APRIL 2014

SITELINES

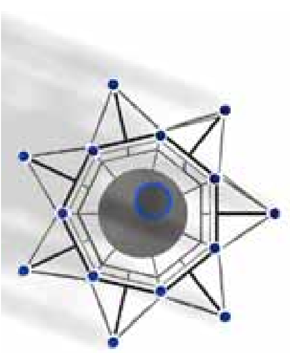
Landscape Architecture in British Columbia

LIVING ARCHITECTURE

New products to inspire a new perspective on play

ZIPKROOZ™ & ZIPKROOZ ASSISTED

With ZipKrooz, kids can soar back and forth, from one end to the other, and enjoy nonstop zooming action. Built-in elevation helps riders gain momentum at the beginning, then slow down at the end.



NETPLEX™

This futuristic climbing experience pushes kids beyond their known boundaries into a world of interconnected cables where there's no right or wrong way to play. They can create their own path through a complex of multi-leveled, webbed nets.

BOOGIE BOARD™

From surfing to lounging, solo or with friends, kids find the most creative ways to use the Boogie Board. Whichever way their imagination goes, they're developing balance, building core strength and learning to work together.

SMART PLAY: MOTION

With developmentally appropriate challenges along with an efficient use of materials, Smart Play: Motion is SMART in so many ways!

British Columbia Society of LANDSCAPE ARCHITECTS

450–355 Burrard St. Vancouver, BC V6C 2G8

T 604.682.5610
F 604.681.3394
TF 855.682.5610
(Canada and US)

E office@bcsla.org
admin@bcsla.org
W www.bcsla.org
www.sitelines.org

Sitelines is published six times per year; February, April, June, August, October, and December by the British Columbia Society of Landscape Architects and is mailed to all BCSLA members, registered landscape architects, associates and affiliates. The editorial deadline is the 8th and advertising is the 16th day of the intervening months. Advertising rate information is available on request. Inquiries regarding editorial, advertising, or other issues should be addressed to the Sitelines Editor, c/o the BCSLA at the above address. To view the full-colour version of Sitelines, please visit www.sitelines.org.

SITELINES GROUP
GUEST CO-EDITOR Randy Sharp
CO-EDITOR Jessica Tan
604.682.5610
ADVERTISING Tara Culham
604.682.5610
fax: 604.681.3394
GRAPHIC DESIGN Addon Creative
604.738.2768
PRINTING Initial Printing Inc.
604.669.2383

The purpose of Sitelines is to provide an open forum for the exchange of ideas and information pertaining to the profession of landscape architecture. Individual opinions expressed are those of the writers and not necessarily of those of the BCSLA.

The Business of Living Architecture

By Randy Sharp, MBCSLA, FCSLA, ASLA, LEED® AP, GRP

Green Roofs, Living Walls and Rain Gardens: BC Business Exports Innovative Technology to North America. For Landscape Architects, the Sky is the Limit!

Maureen Connelly, Cornelia Oberlander, and Randy Sharp on Saturna Island. Image courtesy of Carol Smith.

It is a great pleasure to acknowledge the accomplishments of BC Landscape Architects over the past 50 years in living architecture and green roof design. In particular, two collaborators championed "landscape and architecture as one". Cornelia Hahn Oberlander, LMBCSLA, FCSLA, FASLA, OC and Arthur Erickson defined West Coast modern design, expressed in ecological designs and landscapes over structure. This month we are also celebrating the book launch for Cornelia Hahn Oberlander, Making the Modern Landscape by Susan Herrington.

In 1998 at the ASLA convention, Tom Liptan, Landscape Architect for the City of Portland, introduced the topic of adopting European green roof technology for the West Coast. Fifteen years ago, the "modern" movement of green roofs was initiated in British Columbia on the wildflower meadows of Saturna Island with Cornelia Oberlander and Dr. Maureen Connelly, MAIBC, PhD. We challenged ourselves: how can we transform the urban landscape of Vancouver by replicating the coastal bluff ecosystem on the rooftops? Sharp & Diamond Landscape Architecture is building resilience to climate change by embracing Living Architecture in our work.

The seeds of green roofs in BC were planted on a group of waterfront cabins next to the ferry dock on Hornby Island. Goya Ngan, MBCSLA, will take us on a journey of growing up in the hand built homes covered with meadow roofs on Hornby. Our next stop will be Calgary where Kerry Ross, B.Arts & Sciences, BArch, MRAIC, LEED® GA, GRP, Principal, Green T Design, will tell us about the Alberta Ecoroof Initiative ►

Cover Image: Local green roof supplied and installed by Architek. Image courtesy of Ron Schwenger.

In this Issue:

Continued from page 3.

and the wonderful diversity of prairie plants that thrive on "ecoroofs". Back in British Columbia, Ron Schwenger, Principal of Architek, will give us the "dirt" on how to install and maintain both extensive and intensive green roofs, as well as the importance of green facades for big box retail. Nicolas Rousseau, BSc, MSc, Horticulture Engineer, President of By Nature Design Inc. is teaching GROW 1500 – Green Wall Course, at the Centre for Architectural Ecology at the BC Institute of Technology (BCIT). He will compare the metrics of hydroponic versus soil based living walls, as well as water distribution and lighting systems to ensure long-term performance.

Taking a look at the big picture, Dr. Maureen Connelly of BCIT, will introduce the concept of "soundscape" and the application of acoustic design to green roofs and urban landscapes. Bryce Gauthier, MBCSLA co-founder of The Projects In Place Society, is building demonstration plots for urban agriculture, rooftop gardens, day care spaces and neighbourhood play areas in Vancouver's Downtown Eastside. David Adkins, Project Consultant with Denbow, will bring us back to the ground by introducing innovation in bio-engineering and green infrastructure. How can green roof technology such as engineered growing media be applied over industrial buildings, highway embankments, stream restoration corridors, and vegetated landscape retaining walls?

I hope that you enjoy this rooftop and vertical garden journey. We have now gone full circle with green roofs having created a vibrant growing industry in British Columbia. There will be green roof and living wall tours offered during the BC Land Summit May 14-16, 2014. We would like to pass the torch to the next generation of Landscape Architects who can celebrate their achievements and the next wave of innovation in another 50 years. Just remember, "Landscape architecture is the art and science of the possible". Thank you Cornelia! You are an inspiration to all of us! SL

Early Green Roofs of HORNBY ISLAND

By Goya Ngan, MBCSLA

Shingle Spit Resort and the Thatch, Hornby Island. Image courtesy of Goya Ngan.

Hornby Island, two short ferry rides from central Vancouver Island, is well known for its creative, hand-built architectural tradition and beautiful beaches. The first green roofs on Hornby Island were built at the Shingle Spit Resort during the 1950s. A second cluster was built on the Downes Point property, starting with my family's home in 1971. Blue Sky Design began building their first green roofs, including the house at Dunlop Point, in the mid 1970s. The practice burgeoned and green roofs became the island's vernacular for blending a building with the surrounding coastal bluff landscape. They were called "sod roofs" but if you look at the vegetation composition, typically mosses, sedums, grasses, and bulbs, they would be classified as "extensive green roofs" according to the definitions widely in use today.

The initial idea to put sod on a roof on Hornby Island began with none other than our visionary architect, Arthur Erickson. His design for a modest cabin at Shingle Spit included a green roof. One source thinks it was a graduation project of his. Where did this idea come from? That's the question I posed to him when Cornelia Oberlander introduced me to him in 2004. He said his inspiration came from Norway and from a building in Garibaldi Park near Black Tusk. He may have been referring to an old lodge that was there. He liked seeing the flowers in the spring, and the thermal benefits of summer cooling and winter insulation. The owner of the Shingle Spit Resort, Jack Parnell, used Erickson's plans as "rough guides" for building up the resort. The closest to the original design was likely cabin #3, the smallest; it has since been sold and relocated probably at the time the resort was stratified. Cabins 5, 6, and 7 were larger but also had green roofs. I remember what a perfect picture they made, dots of white stucco with red detailing stretching out to the end of the spit with their green roofs matching the grass above the pebble beach. He also installed a green roof on at least one home on the other side of the spit. A few years later, possibly 1957, Parnell built a pub once again using Erickson's design, only this time enlarging it considerably. It also had a green roof and in the mid-1970s was renamed The Thatch. The cabins and The Thatch continue to be important landmarks for Hornby, visible to all people arriving by ferry. ►

Hornby Island, Cape Gurney House by Blue Sky Design. Image courtesy of Michael McNamara

My parents, Anne and Wayne Ngan, bought a share of land at Downes Point in 1969. They chose a building site that was set back from the waterfront allowing a view of the sea framed by trees with a grass meadow foreground. They built the house in 1971 using salvaged driftwood and other free or inexpensive materials. My mother, who studied architecture and worked in John Lantzius' office, wanted the house to fit into the meadow landscape. The green roofs at the Shingle Spit cabins were a new idea to her and she was eager to try it on her home. At the time, it was unclear how best to detail a green roof. The Shingle Spit green roofs were first built with black poly on plywood—a solution that worked better than you would expect but eventually fell out of favour. Our roof definitely had a layer of black poly—whether or not there was a tar membrane or asphalt shingles beneath is unclear. On top were placed pieces of local sod. Michael McNamara, later a founder of Blue Sky Design, had just arrived on Hornby and was eager to learn this building technique. He writes,

"Helping your parents put sod on the roof of your family home is one of my favourite early Hornby memories. The hot tar was in place, and we spent several days bringing soil over from Tom Burrows' excavation and spreading it over the roof. Quite an educational experience!"

For plants, we were given cuttings from the Shingle Spit green roofs (*Sedum forsterianum*), locally referred to as Spanish moss. These were scattered onto the sod and have proved well adapted to the conditions. The membrane was renovated with a BUR membrane in 1980. This was then covered with a modified bituminous membrane in 1996, a vast improvement, which I expect will last much longer. The plants and substrate are still the originals as they were always saved and simply put back on. Today, the vegetation forms a complete carpet of succulents (*Sedum forsterianum* dominates, *S. spathulifolium*, *S. oreganum* and many other sedum species were added in later years; *Sempervivum tectorum*), grasses (Bromus and other species) and a variety of mosses and lichens. One oddball plant is *Orobanche uniflora*. It is parasitic and obtains nutrients from sedum roots; it seems not to harm them and provides pretty purple flowers in April. This 43-year-old green roof is about 10 centimetres in depth, not irrigated and minimally maintained.

Green roofs were so common on the island by the early 1980s, that when the Community Hall was expanded, there was no question—it would have a green roof. The members of the design committee, Ernst Snijders, Lloyd House, and Michael McNamara, were all versed in green roofs. Blue Sky Design went on to design about 24 green roofs on Hornby and more beyond. Their Cape Gurney residence, visible from Whaling Station Bay, is a stunning example. Bo Helliwell and Kim Smith of Blue Sky Architecture also designed many green roofs around the region, an evolution born out of their early Hornby experience.

Why does little island, with a year round population of not quite 1000, have such a high proportion of green roofs? Erickson planted the seed of an idea which was which was picked up by a wave of creative back-to-the-landers wanting to try new building designs and a beautiful ecosystem to match the conditions of a roof—I think they all contributed to the proliferation of green roofs on Hornby Island.

Many thanks to those who shared their green roof recollections with me: Anne Ngan (2014), Michael McNamara (2003, 2014), Don and Rosemary Nixon (2014), Tina Walker (2004), John Ross (2004), and Arthur Erickson (2004). SL

Related publications:

Helliwell, B., & McNamara, M. (1978). Hand-Built Houses of Hornby Isl. Architectural Design, 48(7), 450-491.

Kahn, L. (2008). Builders of the Pacific Coast. Shelter Publications, Inc.

Prairie Green Roofs: *The Alberta EcoRoof Initiative*

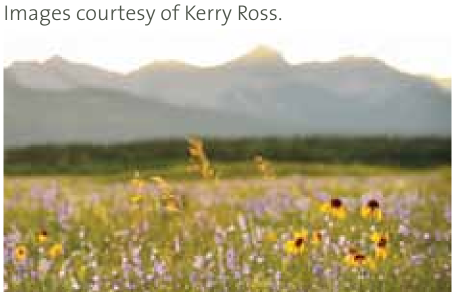
By Kerry Ross, B.Arts & Sciences, BArch, MRAIC, LEED® GA, GRP, Principal, Green T Design

Many have insisted that green roofs weren't relevant or useful on the Prairies given our lengthy winters and all too short summers. To those who build green roofs and love to garden, our climate can certainly be a challenging one given our short growing season, late spring blizzards, high variability in both daily and seasonal temperatures, not to mention the Chinook wind phenomenon which offers a unique perspective on green roof design. Many of us in the local green roof industry have resorted to creating our own recipes for success.

It was in this context and culture that the Alberta Ecoroof Initiative (AEI) was founded in 2004 to learn about green roofs through hands-on experience. The AEI is a long-term project designed to increase public awareness and experiment with green roof systems and plant species. Located in Innovation Park just north of the University of Calgary (Alastair Ross Technology Centre), this project has not only demonstrated the viability of green roofs in Alberta's unique climatic conditions, but serves as a hub for green building leadership through tours and outreach. This summer, the roofs will be fully instrumented for new research.

Top: The Foothills of the Rocky Mountains, wildflowers and grasses of the short grass prairie.

Bottom: Alberta Ecoroof Initiative, green roof test plugs. Right: Alberta Ecoroof Initiative, green roof at the Alberta Technology Centre. Images courtesy of Kerry Ross.



While Calgary has figured consistently in the annual Green Roofs for Healthy Cities inventory, which is aimed at measuring the increase in uptake in green roofs in North America, this inventory captures only the work of their members. It is our experience that there are many green roofs primarily on single-family residential and small commercial projects as owners long for their own patch of green. Smaller urban communities such as Red Deer, Stettler, and Cochrane have been keen to implement green roofs and develop supportive policies.

It is hoped that prominent new projects such as the Vegetated Roof Replacement Project on Calgary's Municipal Hall, the Federal Building in Edmonton, as well as a number of other experimental works including prototypes for Calgary's Parks Department and instrumented research projects at the Enjoy Centre in St. Albert, the Natural Sciences and Engineering Research Council of Canada-funded project at the University of Calgary as well as the AEI in Innovation Park, may further advance better understanding and regionally appropriate designs.

While some projects initially struggled, failed to live up to their design intent or required remedial work, this has not deterred those strongly committed to living architecture in the province. Some of the common reasons for these shortcomings include:

- Failure to install anti-erosion strategies in wind-prone sites.
- Lack of maintenance plan or budget resulting in no site reviews or upkeep.
- Formal design patterns misaligned with maintenance budget.
- A one-size-fits-all design that ignores building geometry and/or microclimates.
- Insufficient growing medium depth relative to selected plant species.

Benefits to the Region

The flood of 2013 in Southern Alberta is Canada's largest natural disaster and caused $1.7 billion in damages for which we will feel the effects for years to come. It is hoped that we use this window of heightened awareness to aggressively move forward with much needed change to the way we protect the quality of our city and watershed including the implementation of green roofs as well as other low impact development strategies to build resiliency into our city and region.

Other key benefits to our region include the provision of rooftop amenity space and habitat for biodiversity, building energy efficiency and the protection of waterproofing of roof assemblies.

Another potential benefit is to make green roofs more ecological where the inputs to and outputs from are kept to a minimum. Opportunities abound for experimentation with new aesthetic designs on rooftops for a blending of urban conservation with contemporary expressions to create projects that are exciting and well suited to the prairie ecozone. SL

Top: The Alberta Flood. Image courtesy of Daniel Nguyen.

Bottom: Nose Hill Park, Calgary. An example of a short grass prairie. Image courtesy of Randy Sharp.

THE BUSINESS OF LIVING ARCHITECTURE:

Green Roofs and Wall Systems

By Ron Schwenger, Principal, ARCHITEK

"The entire fruit is already present in the seed." TERTULLIAN

VanDusen Botanical Garden Visitors Centre green roof by Sharp & Diamond Landscape Architecture and Cornelia Oberlander. Image courtesy of Nic Lehoux.

The seeds planted by the pioneers of living architecture, over a decade ago, have created a thriving new cottage industry in British Columbia. Green building professionals like Cornelia Oberlander, Dr. Maureen Connelly, and Randy Sharp were well ahead of the curve when they articulated their vision for green roofs and living walls. Today's green roof and living wall specialists have the metrics, the mechanics, and the design tools, as well as the commitment to maintain and monitor living architecture for long-term performance. By collaborating with the design team and partnering with the green roof and wall industry, we share the collective vision to transform the urban landscape.

"Living architecture is defined by the integration of inorganic, non-living structures for superior ecological, social, and economic performance." The Rise of Living Architecture by Steven W. Peck.

So what does that mean? It means that performance and longevity should trump low-cost installations. Living buildings should be thoughtfully designed and executed with both infrastructure and horticulture given equal weight. In the absence of established standards such as American Society for Testing and Materials (ASTM) or FLL (Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau), a few basic principles are provided in this article to ensure that the green façades, living walls, or green roofs have the best chance of not only surviving, but thriving.

Extensive green roofs – typically have (lightweight) growing medium at a depth of 4-6 inches (100–150mm). Extensive green roofs may be retrofitted onto an existing building or planned as part of new construction.

Intensive green roofs — or more commonly called "rooftop gardens", or "landscapes over structure", typically have a depth of 8-48 inches (200-1200mm) of growing medium to support trees, shrubs, lawn, sport fields, basketball courts, private patios, outdoor amenity spaces, urban plazas, water features, garden structures, and/or urban agriculture. Intensive green roofs often require more intensive maintenance, structural loading, and significantly more cost.

Basic Principles

- Select a proven engineered build-up from a green roof (GR) system supplier with a proven track record locally.
- Collaborate with the landscape, architectural, structural, and building envelope consultants.
- Scope of work for the supply and installation of extensive green roofs should be included under Division 7, Roofing.
- **Important**: Use engineered growing media company that meets FLL standards. The balance of organics, lightweight aggregates and other materials is critical to the

"From a small seed, a mighty trunk may grow." AESCHYLUS

Greenscreen green façade at MEC North Vancouver store designed by Sharp & Diamond Landscape Architecture, supplied and installed by Architek. Image courtesy of Randy Sharp.

long-life of a healthy thriving green roof. Refer to the FLL Guidelines for the Planning, Execution and Upkeep of Green-Roof Sites.

- Select a community of plants based on local conditions and climate hardiness zones.
- Ensure that the depth of the growing media matches the requirements of the chosen plants and rooting systems.
- Protect the membrane with a compatible green roof build-up system including protection board (for intensive GRs and urban agriculture), mechanical root barrier, drainage layer or integrated drain mat, moisture retention fleece and other elements.
- Select an experienced, certified installer, preferably a Green Roof Professional (GRP). For more information, visit Green Roofs for Healthy Cities www.greenroofs.org and attend Cities Alive in Nashville, Tennessee November 12-15, 2014, www.citiesalive.org, or the Portland Ecoroof Symposium, May 21, 2014 www.portlandoregon.gov/bes/53845.

Green Facades — trellis systems or cable structures installed for climbing plants to grow vertically without attaching to the surface of the building.

Basic Principles

- Collaborate with the architectural team to design the building's structure to support a green façade.
- Retrofit existing buildings with either attached or freestanding green facades.
- Select climbers to match the orientation of the wall (N, S, E, W), the microclimate, and soil conditions to allow sufficient soil volume for the rooting zone to support top growth.
- Avoid planters that may be too small for climbing plants that may grow 30 or 40 feet (9–12m) in height.
- A 24-month establishment maintenance period is essential for good foliage coverage of the climbing plants.
- Remove the nursery stakes and ties and train the vines to spread out horizontally and vertically.

- Include a maintenance contract at the time of tender to ensure regular on-going maintenance. For some walls, that may only entail two visits per year.
- In the Spring, check for winter damage and tightening of brackets, especially if a stainless steel wire rope or web net is used, as well as a greenscreen or rigid trellis panel system. Train new branches to spread out.
- In the Fall, after the climbers finish blooming, prune to encourage lateral growth, production of fruit (if desired), fragrant flowers, and fill in at the base where there may be more shade.

Living Walls — part of the building envelope system where plants are actually planted and growing in a wall system. For more information, please read the next article, Living Walls, Water Management, and Lighting by Nicolas Rousseau and Randy Sharp.

In summary, green roofs, living walls, and green facades offer multiple benefits including biophilia that allows building occupants to be in contact with nature. They provide clean air, a positive soundscape, a productive work environment, and comfort for building occupants. With proper installation and a commitment to maintenance, we can all breathe much easier, and enjoy the cool fresh oxygenated air. SL

Living Walls, **Water Management,** *and Lighting*

By Nicolas Rousseau, BSc, MSc, Horticulture Engineer and Randy Sharp, MBCSLA, FCSLA

ModuloGreen interior living wall.
Image courtesy of Nicolas Rousseau.

Green walls offer multiple benefits including biophilia that allows urban dwellers to be in contact with nature. They provide clean air, a positive soundscape, a productive work environment, and comfort for building occupants. Greens walls are trendy. Retail stores, hotels, and restaurants attract customers, integrate branding, and display merchandise in front of green walls. With the massive shift in the demographic of the baby boomers, we are building new housing for aging in place and health care facilities with therapeutic programs.

A key component of a healthy community is establishing and maintaining an urban forest. If there is not sufficient soil volume or space to plant large canopy trees, green facades offer bio-mass and conductivity with the greater landscape from street level up to the green roof and to interior spaces. Vertical gardens also play an important role in providing places for urban agriculture in tight spaces and gardening on balconies for high density residential.

Green walls offer expanded project scope, increased fees and heightened visibility for landscape architects – yet lingering concerns over viability, liability, and effectiveness have kept practitioners from adding green wall design to their professional service offerings. BCIT is offering *GROW 1500 – Green Walls Course*, an introductory course that identifies opportunities and challenges associated with green walls. The following is a sampling of course content:

Despite the downturn in the US economy, the green wall industry has enjoyed stellar growth. The current size of industry in North America (NA) is estimated at $70M, the annual growth in revenue is between 30–50%. In 2005 we imported French and Japanese technology. In 2013, we exported British Columbian technology to four continents including Europe and Asia.

If we assume that landscape architects calculate our fees at 10–15 % of construction value for specialty projects, we can assume $7–10M in professional fees for green wall design and contract administration on an annual basis. There is a lot of coordination with the owner, the architect, structural, and mechanical engineers for water supply and interior bio-filtration wall, as well as nursery supplier and/or greenhouse for pre-vegetation, and maintenance contractor.

On-going maintenance: Partnerships with local nurseries and landscape horticultural specialist contractors generate another $15M in maintenance fees (NA).

Liability concerns and how to lower risk, collaborative design and division of labor. This is a major commitment by the owner or property manager. On a 1000sq foot living wall, the owner may invest $150K to install and another $30K per year to keep in beautifully maintained.

Structural, architectural, MEP, horticultural design considerations: a bio-filtration wall can be a key component of a building envelope or interior mechanical system, not merely an add-on for decoration.

A bio-filtration wall is a type of active interior living walls that functions as a vertical hydroponic garden complete with a re-circulating water system. Fabric pockets on a large frame support plants in a bare root condition. "As a living air filter, it removes common indoor contaminants and improves the quality of the air. Indoor air is actively drawn through the green wall of plants, activating highly specialized, natural biological processes to break down pollutants into their benign components of water and CO_2. Clean cool air is distributed throughout the space via the mechanical system". (www.nedlaw.com)

The demand for this new course is actually symptomatic of the marketplace: home owners, municipalities, retail managers and office workers have been hearing of the positive impact of plants on health, productivity, and well-being. At the same time they, are fully aware that new technologies and systems make it possible today to install beautiful and healthy living walls that were not possible ten years ago. Yet there are still very few certified contractors that can properly educate their customers and answer their questions.

Green wall trained design professionals, policy makers, property managers, horticulturalists, and contractors have the knowledge to understand the nuances of green walls; differentiate living walls from green facades; decide what technology is most appropriate to vegetate a specific wall; and understand the different components involved to plan, design, install, and maintain leading edge technologies.

They are knowledgeable in plant choices, growing medium, irrigation, as well as team management, job site logistics, and maintenance in order to guarantee the long-

ModuloGreen exterior living wall. Image courtesy of Nicolas Rousseau.

term performance and healthy appearance and can identify horticultural engineering issues that can lead to failures.

In addition, green wall trained professionals can:

- Recognize the difference between a living wall and a green façade, hydroponic and soil based.
- Understand the different components involved including structures, frames, attachments, water proofing, water supply, automatic controls and monitoring, cold climate applications, maintenance equipment, and BC Work Safe requirements.
- Evaluate the feasibility and options for green walls for new and existing installations.
- Select appropriate plant material and system(s) for different wall applications; interior with supplemental lighting, bright interior with natural daylight, and exterior N, S, E and W.
- Propose the most appropriate green wall system to meet the design intent, living architectural metrics; environmental mandate, and specific site / bio-climatic conditions.
- Design a living wall, develop a logistics plan, and a project management timeline for an efficient green wall installation.
- Create a complete maintenance plan, a contract, and long-term care requirements.
- Prepare a cost estimate or a quotation for a green wall project of your choice.
- Evaluate the risks, challenges and the opportunities related to your project.

Living walls or integrated vertical garden systems comprise two different technologies available in the marketplace: hydroponic and soil based systems. Both technologies present pros and cons including different water requirements. For instance, a hydroponic living wall relies on a retention mat and/or horticultural rock wool to absorb and retain the nutrient solution, while a soil based retains more water for a longer time, reducing the weekly irrigation frequencies. Soil based living wall system are heavier and may require special installation equipment such as a frame integrated with a scissors lift platform. The fabric based hydroponic living walls may annually use 700–800L of water per square metre, with significant loss through evapotranspiration. Enclosed soil based living walls may only require 200 – 300 L of water per square metre per year. A hybrid hydroponic enclosed rock wool vertical garden systems may require 400 – 500 litres.

For interior installments with supplemental lighting, both hydroponic and soil based living wall technologies have the similar lighting requirements. To ensure healthy attractive plants for easy maintenance, minimum light levels are required. It is extremely important to always choose the plants according to the natural light available on-site. However, in our northern climate, most indoor applications require some supplemental metal halide lights or energy efficient full spectrum LED lights for growth, flowering, maintenance, and special effects.

In summary, living walls are part of a larger family of engineered greening systems that include green roofs, green facades (climbers attached to structures), vegetated landscape retaining walls, and integrated planter systems and with cascading plants. Living walls typically require plants adaptable to more extreme conditions and stress, inside or outside, free standing or attached to buildings or infrastructure. SL

For more information on GROW 1500, visit www.bcit.ca or contact Nicolas Rousseau at nicolas@bynaturedesign.ca or www.bynaturedesign.ca.

Green Roofs IMPROVE ACOUSTIC SOUNDSCAPE EXPERIENCE

By Maureen Connelly, MAIBC, PhD

Intensive rooftop garden at Broadway Tech Centre by Sharp & Diamond Landscape Architecture. Image courtesy of Randy Sharp.

The capacity of green roofs to increase the ecological performance of buildings and contribute in a positive manner to the urban soundscape has been determined by recent investigations of the acoustical characteristics of green roofs. The research to date confirms that green roofs increase the sound isolation of roof systems, increase the impact isolation of roofs, increase the sound absorption of the roof surface, and alter the rooftop soundscape. To advance the state of practice, findings are presented in an interdisciplinary manner as design principles for landscape architects to address the acoustical quality of building interiors and rooftop soundscapes.

Implementing a green roof system can provide a decrease in the amount of noise transmitting through the roof by at least 50%. Transmission loss (TL) characterizes the reduction of sound level due to energy losses as a result of the sound transmission through an assembly. Extensive green roofs increase TL from 5 to 10 dB at low frequencies, up to 20 dB at mid frequencies, and more at higher frequencies relative to a comparable reference roof. Substrate depth affects the TL however, the effect of different green roof plant communities on TL are not significant; root structures which increase the porosity of the vegetated substrate only minimally reduce TL as the plant community establishes.[1] The noise pollution may be external, such as in residential and mixed-use densification developments below flight paths; green roofs will reduce noise level for the inhabitants. Alternatively, the excess noise level may be generated internally, and the landscape/acoustical design objective is to meet city noise level ordinances; night clubs in mixed-use downtown zones and district water pump stations which operate 24/7 in residential communities are examples of sites which could benefit from green roof technology.

Impact noise from people walking on roofs and using the rooftop for activity is effectively eliminated by a green roof. Field test of the 75 mm and 150 mm green roofs, the two-ply SBS reference roof and common deck material at the BCIT Green Roof Research Facility, provided the first data on the impact isolation classification (IIC) of green roofs. The IIC quantifies the ability of a floor roof assembly to isolate impact noise like footfall or objects being dropped or dragged. International building codes requires a minimum IIC of 45 for field test in new construction, under this parameter, the SBS reference roof (IIC 41), and concrete pavers with plastic pedestals (IIC 44) do not comply with the requirement. The concrete pavers on rubber pad (IIC50) the wooden deck on polystyrene (IIC 55) complied; however, the two green roofs out performed both of these decks by providing double the isolation with an IIC of 64. The green roof with a substrate depth of the 150 mm roof did not have a measurably increase of isolation over the 75 mm of substrate depth.[2]

The green roof acts as a sound attenuating absorptive ground on the roof. Green roofs have a diverse complexity of porosity and moisture content in established plant communities; as such, the sound absorption coefficients of green roofs range significantly.

Noise Reduction Coefficient (NRC) from 0.2 to 0.6 indicates the potential to absorb between 20 and 60% of the incident sound energy.[3] However, it is critical to note that the NRC is not dependent on the depth of substrate once a plant community is established. As an example, a moss-sedum community has a lessor NRC relative to grasses on rooftops: this is due to the moss' need to retain water at the surface level unlike deep rooted grasses. The green roof with highly absorptive properties can be used as a source control for rooftop mechanical equipment noise propagation. The absorption mechanism attenuates street level noise which diffracts over the roof edge from street level and propagates across the green roof.[4] The absorption capacity of green roofs will reduce reverberation within rooftop spaces enclosed by walls by reducing the reflection of sounds from equipment and activity, such as foot traffic and movable equipment, from typically highly reflective building materials.

Green roofs alter the urban soundscape experience on the rooftop. The soundscape is not only altered by the absorptive characteristics of the green roof which reduces noise propagation, the balance of natural sounds changes with the inclusion of the plants on the roof. On the rooftop, natural sounds can be introduced through plants, through the habitat supported by plants, and through the interaction people have with the green roof plant community. Natural sounds are known to reduce stress, cardio disease, and increase cognitive development and performance. In the two rooftop case studies investigated, the rooftop with plants, trees and green roofs had more than six-times the incidence of bird calls, bird sounds, and sounds of water, than a rooftop without vegetation. The sounds of water can be enhanced through the design of water harvesting and distribution. The sounds of wind contains contextual information regarding the external environment, and the plants – as different leaf and branch structures generated sounds at different frequencies and rhythms.[5] Birds and insects which inhabit green roofs introduce new sounds. High sound reflections from urban surfaces are known to affect communications within bird communities.[6] Greening rooftops and creating sky paths will affect bird population, and appropriate green roof plant species will provide habitat for songbirds, bees, and even crickets at the rooftop scale.

Moving forward, urban places such as parks and courtyards have been identified as having opportunity, through soundscape planning, to increase the aural experience and human enjoyment.[7,8,9] Rooftops can now be added to this list. The contribution of green roofs as a design solution to meet an acoustical program and for soundscape planning is site specific and depends on the overall design of the building and the site context. The acoustical and soundscape benefits of green roofs will only be realized if design professionals (urban planners, landscape architects, architects, and engineers) recognize the potential of green roofs and embrace a design program in which the sonic quality of occupied spaces on rooftops is of concern. Restorative design process are a point of entry for design professionals to address the acoustical quality of outdoor spaces and utilize new knowledge of the acoustical characteristic of green roofs and their potential contribution to the ecological performance of the building envelope and the soundscape.

Many of the acoustical characteristics design principles of vegetated roofs may be applied to living walls. Current research has been initiated on the acoustical potential of living walls, internationally and at the BCIT Centre for Architectural Ecology. Stay tuned! SL

Extensive Green Roof Plants in absorptive, lightweight mineral substrate. Image courtesy of Randy Sharp.

References

1. Connelly M. Connelly and M. Hodgson, "Experimental investigation of the sound-absorption characteristics of vegetated roofs", submitted to J. Acoust. Soc. Am., 17 Jun 2013
2. Rodriguez, J. R., Connelly, M., 2013, Comparative field test evaluation of the Impact Insulation Class (IIC) of roofs: 11th Annual Greening Rooftops for Sustainable communities, San Francisco 2013
3. M. Connelly and M. Hodgson, "Measurement of the sound absorption characteristics of vegetative roofs", Canadian Acoustics 38(3) 150-151 (2010)
4. Van Renterghem, T., Botteldooren, D. (2011). In-situ measurements of sound propagating over extensive green roofs. Building and Environment, 46(3), 729-738.
5. Dramstad W. E., Olson, J. D., Forman, R.T.T. (1996). Landscape ecology principles in landscape architecture and land-use planning Harvard University Graduate School of Design; Washington, DC, Island Press, and the American Society of Landscape Architects.
6. Roberts J.P., Kacelnik, A., Hunter, M.L. (1979). A model of sound interference in relation to acoustic communication. Animal Behaviour, 27, 1271-1273.
7. Ulrich, R. S., Simons, R. F., Losito, B. D., Fiorito, E., Miles, M. A., Zelson, M. (1991). Stress recovery during exposure to natural and urban environments. Journal of Environmental Psychology, 11(3), 201-230.
8. Kaplan, R.,S., Ryan, R. (1998). With people in mind: Design and management of everyday nature. Island Press
9. Brown, A. L., Muhar, A. (2004). An approach to the acoustic design of outdoor space. Journal of Environmental Planning and Management, 47, 827-842.



Left: Sole Food Urban Farm, design by Projects In Place Society. Image courtesy of Jim Parkes.
Right: Sole Food Urban Farm. Images courtesy of Bryce Gauthier (top) Randy Sharp (bottom).

IN DEFENCE *of* URBAN AGRICULTURE

By Bryce Gauthier, MBCSLA, Director of The Projects in Place Society
with Contributions from Heather Wray, Engineering PhD Candidate, University of Toronto

To some, the idea of urban agriculture is an esoteric pursuit: the focus of "foodies" and young idealists—a quaint idea. Yet a closer look at projects here in Vancouver and the Downtown Eastside (DTES) in particular, illustrates how urban agriculture can address a range of important issues.

SOLEfood: Vancouver's First "Street" Farm – The first SOLEfood farm was built on a vacant lot, transforming 15,000 square feet of derelict and dangerous space into productive "crop land". Its operators had ambitious goals: to improve the urban environment; provide training and employment opportunities for local residents; give the community members access to fresh produce; and advance the concept of urban farming in Vancouver. Projects in Place designed the farm and organized a series of volunteer builds to get the farm operational.

Four years later, SOLEfood is a thriving enterprise with farms spread throughout the DTES. Beyond the success of the enterprise itself is the impact it has had on the community and its residents. But large scale urban farming is not without its detractors. Because those who lease the spaces sometimes get a tax receipt, there is a cost in the form of lost tax revenue. This underscores a larger issue: even derelict spaces can be expensive. Therefore, finding adequate space can be a challenge.

The Sky Garden, Toronto: A High Tech Garden – Cities are highly controlled environments where issues like waste, noise, smell, and vectors are tightly controlled. These factors, combined with spatial constraints and the temporary nature of many urban farms has led to the consideration of roof tops as a potential alternative to empty lots. Rooftop farming, however, presents its own challenges.

Heather Wray, an Environmental Engineer and early pioneer in the rooftop gardening industry co-founded The Sky Garden, a lightweight rooftop vegetable garden at the University of Toronto. The Sky Garden produces over 500 pounds of organic vegetables every year and serves as a living laboratory for research and education. Automated drip irrigation and rainwater capture reduce potable water consumption as do initiatives like on-site seed saving and composting. Lightweight greenhouse structures extend the growing season and a portion of the harvest is preserved with a solar dehydrator.

The Sky Garden's semi-hydroponic design minimizes the depth of growing media so as not to exceed the structural capacity of the building. Semi-hydroponic or fully hydroponic container gardens typically do not exceed a weight of 100 kg/m2, comparable to the capacity of extensive green roof systems, and lower than most intensive green roofs that would traditionally be required for food production.

SOLEfood II: Rooftop Farm – Stymied in their attempts to find new sites on the ground and inspired by the idea of roof top farming, SOLEfood identified a potential site on a parkade in Chinatown. It was a long process to determine that the parking structure could be used for roof top farming. Most parkades are not built to the same structural standards as occupied space, so it took considerable engineering effort to develop a workable farm plan that did not exceed the structural limitations of the roof deck. In addition, there were a long list of code issues that needed to be addressed, for instance: multiple code-compliant egress points were necessary, as well as a fire suppression system, code compliant railings, and safety lighting.

Ultimately, these design challenges were overcome, but a disagreement between the building owner and SOLEfood scuttled the project, proving that once again, the biggest challenge to urban farming is finding an appropriate space.

Aeroponic Design: Ken Spencer Science Park, Science World – A child's concept of food typically begins and ends at the dinner plate. One of the greatest benefits of bringing food back into the city is giving kids a better understanding of where their food comes from as well as the consequences associated with food production.

Ken Spencer Science Park is a wonderful interpretive children's open space designed by PFS Studio as part of Science World's recent facility upgrade. Projects In Place was engaged to design and build a series of urban agriculture elements designed to demonstrate high-tech methods of food production. An array of green roofs, vertical planters, raised garden beds were installed and centred around a 2m tall aeroponic planter, which towered over children, bursting with vegetables.

Aeroponics, a method of growing plants using drip or micro-head irrigation mist instead of conventional irrigation and soil is a closed-loop system that uses a fraction of the water and nutrients as conventional agriculture. This installation was a great opportunity to introduce children to some of the challenges and potential solutions that are associated with food production.

The Rice Block: Addressing the Problem of Food Scarcity in the DTES – Residents who face economic challenges make their food choices out of necessity. In the DTES, many get sustenance from a mix of soup kitchens, convenience stores, and dumpsters, making the pursuit of a healthy diet difficult. Compounding matters is that fact that the area is effectively a food desert, with few grocery stores in the vicinity.

The garden built behind The Rice Block housing development provides food for women battling addiction. It gives them the opportunity to access healthy produce, but beyond its function, it is an example of how small community gardens can have a positive effect on people who are facing significant economic hardships. The garden brings residents together in the pursuit of growing easy to prepare produce in a safe and supportive environment.

The Keefer Garden Project: A Multi-Generational Approach to Urban Agriculture – While groups dealing with dependency and mental health issues command much of the attention, there is a less well understood segment of the DTES that is also under threat: the elderly.

Beginning in the 1970s, suburbanization, drug addiction, and crime, coupled with economic stagnation began to push/pull families out of the neighbourhood, but those who did not marry or start families tended to remain. Many were immigrants from a wide range of cultures who relied on a support network of churches, temples, markets, barbershops, low rent bars, and gambling dens. As landlords capitalize on the opportunity to rent their spaces to increasingly upmarket businesses, the institutions that were once providing support are disappearing, leaving long-time residents alone and increasingly isolated.

To address this issue within the Chinese community, an empty lot will be converted into a multi-generational community garden project with a special focus on growing traditional Chinese vegetables. The primary objective is to give elderly Chinese the opportunity to get exercise and stay engaged in their community.

Vancouver Buddhist Temple – The Vancouver Buddhist Temple was established in 1904 and has stood at its current location in front of Oppenheimer Park for more than 40 years. Like many of the cultural buildings in this neighbourhood, their congregation has gradually moved away, while those who remain are older and left with the burden of maintaining a culturally significant, yet deteriorating building.

Projects In Place has been working with the buddhist temple to integrate a vertical farming project into the temple. With support from the City of Vancouver, the project would grow culturally significant Japanese vegetables using aquaponic technology. Aquaponics, is a food production system that combines conventional aquaculture, with hydroponics in a symbiotic environment, incorporates the excretions from fish as a fertilizer to feed plant production.

However, this project is about more than just using a fancy technology to grow vegetables. The produce will be donated to an adjacent shelter. The display is planned on an exterior wall in order to make it visible to the public. The temple hopes the display will bring different cultures and generations together and to attract new members. There are also plans in place to convert unused classrooms into a learning environment to teach people about the benefits of urban agriculture.

Conclusion – Time will tell if the pursuit of urban agriculture really changes the way we produce, consume, and think about food, but it is important to bear in mind that the impact of this kind of food production extends beyond the simple metrics of production. Measuring urban agriculture in quantitative terms misses the point. There are many other important reasons why this kind of practice is important and relevant to our communities. SL

The Dynamics of Bio-Engineering *and* Green Infrastructure

By David Adkins, Project Consultant, Denbow

Cascade Live Retaining Wall by Denbow.
Image courtesy of David Adkins.

All life depends upon health of the biosphere. The biosphere system consists of the continuous cycling of matter. In the last 250 years, has humankind's intervention been with global consequences? Bio-engineering, or bio-mimicry, redresses this imbalance by minimalizing the environmental impact of development by using green infrastructure technologies that replace, or integrate with, costly grey infrastructure such as rain gardens, bioswales, green roofs, compost blankets, and vegetated mechanically stabilized earth (MSE) walls. Products from waste streams, for example, forestry residuals and compost, can be diverted from landfill and be reused in these technologies.

The Challenge

In the developed West, 75% of the population lives near polluted rivers and landscapes that include: coliform bacteria, metals—Cu, Cd, Cr, Ni, Pb, Zn, nutrients, nitrogen and potassium, high turbidity TSS (clay and fine silt sediment) and petroleum hydrocarbons—motor oil, diesel fuel and gasoline. Storm water run-off from the built environment and rising river and sea levels have attributed to increased flooding and the need to manage polluted discharge. The main sources of storm water pollution include: parking lots, residential development, highways, streets, rooftops, golf Courses, lawns, pet parks, farms, industrial development and processes, and construction. Priority areas that have incurred damage include: rivers & lakes (eutrophic), trout-salmon bearing streams, reduction of natural capital, beaches and shorelines, red data endangered species, and habitats such as wetlands, forests, and grasslands.

Living Architecture Metrics: LID, LEED, BREEAM, ESTIDAMA

With the emergence in 1990 of ICLEI (Local Governments for Sustainability formerly International Council for Local Environmental Initiatives), sustainable development and storm water management has become a global priority. The use of sustainable performance rating tools, is now commonplace such as Building Research Establishment Environmental Assessment Methodology (BREEAM), Leadership in Energy & Environmental Design & Sustainable Sites (LEED®), Low Impact Development (LID), and ESTIDAMA (Abu Dhabi Urban Planning Council's rating system), to assess and "score" the relative sustainability standards of buildings, and associated landscapes. Since 1990, 200,000 buildings worldwide where awarded BREEAM certification. Many of these organizations then moved on to assess the sustainability standards of a community as a whole. For example, LID assesses restoring natural site hydrology for residential developments. In 2009, Toronto became the first city in the world to enact a green roof bylaw, Masdar City in Abu Dhabi became the first Carbon Free City development, and the VanDusen Botanical Gardens Visitor Centre became the first Canadian Living Building certified by the Cascadia Green Building Council.

Designing with Green Infrastructure and Compost Soil Products

Green infrastructure mimics the natural processes that cools, absorbs, filtres, stores, replenishes and releases water, and reflects sunlight and encourages plant establishment. Green infrastructure can also be designed to integrate with storm water management plans. Tools to deliver LID including:

- Green Roof Systems
- Vegetated MSE retaining walls
- Green facade walls
- Bioswales and rain gardens
- Erosion and sediment controls
- Runoff control ecoblankets
- Vegetated filtre strips
- Engineered growing media
- Channel liners and check dams
- Streambank and slope Stabilization
- Biofiltration and bioretention Systems
- Terraseeding and hydroseeding
- Flood alleviation dykes and berms
- Slope interruption and run-off diversion
- Detention ponds-surface/subsurface
- Permeable paving

Many of these products incorporate forestry and composted waste products. Compost, has been hailed by experts from across many disciplines and professions as a natural solution for successful re-vegetation, establishment and long-term plant growth. The physical and microbial benefits of

Top Left: BC Hydro Field Operations Centre, Maple Ridge by Sharp & Diamond Landscape Architecture Inc.,

Filtrexx terraced hillside by Denbow. Image courtesy of Randy Sharp.

Top Right: South view eco-building in the UK. Image courtesy of David Adkins.

Bottom: Terra seeding by Denbow. Image courtesy of David Adkins.

composts are extraordinary, including the take up and breakdown of pollutants. Performance parameters must be applied to all composting technologies and include: oxygen concentration, FAS and particle size and structure, carbon to nitrogen (C:N) ratio, moisture content, temperature, and pH level. Approved product specifications are available from sources such as the Compost Council of Canada, Filtrexx International, and more recently, Metro Vancouver's compost specification review.

Based on storm water run-off curve, USDA SCS (final infiltration rate of 0.15 to 0.30 in./h) a parking lot driveway, storm sewer or roof scores 98 and a vegetated- seeded 2" Compost Blanket 55, which is the same score as natural woodland 55. (SCS runoff curve number is an empirical parameter used in hydrology for predicting direct runoff or infiltration from rainfall excess).

The key benefits green Infrastructure products and compost are:

- Removal and microbial breakdown of pollutants and protecting water quality of surface and ground waters.
- Reduction of carbon foot print by diversion of natural materials from waste streams, e.g. composted forestry residuals.
- Increase of natural capital and developing greenways to promote regional interconnectivity by building sustainable urban green space planning networks.
- Control of erosion, reduction of run-off, turbidity, and peak flows from urban developments, roof water, and other stormwater.
- Improvement of the quality of and minimizing polluted water discharges to the natural environment
- Added value while minimizing development costs such as drainage grey infrastructure costs.

To conclude, urbanists, landscape architects, architects, engineers and city planners have the unique opportunity to advance biophilic sustainable city design that extends beyond conventional urban parks, and building-centric design to integrating green infrastructure with existing natural capital, corridors and resources. It is about re-defining cities as places of, sustainable development, landscape character, livability and restorative nature.

Bibliography

1. Denbow ESC/Green Infrastructure Presentations
2. The Sustainable Site Design Manual For Green Infrastructure & Low Impact Development, Dr Britt Faucette, Alexander Marks, Rodney Tyler
3. USDA SCS
4. European Landscape Convention (ELC)
5. Green Infrastructure Coalition Ontario

ECO-PRIORA™

SF RIMA™

UNI-ECOLOC®

UNI ECO-STONE®