

THE GREEN ROOF



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Green Roofs for Healthy Cities Opens its Doors

Steven Peck, Executive Director

We have made a number of important changes over the summer in order to strengthen our ability to develop the North American green roof industry. We have opened up membership to a wider range of organizations including architects, governments, non-governmental organizations, horticulturalists, manufacturers, researchers, landscape architects and contractors, engineering firms, roofing contractors and more. We have also restructured and lowered our fees to reflect this diversity.

Our Web site now has new sections on sources of financial and policy support and a virtual tour, starting with Toronto. A password-protected section will allow our members to have access to the new *Green Roof Infrastructure Journal*, a lengthier, more detailed, technical version of the *Green Roof Infrastructure Monitor*. We have also added additional membership services, such as access to our resource library and an FAQ page with contact information for all of our members.

The first North American Green Roof Infrastructure Conference and Trade Show will be held in Chicago in late May 2003. This event will bring together over 500 professionals interested in learning about green roof technology products and services, research projects, exceptional designs and public policy support. Watch our Web site for a call for papers in the coming weeks.

UPCOMING EVENTS

WINNIPEG

Prairie Green Roof Workshop
October 29, 2002

NEW YORK

Greening Gotham's Rooftops
November 22-23, 2002

CHICAGO

The first North American Green Roof Conference and Trade Show
May 29-30, 2003

I hope you enjoy this complimentary issue and will consider joining Green Roofs for Healthy Cities so we can work together to significantly improve our urban environments and develop the green roof industry in North America.

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The Green Roof Infrastructure Monitor

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Green Roofs for Healthy Cities is a network of public and private organizations working to develop a market for green roofs in North America.

www.greenroofs.ca

Environment Canada Releases Major Findings on the Benefits of Green Roofs

On October 9, 2002 City of Toronto Deputy Mayor Case Ootes, and public and private industry delegates gathered at Toronto City Hall for a demonstration of the National Research Council (NRC)-led green roof initiative and to announce findings of the first ever green roof urban heat island study conducted by Environment Canada indicating how green roofs can save millions of dollars in energy consumption, improve air quality, and reduce greenhouse gas (GHG) emissions.

The Green Roof Infrastructure Demonstration Project is a \$1 million public-private partnership between NRC's Institute for Research in Construction (NRC-IRC), Environment Canada, Green Roofs for Healthy Cities, the City of Toronto, the Toronto Atmospheric Fund, and the Technology Early Action Measures component of the Government of Canada's Climate Change Action Fund.

The project consisted of installing green roof infrastructure on the podium of Toronto City Hall, and another on the Eastview Neighbourhood Community Centre, Toronto in order to monitor the performance of the green roofs. Monitoring equipment installed by NRC will convey information on temperature profiles, heat flow and soil moisture content.

The first study of its kind in North America, results from Environment Canada's research shows that green roofs can help the City of Toronto save on energy costs, reduce GHG emissions, reduce emissions of sulphur dioxide and can help cool the city on hot summer days. Toronto's summer temperatures are 4°C to 10°C higher than those in the surrounding countryside, a phenomenon known as the urban heat island effect. This results in higher energy consumption to cool buildings, leading to more air pollution in the form of SMOG and sulphur dioxide, as well as greenhouse gases.

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The Environment Canada study illustrates that installing a relatively small amount of green roof infrastructure, approximately 6% of the total available roof space, can reduce summer temperatures in the City of Toronto by 1°C to 2°C.

"Environment Canada's study shows that green roofs can contribute to a reduction of energy use, which in turn helps reduce the emission of greenhouse gases and air pollutants. We are happy to be involved in the research and thinking for innovative ways of dealing with climate change and clean air," said the Honourable David Anderson, Minister of the Environment. "The Government of Canada not only supports this initiative, but we are acting on it with the construction of Canada's new War Museum in Ottawa, which will feature a green roof."



City of Toronto Deputy Mayor Case Ootes delivers an opening speech.

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About Green Roof Infrastructure and our Network

Green roof infrastructure provides a wide range of public and private benefits. These extend from improved stormwater management and smog reduction to energy efficiency, cost savings and new amenity space for building occupants. **Green Roofs for Healthy Cities** is a network founded by the Cardinal Group Inc. in March 1999 to foster the development of a multi-million dollar market for green roof infrastructure in North America. This involves training, building awareness, technical research and providing support for the implementation of public incentives and policies to help the industry grow. Green roof development involves the creation of 'contained' green space on top of a human-made structure. This green space can be below, at, or above grade, but in all cases the plants are not planted in the 'ground'. A green roof is an extension of the existing roof, which typically involves a special root repelling membrane, a drainage system, a filter cloth, a lightweight growing medium and plants.

Annual memberships in the Network range from \$250 to \$8,000 (USD) depending on the size and type of your organization. For additional membership information, please contact Steven Peck, Executive Director, Green Roofs for Healthy Cities at speck@cardinalgroup.ca or call 416 971-4494 or visit our Web site: www.greenroofs.ca

Our members include:



As little as a 1°C reduction in the urban heat island will result in a 5% decrease in electricity demand for cooling and refrigeration, resulting in lower GHG emissions. Combined with direct energy savings on buildings, green roofs can save an estimated \$1 million in energy costs per year and reduce GHG emissions by an estimated 2.18 megatonnes and remove 30 metric tonnes of pollutants from the air.

"When it comes to climate change, innovative thinking and programs are key," said Herb Dhaliwal, Minister of Natural Resources Canada. "Projects such as this clearly show that we can address climate change while making our cities more liveable."



Dr. Karen Liu gives a tour of the demonstration plots on the podium of Toronto City Hall.

"Green roofs can help Toronto manage projected future population growth by creating accessible green spaces from existing rooftops," said Case Ootes, City of Toronto Deputy Mayor. "Green roof investment and incentives will also generate jobs, here in Toronto, while reducing air pollution."

"Green roof infrastructure investment addresses many key challenges facing cities across North America such as how to grow our cities up rather than sprawling to accommodate new growth and still maintain a very high quality of life," said Steven Peck, Executive Director, Green Roofs for Healthy Cities. "This research will help us to develop appropriate public incentives to encourage widespread private sector green roof installation and build a green roof industry in Canada."

This project allows researchers to monitor stormwater retention, energy efficiency and roof membrane durability. There are further plans to use this data to model the stormwater benefits of green roofs later this year, in partnership with the Toronto and Region Conservation Authority.

For more information please visit the project Web site: <www.greenroofs.ca> or see the *Green Roof Infrastructure Journal*.

Green Roof Instrumentation Completed for Eastview Green Roof

Dr. Karen Liu, Institute for Research in Construction, National Research Council

This project is a \$ 1 million CDN public-private effort jointly supported by the Federal Government's Technology Early Action Measures (TEAM), the City of Toronto, National Research Council (NRC), Environment Canada, the Toronto Atmospheric Fund and Green Roofs for Healthy Cities - a network of public and private-sector partners. Our objectives are to monitor and evaluate the thermal performance and environmental benefits of green roofs on two in-service buildings. During the summer of 2002, NRC completed instrumentation of the Eastview Community Centre green roof.

The Eastview green roof was established on the top of the community centre's gymnasium, by Flynn Canada and Elevated Landscape Technologies in August 2002. It has an area of about 460 m² (5,000 ft²) and is divided lengthwise into two sections where two extensive green roof systems, Soprema's Sopranature™ and Garland's GreenShield™ were installed. The roof was constructed as a conventional roofing system with the thermal insulation covering the roofing membrane. The two extensive green roof systems consist of a lightweight growing medium 75 to 100 mm (3 to 4 in.) in depth. The green roof is not accessible by the general public. Three measurement locations are monitored on each green roof section to obtain a representative value for the large roof area. A roof section without the green roof (on top of the mechanical room beside the gym) was also chosen for reference purposes.

The roof was instrumented to measure the temperature profile and heat flow across the roofing system and the soil moisture content by embedding various sensors within the roofing systems. A weather station was installed on the rooftop to monitor atmospheric conditions such as temperature, relative humidity and solar radiation intensity. The sensors are connected to a data acquisition system, which can be remotely accessed from NRC in Ottawa, for continuous monitoring. These sensors allow us to evaluate and compare the thermal performance of roofs with and without green roofs, as well as the performance of different green roof systems. The data will allow us to quantify the energy efficiency of the roofing systems and the energy savings due to the green roofs.



Installation of the Garland GreenShield™ and the Soprema Sopranature™ green roof systems.

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In addition to thermal performance, combined temperature and relative humidity sensors were installed close to the roof surface to provide information about the microclimate created by the green roofs. Dark roof surfaces absorb solar radiation and re-emit the energy as long wave radiation such as heat, which increases the temperature of the surface layer of air above the roof. However, green roofs have the potential to convert the energy absorbed into latent heat through evapotranspiration, thus cooling down the surface layer of air above the roof and creating a unique microclimate. If the air intake of an air conditioning unit is located near a green roof, the cooling load of the AC unit will be reduced, thus saving additional energy costs.

Green roofs replace impermeable rooftops with permeable surfaces; they therefore, have potential for stormwater management in urban areas. The plants and growing medium can delay roof runoff during a rainstorm, and reduce the rate and the amount of roof runoff. NRC, along



with the City of Toronto's Works Department and the Toronto Region Conservation Authority, is planning to install flow devices on the drainage system of the green roof at Eastview Community Centre. The devices will monitor the rate and amount of roof runoff. A rain gauge has been installed on the weather station to measure the incident rain. The rain and runoff data will allow us to quantify how the green roof systems would help in stormwater management of buildings.

Roof cuts were made on the Eastview Community Centre green roof to allow for sensor installation.

All the sensors in each green roof site are connected to a data acquisition system (DAS) on

site. The data files are stored temporarily on the DAS and are automatically transferred to a central computer at NRC via a modem everyday. Data collection was started in June 2002. Although data analysis has not been performed at this early stage, data from the first two months of operation confirm that all sensors and the DAS are in good operating condition. The Toronto City Hall green roof site data show that growing medium depth significantly affects the temperature profile and heat flow of the roofing system. The Eastview Community Centre data suggests that the temperature was quite uniform across the length of the gym (26 m or 86 ft). The data will be compiled and analyzed semi-annually.

For more information contact Karen Liu at: Karen.Liu@nrc.ca.

Green Roof Research being Conducted at Penn State University

Dr. David Beattie, Penn State University

The Penn State Center for Green Roof Research, headed by Dr. David Beattie, is currently testing the ability of green roofs to minimize the heat flux through roofs, manage stormwater runoff, and filter nutrients.

The research site consists of six buildings, three of which are outfitted with green roofs, and three of which have conventional roofs. Each building is equipped with a heater and an air conditioner whose energy consumption is recorded each half hour. Also being monitored is the ability of the green roofs to filter nitrogen and pollutants, neutralize acid rain, and to reduce the amount of stormwater runoff. These data will be used to evaluate, modify and enhance existing German green roof technologies, and to develop new green roof systems for use in North America.

The project also aims to develop stormwater management computer aided design tools for green roofs, and standard testing protocols for roof systems and components, which will be suited for North American construction techniques and climate conditions. The energy balance, including heating and cooling requirements, will be measured for green roof systems, which will serve as the basis for the development of computer aided models. Drought, and high and low temperature tolerant plants will be evaluated, as well as the various factors that influence plant survivability.

Testing the performance of green roofs under North American climate conditions is an important step to promote the implementation of green roof technology in Canada and the United States. Results from this research endeavour promise to provide more insight into the performance of green roofs and to facilitate the implementation of green roofs in North America.

For more information contact Dr. David Beattie at: B50@psu.edu or visit:
<http://hortweb.cas.psu.edu/research/greenroofcenter/about_ctr.html>.

Waterloo Receives Funding for Green Rooftop Feasibility Study

Karen Moyer

At a national press conference in Ottawa on April 22, 2002 (Earth Day), the Federation of Canadian Municipalities announced that the City of Waterloo would receive grants of \$25,000 for the Green Rooftop Feasibility Study and \$15,000 for the Solar Energy Pilot Study.

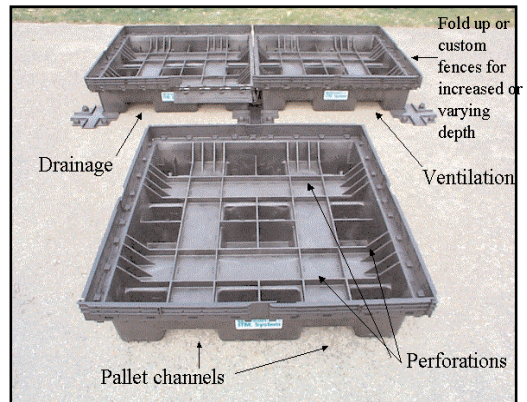
The City of Waterloo is planning to research the feasibility of installing a green roof on one of its municipal buildings. The goal of the study is to promote the use of green roof infrastructure throughout the City, especially on new buildings. Through this project, the City of Waterloo hopes to raise awareness about green roof technology and to gain support for the installation of more green roofs throughout the city.

For more information please contact Karen Moyer at: KMoyer@waterloo.on.ca.

Patron Member Profile: The GreenTech Modular Green Roof System

GreenTech Inc. is the most recent manufacturer to join the Green Roofs for Healthy Cities Network. They have developed a new modular green roof system, which is a derivative of their ITM athletic field system, installed at The All England Lawn Tennis and Croquet Club at Wimbledon and other major stadiums around the world. The base of the system is a high-density polyethylene module with drain holes and air inlets, allowing 40 times the drainage and airflow capacity of conventional construction methods. The shape consists of channels that act as conduits for drainage and climate-control. The containers are 46 inches squared (297 cm²) and can be any depth above 8 inches (20 cm). They contain a prescribed root zone designed for individual plant varieties within a garden design.

Introducing GreenTech's Roof Top Garden Module



The modules can be built off-site and installed at a later date, and their design also allows them to be removed and replaced as needed. The advantages of the GreenTech ITM system are as follows:

1. Each module can contain totally distinct plants thereby allowing the landscape architect the maximum flexibility in the selection of plants and the design.

2. Use of modules makes it possible to construct green roofs on the ground. If advantageous, completed pre-grown modules can be sent to the roof, thereby avoiding possible damage to the roof membrane and minimizing construction disruption on the roof. Some clients may also want the immediate benefit of plants rather than waiting for them to grow and establish themselves.



Pregrown plants in GreenTech modules

3. In accessible green roofs, the modular system allows for changing out plants that have finished blooming with modules of plants ready to bloom.

4. The modular system provides superior drainage because of the pallet channel network, through which drainage can be channelled to drain systems for irrigation water recovery and stormwater management.

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5. The free flow of air through the pallet channels benefits the plants and avoids the collection of moisture, which might cause "root rot". Airflow beneath the root zone through the pallet channels develops deeper root structure and healthier plants.



GreenTech modules are easy to interlock

6. Modular construction provides for greater protection against wind erosion of the root zone.

7. GreenTech modules can support very heavy equipment for mowing and maintenance in green roof applications requiring extensive turfgrass surfaces.

8. In applications requiring greater plant diversity, the growing media can be built up to whatever depth is required.

9. By carefully composing the plant and growing media, significant reductions in weight loads are practical, thereby adding structural efficiency to the modular system.

10. The modular containers create another barrier to root system penetration of the roof membrane through "air pruning".

11. The ITM modules already have curbing built into them, thus helping to avoid this expense.

Roof Garden System - weight specifications for light and heavy soil

Soil Mixture (saturated)	Light Mix (psf)	Heavy Mix (psf)	Sand
8 ½ in. soil depth with module	26	41	55
8 ½ in. soil depth without module	42.5	59.5	93.5
% weight savings using module	38.8%	31.1%	41.2%
11 ½ in. soil depth with module	41	62	85
11 ½ in. soil depth without module	57.5	80.5	126.5
% weight savings using module	28.7%	22.4%	32.8%

Weight of additional soil depth per inch above 11 ½ inch (psf/in)	5	7	11
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Module Dimensions (in)	45.5	Light Mix:	Heavy Mix:
Tributary Area (ft ²)	14.4	40% mature compost	33% mature compost
Total Surface Contact Area (in ²)	625	40% pine fines	33% pine fines
Volume at 11 ½ inch depth (cu ft)	10	20% ground Styrofoam	34% sandy loam

"I can assure you that I was very impressed with the GreenTech modular system and I can see many opportunities to use that system to create rooftop gardens on flat roofs. One of the big problems with most rooftop gardens is that there is insufficient slope to drain water through gravel resulting in numerous drainage problems. The GreenTech system does not restrict the movement of water and it allows for sufficient root depth."

Francis R. Gouin, Professor Emeritus, University of Maryland

For more information on GreenTech's green roof system, please contact: Chris Scott or Charles Plageman at: info@greentechitm.com, (804) 965-0026 or visit www.greentechitm.com.

CH2M HILL Conducts Stormwater Modeling on Green Roofs

Patrick Graham

CH2M HILL, in collaboration with Charlie Miller of Roofscapes, has developed a continuous simulation model to test the effectiveness and potential fit of green roofs as a stormwater management strategy in the Greater Vancouver Regional District (GVRD). Although green roofs have been built for decades throughout the GVRD, they have seldom been designed, or considered, for providing benefits beyond those of landscaping. Green roofs, however, hold significant potential to lead the Vancouver area towards a more sustainable region.

The study conducted by CH2M HILL examined the hydrologic performance of green roofs for a variety of soil profiles, percentages of green roof area, and precipitation scenarios, through continuous simulation modeling at both site and watershed scales. An important aspect of the study was to define the relationships between hydrologic performance measures (volumes and rates runoff) and key factors affecting performance (e.g. land use, precipitation, soil depth).

The study determined that in urban areas suitably designed green roofs have great potential benefit as stormwater source control. The study determined green roofs to be most effective at reducing runoff volumes in lower rainfall locations. For example, Figure A shows that runoff volumes from medium density areas in the drier parts of the

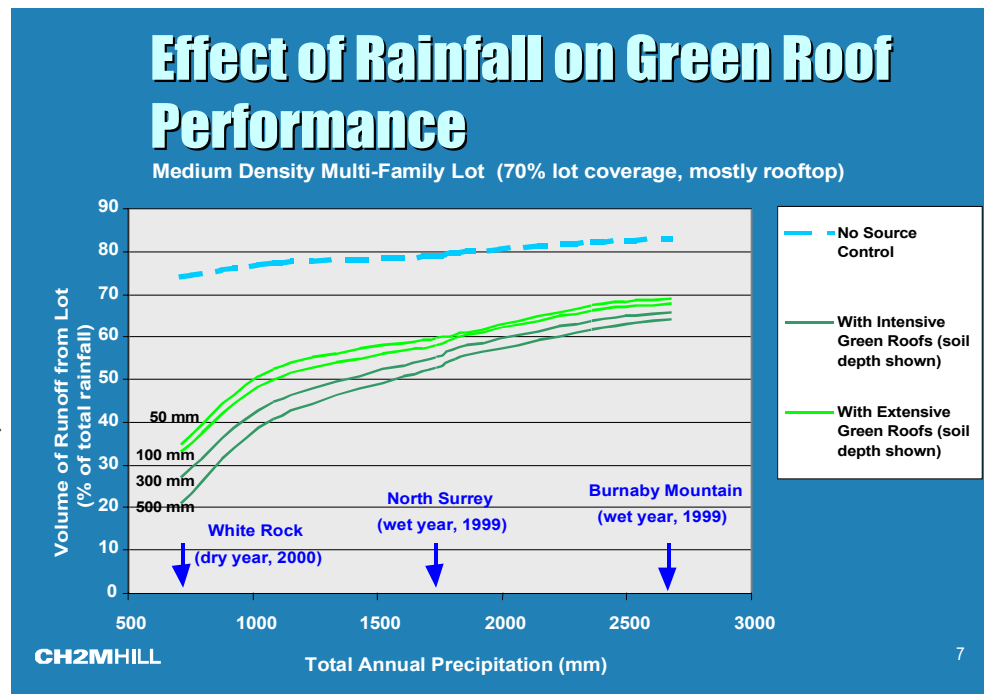


Figure A.

GVRD could be reduced by about 55% with lightweight extensive green roofs, and up to 75% with intensive green roofs with deeper soil.

Green roofs were also determined to be very effective at reducing peak runoff rates from high intensity, short duration "cloudbursts".

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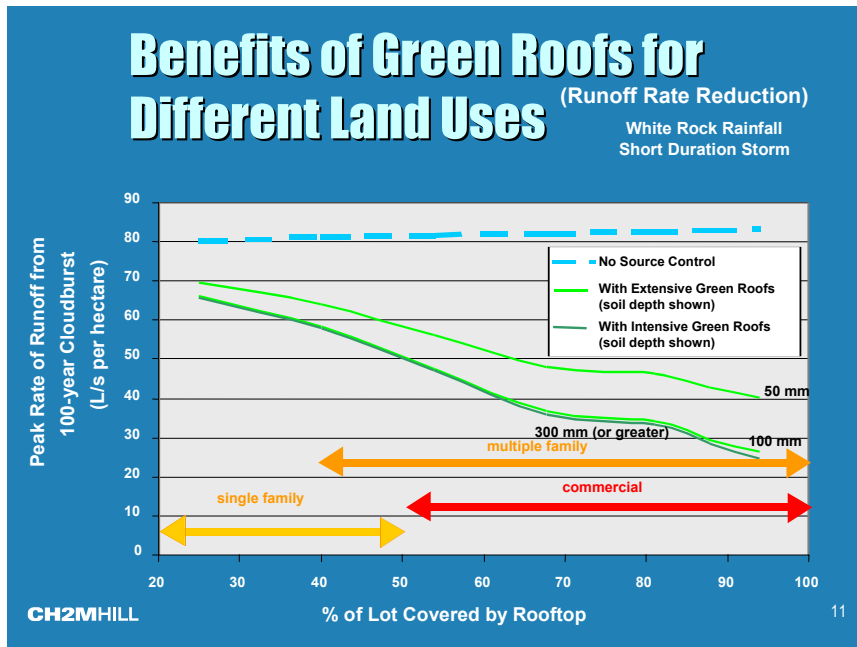


Figure B

For example, Figure B shows that peak runoff rates from a damaging cloudburst (100-yr, 2-hour storm) that occurred in White Rock could have been reduced by up to 70% with lightweight extensive green roofs.

The stormwater modeling has shown that green roof infrastructure holds great potential to effectively manage urban stormwater.

For more information on this study please contact: Patrick Graham pgraham@ch2m.com or visit the *Vancouver Green Roof Workshop Proceedings* now available on-line at: www.greenroofs.ca.

Greater Vancouver Regional District Conducting Green Roof Inventory

Kim Davis

In response to the growing interest in green roofs, and the potential benefits from their widespread implementation in the Vancouver Region, the Greater Vancouver Regional District (GVRD) is developing a green roof inventory of existing projects in the GVRD. The inventory will document the approximate number, types, and performance of existing green roofs, and will also note upcoming projects.

The inventory will focus on multi-family, commercial, and industrial buildings, particularly those in the urban core and city/municipal centers. It seeks to identify all roofing surfaces, including garage roof decks, presently accommodating vegetation. It is believed that this inventory will be a valuable tool in encouraging the implementation of green roofs in the Region. The completed inventory will be made available to survey participants and the general public through the GVRD's Web site in the first quarter of 2003.

For more information about the GVRD project please contact the Project Consultant, Kim Davis at: tree.dreams@3web.net.

Green Roof Demonstration Project in Prince George, BC

Patrick Lucas and Emily Hansen

The municipality of Prince George, British Columbia, had its very first rooftop greening research, education, and demonstration program this past summer 2002. Initiated by Patrick Lucas and Emily Hansen, students from the University of Northern British Columbia, this project involved the installation of a small demonstration green roof on the Prince George City Hall in June 2002, and an educational campaign to raise interest and awareness about the economic, social, and environmental benefits of green roof technology. The green roof, which is about 19m² (200 ft²) in size, consists of native grasses, wildflowers, shrubs, and dwarf trees. Funding for this project was provided by the City of Prince George, the Real Estate Foundation of British Columbia, the Northern Land Use Institute at the University of Northern BC, Human Resources Development, as well as a number of local businesses.



Green roof demonstration project on the Prince George City Hall

The central aspect of the project is a feasibility study examining how the City of Prince George can integrate rooftop greening into its overall plans and strategies for stormwater management within a northern/winter city context. The study, which is the result of a partnership between the University and the Prince George Public Interest Research Group, will evaluate the limitations and opportunities that exist with respect to the utilization of rooftop greening technologies in a northern city, and make recommendations for public policy that will assist the community in capitalizing on the numerous benefits of the technology.

One attribute of Prince George, and many northern communities, which stands in stark contrast to cities in the south, is the difference in land use densities. Cities such as Prince George, with much lower densities than many southern cities, may not reap the same degree of public benefits. The key is to gain a comprehensive understanding of how rooftop greening will fit into our community and to create policies that will effectively assist us in capitalizing on the numerous benefits this technology has to offer in the long-term.

This study aims to show that even in northern communities, rooftop greening can be an important tool for stormwater management. Thus far, the project has been a spectacular success with a great deal of positive feedback and enthusiasm from the community.

For more information please contact the Project Coordinators, Patrick Lucas and Emily Hansen at: pgrooftop@hotmail.com.

How Green Roofs fit into LEED™

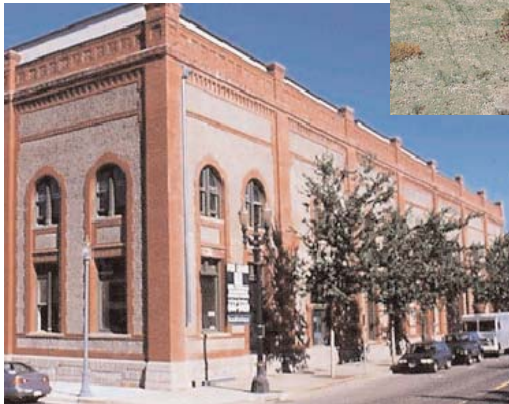
Luke Garnham, Research Associate, Green Roofs for Healthy Cities

The development of so-called 'green buildings' has intensified over the last decade as concerns have grown over the lack of sustainability in current construction practices. Design professionals and the construction industry have recognised that designing buildings that save energy and resources, reduce stormwater and avoid pollution are not only ecologically responsible but also cost effective and competitive.

The design of the roof makes an important contribution to the overall sustainability of any potential green building. According to Tom Liptan of the City of Portland, Bureau of Environmental Services, "...a widely adopted industry standard certification system that recognises this contribution to building sustainability is an important step in the development of green roof infrastructure in North America".

The U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED™) Green Building Rating System™ is the foremost means of certification through which prospective green buildings in the United States are assessed for the environmental quality of their design and construction. It is a voluntary, consensus-based national standard designed to

The Jean Vollum Natural Capital Centre and Ecoroof in Portland Oregon: The first historic building to be LEED™ Gold Certified. (Picture credit: Ecotrust)



provide a complete framework for assessing building performance and meeting sustainability goals.

Since the launch in 2000 of the latest rating system iteration, LEED™ 2.0, registrations for LEED™ have grown to over 500 projects, totaling approximately 70 million square feet (6.5 million m²) of constructed area and representing nearly 3% of new commercial construction projects annually.

One building that has achieved LEED™ certification is the Jean Vollum Natural Capital Centre in Portland, Oregon. Eugenie Frerichs of Ecotrust, the building's owner, emphasizes the increased exposure the building has attracted through its status as LEED™ Gold Certified: "As the first historic building to be LEED™ Gold Certified, we get a lot of enquiries regarding LEED™ and the design of our building". The building, an 1895 warehouse refurbished in 2001, demonstrates how effective LEED™ can be in stimulating interest in green building, particularly green roofs.

Using established and advanced industry practices, principles and standards, LEED™ emphasizes technologies and strategies to achieve credits in six main project design categories.

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These categories include Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, and Innovation and Design. Within each of these main categories, points are awarded for the different credits. Depending on the degree, to which credit targets are met, points are awarded for each credit and totalled to provide the overall LEED™ rating for the project. The rating is differentiated as follows: Certified (26-32 points); Silver (33-38 points); Gold (39-51 points); and Platinum (52-69 points).

“Green roofs are a great example of the integrated building strategies necessary to achieve the overall green building goals supported by the LEED™ Rating System”.

In LEED™ 2.0, green roof infrastructure can contribute directly towards a maximum of 3 points under the Sustainable Sites category: 1-2 points under Stormwater Management (Credit 6.1 & 6.2) and 1 point under Landscape and Exterior Design to Reduce Heat Islands (Credit 7.2).

Green roofs also provide other direct benefits to the building that contribute to its sustainability. Tom Liptan believes these benefits should be better recognised by LEED™: "Green roofs are underrated in LEED™, especially for energy optimization, savings in materials and resources and waste reduction due to extra roof longevity".

Peter Templeton, LEED™ Program Manager with the USGBC, agrees that green roofs can contribute to achieving other LEED™ performance criteria and stated that, "Although green roofs may not be referenced specifically in all of the credit categories where they may apply, green roofs are a great example of the integrated building strategies necessary to achieve the overall green building goals supported by the LEED™ Rating System".

Liptan also considers the LEED™ system a very useful framework for policy makers to adopt in designing policies to encourage wider adoption of green building practice, and it also helps them to recognise that green building saves money in the long run. Indeed, a number of local authorities have adopted policies or regulations that require new and existing buildings to comply with LEED™ certification. For example, the City of Portland adopted a LEED™-based Green Building Policy in 2001, the City of Seattle has recently adopted LEED™ for its municipal buildings, and the State of New York has developed LEED™-based energy efficiency goals for all State buildings and a Green Building Tax Credit. Other public authorities have specified green building standards and green roofs for department building projects or council offices (e.g. the City Hall in Chicago).

Future versions of the LEED™ Rating System should include more direct acknowledgement of the integrated benefits of green roof infrastructure, especially as scientific research into their building scale impacts progresses. As it stands, LEED™ still provides a very useful framework around which to promote green roofs as an integrated green building strategy.

A more detailed version of this article is available in the *Green Roof Infrastructure Journal* in the *Members Only* section of our Web site. For more information on LEED™ see the USGBC Web site <www.usgbc.org>.

Performance Rating System Introduced in Germany

Ireen Wieditz, Director, Green Roofs for Healthy Cities

The past 20 years in Germany have witnessed considerable advances in vegetation and construction technology, thus increasing acceptance for green roofs among building owners, architects and planners. Despite these advances, there is still a need to better define the ecological performance of different types of green roofs, in terms of air and water filtration, stormwater retention etc. This information is useful for land use and site planning processes, to ensure compliance with regulations and to ensure that the proposed green roof system is of high quality and can achieve its performance goals¹.

In Germany green roofs qualify as a measure to mitigate and replace environmental damage caused by urban development as outlined in the federal *Regulations on Interventions/Intrusions*. City planners are often faced with the question, what type and what extent of green roof is needed or will suffice to offset the environmental damage caused by a development? There is an immense difference in design, use and ecological function between an extensive green roof 3 to 4 cm (1.2 to 1.6 in) in depth, and an intensive green roof 80 cm (31 in) in depth. Moreover, planners need a gauge, by which to determine whether or not building owners have complied with design requirements. Residential, industrial, and commercial building owners also want assurances of a high quality performance green roof system.

For these reasons, an evaluation system has been developed in order to rate the ecological function of different green roof systems and their ability/suitability to mitigate environmental damage caused by urban development. In 1998, the Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V. (FLL) (The Landscaping and Landscape Development Research Association), well-known for their work in setting standards for green roof installation and maintenance in Germany, published a set of guidelines for an evaluation system based on the work of Krupka (1994; 1996; 1997)² and Neumann (1995)³ as well as other eminent green roof proponents and researchers.

The rating system is comprised of two components. The first component consists of a chart, which outlines how well intensive, semi-intensive, extensive and sloped green roofs of various plant composition and combined depth of growing medium and drainage layer can mitigate environmental damage. The green roof systems are rated on a scale, of high, medium and low. See Box 1 for an example.

The second component of the system involves assigning point values to green roof systems, based on the combined depth of the drainage layer and growing medium, the plant composition, and the water retention capacity.

BOX 1

Under the rating system, a semi-intensive grass-herb green roof, with a combined growing medium and drainage layer depth of 19 cm (7.5 in) has a *high* ability to replace soil lost at grade, a *medium* ability to filter water, and a *low* ability to provide recreational space.

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The greater the depth and more diverse the plant population, the greater the point value. This component of the rating system has great potential to aid planners when instituting green roofs in the legally binding local development plan.

By defining a fixed point value for the green roof in development plans, variations to the design of the green roof system can be made, as long as the total point value remains the same, allowing for trade offs to be made. For instance, if the total area of the green roof needs to be reduced (because of changes made to the building plans), its growing medium depth can be increased to maintain the same point value and thus the same ecological value⁴.

This rating system can also be of use to green roof manufacturers and potential green roof buyers. By assigning point values to their green roof systems, manufacturers can draw attention to systems of different construction and materials, but with similar ecological value. Property owners and developers can also benefit from more insight into the quality and ecological function of green roofs, especially when comparing various systems.

This rating system has the potential to allow for flexibility in the design of green roofs, while simultaneously ensuring compliance with design regulations. The adoption of this system at the municipal level of government would provide local authorities in Germany with a way to more clearly define the type of green roof system needed to mitigate environmental damage, while simultaneously providing a means by which to ensure regulation compliance. It can also be applied to incentive-based programs, for example stormwater fee reductions, to ensure that building owners install green roof systems that meet government fee requirements to qualify for the tax reduction.

Furthermore, this rating system has the potential to define a set of quality standards for green roof systems. By adhering to these standards, manufacturers can develop a credible market reputation and building owners are guaranteed a sound product.

In North America, the American Society for Testing and Materials (ASTM) has begun to look at establishing a set of standards for green roofs, and may find this new system to be very helpful.

¹Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V. FLL (1998) *Bewertung von Dachbegrünungen: Empfehlungen zur Bewertung in der Bauleitplanung, bei der Baugenehmigung und bei der Bauabnahme*. Bonn.

² Krupka, B. (1994) "Ein Bewertungssystem für Dachbegrünung nach Punkten" *Das Gartenamt*. Volume 43(7) pp. 448-450.

Krupka, B. (1996) "Bewertungssystem für Dachbegrünungen" *Bundesbaublatt*. Volume 5 p. 379-381.

Krupka, B. (1997) "Die Bewertung von Dachbegrünungen" *Dach + Grün*. Volume 6(1) pp. 4-9.

³ Neumann, K. (1995) "Dachbegrünung als Kompensationsmaßnahme gemäß § 8 BNatSchG" *Stadt und Grün*. Volume 44 pp. 477-485.

⁴ Krupka, B. (1994).

A more detailed version of this article is available in the *Green Roof Infrastructure Journal* in the *Members Only* section of our Web site.

FEATURE: Green Roofs and the Promise of Urban Agriculture

Luke Garnham, Research Associate, Green Roofs for Healthy Cities

Amongst their numerous ecological, social and economic benefits, green roof infrastructure provides significant potential for increasing production of food through urban agriculture. At first glance the notion of 'urban agriculture' may appear to many as something of an oxymoron - 'Surely our food is grown in agricultural areas in the countryside, outside of towns? Urban areas are for people not agriculture.' Whilst this is a common belief in the more developed, richer nations of the world, it is being challenged by a current resurgence of interest in urban agriculture.

The United Nations officially defines urban agriculture as '...an industry that produces, processes, and markets food and fuel within a town, city or metropolis on land and water dispersed throughout the urban and peri-urban area'¹. Urban agriculture involves a whole range of activities that vary in scale from the small private garden, through community gardens to large-scale commercial production of food and other agricultural goods.

Urban agriculture provides many interacting, synergistic, benefits to a city. Environmental benefits include: a reduction in the distance over which food is transported, thereby lowering emissions of carbon dioxide and other air pollutants; lowering the urban heat island; increasing biodiversity; and the potential to use urban organic wastes as a productive resource (e.g. through compost or biogas production) (See also *The Earthpledge Initiative* on page 18). Wider social and economic benefits include increased food security, new employment, training and recreational opportunities, personal reconnection with ecological cycles, and marketing of organic high value foods direct to consumers.

Fairmount Waterfront Hotel Rooftop Herb Garden

An outstanding example of green roof food production can be seen on the third floor terrace herb garden at the Fairmount Waterfront Hotel in Vancouver, British Columbia. By providing ingredients for the hotel's kitchen, the garden saves \$25,000 to \$30,000 CDN in herb costs annually. In addition to making locally grown produce available, the green roof also provides pleasant amenity space for hotel patrons and higher room rates for those located adjacent to it.

Initial construction of the green roof began in 1990-91, with the planting of ivy plants divided by pea gravel paths on the third floor terrace. In 1994, the south side of the roof was converted to a herb garden at a cost of \$25,000 CDN. The garden covers an area of 2,100 ft² (195 m²) with a soil depth of 18 inches (45.7 cm), and is divided into 11 variously shaped beds, each one amended in order to accommodate the particular needs of the herbs in the bed.

The Fairmount Hotel green roof is an excellent example of the multiple benefits that can be achieved with green roof technology.



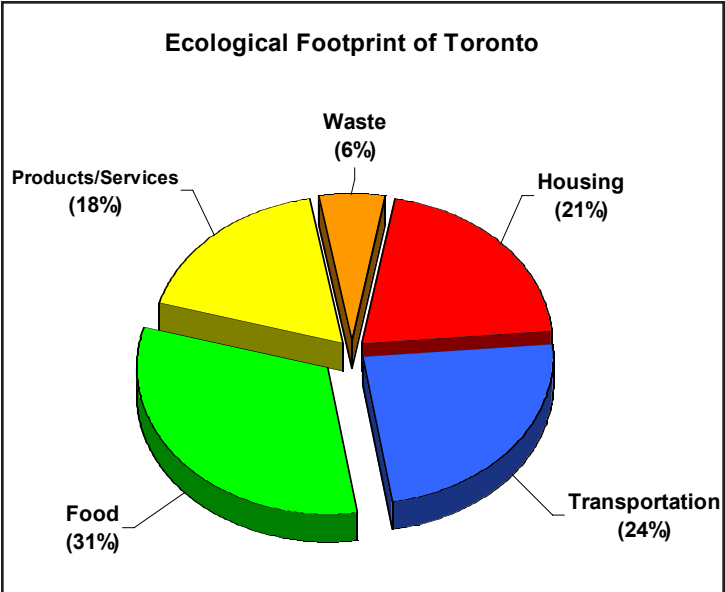
Green roof on the Fairmount Hotel
Photo by: David Walker

A detailed case study on Fairmount is being prepared by Green Roofs for Healthy Cities, which will be available by the end of this year.

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Rising urban populations, combined with a concentration of resource use and consumption in urban areas, mean that cities have become an important focus for promoting the principles of sustainability. The environmental, social and economic impact of a city, country or individual

upon world resources has been described by researchers as its 'ecological footprint'. For example, the City of Toronto has a total footprint that extends about 200 times its surface area of 630 km². This means that supplying all the resource consumption needs for Toronto and assimilating all of its wastes, would require 127,427 km² of productive land area².



Adapted from: City of Toronto Web site².

In order to make progress towards sustainability, the ecological footprint of urban areas must be reduced. Urban agriculture has been recognised as an important way to achieve this while ensuring food security for low-income groups.

Urban agriculture has the potential to reduce the ecological footprint significantly because a major component of a city's ecological footprint is related to the food system. In Toronto, approximately 31% of the average individual's footprint is directly related to food (see Pie Chart). A major environmental benefit of urban agriculture is reducing the production of transport related greenhouse gases. For example, of the food consumed in Toronto, approximately 50-60% is imported, mostly from Florida, California and Mexico, and travels an average of 1,300 miles from field to table³.

One of the major perceived barriers to urban agriculture is lack of available land. There simply isn't enough land available in cities to farm efficiently or cost-effectively. Supporters of urban agriculture argue that there is in fact enough land available in most cities to accommodate intensive food production - e.g. in hydro corridors or in green houses on reclaimed industrial or brownfield sites. The urban roofscape may comprise up to 30% of the total land area of a city and is too often overlooked when considering land availability for urban agriculture.

Toronto Food Policy Council member Wayne Roberts regards rooftops as a food production resource of great potential but notes that "...people don't recognise this because it is not under their nose - it is over their heads." Roberts believes that the use of roofs to grow high quality food will allow the synergistic benefits of urban agriculture to come to the fore, without competing with the many other demands on urban land.

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The idea of growing food up on rooftops is not new. There is a long history of small-scale gardening and limited food growth using tubs and planters on urban roof decks and balconies. Recently, however, researchers have been experimenting with more concentrated production of food on roofs, utilising extensive and intensive green roofs.

FoodShare, a Toronto based community and food security organisation, has been involved with research and experimentation into roof top urban agriculture over the past five years. Urban Agriculture Co-ordinator Lauren Baker, believes that the urban roofscape will provide a valuable resource for food production as long as technical limitations are overcome and the market for urban food produce properly developed.



Greenhouse on the roof of the Field to Table warehouse.

As with any green roof, those designed for food growth face design issues related to weight and structural support. This is particularly true of rooftop food gardens because most food crops require high levels of nutrient intake to sustain growth, which usually requires a deeper growing medium. Baker believes that roofs specially designed (or retrofitted) to hold deep soil loads of 12 to 18 inches will provide a high quality growing medium and, with appropriate protection from the climate extremes of rooftop environments (particularly wind and high temperatures), will be able to grow large quantities of high quality produce. The continuing development of lightweight growing media, rooftop greenhouses and hydroponic techniques means that food will be able to be grown intensively on a wider range of roof types.

The development of a market for urban rooftop food production will also depend largely on the entrepreneurial skills of those involved. Baker believes that with suitable training and the development of information and resource material, this is achievable.

Green roofs provide numerous urban ecosystem benefits, which when combined with the tangible economic and social benefits of urban agriculture, promise to contribute strongly to the increased sustainability of North American cities.

¹ UNDP (1996) *Urban Agriculture: Food, Jobs and Sustainable Cities*, New York: UNDP

² City of Toronto Website (2001) Toronto's Ecological Footprint <www.city.toronto.on.ca/energy/footprint.htm>

³ Toronto Food Policy Council (1999) *Feeding the City from the Back 40: A Commercial Food Production Plan for the City of Toronto*, from City of Toronto Web site <http://www.city.toronto.on.ca/health/tfpc_feeding.pdf>

A more detailed version of this article is available in the *Green Roof Infrastructure Journal* on the *Members Only* section of our Web site.

FEATURE: Greening Gotham's Rooftops

The Earth Pledge Green Roofs Initiative

Colin Cheney

In his August 13, 2002 article in *The New York Times*, journalist James Brooke writes, "With Tokyo's summer temperatures bound to continue upward, city officials say they want to make roof gardens as common for the buildings here as stairways"¹. Here, in Manhattan's Murray Hill neighborhood, a small organic garden of tomatoes, summer squash and arugula has become the seed for a campaign that encourages New York to pursue a similar path. The Earth Pledge *Green Roofs Initiative*, launched in June 2002, is committed to facilitating the development of green roofs in New York City. The initiative responds to a need for innovative solutions to the ecological and human health issues that the city faces in this new century.

Earth Pledge has been a fixture in New York City's non-profit world since it was founded in support of the Rio de Janeiro Earth Summit in 1991 by legendary labor mediator Theodore Kheel. We are committed to promoting the principles of sustainability and finding innovative ways to incorporate them into everyday behavior. Throughout the last ten years, Earth Pledge has been a leader in heightening awareness of sustainability's relevance to the fields of architecture and design, and agriculture and cuisine. In addition to the *Green Roofs Initiative*, Earth Pledge also houses two other initiatives - *Farm to Table*, a project to promote sustainable agriculture and connect farmers with consumers, and *FoodWaste=Fuel*, a campaign to build an anaerobic digester facility to convert New York City food waste into useable biogas.

The rooftop kitchen garden proved to be a prescient marriage of Earth Pledge's two key program areas: design and cuisine. Balmori and Associates, a New York landscape design firm, designed the garden and Chicago-based American Hydrotech donated the semi-intensive green roof system. The kitchen garden was planted in May 2002, and has grown thick with vegetables and herbs. The staff composts and vermicomposts our food scraps and garden waste, and the compost is then recycled back up to our garden. Vegetables from the roof are used in Earth Pledge's Sustainable Cuisine cooking classes.

The *Green Roofs Initiative* was created out of the realization that green roofs could further the expansion of urban gardens, while responding to the clear environmental issues that New York will continue to face in the coming years: the urban heat island effect and combined sewage overflows.



Cucumbers thrive in New York on Earth Pledge's rooftop garden

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In a July 2001 report, The Columbia Earth Institute concluded that problems associated with New York's urban heat island effect will only be compounded by projected regional warming associated with climate change, particularly in the areas of energy use and air quality². Meteorological models have found that temperatures in New York City can be 3.6°F to 5.4°F (2°C to 3°C) greater than in surrounding suburbs on summer afternoons³. Global Climate Models project warming of between 1.7°F to 3.5°F (1°C to 2°C) by 2020s for the New York Metropolitan Region. In this warming climate, the demand for electricity required for cooling in summer months - already far exceeding winter peak electricity loads - will continue to rise. Researchers believe that the health effects of this warming trend will not be distributed equally across the city, and that the elderly poor will be at greater risk from heat stress related illness⁴. The federal government believes that strategies involving the use of

high-albedo roof surfaces and urban re-vegetation could lead to temperature reductions in New York City of 3.6°F (2°C)⁵. Green roofs would clearly be an excellent strategy as well, providing the double service of replacing heat absorptive roofs and providing increased urban vegetation.

GREENING GOTHAM'S ROOFTOPS

On **November 22nd and 23rd**, Earth Pledge will hold *Greening Gotham's Rooftops*, a two-day event devoted to developing a green roof plan for the city. The forum on Friday morning will be a unique opportunity for New York City and State officials to become better acquainted with green roof technology and to explore options for government support of green roofs. On Saturday, Earth Pledge will hold its second Green Roof Symposium, featuring presentations of innovative green roofs projects from across North America, and a presentation on sustainable design and development projects in New York City.

The potential of green roofs to help reduce combined sewer overflows (CSO) is also of great use to New York. While the initial costs of green roof infrastructure are higher than those of high-albedo paint or roofing materials, reflective roofs do not offer the additional benefits of storm-water retention and increased urban vegetation. New York City continues to make progress in reducing combined sewage overflow. According to a 2002 NYC Department of Environmental Protection report, water quality in New York harbor is the best it has been since it was first surveyed ninety years ago. In 2001, the city was able to capture and retain 61% of rainwater entering the CSO system - greatly reducing stress on the treatment facilities⁶. However, the report makes clear that much remains to be done to improve the quality of harbor waters - yet there are limited funds available for continued improvements to the CSO system. Green roofs can provide an alternative means of trapping rainwater above and beyond modifications to the CSO rainwater capture systems.

With the aesthetic value of green roofs in one hand, and the pragmatic environmental and health benefits in the other, Earth Pledge established the *Green Roofs Initiative*, the brainchild of Earth Pledge's executive director, Leslie Hoffman, to explore how to best facilitate the development of green roof infrastructure for New York City. At our first symposium, held in June 2002, we convened a collection of leading figures involved in green roof, urban heat island reduction, or environmental protection work, to discuss the feasibility of creating green roofs for New York City.

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Speakers included: Steven Peck of Green Roofs for Healthy Cities, Hashem Akbari of the Urban Heat Island Group, Linda Velazquez of greenroofs.com, Diana Balmori of Balmori and Associates, Hillary Brown of New Civic Works, and Justin Bloom of Riverkeeper. The event sparked excellent press coverage in both The New York Times and The New York Sun.

In the *Green Roofs Initiative*, Earth Pledge is able to bring together organic agriculture and innovative design to the end of making New York - and the daily lives of New Yorkers - more sustainable. Green roofs provide a way for residents of our city to take an active part in restoring the ecology of our urban landscape. With this in mind, Earth Pledge has also committed itself to seeing green roofs built atop the new developments at the site of the World Trade Center - creating a living testament to a reinvestment of ourselves in its broken ground.



Tomatoes on Earth Pledge's urban agriculture green roof.

Earth Pledge is proud to be part of the international effort to further green roof infrastructure and is committed to using this initiative to help make New York a greener, cooler, and more sustainable city.

¹Brooke, James. 2002. 'Heat Island' Tokyo Is in Global Warming's Vanguard. The New York Times, 13 August, final edition.

² Rosenzweig, C. and W.D. Solecki (Eds.). 2001. Climate Change and a Global City: The Potential Consequences of Climate Variability and Change - Metro East Coast. Report for the U.S. Global Research Program, National Assessment of the Potential Consequences of Climate Variability and Change for the United States, Columbia Earth Institute, New York. p. xiii

³⁻⁵ Ibid, p. 136, pp. xii, p. 136

⁶ New York City Department of Environmental Protection, 2002. 2001 New York Harbor Water Quality Report. p. 4

A more detailed version of this article is available in the *Green Roof Infrastructure Journal* in the *Members Only* section of our Web site.

Colin Cheney is the Coordinator of the Earth Pledge Green Roofs Initiative. For more information on the initiative, or the Greening Gotham's Rooftops event of November 22 & 23, 2002, please contact him at: ccheney@earthpledge.org or visit www.earthpledge.org.

Earth Pledge is the first non-profit organization to join the Green Roofs for Healthy Cities Network.

PROJECTS UPDATE

The Ford Plant in Dearborn, Michigan is in the process of installing a green roof over 12 acres in size, making it the largest green roof on an industrial building in North America. *For more information please contact Don Russel at: drussel@ford.com.*

An accessible green roof will be installed on family housing residences at the University of Toronto. The green roof will transform 10,000 ft² (929 m²) of cement-covered terrace into gardens of various design, including a children's learning garden. The roof will be open for scheduled visits from environmental and community groups, researchers, designers and the media. *For more information please contact Project Coordinator, Nancy Chater at: nancy.chater@utoronto.ca.*

Mountain Equipment Co-op, in Winnipeg, Manitoba is installing a prairie ecosystem green roof by Flynn Canada. *For more information please contact Richard Kula at: richard@prairiearchitects.ca.*

The Maryland Department of the Environment, Baltimore relocated to a newly renovated building, which has a green roof. Before making the decision to relocate, the Department of the Environment stipulated that it must select an existing building and that it must meet the US Green Building Council LEED™ criteria. *Please visit: <www.mde.state.md.us>.*

A 20,000 ft² green roof will be installed at the Montgomery Park Business Center in Baltimore, MD. The aims of this project are to reduce stormwater runoff by 50% to 75% and reduce the surface temperature of the roof. *For more information please contact John McCoy at: jmccoy@dnr.state.md.us.*

The Jackman Public School in Toronto is planning to install a green roof on its three storey building to help offset hot summer temperatures. *For more information please contact Lisa Milne at: lisa@globalcolors.com.*

The City of Portland is home to a number of new projects. A 12,000 ft² roof will be installed on the Multnomah County building in the spring. Stormwater runoff and heat flux will be monitored at this site. Portland State University is constructing a new building, on which a green roof will be installed. In addition, owners of an apartment building in the downtown core are planning to install a green roof on their building.

The California Academy of Sciences in San Francisco is building a new facility, which will include a green roof. The green roof, complete with undulating contours, will be "draped" over the buildings, thus tying the roofscape into the hilly city terrain.

Please send project notices or updates to Ireen Wieditz at: iwieditz@cardinalgroup.ca.

QUICK RESOURCE GUIDE

EVENTS

The *Urban Heat Island (UHI) Summit* held on May 1-3, 2002 was attended by over one hundred participants. Formal presentations were made by some of the most distinguished and outstanding scholars and practitioners in the field of UHI from across Canada, Europe, Asia and the USA. The conference proceedings will be available on-line in November 2002. For more information, please contact Eva Ligeti at: eligeti@tafund.org.

The *Green Roof Tour, Press Conference, and Reception* held at Toronto City Hall, on October 9, 2002 was a great success. Visit our Web site <www.greenroofs.ca> to download the press release, technical backgrounder, and graphics.

The New York City symposium, *Greening Gotham's Rooftops*, will be held on November 22 and 23, 2002. Visit <www.earthpledge.org> for more details.

The *Prairie Green Roof Workshop* in Winnipeg will be held on October 29, 2002 at the University of Manitoba, with the Centre for Indigenous Environmental Resources. Please visit our Web site for more details. The cost of the conference is \$195 CDN - member discounts are available. Space for this event is limited.

The first ever *North American Green Roof Conference and Trade Show* will be held in Chicago from May 29-30, 2003. Stay tuned to our Web site for more details and a call for papers.

RESOURCES

Visit our new Web site at <www.greenroofs.ca> featuring new information on policy and financial support and a virtual tour of green roof projects in Toronto. We have also developed a new, detailed annotated bibliography of green roof resources, which is available to members only on-line.

The *Vancouver Green Roof Workshop Proceedings* are now available on our Web site, free of charge.

A new article from Professional Roofing magazine, "Going Green: A National Research Council Canada study evaluates green roof systems' thermal performance.", by Dr. Karen Liu is available on-line. Visit <www.professionalroofing.net/article.aspx?A_ID=130>.

To submit an article to the *Green Roof Infrastructure Monitor*, or the *Green Roof Infrastructure Journal*, please visit the *Resources* section of our Web site and click on *submit an article* for more information.

If you would like to subscribe to the *Green Roof Infrastructure Monitor*, or have any questions, please contact: Ireen Wieditz, Director, Green Roofs for Healthy Cities, at: iwieditz@cardinalgroup.ca or (416) 971-4484.