

# Green Roofs and Walls

*Presentation to Landscape Ontario Congress  
January 12, 2012*

Jordan Richie, GRP  
Green Roofs for Healthy Cities

# *Green Roofs*



**Millenium Village, Vancouver**  
2011 Award of Excellence Winner (Intensive Residential)



# *Green Walls*



**Phoenix Convention Center**  
2011 Award of Excellence Winner (Green Wall Design)



# About Green Roofs for Healthy Cities (GRHC)



## **Big Sur Residential**

Source: Fred Ballerini

2009 Award of Excellence Winner (Extensive Residential)

Member-based non-profit industry association established in 1999.


Mission:

*To increase the awareness of the economic, social and environmental benefits of living architecture through education, advocacy, professional development and celebrations of excellence.*



## *About GRHC – Education*

# LIVING ARCHITECTURE ACADEMY

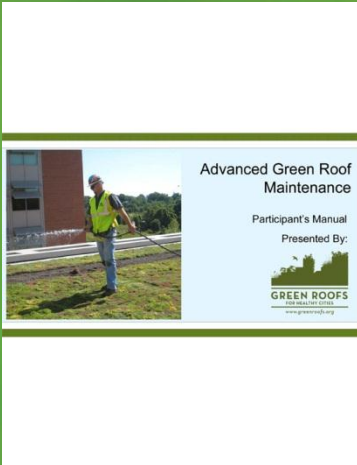


Green Roof Professional (GRP) training and accreditation program.  
Specialized half-day workshops.  
Online learning via the Living Architecture Academy.

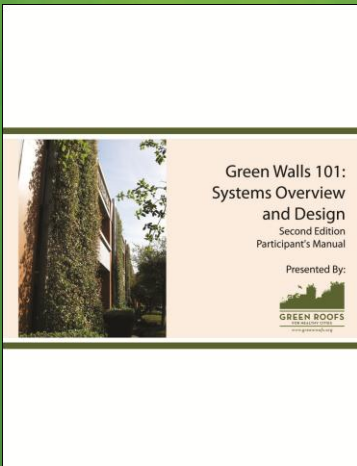


## *Training at Landscape Ontario Congress*

Advanced Green Roof Maintenance  
1:30 pm – 4:30 pm



Green Walls 101: Systems Overview and Design  
1:30 pm – 4:30 pm



*These courses are in the approval process for Landscape Industry Certified Continuing Education Credits.*



## *Upcoming GRP Training in Ontario*

- GRP Training Program – Ottawa – Algonquin College
  - Evening sessions every Wednesday from February 8 to March 28
- Toronto Green Roof Boot Camp (all four GRP courses on consecutive days)
  - February 23<sup>rd</sup> to 26<sup>th</sup> at Ryerson University and Carrot Common

Register at [www.greenroofs.org/education](http://www.greenroofs.org/education)



## *About GRHC – GRP Accreditation*

### Green Roof Professional (GRP) Accreditation Program



Industry-driven, exam-based certification.

Launched in June of 2009.

Now over 400 GRPs in the marketplace.

- Enables professionals to differentiate themselves in the marketplace
- Improves multi-disciplinary collaboration
- Increases customer confidence in green roof technology
- Results in better green roof design and installation practices
- Protects the industry from the inevitable failures that result from inappropriate design, installation and maintenance practices



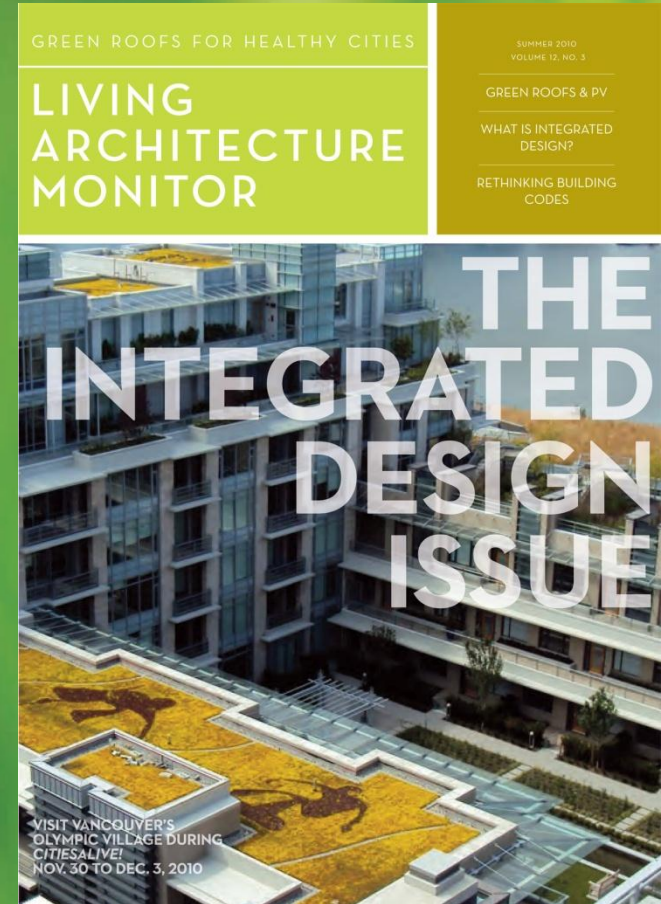
## *About GRHC – GRP Accreditation*





## About GRHC – Communications

- Web site: [www.greenroofs.org](http://www.greenroofs.org)
  - Contains resources and tools like the GreenSave Calculator, Green Roofs Tree of Knowledge, and Living Architecture Toolbox
  - Connect with GRPs and our members: designers, product manufacturers, and service providers
- Annual industry survey
- Quarterly *Living Architecture Monitor* magazine
- Awards of Excellence program
  - Recognizes outstanding North American green roof and wall projects
- *Green Infrastructure Webinar Series*



*Living Architecture Monitor* magazine.  
Published quarterly.



## About GRHC – Conferences & Symposia



*Schwab Rehabilitation Hospital. Chicago, IL.*

- Policy, Design & Case Studies, and Research tracks
- Trade show
- GRP and specialized half-day training courses
- Awards of Excellence ceremony
- Local green roof and wall tours

## *About GRHC - Membership*

Three types of membership:

### **Corporate Membership**

- Green roof and wall product manufacturers, suppliers, or service providers.

### **Individual Membership**

- Individuals practicing the art of living architecture.

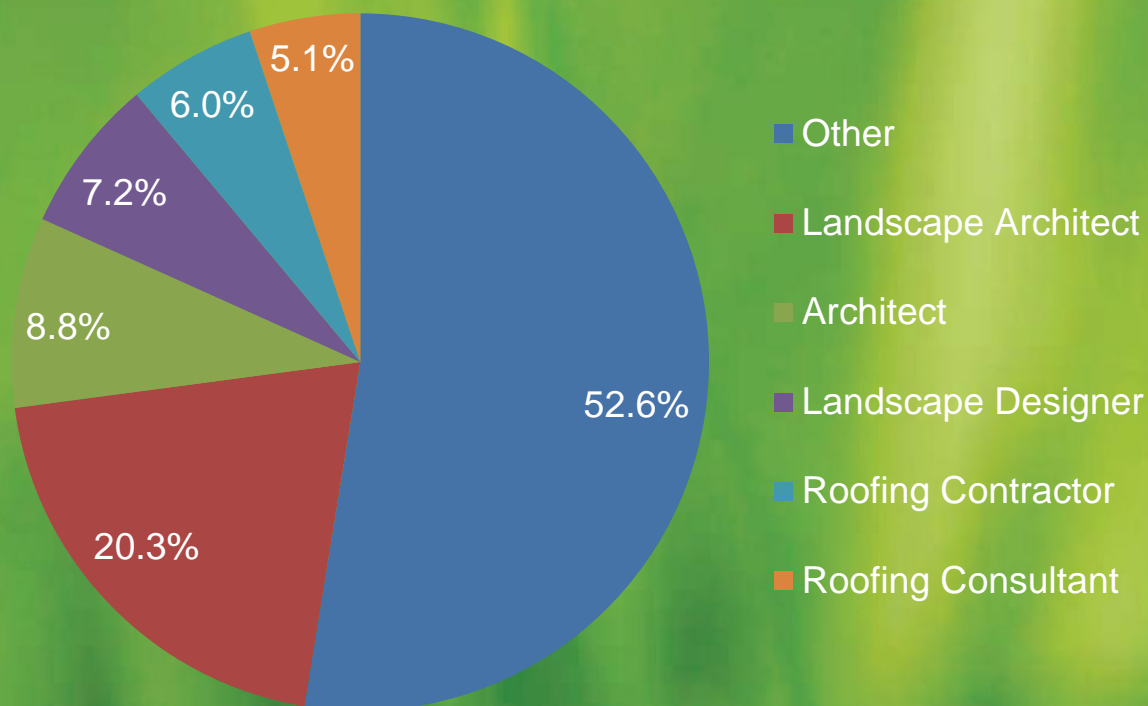
### **Supporter Membership**

- Individuals with a personal or professional interest in living architecture who wish to subscribe to the *Living Architecture Monitor* magazine.

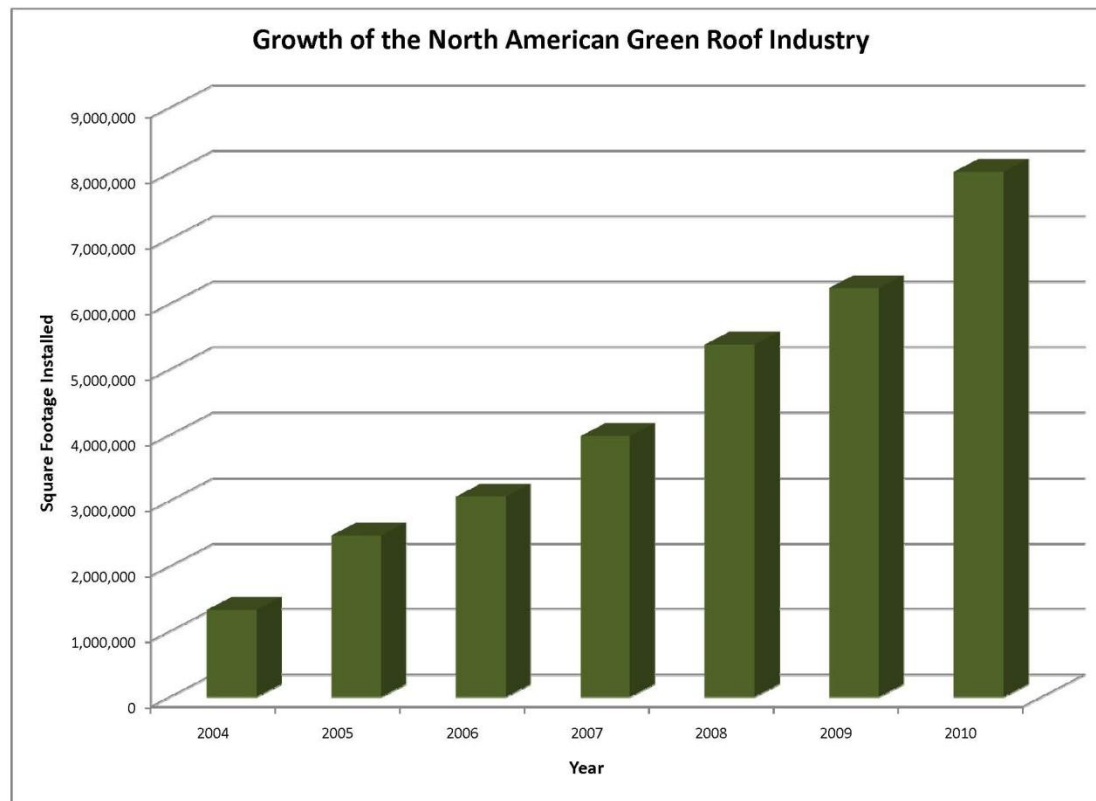


## About GRHC - Membership

### GRHC Individual Membership by Profession



# *Green Roof Industry Growth*



Source: GRHC Industry Survey.



## *Industry Growth*

### Top Ten Green Roofs Cities – 2010

<u>Metropolitan Area</u>	<u>State/Prov</u>	<u>Total Installed (SF)</u>	<u># Projects</u>
Chicago	IL	539,171	59
Toronto	ON	439,892	59
Washington	DC	410,245	46
New York	NY	233,333	58
Ottawa	ON	230,686	10
Vancouver	BC	224,550	4
Philadelphia	PA	147,592	24
Norfolk	VA	132,869	9
Milwaukee	WI	130,132	14
Baltimore	MD	90,079	14

## *Green Roofs*

A green roof is a 'contained' green space on top of a human-made structure below, above, or at grade.

**Howard Hughes Medical Institute**

Chevy Chase, MD

*Source: Sika Sarnafil*





# Overview of Green Roofs - History

- 600 BC: Ziggurats of Ancient Mesopotamia
- 800-1000 AD: Vikings



**Hanging Gardens of Babylon**

Mesopotamia



**Sod Roof**

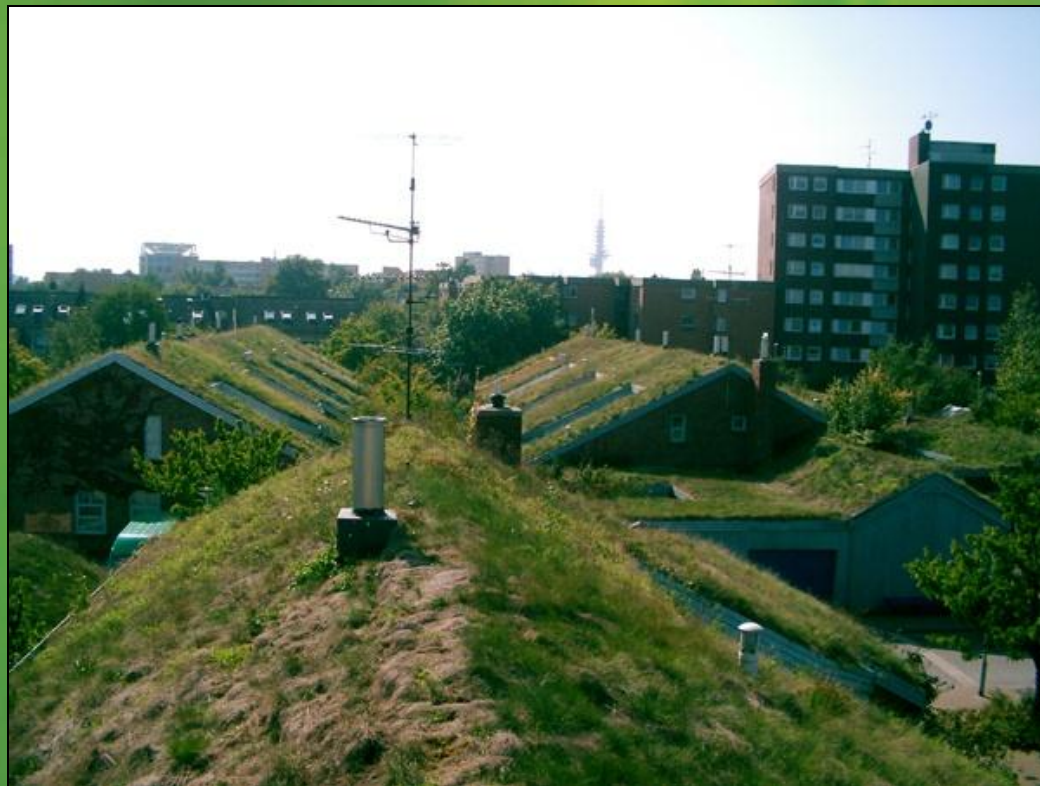
**Restored Viking Settlement**

L'ance aux Meadows, Newfoundland

*Source: Steven W. Peck*



# Overview of Green Roofs - History



**Residential Development**

Germany

*Source: Steven W. Peck*



**Daimler-Chrysler Building**

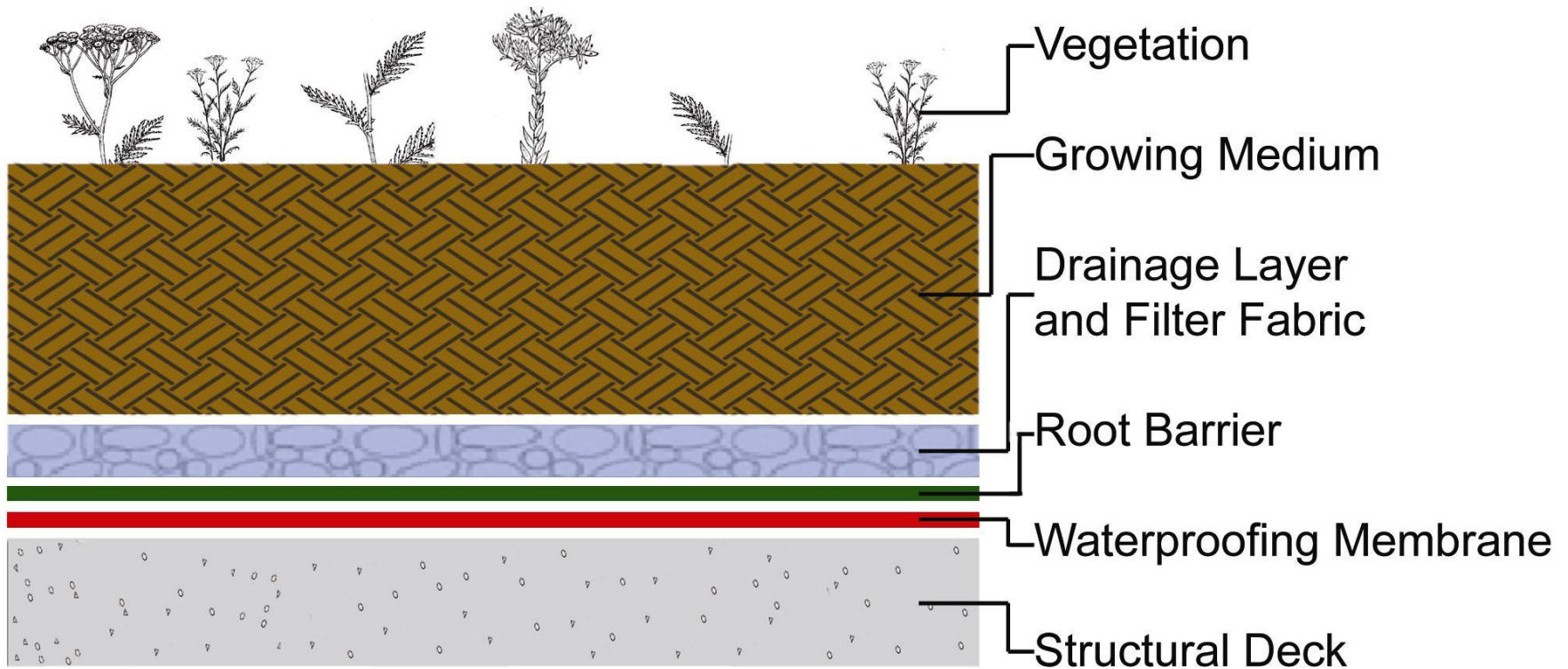
Berlin, Germany

*Source: Steven W. Peck*



# Green Roof Components

## Basic Green Roof Assembly



# Green Roof Overview - Categories

CHARACTERISTIC	EXTENSIVE	SEMI-INTENSIVE	INTENSIVE
Growing Medium Depth	6" or less	25% above or below 6"	More than 6"
Accessibility	Often inaccessible	May be partially accessible	Usually accessible
Fully Saturated Weight	Low 10-35 lb / ft <sup>2</sup> (48.8 - 170.9 kg / m <sup>2</sup> )	Varies 35-50 lb / ft <sup>2</sup> (170.9 – 244.1 kg / m <sup>2</sup> )	High 50-300 lb / ft <sup>2</sup> (244.1 – 1,464.7 kg / m <sup>2</sup> )
Plant diversity	Low	Greater	Greatest
Cost	Low	Varies	High
Maintenance	Minimal	Varies	Varies, but is generally high

EXTENSIVE	SEMI-INTENSIVE	INTENSIVE
Lightweight	Combines best features of extensive and intensive	Greater diversity of plants
Suitable for large areas	Utilizes areas with greater loading capacity	Best insulation properties and storm water management
Low maintenance costs and may be designed for no irrigation	Greater coverage at less cost than intensive	Greater range of design
More suitable for retrofit projects	Average maintenance	Usually accessible
Lower capital costs	Greater plant diversity than extensive	Greater variety of human uses
Easier to replace	Greater opportunities for aesthetic design than extensive	Greater biodiversity potential



# Green Roof Systems

## Modular Systems



Source: Green Grid



Source: Green Roof Blocks



Source: Eco-Roofs



Source: Mule-Hide Products



# *Green Roof Systems*

## Loose Laid Systems



Source: Stancils



Source: Rooflite



Source: American Landscape



## *Green Roof Growing Media*

Growing medium is made up of four components:

- Inorganic material (a.k.a. aggregate)
  - Vermiculite, expanded slate, clay, volcanic rock, coarse sands, pumice stone, scoria, zeolite, diatomaceous earth, perlite, crushed roofing tile, and rock wool.
- Organic material
  - Straw, saw dust, wood, grass, leaves, clippings, agricultural waste, worm castings, peat or peat moss, and manures. Bio-solids and Animal carcasses can be used but must be done exercising caution.
- Water
- Air



## *Green Roof Growing Media*



J.C. Raulston  
Arboretum

Raleigh, NC

Source: Chuck Friedrich,  
Carolina Stalite



## *Green Roof Growing Media*

### Properties of Green Roof Growing Media

- Minimal contribution to weight load
- Retention of nutrients/moisture
- Offer a high void (air volume) ratio even when saturated
- Sufficiently porous for internal aeration
- Ability to prevent rotational movement, shrinkage, and compaction
- Resistant to heat and rot
- An ability to anchor plants
- Readily drainable
- Free of material which may degrade, clog, or corrode drainage or waterproofing system

## *Green Roof Vegetation*

Commonly used plant categories for green roofs include:

- Succulent plants
- Grasses
- Herbaceous plants
- Woody plants



# Green Roof Vegetation



## Woodlands Assisted Living

New Westminster, BC

Source: Nat's Nursery

## 4287 Kingsway

Vancouver, BC

Source: Steven W. Peck



## Chicago City Hall

Chicago, IL

Source: City of Chicago



## *Green Roof Vegetation - Sedums*



*Delosperma nubigenum* 'Basutoland'



*Sedum reflexum*



*Sedum album*



*Sedum spurium* 'John Creech'



# *Green Walls*

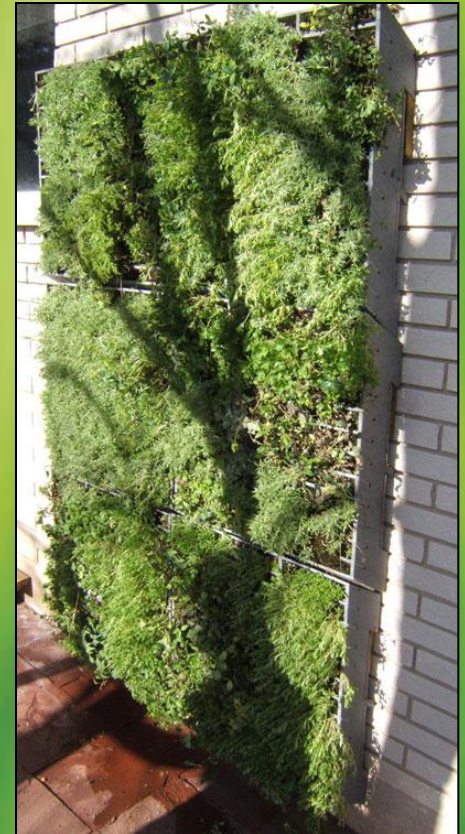
‘Green wall’ is an all-encompassing term used to refer to various forms of vegetated vertical surfaces.

## Green Façades



Source: Jakob

## Living Walls



Source: Elevated Landscape  
Technologies



## *Green Walls – Green Façades*



Source: greenscreen

A '**Green Façade**' or façade greening, features a training structure that support vines or climbing plants growing upward from the ground away from the building.



Source: Jakob



## *Green Walls – Living Walls*



Source: Randy Sharp



Source: Green Living Technologies

A ‘**Living Wall**’ is part of a building envelope system, comprising pre-vegetated or planted on site panels with plants, growing medium or liquid nutrient installed in or on a frame, secured to a structural wall or free standing.



## *Green Walls – Living Walls*



*Urban Food Chain. Green Living Technologies.*

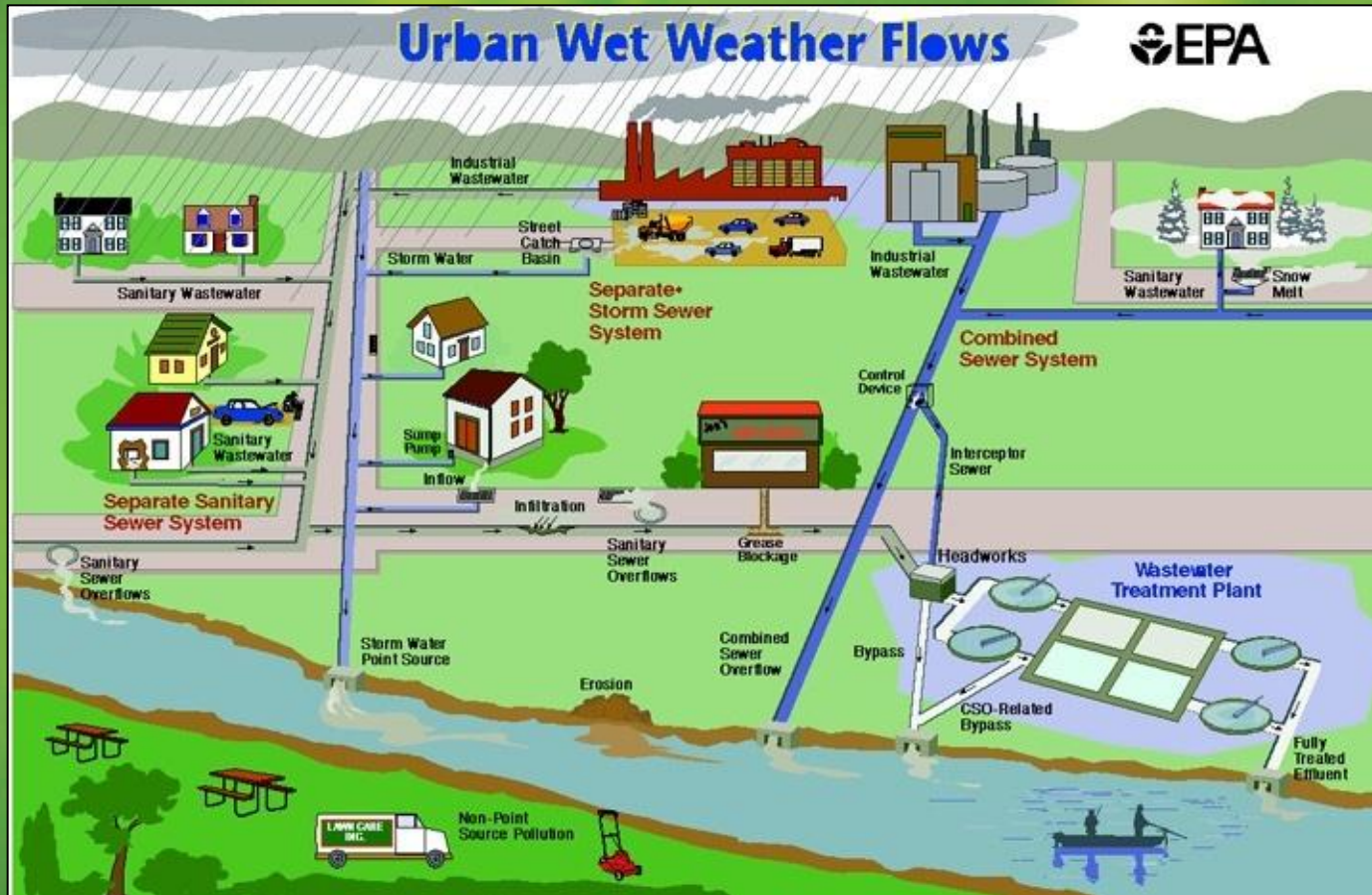


## *Green Roof Overview – Public Benefits*

Green roof benefits that can accrue to the public include:

- Stormwater Management
- Urban Heat Island Mitigation
- Improved Air Quality
- Aesthetics
- Waste Diversion
- Improved Liveability
- Green Job Creation – Design, Mfg, Installation and Maintenance

# Green Roof Overview – Stormwater Management



Source: US Environmental Protection Agency



# Green Roof Overview – Stormwater Management



10<sup>th</sup> @ Hoyt Apartments

Portland, OR

Award of Excellence 2006

*Source: Koch Landscape Architecture*



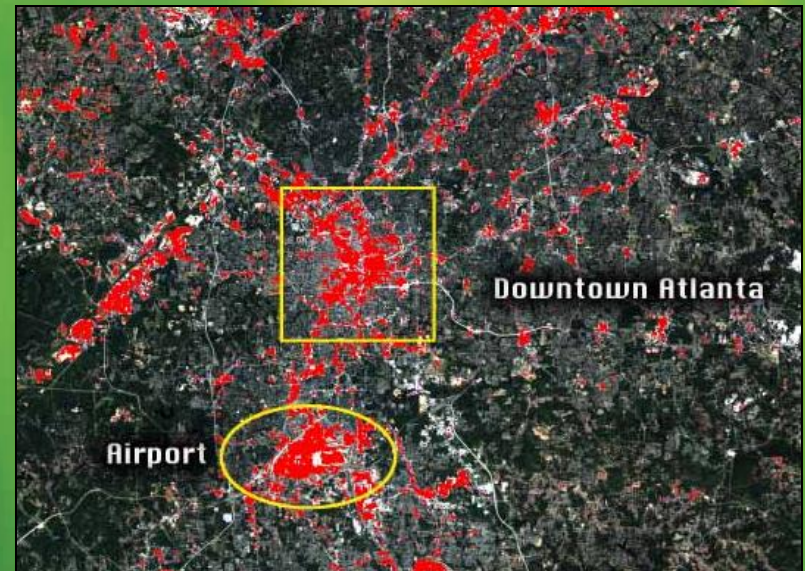


## *Benefits – Urban Heat Island Mitigation*



*Toronto, ON*

The urban heat island (UHI) effect is the temperature increase in urban areas associated with the replacement of “natural vegetation with pavements, buildings, and other structures necessary to accommodate growing populations” (Wong 2005).



*Source: Remote Sensing Advanced Technology*



### Causes of Urban Heat Islands

- Replacement of the vegetated landscape with urban structures and materials
  - Properties of urban materials, different thermophysical characteristics
  - Geometry of the Urban Form
- Anthropogenic Heat

## *Benefits – Additional Public Benefits*

Additional public benefits of green roofs include:

- Creation of Amenity Spaces
- Local Job Creation
- Waste Diversion
- Aesthetic Appeal



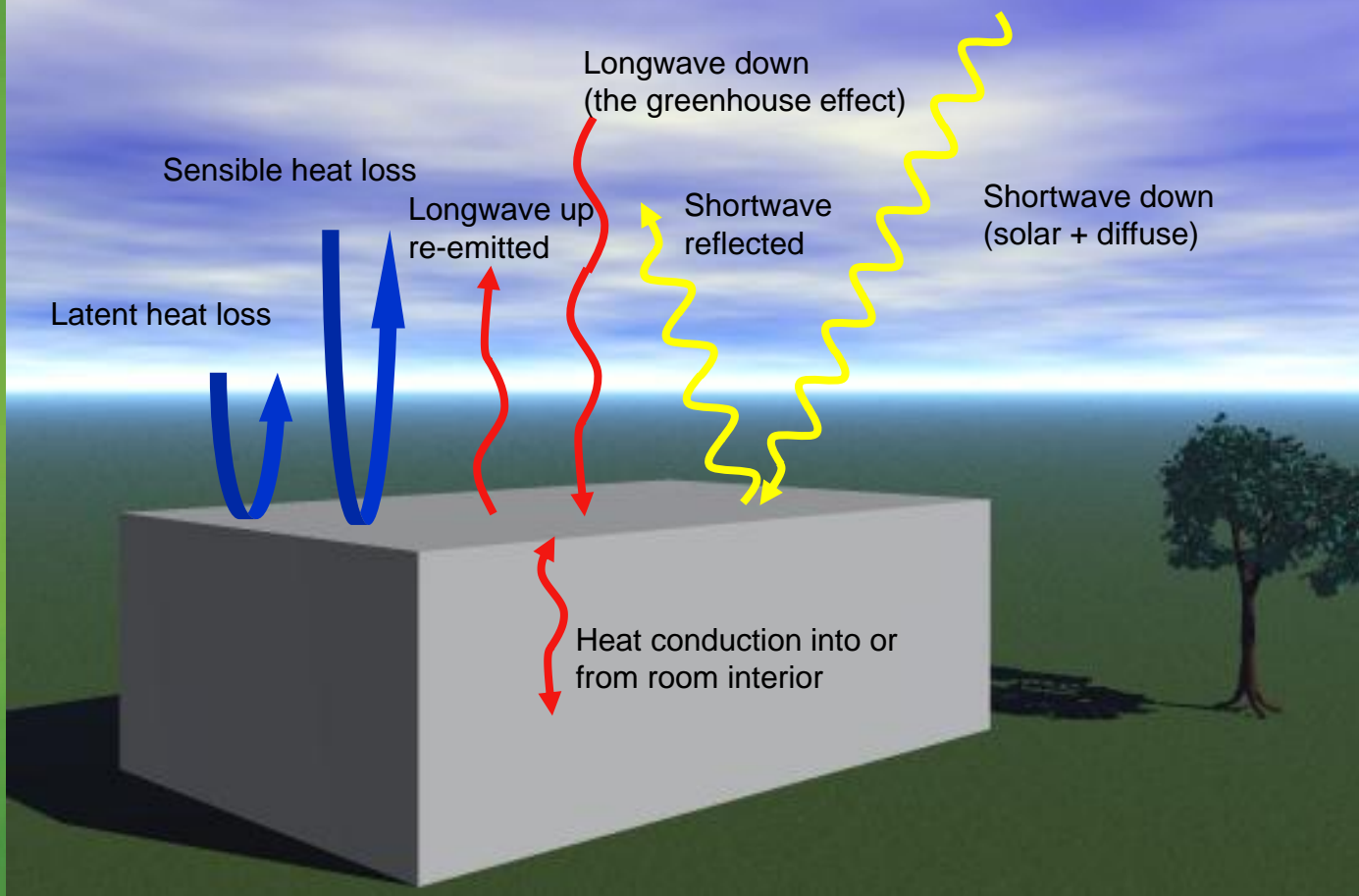
## *Green Roofs – Private Benefits*

Building-scale benefits that accrue to building owners or occupants include:

- Energy Efficiency
- Increased Membrane Durability
- Noise Reduction
- Increased property values and marketability

## *Private Benefits – Energy Efficiency*

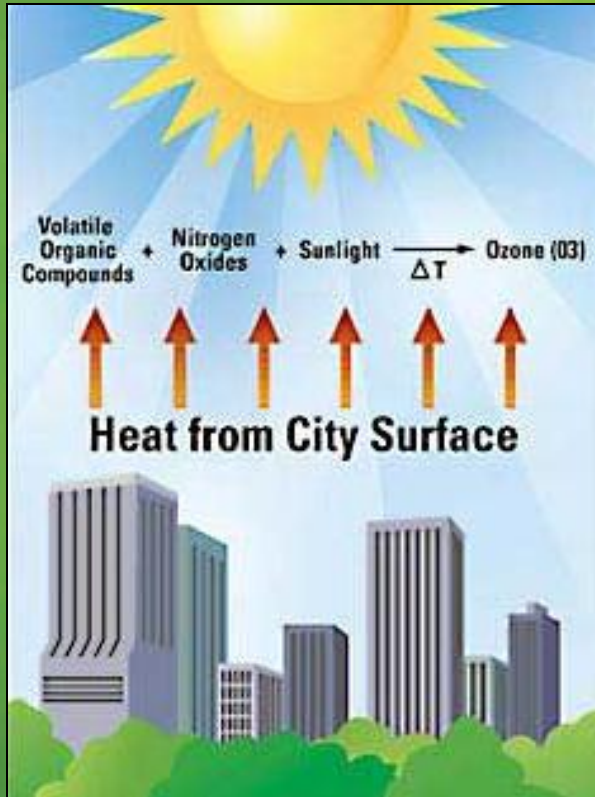
### Basic Roof/Surface Energy Balance Model



Source: Stuart Gaffin, Center for Climate Systems Research, Columbia University.



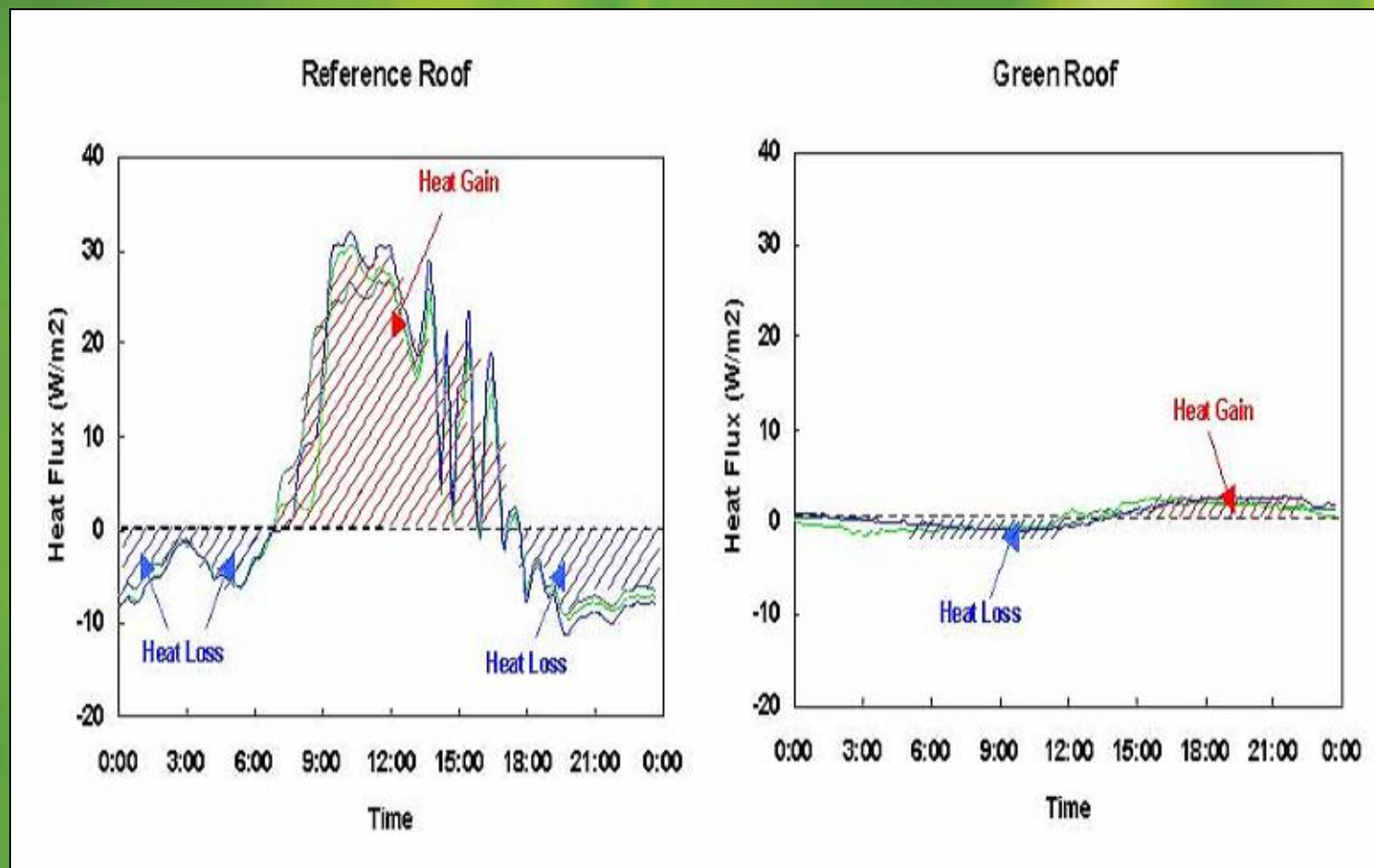
## *Private Benefits – Air Quality Improvement*



Typical sunny day temperatures on roof surfaces:

- Asphalt Roof: 158°F/ 70°C
- White PVC: 101°F/ 38 °C
- Green Roof: 90°F/ 32 °C

# Private Benefits – Energy Efficiency



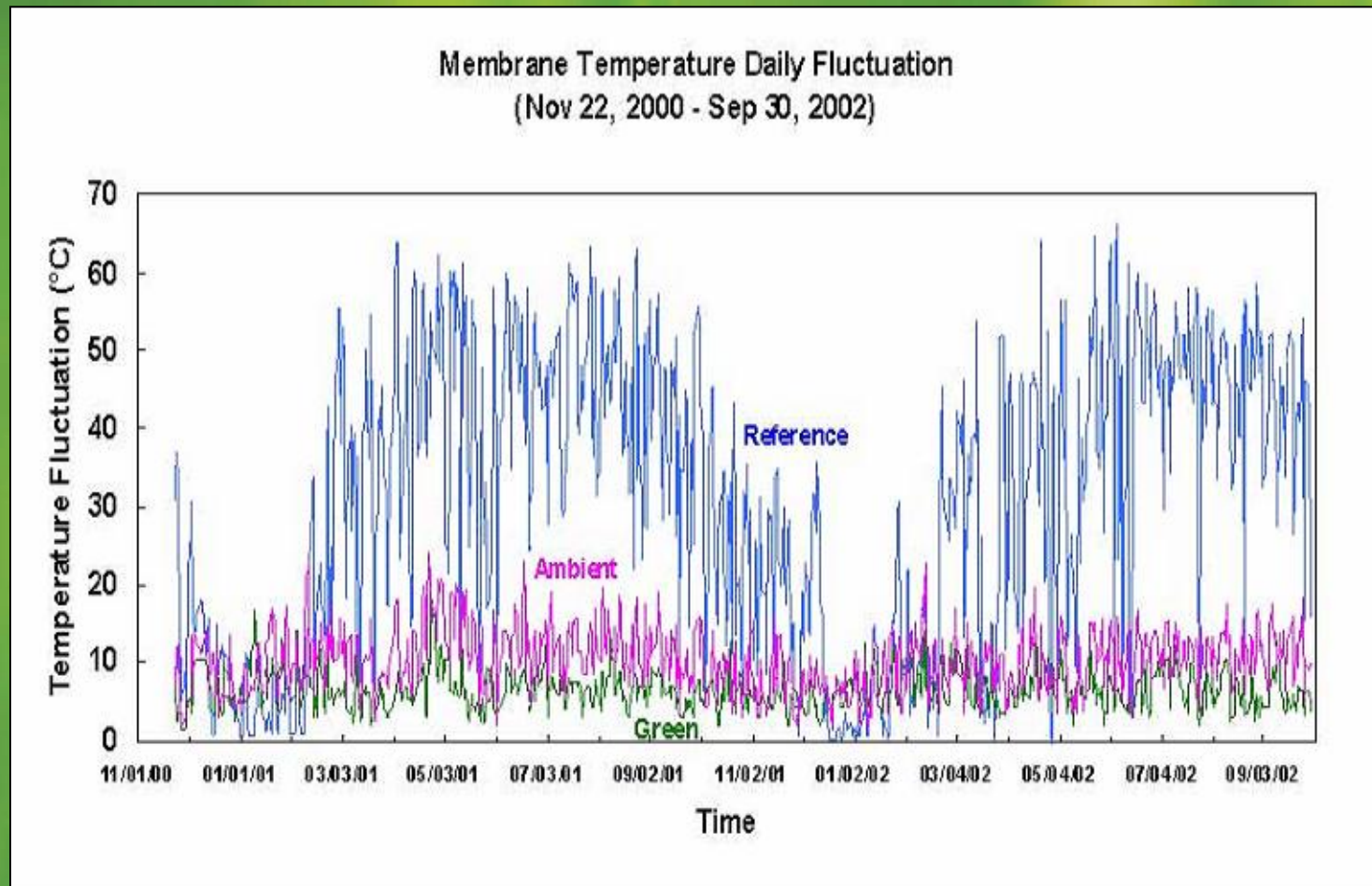
Source: National Research Council, Institute for Research in Construction



## *Private Benefits – Increased Membrane Durability*

- North American roofs have an average lifespan of 10-15 years
  - Average across climates and membrane types
- Waterproofing membranes in green roof assemblies have lasted over 40 years in Germany

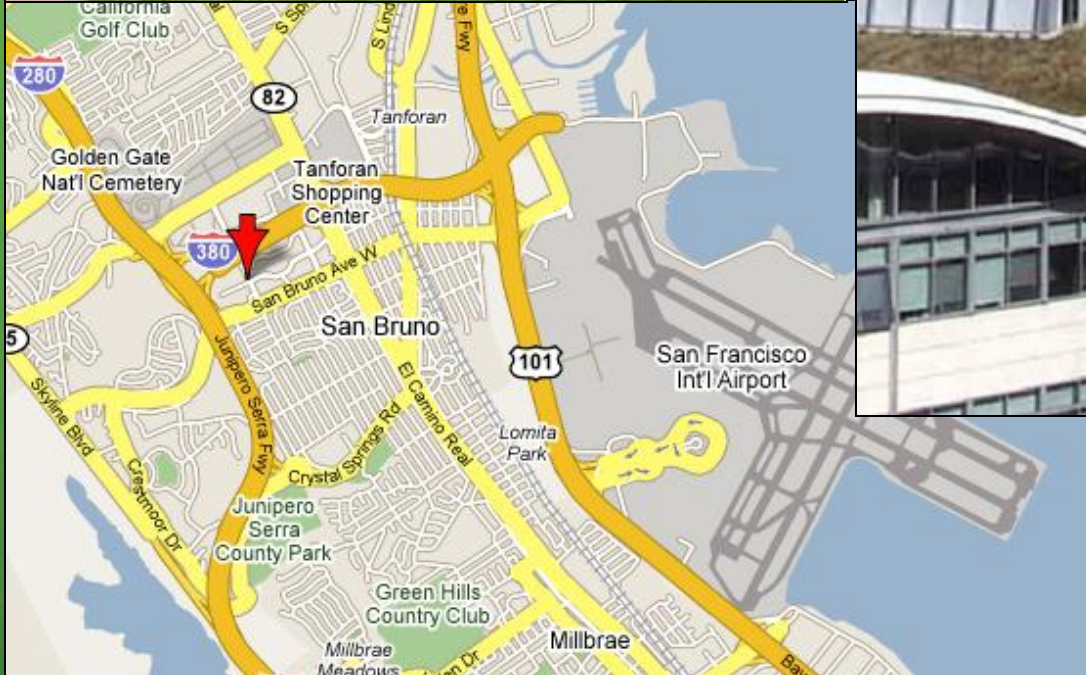
## *Private Benefits – Increased Membrane Durability*



*Source: National Research Council , Institute for Research in Construction*



## *Private Benefits – Noise Reduction*



**GAP Headquarters**

San Bruno, CA

**Award of Excellence 2003**

*Source: William McDonough + Partners*

## *Private Benefits – Marketability*

Green buildings have been identified as facilitating:

- Sales
- Lease outs
- Increased property value due to increase efficiency
- Easier employee recruiting
- Lower employee turnover



## *Private Benefits – Marketability – LEED Certification*

Through the process of integrated building design, green roofs may earn LEED® direct credits for:

- Storm water retention
- Reducing heat island effects
- Energy efficiency
- Water use efficiency

**Solaire Building**  
Battery Park City, NY  
**Award of Excellence 2004**

*Source: Simon Bird*



## *Private Benefits – Marketability*



### **Exhibition Place**

Toronto, ON

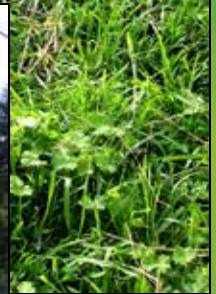
*Source: Melinda Zytaruk*



### **Old Country Market**

Coombs, BC

*Source: Steven W. Peck*





## *Project-Specific Benefits*

Additional project specific-benefits  
of green roofs:

- PV Integration
- Increased Biodiversity
- Improved Health and Well-Being
- Urban Agriculture



**Earth Pledge Green Roof**

New York, NY

*Source: Earth Pledge*

## *Barriers to Implementation*

Barrier to green roof implementation:

- Higher upfront costs
- Many of the benefits accrue to the public at large, not directly to building owners
- Lack of familiarity with the technology
- Lack of long-term performance data



## *Barriers to Implementation*

There are four ways in which this technology can be made more affordable:

- Public incentives at municipal, state/provincial, or federal levels
- Product development and technological innovation
- Integration of green roofs with other building systems or programs
- Market expansion through improved delivery and training

### **Toronto Eco-Roof Incentive Program**

- Green roof incentive program introduced in 2006
- Installations on existing commercial, industrial or institutional buildings are eligible
- \$50/m<sup>2</sup> up to \$100,000
- To date program has supplied over \$700,000 in funding



Toronto City Hall.



## Toronto Green Roof Bylaw



Toronto City Hall.

Gross Floor Area (Size of Building)	Green Roof Coverage Requirement
2,000 – 4,999 m <sup>2</sup>	20%
5,000-9,999 m <sup>2</sup>	30%
10,000-14,999 m <sup>2</sup>	40%
15,000-19,999 m <sup>2</sup>	50%
20,000 m <sup>2</sup> or greater	60%

### **Toronto Green Roof Bylaw**

- 103 green roofs required under bylaw as of August 2011 (105,000 sq. metres)
- 38 voluntary roof in same period (20,000 sq. metres)
- Prior to bylaw there were estimated to be 133 green roofs (36,517 sq. metres)





### Standards and Guidelines:

- 1995: FLL Green Roof Guidelines (Germany)
- 2002: FLL Green Roof Guidelines revised (Germany)
- 2005: Publication of 5 ASTM Standards (Appendix V)
- 2006: Publication of 1 ASTM Guideline
- 2006: FM Global 1-35
- 2010: ANSI/SPRI VF-1 Fire Design Guidelines
- 2010: ANSI/SPRI RP-14 Wind Design Standard
- 2009: City of Toronto Green Roof Construction Standard.

# Standards Development



## ANSI/SPRI VF-1 External Fire Design Standard for Vegetative Roofs

This standard was developed in cooperation with Green Roofs for Healthy Cities.

Approved January 29, 2010

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#### Disclaimer

This standard is for use by architects, engineers, roofing contractors and owners of low slope roofing systems. SPRI, its members and employees do not warrant that this standard is proper and applicable under all conditions.



## ANSI/SPRI RP-14 Wind Design Standard for Vegetative Roofing Systems

This standard was developed in cooperation with Green Roofs for Healthy Cities.

Approved 8/3/2010

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## *Projects – Vancouver Convention Centre*



Vancouver Convention Centre Expansion Project, Vancouver, BC.  
2010 Award of Excellence Winner. PWL Partnership Landscape Architects Inc.



## *Projects – Vancouver Convention Centre*

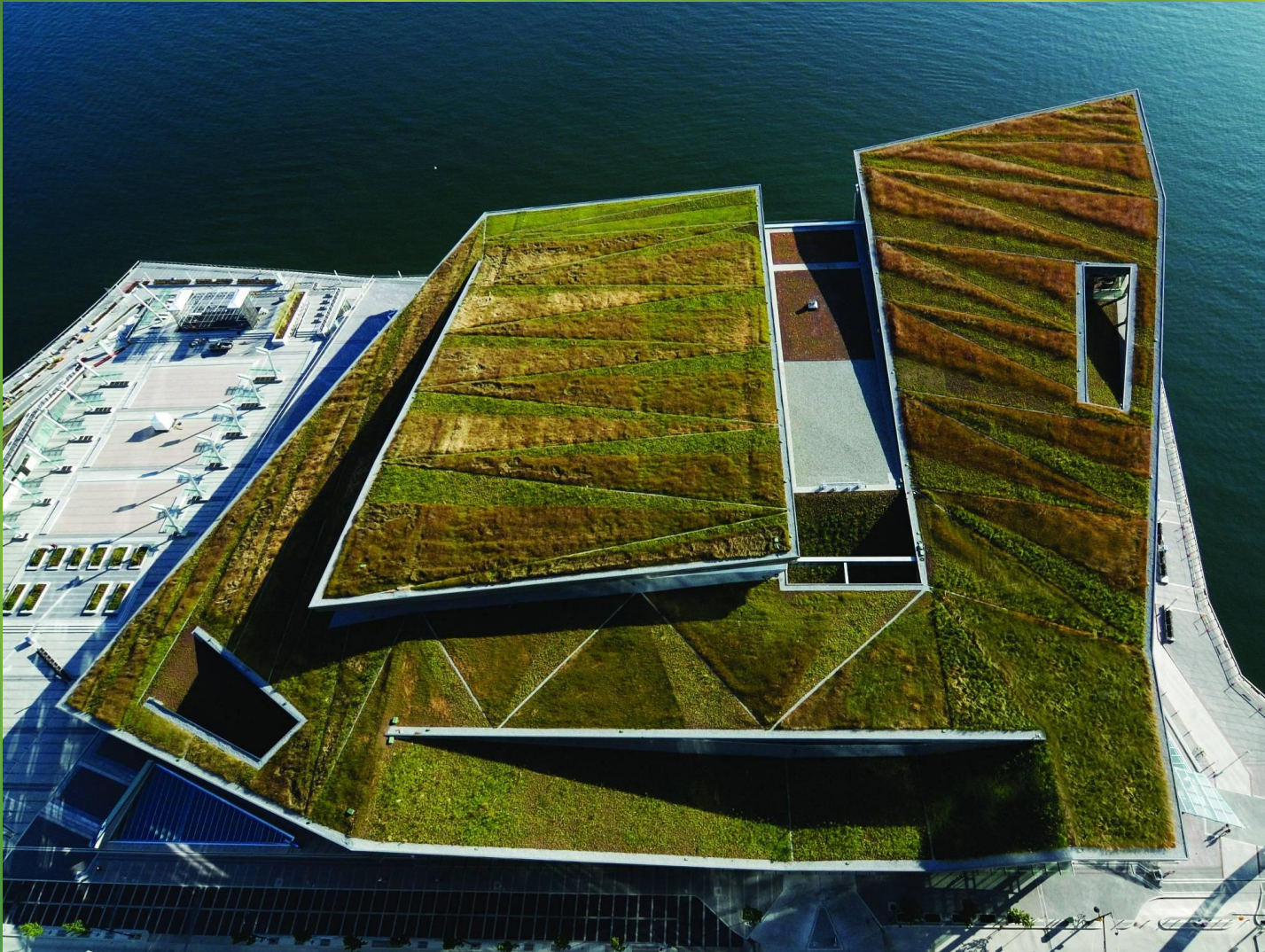


Photo credit: DA Architects and Planners



## *Projects – Vancouver Convention Centre*



Photo credit: *PWL Partnership Landscape Architects*



## *Projects – Minneapolis Target Center*

Target Center, Minneapolis, MN.

2010 Award of Excellence Winner. The Kestrel Design Group, Inc., and Sika Sarnafil.



Photo courtesy: Sika Sarnafil and Bergerson Photography.



## *Projects – Minneapolis Target Center*



Photo credit: The Kestrel Design Group, Inc.



## *Projects – California Academy of Sciences*

California Academy of Sciences, San Francisco, CA.  
2008 Award of Excellence Winner. Rana Creek Living Architecture.





## *Projects – California Academy of Sciences*





## *Projects – California Academy of Sciences*





## *Projects – Brooklyn Grange*





## *Projects – Brooklyn Grange*





## *Integrated Design*



**Mountain Equipment Co-op Retail Store**

Winnipeg, MB

*Source: Richard Kula*





## *Integrated Design*



EPA Region 8 Headquarters. Denver, CO.



## *Final Thoughts*



Vancouver Public Library. Cornelia Oberlander.

## *Upcoming GRHC Training in Ontario*

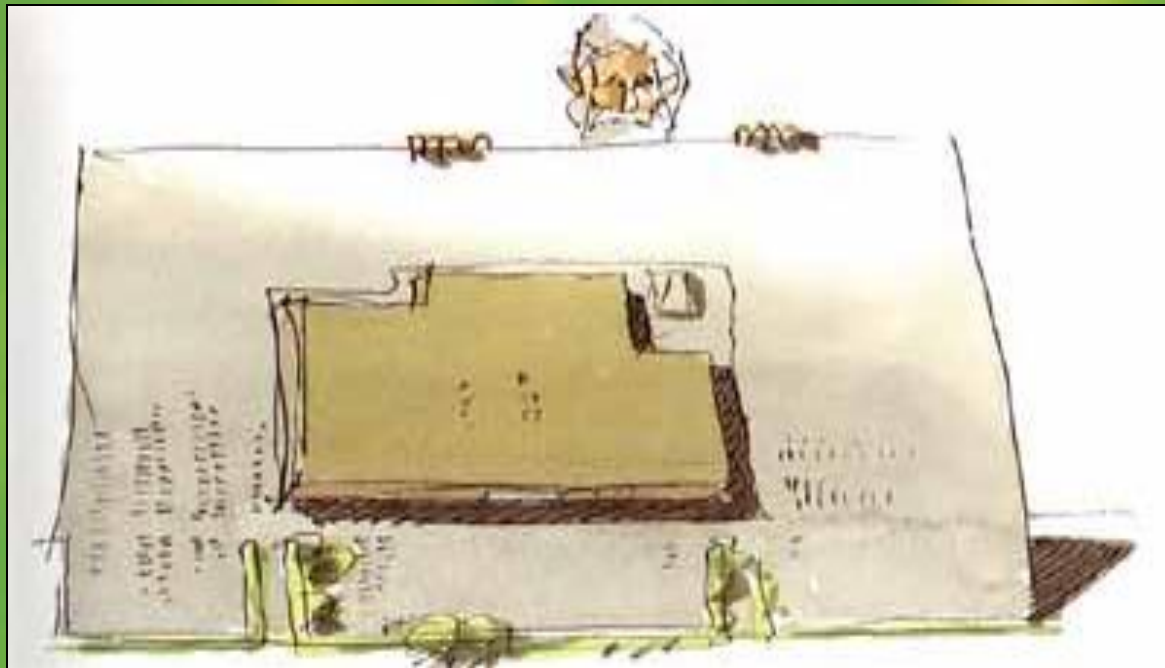
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Register at [www.greenroofs.org/education](http://www.greenroofs.org/education)



## *Living Architecture*

“We look at architecture the wrong way: sideways, so what we see is only a thin sliver of the reality around us.”



“To see architecture fully, you must tip it up, stand it on its edge. When you do, you always see dead land on display.”

*Malcolm Wells, Rediscovering America*