Green Roofs: Multi-Functional Environmental Protection Technology

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Aerial Image - Glen Innes

The University of Auckland
Faculty of Engineering
Omaru Creek, Glen Innes
Flooding Issues

Omaru Creek, Glen Innes
High-flow impacts from every-day storm events
Sources of Water Quality Impacts from Urban Development

Catchpit on Symonds St

Garfield Rd, Parnell

Low Impact Design (LID) in Portland (Oregon, USA)
South Waterfront
USA
Chicago City Hall

London: Canary Wharf
Tube Station
New Zealand

Potential Benefits

- Reduce building energy consumption by providing thermal mass and insulation
- Mitigate the “urban heat island” effect (i.e., lower ambient temperatures from plant transpiration)
- Reduce stormwater runoff volume & flow rate
- Absorb airborne pollutants
- Protect roof surface from damaging UV rays & cracks caused by flexing with temperature fluctuation
- Create urban habitat
- Provide amenity & aesthetic value
Extensive Green Roof System Components

Vegetation
- Reduces absorption of solar radiation
- Cools surrounding air
- Intercepts rainfall
- Prevents substrate migration.

Drainage Layer
- Provides free drainage for precipitation in excess of system storage capacity
- Geotextile supports substrate & prevents migration
- Provides air for plants

Substrate
- Supports plants (physically and nutritionally)
- Stores precipitation
- Extends flow path
- Provides insulation and/or thermal mass

Waterproof Membrane
- Protects structure from water damage
- May include multiple layers, including a root barrier

Test Site: Roof of UoA School of Engineering

- Total roof area ~250 m²
- Greened area ~ 234 m²
Dr. Elizabeth Fassman

Research Objectives

Stormwater Management

- Determine green roof design to mitigate stormwater runoff under local climate conditions.
  - Storage of 10-20 mm precipitation (i.e., no runoff from "everyday" events.)
  - Monitor and model hydrologic budget for engineering guidance.
- Develop system suitable for new and retrofit construction.
  - Dry bulk density < 800 kg/m^3
  - Wet system weight < 100 kg/m^2
- Identify suitable and evaluate effectiveness of locally available materials vs. "proven" materials used overseas.
- System should be as "easy" as possible (i.e. low maintenance, no irrigation).

Habitat & Biodiversity

Results to Date: Engineering Green Roof

- 89 storms over 7 months
- 630 mm rainfall
- ~96% reduction in peak flow rate
- 75% of rainfall doesn't become runoff (literature values: 50-68% retention)
- ~99% retention for storms less than 25 mm (water quality storm)
- 0 difference between 50 mm and 70 mm system for stormwater control (plants thriving in 70 mm)
Evidence of Energy Benefits

- Insulation is significant
  (Akbari et al. 2001; Alexandri and Jones 2007; Connelly and Liu 2005; Liu and Baskaran 2003; Takebayashi and Moriyama 2007)
- Reduction in heat flow from a building by 70-80%, thereby reducing heating and/or cooling energy demand
  (Akbari et al. 2001; Connelly and Liu 2005)
- Creation of microclimate significantly reduces surface air temperature
  (Connelly and Liu 2005; Environmental Affairs Department 2006; Takebayashi and Moriyama 2007).
  - increase air conditioner efficiency (Liu 2003)
  - mitigate urban heat island effect (Environmental Affairs Department 2006; Sailor and Dietsch 2007; Voogt 2004)
- Incorporated into EnergyPlus model in LEED (USA) (Sailor 2008)
- Auckland green roofs... watch this space
Conclusions to date

- Green roofs provide opportunities for multiple environmental benefits from a single technology.
  - Stormwater control reduces erosion potential in streams, transport of contaminants, and potential for combined sewer overflow.
  - Thermal mass and insulation passively reduces energy demand for heating and cooling.

- A long period of monitoring is necessary to fully understand the complex behaviour of an EGR for stormwater control and energy demand mitigation, but results to date are promising.

- Design manual due to be published by Auckland Regional Council, hopefully later this year (draft is under review).

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Questions?