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INSIDE THIS ISSUE:

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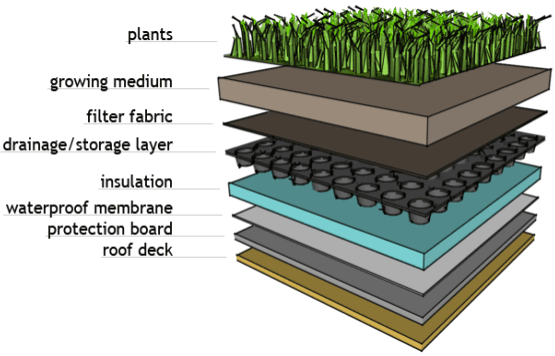
GREEN ROOFS: AN OVERVIEW

BY JAY LAZZARIN

The current movement of green architecture in North America has been present for approximately the past ten years. In reality, green roofs have a much longer tradition in Europe and have earlier ties to North America, utilizing older technology and heavier materials. The intent of this article is to provide a general overview on the basic components, types of green roofs, and their benefits.

Basic Components

All green roof systems contain a number of essential components that should be specified on all projects. As illustrated on the sketch below, these include a waterproofing membrane, insulation,



root barrier, drainage layer combined with filter cloth, growing medium and vegetation.

There are also a number of optional components which, depending on design, can be instrumental to a project's ability to meet its performance goals. These include a water retention layer, irrigation system, water features, walkways & patios, curbs and edging, railings and lighting.

The products and installation methods will vary from project to project to meet design requirements, budget and project constraints. Numerous green roof products are on the market which respond to specific design opportunities and constraints.

Green Roof Categories

There are three basic categories of green roof infrastructure, based on the depth of the growing medium and its ability to support particular plant species: **extensive, semi-intensive and intensive**. Each of these three types have different characteristics as described in Table 1-1 (at end of article).

Generally speaking, each category of green roof provides design and performance based opportunities which reflect its characteristics. Some of these design characteristics are as follows:

- the deeper the growing medium, the greater the diversity of plant species.
- extensive roof systems have lower capital and maintenance costs and maybe designed with no irrigation system. (In most situations, semi-intensive and intensive roof systems require irrigation systems).

Extensive green roof
Nanyang Technological University, Singapore

- intensive roof systems provide the best insulation properties and storm water management.

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Intensive green roof system
Vancouver Public Library, Vancouver, BC

Benefits

Green roofs provide a wide variety of private and public benefits. Some benefits are common to all projects, while others result from specific design and owner objectives. The challenge of green roof designers is to develop green roofs with multiple benefits, integrating the green roof design into the overall function of the building. Several common and project specific benefits associated with green roofs are as follows:

Reduction of Urban Heat Island

Green roofs are recognized to have a positive effect on reducing the Heat Island Effect, minimizing impact on microclimate and human and wildlife habitat.

Biodiversity -Green roofs can provide important refuges for wildlife in urban areas.

Water - Green roofs can significantly reduce the surface run off volumes and rates of rainfall leaving roofs. As a source control mechanism in the Sustainable Urban Drainage System green roofs can help reduce flash floods as a consequence of intense rainfall events. This will become increasingly important as a consequence of climate change.

Green roofs also improve the quality of water, and although the amount of water is reduced, it is possible to harvest rainwater from roofs which have been greened.

Thermal Performance - Green roofs cannot be given a U-value at present, however they have been shown to significantly reduce the need for air conditioning in summer and can provide a degree of insulation in the winter.

Sound Insulation - The combination of soil, plants and trapped layers of air within green roof systems can act as a sound insulation barrier. Sound waves are absorbed, reflected or deflected. The growing medium tends to block lower sound frequencies whilst the plants block higher frequencies.

Urban Agriculture - Food products could be generated from propagation on green roofs.

Air Quality - Airborne particles and pollutants are filtered from the atmosphere by the substrates and vegetation on a green roof.

Amenity Space - In dense urban environments there is often a lack of green space for residents. Roof Gardens and roof top parks provide valuable space for relaxation and refuge.

Extended Roof Life - Although green roofs are relatively new in North American, European examples have show that the life span of a roof membrane can be extended 2 to 2.5 times longer.

With all these benefits, why aren't more green roofs being developed? As you can surmise, the primary reason is capital cost. The cost to develop an extensive green roof, (the cheapest of the three categories), is $10 to $19 per square foot. Hopefully, as new technologies and materials become more readily available, this cost can be reduced. In addition, as more municipalities (such as Portland, Oregon; Chicago, Philadelphia and Toronto) embrace the numerous benefits of green roofs and offer incentives for their installation, it is hoped that bonuses, cash fee rebates and incentives to develop green roofs will be available in more cities to accelerate their construction.

Semi-Intensive green roof system
Agora—UNBC, Prince George, BC

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Table 1-1

CHARACTERISTIC	EXTENSIVE	SEMI-INTENSIVE	INTENSIVE
Growing Medium Depth	6" or less	25% above or below 6"	More than 6"
Accessibility	Often inaccessible	Maybe partially accessible	Usually accessible
Fully Saturated Weight	Low 10 - 35 lb / ft^2 (48.8 - 170.9 kg / m^2	Varies 35-50 lb / ft^2 (170 - 244.1 kg / m^2)	High 50 - 300 lb / ft^2 (244.1 - 1,4641 7 kg / m^2)
Plant diversity	Low	Greater	Greatest
Cost	Low	Varies	High
Maintenance	Minimal	Varies	Varies , but is generally high

Chart: Green Roofs Infrastructure: Design and Installation 201
Participant's Manual
Green Roofs for Healthy Cities
www.greenroofs.org

TORONTO'S GREEN ROOF BYLAW—A MODEL

By Steven W. Peck

From Living Architecture Monitor, Fall 2011

10 years: 10.4 million square feet

Cities around the world have begun mandating green roofs on their new buildings because they turn wasted roof spaces into green infrastructure that generates multiple benefits. Toronto's leadership with the Green Roof Bylaw is helping law makers across North America. For example, in Devens, Massachusetts, they recently used the Toronto Bylaw to model their new green roof policy which also includes a requirement for accredited Green Roof Professionals (GRP's) to work on green roof project teams.

Toronto's Bylaw has already resulted in more than 1.2-million-square-feet of new green space planned on new commercial, institutional, and multi-unit residential developments across the City. The Bylaw came into effect January 31, 2010, and the resulting public and private green roof benefits will include the following:

- More than 125 full-time jobs related to manufacture, design, installation and maintenance.
- Reduction of more than 435,00 cubic feet (approx. 50 Olympic sized swimming pools) of stormwater each year.
- Tangible reduction of the urban heat island effect, the artificial heating of the city.
- Annual energy savings of over 1.5 million kWh for building owners and improved air quality.
- Extension of the waterproofing life expectancy which saves building owners money and reduces landfill waste.
- Aesthetic improvements and new recreational opportunities on accessible green roofs.
- Preservation of biodiversity, particularly birds, bees, and other beneficial insects and plants that support urban agriculture.

If we continue to implement green roofs in Toronto at this rate, we can see significant annual impact on energy consumption and a reduction in the urban heat island effect. Environment Canada modeling has demonstrated that an area covered by 10-million square feet of green roofs, the size of 10 Queens Parks, would reduce temperatures in that area by one to two degrees centigrade and will help save tens of millions in energy costs by reducing the peak load demand in Toronto. Environment Canada scientists have estimated that the energy savings on heating and cooling generated by 10-million square feet of green roofs in Toronto are over 15 million kWh, the equivalent of running 29,593 60-watt light bulbs year-round. *For more information about Toronto's Green Roof Bylaw go to www.toronto.ca/greenroofs/overview*

FEATURED PLANT

AZALEAS AND RHODODENDRONS

On many occasions, I have been asked if Azaleas and Rhododendrons will thrive in North and Central British Columbia. There are a few hybrids which are hardy to –35°C and research is ongoing to increase this selection. The genus 'Rhododendron' is one of the largest genera of woody plants, containing over 800 species. The names 'Azalea' and 'Rhododendron' are general terms used to describe sub-groups within the genus. The few Azaleas which survive in North/Central British Columbia belong to the sub-genus Pentanthera and are characterized by being deciduous. The majority of Rhododendrons have evergreen leaves and usually two stamens within the flower, and are not hardy to North/Central BC.

Northern Lights Series of Hybrid Azaleas ("Pink Lights') *pictured at left*
Flower Color: Light pink with a sweet floral scent.
Mature height/spread: 2.4m (8'-0")
Hardy: To –40ºC

"White Lights" Azalea (*pictured right)*
Flower color: White with a slight yellow blotch, extremely floriferous.
Hardy: To –35ºC
Mature height/spread: 1.52m (5'-0")

"Orchid Lights" Azalea *(pictured left)*
Flower color: Lilac pink
Hardy: To –45ºC
Mature height/spread: 1.0m (3'-0")

Rhododendron "P.J.M." *(pictured right)*
One of the few evergreen Rhododendrons hardy to North/Central BC.
Flower color: Lavender pink flowers
Hardy: To –35ºC
Mature height: 0.6m (2'-0")
Mature Spread: 1.0m (3'-0")

SITE SELECTION AND SOIL PREPARATION

The ability to grow Azaleas and Rhododendrons successfully depends on site selection and soil preparation. For Azaleas, an area with full sun to partial sun is preferable although they will tolerate slight shade. The evergreen Rhododendrons will tolerate more shade than Azaleas and need protection from winter sun to prevent leaf burn.

Azaleas and Rhododendrons are also sensitive to extreme heat. Try to avoid selecting areas such as an exposed south side of a house where heat is reflected and can build up. Also avoid areas where wind and root competition with other plants could be a problem.

Because of their shallow, fibrous root systems, Azaleas and Rhododendrons tend to dry out rapidly and will require watering during dry periods, especially during hot summer days. With this need for irrigation, a site with good drainage is a must.

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Azaleas and Rhododendrons require an acid soil for best growth. As most of our northern soils are not acidic, the addition of compost, peat, sulphur, or ferrous sulphate can lower the pH. A pH of 4.0 to 5.5 is optimum. Organic matter should also be added liberally to the soil. Compost, manure or peat moss will provide necessary organic matter.

In our climate, Azaleas and Rhododendrons do not have many serious pest problems and pesticides are usually not necessary. If proper species and cultivars are chosen, no winter protection is needed other than that used to discourage rabbits, mice, and deer.

FEATURED PROJECT

COMMONWEALTH SENIORS COMPLEX

Client: BC Housing & Commonwealth Financial Partnership
Architect: Access Engineering & Graham Goodall Architect
Contractors: Yellowridge Construction
Landscape Architect: Jay Lazzarin Landscape Architect
Landscape Contractor: L&L Landscape & Design Ltd.
Completed: July 2012
Landscape Value: Approximately $100,000.00

A former gaming hall and associated onsite parking lot have been transformed into a medical building and a 36 unit, 4 storey senior's housing complex.

In conjunction with the senior's complex, a 340m^2 irrigated green roof was constructed on the former suspended concrete parking lot. The green roof consists of a highly valued semi-private patio, semi-intensive green roof, planting beds and two screened outdoor courtyards adjacent to two senior units. The 78m^2 hydrapressed concreted patio, located adjacent to the meeting / all-purpose room, provides the opportunity for group outdoor activities, BBQ's, personal reflection and year round visual appeal. The courtyard provides protection from sun and wind with the installation of an overhead trellis, enclosure on three sides with building walls, and on the remaining south side, a 6'-0" high stained, wood screen fence.

As 'phase 1' of a two phase housing project, the hydrapressed slab walkway will connect with the outdoor patio of an adjacent second housing development. The fence on the south boundary provides a temporary division between a united outdoor courtyard, approximately twice the current size.

Plant material consists of three varieties of Sedum, Blue Oat Grass, Virginia Creeper and Explorer Series Roses, that provide flower color during the summer months.

A SKY-LEVEL ANSWER TO THE ISSUE OF FOOD SECURITY

From Living Architecture Monitor, Fall 2011, 2011 Awards of Excellence
Award Recipient: Brooklyn Grange

Brooklyn Grange is a pioneer in rooftop agriculture. The 40,000 square foot commercial farm is located on the rooftop of a six-storey building in the dense environment of Queens, New York. The project integrates traditional intensive green roof design with organic agriculture and permaculture principles to create a commercially viable urban farm. In its first abbreviated growing season, the farm raised 13,000 pounds of produce, a number that will be topped in 2011. In its second season (year) of full production, the farm is producing dozens of varieties of vegetables and herbs and is selling the output to local restaurants and direct to the public through farm markets and community supported agriculture (CSA) shares. This local distribution lowers the fossil fuel consumption by transportation. The farm participates in community outreach programs by providing tours and volunteer opportunities to local residents, schools, community groups, and other community members who otherwise would not have an opportunity to experience an organic farm.

The green roof uses a 6"-18" media depth depending on the location, using organic soil media by Rooflite mixed with compost. The roof is designed to use minimal resources. Food scraps, fallen leaves, wood shavings, and other biodegradables are collected from the local community for Brooklyn Grange's compost program, and this further reduces the amount of inputs needed to maintain the growing medium. As well, the green roof system holds up to 1" of water in reserve, reducing the burden on New York City's stormwater management system and allowing for less frequent crop irrigation.

The farm has entered into unchartered territory in the urban agriculture movement by achieving a scale never before seen in an urban rooftop farm application. This hybrid green roof farming project has generated global interest and has proven the feasibility of commercial rooftop farming in the urban environment. Brooklyn Grange is an innovator in the roof is continuing to grow. A chicken coop was recently installed and a small flock of Rhode Island hens lay eggs and call the roof their home. Four beehives were also added in 2011. As Brooklyn Grange continues to evolve, it will further cement itself as a successful link between the green roof and urban agriculture communities.

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