

# U.S. Environmental Protection Agency (EPA)

## Office of Wetlands, Oceans, and Watersheds (OWOW)

The U.S. Environmental Protection Agency leads the nation's environmental science, research, education and assessment efforts. Its mission is to protect human health and the environment. Since 1970, EPA has been working for a cleaner, healthier environment for the American people.

.....

EPA works with the National Association of Clean Water Agencies, the Natural Resources Defense Council, The Low Impact Development Center, Inc., and the Association of State and Interstate Water Pollution Control Administrators to promote green infrastructure as an environmentally preferable approach to stormwater management. Green infrastructure allows stormwater to infiltrate, evapotranspire, or be captured and reused.

At the largest scale, the preservation of forests, floodplains and wetlands is a critical component of green infrastructure. On a smaller scale, green infrastructure practices include rain gardens, porous pavements, infiltration planters, trees and tree boxes, and green roofs.

The EPA Office of Wetlands, Oceans, and Watersheds (OWOW) collaborates with partners like Penn State University to study green infrastructure technologies including green roofs. EPA also recognizes local governments who effectively promote innovative stormwater practices through policies that encourage these green building techniques. Does your community invest in green infrastructure? To learn more go to: [www.EPA.gov/owow/greenroofs](http://www.EPA.gov/owow/greenroofs).



# Join the Green Roof Movement



Vegetated roofs have been planted for thousands of years.

The Guinigi Tower in Lucca, Italy, which was built in the 14th century, has a roof with seven oak trees. In the U.S.,

green roofs have been growing on New York City's Rockefeller Center since the 1930s. In addition to creating pleasant rooftop areas, green roofs can:

- Reduce city "heat island" effect
- Improve air quality
- Reduce carbon dioxide impact
- Reduce summer air conditioning cost
- Reduce winter heat demand
- Double or even triple roof life
- Remove nitrogen pollution in rain
- Neutralize acid rain effect
- Reduce noise
- Reduce pollution runoff to waterways
- Provide attractive outdoor space
- Provide habitat for songbirds



Cities like Chicago provide incentives such as expedited permitting for builders who incorporate green roofs into their designs, and millions of square feet of rooftops have been planted there.

Companies like the Ford Motor Company in Dearborn, Michigan found it was cheaper to plant a ten-acre green roof to treat stormwater runoff than building traditional stormwater treatment facilities.



Communities can enhance their sustainability with green roofs. Ask your elected officials to consider modeling policies on communities which have successful programs. For examples visit:

[www.epa.gov/owow/greenroofs](http://www.epa.gov/owow/greenroofs)

# Green Roofs for Healthy Cities Green Wall Committee



This green wall project is made possible through our dedicated members.

‘Green wall’ is a modern concept related to the ancient practice of training grape vines on walls. Two different approaches are used to create green walls: the **Green Facade** employs climbing plants or cascading groundcovers trained over separate supporting structures; **Living Walls** are pre-vegetated panels, vertical modules or planted blankets fixed directly to a structural wall or frame.

Green walls provide a wide range of public and private benefits:

- aesthetic improvements
- reduction of the urban heat
- improved air quality, energy efficiency, and stormwater management
- noise reduction
- building structure protection

Green wall courses are widely available. For more information visit Green Roofs for Healthy Cities at [www.greenroofs.org](http://www.greenroofs.org).



# Today's Agricultural Technology ...Tomorrow's Energy

## LEED Credits Awarded by use of a Green Roof in New Construction version 2.2 Guidelines

### Sustainable Site Credits

#### 5.1 - Protect or Restore Habitat

- One credit may be awarded for restoring or protecting a minimum of 50% of the site area (excluding the building footprint) with native or adapted vegetation.
- If the site was selected based on Credit 2 (Development Density & Community Connectivity) and if green roof plants meet the definition of native/adapted, then green roof may be applied

#### 5.2 - Maximize Open Space

- One credit may be applied if site was selected based on Credit 2 (Development Density & Community Connectivity) and open space criteria guidelines are met

#### 6.1 - Stormwater Quantity Control

- One credit awarded for reducing stormwater runoff from impervious surfaces to certain standards depending on pre-development conditions

#### 6.2 - Stormwater Quality Control

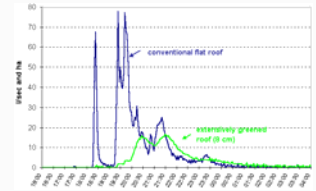
- One credit awarded for reducing pollutants by treating 90% of average annual rainfall

#### 7.1 - Heat Island Reduction

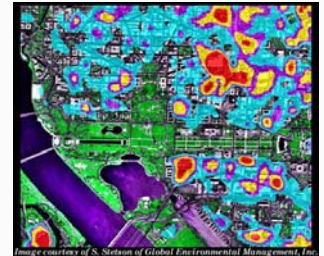
- Defined as "thermal gradient differences between developed and undeveloped areas"
- One credit awarded for installing a vegetated roof for at least 50% of the roof area

## Benefits versus Traditional Roof

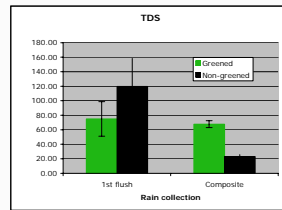
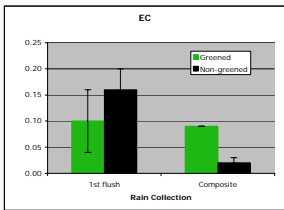
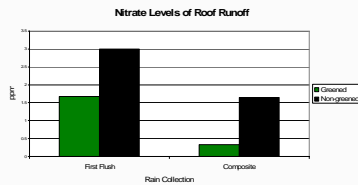
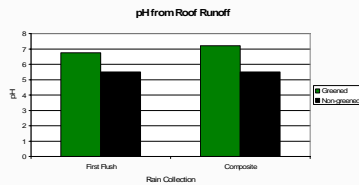
- Attenuate stormwater
  - Runoff volume reduction
  - Peak runoff rate reduction
  - Delay the runoff event
  - Delay the peak runoff rate
- Thermal Barrier
  - Reduce heat island
  - Reduce roof surface temperature
  - Insulates against summer heat
- Weather Barrier
  - Increases longevity of roof by protecting against:
    - Ultraviolet degradation
    - Wind Loads
    - Snow Loads
    - Rainfall degradation
- Lower Energy Consumption
  - Lower cooling costs in summer because heat absorbed by roof



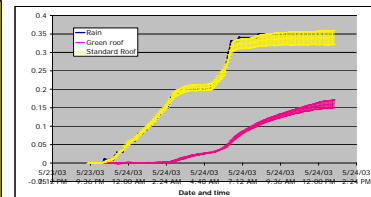
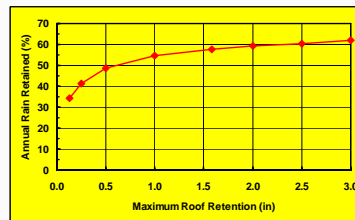
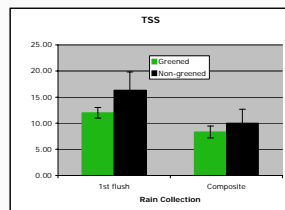
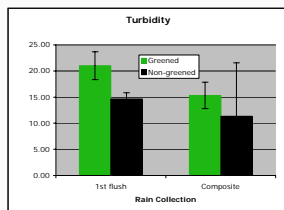
Stormwater Runoff and Drain Delay



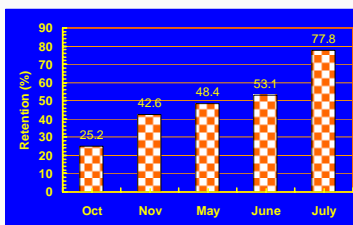
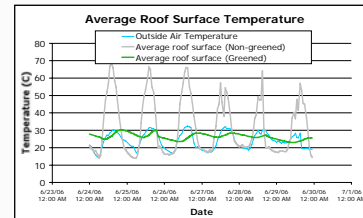
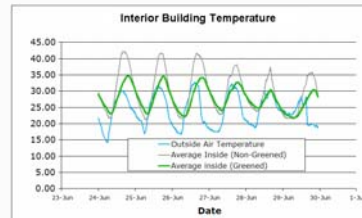
Washington D.C. Heat Islands



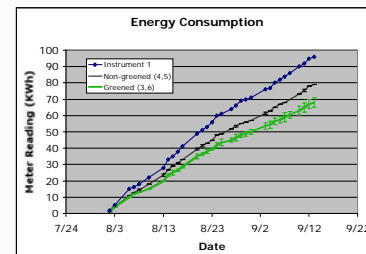
Rain collected 10/11 - 10/13/2002 Center for Green Roof Research at Penn State



Typical Cumulative Stormwater Runoff



Summary of Retention Results



# Biodiversity and Green Roofs

Roofs are open, relatively undisturbed and underutilized spaces. Green roofs offer many benefits to building owners and urban areas such as storm water mitigation, reduction in urban heat island effect, and they also can extend the life of the roof. Green roofs also have the potential to offer habitat and forage resources for local and migrating fauna in disturbed regions such as cities.

## Pollinators on Green Roofs

Declines in pollinators have been documented across the world. This decline can be due to many factors such as habitat degradation, fragmentation, pesticides, introduced pests and diseases, and climate change. Green roofs have the capability to help supplement the pollinators in our communities with habitat and forage resources. Green roofs can be designed to provide habitat for native birds and insects by mimicking their natural habitat. The most common type of green roof is an extensive green roof that consists of mostly *Sedum sp.* because of their ability to survive in the harsh conditions found on roof tops. These plants are known to attract all sorts of different insect pollinators. Research is currently being conducted at The Pennsylvania State University regarding pollinators and green roofs.

maarec.cas.psu.edu

## Green Roofs and Wildlife Conservation

Green roofs can also be used as a tool to aid in conserving our endangered wildlife such as the case in London, England and the Black Redstart (*Phoenicurus ochruros*). The Black Redstart Action Plan is a project that has been launched to help protect this ground nesting bird. The Black Redstart is a rare bird in England that is only found in urban centers. This bird nests in rubble piles on empty lots and abandoned industrial sites. In the early 1990's London was revitalizing its urban centers and these lots were being developed and the Black Redstart's population was dropping in London. This all changed when the United Kingdom declared the bird and its nesting sites as protected. What this meant is that developers that were planning to build where the bird was known to nest needed to replace this habitat and they did so by providing a green roof that mimicked the terrain found on the ground making certain to include the rubble piles it prefers to nest in. These types of roofs have been renamed as brown roofs to correct confusion that initially plagued the project, as the empty industrial lots are referred to as brownfield sites in the United Kingdom. This project has demonstrated to the world that conservation efforts can be achieved by implementing certain mitigation strategies on otherwise underutilized surfaces in urban areas. The utilization as roofs for conservation is another benefit of green roof technology.



www.blackredstarts.org.uk

Craig Churchill

•Dunnett, N., and N. Kingsbury. 2008. *Planting Green Roofs and Living Walls*. Portland, OR: Timber Press

•Gedge, Dusty. 2003. ...From Rubble to Redstarts... In *Proceedings of the First North American Green Roof Infrastructure Conference, Awards, and Trade Show: Greening Rooftops for Sustainable Communities*, Chicago, IL, May 2003. Toronto: The Cardinal Group

•Thorp, R., E. Evans, and S. H. Black. 2007. Bumble Bees in Decline. Available from <http://www.xerces.org/bumblebees/index.html> (accessed 19 May 2008).

### For more information contact:

The Penn State Center for Green Roof Research  
The Pennsylvania State University  
102 Tyson Building  
University Park, PA 16802

<http://hortweb.cas.psu.edu/research/greenroofcenter>

# ACKNOWLEDGEMENTS:

Green Roof Plants Provided by Emory Knoll Farms Inc.

[Greenroofplants.com](http://Greenroofplants.com)

Rooflite Green Roof Media Provided by SkylandUSA

[Skylandusa.us](http://Skylandusa.us)

Exhibit Constructed by Center for Green Roof Research

Penn State University

Exhibit Sponsored by EPA

# Current Greenroof Research At Penn State University

- Mitigation of Stormwater Runoff
- Development of Media Incorporating Recycled Materials
- Reduction of Buildings' Energy Needs
- Impact on Biodiversity
- Potential for Treatment of Gray Waters
- Delineation of Microbial Ecology
- Identification of Optimal Plant Species
- Integration with Living Walls & Constructed Wetlands
- Reduction of Air Pollutants

For more information on these projects, opportunities to participate or support, please contact Rob Berghage([rdb4@psu.edu](mailto:rdb4@psu.edu)) or Bob Cameron([rdc170@psu.edu](mailto:rdc170@psu.edu))

GREEN WALLS

# ELT Easy Green™



**Living walls can be used indoors or outdoors.**

**Indoors they act as natural humidifiers and can cleanse the air of toxic gases released by indoor furnishings and construction materials.**

A living wall, like this one from ELT Easy Green™ has vertical panels that are be planted with herbs, small

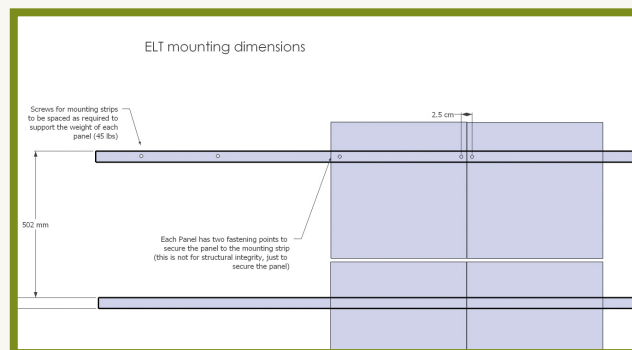
vegetables, and perennials for outdoors, and tropical plants for indoors.

The panels are designed with a series of grooves to allow root and water movement throughout the wall. This allows complete saturation using a minimum amount of effort and water. The design also leaves a small reservoir of water in each cell to help the plants through drought periods.

The panels are installed by simply hanging on to a mounting strip. Most plants establish within a few

weeks to cover the entire panel for a completely green wall.

GRHC thanks ELT Easy Green™ for the installation of this green façade.



For more information about green walls, go to [www.greenroofs.org](http://www.greenroofs.org).



GREEN WALLS

# Jakob<sup>®</sup> INOX LINE

**Green Façades are appealing, ecologically sensible and useful.** The latest insights on climbing plants combined with tastefully designed and technically sophisticated training systems open a treasure chest of greening variations and styles.

Greening makes sense from a construction physics point of view and has many ecological benefits. The future is indeed green: it will be shaped by the creative collaboration of innovation-driven architects with

greening specialists. Green Façades are attractive training systems for microgardens and can be built with a few easy-to-assemble components made of high-grade stainless steel. The days of haunted castles are over!

Green Roofs for Healthy Cities thanks Jakob<sup>®</sup> INOX LINE for making this portion of the exhibit possible.



For more information about green walls, go to [www.greenroofs.org](http://www.greenroofs.org).

## GREEN WALLS

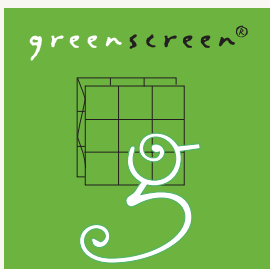
# Modular Trellis Panels



**Vines used for green walls are an excellent solution for contributing to urban reforestation.**

Vines can help shade a building's surface during warm seasons, indigenous vines can be used to reestablish habitat, and vines have been shown to filter some harsh materials from our air. They work well on modular trellis panels.

The building block of this modular system is a rigid, light weight, three-dimensional panel constructed from galvanized steel wire that supports plants with both a face grid and a panel depth. This system is designed to hold a green wall facade off the wall surface so that plant materials do not attach to the building, helping to maintain the integrity of a building membrane. Panels can be stacked and joined to cover large areas, or formed to create shapes and curves, are made from recycled-content steel and are recyclable. Because the panels are rigid, they can span between structures and can be used for freestanding green walls.



GRHC would like to thank greenscreen® for its generosity in making this exhibit possible.

For more information about green walls, go to [www.greenroofs.org](http://www.greenroofs.org).

GREEN WALLS

# Green Facade

A vertical garden is essentially a living cladding system with many of the benefits of a green roof. This featured green façade is a mounted trellis system of flexible mesh. The material is constructed of stainless steel cables and ferrules which form a diamond pattern when installed. The resulting matrix is extremely strong yet amazingly flexible. It is highly corrosion-resistant, well suited to the harshest climates, is a light, scalable structure and is fully recyclable.



GRHC thanks Carl Stahl-DécorCable for the installation of this green façade.



  
**Carl Stahl**<sup>®</sup>  
**DÉCORCABLE**  
The Best InTension

For more information about green walls, go to [www.greenroofs.org](http://www.greenroofs.org).