

# Green Roofs



By: Joshua Campbell

Not a "Green" Roof



# These are "Green" Roofs



FREEWAY PARK



SINGAPORE ART ACADEMY



ROCKEFELLER CENTER



CALIFORNIA ACADEMY OF SCIENCES



SAN FRANCISCO

# What are the benefits of Green Roofs?

- On site water retention.
- Reestablish predevelopment hydrology and ground cover.
- Decreases the need to expand or rebuild separate storm sewer infrastructure
- Decrease hydraulic loads in existing sewer systems
- Alternative roofing material.
- Cost effective insulation.
- Reduces urban heat island effect.

# Types of Green Roofs

There are two types of green roofs: Extensive and Intensive. Either type will need temporary irrigation or watering for establishment.

## 1. Extensive:

- typically not designed for foot traffic or occupancy except for maintenance
- designed to minimize the additional load on the roof structure, with only 2-6" of soil,
- minimal plant diversity and require minimal maintenance
- These features result in the lowest capital cost of the different green roof types
- may also be placed in trays that rest on the membrane allowing for ease of replacement or access to the roof structure or membrane.
- may 'brown-out' over dry summers, but dormant plants revive when rainy season begins

## 2. Intensive:

- may be accessible as a roof garden
- will have deeper soil, therefore heavier weight
- deeper soil allows more plant diversity, therefore have higher maintenance
- Soil depth typically between 8-24"
- typically more attractive than extensive roofs during the dry season
- may be irrigated depending on soil depth, plant selection and location

# Planting on a Green Roof

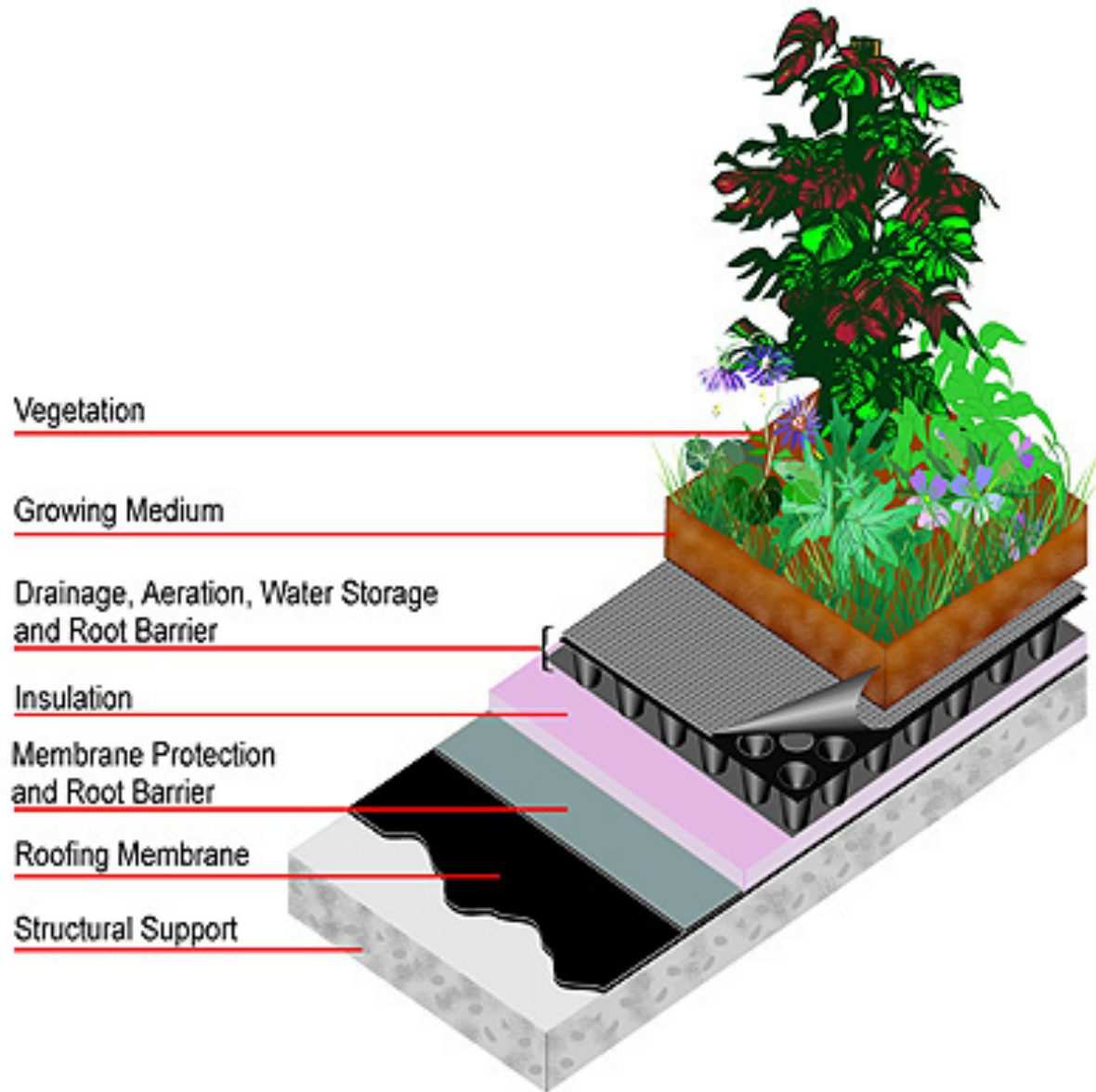
There are many different ways to plant the plants in the soil, depending on the depth of the soil, and the desired speed of fill-in, as well as cost restraints.

6"+ Soil Depth Intensive

2"-6" of Soil Depth Extensive

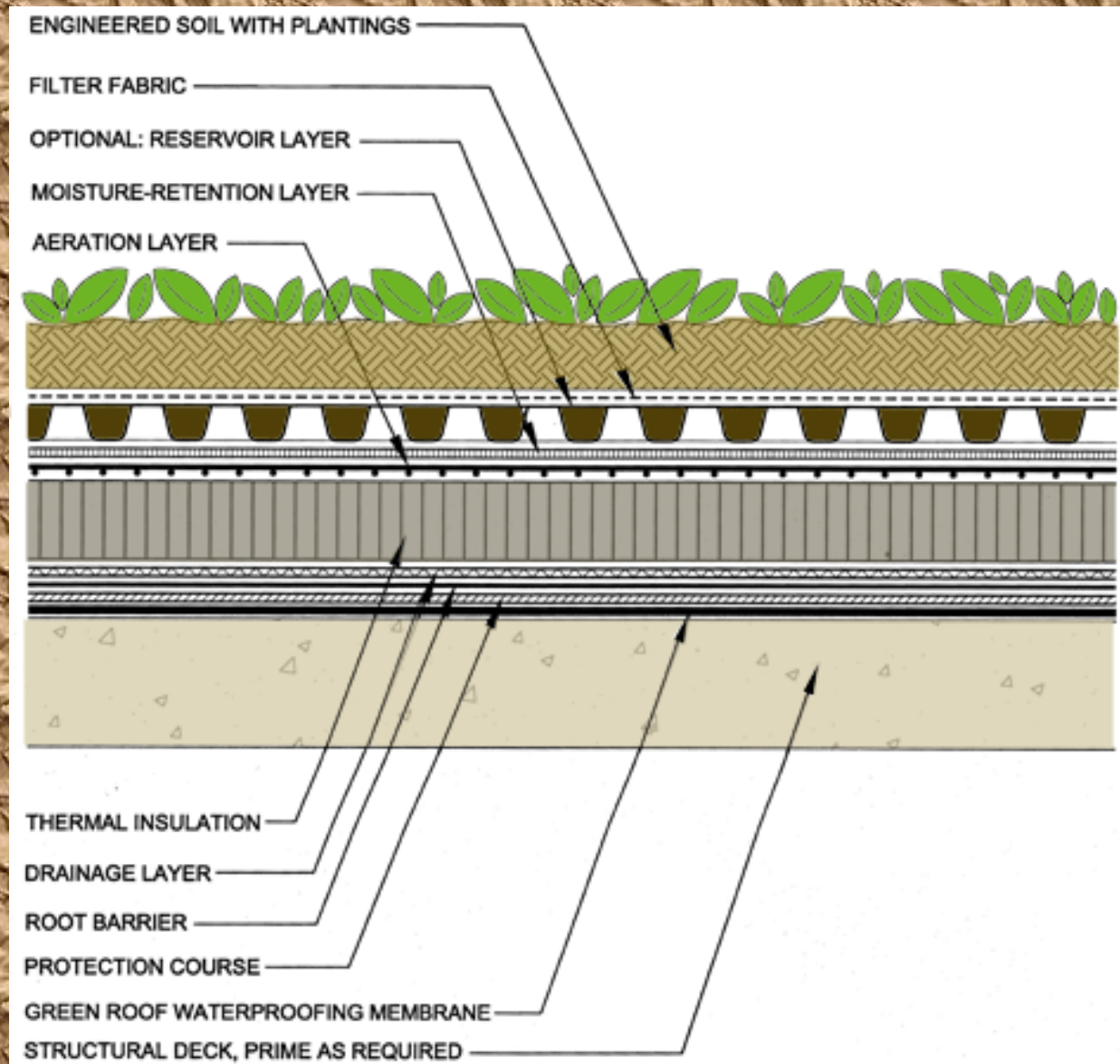


# Possible orientation of roof Layers





Extensive green roofs have recently been installed at the Seattle Justice Center and the Seattle City Hall. Over 10 extensive green roofs have been installed on Portland buildings, both commercial and residential.



# Does a Green Roof need maintenance?



Yes! During the dry months of summer, Green Roofs need to be watered once every 1-3 weeks (depending on the type of Green Roof and plant selection). During the establishment period, check for weeds once every few weeks until the plants have covered the soil. Then check for weeds a couple times per year. Only fertilize plants when they are nutrient deficient. Most plants and growing medium contain fertilizer when they are sold.

# Green Roof Growing Medium Components

## Intensive Layer

6" or more deep	Inorganic coarse lightweight aggregate	35-60%
	Sand or fine inorganic lightweight aggregate	25-50%
	Organic matter	5-20%

## Extensive Layer

2"-6" deep	Inorganic coarse lightweight aggregate	40-80%
	Sand or fine inorganic lightweight aggregate	0-25%
	Sand or fine lightweight aggregate	0-35%

### Inorganic aggregate

Coarse sands

Crushed roofing tile

Diatomaceous earth (chalk-like sedimentary rock)

Expanded clay, shale or slate

Perlite (volcanic glass)

Rockwool (synthetic man-made fibers, insulation fiber)

Pumice and Scoria (volcanic rock)

vermiculite (mica clay, used as soil conditioner and insulator)

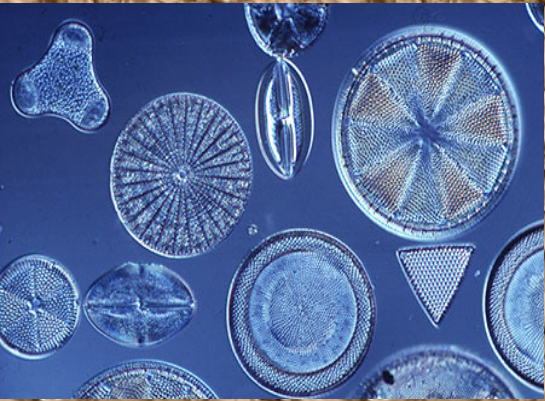
### Organic Matter

Compost/Humus

Peat

Sawdust

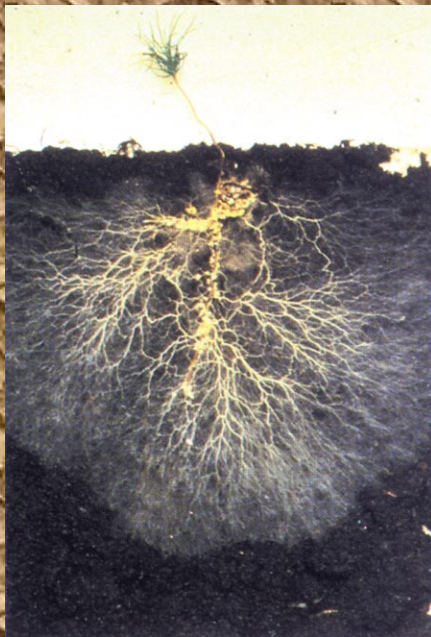
Worm Castings



# Plants, and how the soil composition influences plant options.

Because the soil must be light, well drained, and mostly stable the soil is engineered to be light on organic matter meaning that it is also light on nutrients.

As a result the plants that are used in green roofs must be adaptive to hot, dry areas with soil that has low organic content and dose not retain a lot of water. Also because the plants are located on a roof with a waterproof membrane under them to keep water from leaking into the building, the roots of these plants can not be very aggressive.



It is very important to think about the roots of the plants because you don't want this on your roof

# Preferred Plant Varieties

Some of the plants that are best suited for the previously mentioned conditions are Sedums, Kinnikinnick, Hens and Chicks, Yarrow and Stonecrop as well as many others.



Kinnikinnick a native groundcover



A taste of the wide range of colors  
and styles of Hens and Chicks

Here is an example of Stonecrop





These are all examples of Sedums as you can see they come in a wide range of colors and textures and are extremely drought tolerant, making them one of the ideal plants for green roof applications.





# Planting Practices for Extensive (2"-6" soil depth)



**Unrooted Sedum Cuttings-**  
Unrooted Sedum cuttings, are sold by the pound. They are very simple, and an inexpensive option. However, birds will pull a few of the unrooted cuttings out. An 1/8 lb per square foot will reach 90% coverage in approximately 6 months.



**Plugs-**  
The cells are 1.5" across, and sold in flats of 72. At 2 plugs per square foot, the area will reach 90% coverage in 12 months. At 4 plugs per square foot, the area will reach 90% coverage in 6 months.

## Sedum Carpet-

This creates an easy, instant effect. A carpet of rooted sedum cuttings in one-half inch of soil on top of a one-half inch coir (coconut fiber) mat. 10" x 20", comes in a plastic tray, for transportation purposes only. Weighs an average of 4 pounds and can be used in both extensive and intensive applications a instantly full effect for extensive.



## 4 Inch-

Comes in pots 3.5" across, sold in flats of 18. Larger plant size for a fuller instant effect similar to the carpet, but used more in the intensive variety of green roof. The higher organic matter in the potting soil will decompose at a faster rate than the green roof soil.



## 1 Gallon-

The 1 gallon pots are 6" across, and sold individually. Mainly used for intensive garden style roofs with 8" or more of soil. Like in the 4" pots the higher organic matter in the potting soil will decompose at a faster rate than the Green Roof soil.



# Water Retention in Green Roofs

The big question is, How much water is retained with a green roof?

- And the answer is, it depends, an intensive green roof will retain water more so than an extensive green roof. However, the soil its self is light on organic material which is what holds the moisture in the soil.
- This is again why the plants need to be drought tolerant, and each plant retains water differently. Sedums for instance are fleshy and hold a lot of water. So water retention depends on plant selection.
- Of course green roofs are on top of buildings, and those buildings are heated, and though insulation dose a lot to try and minimize the heat exchange, it is still heating the roof and that combined with the thin soil depth causes the water to evaporate faster, which still prevents dumping it into the sewer system.
- More research needs to be done and the groups [www.greenroofs.com](http://www.greenroofs.com) and [www.greenroofs.org](http://www.greenroofs.org) are coordinating some research on how to quantify that information.

# Precedents

Extensive

Seattle Center Parking Garage  
516 Harrison, 5th Ave N and  
Harrison St in downtown  
Seattle Across from the  
Experience Music Project  
Pacific Earthworks  
Open roof with Sedum plugs



Intensive

Whatcom Educational Credit  
Union

GreenGrid by Weston  
Solutions

4" deep modules with Sedums  
8" deep modules with  
perennials



Ruby Condominiums

Eastlake Ave E and East Alison  
GreenGrid by Weston Solutions  
8" deep modules with perennials





Ballard Library



Seattle City Hall



Olive 8 Hotel

# SOURCES

## Industry Networks

<http://www.greenroofs.org/>

<http://www.greenroofs.com/>

<http://www.walp.org/>

## City of Seattle

[http://www.seattle.gov/DPD/GreenBuilding/OurProgram/Resources/TechnicalBriefs/DPDS\\_009485.asp](http://www.seattle.gov/DPD/GreenBuilding/OurProgram/Resources/TechnicalBriefs/DPDS_009485.asp)

## T&L GreenGrid

<http://www.greengridroofs.com/>

## Green Roof Catalog List

[http://www.tandlnursery.com/green\\_roofs\\_downloads/T%26L\\_Gree\\_Roof\\_Plant\\_Catalog.pdf](http://www.tandlnursery.com/green_roofs_downloads/T%26L_Gree_Roof_Plant_Catalog.pdf)

## Maintenance Suggestions

[http://www.tandlnursery.com/green\\_roofs\\_downloads/T%26L\\_Green\\_Roof\\_Maintenance\\_Recommendations.pdf](http://www.tandlnursery.com/green_roofs_downloads/T%26L_Green_Roof_Maintenance_Recommendations.pdf)

## Plants for Green Roofs in the Pacific Northwest

[http://www.tandlnursery.com/green\\_roofs\\_downloads/T%26L\\_Plants\\_for\\_Green\\_Roofs.pdf](http://www.tandlnursery.com/green_roofs_downloads/T%26L_Plants_for_Green_Roofs.pdf)

## Green Roof Resources

[http://www.tandlnursery.com/green\\_roofs\\_downloads/T%26L\\_Green\\_Roof\\_Resource\\_List.pdf](http://www.tandlnursery.com/green_roofs_downloads/T%26L_Green_Roof_Resource_List.pdf)

## Spacing Information

[http://www.tandlnursery.com/green\\_roofs\\_downloads/T%26L\\_Spacing\\_Information.pdf](http://www.tandlnursery.com/green_roofs_downloads/T%26L_Spacing_Information.pdf)

## Green Roof Soil Suppliers

<http://www.swansonbark.com/>

## Roofing Products

[www.carlisle-syntec.com](http://www.carlisle-syntec.com)

[http://www.colbond.us/greenroof\\_roofgardens.htm](http://www.colbond.us/greenroof_roofgardens.htm)

## LEED

<http://www.usgbc.org/DisplayPage.aspx?CMSPageID=222>

## King County

[http://your.kingcounty.gov/solidwaste/greenbuilding/documents/KCGreenRoofStudy\\_Final.pdf](http://your.kingcounty.gov/solidwaste/greenbuilding/documents/KCGreenRoofStudy_Final.pdf)