Burlington Green Environmental Association

Community 20/20 Research Report

Green Roofs

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1. Low Impact Development (LID) Opportunities for the Emshih Site

Green Roofs have been identified as the research area of focus for 2017 for the Community 20/20 demonstration project. Through researching examples and case studies it has been determined that incorporating Green Roofs into the site can play an active part in achieving the goals of developing a healthy, sustainable, and vibrant urban mixed use development. The opportunity exists to create an example for the broader community on how to build sustainable communities with a triple bottom line approach including economic, environmental, and social benefits.

2. Green Roofs

AIM: increase energy efficiency, reduce stormwater runoff, mitigate flood risk, mitigate urban heat island effect, create habitat for native flora and fauna including pollinators, improved aesthetics, increased materials / infrastructure lifespan, create areas for recreation / social gathering, achieve mental health co-benefits.

The main benefit provided by green roofs is the increase in building energy efficiency primarily through enhanced thermal insulation via water, soil, and biomass throughout the planting media (Berardi, 2014). The soil, water and plants within the planting media also provide regulation of surrounding microclimate and a reduction in the urban heat island effect prevalent in urban environments through evapotranspiration (Berardi, 2014). Another service provided by green roofs is the absorption of rainwater resulting in reduced stormwater runoff volumes. This can translate to positive effects on the longevity and function of surrounding stormwater infrastructure. Green roofs also create habitat, and provide a pleasing vegetated aesthetic which can be used for recreation and aid in fostering a healthy mental state of users (Wolfe, 2014).

In future years, if the City of Burlington decides to adopt a separated stormwater rate system where incentives are offered to reduce stormwater runoff volumes, green roofs can be a primary mechanism for achieving volume reductions.

The following information has been summarized from U. Berardi et al. *State-of-the-art analysis of environmental benefits of green roofs*. Applied Energy 115 (2014) 411-428.

3. Classifications of Green Roofs

Green roof systems are generally categorized as extensive or intensive. The main differences between the two systems have been summarized in Table 1 below.

Table 1 provides a general comparison of Extensive versus Intensive green roof systems. Source: U. Berardi et. al. *State-of-the-art analysis of environmental benefits of green roofs*. Applied Energy 115 (2014) 411-428.

Main attributes	Extensive	Intensive
Thickness of growing media	Below 200 mm	Above 200 mm
Accessibility	Inaccessible (fragile roots)	Accessible (usable for recreation purpose)
Weight	60–150 kg/m^2	Above 300 kg/m^2 (may require a reinforced structure)
Diversity of plants	Low (moss, herb and grass)	High (lawn or perennials, shrub and tree)
Construction	Moderately easy	Technically complex
Irrigation	Often not necessary	Necessity of drainage and irrigation systems
Maintenance	Simple	Complicated
Cost	Low	High

As the above table depicts, extensive and intensive green roofs differ in a number of variables which determine the performance, cost, and application of each. The increased soil depth and biodiverse vegetation cover of the intensive green roofs translates to increased absorption of stormwater and improved insulating value which increases building energy efficiency. Intensive green roofs also allow for recreational uses and provide more textures and colours for an enhanced, more interactive aesthetic.

Table 2. Summary of the Advantages and Disadvantages of **Extensive** Green Roofs (Adapted from: http://www.lakesuperiorstreams.org/stormwater/toolkit/greenroofs.html)

Extensive Green Roof Systems	
Advantages	**Disadvantages**
Lightweight. Roof reinforcement not usually required. Ideal for retrofit projects.	Benefits of stormwater retention and energy efficiency are less than with an intensive green roof
Can cover large areas and sloped roofs (beyond 20° slope with a soil stabilization system)	Limited plant choice and harsh growing conditions compared to an intensive green roof
Relatively low cost to install and requires less technical knowledge	Not as visually appealing and not available to the public as is an intensive green roof
Requires low human intervention maintenance efforts. Allows for spontaneous growth of vegetation	
Typically does not require irrigation system or special drainage systems	
Long lifespan of roof materials	
Provides a natural aesthetic	

Table 3. Summary of the Advantages and Disadvantages of **Intensive** Green Roofs (Adapted from: http://www.lakesuperiorstreams.org/stormwater/toolkit/greenroofs.html)

Intensive Green Roof Systems	
Advantages	**Disadvantages**
Greater stormwater retention capacity and improved insulating factor. Increases energy efficiency	Heavier weight loading compared to extensive green roofs
Greater selection of plants available and allows development of a number of plant habitats	Requires irrigation and drainage systems which requires expenditures for energy, water, and materials
More aesthetically engaging and allows for public access promoting social interaction and use	Installation and maintenance requires a greater level of expertise than an extensive green roof system
Prolonged life of roof materials and membranes	Higher capital costs and maintenance costs compared to an extensive green roof

Figure 1. A cross section / elevation view of an intensive green roof system. Notice the filter membranes, waterproof/root repellant, thermal insulation, and structural support layers. Source: *www.reenroofs.org*

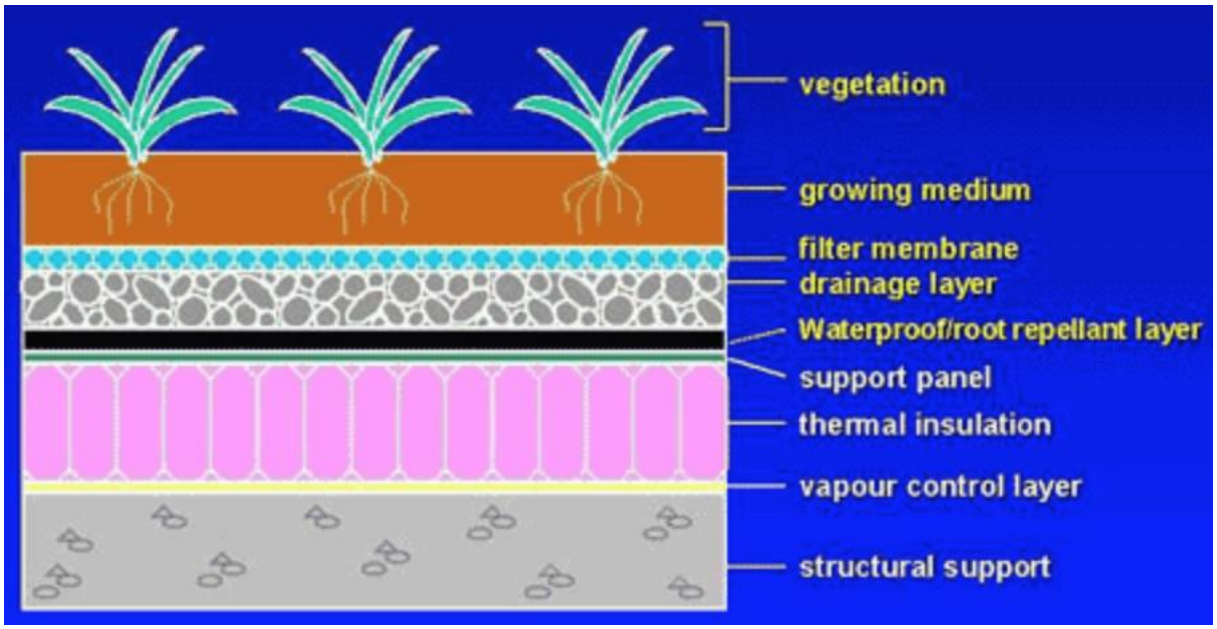
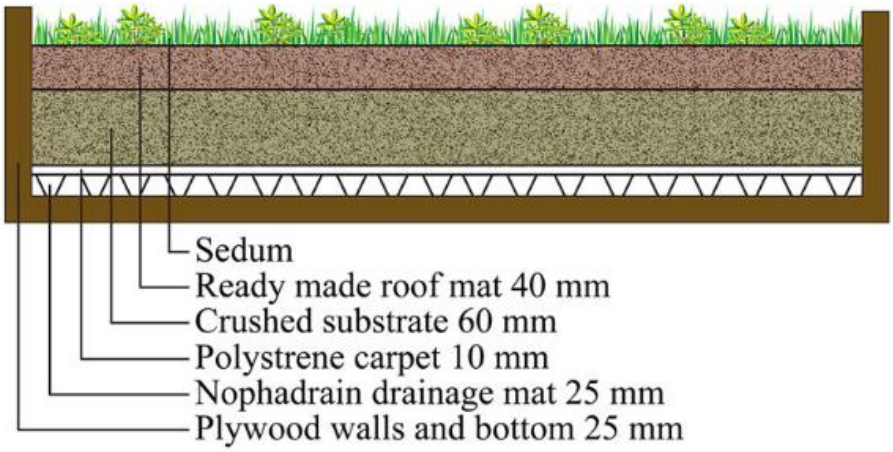


Figure 2. A cross section / elevation of an extensive green roof system (Source: Krebs et. al. *Simulation of green roof test bed runoff.* Hydrological Processes 30 (2016) 250–262)



4. Construction Types of Green Roofs

A variety of green roof systems are available on the market. In addition to the classification of extensive and intensive, the construction methods used also influence performance, cost, and application. Generally, the three most often used construction methods for green roofs are: pre-cultivated systems, modular systems, and complete systems. The three systems are compared in Table 4.

Table 4. Construction classifications of green roof systems. Source: U. Berardi et. al. *State-of-the-art analysis of environmental benefits of green roofs*. Applied Energy 115 (2014) 411-428.

Issue	Pre-cultivated system	Modular system	Complete system
System	Pre-planted	Pre-planted	Layered system
Weight	Low	Average	Generally high
Installation	Simple and fast	Simple and fast	Complex
Maintenance	Simple	Simple	Complex
Cost	Low	Average	High

Consider a **modular system** as one that arrives as pre-constructed pieces that are placed on the roof. A popular modular roof system comes from the German company Purus and their modular green roof system known as Eco-Sedum (http://www.purus-plastics.de/en/ecosedum-pack-roof-greening/).

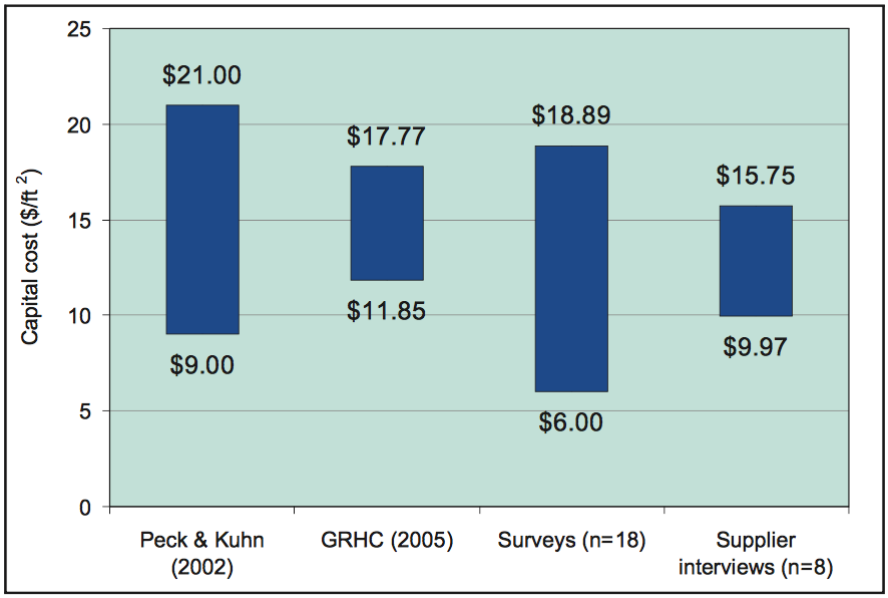
Consider a **complete green roof system** to be one that is assembled piece by piece on site during the roof construction phase. Instead of plants growing in cup-like structures as with the Eco-Sedum example, the

plants in a complete system are living in the growing medium of the roof.

5. Cost of Green Roofs

The Toronto and Region Conservation Authority and their Sustainable Technologies Evaluation Program gathered data on the economic viability of green roofs. Refer to Figure 3 for a summary of green roof installations per square foot. This study is approaching ten years old so green roofs are likely more economically affordable as installation expertise increases, material costs decline, and government based incentives become available. As the Figure shows the cost of green roofs ranges from $6 - $21 per square foot with an average cost around $14 per square foot.

Figure 3. Summary of installed capital cost of extensive green roof systems from various sources. (TRCA, STEP, 2007).



6. Examples of Toronto Green Roofs Similar to the Emshih site anticipated uses.

Source:
http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=3a7a036318061410VgnVCM10000071d60f89RCRD

ESRI Canada Ltd., 12 Concorde Place

This intensive green roof is a private commercial retrofit with 100 per cent coverage of available roof space. It was designed by Gardens in the Sky and Scott Torrence Landscape Architects and hosts 52 plant types including sedums, grasses, flowers, herbs, shrubs and trees. The outdoor space can now be used for formal office meetings, corporate events, and informal lunch breaks.

DUCA Financial Services, 5290 Yonge St.

This carefully and innovatively planned green roof was built to improve the quality of life of building employees, and last to survive over the life of this new building. The roof consists of two separate green spaces, an intensive roof space which is used as a recreational outdoor area for building employees and an extensive roof which consists of long grasses and evergreen trees viewable from conference rooms for all year round greenery. Water retention panels store water in pockets under the soil, for use in times of drought. The total green roof size is 641m2 at a total coverage of 55 per cent.

Metro Toronto YMCA, 20 Grosvenor Ave.

This private retrofitted green roof is a total of 630m3. It was designed with participatory input from YMCA members, staff, and community members. This space is used recreationally as a running track, and exercise class space where YMCA members can enjoy yoga and Pilates outdoors surrounded by greenery, gardens and fountains.

7. Existing Green Roofs in Hamilton / Halton

Hamilton City Hall

Location: Hamilton, Ontario, Canada. Project Size: 4000 sq. ft. Installation Date: April, 2010. Grower: LiveRoof Ontario, Inc. This vegetative roof was installed appropriately on Earth Day 2010 after a major renovation to the building. (Adapted from: http://www.liveroof.com/showcase-view/?project=267_1_e_hamilton-city-hall_hamilton_ontario)

MacNab Transit Terminal, Hamilton

Location: Hamilton, Ontario, Canada· Installation Date: January, 2011 (approx.)
This is an important upgrade to the city of Hamilton and a valuable public urban space. The two-storey terminal includes a green-roof as a significant addition to the design of the building. (Adapted from: http://dtah.com/project/hamilton-transit-terminal/)

Juravinski Hospital

Location: 711 Concession Street, Hamilton, Ontario
The expansion of the former Hamilton Regional Cancer Centre (renamed the Juravinski Cancer Centre) included redevelopment of exterior spaces on both roof deck and ground levels, completed in 2004. Using green roof technology, the intensive and extensive plantings are situated in various levels over radiation bunkers and corridors. (Adapted from: http://oala.ca/ground_issue/ground-18-health/landscapes-that-heal/)

8. Current City of Burlington green roof installations:

445 Elizabeth Street, Burlington, ON:

Environmental Design Group Ltd. Installed intensive terrace about 10 years ago. (Adapted from correspondence with Environmental Design Group Ltd.)
http://environmentaldesign.ca/
Phone: 905 689 5373 - Jacob
Also, Jacob, the owner of Environmental Design Group Ltd., lives in Burlington. He installed on his own roof a slope extensive green roof and smaller biodiverse roof on the garage.

NEW Joseph Brant Hospital, Burlington, ON:

Details not yet available.

9. Other green roof installations in Halton (Town of Oakville):

Kinoak Arena

Location: 363 Warminster Dr., Oakville
The Kinoak Arena is the first town facility to have implemented a green roof pilot project. The town used this small green roof as an example for gaining information on the operation and maintenance requirements of a green roof. This project contributed to valuable experience in green roof designs and installations for the Town of Oakville. Green roofs contribute to sustainable building by reducing energy needs for heating and cooling, decreasing storm water runoff, and creating habitats for insects and birds.

Clanmore Montessori School

Location: 2463 Lakeshore Rd. E, Oakville
Clanmore Montessori installed a green roof to their eco-friendly expansion. The most exciting part about the new roof is that the students of the school took part in planting it. (Adapted from: http://www.clanmore.ca/2012/11/29/clanmore-montessori-and-a-green-roof/)

Kensington Retirement Residence by Revera

Location: 25 Lakeshore Rd. W, Oakville
Beyond its residential enjoyment, the Kensington green roof also features:

- Storm water retention which insulates the building
- Building cooling features
- Cleaning of the air
- Sound absorption
- Food production
- Habitats for bird and insects to flourish and enjoy

The Kensington green roof can increase energy efficiency, improve air and water quality, as well as beautify the town by providing natural green spaces in built-up areas.

Green Roof above shared garage

Location: 350 Lynnwood Drive and 1240 White Oaks Boulevard, Oakville
The green space that occupies the roof of 350 Linwood Drive and 1230 White Oaks Boulevard shared garage consists of a well-kept natural landscape and interlocking pathways. (Adapted from: http://www.oakville.ca/assets/general%20-%20environment/2010SustainableLivingBuildingAGreenerOakville.pdf)
However, most green roof specialists refer mostly to Toronto green roof installations, which are required according to bylaw following the Toronto Green Roof Construction Standard.
Some Canadian cities have adopted Green Roof policies to promote the benefits of these building techniques.

10. City of Toronto - Green Roof Bylaw

The City of Toronto implemented their bylaw in 2009, after an extensive benefits study in 2005.
Toronto is the first City in North America to have a bylaw to require and govern the construction of green roofs on new development. It was adopted by Toronto City Council in May 2009, under the authority of

Section 108 of the City of Toronto Act.

The Bylaw applies to new building permit applications for residential, commercial and institutional development made after January 31, 2010 and to new industrial development as of April 30, 2012. The green roof coverage requirement is graduated, depending on the size of the building. Available Roof Space is defined as the total roof area minus areas designated for renewable energy, private terraces and residential outdoor amenity space (to a maximum of $2m^2$/unit).

Table 5. Requirement Ranges of Available Roof Spaces for Commercial, Institutional, and Residential Development

Gross Floor Area (Size of Building)	Coverage of Available Roof Space (Size of Green Roof)
2,000-4,999 m^2	20%
5,000-9,999 m^2	30%
10,000-14,999 m^2	40%
15,000-19,999 m^2	50%
20,000 m^2 or greater	60%

Requirement for an Industrial Buildings:

The Green Roof Bylaw applies to new building permit applications for industrial buildings or additions to industrial buildings where the Gross Floor area is 2,000 m2 or greater and the application was made on or after April 30, 2012. Under the Green Roof Bylaw, Industrial buildings are required to provide one of the following:

- A Green Roof covering the lesser of 10 per cent of Available Roof Space or 2,000 m2; or
- A roof that uses Cool Roofing Materials for 100% of the Available Roof Space and complies with the stormwater management performance measures required through the Site Plan Approval process. Where the Site Plan Approval is not required, the first 5 mm from each rainfall or 50% of annual rainfall volume falling on the roof is retained or collected for re-use at least through systems that incorporate roof surfaces.

(Adapted from: City of Toronto. Green Roofs Bylaw) http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=83520621f3161410VgnVCM10000071d60f89RCRD&vgnextchannel=3a7a036318061410VgnVCM10000071d60f89RCRD)

11. Green Roof Professionals (GRP)

Accredited Green Roof Professionals (GRP) are individuals who have achieved a specific knowledge level with respect to green roof design, project management, installation and maintenance. The curriculum that supports GRP accreditation focuses on maximizing the benefits of projects for owners by ensuring that

green roofs operate in concert with other building systems and are installed and maintained in accordance with the industry's best practices.

Table 6. Green Roof Professionals in Burlington/Hamilton

Name	Location	Phone Number
Leslie Camm	Burlington	905 - 615 - 3200
Leon Denbok	Burlington	905 - 336 – 3476 ext.106
Meredith Plant	Hamilton	289 - 456 - 0310
Robert Jocelyn	Hamilton	905 - 577 - 0777
Sam Guida	Hamilton	905 - 561 - 7780

(Adapted from: Green Pages. Green Roof and Wall Industry Directory 2016/2017. https://issuu.com/grhcna/docs/grhc)

12. Service Providers in the GTHA

Hendrik OP't Root Architects http://optrootarchitect.com
Scott Torrence Landscape Architects http: //www.scotttorrance.ca
Nedlaw Living Roofs Co. http://nedlawlivingroofs.ca/index.php
Environmental Design Group http://environmentaldesign.ca
ZinCo Green Roof Systems http://www.zinco.ca/index.html
Vitaroofs http://www.vitaroofs.com

13. Sources and additional resources

Burlington Post green roof article (2009). Residential green roof.
http://www.insidehalton.com/news-story/2906829-roofing-goes-green-literally/

City of Toronto green roof examples. Municipal, Commercial, Institutional green roofs.
http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=3a7a036318061410VgnVCM10000071d60f89RCRD

Sustainable Technologies Evaluation Program. Economic viability research on green roofs
http://www.sustainabletechnologies.ca/wp/home/urban-runoff-green-infrastructure/low-impact-development/green-roofs/economic-analysis-of-green-roofs-in-the-greater-toronto-area/

U. Berardi et. al. *State-of-the-art analysis of environmental benefits of green roofs*. Applied Energy 115 (2014) 411-428.

Krebs et. al. *Simulation of green roof test bed runoff.* Hydrological Processes 30 (2016) 250–262.

Wolf, Kathleen, L. 2014. Water and Wellness: Green Infrastructure for Health Co-Benefits. University of Washington, College of the Environment.

http://www.lakesuperiorstreams.org/stormwater/toolkit/greenroofs.html

www.greenroofs.org