LIVING ARCHITECTURE MONITOR®

A GREEN ROOFS FOR HEALTHY CITIES PUBLICATION

VOLUME 18 / ISSUE 1 / SPRING 2016

THE STORMWATER ISSUE

- ON THE ROOF WITH... FOUR EXPERTS ON STORMWATER RETENTION BENEFITS
- THE DIFFERENT ROLES OF PLANTS IN MANAGING STORMWATER
- TOWARDS GREATER LANDSCAPE PERFORMANCE: BARBARA DEUTSCH AND THE COAST GUARD NATIONAL HEADQUARTERS
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VOLUME 18
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INSIDE

LIVING ARCHITECTURE MONITOR®

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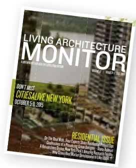

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Correction: *Photos provided for the Winter 2015 issue's "Confessions of a Green Scientist" were provided by Roofmeadow Inc. Photos provided for Krishna P. Singh Center for Nanotechnology Design Award are credited to Peg Woolsey.*

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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STORMWATER FUELS INDUSTRY GROWTH - AND THE PROMISE OF GREATER CLIMATE RESILIENCY

It is well known that green roofs provide a wide range of benefits, such as stormwater retention. In many parts of the country, the regulation of stormwater runoff is currently driving the development of green roofs. There is no coincidence in the fact that the top five markets for green roofs have implemented stormwater driven incentives and/or regulations. Our 2015 corporate member survey found that stormwater is the number one driver of green roof implementation, followed by energy savings, property value increases and water quality improvements.

This is not surprising, given that stormwater is a big challenge - a very big challenge. It is estimated that each year, more than 10 trillion gallons of stormwater runs off into our rivers, lakes and estuaries. And it is not pretty! Along the way it picks up a wide range of sediments, toxic substances and pathogens from lawns, construction sites, parking lots, roads and even traditional rooftops, often combining in older cities, with sanitary sewage. This toxic brew causes severe erosion, beach closures, threatens aquatic food production, undermines ecosystem health and may even threaten the integrity of water supplies.

If that's not bad enough, stormwater increasingly packs a double punch, because the severity of storm events is increasing - the one in a hundred year storm is becoming the one in ten year storm. Of course when this happens, old grey infrastructure can't handle the high volume of water, resulting in massive flooding, road and bridge collapse, with corresponding property damages running into the billions of dollars per year.

Many jurisdictions are grappling with these challenges with a wide range of incentives and regulatory tools to better manage storm water. Washington DC is undoubtedly one of the leaders introducing tradeable stormwater credits. (See article by Dr. Hamid Karimi) Providing monetary values for stormwater runoff is a very important first step in recognizing the important services that green infrastructure provides and in creating financial incentives for implementation. The costs of stormwater best management practices (bmps) however, vary significantly. In many cities, some bmps, such as bioswales, utilize too much space or are too costly due to high property values. More innovative practices in stormwater design and cost-benefit analysis can lead to self-financing green roofs, as is profiled in our Seattle case study.

In addition to monetizing stormwater, another needed step is for policy makers to recognize the link between stormwater management and the urban heat island effect. Cities worldwide are getting steadily hotter, and electricity use is rising as a result. Green roofs and walls have the capacity to address these twin challenges – by managing stormwater and reducing the urban heat island.

Stormwater needs to be recognized as a resource, as the fuel for green infrastructure to be captured, stored and used by green roofs, walls, urban forests and other forms of green infrastructure to cool cities through evapotranspiration. This is transformational thinking. We can design green roofs to maximize retention and evapotranspiration. Read the insights from experts in our On the Roofs With feature and Dr. Brad Rowe's article about plants and stormwater.

Transformational thinking can lead to more integrative policy. If we combine the regulatory power of energy and water utilities with that of governments, we could strengthen green infrastructure implementation with more incentives, and improve the climate resiliency of our cities. We are moving in this direction, but need to accelerate the pace of change to prepare for the inevitable challenges of extreme weather which lie just upon the horizon.

Sincerely,

Steven W. Peck, GRP
Founder & President, GRHC

Please join us at Grey to Green June 1-4, 2016 in Toronto, Canada as we explore how green infrastructure addresses the challenges of climate change. Visit greytogreenconference.org

LIVING ARCHITECTURE DOCTOR

Many green roofs and walls suffer from design and maintenance issues, creating an emerging market for diagnosis and treatment. The Living Architecture Doctor is a new feature that challenges you to figure out what went wrong and how to fix it. Test your skills – tell us what went wrong on this green roof. Diagnose the problem by emailing editor@greenroofs.org. Your response could be featured in the next issue of the Living Architecture Monitor magazine.

Image left: This extensive green roof in downtown Toronto was originally planted with just lilies but is now home to more than 60 species.

YOUR TREATMENT LAST ISSUE:

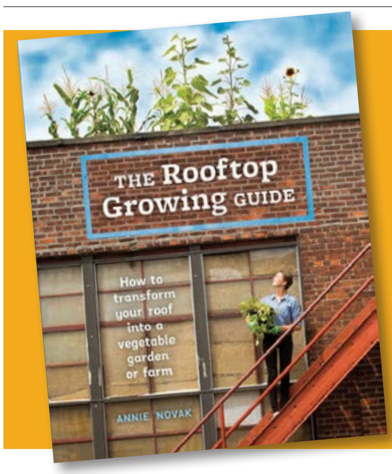
"This problem is a nutrient or water uptake problem. It has something to do with too low ph."

Kees Ammeraan

ACTUAL TREATMENT

"Lack of light, moisture or nutrients likely lead to loss of this species. A hardier species should be used."

GRHC



BOOK REVIEW: "THE ROOFTOP GROWING GUIDE" BY ANNIE NOVAK

In this how-to guide for aspiring rooftop farmers, Eagle Street Rooftop Farm co-founder and head farmer Annie Novak draws on her experiences on New York City roofs, as well as interviews and profiles of leaders in this emerging field to describe challenges and solutions unique to rooftop agriculture.

The book presents practical information on green roofs, container gardening, hydroponics, greenhouse growing, crop planning, pest management, harvesting tips, and more. Beautiful photos and illustrations make this a great resource for anyone looking to realize the agricultural potential of underutilized roof space. Ten Speed Press, Berkely, 2016.

For questions about joining the editorial review board, submitting manuscripts or policies and procedures, contact Dr. Reid Coffman at rcoffma4@kent.edu or Dr. David Tilley at dtilley@umd.edu.

JOURNAL

OF LIVING ARCHITECTURE - VOL. 4, ISSUE 1

The Journal of Living Architecture (JOLA) is the official, peer-reviewed journal of Green Roofs for Healthy Cities. The JOLA is written, reviewed, and edited by living architecture research professionals, sharing with their colleagues: successful educational applications, original research findings, scholarly opinions, educational resources and challenges on issues of critical importance to living architecture professionals and educators. The JOLA is published exclusively on the *Living Architecture Monitor* magazine website. The magazine publishes the abstracts of each published JOLA manuscript, with a link to the full paper online.

FEATURE

Controlling ivy attachment to wall surfaces by applying paints, metal meshes and sheets, Faye Thomsit-Ireland, Tijana Blanuša, Emmanuel Essah, Paul Hadley

Growing ivy around buildings has benefits. However, ivy potentially damages buildings which limit its use. Options for preventing ivy attachment were investigated to provide ivy management alternatives. Indoor and outdoor experiments were conducted, where metals (Cu, Zn) and anti-graffiti paints were applied to model wall panels. Metal treatments, in both indoor and outdoor experiments, fully prevented ivy attachment. For Hedera helix, silane-based anti-graffiti paint prevented attachment in the laboratory and required under half the peak detachment force necessary to detach the control in the outdoor experiment. In conclusion, metals and silane-based paint are management possibilities for ivy attachment around buildings.

Read the entire paper here: *http://goo.gl/oePdvR*

CALL FOR SUBMITTALS

Kinetic Living Architecture

This is a call requesting manuscript submittals for a special topic issue discussing mobile, movable and kinetic forms of living architecture. This themed issue will profile the current state of projects, describe research findings, and deliver commentary to advance our understanding of living architecture that possesses movable traits or specific kinetic characteristics for green roofs, biofilters, screens, and walls. All submittal and dissemination will proceed within the Journal of Living Architecture's current, peerreviewed, open access format.

Submission Categories:

- Commentary articles challenge or present an opinion on an issue of concern to the living architecture industry, or discuss a manuscript previously published in the JOLA. [1500-2500 words]
- Ideas at Work describe novel ideas, innovative programs and new methods of interest to professionals. [1500-2500 words]
- Tools of the Trade report on specific materials, books, techniques and technologies useful to professionals. [1500-2500 words]
- Research in Brief manuscripts summarize research results of importance to living architecture professionals. The focus of a Research in Brief manuscript is more specific than a Feature. [1500-2500 words]
- Feature manuscripts discuss concepts and research findings of particular significance to living architecture professionals and to the living architecture knowledge base, methodology, practice and organization.
- Visuals drawings, maps or graphic communication.

Manuscripts due: June 1, 2016
Visit livingarchitecturemonitor.com/index/php/journal/submit for details.

Photo Courtesy

IN SEARCH OF GREATER STORMWATER MANAGEMENT

EXPERTS SHARE THEIR INSIGHTS ON PRODUCTS & DESIGNS

There are many options available to designers to maximize stormwater management on green roofs through design practice and the use of new technologies. We asked the following experts to share their views on the topic: Lee Jaslow (LJ) is the President of Conservation Technology. Gaelle Wormus, (GW) P.E., is the Chief Product Officer of Vegetal i.D., Charlie Miller,(CM) P.E., is the President of Roofmeadow and Alex Drescher, (AD) is the Roof Garden Product Manager at Carlisle.

LAM: Stormwater retention is a recognized benefit of green roofs, but not all systems perform the same way. What do you typically do to maximize this benefit for your green roof projects?

LJ: Beyond the obvious approach of increasing the media depth, it depends on which system we use. In our Drainage Plate System, we can substitute a taller waffled drainage plate with deeper water storage cups. In our Drainage Media System we can substitute thicker geotextile mats with enhanced water retention and capillarity, or we can add ponding membranes and special drains to create flooded systems that can store most of the annual rainfall, essentially turning the green roof into a giant self-watering planter.

GW: A normal green roof, when reaching its saturation, cannot hold more water during a rain event. If, before it starts raining, the green roof is wet, its capacity to absorb more water will be limited, which is often the condition in the spring. Civil engineers need a reliable green infrastructure technology with stable performance for any season of the year. Vegetal I.D. has developed a technology that incorporates green infrastructure benefits and grey infrastructure reliability and predictable elements. When the vegetated layer is full of water, a sub water reserve will start filling up, releasing water at a constant and very slow rate to be able to handle a lot of volume. Flushing of this reserve is activated before a rain event to make space if it is already filled. This smart green technology increases stormwater performance significantly for a low profile and light green roof.

CM: Stormwater retention in

green roofs is achieved via evaporation and plant transpiration, only. Therefore, successful designs require optimization of moisture uptake by plants. To accomplish this goal: coordinate plant selection and the roof profile to foster root development in the zone where moisture will persist for the longest time; slow the horizontal flow of seepage toward the roof drains, prolonging contact with roots; maintain plant vigor, so that plants are primed to absorb, use and transpire moisture. 'Pump priming' in green roofs is accomplished by low-rate supplemental irrigation, strategic fertilization, and by promoting soil biology; focus on plant communities that have a high transpiration potential.

AD: One of the primary benefits of a properly designed Carlisle Roof Garden is that it can capture a large percentage of rainfall and delays runoff from the roof. Studies have shown a 4 inch extensive sedum roof is able to capture 60 -75 per cent of annual rainfall in temperate climates. In Carlisle's layered systems, both the growth media and the moisture retention layer are designed to capture stormwater before it becomes runoff. Carlisle's strategic partnership with Columbia Green Technologies offers a tray system that features ridges and troughs which capture and slowly release peak stormwater flows via a specific pattern of small drain orifices.

LAM: How do you measure, or predict, the stormwater retention performance of your green roof projects?

LJ: Our systems are inspired by German practice, so we start with what the Germans have learned from more than a quarter century of continuous monitoring. The problem is that the ability of a green roof to capture and retain rainwater at any given time is affected by the weather in the preceding days, so once a green roof system is saturated, it will not retain additional rainwater until drainage and evapotranspiration restore some of that capacity. Rainfall in North America tends to be much less evenly distributed than in Germany, which is problematic if stormwater management is a key factor in installing a green roof. Fortunately, we understand enough about the behavior of all of the components in green roofs that we have a good idea of the likely results. If we need to guarantee performance, we rely on flooding systems with delayed release so we can accurately calculate retention.

GW: We have partnerships with universities that have collected enormous amounts of data and have developed a model to predict stormwater performance for our Hydropack and Hydroventiv systems. This helps us calibrate the technology for a given city. As the rain events are harder to predict due to climate change, and because performance of a living technology evolves over time, we also provide a real-time monitoring system, accessible on a dashboard. This tool is connected to sensors on the roof to manage maintenance and to insure that the technology is performing as designed originally.

CM: Quantifying potential water loss due to evapotranspiration (AKA retention) can only be achieved by conducting long-term modeling based on actual rainfall distributions and climate data. We conduct modeling using 10 or 20 year rainfall records. Testing or monitoring data for green roof profiles is required as a starting point. Consideration of single-event design storms cannot provide useful information about stormwater retention performance. Seasonally adjusted estimates of retention can be obtained using field-verified algorithms that take into account potential evapotranspiration, moisture distribution in the green roof profile, and patterns of seepage flow. In its simplest form, this approach can be implemented with a spreadsheet.

AD: Jurisdictions tend to look at either the total pore volume or the maximum water-holding

THE EXPERTS

Lee Jaslow is President and Chief Engineer of Conservation Technology, a provider of green roof systems and components for more than 30 years. While studying to become a mathematician and theoretical physicist, Lee's travels exposed him to global environmental issues that seemed far more important than the career path he had envisioned. He created Conservation Technology as a vehicle to bring the best technology for green building and environmental resource management to the North American market.

French born, Gaelle Wormus is an Architectural Engineer with Vegetal i.D. She has been working with green roofs since 2010. Passionate and technically oriented, Gaelle has contributed R&D to improving Vegetal i.D.'s various technologies over the years.

Charlie Miller has 35 years of experience in projects related to hydrogeology and environmental engineering. He is the Founder and President of Roofscapes, Inc. ne Roofmeadow, which has been designing green roofs since 1997. Prior to Roofmeadow, his engineering work focused on waste management, groundwater contamination abatement and urban stormwater management projects.

Alex Drescher is the Roof Garden Product Manager for Carlisle SynTec Systems in Carlisle, Pennsylvania.

COLUMBIA GREEN TECHNOLOGIES DEVELOPED A MODELING HYDROGRAPH TOOL THAT ALLOWS US TO DO SITE-SPECIFIC ANALYSES OF STORMWATER BEHAVIOR IN OUR TRAY SYSTEMS. BY ENTERING A FEW SIMPLE VARIABLES, THE TOOL PROVIDES A MODEL THAT CALCULATES THE SYSTEM'S STORMWATER RETENTION OVER A PERIOD OF TIME.

capacity percentage of the growth media and water retention/drainage layers utilized in the green roof system. All of Carlisle's Roof Garden components are specially formulated to maximize water retention while supporting plant health. In-depth analysis and testing of our Roof Garden products, using ASTM standards, gives us the ability to accurately measure the performance of these systems, as well as predict performance on future projects.

LAM: Please describe any new developments in products or design practices related to stormwater management in green roofs!

LJ: In addition to supplying systems and components for green roofs, we have been a major supplier to the rainwater harvesting industry and are integrating those technologies into our green roof projects; for example using cisterns to capture runoff for irrigation during drier periods. Our newest product, the X-Box, is a modular plastic structure that creates a continuous water storage and drainage cavity under greenroofs, pavers, planters, and other elements of rooftop landscapes creating a "blue/green" roof that can store, release, or reuse nearly 100 per cent of the annual rainfall at a lower cost than typical cisterns.

GW: The latest innovation in green roofs is Hydroventiv, developed in Europe. While it is hard to predict performance of a living technology, combining it with a "grey" technology and a smart connection makes it reliable, easy to control and a great tool for engineers to use in their stormwater designs. This technology is unique and the first connected smart green roof in the market. It has won many innovation awards across the world and is the next generation of green infrastructure to come.

CM: Improvements in green roof design will arise from more informed use of familiar materials and basic design tools. The most significant recent advance in design practice has been the thoughtful combination of "blue" and "green" measures. With this strategy, rainfall is either: detained in shallow pools and allowed to slowly discharge into a receiving green roof, or percolated rainfall fills the basal zone of the green roof for subsequent uptake by plants. This delays and attenuates runoff rates, maximizes evapotranspiration losses, and provides biofiltration. The approach can be used with extensive green roofs. Moreover, it enables beautiful landscapes for amenity spaces.

AD: Carlisle's strategic partnership with Columbia Green Technologies allows us to provide stormwater calculators for each major municipality. Columbia Green Technologies developed a modeling hydrograph tool that allows us to do site-specific analyses of stormwater behavior in our tray systems. By entering a few simple variables, the tool provides a model that calculates the system's stormwater retention over a period of time. In addition to providing measured, site-specific stormwater retention information for a project, this tool provides essential support to decision-makers who may struggle with the economic justification of installing a Roof Garden.

STORMWATER MANAGEMENT & GREEN ROOFS - BY THE NUMBERS

Estimated number of gallons per year of untreated stormwater that runs off US roofs, roads, parking lots, and other paved surfaces, often through the sewage systems, into rivers and waterways that serve as drinking water supplies and flow to beaches:
10 trillion

Estimated number of US cities where stormwater combines with wastewater into a single piping system – a combined sewer system that overflows raw sewage during rainstorms:
+700

Number of cities, towns and utility districts in the U.S. that use parcel-based stormwater fees based entirely or in part on the impervious area of property:
400

Number of communities facing *Clean Water Act* obligations to reduce combined sewer overflows:
800

Number of acres of impervious surface in Philadelphia targeted for managing the first inch of stormwater under the Green City, Clean City Waters program:
10,000
over 25 years.

Estimated cost of fixing aging stormwater and combined sewers and expand existing systems in the US:
$100 billion
over 20 years.

Estimated design and installation costs per square foot to manage first inch of water with a rain garden in Philadelphia:
$1.42 – 1.45,
for porous pavement:
$2.10 - $20.96

Estimated design and installation cost per square foot to manage first inch of water with an green roof (including waterproofing) in Philadelphia:
$31.43

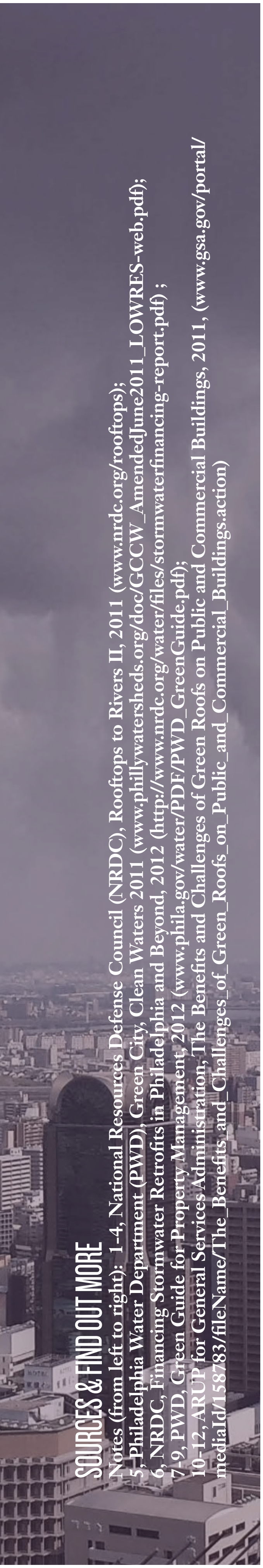
Annual savings on stormwater fees in Philadelphia by capturing first inch of water on one acre of impervious area:
$4,350

Estimated US national average incremental cost increase (not including waterproofing) of a 5,000 square foot extensive green roof:
$12.60

Average payback period for a 5,000 square foot extensive green roof, based on average energy savings, stormwater savings and deferred replacement costs:
6.4 years

The net present value per square foot of community benefits, such as air quality improvements and urban heat island mitigation from an extensive green roof over a 50 year period:
$38

Photo Courtesy Steven Peck



SOURCES & FIND OUT MORE

Notes (from left to right): 1-4, National Resources Defense Council (NRDC), Rooftops to Rivers II, 2011 (www.nrdc.org/rooftops);
5-Philadelphia Water Department (PWD), Green City, Clean Waters 2011 (www.phillywatersheds.org/doc/GCCW_AmendedJune2011_LOWRES-web.pdf);
6, NRDC, Financing Stormwater Retrofits in Philadelphia and Beyond, 2012 (http://www.nrdc.org/water/files/stormwaterfinancing-report.pdf) ;
7-9, PWD, Green Guide for Property Management, 2012 (www.phila.gov/water/PDF/PWD_GreenGuide.pdf);
10-12, ARUP for General Services Administration, The Benefits and Challenges of Green Roofs on Public and Commercial Buildings, 2011, (www.gsa.gov/portal/mediaId/158783/fileName/The_Benefits_and_Challenges_of_Green_Roofs_on_Public_and_Commercial_Buildings.action)

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Steven Peck, GRP, Hon. ASLA
Founder & President, Green Roofs for Healthy Cities, Toronto

Designing Climate Resilient Communities

Barbara Deutsch, FASLA
Executive Director, Landscape Architecture Foundation, Washington, DC

Beyond Form and Function: Integrating Performance-Based Design into Beautiful Practice

Glen R. Murray, MPP
Minister of the Environment and Climate Change (invited)

Addressing Climate Change in Ontario

Featured Speakers

Dr. Victoria Kramkowski,
Stormwater Charge Program Coordinator, City of Mississauga

Financial Tools to Support Adaptation: Mississauga's New Stormwater Charges and Fees

Craig Applegath,
Architect, OAA, AIA, FRAIC, LEED AP BD+C
Principal, DIALOG

Automating Benefit Cost Analysis, Life-Cycle Cost Analysis and Triple Bottom Line Analysis

Sheila Boudreau,
Urban Designer, City Planning
City of Toronto

Toronto's New Green Streets: Building a Resilient City through Green Infrastructure

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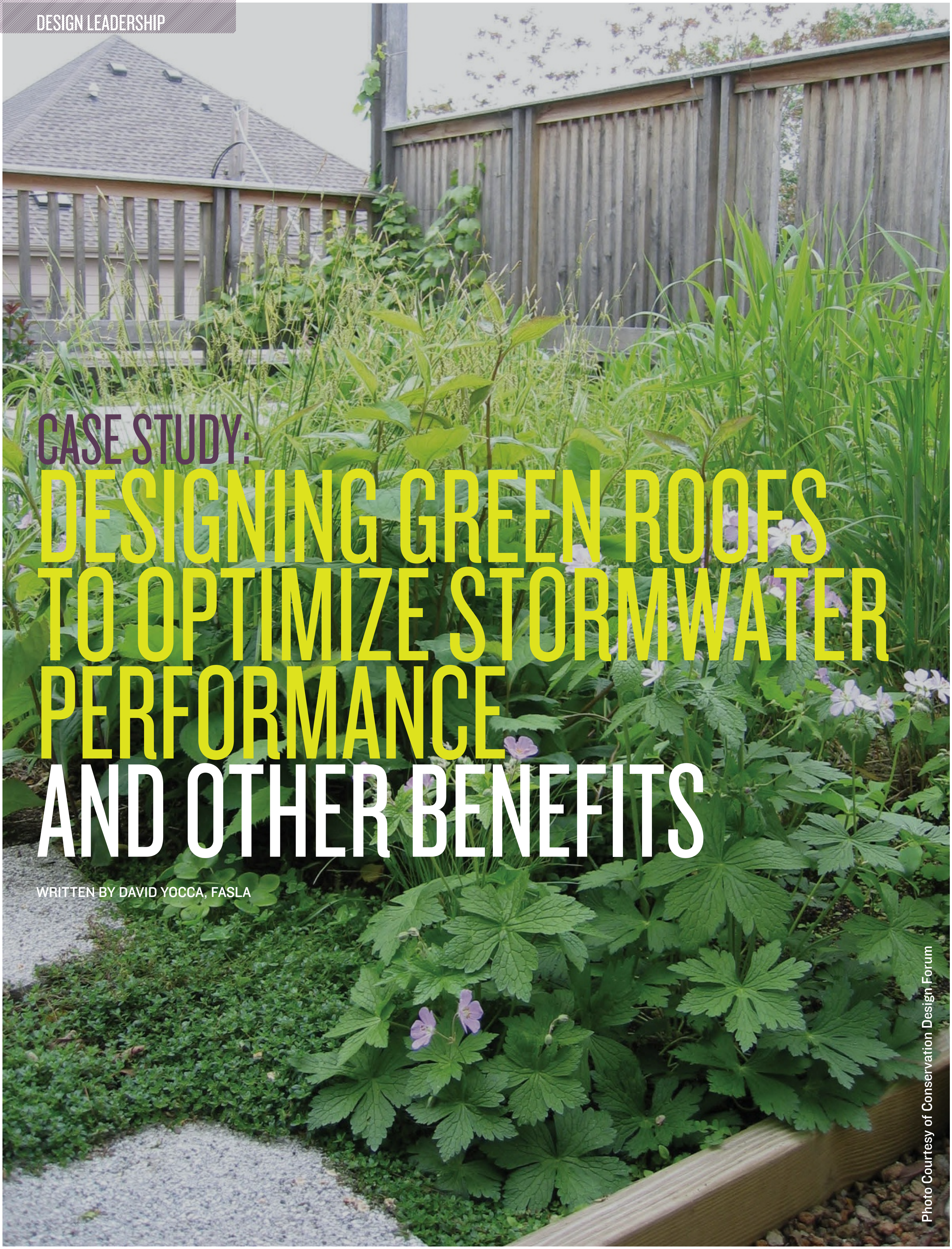


CASE STUDY: DESIGNING GREEN ROOFS TO OPTIMIZE STORMWATER PERFORMANCE AND OTHER BENEFITS

WRITTEN BY DAVID YOCCA, FASLA

Photo Courtesy of Conservation Design Forum

Green roofs have enormous potential to reduce stormwater runoff, help mitigate problems of urban flooding, and improve water quality in downstream aquatic resources. Following the completion of the Chicago City Hall green roof pilot project in 2001, which was Conservation Design Forum's first foray into green roof applications, we undertook a green roof study. This study, located in Elmhurst, IL, near Chicago, was intended to explore the stormwater performance of standard green roof systems. We wanted to closely examine the fundamental components and elements of green roof systems to better understand their stormwater characteristics so that we could better calibrate and optimize overall site stormwater performance/balance in our projects.

The study entailed a complete replacement of the existing worn waterproofing system with a new waterproofing membrane and green roof. The green roof was installed on the entire 5,730 sf of roof area on the 1 and 2-story building, except for a small control area. Several different proprietary green roof systems were installed, and represented what were then most of the available products on the market in the Midwest. The roof area was divided into hydrologically isolated plots, with varying systems and depths of growing media- 2 inch, 3 inch, and 8 inch, and with varying drainage materials. Eight of the plots were set up for stormwater monitoring, most of which were planted with the same mix of sedums- one plot was planted with a pre-grown sedum mat, and the 8 inch roof depth was planted with perennials and vegetables as a demonstration garden. Irrigation was not installed and the only portion of the roof that received supplemental water over and above rainfall was the 8 inch portion to support the vegetables.

We sought and received support funding through an EPA Section 319 grant, which allowed us to pay for specialized monitoring equipment and software. This allowed us to measure runoff from each of the distinct plots following every rainfall event for approximately two years. The grant was focused on non-point source pollution reduction, demonstration/education for green roofs, and performance monitoring. The green roof was installed and maintained during the life of the study by Conservation Land Stewardship (CLS), housed within the same building.

ROOF PLAN

Diagram of the various test plots of varying thicknesses and drainage systems.

		Pounds/SF
S1	3" soil, drain board 2 mixes of veg.	20
S2	3" soil, retention board 2 mixes of veg.	20
S3	3" soil, gravel drainage 2 mixes of veg.	20
S4	2" soil, drain board 2 mixes of veg.	8.25
S5	2" soil, retention board 2 mixes of veg.	8.25
S6	2" soil, drainage man. fabric	8.25
S7	8" soil, gravel drainage Diversity of deeper root vegetation	100

Courtesy of Conservation Design Forum

Photo Courtesy of Conservation Design Forum

The results were very enlightening for us, confirming some assumptions and dispelling others:

- Smaller rainfall events (typically less than 0.25 inches of rainfall in an 8-hour period) resulted in zero runoff;
- Larger events, and/or events immediately following another rain event, produced runoff, but at a reduced volume and peak discharge time;
- Generally, the systems with deeper growing media retained more water than the thinner systems;
- Approximately 75 per cent of the total annual runoff volume was attenuated entirely on the green roof.

We also observed anecdotally that the building's upper floor was noticeably quieter (it is situated across the street from a busy rail line). Annual energy use fell by approximately $1,400, or about 15 per cent, with the addition of the green roof. Our staff loved having a small "community" garden space to grow flowers and vegetables, and go out onto for breaks and lunches.

We have since designed a number of green roofs as part of an overall approach to balancing rainwater on-site to the degree possible, and continue to explore the potential to benefit from green roof performance at the site, neighborhood, and community scale. Green roofs clearly play a critical role in urban stormwater mitigation, and equally clear is the need for further research and on-going monitoring of stormwater performance on green roofs in different climactic regions.

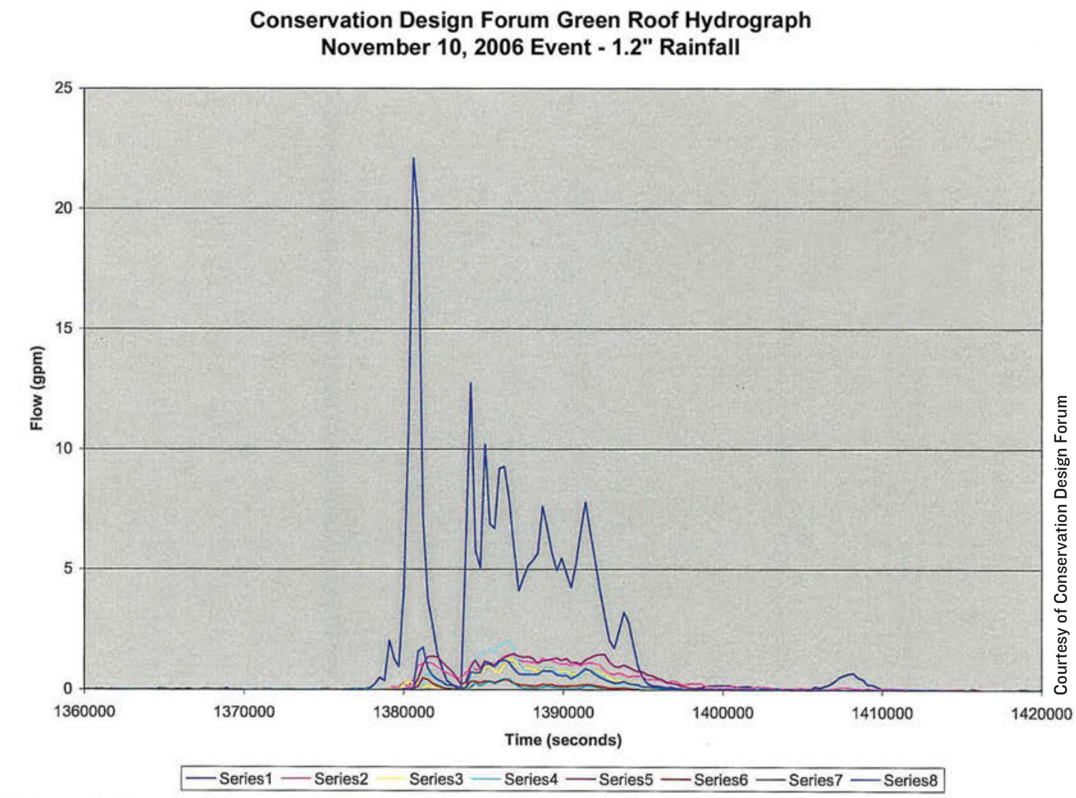
David Yocca is a Senior Partner and Principal Landscape Architect at Conservation Design Forum, and a member of the Board of Directors for Green Roofs for Healthy Cities. Conservation Design Forum (CDF) is a restorative planning, design, and engineering firm.

FIND OUT MORE

Final Report on the EPA 319 Grant and Project:
http://www.cdfinc.com/

Article on CDF Green Roof Study by Bruce Dvorak:
https://www.researchgate.net/profile/Bruce_Dvorak2/publication/258310905_Green_Roof_Test_Plots_A_Green_Roof_Comparison_Project_The_Illinois_EPA-CDF_Green_Roof/links/546a51f40cf2397f783016b5.pdf

CDF Green Roof Final Report:
http://www.cdfinc.com/xm_client/client_documents/2005-03-30%20Final%20Report.pdf



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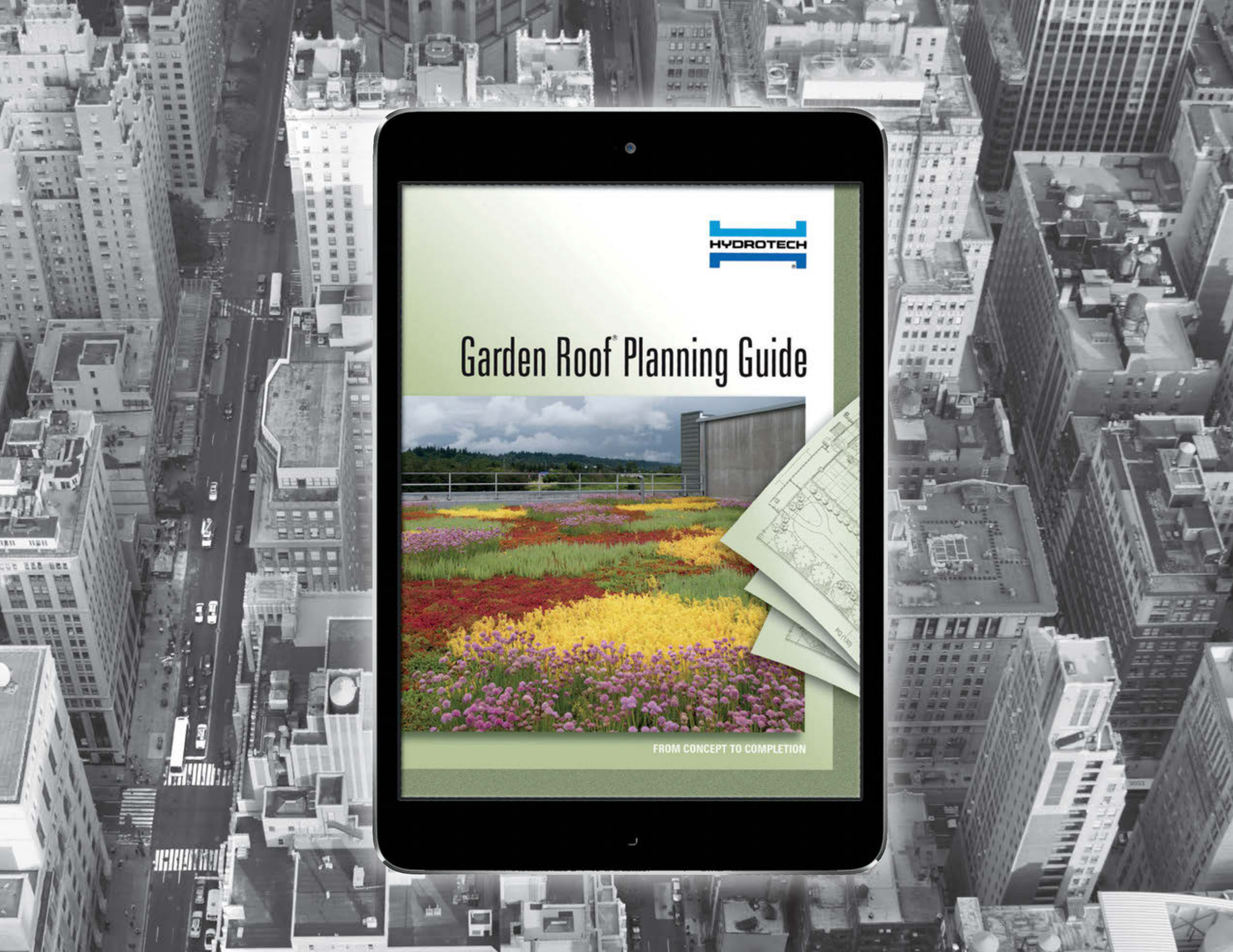
Courtesy of Conservation Design Forum

Hydrograph for a rainfall event in excess of 1 inch; dark blue line is the control section and the other colors represent the green roof panels of varying products and thicknesses.

CONSERVATION DESIGN FORUM



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TOWARDS GREATER LANDSCAPE PERFORMANCE

AN INTERVIEW WITH BARBARA DEUTSCH, LANDSCAPE ARCHITECTURE FOUNDATION, ON PERFORMANCE AND THE NATIONAL COAST GUARD HEADQUARTERS, WASHINGTON DC.

INTERVIEW BY STEVEN PECK

Photo Courtesy of "The Rise of Living Architecture"

Barbara Deutsch has been a pioneer for more rigorous assessments of the performance of landscapes for more than a decade. She has a Master's degree in Landscape Architecture and is a Harvard Loeb Fellow. Since 2009, Barbara has been the Executive Director of the Landscape Architecture Foundation (LAF) where she has spearheaded the effort to research and promote the quantification of landscape performance, with an emphasis on collecting data on a wide variety of projects. One of their more recent accomplishments involves the quantification of the landscape performance of General Services Administration's (GSA) National Coast Guard Headquarters, a 31 acre site. The integrated landscape design includes a 400,000 square foot multi-leveled green roof, green walls, 985 new trees and a 2.4 acre wetland.

Living Architecture Monitor (LAM) recently caught up with Barbara to learn more about LAF's innovative program to transform the practice of landscape design and engineering in Washington DC.

LAM: Landscape architecture has traditionally been focused on maximizing aesthetic appeal. How has this been changing?

BD: Landscape architecture has always been about designing for natural processes, natural resources, and people. Because it is for people it has to be done in an aesthetic way to connect people to nature and create enduring places. Look at Olmsted's work with Central Park as the lungs of New York City, the Emerald Necklace in Boston as flood control, water quality and habitat improvement measures, and the preservation plan for Yosemite and landscaped parkways that have stood the test of time.

The practice of landscape architecture has taken on varying expressions of form and function over its history depending on society's values and the profession's ability to shape them. In recent times, there has been a growing assertion of the value of landscape approaches to infrastructure over

THE MULTIPLE GREEN ROOFS OF THE NATIONAL HEADQUARTERS OF THE COAST GUARD IN WASHINGTON DC CAPTURE AND STORE 100% OF THE WATER FROM A 1.7 INCH STORM EVENT, THE GSA REQUIREMENT.

traditional engineering grey infrastructure solutions due to a greater understanding of their performance and ability to achieve multiple social, economic, and environmental benefits. And though we still have a long way to go to realize a landscape view of the world, we are seeing less ugly detention ponds and black top roofs, and more engaging streetscapes, parking lots, and public places that support natural processes, natural resources, and people.

LAM: The Landscape Architecture Foundation has been collecting performance data on green infrastructure projects over the past few years. Why are you doing this?

BD: The role of the Landscape Architecture Foundation is to lead with not just the best practices, but the next practices for the profession. LAF is working to integrate the basic business practice of performance planning, measurement, evaluation, and documentation into design practice. Without performance objectives and evaluation, there can be no process of improvement. Without documentation, there can be no body of knowledge to advance practice, influence policy, and show the value of the work. Without being able to show the value of the work, landscape solutions will not be fully utilized to their greatest potential to help achieve sustainability.

LAF develops case studies of exemplary landscape projects with performance data through its Case Study Investigation Program (CSI) and makes them free and accessible through its Landscape Performance Series.

LAM: What do you see as the role of performance data in terms of the future of landscape architecture?

BD: Performance planning, measurement, evaluation, and documentation is "Marketing 101" for practice and will be standard operating procedure. The resultant performance data provides the case for support to achieve a greater awareness and demand of services; a greater ability to participate in certification programs, regulatory solutions, and financial models that require the ability to quantify benefits; and more opportunities for increased partnerships and collaboration.

LAM: How, or does your work on performance data relate to the new Sustainable Sites program?

BD: The LAF Landscape Performance Series (LPS) and Sustainable Sites initiatives are two separate and distinct but complementary programs. Sites is a rating system modeled after LEED for projects with few or no structures and provides a way to help design to achieve sustainability. The LPS is not a rating system. It profiles exemplary, high-performing landscape built projects. Both programs share an interest in setting performance objectives - Sites to design to them, and in the LPS, to have objectives from which to evaluate performance against. The LPS quantifies and documents environmental,


Photo Courtesy Steven Peck

social, and economic benefits through the LAF Case Study Investigation (CSI) program which can in turn be used to gain monitoring credits in SITES.

LAM: You were recently involved in evaluating the performance of the green roof and landscape at the Coast Guard Headquarters in Washington, DC. What was involved with this and what were the outcomes of this research?

BD: The U.S. Coast Guard Headquarters site contains the third largest green roof in North America and serves as an innovative model for U.S. General Services Administration (GSA) in its commitment to sustainability. GSA contracted with LAF and the University of Maryland to develop a research plan and implement phase one to monitor, evaluate, and document the performance of the US Coast Guard Headquarters site toward achieving GSA's sustainability objectives. Understanding the project's performance would help drive further innovation and reduce risk in future projects.

Key findings are documented in the LPS case study and include: lessons learned with maintenance, the need for a landscape management plan, and key insights into the role that green roofs play in reducing surface temperatures on-site, stormwater retention, potable water savings, and carbon sequestration.

LAM: Thank you Barbara.

COAST GUARD HEADQUARTERS LANDSCAPE PERFORMANCE

The primary goals of the year-long research were to learn from the design and construction of the headquarters in order to inform future GSA projects, promote GSA's leading work as a model and precedent for others, and increase the collective capacity to achieve sustainability through landscape solutions. The site's performance is quantified over a range of environmental, social and economic benefits, including the assessment of biodiversity, heat-island effect, carbon sequestration, stormwater management, infiltration and cost avoidance.

BIODIVERSITY

The performance review indicated an increase of eight times more native trees and seven times more native woody species than was found on a comparable site of traditional office building design. Twelve distinct animal species including eagles, turkeys, foxes, deer, ground hogs, skinks and insects were observed on the site.

URBAN HEAT ISLAND

Overall, the headquarters weighted average surface temperatures were up to 15 degrees F cooler at peak times and 1.6 F degrees cooler on average than a traditional office complex during the July study period. The native meadow portions of the green roof produced the lowest daytime surface temperature measurements on-site, which were ten degrees F cooler than a traditional rubber roof at peak times and four degrees cooler on average.

STORMWATER MANAGEMENT

One hundred percent of water quality goals were to be met using green roofs and a wet pond. The green roofs capture and store up to 424,000 gallons, or 100 per cent of the 95th percentile storm (1.7 inches).

WORKER SATISFACTION AND SUBJECTIVE SITE ASSESSMENT

Research on workplace productivity shows positive effects of contact with nature on absenteeism, staff retention and job performance. This can lead to thousands of dollars of productivity per employee. A workplace survey of 101 employees indicated that 66 per cent of Coast Guard headquarters employees were satisfied overall with their workplace. In contrast, 88 per cent were satisfied with the outdoor spaces and courtyards. Approximately 17 per cent of employees access the courtyards daily, and access is distributed evenly throughout the day.

FIND OUT MORE

Landscape Performance Series: www.LandscapePerformance.org .
Ellis, C. & Reilly, C. (2015) Landscape Performance Report: US Coast Guard Headquarters. University of Maryland, College Park, MD.
See: http://landscapeperformance.org/case-study-briefs/us-coast-guard-headquarters
Barbara Deutsch, FASLA will be a keynote presenter at the Grey to Green conference in Toronto on June 2, 2016.
See www.greytogreenconference.org.

AN UPDATE GREEN ROOF STANDARDS DEVELOPMENT: WIND UPLIFT

WRITTEN BY RICHARD C. HAYDEN

Wind has always played an important part in the proper design of green roofs all across the United States and Canada. While there is little, if any, evidence of a green roof assembly being blown off a properly designed roof, winds have been known to dislocate growing media, plants and erosion control netting when not properly designed. Proper roof design remains the key to preventing serious property damage or personal injury.

In early 2015, the Canadian Standards Association (CSA) adopted a new standard (CSA 123.24-15) entitled "Standard test method for wind resistance of modular vegetated roof assembly" was adopted in early 2015. This protocol was developed at the National Research Council of Canada (NRCC) facility and addresses modular roof assemblies (trays) only. The protocol was developed with a very narrow focus of the green roof industry and without the engineering experts who developed the original wind data that eventually formed the basis of ANSI/SPRI RP-14 "Wind Design Standard for Vegetative Roofing Systems".

Prior to the publication of this new standard, CSA received numerous requests for a more comprehensive testing protocol that could be developed – one that encompasses all types of vegetated roof assemblies. Despite the body of correspondence, the CSA maintained that the process could not be held up, but did assure us that the CSA 123.24 could in fact be modified to respond to the concerns of the industry.

On January 20, 2016, the National Research Council of Canada (NRCC) held a meeting to begin the process of potentially modifying the testing protocols outlined in CSA 123.24-15. Approximately 20 representatives from the green roof industry from Canada and the United States were present for this meeting. Highlights from the discussion include:

A consolidated, universal standard: The revised CSA standard will become universal and applicable to both built-in-place and modular (tray) green roof assemblies.

Test Platform: Modifications and expansions to the test bed size will be explored to give more meaningful data reflective of actual conditions.

Roof architecture: Parapets are a critical component of proper roof design; today architects incorporate a multitude of parapet configurations into their buildings. The revised standard should reflect the process used in the original NRCC research that included parapets of various heights.

Vegetation-free-zones: Similar to the parapet issue, these zones are being looked at for inclusion in the revised testing protocol.

Wind speed: While the original intent was to test the wind flow to 90 mph, there were discussions to increase the wind speeds to at least 120 mph or higher if possible.

Updates to ANSI/SPRI RP-14 AND VF-1: The original ANSI RP-14 and VF-1 External Fire Design Standard for Vegetative Roofs documents are going through the required ANSI 5-year review process. There is a goal of getting ANSI RP-14 incorporated into the International Building Code.

Watch for future standards updates in the Living Architecture Monitor.

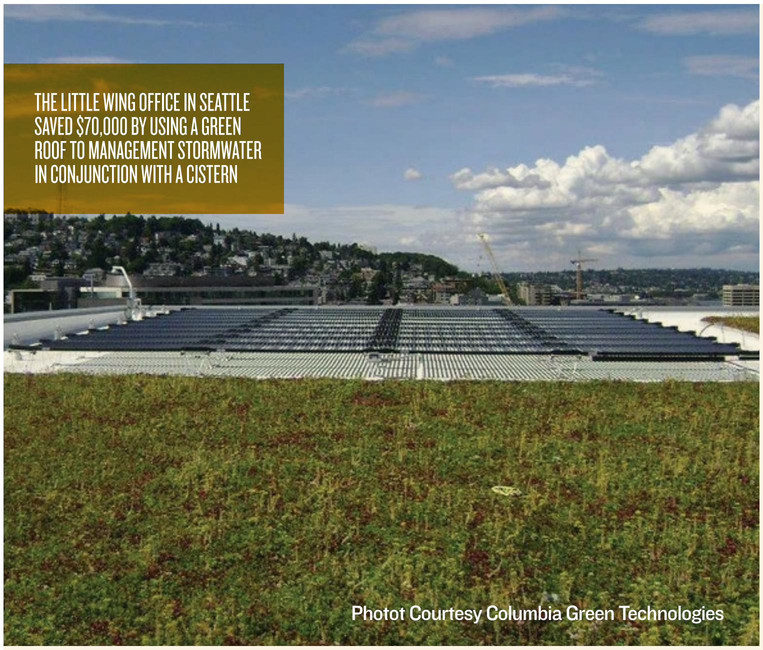
Richard C. Hayden RLA ASLA CLARB GRP, Garden Roof Department Manager, American Hydrotech, Inc. and GRHC's Standards Representative.

THE BUSINESS CASE: SEATTLE GREEN ROOF SAVES $70,000 ON STORMWATER

WRITTEN BY ANDREA SAVAN
TECHNICAL DIRECTOR OF COLUMBIA GREEN

The 'Little Wing' office building was constructed on a corner lot in Seattle next to existing, adjacent residential buildings in 2013. The building's core was placed to one side in order to maximize the efficiency of plumbing utilities and to provide a buffer between the adjacent residential uses. The civil engineer had initially planned to do underground detention tanks to meet on-site stormwater regulatory requirements, but Jason Twill, Vulcan Inc. Project Manager, challenged the team to see if a combination of a green roof for retention/filtration and rainwater harvesting tanks for non-potable water reuse could do double-duty… which they did.

By eliminating underground stormwater detention (~$80k), and a secondary storm/sewer discharge connection 18 feet below the street, which would have required excavation, street closures, etc. to the cost of approximately $170k, the project was able to save roughly $250,000 on traditional infrastructure. This savings more than paid for the cistern, (~$140k) and allowed the size of the green roof to be roughly doubled to 4,200 sf. The extensive green roof was a layered system provided by Columbia Green Technologies, which also provided technical support to the design team. In addition to providing an immediate "green" amenity to the building, the project also received more LEED points as a result of the inclusion of the vegetated roof. The net savings from stormwater alone was $70,000.



THE LITTLE WING OFFICE IN SEATTLE SAVED $70,000 BY USING A GREEN ROOF TO MANAGEMENT STORMWATER IN CONJUNCTION WITH A CISTERN

Photot Courtesy Columbia Green Technologies

"GREEN ROOFS ARE OFTEN THE MOST COST EFFECTIVE B.M.P. FOR DEALING WITH STORMWATER REGULATIONS IN URBAN ENVIRONMENTS."

VANESSA KEITGES, PRESIDENT AND CEO, COLUMBIA GREEN TECHNOLOLGIES

Project Overview

Project: 'Little Wing'. Built 2013

54,000 sf Experience Music Project administrative office building

Location: Seattle, Washington

LEED platinum

Uses a combination Cistern / Green Roof to manage stormwater

Extensive Green Roof: 4,200 sf

Green Roof System: Columbia Green Technologies' Extensive Layered System planted with sedum tiles

Cost: Rainwater harvesting cistern (~$140k)

Cost: Green Roof (~$40k)

Savings: Eliminate underground detention tank (~$80k)

Savings: Eliminate secondary storm/sewer discharge connection below the street (~$170k)

Project Team

Vulcan Inc.	Owner / Developer
Howard S. Wright	General Contractor
Collins Woerman	Architect
Wayne's Roofing, Inc	Green Roof Installer
Columbia Green	Green Roof Provider

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UNDERSTANDING HOW PLANT SELECTION INFLUENCES STORMWATER MANAGEMENT

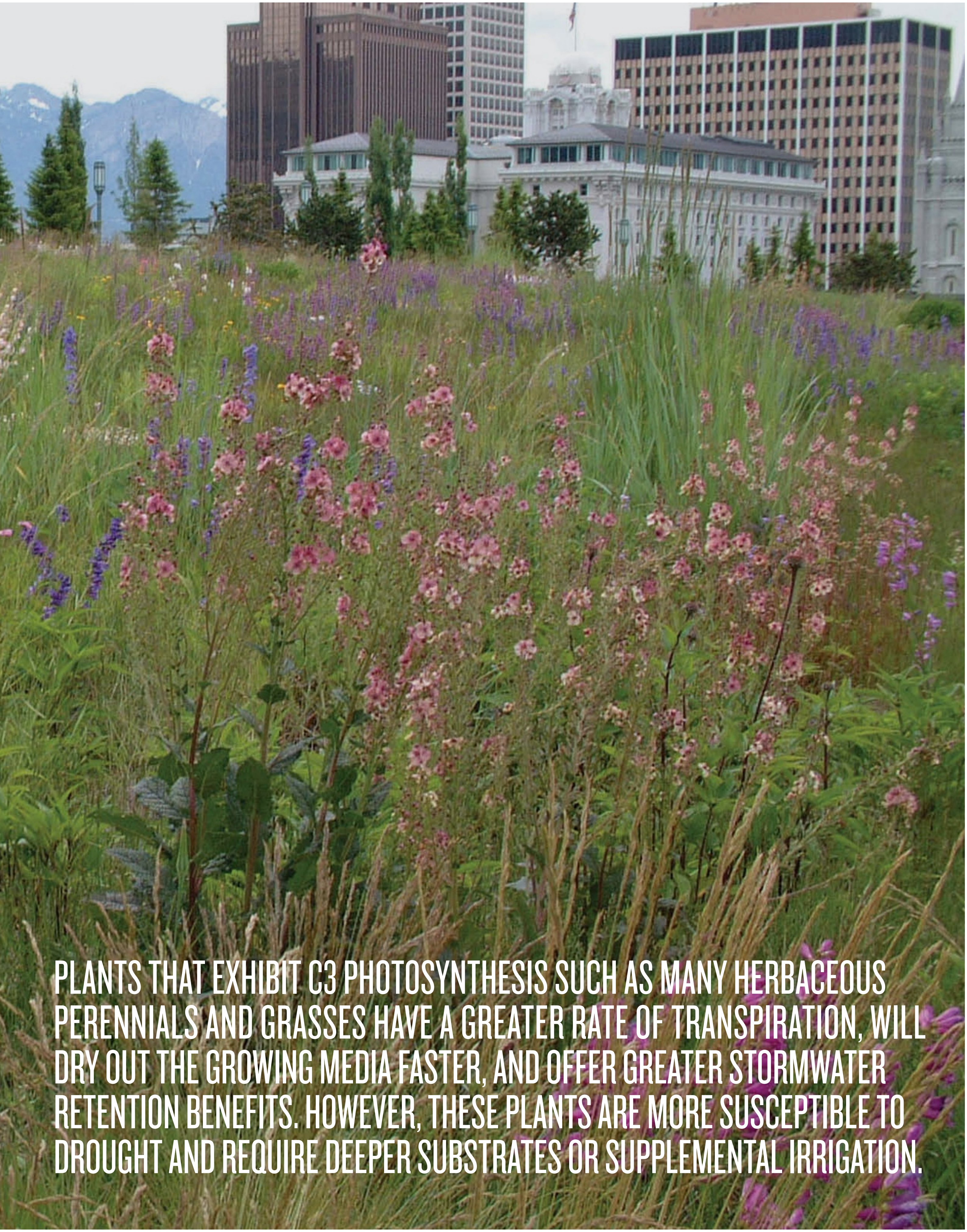
WRITTEN BY DR. BRAD ROWE, MICHIGAN STATE UNIVERSITY, EAST LANSING

The success of a green roof in terms of stormwater management is a function of how well a roof retains stormwater. This includes water that is held in the growing media, transpired through the plants, and evaporation from the growing media surface. Many plant related and environmental factors influence water balance, but what we have the most control over, is plant selection, growing media composition and depth, and irrigation practices.

There are three major categories of plants that can be used on a green roof: C3, C4, and CAM (Crassulacean Acid Metabolism). The vast majority of plant species on earth exhibit C3 photosynthesis. They thrive under cool and moist conditions because their photosynthetic pathway is shorter and requires less energy than CAM or C4 plants. However, C3 plants suffer under hot and dry conditions because they exhibit poor water use efficiency and are subject to photorespiration. In contrast, CAM plants are well adapted to water-stressed conditions and thus are ideal for many extensive green roofs. CAM plants have the ability to fix CO_2 in the dark for later use in photosynthesis and because stomata are closed during the day, plant gas exchange occurs at night, thus reducing transpirational water loss.

Numerous studies have shown that vegetation type can influence stormwater retention. In addition to transpiration, rainwater will be intercepted by foliage and may evaporate before reaching the substrate surface. A study in England compared grasses, forbs, and sedum, and reported that the grasses were most effective in reducing stormwater runoff

Photo Courtesy of Brad Rowe



PLANTS THAT EXHIBIT C3 PHOTOSYNTHESIS SUCH AS MANY HERBACEOUS PERENNIALS AND GRASSES HAVE A GREATER RATE OF TRANSPIRATION, WILL DRY OUT THE GROWING MEDIA FASTER, AND OFFER GREATER STORMWATER RETENTION BENEFITS. HOWEVER, THESE PLANTS ARE MORE SUSCEPTIBLE TO DROUGHT AND REQUIRE DEEPER SUBSTRATES OR SUPPLEMENTAL IRRIGATION.

followed by the forbs (Nagase and Dunnett, 2012, Landscape and Urban Planning). It was also shown that the size and structure of plants significantly influenced the amount of water runoff. Plant species with taller height, larger diameter, and larger shoot and root biomass were more effective in reducing water runoff than plant species with shorter height, smaller diameter, and smaller shoot and root biomass.

Non-CAM plants definitely transpire at a higher rate than CAM plants. CAM plants need about 50 grams of water to produce 1 gram of plant dry matter. C3 plants need 450 – 950 grams of water and C4 plants need 250 – 350 grams of water to produce the same 1 gram of dry matter. That is a lot of 'wasted' water for C3 plants, but is beneficial if you want the media to dry out before the next rain event. Evapotranspiration depends on the plant and factors such as canopy coverage (bare soil will lose water more quickly) and other environmental factors such as temperature, irradiance levels, wind, etc.

Growing media substrates are also a major factor in stormwater retention. In addition to physically supporting the plants and providing nutrients, they play a critical role in water management as deeper depths will hold more water and allow for a larger plant palette which includes C3 plants. Water retention can be manipulated

IT WAS ALSO SHOWN THAT THE SIZE AND STRUCTURE OF PLANTS SIGNIFICANTLY INFLUENCED THE AMOUNT OF WATER RUNOFF. PLANT SPECIES WITH TALLER HEIGHT, LARGER DIAMETER, AND LARGER SHOOT AND ROOT BIOMASS WERE MORE EFFECTIVE IN REDUCING WATER RUNOFF THAN PLANT SPECIES WITH SHORTER HEIGHT, SMALLER DIAMETER, AND SMALLER SHOOT AND ROOT BIOMASS.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ANY PLACE

by altering substrate components and by changing depth. Physical properties of substrates include bulk density, pore space, water holding capacity, container or field capacity, and capillary water rise. These are the main properties that determine stormwater retention as well as available air and moisture for the plants. As aerated pore space increases, water holding capacity decreases and vice versa. In addition, substrate depth has a major impact on moisture content and water retention. Given the same substrate blend, a shallower substrate will not be capable of retaining as much water and the water that is retained will be lost through evapotranspiration in a shorter period of time.

With the current desire to specify more herbaceous perennials and grasses (mostly C3 and C4 plants) for green roofs, there is potential to increase transpiration on rooftops. However, there must be enough substrate moisture for these plants to survive. High transpiration rates are dependent on available moisture and if moisture is not available, these species will become stressed or die. Providing deeper growing substrates or supplemental irrigation could maintain substrate moisture so that high transpiration rates would not be a problem. Overall, a balance must be found between providing enough water to maintain plant health while allowing the substrate to dry out enough to provide stormwater storage capability for the next rain event. As green roof practitioners, the choices we make in these areas will go a long way in determining how well a green roof performs.

Brad Rowe began conducting green roof research at MSU in 2000. He chaired the GRHC Research Committee from 2004-2007 and was the recipient of the GRHC Excellence in Research Award in 2008. His research focuses on plant selection, carbon sequestration, roof vegetable production, substrates, and stormwater managment.

OVERALL, A BALANCE MUST BE FOUND BETWEEN PROVIDING ENOUGH WATER TO MAINTAIN PLANT HEALTH WHILE ALLOWING THE SUBSTRATE TO DRY OUT ENOUGH TO PROVIDE STORMWATER STORAGE CAPABILITY FOR THE NEXT RAIN EVENT.

DC'S INNOVATIVE STORMWATER MANAGEMENT MODEL: A MIX OF REGULATIONS AND INCENTIVES

WRITTEN BY DR. HAMID KARIMI

The District of Columbia (DC) is highly developed. Like other older US cities, this development causes significant stormwater runoff. There are over 3.2 billion gallons of sewage and stormwater overflows to the District's rivers per year. Since typical stormwater retention best management practices (BMPs) for suburban and rural areas do not lend themselves to urban areas, we must be creative.

For many years, the District has been a national leader in the numbers of trees planted and green roofs installed per capita. DC has many popular green infrastructure incentives to help make this possible, including subsidies and rebates for the installation of green roofs and other stormwater BMPs. Despite this success, we began to ask ourselves if a solely voluntary program would be adequate and sustainable in the long run. The answer was "no" because only 10 per cent of regulated development projects were voluntarily retaining stormwater. With a new 1.2-inch retention requirement from one of the country's most stringent Municipal Separate Storm Sewer System permits, we needed the other 90 per cent of development projects to participate too.

A review of DC's 2009 rainfall data (see figure) showed that most of the annual rain events less than 1.2 inches, and most of the larger rain events were between 1.2 and 1.7 inches. This means the majority of storms throughout the year would completely fill small BMPs, but only partially fill large BMPs. For example, if a 0.6-inch storm filled 5,000 gallons in a BMP with 10,000-gallon capacity, two BMPs with 5,000-gallon capacity would achieve 10,000 gallons of total retention, or double the amount of the larger BMP. This means increasing the number of smaller BMPs throughout the city would provide more stormwater retention annually and capture more of the first flush of pollutants, than focusing on larger BMPs.

In addition to environmental concerns, many properties in the District's core are built lot line to lot line and have several competing requirements for utilities and public access. While a green roof is a viable option to address these

Courtesy of Furbish

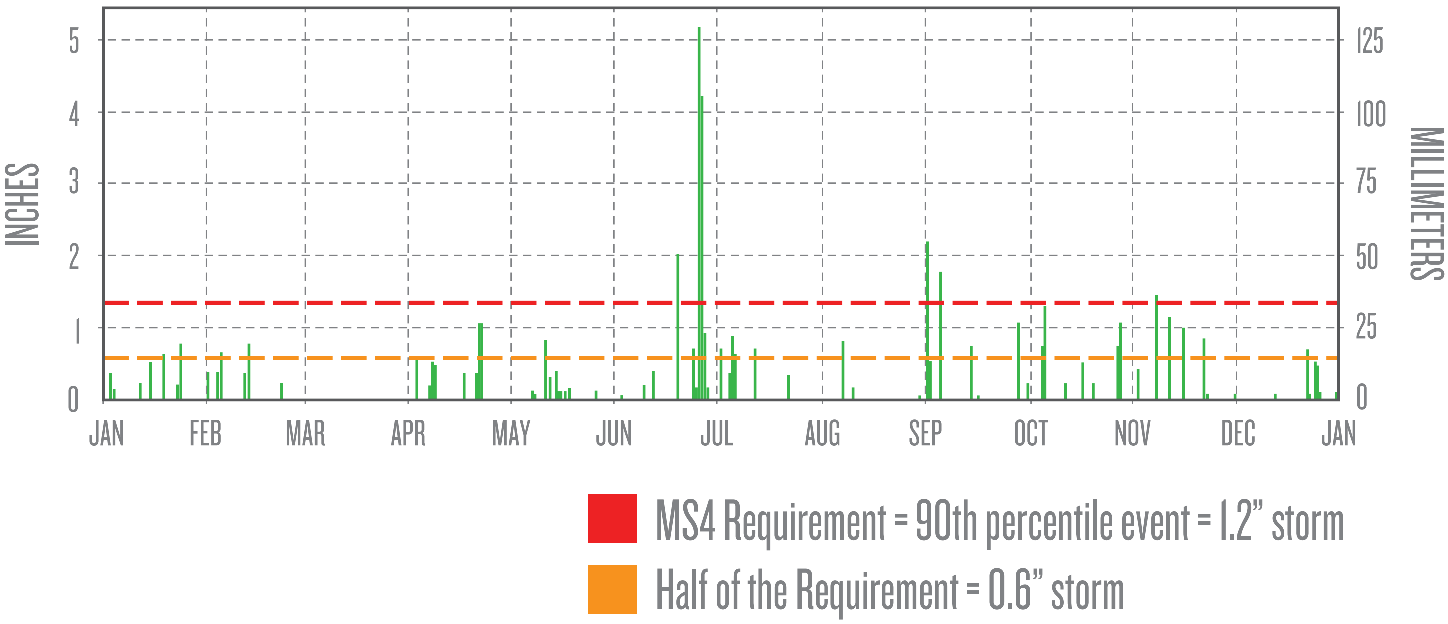
constraints, it is often still challenging to achieve 1.2 inches of retention. A large portion of DC's development projects are large-scale, large-budget interior renovations that do not disturb any land (i.e., major substantial improvement projects). We needed to capture these large renovation projects that previously did not trigger stormwater requirements, but we also needed to provide flexibility to offset their many constraints.

DC's innovative solution to addressing space requirements, maximizing retention, and offering flexibility was to allow regulated sites to meet up to 50 per cent of their retention obligation off-site and to encourage non-regulated entities to voluntarily install stormwater BMPs. The new regulations require major land-disturbing sites to retain 1.2 inches and major substantial improvements sites to retain 0.8 inches. Both can get credit for retention up to 1.7 inches; and both have the off-site retention option.

Voluntary BMP installations can earn money by generating Stormwater Retention Credits (SRCs) that are sold to help regulated developers meet their requirements. An SRC represents one gallon of retention for one year. After meeting its 1.2- or 0.8-inch requirement, a regulated site can also earn SRCs for retention up to 1.7 inches.

SRC trading transitions a large share of the District Government's investment in green infrastructure to regulated development over the long term. It increases private investment and can achieve more retention than regulated sites would achieve alone. SRC trading also promotes installation of voluntary stormwater BMPs in less dense, less expensive areas, which spreads the beauty and environmental benefits of green infrastructure to more areas of the city.

RAINFALL PATTERN IN 2009 AND TWO EVENT BASED RETENTION TARGETS Courtesy DOEE with NOAA data.



THE INCREASE IN THE DC AREA'S GREEN ROOF INDUSTRY OVER THE LAST SEVERAL YEARS IS ONE INDICATOR THAT THIS COMPREHENSIVE STRATEGY OF COMBINING REGULATIONS AND INCENTIVES IS WORKING. EVERY CITY IS DIFFERENT, AND THERE IS NO SILVER BULLET SOLUTION.

Regulated development projects have two options for off-site retention. They can pay the District Government's In-Lieu Fee of $3.58 per gallon per year, or they can pay the private market rate for SRCs, which has ranged from $1.90 to $2.55. And since the private sector is more cost-effective in the business of installing stormwater BMPs, the District Government's next step will be to invest in the market by setting up a program to purchase and retire SRCs.

Since taking effect in July 2013, we have also nurtured the new stormwater regulations by providing resources to make it easier to participate in the SRC trading market. The District of Columbia's Department of Energy and Environment developed a template contract for SRC sales and established an online registry where potential buyers and sellers can view current SRC market information (visit doee.dc.gov/src).

DC has also adopted several complementary regulations and requirements to promote green roofs and green infrastructure. The Green Area Ratio is a zoning regulation that requires properties to achieve the target score for their zone by installing or preserving a variety of landscape elements weighted by environmental value. Green roofs achieve a high score and green walls are another option. DC's Green Building Act requires all public and publically financed commercial new construction and major renovation projects to be LEED silver or higher, and all private sector new construction and major renovation projects greater than 50,000 square feet must meet the LEED Certified level or higher. DC's Stormwater Utility Fee charges property owners a rate based on the area of impervious surface, which can be lowered with green infrastructure retrofits.

The increase in the DC area's green roof industry over the last several years is one indicator that this comprehensive strategy of combining regulations and incentives is working. Every city is different, and there is no silver bullet solution. While DC is similar to many other dense urban areas, each city has varied federal requirements and environmental challenges as well as stakeholders with unique concerns. Hopefully DC's model will offer elements other cities can translate and adapt to further their environmental goals.

Hamid Karimi, Ph.D. is the Deputy Director of Natural Resources Administration, Department of Energy and Environment, Government of the District of Columbia and a board member of GRHC.

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- New York: March 31st to April 2nd
- San Francisco: April 28th to 30th
- Washington, DC: date TBA

NET ZERO WATER FOR BUILDINGS AND SITES
- Online: March 21st to May 15th– 7.5 CEUs
- Toronto: June 24th (in partnership with Canadian Water Summit) – 7.5 CEUs

ADVANCED GREEN ROOF MAINTENANCE
- Toronto: March 15th (in partnership with Landscape Ontario) – 3.5 CEUs
- Washington, DC: date TBA – 3.5 CEUs

GREEN ROOF PROFESSIONAL (GRP) ACCREDITATION EXAMS
- Washington, DC: date TBA
- Toronto: June 1st (in conjunction with Grey to Green Conference)

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SAVE THE DATE | 2016 MAJOR EVENTS

Grey to Green Conference

Toronto, Canada at Ryerson University, June 1-4, 2016. More than 40 speakers will be sharing information on research, policies, and projects covering green roofs, walls, urban forestry and other forms of green infrastructure. Tours, training, networking events and trade show. See **greytogreenconference.org** to register.

14th Annual CitiesAlive

Washington DC Nov. 1-4, 2016 at the UDC Campus. We will be rising to the stormwater challenge with tours, a special technical session on stormwater, a trade show and more. See **citiesalive.org** for more information.

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SPRING IS COMING… DO MAINTENANCE CREWS HAVE TO DO ANYTHING?

WRITTEN BY ANDY CREATH

"Green roof maintenance is always required." I say this frequently to classes and in meetings with designers. It's true, I believe, but to varying degrees.

Green roof maintenance is in place for two overarching purposes: to ensure that building systems affected by the green roof continue to run effectively and efficiently; and to support the design intent of the green roof.

This is where the "to varying degrees" comes in, because everything depends upon the design intent of each particular green roof project. The design intent can be based on a single purpose such as ecological value or aesthetic beauty. Or it can be based on the multitude of diverse functions a green roof can provide. The design intent must also take into account budgetary considerations—how available are finances to both build and maintain a green roof into the future.

At a minimum, a green roof maintenance program needs to ensure that building systems continue to operate properly, at least through yearly visits. For more complex projects, daily visits may be required to maintain a specific type of function in the design intent.

This means that it is imperative to discuss the maintenance program, and its costs, at the beginning of any project, prior to the decision to include a green roof in a design. If there is no budget to properly maintain a green roof into the foreseeable future, then considerations need to be made either to change the design, or to leave out the green roof entirely.

Once a decision is made to go forward, and the budget is in place, then early and consistent maintenance will help ensure a successful project, thereby saving future costs of repair or replacement. A solid maintenance program takes a green roof project from installation through establishment, always with the original design intent in mind, especially for decisions about plant substitution or volunteer species. A maintenance plan spells out the proper direction for the specific green roof in question.

DO NOT FEAR MAINTENANCE, BECAUSE IT IS FUNDAMENTAL TO THE ONGOING PERFORMANCE OF YOUR GREEN ROOF OR WALL PROJECT, WHETHER IT IS PRACTICED TWICE A YEAR, TWICE A MONTH OR ON A DAILY BASIS.

At their best, green roofs create an adaptable and functioning ecosystem which provides a multitude of known benefits. To ensure they function at their best, however, well-planned maintenance is critical.

Do not fear maintenance, because it is fundamental to the ongoing performance of your green roof or wall project, whether it is practiced twice a year, twice a month or on a daily basis.

Andy Creath is the President of Colorado Green Roofs and a board member of the Green Infrastructure Foundation. See GRHC's Advanced Maintenance Class for more information.

GRHC MEMBERSHIP APPLICATION

For a full list of all membership categories and benefits, or to apply online, please visit www.greenroofs.org/membership.

Date: Name: Company:

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State/Province: Postal/Zip Code: Country:

Telephone: Fax: Email:

MEMBERSHIP APPLICATION FOR (PLEASE CHECK ONE):

○ Supporter $55 US ○ Individual $160 US ○ Individual Affiliate $100 US ○ Corporate (see below)

○ Individual GRP $160 US ○ GRP Renewal $207.50 US

IF YOU WISH TO BECOME A CORPORATE MEMBER, PLEASE CHOOSE THE MOST APPROPRIATE CATEGORY (IN US DOLLARS):

○ Charitable/Not-for-Profit ($550) ○ Government & Institutional ($550) ○ Professionals ($550) ○ Nurseries ($750)

○ Green Walls ($1,250) ○ Distributors & Suppliers ($3,800) ○ Manufacturers ($5,200) ○ Corporate Leaders($12,700)

PLEASE CHOOSE THE TITLE THAT BEST DESCRIBES YOU OR YOUR ORGANIZATION:

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○ Developer	○ Educator	○ Government	○ Energy Consultant	○ Engineer
○ Environmental Consultant	○ Facilities Manager	○ Horticulturalist	○ Consumer	○ Landscape Architect
○ Landscape Designer/Consultant	○ Roofing Consultant	○ Manufacturer or Supplier	○ Media	○ Not-for-profit
○ Policymaker	○ Planner	○ Researcher	○ Student	○ Sustainability Manager
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