# Green Roof

## Types: Intensive and Extensive

Four Season Hotel (Extensive Green Roof) - Boston
*http://www.greenroofs.com/projects/pview.php?id=127*
Accessed 06/02/2008

## DESCRIPTION

Green roofs are rooftops which are covered with vegetation. Green roofs have a waterproof layer on top of which lies a drainage system and a layer of engineered soil which can be planted with a variety of vegetation. Rain water that falls on a green roof will be absorbed by the soil, taken up by the vegetation and transpired back into the atmosphere, reducing rooftop runoff. Green roofs add extra insulation to a building, reducing overall energy costs, and protect the underlying roofing materials from destructive ultra violet rays, extending the lifespan of the roof. There are two types of green roofs: *extensive,* which are constructed with a minimal soil layer (less than 6") and support primarily dense, low growing, drought-resistant vegetation; and *intensive*, which have a thick layer of soil (greater than 6") and can support all types of vegetation, including shrubs and trees. Some green roofs are open to the public and may look similar to an urban park.

## BENEFITS

### Overall

- Reduces stormwater runoff volume, flow rate and temperature
- Provides local flood control
- Improves quality of local surface waterways
- Provides wildlife habitat
- Reduces building energy costs
- Improves air quality
- Extends the life span of underlying roofing materials
- Moderates the urban heat island effect
- Enhances the beauty of residential, commercial or industrial sites
- Serves multiple purposes, acting as parks, gardens or putting greens

### Pollutant Removal

The soil medium and vegetation of a green roof can act as a filter for water running off non-vegetated portions of a roof or rooftop runoff from above and can prevent runoff from particulates and nutrients accumulated from atmospheric depositions:

- Total Suspended Solids: 90%
- Metals: 80%[6]

### Volume Attenuation/Flow Reduction

Volume attenuation and flow reduction are the primary stormwater benefits associated with green roofs. The volume of rain water a green roof can retain will vary with thickness and porosity of the soil medium and size of the vegetated area.[3] Generally, green roofs can retain 70% - 90% of rainfall in the summer and 25% - 40% of winter precipitation.[2] Additionally, green roofs can reduce peak flows by 50% - 90% during a single storm event.[5]

## MAINTENANCE

### Needs and Frequency

- Maintain vegetation and perform general landscaping, requires more attention during the establishment period or periods of drought and high winds
- Clean and maintain drainage structures
- Repair underlying roofing and waterproofing materials as needed, these repairs will need to be made very infrequently on a properly constructed roof[5]

### Cost

Similar to traditional landscaping, $0.25 - $1.25/sq. ft.

## INSTALLATION COST

$5 - $50/square foot including all structural components, soil and plants[5,7]

Green roofs are more expensive to install than traditional roofs, however, they have a longer lifespan and decrease energy costs. Installing a green roof as a retrofit may be more expensive than installing a green roof during new construction.[6]

Private Residence (Semi-Extensive Green Roof) - Boston
*http://www.greenroofs.com/projects/pview.php?id=44*
Accessed 06/02/2008

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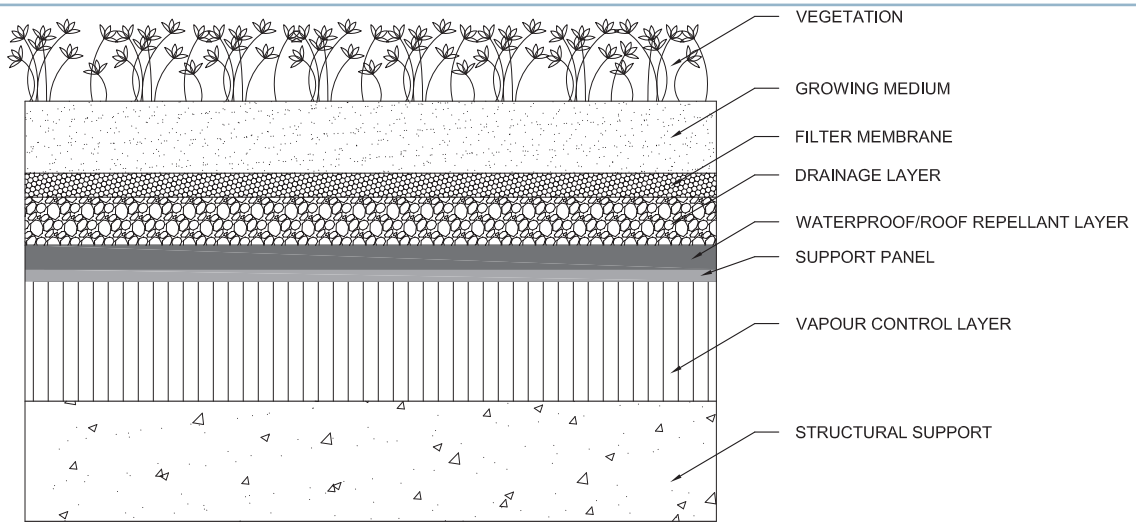
## SCHEMATIC




Adapted from:
Principal Green Roof Technology (National Research Council, Institute for Research in Construction)
*http://www.greenroofs.org/index.php?option=com_content&task=view&id=26&Itemid=40*, Accessed April 2008

## EXAMPLE PROJECTS

**Howard Ulfelder, MD Healing Garden**
*Boston, MA*
This rooftop garden sits atop the 8th floor of the Massachusetts General Hospital's Yawkey Center for Outpatient Care. The garden serves as a serene site for hospital patients and staff to relax and escape from the hospital environment.[4,7]

**Whipple Riverview Place**
*Ipswich, MA*
An extensive green roof was installed as part of a retrofit to transform this old school building into affordable housing units for senior citizens.[7]

## ADDITIONAL CONCERNS OR UNKNOWNS

- Roof must be structurally capable of supporting the load of saturated soils.[6]
- Extensive green roofs can be constructed on roofs with up to a 40% slope, however, roofs with a greater than 15% slope may require extra structural supports to hold soil medium and vegetation in place.[5]
- An electronic leak detection system can be included at a minimal cost to quickly detect and locate leaks.[5]
- Not recommended in locations where groundwater recharge is a priority.
- Cost to volume of stormwater treated ratio is higher than many other stormwater best management practices.[1]

## SOURCES

[1]Center for Watershed Protection. (2007, August). Urban Stormwater Retrofit Practices Appendices. Urban Subwatershed Restoration Manual Series.

[2]Green Roofs for Healthy Cities. (2005). About Green Roofs. http://www.greenroofs.org/index.php?option=com_content&task=view&id=26&Itemid=40. Accessed June 6, 2008.

[3]Low Impact Development Center (LIDC). (2005, November). Low Impact Development for Big Box Retailers. Available at: http://www.lowimpactdevelopment.org/bigbox/lid%20articles/bigbox_final_doc.pdf.

[4]Massachusetts General Hospital Cancer Center. Howard Ulfelder, MD Healing Garden. http://www.massgeneral.org/cancer/about/environment/healing/index.asp. Accessed June 9, 2008.

[5]Metropolitan Area Planning Council (MAPC). (Unknown year). Massachusetts Low Impact Development Toolkit. Fact Sheet #4 Green Roofs. Accessed February 27, 2008. http://www.mapc.org/regional_planning/LID/green_roofs.html.

[6]Minnesota Stormwater Steering Committee (MSSC). (2006, September). Minnesota Stormwater Manual: Version 1.1. Available at: www.pca.state.mn.us/water/stormwater/stormwater-manual.html.

[7]University of New Hampshire Stormwater Center – Nonpoint Education for Municipal Officials. Innovative Stormwater Management Inventory. Accessed May 28, 2008. www.erg.unh.edu/lid/index.asp.

[8]US EPA. (October 12, 2007). Green Roofs. Heat Island Effect. http://www.epa.gov/hiri/strategies/greenroofs.html. Accessed June 6, 2008.