The Benefits of Green Roofs

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What is a green roof?

A veneer of media and vegetation on a roof

Extensive roof - Shallow root zone <6”
Intensive roof
Deep root zone – 12”+
Semi-extensive/Semi-intensive
Typical green roof construction

- Roof deck
- Adhesive
- Waterproofing membrane
- Moisture mat
- Root barrier
- Drainage
- Filter fabric
- Medium
- Plants

Typical costs - $10 - $30+ per square foot
The benefits of green roofs

- Aesthetics
- Stormwater
- Energy
- Roof longevity
- Habitat and biodiversity
- Air quality
- Noise reduction
Aesthetics

Interior and Exterior Views

Flat roofs are ugly
Aesthetics

Interior and Exterior Views

Flat green roofs are more attractive

The roof spaces may even be more attractive than the surrounding landscaping
Chicago City Hall
Daimler-Chrysler headquarters
Amenity space

Heinz 57
Planted 2001
Novelty
What does this mean to a building owner? Improved occupancy
And for the rest of us?

Health and human welfare benefits:

- Improved patient outcomes
- Air pollution reduction
- Reduced urban heat island
- Noise reduction
- Stress reduction
- Violence reduction
What is the Value? (ROI)

- Satisfaction with your environment – improved health and welfare
- Reduced absenteeism
- Increased occupancy
- Reduced Hospital stays
- Improved quality of life
Stormwater

CSO’s cost everyone

• 1/10th inch of rain can result in a CSO in Pittsburgh
• 48 days with CSO alerts in Allegheny County between May 1, and Sept. 30, 2008 (31% of the time during that period)
• Bacteria levels in the Ohio River (ORSANCO) exceeded federal water quality standards 19 out of the 25 weeks during that same period
Rain 100%

Evapotranspiration 50 - 60%

Groundwater recharge 30 - 40%

Runoff 10%

Pre-development Hydrologic cycle
Rain 100%

Runoff 90+%

Post-development hydrologic cycle
A green roof restores ET

Green infrastructure and the post-development hydrologic cycle

Runoff 40-50%

Evapotranspiration

Rain 100%

50 - 60%

Fifth Ave Place
Runoff and precipitation from green roofs in 2005.
Rainfall and green roof runoff from 4 monitored green roof installations. A Walmart in Chicago, The Penn State Center for Green Roof Research in central PA, The Bronx Courthouse, and the Gratz Building in New York, New York. CN curves were generated using the standard SCS equation with an initial abstraction of 0.2s.
Cumulative precipitation and runoff from the green roof for a series of rains in June 2009
Rainfall and green roof runoff hydrograph for a series of rains in June 2009
Relationship between peak flow rate and peak precipitation rate. Average peak attenuation was 65%.

\[ y = 0.3534x \]
\[ R^2 = 0.8409 \]
Rainfall and green roof runoff hydrograph of a series of short peaks recorded 19 June 2009 during the first part of that storm.
Runoff quality

- Plant growth and runoff quality: pH
  - Nutrients
  - Metals
pH of runoff from green and non-green roofs
Nitrate concentration of runoff from green and non-green roofs.
Nitrate load of runoff from green and non-green roofs.
What is the value of the stormwater management function of a green roof?

- Reduce runoff (80% in summer) (30-40% in winter)
- Retain most 0.5-1” summer rains (average storms)
- Reduce and delay peak flows
- Improve runoff quality in some cases (Fertilizer management can reduce quality impacts)

Solution that Increases property values

ROI - Cost of alternative solutions to meet requirements
Energy

Green roofs act as evaporative coolers reducing air conditioning costs.
Vegetation “cools” the surrounding environment

- Sedum spurium 82°F
- Gravel 119°F
- Dark roof Surface 145°F

Infra-red surface temperatures
Ambient air was 90°F
Average Roof Surface Temperature

- Outside Air Temperature
- Average roof surface (Non-greened)
- Average roof surface (Greened)

Interior Building Temperature

- Outside Air Temperature
- Average Inside (Non-Greened)
- Average inside (Greened)
What is the value of the roof for energy savings?

Depends on many factors
• Insulation
• Roof type
• Roof to wall ratio
• Moisture
Green roof garden sheds use ~10% less electricity for air conditioning
Schools - air conditioning needed?
Green roofs and Peak Energy Use Shaving

Reduce demand during peak hours. Keep inefficient power stations off line. Reduce infrastructure costs.
Roof Longevity

Protect the waterproofing from UV and temperature extremes
Placing a value on Roof Longevity

The green roof should last 2-3 times longer than an equivalent flat roof (50+ years?)
Habitat and biodiversity
Oasis of diversity in the urban desert
This roof provides food for pollinators lacking in the rest of this landscape
Green Roofs:
The contribution of the plants

• Aesthetics
• Stormwater
• Energy
• Habitat and biodiversity
• Air quality
• Noise reduction
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