

# GREEN ROOFS

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## General Information

### *Summary*

Green Roofs, also known as vegetated rooftops or eco-roofs, are essentially rooftop areas that have been installed with living vegetation. There are a variety of different types of green roofs, ranging from small gardens and planters to roofs that are completely covered by sod and plants. They have been used in Europe for decades and are growing in popularity in the U.S. and Canada. Lighter, thinner green roofs are known as extensive roofs, while the heavier more layered roofs are known as intensive. Green roofs can only be used on flat roofs or on roofs with gentle slopes (although some innovative techniques in Europe have grown turf on 45 degree angles). While weight is generally not an issue, as most green roof vegetation is actually lighter than a standard gravel and tar roof, consideration must still be given to soil selection and building structure to assure structural stability. The soil collects and holds rainwater and filters out contaminants, while plants soak up the water and provide evapotranspiration.



*The green roof atop Chicago's City Hall (Photo: Roofscapes, Inc.)*

### *Advantages*

- ❑ Roofs represent a large percentage of impervious surfaces; placing vegetation on them can substantially reduce stormwater runoff.
- ❑ Green roofs can manage much or all of the runoff that would otherwise be generated by a building's roof area.
- ❑ Green roofs cover normal roofing materials, shielding them from wear and prolonging their life.
- ❑ Rooftop vegetation adds to the insulation of a building, reducing cooling and heating requirements.
- ❑ The collective effect of several buildings with green roofs can reduce the “heat island” effect of urban areas, improve air quality, and reduce dust and other airborne particles.

### *Disadvantages*

- ❑ Installing green roofs as a retrofit on an existing building can be costly in both design and construction if the additional weight requires extra roof support. Additional costs are incurred when building for a slanted roof, as erosion controls are necessary.

- ✘ Leaks in roofing material could pose substantial problems and costs to repair, although some companies offer electronic leak detectors.
- ✘ Maintenance for rooftop vegetation can be labor intensive, depending on access to the roof and the extent of the vegetation.

### ***Conventional Alternatives***

Green roofs replace rooftop gutters and drains that feed into sewers.

## **Design Information**

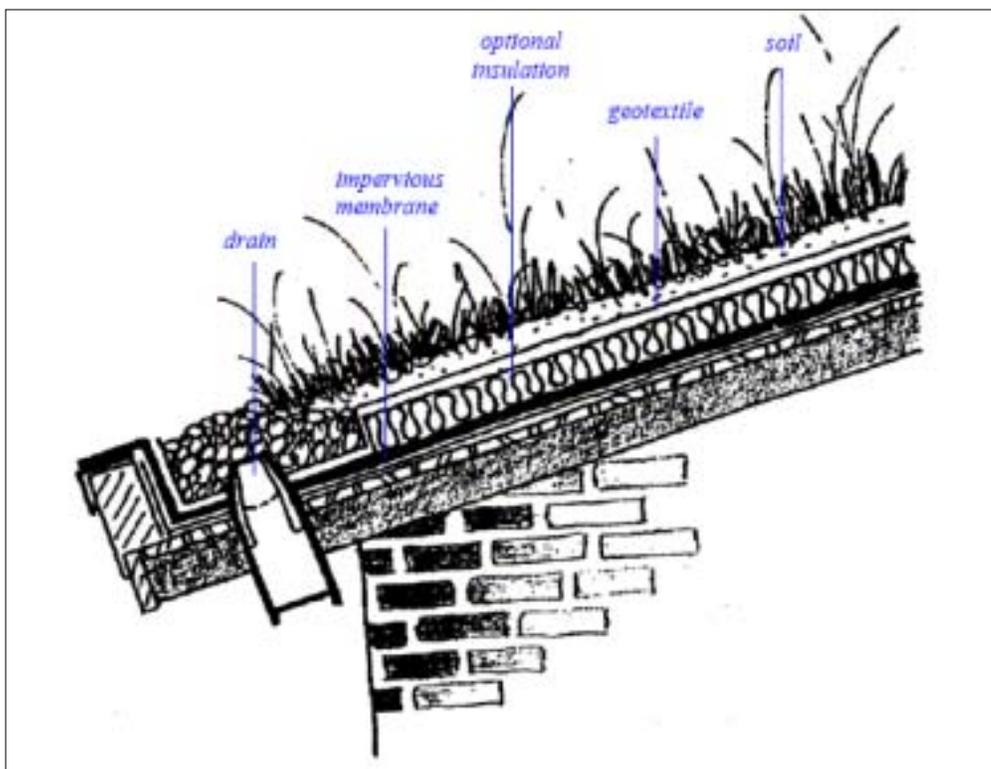
Three major design factors must be considered when installing a green roof: weight, drainage, and slope. Considerations must be taken into account for saturation. Green roofs will be heavier during and after a rainfall than when they are dry. Additional load-bearing capability may be necessary for green roofs that weigh more than 17 pounds per square foot. Green roofs are most easily built on flat surfaces. They can be built on slopes, but 25 degrees is generally the maximum allowable incline. Various membranes and water proofing materials are available, but a drain system is required to drain water that soaks through any soil. Other design factors that should be considered include plant type and access for maintenance.

### ***Uses in combination with other techniques***

Green roofs can be combined with rain barrels, dry wells, and bioretention to collect excess runoff.

### ***Cost***

Green roof costs can vary depending on the size and weight of the roof, access, the amount of retrofitting or new construction, and the region. For example, the green roof built by Ford Automotive at its Dearborn, Michigan plant cost approximately \$8 per square foot. Because the project was so large (450,000 square feet) economies of scale lowered the cost. For more common projects, prices range from \$14 to \$25 per square foot for smaller roofs and \$25 to \$40 for more intensive heavier roofs.<sup>29</sup>



*Sloped green roof diagram (Drawing: Prince George's County LID Design Guide)*

### ***Runoff Reduction***

As mentioned in the rain barrel section, rooftops can produce a great deal of water. One inch of rain over a 1000 ft<sup>2</sup>. roof can create 600 gallons of water. A roof with vegetation that uses the water, retains it in soil, and promotes evapotranspiration that can significantly reduce or eliminate this runoff.

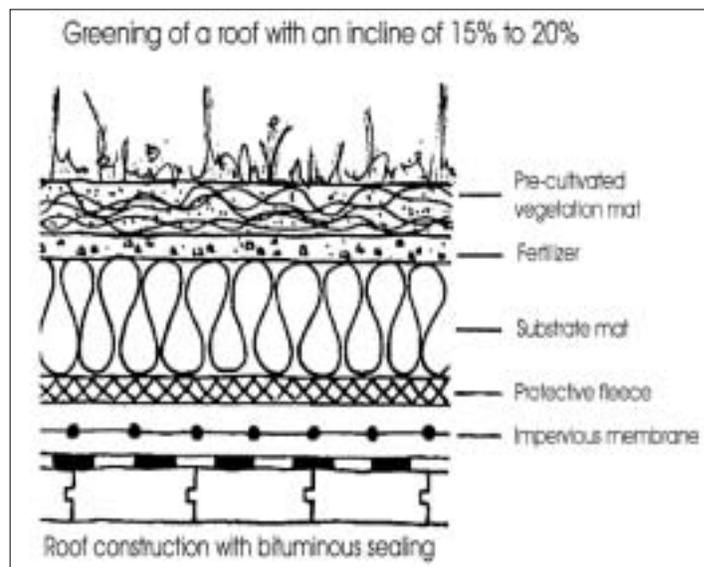
## **Specialized Information**

### ***Cold Climates***

Evapotranspiration rates are generally very low during cold, dormant seasons. However, vegetated rooftops can be useful through winter seasons, as grass, other vegetation and soil will absorb varying amounts of water year-round. However, the roof under-drain system must be designed to handle the excess water caused by the melting of large volumes of snow.

### ***Soil Type***

Green roofs must use lightweight "engineered" soils that are manufactured so as to be devoid of weeds, pollutants and other potential problems. This relieves added stress on the building and helps maintain a healthy growing environment.



*Green roof cross section (Drawing: Prince George's County LID Design Guide)*

## **Case Study - Ford Motor Company, Dearborn Plant**

At approximately 450,000 square feet, the Ford Motor Company's Dearborn assembly plant has the largest green roof in the world. The project was designed by McDonough and Associates as part of a larger sustainable design plan proposed by Ford CEO Bill Ford in a bid to push the company toward more environmentally sound practices and reduce other building costs. The plant will officially open in late 2004.

The roof is expected to provide habitat, decrease the building's energy costs, and extend the roof membrane's life by protecting it from thermal shock and UV degradation. Because the drought-resistant sedum plants used will absorb sunlight that would otherwise degrade the roofing materials, the roof is expected to last at least 20 and possibly as long as 40 years. Although the roof cost \$3.6 million to install (twice that of a conventional roof) Ford believes it will make up the costs over the life of the roof. In addition to lasting longer than a conventional roof and reducing energy costs by insulating the plant better, the roof is also expected to be able to absorb, hold, and filter more than 4 million gallons of runoff water. This will eliminate the need for storm sewers and a stormwater treatment system, potentially saving as much as \$35 million.

The Great Lakes region boasts other green roofs, including the 33,000 square foot roof atop Chicago City Hall in Chicago Illinois and the roof on the Milwaukee Metropolitan Sewerage District headquarters, which is covered with nearly 4,000 native plants.

## **Additional Sources**

Green Roof Resource Center  
<http://www.greenroofs.com/>

Green Roofs for Healthy Cities  
<http://www.greenroofs.ca/grhcc/index.html>

Green Roof Resource Center Research Links  
[http://www.greenroofs.com/research\\_links.htm#Private](http://www.greenroofs.com/research_links.htm#Private)

Green Roofs for Healthy Cities Contractor and Designer FAQ

[http://www.greenroofs.ca/grhcc/gr\\_suppliers.pdf](http://www.greenroofs.ca/grhcc/gr_suppliers.pdf)

Green Roof Program and Michigan State University

[http://www.hrt.msu.edu/faculty/Rowe/Green\\_roof.htm](http://www.hrt.msu.edu/faculty/Rowe/Green_roof.htm)

Roofscapes, Inc.

<http://www.roofscapes.com/index.html>



*Evansville, Indiana - Vanderburgh Public Library (Photo: Roofscapes, Inc.)*