

Ecoroof Guide for Municipalities



Introduction to the Guide



Who is it for?

This guide is a starting point for Alberta municipalities considering ecoroofs as one of the tools in the climate change adaptation toolbox.

Why have we created it?

- **Ecosystem services** – Before your community existed, the landscape provided a suite of ecosystem services. As development occurs, the ecosystem services nature provides are altered and most often, lost to non-permeable surfaces and buildings. Ecoroofs are one strategy communities can use to help replace some of what was lost due to development.
- **Context of a changing climate** – imagine your community 20 years from now. Is precipitation more frequent? Longer droughts? Are temperatures higher and growing seasons extended? Is your community net zero or working towards that goal? Are you growing more local food? Have the buildings in your communities been designed to adapt to the changing climate?

Ecoroofs are one tool municipalities can use to help address many of the issues projected to face communities in the future.
- **Roofs constitute about 20 to 25% of the urban surface** (Akbari et al., 2003). Urban-wide conversion of rooftops into green roofs results in many public benefits such as: UHI improvements; air quality, storm-water management, biodiversity and green space amenities (Oberndorfer et al., 2007); and, at a building scale: increase the life span of the building materials underneath the soil; reduce pollution for occupants, and decrease building energy use especially during summer (Saiz et al., 2006). Many traditional black, flat roofs could be converted into extensive ecoroofs which are relatively lightweight - without the need for additional structural support (Castleton et al., 2010; Johnston and Newton, 1996).



About Ecoroofs

An ecoroof, also known as a green roof, vegetated roof, rooftop garden, or living roof is an extension of an existing roof which involves high quality waterproofing membrane, root repellent system, drainage system, filter cloth, lightweight growing medium (soil), irrigation system, and plants. Some designs might also include amenities such as water features, gathering spaces, play structures, garden plots, art installations, or barbecue areas.

Ecoroof implementation involves the creation of “contained” green space on top of a structure. This green space could be at, or above grade, on residential, commercial, office or industrial buildings.

Ecoroofs provide ecosystem services in urban areas including improved stormwater management (both quantity and quality), better regulation of building temperatures, reduced urban heat island effects, and increased urban wildlife habitat and biodiversity (Oberndorfer et al., 2007). Some jurisdictions refer to ecoroofs as a ‘no-regrets’ climate adaptation measure (Mees, Driessen, Runhaar, & Stamatelos, 2013) because they serve multiple societal goals.

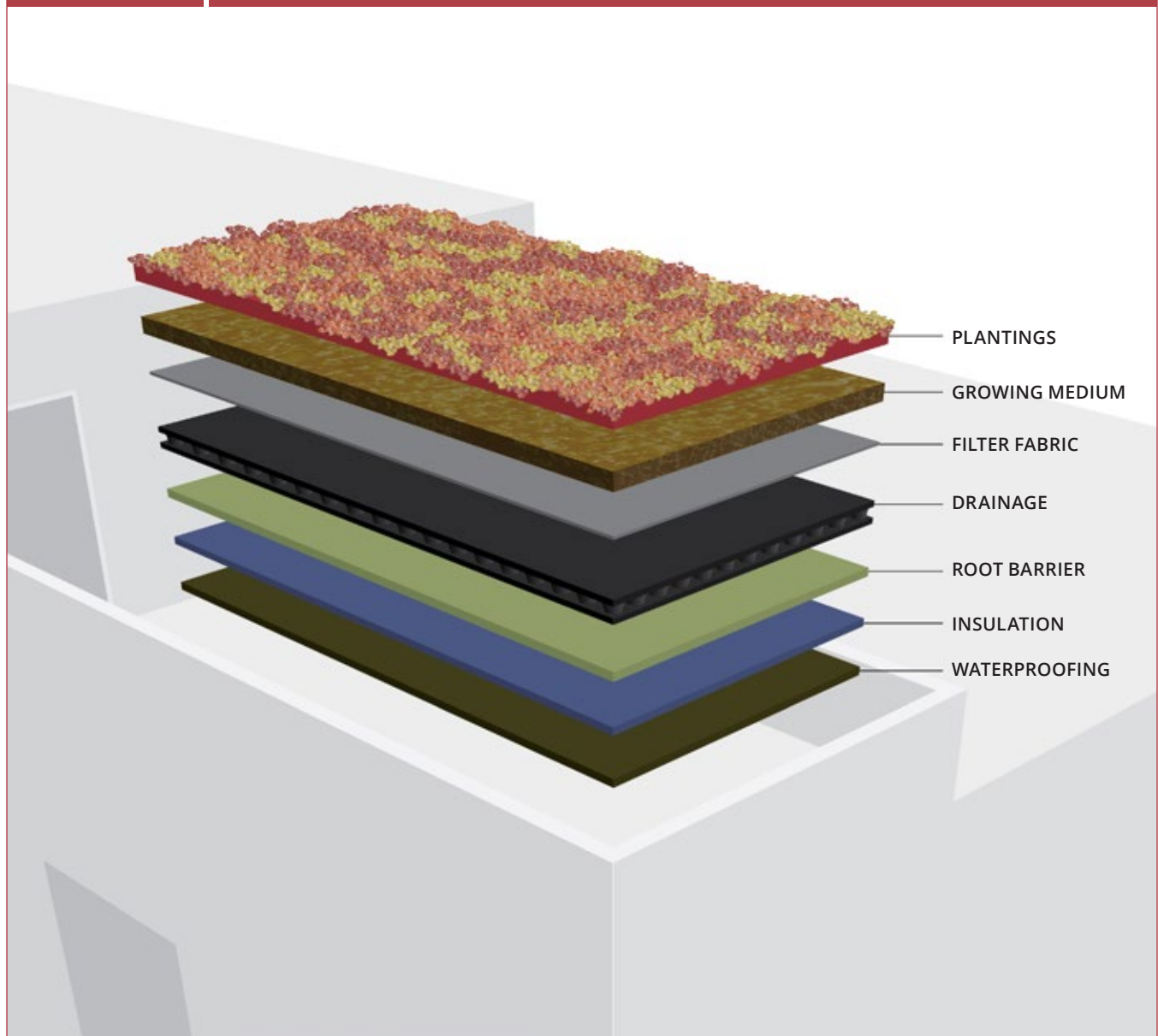
Throughout the Municipal Guide, the terms ecoroof and green roof are used interchangeably.

Ecoroofs are typically described in one of two ways:

1

Extensive roofs

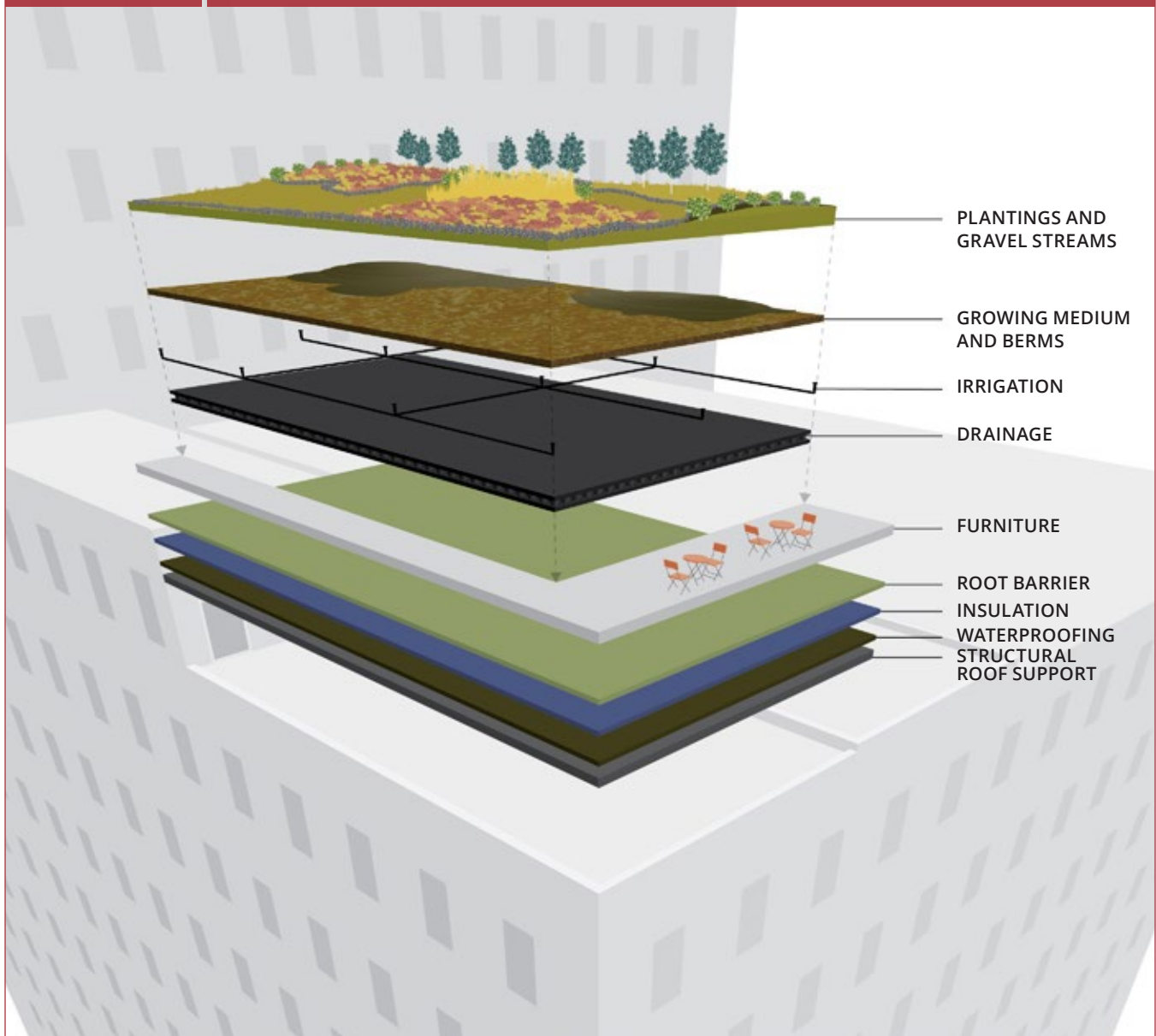
Extensive roofs are lightweight systems and typically include drought tolerant self-seeding sedums, grasses, mosses and meadow flowers requiring little or no irrigation (dependent on the regional climate) and less maintenance after establishment. These roofs are not intended for recreation, or to accommodate the weight of people, larger shrubs or trees (Green Plants for Green Buildings, 2014).



2

Intensive roofs

Intensive roofs can be thought of as a rooftop garden where anything is possible if you have the weight bearing capacity. Trees, shrubs, gardens, patio areas and water features may be installed and provide access for people.





Frequently Asked Questions about Ecoroofs

Photo by Holly Kins

Can ecoroofs be installed on existing buildings?

Yes. Ecoroofs can be installed on new builds, or on existing buildings. Since every rooftop is unique and has its own microclimate, it is extremely important to have an experienced ecoroof/green roof professional consult on the project to assist the building developer/owner with design considerations.

Are there people that are ecoroof professionals?

Yes. In 2009, Green Roofs for Healthy Cities (GRHC) launched the Green Roof Professional (GRP) Training & Accreditation program in an effort to bridge the knowledge gap in industry training and best practice. Before this, no traditional discipline or training contained all of the competencies necessary for green roof success - from building science, horticulture, irrigation, waterproofing, plant physiology, structural engineering and beyond. Since then, over 750 individuals have successfully completed the GRP Accreditation Exam to earn the GRP designation. Find a GRP in your area by visiting Green Roofs for Healthy Cities' website at www.greenroofs.org/find-a-grp

What are the design considerations?

One of the first things to think about when designing an ecoroof is to make sure there is agreement on the key motivator for the roof and design accordingly. Here are some possible key motivators for an ecoroof: urban agriculture, open space, building energy savings, biodiversity, habitat, stormwater retention, noise attenuation, air quality improvements, quality of life for occupants with access or a view to the ecoroof, real estate value.

Once the key motivator for the ecoroof is established, these are the other factors the designer will consider:

Access. Ecoroofs can be designed for maintenance only access, or public/occupant access. If the roof is designed for maintenance access only, the designer should consider a vegetation free zone at the roof perimeter, tie-back anchors for workers to safely access the vegetation for maintenance and compliance with applicable safety requirements. Public or occupant access considerations include exits, guard rails, live load capacity, and accessibility.

Sun exposure and wind uplift. These factors will help determine whether irrigation is advised, the type of plants best suited for the roof, the type of soil, safety and maintenance considerations.

Structural loading. Ecoroofs can add loads to a roof structure which are significant in comparison to typical roof design loads. The weight, stability and moisture retention characteristics of the system (particularly the growing medium and water retention mats) need to be determined. As with any building development or redevelopment, a structural engineer needs to be consulted.

Slope. Sloped roofs can support ecoroofs if they are designed appropriately. The City of Toronto's Green Roof Construction Standard Supplementary Guideline recommends slopes in excess of 10 degrees require anti-shear measures. The Guideline suggests slopes above 30 degrees utilize light-weight, pre-cultivated mats to avoid lack of root establishment due to the slope.

Waterproofing. Increased waterproofing membrane quality is likely what would be recommended by most ecoroof designers. Maintaining the waterproofing function of a membrane for an ecoroof system is considerably more critical than a conventional roof system because of the added cost of repair. Leak detection systems are available for ecoroofs.

Plant selection and growing media. For a successful ecoroof, the design and selection of growing media (substrate, soil), irrigation systems, and plantings should be thought of as a system. Alpine species are commonly used since they can resist extreme conditions of heat, cold, high winds, extreme sun exposure and long drought periods with succulents (sedum species) being the most frequently selected species, because of their capacity for storing water in their leaves and roots, and because of a low substrate depth required for their establishment.

The deeper the growing media, the better. The Toronto Supplementary Guidelines recommends a depth above 100mm to increase biodiversity. It is recommended to provide protection to the growing media after seeding and until the vegetation is established. When selecting the growing medium the physical characteristics of the substrate such as the proportion of organic content, granulometric distribution, porosity, dimensions, water retention capacity and material type for each course on the substrate are factors to consider and are best advised by someone with expertise in ecoroof design.

For more information on how windlift is calculated for vegetated roofs visit [National Research Council Canada](https://www.nrc.ca/canada).

Is there fire and safety risks with ecoroofs?

Over the past decade, robust standards for ecoroofs have been developed with multi-stakeholder committees. When designed in accordance with these accepted standards, the roofing system is more resistant to wind and fire. As well, for any roof type, roof safety has become more stringent.

Is liability a challenge?

As with the integration of new building technologies, there can be increased liability resulting from potential errors in design, installation and maintenance (or lack of adequate maintenance) particularly with inexperienced design or construction teams. To mitigate liability, project stakeholders should clearly detail their expectations and performance requirements in their contract documents.

Green building owners and general contractors should engage experienced green roofing professionals (GRPs) when building an ecoroof. The green roofing industry has begun to assist in this regard by designating GRPs in a manner similar to that of the LEED Green Associate or Accredited Professional designations. Green Roofs for Healthy Cities, the green roof and living wall industry association, has established the *Green Roof Professional* ("GRP"), which designation was created to distinguish certain individuals that have achieved a specific knowledge level with regard to the full spectrum of ecoroof/green roof design, project management, installation and maintenance.

Find a Green Roof Professional in your area by visiting Green Roofs for Healthy Cities' website at www.greenroofs.org/find-a-grp



Are the upfront costs higher than a conventional roof?

Yes. Up-front costs to install an ecoroof are more expensive than a conventional roof and can vary widely. More labour and materials are required to construct an ecoroof compared to a conventional roof, therefore, the capital costs or first costs of an ecoroof are higher.

For example, the first costs of an extensive ecoroof in Calgary can range from \$34 to as much as \$50 per square foot (2018). This cost range includes the cost of the conventional roofing membrane (\$14-16/square foot). Some reasons for this large gap may be due to the differences in the complexity of green roof design, travel distance of many of the supplies to market and a lack of market competitiveness. Typically, costs will vary depending upon the building type, size and height of the roof above grade. Other factors influencing the first cost include whether there is sufficient storage space for materials on site, access for cranes and hoisting and ease of mobilizing on site. The scheduling and lead times of a project also have an impact, as does the number of trades to coordinate involved in the construction.

In Alberta, the cost differential between ecoroof and conventional roofing systems is greater than many other jurisdictions which are advancing ecoroofs. The first costs for ecoroofs in Toronto dropped as much as 30% since mandating ecoroofs in 2009 (Lilauwala & Peck, 2017). A host of other cities such as Vancouver, San Francisco, Chicago and Portland have also experienced cost reduction in ecoroof installation as the markets matured.

The first costs for ecoroofs in Toronto dropped as much as 30% since mandating green roofs in 2009. A host of other cities such as Vancouver, San Francisco, Chicago and Portland, Oregon have also experienced cost reduction in ecoroof installation as the markets matured.

What are the maintenance and operations costs?

The maintenance required for an ecoroof is dependent upon the system type, plant species selection, whether irrigation is used, aesthetic design goals, purpose and use by public. Typically, the first few years of the life of an ecoroof will require more maintenance while the plants are establishing. Ecoroof maintenance costs can range from \$0.30-\$1.00/square foot, annually. Conventional roofs require regular inspection and maintenance, the costs of which may be overlooked. As a minimum, conventional roofs should be inspected twice yearly, as well as after major storm events. Maintenance costs for conventional roofs is estimated at \$0.18/square foot, annually (Lilauwala & Peck, 2017).



Photo by Kerry Ross

Is it possible to put solar panels on ecoroofs?

Yes. Many sources such as [*BCIT's Centre for Architectural Ecology*](#), state that ecoroofs and photovoltaic panels are complementary technologies that improve each others' performance. The PV functions more efficiently thanks to the cooler ambient temperatures the ecoroof provides, and the ecoroof benefits from areas of shade. Remember, when choosing plants for installation under solar panels, consider shade tolerant, low growing species.

What building codes are required for ecoroofs?

According to the Government of Alberta, the following section from the building code applies to ecoroofs:

5.6.1.2. Installation of Protective Materials

2) Where protective materials applied to assemblies to provide the required protection from precipitation are part of a vegetated roofing system, they shall be resistant to root and rhizome penetration when tested in accordance with ANSI/GRHC/SPRI VR-1, "Investigating Resistance to Root Penetration on Vegetative Roofs."

Vegetated Roofing Systems.

The integrity of some assemblies installed to provide the required protection from the ingress of precipitation in vegetated roofing systems can be compromised due to an inadequate resistance to the penetration of plant roots and rhizomes. Additional information on vegetated roofing systems and the performance of protective materials can be found in the German Landscape Research, Development and Construction Society's (FLL) "Guidelines for the Planning, Construction and Maintenance of Green Roofing" and in the National Roofing Contractors Association's "Vegetative Roof Systems Manual."

Please see [*Resources*](#) section for links to technical resources.

Can you get a warranty for an ecoroof?

Alberta Roofing Contractors Association (ARCA) was established in 1961 by a group of Calgary and Edmonton roofing contractors. The association's primary objective is to develop comprehensive guidelines for roofing product applications to support and advance Alberta's roofing industry. ARCA members annually perform approximately 70% of Alberta's Industrial/Commercial roofing applications – new and re-roof. Only ARCA members can issue the Warranty Certificate, which is a workmanship warranty backed by ARCA Warranty Ltd. They have developed specific requirements for ecoroof systems to be covered under the ARCA Warranty. At a recent Ecoroof Workshop in Edmonton, there was extensive discussion about some of the limitations the ARCA warranty puts on ecoroof installations. You can read more about ecoroof warranties in Alberta [*here*](#).

Many sources such as BCIT's Centre for Architectural Ecology, state that ecoroofs and photovoltaic panels are complementary technologies that improve each others' performance.



Ecoroof Benefits and Performance Examples

Photo by Holly Kins

Benefits to the public

The following section provides a summary of a more detailed report: The Edmonton Ecoroof Function Research available at www.rockies.ca/ecoroofs

Water retention

Ecoroof stormwater performance is affected by regional climatic conditions, storm size, rain intensity, frequency, and duration, antecedent moisture in the soil, transmissivity of drainage layer, vegetation species and diversity, length of flow path, roof size, growing medium composition and depth, and roof age.

(Source: Minnesota Stormwater Manual)

For small rainfall events (typically less than 1.3 cm) little or no runoff will occur. Lower intensity storms also result in greater stormwater retention than high intensity storms. For storms of greater intensity and duration, a vegetated roof can significantly delay and reduce the runoff peak flow that would otherwise occur with a traditional roof.

Annual runoff volume reduction in northern temperate regions is regularly measured to be 50 to 70 percent when the media thickness is 7.6 to 15.2 cm (e.g. Berghage et. al., 2010; Carter and Rasmussen, 2006; Van Woert et. al., 2005; Moran et. al., 2005; Van Seters et. al., 2007; Berghage et. al., 2009).



Photo by Kerry Ross

Urban Heat Island reduction

As with trees and vegetation at grade, vegetation on an ecoroof shades surfaces and reduces surface temperatures, through evapotranspiration. The surface of a vegetated rooftop can be cooler than the ambient air, whereas conventional rooftop surfaces can exceed ambient air temperatures by up to 50°C (90°F) (U.S. Environmental Protection Agency, 2008a). Reducing temperatures of the roof surface will reduce the temperatures of the surrounding air, thereby assisting in lowering air temperature in areas of the city where ecoroofs are present, and depending on the local climate, in other areas as well. Reduced surface temperatures also reduces the temperature of the air being drawn into the building for the air exchange, reducing the amount of energy required to cool the building (Moseley et al., 2013).

Air Quality improvements

Air quality plays a major role in human and ecosystem health, especially in the urban environment where pollutants can be heavily concentrated and the urban heat island effect can occur. There are several ways that ecoroofs can improve air quality, especially within an urban setting. As explained in earlier sections, ecoroofs help reduce ambient air temperatures and insulate buildings, increasing energy efficiency and reducing the needed for cooling systems, thus reducing emissions. With the reduction in ambient air temperatures and the mitigation of the urban heat island effect, the production of pollutants decreases and ultimately creates better air quality.



Photo by Holly Kins

Another way ecoroofs enhance air quality is in the physiology of the plants that make up the roofing system. Trees, shrubs and other natural vegetation in urban areas positively affect air contaminant levels through photosynthesis, and by extension, air quality and the overall experience of health and well-being of residents.

There are also additional key factors that influence the ecoroof's ability to reduce air pollution such as ecoroof area and vegetation type, because some plants are more efficient at capturing pollutants than others (Tomalty & Komorowski, 2010 as cited in van Beukering et al., 2015).

Habitat/biodiversity

Researchers have only recently begun to study the ability of ecoroofs to contribute to conservation of biodiversity and habitat within the urban environment, where green space is scarce. Evidence suggests that ecoroofs can provide habitat for plants and highly mobile animals (ex. birds) and insect species. Further research seeks to conclude if these microhabitats can function as “corridors, linking fragmented habitats and facilitating wildlife movement and dispersal” (Marinelli, 2006). Ecoroofs can also be designed specifically to create an ideal habitat for pollinators such as bees, butterflies, and hummingbirds, by planting native flowering plants and trees.

Trees, shrubs and other natural vegetation in urban areas positively affect air contaminant levels, and by extension, air quality and the overall experience of health and well-being of residents.



Photo by Holly Kinas

The very essence of ecoroofs, being human-altered/controlled environments, can facilitate conservation in ways not often possible, by providing the opportunity to design an ideal habitat for specific species such as an endangered species. Providing a microhabitat tailored to an endangered species' needs gives that species a competitive advantage and thus ecoroofs become an important tool for species conservation. Additionally, research is beginning to suggest that "if suitable niches are provided on ecoroofs, plants and animals will move in rapidly and establish communities," which in turn contributes to overall biodiversity and habitat enhancement in an otherwise nature-starved urban environment (Marinelli, 2006).

Benefits to building owners/occupants

Energy savings (heating/cooling)

One of the many benefits ecoroofs provide is the increase in building energy efficiency, thus a reduction in heating and cooling needs and a reduction in greenhouse gas emissions (GHG) (K. Liu & Baskaran, 2005; K. K. Y. Liu & Bass, 2005). Ecoroofs can increase building efficiency "through direct shading of the roof, evapotranspiration and improved insulation values" (Minke and Witter, 1982; Liesecke et al., 1989; Christian and Petrie, 1996; Eumorfopoulou and Aravantinos, 1998; Palomo, 1998; Environmental Building News, 2001 as cited in K.K.Y. Liu & Bass, 2005). Both plants and the ecoroof growing medium contribute to the insulation value of an ecoroof (K. K. Y. Liu & Bass, 2005).

With the growing commitments to reduce GHGs, ecoroofs can play an important role in this reduction as "buildings account for approximately 30% of energy use and 27% of greenhouse gases emission in Canada



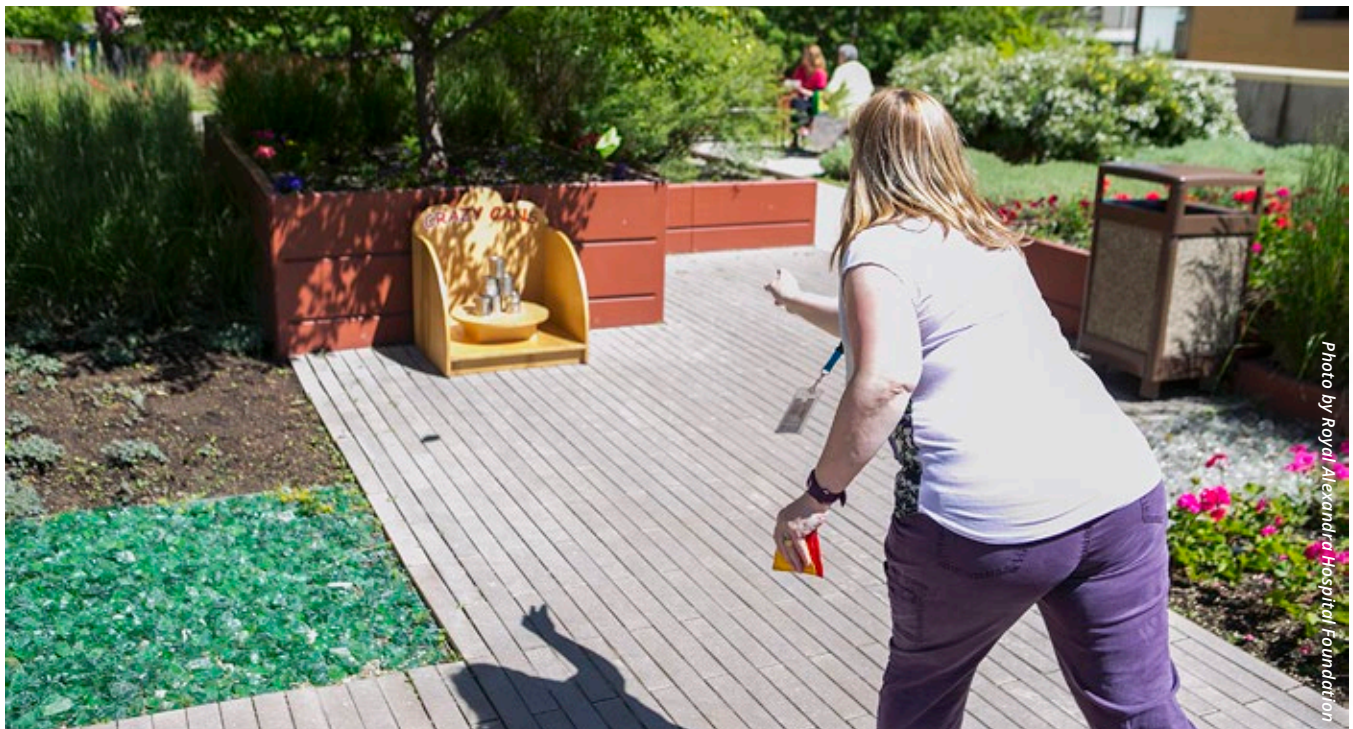
With the growing commitments to reduce GHGs, ecoroofs can play an important role in this reduction as “buildings account for approximately 30% of energy use and 27% of greenhouse gases emission in Canada” (Natural Resources Canada 2004 as cited in K. Liu & Baskaran, 2005). There is also a growing trend towards sustainable building certifications, such as LEED (Leadership in Energy and Environmental Design) Green Building Rating System, which includes ecoroofs as a sustainable design feature (K. Liu & Baskaran, 2005).

Amenity space (recreation, agriculture, gardening, respite)

Ecoroofs positively affect the urban environment by increasing amenity and green space. Ecoroofs can serve any number of functions and uses, including community gardens (e.g. local food production or co-ops), commercial space (e.g. display areas, restaurant terraces, produce for restaurants), and recreational space (e.g. lawn bowling, children’s playgrounds, passive recreation spaces).

Increased lifespan of roof

An ecoroof decreases the exposure of waterproofing membranes to large temperature fluctuations that can cause micro-tearing, and ultraviolet radiation. The lifespan of ecoroofs have been documented between 30 and 75 years. Conventional (non-greened) roof spans average 15 to 20 years before requiring replacement.





Resources

Building Code References

ANSI/GRHC/SPRI VR-1, "Investigating Resistance to Root Penetration on Vegetative Roofs."

www.spri.org

German Landscape Research, Development and Construction Society's (FLL)

"Guidelines for the Planning, Construction and Maintenance of Green Roofing
[*Green Roof Guidelines*](#)

National Roofing Contractors Association's "Vegetative Roof Systems Manual

www.nrca.net

Ecoroof Associations

- [*Green Roofs for Healthy Cities*](#)
- [*European Federation Green Roofs and Walls*](#)

Ecoroof Research Institutes

GRIT (Green Roof Innovation Testing) Lab, Toronto. Established in 2010 on the roof of the John H. Daniels Faculty of Architecture, Landscape, and Design at 230 College Street in Toronto, the GRIT Lab is a state-of-the-art facility — and the only one of its kind testing the environmental performance associated with green roofs, green walls and solar photovoltaic technologies in Canada.
[*GRIT Lab*](#)

British Columbia Institute of Technology's (BCIT's) Great Northern Way Campus is home to the Architectural Ecology Centre, where vegetation-growing roofs are tested, demonstrated, taught about, and improved upon.

[*BCIT Architectural Ecology Centre*](#)

Penn State Center for Green Roof Research is the only location in North America with small test green roofs on replicated buildings, that characterizes and quantifies the performance of green roofs and promotes their discoveries through education and outreach.

[*Center for Green Roof Research*](#)

Municipalities with Ecoroof Programs/Policies/Bylaws

[Source: *How Your Community Will Benefit from Adopting Green Roof Policy, GRHC 2015*]

The following section is from Green Roofs for Healthy Cities 2015 study and is to provide examples of the types of incentives or programs municipalities have in place to encourage ecoroof implementation locally. Several municipalities are developing or have adopted ecoroof programs since the 2015 study.

CANADA

Toronto, ON: Green Roof Bylaw / Procurement

- Green roofs are required on all new commercial, institutional, multi-unit residential developments and new buildings. Incentives of \$7 per square foot. Over 2.5 million square feet permitted.
- Green roofs required on public buildings.

USA

Chicago, IL: Green Roof Permit Program

- Many incentives and an expedited building permit program.

Devens, MA: Vegetated (Green) Roof Construction Standard

- Green roofs and green walls are a requirement for development under this construction standard.

Grand Rapids, MI: Greenspace Provision

- Green roofs and green walls qualify under this provision.

Milwaukee, WI: Regional Green Roof Initiative

- \$5 for each square foot of approved green roof.

Minneapolis, MN: Stormwater Credit Program

- Up to 100% discount on stormwater utility fees for properties that manage their stormwater quality and quantity. Green roofs are listed as an applicable tool.

Nashville, TN: Green Roof Credit

- A \$10 rebate for each square foot of green roof.

New York, NY: Green Roof Tax Abatement

- A \$5.23 rebate for each square foot of green roof up to \$200,000 per project.

Philadelphia, PA: Green Roof Tax Credit

- A credit of up to 25% of all costs incurred to construct a green roof with a maximum of \$100,000 per project.

Portland, OR: Floor Area Ratio (FAR) Bonus

- 10-30% Green Roof = 1 extra square foot of floor area.
- 30-60% Green Roof = 2 extra square feet of floor area.
- 60%+ Green Roof = 3 extra square feet of floor area.

Syracuse, NY: Green Improvement Fund

- Funding available to projects utilizing green infrastructure solutions and elements. Nearly \$4 million towards 37 projects so far, many include green roofs.

Seattle, WA: Green Factor Program

- Green roofs and green walls qualify under this program which sets minimum green infrastructure thresholds for new and redevelopment.

Washington, DC: Green Roof Rebate Program

- Base funding between \$7 and \$10 per square foot of green roof depending on the project's sewage shed area.

Calculators, Toolkits, Guides

GreenSave Calculator

greenroofs.org/greensave-calculator

Green Roofs for Healthy Cities has developed a green roof calculator (GreenSave Calculator) to help municipalities and others address the issue of cost. The GreenSave Calculator is an online tool that allows users to compare roofing alternatives over a specific time period to determine which has the lowest life-cycle cost.

This tool can be utilized to determine whether higher initial costs are justified by reducing such future costs as operating, maintenance, repair or replacement costs and/or producing additional benefits, such as energy savings, and whether some roofs have lower initial costs that inflate over time. You must have a membership to access the tool.

Green Roof Energy Calculator:

sustainability.asu.edu/urban-climate/green-roof-calculator/

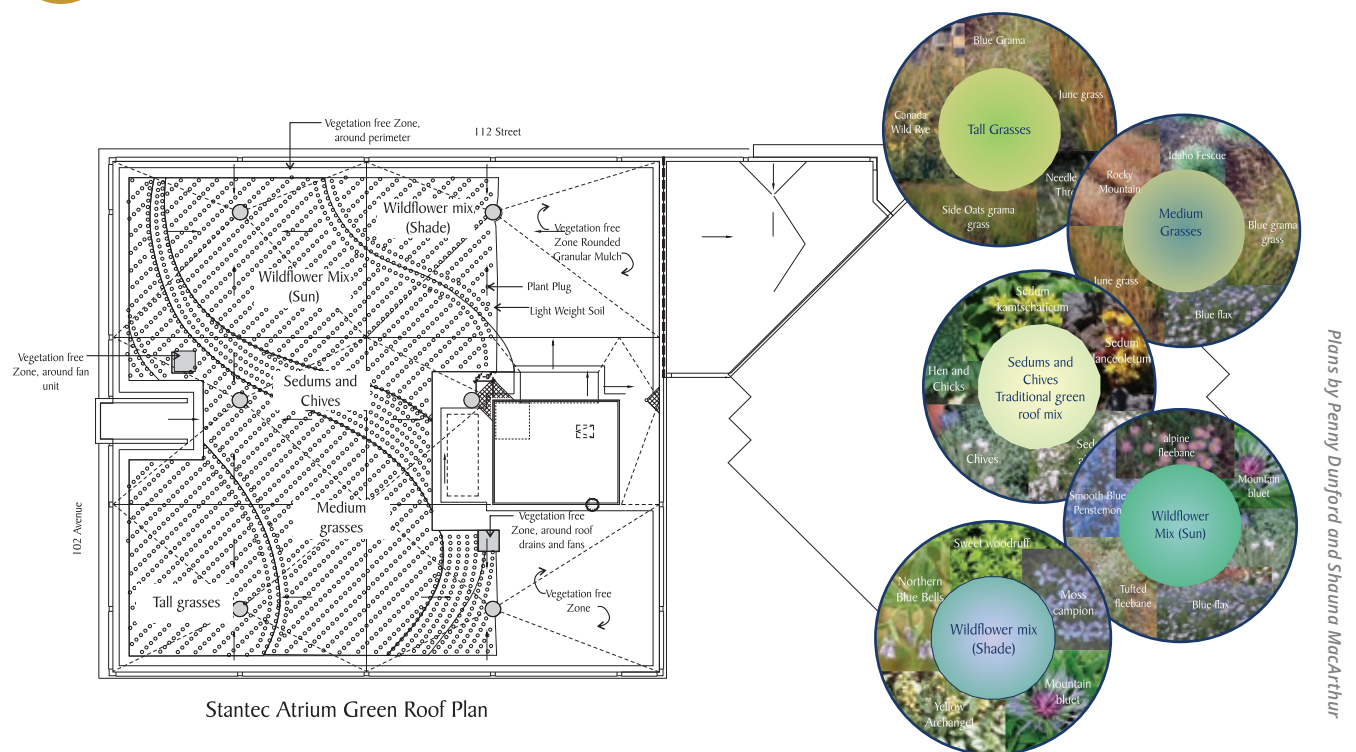
Hosted by Arizona State University, this calculator was developed through a collaboration led by Dr. David Sailor (while he was on the faculty of Portland State University), along with Brad Bass at the University of Toronto, and with input from Steven Peck at Green Roofs for Healthy Cities in Canada. The green roof energy calculator allows you to compare the annual energy performance of a building with a vegetative green roof to the same building with either a dark roof or a white roof. The only Alberta option at the moment is Calgary.



Case Studies

The building of the Stantec Centre ecoroof is documented in the following series of photos, and gives insight into the process of planning and building an ecoroof on an existing building.

- 1 The Stantec building and its rooftop shown before the ecoroof is installed. During the design phase, plans for the ecoroof layout and plantings are developed before installation begins.



2

Materials are loaded onto the roof and the first phase of installation begins – first by laying down the drainage layer, followed by a water retention mat and flexible irrigation which are enclosed by a root retarder impregnated fabric layer at the bottom and breathable landscape fabric covering the top.



3

Light weight soil is blown on top of the water retention mat assembly until the surface is covered to the design depth of 4". Roof drainage is isolated to prevent blockage from soil. Surveying takes place to locate the curves of the planting design.



Photo by Corey Mandrusiak



Photo by Shauna MacArthur

4

The soil is seeded and planting begins.



5

The plant community becomes established and flourishes in the years following installation, and can fluctuate as plants begin to compete and find their niche, as in any ecosystem. Maintenance is critical in the first few years as weeds may try to invade – plants need to be monitored and nurtured, and replaced if they don't survive or seed properly.





Photo by Shauna MacArthur



Photo by Shauna MacArthur



Photo by Shauna MacArthur

Additional Case Studies

While the items below are only a sampling of case studies, a quick internet search will provide a variety of case studies from around the globe. Happy reading!

- **City of Edmonton, AB Case Studies**

The City of Edmonton funded the Edmonton Ecoroof Initiative for Climate Change Resiliency. The Miistakis Institute inventoried known existing ecoroofs in Edmonton and created case studies for each.

[Edmonton Case Studies](#)

- **Calgary, AB Alistair Ross Technology Centre**

The ecoroof built in 2005 covers an area of 3,000 square feet (280 square metres) and spans two existing roofs on a one story building located at the University of Calgary's Alastair Ross Technology Centre. This project not only demonstrates that green roofs can help address a number of urban environmental challenges but that they are viable in Alberta's unique climatic conditions.

For more information see: www.landstewardship.org/green-roofs/

- **Toronto, ON Esri Canada "Garden in the Sky"**

Esri Canada chose to install a 704 square metre ecoroof in 2009 as the result of a Ryerson University study that showed widespread greening of building roofs in Toronto could reduce the City's ambient air temperatures up to 2° Celsius. Choosing to lead by example, Esri Canada created the ecoroof on the 9th floor terrace of the building, to provide an environmental asset for the city and to demonstrate to their customers, partners and the community that a rooftop garden can help reduce urban heat. Read the three-page case study here:

[Ecoroof Case Study](#)

- **Walmart Chicago, IL Cost Benefit Analysis**

This report summarizes the findings of the Walmart green roof performance evaluation project. This work centered on a purpose-built research roof that was constructed in 2006 at Walmart store #5402 at 4650 West North Avenue in Chicago, IL. The 133,000 square foot (12,350 square metre) roof is just over half green (vegetated) and just under half white, "cool" roof. When constructed, this roof was the largest, most intensively monitored green roof in the world. For more information:

[Green Roof Performance](#)



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Visit www.rockies.ca/ecoroofs for more information