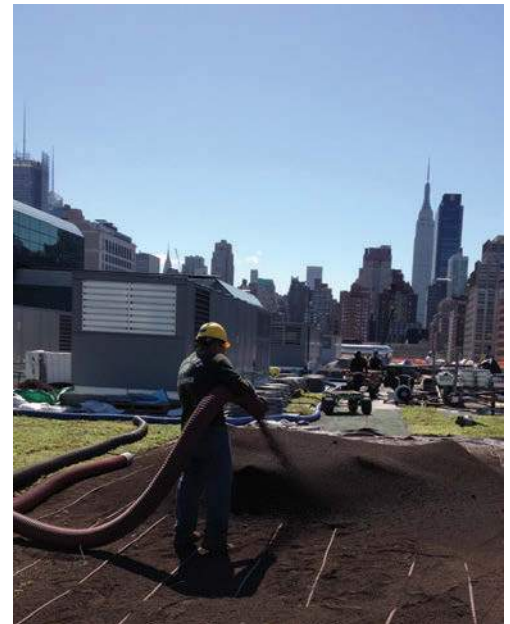
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*On the cover: A collage of the four cover pages showing the evolution of this magazine.*



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## MISSION

Green Roofs for Healthy Cities' mission is to develop and protect the market by increasing the awareness of the economic, social and environmental benefits of green roofs, green walls, and other forms of living architecture through education, advocacy, professional development and celebrations of excellence.

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IT WAS 20 YEARS AGO TODAY...

1999

Welcome to the 20th Anniversary Edition of the Living Architecture Monitor™, the first issue of which was published way back in the Summer of 1999. Heady times were those. In 1999, we were perched on the eve of the Millennium. The world it was feared by many, was going to come to an end because computers were not programmed to deal with 2000 and could stop working on January 1, 2000 – the Y2K problem it was called. Millions were spent, and the date switched over and... we are still here... President Clinton was acquitted by the Senate of perjury and obstruction of justice after a five-week long impeachment trial. Vladimir Putin, who still dominates the news cycle, replaced Boris Yeltsin as President of Russia. Peace finally broke out in the Balkans after years of blood shed and the world's population topped 6 billion. The Euro was implemented as a common currency in Europe. My Space and Napster were launched. The Red Hot Chili Peppers released "Californication" and Cher topped the charts with "Believe". On the natural disaster front, catastrophic mudslides and floods killed tens of thousands in Venezuela and Mexico. Hurricane Floyd, a category 4 storm, slammed into the East Coast with wind speeds in excess of 140 miles per hour. Three million people were evacuated and approximately 68 people died in that extreme weather event.

In North America, the green roof industry was in its infancy, with only a handful of policy makers, companies, designers and researchers exploring these technologies. I was one of them, having just established Green Roofs for Healthy Cities as a consortium of companies that agreed to pool resources to build a green roof research and demonstration project at City Hall in Toronto. We completed the project

in 2001 after jumping through many hoops, and had an official launch event in July. There were eight plots, all with different plants and two types of growing media. Several of the plots failed and we learned that you can't grow corn in six inches of growing media with windy conditions, or

**"WHILE WE'VE COME A LONG WAY SINCE 1999 THERE ARE MANY MILES TO GO YET BEFORE WE REACH A POINT WHERE THE APPLICATION OF GREEN ROOFS AND WALLS IS COMMONPLACE ALL OVER THE WORLD."**

- STEVEN W. PECK

replicate a black oak savannah ecosystem without oak trees or sandy soils. We learned. We're still learning.

At the outset of this project, we also worked in a multi-disciplinary fashion to gain approvals for the project, design it, develop a research plan and raise the funds to build and maintain it. The project was designed to address the recommendations of a research report titled "Green Backs

from Green Roofs: Forging a New Industry in Canada", funded by Canada Mortgage and Housing Corporation. It was completed in March of 1999 by Monica Kuhn, Brad Bass, Chris Callaghan and myself. (<https://commons.bcit.ca/greenroof/files/2012/01/Greenbacks.pdf>) In this report we identified many of the benefits of green roofs, and the desperate need for education, performance data, standards and policy support as key pillars in developing a new industry in Canada and the US. The first issues of the LAM in 1999 and 2000, then called The Green Roof Infrastructure Monitor, contained basic stories about what a green roof was and how it could benefit building owners and society.

We've come a long way since 1999, and there are many miles to go yet before we reach a point where the application of green roofs and walls is commonplace all over the world. As we turn 20 this year, we will be publishing a number of retrospective interviews and case studies on iconic projects that have helped define the industry during its North American evolution and shed some light on its future.

I hope you enjoy this recent history of our collective endeavor to develop Living Architecture across North America and around the world.

Sincerely yours,



Steven W. Peck,  
GRP, Honorary ASLA  
Founder and President



## GRHC MAKES SUBMISSIONS TO NYC HEARINGS ON GREEN ROOF POLICY

In June 2018, New York City Council Members Costa Constantinides, District 22; Rafael Espinal, District 37; Stephen Levin, District 33; and Donovan Richards, District 31; formally introduced a package of legislation aimed at expanding green roofs in New York City as a concerted effort to combat climate change. On Monday, January 28,

2019, New York City Council's Committee on Environmental Protection reviewed the legislation, at which Green Roofs for Healthy Cities and several other partners and members were in attendance to put their support behind these measures through collected letters of support, written testimony, and oral presentations. Green Roofs for Healthy Cities looks forward to contributing to the ongoing development green roof legislation in the city of New York. Read the written submissions by GRHC to the Department of Environmental Protection and listen to the hearings. <https://livingarchitecturemonitor.com/news/2019/1/30/new-york-city-council-committee-on-environmental-protection-considers-green-roof-legislation>

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ON THE ROOF WITH...

# ECO-ARCHITECT ROGER SCHICKEDANTZ ON TWENTY YEARS OF INNOVATIVE GREEN ROOF DESIGN

INTERVIEW BY STEVEN W. PECK, GRP, HONORARY ASLA



As part of our celebration of 20 years of publishing the LAM, we've asked a number of experts to share with us their thoughts on the development of the green roof and wall industry. This edition of "On the Roof With" features Roger Schickedantz, AIA, LEED AP, BD + C, GRP, Director, William McDonough + Partners an early adopter of green roofs with projects all over North America and around the world. Roger was also instrumental in the early days of the green roof industry by providing his expertise during the development of the Green Roof Professional (GRP) training courses and manuals. Here he shares the accumulated wisdom of more than twenty years of experience of designing award winning and iconic green roof projects.

**LAM:** *What do you think are the major changes in the industry that have taken place over the past twenty years, from a designer perspective?*

**RS (Roger Schickedantz):** Twenty years is a long time in the North American green roof industry and it is amazing how much has changed. William McDonough + Partner's first green roof was the 901 Cherry building in Silicon Valley (built for The Gap, now YouTube's headquarters) installed in 1997. It consisted of 6" of

growing medium, intended to reproduce the habitat of the ground plane replaced by the building. We relied on the expertise of Paul Kephart for a native prairie grass meadow. At the time, the concept of extensive green roofs remained largely undiscovered in the Western Hemisphere - although quite common in places like Germany. The idea of doing any kind of green roof was novel in the late 90's and many building professionals were skeptical that it should be attempted at all.

A few years after the Gap project, we worked with David Yocca, FASLA then with Conservation Design Forum now Biohabitats, and Charlie Miller P.Eng. then with Roofscapes now Roofmeadow, on the Chicago City Hall project. One of the interesting manifestations of that green roof was the use of stacked layers of lightweight insulation to create a varied topography. It was counterintuitive to imagine that these artificial hills could generate the resulting delightful rolling sky garden filled with lush vegetation.



When we began the design process for the Ford Rouge Assembly Plant project in 1999, we looked for a lightweight technology suited to long-span structures. In the late 90s there were a few roofing companies with European ties which could provide expertise, backed by EU testing of their products through organizations such as the FLL in Germany. In the mid-2000's ASTM began publishing standards.

Through an investigation of various companies operating in Germany, we were put in touch with Mr. Wolfgang Behrens, the founder of XeroFlor. Mr. Behrens had developed a lightweight green roof camouflage for German military hangars and pioneered Sedum mat technology. His deep horticultural knowledge gave us confidence that the design was robust, although there was some concern that Sedum might not survive the severe Midwest summers and winters. The success of the Ford green roof helped establish extensive Sedum roofs as a cost-effective and provable green roof technology in North America.

Our sister company, MBDC, created an experimental prototype tray system that was installed on a roof at the Ford Motor Co. headquarters. The trays were made of polypropylene and contained super-absorbent polymer pillows covered by a variety of substrates such as cocoa fiber. While successful at a small scale, this technology was not particularly suited for large-scale application on the Rouge factory roof. Instead, acres of XeroFlor Sedum mats were pre-grown off site, palletized, lifted onto the roof with a crane and installed in 1-meter squares. The logistics to install the 10.4-acre green roof drove the technological solution. Subsequently, tray systems have flourished and led to a number of competing products in the market.

Over 20 years the green roof market has matured and become more mainstream in many markets. Many roofing product manufacturers have incorporated green roofs within their standard product lines or created strategic partnerships with green roof companies. GRHC's important advocacy with cities has created green roof requirements or incentives in places such as Toronto, Minneapolis, San Francisco, Washington, D.C. and most recently Denver. Given the pressures of increased rainfall tied to global climate change, cities such as Vancouver, B.C. and New York are developing mandatory green roof legislation. This growing emphasis on resilience is a reaction to environmental factors which were scarcely on the radar twenty years ago.

Lastly, the subject of food production has gained increased prominence. Many factors including the economic downturn of 2007/2008, health concerns (a lack of access to nutritious options



in food deserts), and increased energy consciousness (i.e., long-distance transportation of food) have led to an appreciation for locally grown food to support underserved populations in urban areas. The do-it-yourself movement led initially to an explosion in backyard and community gardens, which then expanded to rooftops and balconies as the trend accelerated. We saw the ultimate effect of the trend with our 2018 Award of Excellence winning rooftop greenhouse for Gotham Greens above Method's soap factory in the Pullman district of Chicago. The 75,000 sq. ft. greenhouse provides leafy greens directly to local grocers, improving shelf life compared to produce trucked in from the West Coast. It has become so successful that Gotham Greens is build-

"FOR CENTURIES ARCHITECTS HAVE STRIVED TO KEEP NATURE OUT OF BUILDINGS AND REDUCE THE WEIGHT OF BUILDING MATERIALS. WITH GREEN ROOFS AND WALLS THAT PROCESS HAS BEEN REVERSED."

- ROGER SCHICKEDANTZ

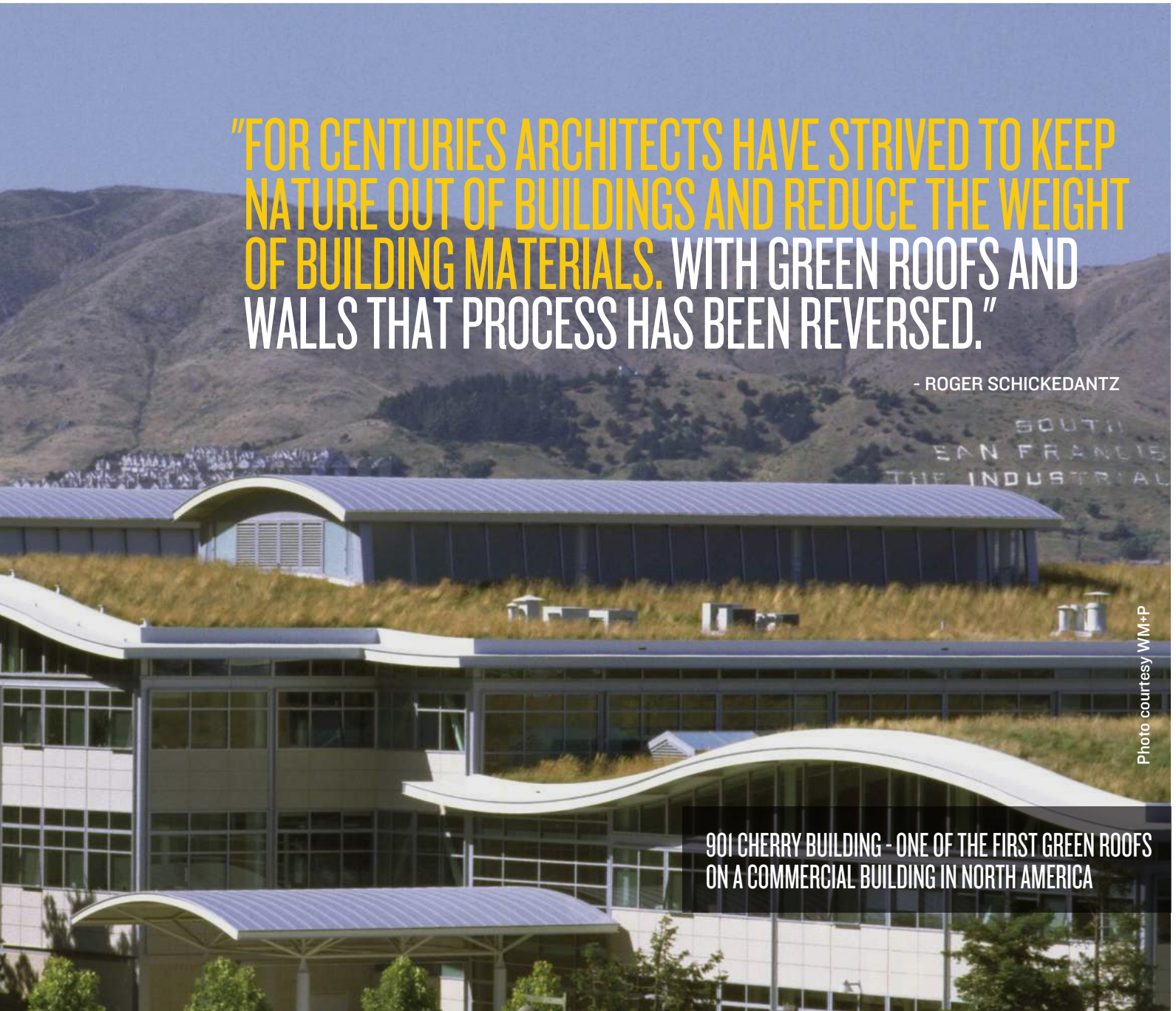
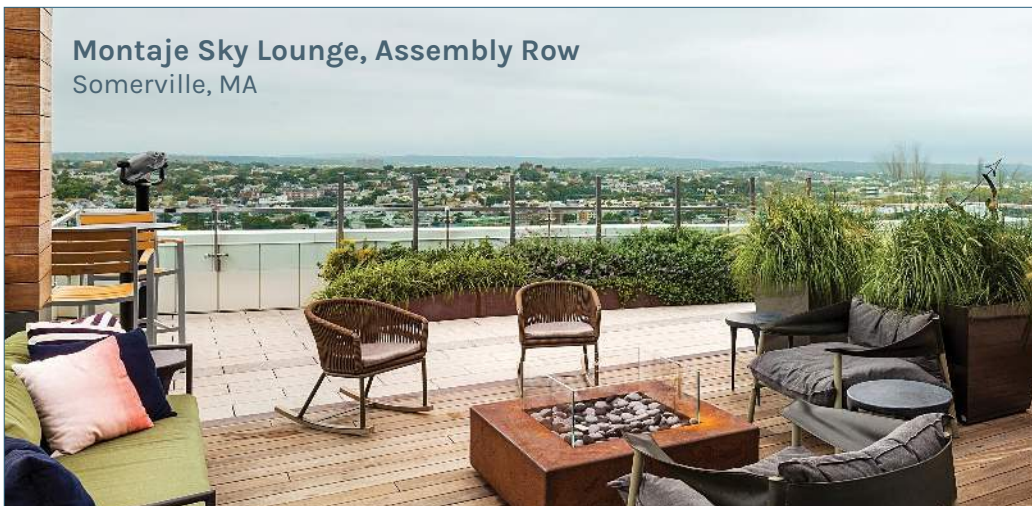


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- ROGER SCHICKEDANTZ

ing a second greenhouse on the ground next door. Sophisticated high-tech hydroponic systems have facilitated this burgeoning greenhouse industry.

**LAM:** *What are the biggest challenges for designers right now, regarding green roof and wall design and installation?*

**RS:** Vegetated infrastructure has become so tied to the typology of "green buildings" that green roofs and walls have almost become clichéd. While the benefits are clear, there is an ideological symbolism that ties greenness with big cities, which can be off-putting to some. Of greater consequence, however, may be the lack of familiarity and technical knowledge of green infrastructure outside of major urban areas. It often remains a big hurdle for building professionals to promote a technology that is somewhat counter-intuitive. For centuries architects have strived to keep nature out of buildings and reduce the weight of building materials. With green roofs and walls that process has been reversed.

**LAM:** *What do you think about the business model for green roofs and walls?*

**RS:** For many clients, including institutions and large developers, the additional cost of a green roof is worthwhile because it can generate higher rents and attract tenants. For others, however, the perception of greenness is still new and associated with higher costs and potential liability.

One of the more promising developments of green roofs is the concept that they can be combined with photovoltaic, (PV) panels, leading to increased PV efficiencies due to decreased roof temperatures. As PVs become more necessary and ubiquitous as a response to global warming, the combined benefits of PV effectiveness and a reduced Urban Heat Island effect make green roofs an ideal solution.

Because green roofs are still relatively new in North America, they will need to exhibit an ability to stand up to time. Once builders and owners really see that roof membranes last much longer when protected over decades, the financial benefits will become even more obvious.

**LAM:** *If you look into your crystal ball, what do you think lies in store over the next decade or so?*

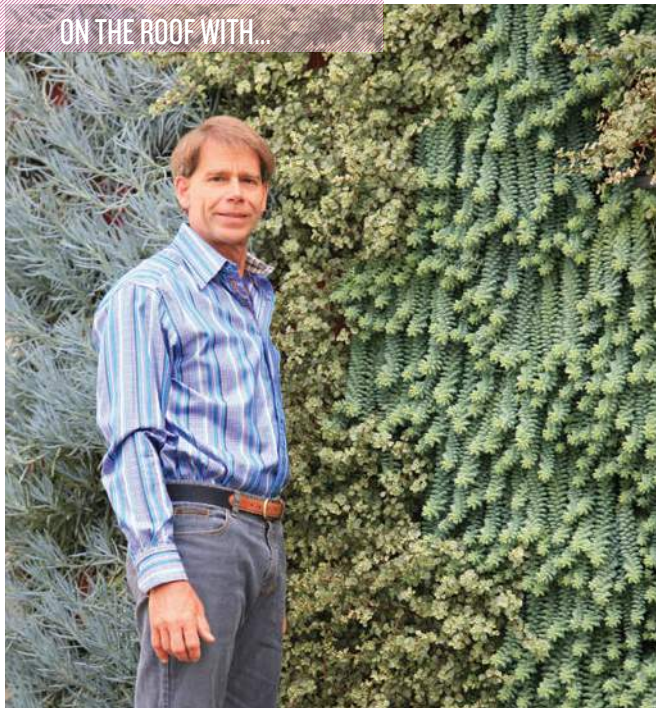
**RS:** The topic of resilience is catching on more and more as people witness the effects of climate change on their communities. Flooding, forest fires and heat waves increasingly affect larger populations, that now only a minority question the legitimacy of human-caused global warming. In this current atmosphere it is easier for public officials to offer up creative programs for storm-water management that reduce the burden on infrastructure.

Younger generations, who are economically constrained to live in apartment buildings, have high expectations for social spaces which can easily be accommodated on rooftops. Additionally, higher expectations for healthy lifestyles and wellness can be satisfied in part through the biophilia effect provided by green roofs and walls.

---

*Roger Schickedantz, Director, William McDonough + Partners, [rschickedantz@mcdonough.com](mailto:rschickedantz@mcdonough.com).*





ON THE ROOF WITH...

# DAVE MACKENZIE, THE FOUNDER OF LIVEROOF

INTERVIEW BY STEVEN W. PECK, GRP, HONORARY ASLA

Dave MacKenzie, the founder of Hortech Inc. (wholesale perennial nursery), LiveRoof, LLC (green roof system provider) and LiveWall, LLC (planted wall system provider). In this commemorative edition of "On The Roof With..." David provides insights into the progress, challenges and opportunities facing the green roof and wall industry.

**LAM:** David, as one of the leading manufacturers of modular green roof and wall systems, what do you think are the biggest changes you've seen in the green roof and wall industry over the past fifteen years or so?

**DM (Dave MacKenzie):** With green roofs, I think we're beginning to see a gradual maturation of the specifier, owner and developer... where they are gaining more appreciation for value beyond "code compliance" or storm water management. Because of this, the green roof is more likely to be sited in a visible location than was the case a few years ago, and this increases the likelihood of proper maintenance. Collectively these trends increase the likelihood of additional specifications and purchases in the future.

With planted walls, we're beginning to see a very modest appreciation for their biophilic and wellness benefits—perhaps slowly moving beyond planted walls as a novelty. Green walls are still very much in their infancy.

**LAM:** What do you think the industry needs

to focus on to grow more rapidly over the next ten years or so?

**DM:** First: We must continue to foster code compliance at the municipal level—based upon "municipal benefits" (sewage system savings, heat island mitigation, protecting lakes and streams, carbon emissions, green space). Secondly, we must assertively promote "owner benefits" to specifiers and property owners (aesthetics, rent-ability, extension of roof life, energy savings, wellness, biophilia).

**LAM:** What are the biggest challenges facing the industry in the near term?

**DM:** I don't think it's money. I think it's education. If specifiers and property owners are better educated (as to the benefits of green roofs and planted walls) they will prioritize accordingly. Each time I visit a project where the green roof or wall was taken out because it was deemed "unaffordable", I feel like we've failed to educate. These same projects usually have plenty of "luxurious" amenities that were prioritized above the "green" elements.

**LAM:** What advice would you give to specifiers who are considering green roofs or walls in their projects?

**DM:** Take time to learn about the many benefits of green roofs and planted walls. By being aware of the "buffet of benefits" of green roofs and walls, it will be easier to educate owners and developers, and they will be more likely to prioritize green infrastructure. As an aside: I've never met a specifier that doesn't envision a "greener" world, or isn't frustrated by value engineering. Allow us, as green industry professionals, to partner with you in creating a greener planet.

*Dave MacKenzie has authored four books on plants, and currently focuses his time on staff and customer education, marketing, and product development. He is an undying proponent of bio-control based plant culture, waste reduction, and continual improvement. [www.liveroof.com](http://www.liveroof.com) GRHC has many online training courses on green roofs, walls, advance maintenance and more. Visit <http://livingarchitectureacademy.com> for details and to register.*

## PLANT PROFILE:

# A CRITICAL REVIEW OF TWENTY YEARS OF GREEN ROOF PLANT RESEARCH IN NORTH AMERICA

DR. BRADLEY ROWE, MICHIGAN STATE UNIVERSITY, EAST LANSING

In this 20th Anniversary issue of the LAM, I reflect on the state of plant research over the past 20 years: how it started, what's been accomplished, and what the future holds.

Our green roof research program at Michigan State University (MSU) began 20 years ago when Clayton Rugh and I were involved with Ford's green roof in Dearborn (see Rugh's article on page 30). This project provided the opportunity for Clayton to leave MSU in 2006 to become the managing director of XeroFlor America. Prior to the Ford installation, we had some German publications translated into English and we took a couple of trips to Germany in 2001 to educate ourselves. We didn't really know what we were doing in the beginning and I don't think anyone else did either. For example, we attended the first ASTM meeting of the green roof systems subcommittee in Dallas 2001 and after four hours we still hadn't agreed on a definition for a green roof.

When we heard that there was going to be a green roof conference in Chicago in 2003, we had to be there. This is where we first became involved with Green Roofs for Healthy Cities (GRHC), first met Steven Peck, and first learned that other institutions such as Penn State were also conducting green roof research. Realizing the importance of research, Steven held a meeting for anyone interested and the GRHC Research Committee was born shortly thereafter. The second GRHC conference was held the following year in Portland, Oregon. This conference was memorable to me because the trade show and poster session were held in the hotel parking garage. One of my graduate students wondered why we even came to an event with these accommodations and I told him that everyone here

was making history and that this will make a great story someday. That someday is now.

Portland was the location for the first official meeting of the GRHC Research Committee. Those in attendance included Brad Bass (Environment Canada), David Beattie and Robert Berghage (Penn State), Stephan Briennesen (University Waedenswil, Switzerland), Reid Coffman (University of Oklahoma, now at Kent State), Nigel Dunnnett (University of Sheffield, UK), Angie Durhman (MSU graduate student, now owner of AD Green Roofs), Tobias Emilsson (Swedish University of Agriculture Science), Bill Hunt (North Carolina State University), Jeremy Lundholm (St. Mary's University, Nova Scotia), and myself (MSU). Other original members

that contributed, but were not present at this meeting included Maureen Connelly (British Columbia Institute of Technology), Tom Liptan (City of Portland), and Karen Liu (National Research Council Canada, now with Low and Bonar). I served as chair or co-chair (with Maureen Connelly) from when the committee was formed after the 2003 Chicago meeting up through the conferences in Portland (2004), Washington, DC (2005), Boston (2006), and Minneapolis (2007) when I passed the chairmanship to Brad Bass.

Reviewing the minutes from these early committee meetings I can see that some of the topics have come to fruition and others have not. Six long-term objectives agreed upon at the 2004 meeting were: (1) identify



**GREEN ROOF RESEARCH BEDS AT MSU**

Photo courtesy B. Rowe

research priorities, (2) encourage high quality research, (3) encourage regional and international collaborative and multi-disciplinary research, (4) disseminate our knowledge, (5) help locate research funding, and (6) develop an endowment.

We have somewhat reached our goals for objectives one through four. Back in 2004, the idea of a peer-reviewed journal on green roofs was discussed and by 2008 Jeremy Lundholm spearheaded a special issue on green roofs in the journal *Urban Ecosystems*. Then in 2013, the first paper was published in the *Journal of Living Architecture*, which is now part of the Green Infrastructure Foundation. To date,

there have been 26 peer-reviewed papers published in this journal which is available on the GRHC website <https://greenroofs.org/journal-of-living-architecture/>. Reid Coffman was the main driver in making this journal a reality. Research has also been disseminated through GRHC conferences. As for research collaboration, conferences and the research committee provide numerous opportunities. The recent establishment of four regional centers of living architecture excellence is a good example. In my case, I have participated in interdisciplinary research within my own university with collaborators from Plant, Soil, and Microbial Sciences; Environmental Engineering; Mechanical

Engineering; Fisheries and Wildlife; Geography; and Landscape Architecture; as well as internationally with other researchers in Germany, China, Malaysia, Turkey, Spain, Trinidad, and the Dominican Republic.

However, we are still a long way from meeting our objectives. In my opinion, the number one reason why there isn't more research being conducted is due to the lack of funding. We tried to address this issue in 2005 when we invited representatives from numerous federal funding agencies to the conference in Washington, DC. Only one representative from the American Nursery and Landscape Association (now American Hort) attended and his visit did not materialize into any immediate funding.

In the Summer Issue of the LAM, I will explore some of the realities of conducting green roof and wall research and suggest some possible ways forward on these important objectives.

---

*Dr. Brad Rowe has been conducting green roof research at MSU since 2000. Research topics include plant selection, growing substrates, carbon sequestration, stormwater runoff, energy conservation, and roof vegetable production and he received the GRHC Research Award of Excellence in 2008. Brad also teaches a course on green roofs and walls at MSU ([www.greenroof.hrt.msu.edu](http://www.greenroof.hrt.msu.edu)).*

# EXTENSIVE GREEN ROOF MAINTENANCE TIPS FOR SPRING

BY KAITLIN THOMPSON AND BAILEY WIEBE, GINKGO SUSTAINABILITY

Spring is in the air, and with that comes the important task of preparing green roofs for the season ahead. Good maintenance means good performance! While green roof maintenance plans vary according to the system, there are a few key things to know about facilitating the transition from dormant winter Sedums to summer blooms. Our team maintained over 200 green roof sites in the 2018 season in the Greater Toronto Area, and here we share a few trade secrets in this article.

In the Toronto region, April is the month to lay the groundwork for green roof health by assessing nutrient levels in the soil. Once the frost melts and the growing media begins to thaw, a sample should be taken and sent to a green roof diagnostic lab for recommendations on soil nutrient deficiencies. This is more important on juvenile green roofs with less than three years of growth, but should be considered on established roofs if there are signs of chlorosis, stunted growth, or other deficiencies. Since we deal with many roofs of several manufacturers (ie. similar nutrient levels), we undertake soil tests on a representative sample of roofs. If it is a larger roof we will still do only one sample, but several samples could also be taken to account for any variation across the roof. Based on nutrient levels in the soil, a fertilizer that compliments the nutrient deficiencies of the particular green roof should be selected. It may be useful to research fertilizer suppliers or speak with a local nursery or landscaper for suggestions. On Sedum roofs we

typically recommend an NPK ratio (nitrogen, phosphorus, potassium) of 5-2-6, which is lower than most commercial fertilizers. This is to avoid burning plant material by over fertilizing, and is based on the logic that one can always add more fertilizer if growth is not as desired. Typically, fertilizer is dispersed by hand or using a handheld applicator.

Meanwhile on the roof... seasonal variation in when sedums break dormancy is not uncommon, and can range from mid-April to mid-May.

At this time of year, expect to see dormant, brittle and brown vegetation.

In May, vegetation has broken dormancy and plants begin to increase their nutrient uptake and put forward new growth. Different maintenance providers fertilize at different times of year, but May is when we recommend that it's done perhaps earlier for green roofs in more moderate climates. As Sedums and other intentionally planted species exit dormancy, so do weeds and volunteer species. Time spent



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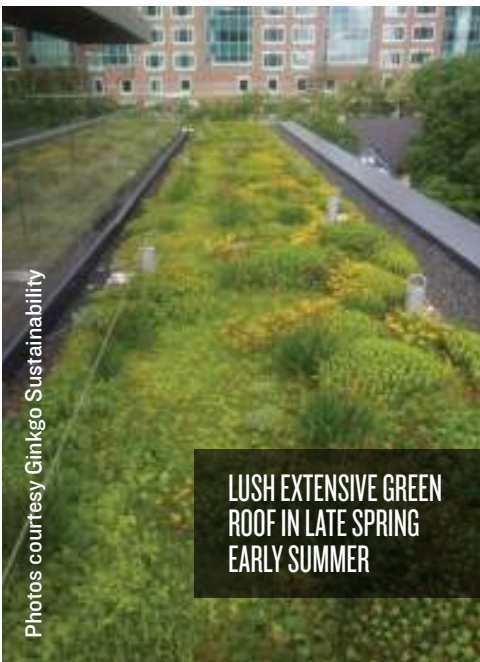
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EXTENSIVE DORMANT GREEN ROOF IN MID-APRIL



EXTENSIVE GREEN ROOF IN MAY JUNE IN GREATER TORONTO AREA



LUSH EXTENSIVE GREEN ROOF IN LATE SPRING EARLY SUMMER

# “NEGLECTED GREEN ROOFS CAN QUICKLY BECOME OVERGROWN AND FAIL TO ACHIEVE PERFORMANCE BENEFITS SUCH AS STORMWATER RETENTION.”

- KAITLIN THOMPSON

on weeding in May will help manage weed presence throughout the rest of the season... especially if you remove the root system of the weed so that it doesn't grow back. Other than staying on top of weeding, non-living roof components should also be checked for damage from overwintering. Things to look for include blocked drains, wind uplift, erosion, and broken edging. We usually test whether irrigation systems are on in May, in preparation for the coming warmer months. That also gives us plenty of time to let building management know if they need to look into turning on water access.

By June, plants should be showing signs of fertilization, with new growth, signs of budding, and perhaps early flowering. Attention to weeds will continue to be a priority through the month. Irrigation is another factor that starts to play a role on plant health in June. It's important to be aware of precipitation trends and weather conditions to make sure that the vegetation is getting an adequate amount of moisture, especially for

juvenile green roofs (less than two to three years old). While established sedums are drought tolerant and able to withstand hot summer temperatures, less established plants still require rainfall about once per week during summer months. If seasonal precipitation is low and no built-in irrigation is present, consider other irrigation options such as a temporary system composed of a timer, hoses and sprinklers or hand watering from a hose bib at roof level.

Neglected green roofs can quickly become overgrown and fail to achieve performance benefits such as stormwater retention. Follow these simple guidelines to maintenance, and you should be set for healthy flowering and new growth into the summer months.

*Kaitlin Thompson, BES Maintenance Operations and Marketing, and Bailey Wiebe, Maintenance Manager, Ginkgo Sustainability, Ontario's leading living roof installer; [www.ginkgosustainability.com](http://www.ginkgosustainability.com) GRHC has a half day Advanced Green Roof Maintenance Course online which is available at <https://livingarchitectureacademy.com>*

# INSIDE THE DENVER GREEN ROOF ORDINANCE

BY JENNIFER BOUSSELOT, PH.D., COLORADO STATE UNIVERSITY  
AND ANDY CREATH, GREEN ROOFS OF COLORADO

The most common critique of the 2017 Denver Green Roof Ordinance re-write is that the original intent of the ordinance was diluted. Only at face value does it appear so – those of us involved with the re-write process know otherwise.

## COMPLIANCE OPTIONS FOR NEW AND EXISTING BUILDINGS

### NEW BUILDINGS:

#### COOL ROOF + 1 OF 8 COMPLIANCE OPTIONS:

1. A GREEN ROOF OR GREEN SPACE ANYWHERE ON THE SITE.
2. A FINANCIAL CONTRIBUTION FOR OFF-SITE GREEN SPACE.
3. A COMBINATION OF GREEN SPACE AND SOLAR PANELS.
4. A COMBINATION OF GREEN SPACE AND ENERGY EFFICIENCY MEASURES.
5. A SOLAR ARRAY COVERING 70 % OF THE ROOF.
6. ENERGY EFFICIENCY MEASURES  $\geq$  12 % MORE EFFICIENT THAN CURRENT ENERGY CODE.
7. LEED GOLD OR EQUIVALENT CERTIFICATION.
8. ENTERPRISE GREEN COMMUNITIES CERTIFICATION.

### EXISTING BUILDINGS:

#### COOL ROOF + 1 OF 5 COMPLIANCE OPTIONS AT TIME OF ROOF REPLACEMENT:

1. A SMALL GREEN ROOF OR GREEN SPACE ANYWHERE ON THE SITE.
2. AN ONSITE SOLAR ARRAY.
3. LEED SILVER OR EQUIVALENT CERTIFICATION.
4. A FINANCIAL CONTRIBUTION FOR OFF-SITE GREEN SPACE.
5. ENROLLMENT IN A FLEXIBLE ENERGY PROGRAM TO ACHIEVE EMISSION REDUCTIONS.

The updated version of the Denver Green Roof Ordinance builds in new options for resiliency; will result in greater overall environmental benefits and more green roofs getting built than before the ordinance. With local green roofs being the backdrop for numerous press events, the design and building community were shown how they can be successful in our dry climate. Green roofs have become considered a viable option, when prior to the ordinance they were considerably harder to get added to projects. As passed in the November 2017 election, the original code would have resulted in up to 90 per cent of existing buildings being exempted due to roof loading capacity limitations. Also, the general feeling of the development/building owner community was that this ordinance over-reached in terms of private interests and decision-making. Between these two major factors, few successful green roofs would have been mandated. Denver is still a remnant of the wild west.

The updated ordinance gives building owners and developers compliance options in order to fight climate change in our community. Making private building owners contribute to the greater good for public benefit is a new concept in a state like Colorado that values personal property and personal choices. Now there is no building in Denver over 25,000 gross square feet, existing or new, exempt from making a measurable impact on our climate. Remember that Denver is the third worst jurisdiction in the US for Urban Heat Island Effect and the eleventh worst for air quality.

Since there are now options for compliance, the question

becomes: What option will be the most frequently chosen? Until crystal balls become reliable, we can only assume that each of the eight options for existing buildings will be chosen roughly equally. The City of Denver calculated that the options would add between 0.4 per cent and 1.7 per cent to new construction costs. For existing buildings, the options would add between two to three per cent for office, retail, and industrial facilities and 14 per cent for apartments.

However, it is safe to say that the public in Denver will now demand green spaces on the tops of buildings more than they would have ever done before November 2017. We believe that the market will favor those building owners that decide to do green roofs and amenity decks because they will rent out sooner, retain leases longer, and be able to more effectively market their environmental and social benefits to potential clients.

In specific building sectors, such as retail, using one of the green roof compliance options may make the most economic sense. The tenants of the retail space are paying the energy bill, not the owner or developer. A green roof would lead to more of

a payback for the owner due to increased membrane longevity and storm-water runoff reduction than the energy efficiency option would for a tenant.

The Denver Green Roof Ordinance debate raised voter awareness about green roofs and other forms of green infrastructure in a way that few other efforts could. Denver City Council updated the ordinance in October 2018, which is very recent for the typical timeline of building permitting. Even so, there is an upswing in green roof installations planned in the Denver metro area for the upcoming building

season. While few of these green roofs are a direct result of the ordinance requirements, it means that developers and building owners already see the value of having green spaces in an increasingly impervious city like Denver.

---

*Andy Creath is the Founder and Owner of Green Roofs of Colorado and Dr. Jennifer Bousset is Assistant Professor, Horticulture and Landscape Architecture, Colorado State University. GRHC is organizing a training course and symposium on Green Roofs and Walls on August 7-9 in Denver.*



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COMMEMORATIVE CASE STUDY:

# CHICAGO CITY HALL GREEN ROOF - A 20-YEAR RETROSPECTIVE

BY DAVID YOCCA, FASLA, RLA, GRP, SENIOR LANDSCAPE ARCHITECT, BIOHABITATS  
AND MICHAEL BERKSHIRE, GREEN PROJECTS ADMINISTRATOR, CITY OF CHICAGO

Chicago's City Hall rooftop garden is arguably one of the more recognized green roof applications on the continent. It helped shepherd in a new era of urban greening and resiliency efforts in Chicago and other major metropolitan areas. It remains an icon of living architecture in a continually evolving, expanding practice. Since its design and implementation nearly 20 years ago, Chicago City Hall continues to offer a dramatic, relevant image of the opportunities and challenges associated with the use of living architecture technologies.



**CHICAGO CITY HALL  
FLOURISHING (2018)**

Photo courtesy of D. Yocca

As we reflect on the City Hall green roof, we should ask ourselves what lessons can apply to realizing the vast potential for living surfaces to provide multiple functions and values in more livable and resilient towns and cities.

Former Mayor Richard M. Daley sincerely believed that in order to remain a viable, internationally competitive city, Chicago needed to embrace green practices in a profound way. On a trip to Europe in the late 1990's, he was inspired by German cities where green roofs and other green infrastructure systems were

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## Living Facades

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## Water Management: Rainwater Harvesting

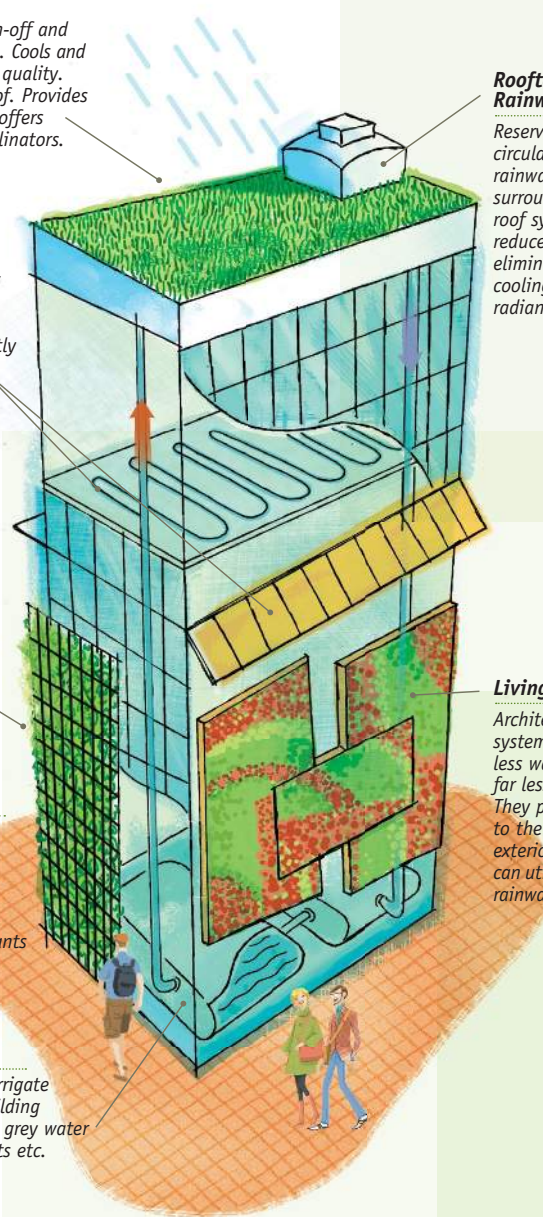
Captured rainwater can irrigate landscapes, cool the building and provide an optional grey water source for flushing toilets etc.

## Rooftop Rainwater Cisterns

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**LOCATION:** Chicago, IL

**COMPLETION DATE:** 2001

**SITE SIZE:** 21,000 s.f. green roof portion;  
38,000 s.f. total roof area

**CONSTRUCTION BUDGET:** \$2.5 million  
(incl. building repairs/improvements)

**PROJECT TEAM:**

Conservation Design Forum – Lead Designer,  
Landscape Architect, Ecological Design

Weston Solutions – Project Lead,  
Project Management

McDonough + Partners – Design Architect

Herbert Dreiseitl/Atelier Dreiseitl –  
Green Roof/Water Systems Engineering

Bennett and Brosseau – Roofing Contractor

RoofMeadow (formerly Roofscapes) –  
Green Roof System Design and Oversight

Michael Curry (now with Montale Gardens)  
Engineered Soils

Intrinsic Landscape – Planting Installation

City of Chicago and A Safe Haven –  
Long-term Landscape Maintenance

already commonly used. Following his visit to Germany, he authorized staff to explore a green roof demonstration project in Chicago.

Between 1999-2001, the City of Chicago simultaneously put a green roof on City Hall, their most visible structure, and also prioritized the development and implementation of a suite of policies and incentives to promote green roofs and other green practices. The \$2.5M installation was a complete reconstruction of the 108-year-old City Hall building's roof, including significant structural repairs, changes to the drainage, waterproofing and irrigation systems, adding green roof components such as four to eight inch lightweight engineered growing media over the drainage system, and 150 species of sedums/succulents, perennial forbs and grasses, trees, shrubs, and climbing vines.

**COMPREHENSIVE APPROACH-TAKE ADVANTAGE OF EVERY OPPORTUNITY**

The City Hall green roof was envisioned as an ideal, highly visible opportunity to demonstrate the adaptation of practices in Chicago that originated in Europe,

without costing taxpayers a dollar. Timing for the project was propitious:

- The City Hall roof leaked, and needed long-deferred repairs and replacement;
- The City had a large settlement from Commonwealth Edison (levied for power failures during a deadly heat wave the previous summer) to spend on urban heat island reduction strategies;
- The project was selected to receive a grant from the original U.S. EPA Urban Heat Island Pilot Project Initiative; and
- The City was getting positive citizen support on other green initiatives such as extensive tree planting.

The City Hall green roof pioneered an approach to turn wasted rooftop space into landscape, and re-think landscapes as something much more than for beauty alone. Chicago's roof garden focuses on urban cooling, reduction in stormwater runoff, water conservation, air quality, urban ecology/habitat AND aesthetic quality. The rooftop landscape allows staff, elected officials, developers and real estate investors the opportunity to see and understand the potential for living systems to provide a wide range of benefits for individual sites and the

# 20 Years

## HAPPY ANNIVERSARY

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City overall.

Data collected at City Hall over the years shows:

- that the rooftop temperatures in the summer are on average 30 degrees cooler than the standard roof and saves the city a substantial amount in energy costs;
- the plants utilize much of the rainwater that falls on the roof; and
- the green roof protects the waterproofing system and structural aspects from the elements and allows them to last much longer with less maintenance.

The project involved design, innovation and stewardship, incorporating features that are biophilic, biodiverse and beautiful. A wide range of habitat conditions were created by adding a relatively thin veneer of living components with lightweight material over an undulating surface newly created by infilling space between the discontinued skylight structures. The green roof is irrigated with a drip irrigation system using available rainfall, harvested from the upper-story mechanical room roof and stored in two 500-gallon cisterns.

While the establishment of a living ecology on top of City Hall was a key aspiration of the original design intent, it has only begun to be truly realized through an appropriately tailored long-term maintenance and management (stewardship) program. The annual maintenance is provided through an agreement with A Safe Haven (formerly the Chicago Christian Industrial League), which provides training in landscape maintenance for hard-to-employ individuals.

The rooftop landscape becomes healthier and more diverse with each season. As it has evolved, species diversity has approximately doubled, with new native/adapted species added throughout the year, while aggressive species and weeds are managed. In addition to nurturing songbirds and pollinators, thousands of residents and office workers in the 30 skyscrapers surrounding City Hall enjoy the garden's beauty year-round from their windows.

Countless people have seen and experienced Chicago's rooftop garden on City Hall. Many have been able to visit it in person, and virtually all are moved by the sounds, smells, sights, and other sensations of being immersed in a landscape that is truly alive, surrounded by a sea of skyscrapers. The roof is visibly changing almost weekly throughout the seasons, attracting wildlife of all kinds, in such an unexpected place on top of a building in downtown Chicago.

Chicago's City Hall rooftop garden is a highly recognized, beautiful, high performing urban living architecture space that continues to be enjoyed, studied and written about after nearly two decades. It remains a leading-edge example of an ecological system wholly integrated with building architecture withstanding the test of time.

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*David Yocca, FASLA, RLA, GRP, Senior Landscape Architect/Ecological Planner; Biohabitats and the Board Chair - Green Infrastructure Foundation (GIF). Michael Berkshire is the Green Projects Administrator for the City of Chicago. dyocca@biohabitats.com*



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# JOURNAL

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## OF LIVING ARCHITECTURE

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A GREEN INFRASTRUCTURE FOUNDATION PUBLICATION

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The Journal of Living Architecture (JLIV) is the official, peer-reviewed journal of the Green Infrastructure Foundation. The JLIV is written, reviewed, and edited by living architecture research professionals. The JLIV is published exclusively in the Living Architecture Monitor magazine and online at [livingarchitecturemonitor.com](http://livingarchitecturemonitor.com). The magazine publishes the abstracts of each published JLIV manuscript, with a link to the full paper online.

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Volume 6 Number 1 Pages 1-13

### MODULAR LIVING WALL: COLLABORATIVE, REGIONAL DESIGN ON AN URBAN CAMPUS IN TEXAS

Danelle Briscoel\*, Michelle Bright<sup>2\*</sup>,<sup>1</sup> Associate Professor, University of Texas at Austin School of Architecture  
<sup>2</sup> Capital Projects Manager, Waller Creek Conservancy (previously at the Lady Bird Johnson Wildflower Center)  
\*Corresponding Authors, [briscoed@utexas.edu](mailto:briscoed@utexas.edu) [mbright@wallercreek.org](mailto:mbright@wallercreek.org)

This paper discusses the design and installation of an extensive west facing living wall on the University of Texas at Austin campus. The pilot project illustrates the importance of bringing multiple expertise together to address challenges in urban design. In its hot and subtropical climate, this custom, prefabricated system holds 99 hexagonal cells that are alive with diverse regional plant species, and varied wildlife habitats. The design of the honeycomb system allows for an appropriate level of installation and fabrication efficiency, alongside its aesthetic provision. Every cell in the wall holds flora and fauna specificity with a geometric logic for self-shading the substrate volume. The appropriateness of the vegetation indicates that there are suites of native plant species, tolerant of higher temperatures and limited water availability, especially critical in the specific climate of this application. The project ultimately manifests a new approach to architectural design with a living wall system to integrate fauna with flora and utilizes nature's intelligent honeycomb patterning throughout its fabricated domain.

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Volume 6 Number 1 Pages 15-30

### THERMAL HEAT FLUX EVALUATION OF SLOPED GREEN ROOFS AND SHINGLE ROOFS

Serdar Celik<sup>1\*</sup>, Daniel Murphy<sup>2</sup>, Susan Morgan<sup>3</sup>, Bill Retzlaff<sup>4</sup>,<sup>1</sup> Associate Professor, Mechanical and Industrial Engineering, Southern Illinois University Edwardsville, <sup>2</sup> Graduate Student, Biological Sciences, Southern Illinois University Edwardsville, <sup>3</sup> Professor, Civil Engineering, Southern Illinois University Edwardsville, <sup>4</sup> Professor, Biological Sciences, Southern Illinois University Edwardsville, \*Corresponding Author, [scelik@siue.edu](mailto:scelik@siue.edu)

This study focused on the evaluation of a modular green roof system designed for residential roofs to determine its thermal performance. The green roof system was installed on roof models with three slope angles: 1°, 20° (5/12 pitch), and 40° (10/12 pitch). Differences in the average temperature of the undersides of the roof decks were compared between green roof models and shingle roof models at the three slope angles. Experimental data were collected for three summer months to compare the cooling load difference of both roof types at all slope angles. A case study was conducted on a residential single-story unit in St. Louis, Missouri. Results showed that a residential green roof system can yield significant energy savings in the summer season. Roof slope angle is also an important factor in heat gain of building envelopes due to its relationship with the sun's incident angle that affects the solar irradiation on the building.

Read more at [livingarchitecturemonitor.com](http://livingarchitecturemonitor.com)



EXPERIMENTAL GREEN ROOF SYSTEMS AT STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN NJ

## REGIONAL CENTERS OF LIVING ARCHITECTURE EXCELLENCE: PROFILE OF STEVENS INSTITUTE OF TECHNOLOGY LIVING LABORATORY

BY DR. ELIZABETH FASSMAN-BECK, STEVENS INSTITUTE OF TECHNOLOGY

The Living Laboratory is a stormwater green infrastructure (GI) research and demonstration site on the campus of Stevens Institute of Technology, in Hoboken, New Jersey and one of the four new Regional Centers of Living Architecture Excellence. With 47 individual GI systems custom-built from the ground up to measure real-world results, the Living Laboratory is dedicated to discovering solutions for local, and ultimately national stormwater issues.

The Living Laboratory was conceived to research hydrologic mitigation and water quality performance for GI technologies, to address runoff challenges on campus, to provide opportunities for education and public engagement, and to demonstrate Stevens' commitment to sustainable development. Across campus, the Living Laboratory currently consists of experimental green roof systems, four bioretention planters, and three rain gardens, all constructed since 2016.

The Living Laboratory's green roof research site consists of 40 custom tables on the roof of a 3-storey building. The site allows for concurrent testing of 19 green roof configurations in duplicated tables (for research quality assurance), plus two reference, "black" roofs. Beginning with substrates considered "typical" for extensive green roofs (non-proprietary blends comprised predominantly of light-weight aggregate and a small addition of organic matter), multiple combinations of baseline mixtures and amendments are currently under investigation.

Overall, the current objective of green roof research is to explore the influence of substrate composition on extensive green roof stormwater retention and water quality. With



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Photos courtesy E. Fassman-Beck

respect to water quality, the incoming rainfall is “clean,” but there is some concern that nutrients may discharge from green roofs at high concentrations.

The Living Laboratory team is testing the hypothesis that nutrient retention or release can be related to the engineered media’s laboratory-measured geochemistry. Ideally, the team will quantify the extent to which nutrients discharge from green roof substrates, while concurrently identifying physical and chemical characteristics of materials that prevent or minimize nutrient leaching.

Each experimental table features: ~10 ft<sup>2</sup> of 4” depth media over conventional green roof drainage layer, 4 sedum varieties, ~1ft<sup>2</sup> downstream PRB. Underflow discharge to covered gutter and captured in a covered bucket for sampling.

Introducing the next generation to GI Technologies and stormwater management is a key activity in the Living Laboratory. Beyond integrating research into undergraduate and graduate teaching at Stevens, a research grant from the National Science Foundation is bringing GI education and the Living

Laboratory into STEM programs in middle schools in New Jersey. Dr. Fassman-Beck and Dr. Gail Baxter, Director of Stevens’ Center for Innovation in Engineering Science and Education, are developing hands-on curricula for grade 6-8 science classes. Virtual tours of all the GI technologies in the Living Laboratory and Ask-an-Expert interviews aim to spark students’ awareness of, and interest in, careers across diverse disciplines engaged in GI. By preparing the teachers, the program offers potential to reach more than one thousand students in urban communities in the first two years.

The GI installations across Stevens’ campus are all relatively new facilities that aim to establish long-term performance data sets with statistically verifiable results.

*Dr. Elizabeth Fassman-Beck is an Associate Professor in the Department of Civil, Environmental and Ocean Engineering at Stevens Institute of Technology in Hoboken, NJ. [efassman@stevens.edu](mailto:efassman@stevens.edu) Join us June 5 and tour the Living Laboratory at Stevens. [www.greenroofs.org/events](http://www.greenroofs.org/events)*

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# BIOPHILIC HYATT REGENCY SPINOZA HOTEL AMSTERDAM – THE MOST SUSTAINABLE HOTEL IN THE NETHERLANDS

BY RIANNE SLOOTWEG, SEMPERGREEN

The award-winning Hyatt Regency Spinoza hotel in the heart of Amsterdam is a model of sustainable building. This luxurious 5-star hotel of 183,000 s.f. with 211 rooms was built on the site of the former Emma Children's Hospital. From the first stone, a classy and sustainable hotel was built. These tremendous efforts have been rewarded with a BREEAM-NL Excellent certificate. Hyatt Regency Amsterdam achieved a score of 73.26 per cent, the highest score ever awarded to a Dutch hotel, making it the most sustainable hotel in the Netherlands.

The new building, opened in 2017, contains all the amenities that can be expected from an international 5-star hotel such as a conference center, bars, a restaurant with green terraces, accessible spa and fitness facilities and underground parking. But the most striking feature is the indoor living wall in the lobby. Architects Van Dongen-Koschuch reached out to Sempergreen to create a full concept biophilic design in cooperation with landscape architect Max Tavenier. The indoor living wall is a hydroponic system which creates a connection between several spaces, which encourages



HYATT REGENCY SPINOZA  
- GREENEST HOTEL IN THE  
NETHERLANDS FEATURES  
GREEN ROOFS AND WALLS -  
INSIDE AND OUT

NORTH FACING GREEN  
WALL MAKES USE OF  
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interaction between hotel guests and local public. The spaces each have their own identity that fits within the larger whole.

For the lobby, the client expressed the wish that the room should feel like a living room. That's why *Fatsia Japonica* was chosen for the plants. This plant contributes to the lush, exotic atmosphere and forms an integral whole with the other interior plants and the patio. It gives visitors the feeling of entering an urban oasis. Next to the eye-catching living wall the patio was equipped with hanging plants in pots. The green decoration with many plants, flowers and botanical artwork is inspired by the location of the hotel: near Hortus Botanicus Amsterdam, one of the oldest botanic gardens in the world.

In front of the hotel, a number of trees had to be removed and were compensated by order of the municipality. This compensation was realized in the form of an outdoor green wall as well as a green roof on top of the hotel. In the composition of the plants of the outdoor living wall, the unique location and the climatic circumstances of the façade were taken into account. The green wall is oriented to the north, so the landscape architect selected

**"THE INDOOR LIVING WALL IS A HYDROPONIC SYSTEM WHICH CREATES A CONNECTION BETWEEN SEVERAL SPACES, WHICH ENCOURAGES INTERACTION BETWEEN HOTEL GUESTS AND LOCAL PUBLIC."**

- RIANNE SLOOTWEG



**"THIS PLANT CONTRIBUTES TO THE LUSH, EXOTIC ATMOSPHERE AND FORMS AN INTEGRAL WHOLE WITH THE OTHER INTERIOR PLANTS AND THE PATIO. IT GIVES VISITORS THE FEELING OF ENTERING AN URBAN OASIS."**

**- RIANNE SLOOTWEG**

100 per cent evergreen plants, without any flowering plants. By applying different leaf textures and leaf colors, a vivid spectacle is created that fits well within the lively streets of Amsterdam.

The maintenance of the green walls is performed by Sempergreen. Both indoor and outdoor living walls are equipped with a unique Plant Care System. Thanks to the sensors that have been installed in the façade systems, the administration of water and nutrients is monitored 24/7 via the internet. Settings can be changed remotely. This technique has the advantage of carrying out maintenance more effectively and efficiently. The green walls are visited six to eight times a year by the maintenance team for adding of nutrients and inspection of the plants. Twice a year the outdoor living wall is pruned in both spring and fall. In this way the owner is completely unburdened by maintenance and water consumption is reduced to a minimum amount.

The main challenge in shaping the new hotel was finding an idiom that does justice to the history and layering of this complex location. In an architectural sense, this is achieved by preserving the three historic façades and by transforming each one in a unique way and incorporating it into the new structure of the hotel. Already during the planning of the construction of the hotel, sustainability was the starting point of each decision in the development of a building. Examples are the heat and cold storage and the indoor vertical garden that runs right through the lobby. The outer façade also features a beautiful outdoor green wall and with the installation of a green roof the Hyatt has made a conscious choice to save as much energy as possible. These and many other measures resulted in 40 per cent less energy consumption and CO<sup>2</sup> emissions than a comparable building.

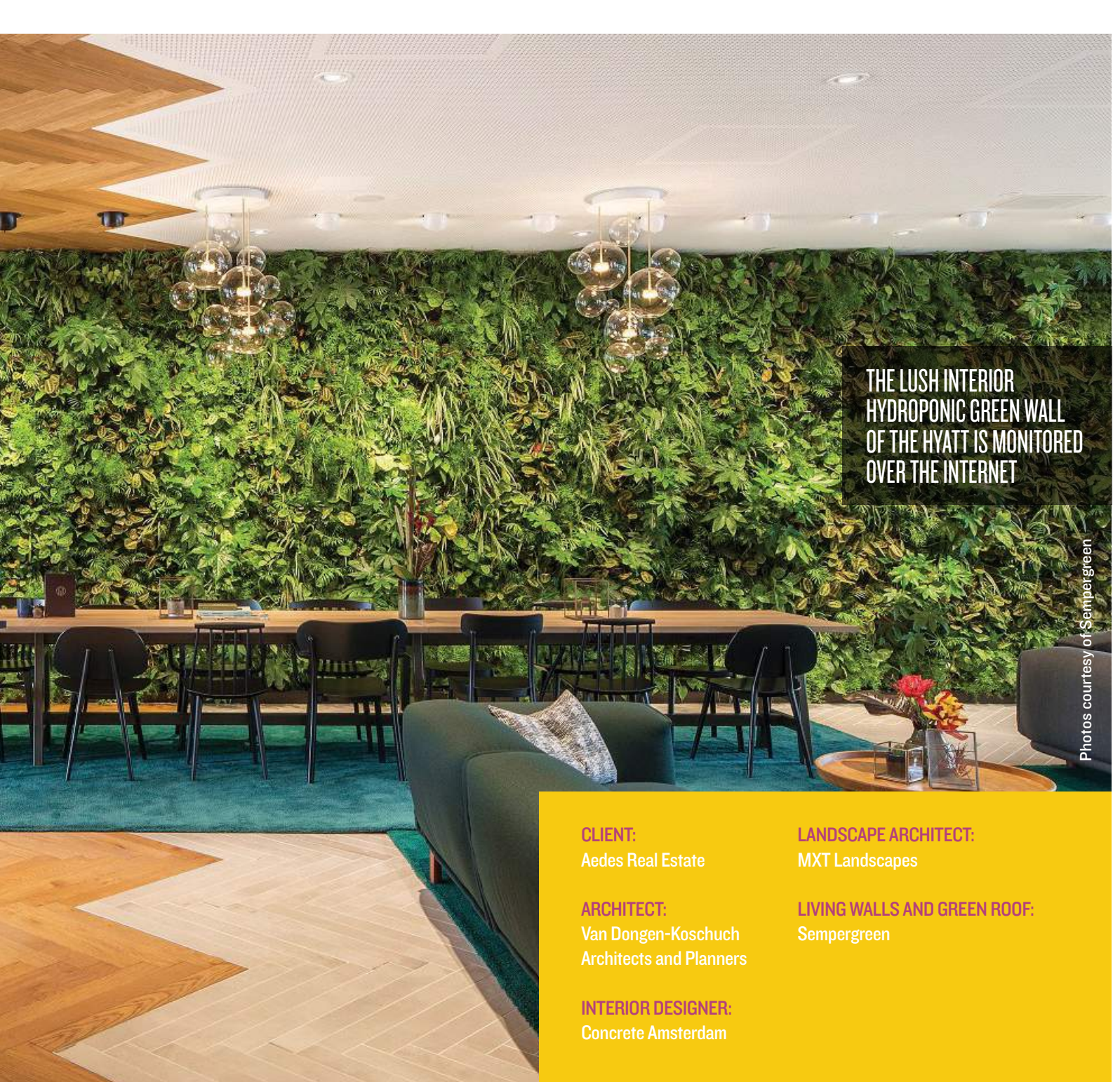
As is the case for every hotel, safety measures were essential in this project, especially fire safety. The indoor and outdoor vertical



gardens have been tested and certified for fire safety in the highest European class and can therefore even be used in escape routes.

Together, all green applications resulted in Sempergreen winning an award for 'Best interior landscaping of the year 2018'. Last but not least, Hyatt Regency Amsterdam has been nominated for an Entrance Award within the 'Best Hotel Design' category, the leading Hotel Awards in the Netherlands.

*Rianne Slootweg is the Marketing Manager for Sempergreen, an international green roof and wall company.  
Rianne.slootweg@sempergreen.com*



THE LUSH INTERIOR  
HYDROPONIC GREEN WALL  
OF THE HYATT IS MONITORED  
OVER THE INTERNET

Photos courtesy of Sempergreen

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## FORD'S DEARBORN TRUCK PLANT LIVING ROOF: DRIVING THE U.S. GREEN ROOF INDUSTRY FORWARD

BY DR. CLAYTON RUGH, DIRECTOR, XEROFLOR NORTH AMERICA

Nearly 20 years ago, William McDonough (founder WM+P) insinuated himself into a meeting with William Clay Ford Jr. at the Ford Motor Company world headquarters in Dearborn MI. Initially informed that Mr. Ford could spare fifteen minutes, Mr. McDonough's vision for renovation of the Rouge Manufacturing Complex was sufficiently compelling that Mr. Ford cancelled the day's meetings, ultimately collaborating for a sustainable overhaul of the Historic Rouge property's continued operation and new construction.

Chief among Mr. McDonough's proposed sustainable design elements was a vast living roof to cover a new vehicle assembly plant. Living or vegetated "green" roofs were virtually unknown in North America with few examples: Chicago City Hall and GAP HQ in San Bruno CA (both designed by WM+P), so its consideration was quite a leap for Mr. Ford. Moreover, early North American green roof designs were much heavier than the limited load bearing capacity of the proposed vehicle assembly plant, necessitating a lighter green roofing option. Early trials evaluated a novel modular tray system alongside established European approaches with lightweight mineral-based media and drought tolerant Sedum species. Among these trials, the XeroFlor pre-grown vegetation blanket system distinguished itself as a proven and lightweight "instant green" approach, while offering logistical management advantages and greatly reduced maintenance requirements compared to other tested systems.

Wolfgang Behrens, XeroFlor creator and owner, contributed decades of global green roof experience to the Ford, WM+P, and Michigan State University development team. Early tests conducted in Michigan and Georgia showed the XeroFlor system to be easy to grow, handle and install; though of even greater importance for long-term performance and maintenance was its inherent resistance to weed infestations due to its ultra-thin profile and

pre-established vegetated coverage. The project team unanimously agreed the 10 lb/sf saturated weight XeroFlor assembly to be the ideal horticultural and logistical solution for the Rouge Complex's Dearborn Truck Plant green roof.

The XeroFlor vegetation mats were grown five miles from the Rouge facility on nearby Ford property, greatly reducing shipping costs and vehicle emissions for delivery to the Assembly Plant for installation. Field cultivation was initiated May 2002, harvest and installation began mid-September 2002, with completion of the 454,000 sf green roof by early November 2002. Final detailing with growth media top-dressing and border edging securement was completed in April 2003. The XeroFlor system matured very rapidly achieving full coverage the summer of 2003. A commercial-grade irrigation system was installed as an "insurance policy" for this highly visible project. Irrigation support was run 2-3 times per week during the initial 2003 growing season, 2-3 times per month during summer 2004, and never thereafter, relying only on rainfall. The Assembly Plant green roof continues to be inspected three times per growing season with annual spring-time application of slow-release fertilizer. Inspections confirm full coverage with diverse Sedum and succulent communities and total absence of weeds, consequently requiring absolutely no weed removal effort or expense.

XeroFlor partnered with Michigan State University in 2009 and 2010 to survey the Truck Plant green roof for surviving species from the original plant mix and overall seasonal vegetated coverage. These surveys found thirteen of the original fifteen plant varieties still present in the vegetated mix. More detailed analysis showed

dynamic coverage and biomass succession among the individual plant varieties throughout the growing season. Overall vegetated coverage was observed to be approximately 95 per cent of the total green roof area demonstrating the lightweight XeroFlor system continues to thrive nearly two decades after installation. Analysis of cut-samples from exposed and protected membranes demonstrated the Ford green roof protects the roof membrane with no apparent aging deterioration compared to preserved reference samples, unlike exposed membrane samples that displayed expected aging effects. Additional peer-reviewed published research showed the Ford green roof removes large volumes of atmospheric CO2 and serves as an urban oasis for migrating birds and pollinating insects.

An early example of commercial-scale green roofing in North America, the Dearborn Truck Plant green roof is literally a text book lesson for sustainable architectural design and modern construction curricula. While serving as an important academic and industrial guidepost, the Rouge Complex green roof also achieved recognition with GRHC Award of Excellence and entry in the 2004 Guinness Book of World Records as the "Largest Living Roof". In addition to these notable accomplishments, Ford's green roof continues to inform and inspire more than 150,000 yearly visitors overlooking its 10.4 acre expanse from the Visitor's Center observation deck of the Ford Factory Tour.

*Clayton Rugh, PhD, is a Director for XeroFlor North America and an early pioneer in the development of the green roof industry in North America. [clayton@xeroflora.com](mailto:clayton@xeroflora.com)*

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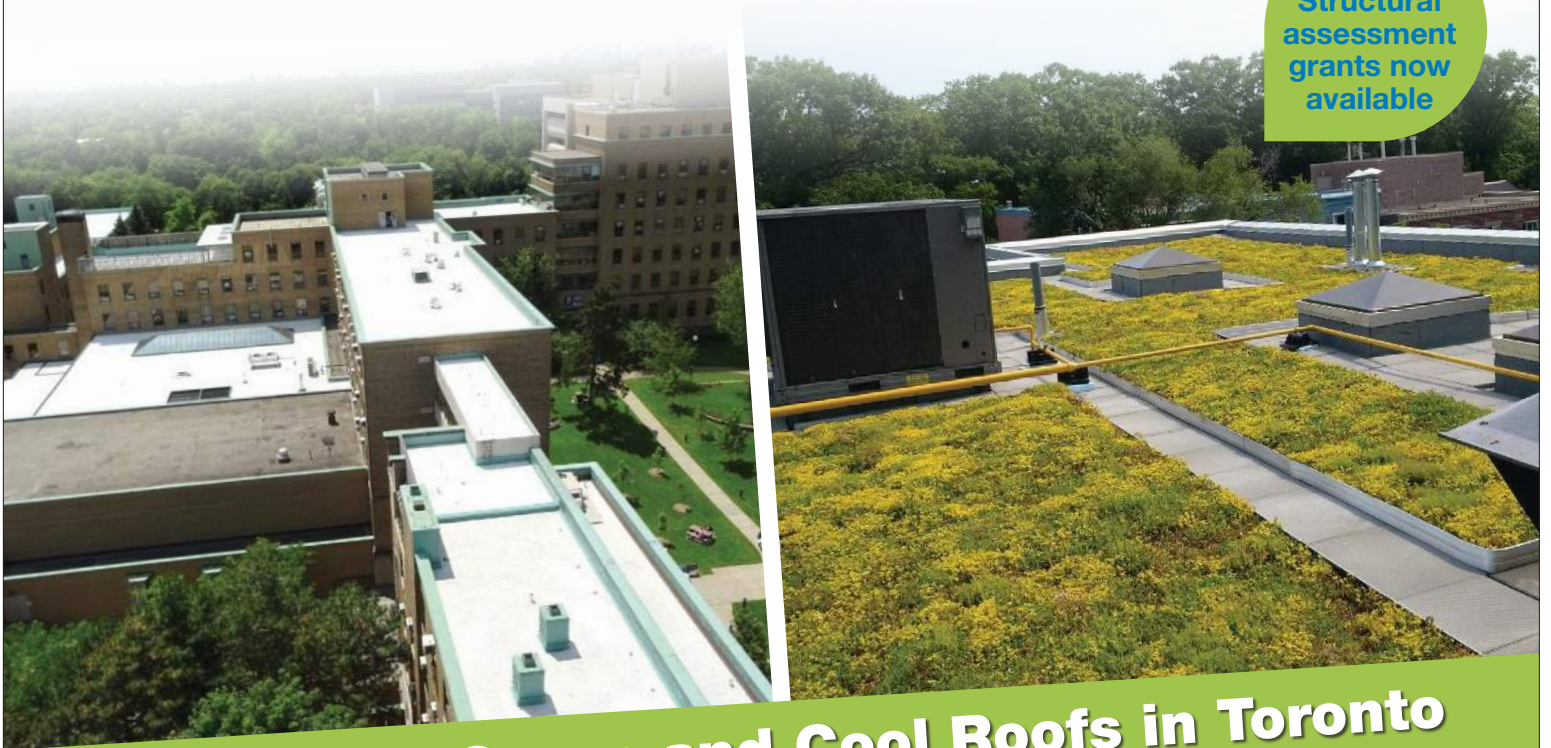
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# REFLECTIONS ON THE DEVELOPMENT OF THE INDUSTRY

BY ED SNODGRASS, OWNER AND PRESIDENT, EMORY KNOLL FARMS AND GREEN ROOF PLANTS

**T**wenty years ago, the North American green roof industry was just beginning!

In 1998, I started a nursery in Maryland, the first in North America focused solely on horticulture of green roof plants. Within the next year, Green Roofs for Healthy Cities (GRHC) published its first issue of the Living Architecture Monitor (LAM). Little did I imagine that within the following two decades, I would be involved in over 2000 green roofs, six books, and would be consulting on projects in Europe, China, Morocco, Mexico, Ecuador, New Zealand, and Australia. In that same timespan, GRHC has been instrumental in educating and informing the green roof market and advocating for supportive policy, in the US, Canada and worldwide through the World Green Infrastructure Network.

By the late 1990s, Germany had a considerable history of green roofs, so a selection of proven plants for that region of the world already existed. This list was comprised primarily of hardy succulents, most of which were in the genus *Sedum*. Soon they became the work-horses in the burgeoning North American market, as well. But the multitude of climates within North America made it necessary to investigate new horticultural possibilities.

As our market matured, green roof stakeholders, such as designers and building owners, began asking more from green roof horticulture. Terms such as “ecosystem services” and “pollinator-friendly” started to enter the green roof lexicon. The dependable *Sedum* provided nectar and pollen, but, the desire for expanded performance begged for an expanded plant palette. In response to that demand, I collaborated with horticulturists and universities to test over 3000 varieties of plants, for possible green roof applications. The results were published in my 2006

book, “Green Roof Plants”. We continue research, to this day, to improve plant choices for long term success. What do we need going forward?

In the face of market pressure for a “one-size-fits-all” mentality, much work is needed. We should reaffirm that green roofs are living systems, ever-adapting to new environmental pressures. Participation in, and encouragement of, solid, regional university research will be invaluable (See Brad Rowe’s article). It should be promoted throughout the industry, with collaboration among designers, horticulturists, and local governments. Long term plant trials, focused on survivability, and biological compatibility for insects and plant communities, are needed to connect ground plane landscapes with green roofs. Dedication, at the design level, to providing clear goals of the roof, will help ensure that appropriate plants are specified accordingly. Plant choices need to integrate climate differences with design intent. Providing strong horticultural knowledge and skills, to our installation and maintenance labor forces, will help to deliver promised benefits. Green roofs reach their maximum potential when they fully aggregate their ecosystem services - the ultimate goal, for long term success.

I am very proud to be a part of the first 20 years of the green roof industry in North America. The next 20 should bring exciting innovation, and a renewed commitment to successful horticulture on roofs. Our industry can, and should, aim to be a much-needed leader for facing the complicated challenges within our changing environment.

---

*Edmund Snodgrass is the Owner and President of Emory Knoll Farms, Inc. and Green Roof Plants. [greenroofplants.com](http://greenroofplants.com)*



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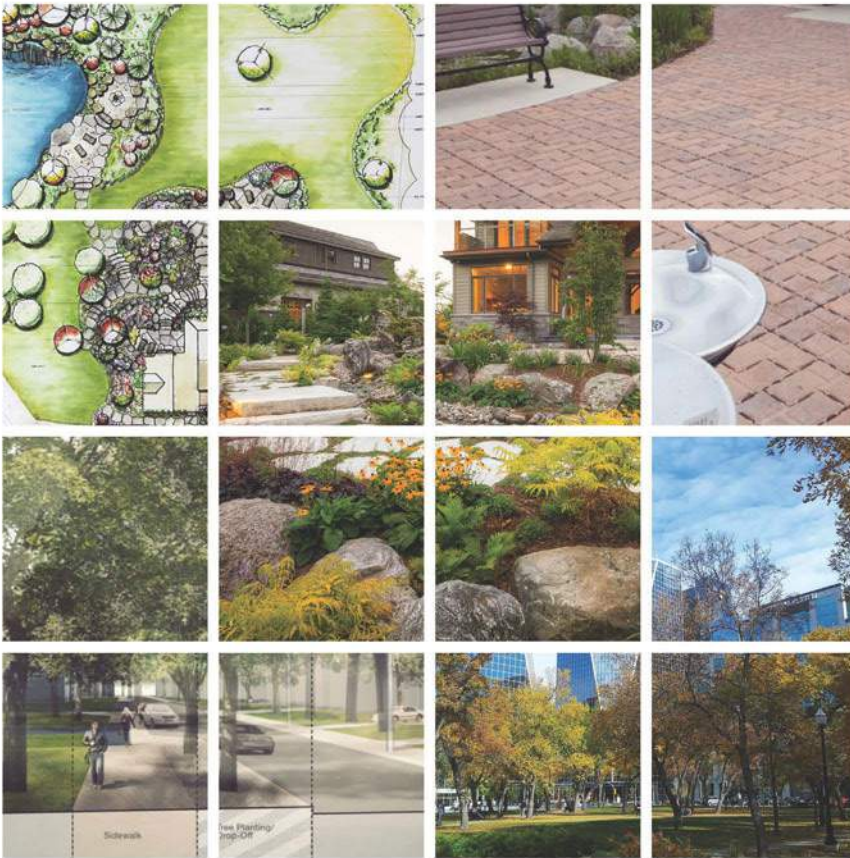


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