Dry Climate

GREEN ROOF DESIGN
Green Roof

An engineered version of a natural soil profile.

Source: Donald Bren School of Environmental Science and Management. University of California, Santa Barbara
Benefits of Green Roofs

- Public Benefits
  - Stormwater capture and treatment. “First Flush Event”
  - Urban heat island effect. Lower albedo (reflectivity) of roof tops
  - Air quality. Filters air and improves quality, esp. in urban settings
  - Aesthetics. Nicer to look at than some other options
  - Wildlife habitat. Creates small functional ecosystems (depending on design)
Benefits of Green Roofs

- Private Benefits
  - Energy savings. Heating and cooling costs
  - Extended roof life. Increase from average 15-20 years to average expected roof life of 40 years.
  - Noise reduction. Studies show decrease in noise from 4 to 40 db.
  - Food production. Limited opportunities, but being attempted
Design Considerations

- Support structure (weight/load)
  Generally the responsibility of the architect & engineer, but they need the wet weight (at field capacity) of engineered substrate and any hardscape material designed for the roof.
Design Considerations

- Support structure (weight/load)
- Extreme conditions. Wind, exposure, Sun, etc

Climatic variations, storm frequency and intensity, freeze/thaw cycles, etc. affect the stability of the substrate and the plant community.
Design Considerations

- Support structure (weight/load)
- Extreme conditions. Wind, exposure, Sun, etc
- **Soil moisture**
  
  Consider the water holding capacity of the substrate material. Balance between field capacity, air exchange, organic matter content (N cycling), weight, and cost.
Design Considerations

- Support structure (weight/load)
- Extreme conditions. Wind, exposure, Sun, etc
- Soil moisture

- **Rooting depth**

  Substrate depth will define available plant pallet. Balance root requirement of the plant material with substrate depth. Is root penetration into the membrane an issue?
Design Considerations

- Support structure (weight/load)
- Extreme conditions. Wind, exposure, Sun, etc
- Soil moisture
- Rooting depth
- Access to parent material lacking

Especially important in ecology based systems. Mycorrhizal communities access parent material for minerals. Are these associations fully functional in a created roof?
Design Considerations

- Support structure (weight/load)
- Extreme conditions. Wind, exposure, Sun, etc
- Soil moisture
- Rooting depth
- Access to parent material lacking

**Expectations**

What are the expectations of the owner. Many functional roofs in dry climates are installed with small containerized plants. Does the owner and general contractor understand this? How does the owner envision the functional aspect of the roof?
Design Considerations

- Support structure (weight/load)
- Extreme conditions. Wind, exposure, Sun, etc
- Soil moisture
- Rooting depth
- Access to parent material lacking
- Expectations

**Aesthetic expectations**

What is the aesthetic component of the project? Is the roof purely functional, or does the roof provide an amenity for the building or community?
Design Considerations

- Support structure (weight/load)
- Extreme conditions. Wind, exposure, Sun, etc
- Soil moisture
- Rooting depth
- Access to parent material lacking
- Expectations
- Aesthetic expectations

- **General Contractor concerns (sometimes)**
  Does the general contractor know what you’re doing? Do they understand the process and timing needs? Coordination with other companies/contractors?
Substrate

- Stability
  How does the substrate hold up to freeze/thaw cycles, high water input (storms), and wind?

  Long term stability normally achieved by limiting organic matter and fine material. Leads to low nutrient exchange capacity.

  Organic matter is rapidly decomposed. Use a more completely composted source of organic matter?

  How can you balance the two?
Substrate

- Stability
- Physical composition

What is the substrate composition? Commercial mixes are generally designed for high moisture areas (i.e. Portland, Seattle, Chicago, London). Low percentage of fines.

Particle size distribution affects water holding capacity, permeability, air flow, and stability of substrate.

Particle size generally ranges from <0.25 mm to < 12.5 mm
Substrate

- Stability
- Physical composition
- Chemical composition
  
  pH measurement. Neutral ideal.

Salts. Potassium levels occasionally an issue with composted organic matter. Check source.
Substrate

- Stability
- Physical composition
- Chemical composition
- Nutrient cycling (N availability and nitrification)
  
  Low organic matter = lower stability/viability of established plant material.

  Nutrient inputs (fertilizers) affects quality of runoff. Point source pollutant?

  Organic matter is rapidly decomposed.
Plant Choices

- Typical plant material includes:
  - *Sedum* species
  - *Sempervivum* species
  - Grasses
  - Mosses

*How does this work in a dry environment?*
Plant choice considerations

- Drought resistance
- Rooting depth
- C3 vs C4 (CAM plants)
- Community structure
- Aesthetics
Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources; they are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing the spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its probable response to disturbance. Ecoregions are directly applicable to the immediate needs of state agencies, including the development of biological criteria and water quality standards. They are also relevant to integrated ecosystem management, an ultimate goal of many federal and state resource management agencies. The approach used to compile this map is based on the premise that ecological regions can be identified through the analysis of the spatial patterns and the composition of biotic and abiotic phenomena that affect or reflect differences in ecosystem quality and integrity. These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife distributions, and hydrology.

US Environmental Protection Agency, Western Ecology Division 2011
Reference communities
Case study: Bend Office Building
Marketing; ODS green roof mockup
Coordination
And so it begins...
Collaboration?
Drainage layer
Necessity the mother of all...
Work with your friends!
Engineered substrate
Community structure
Changes and additions