



buildings

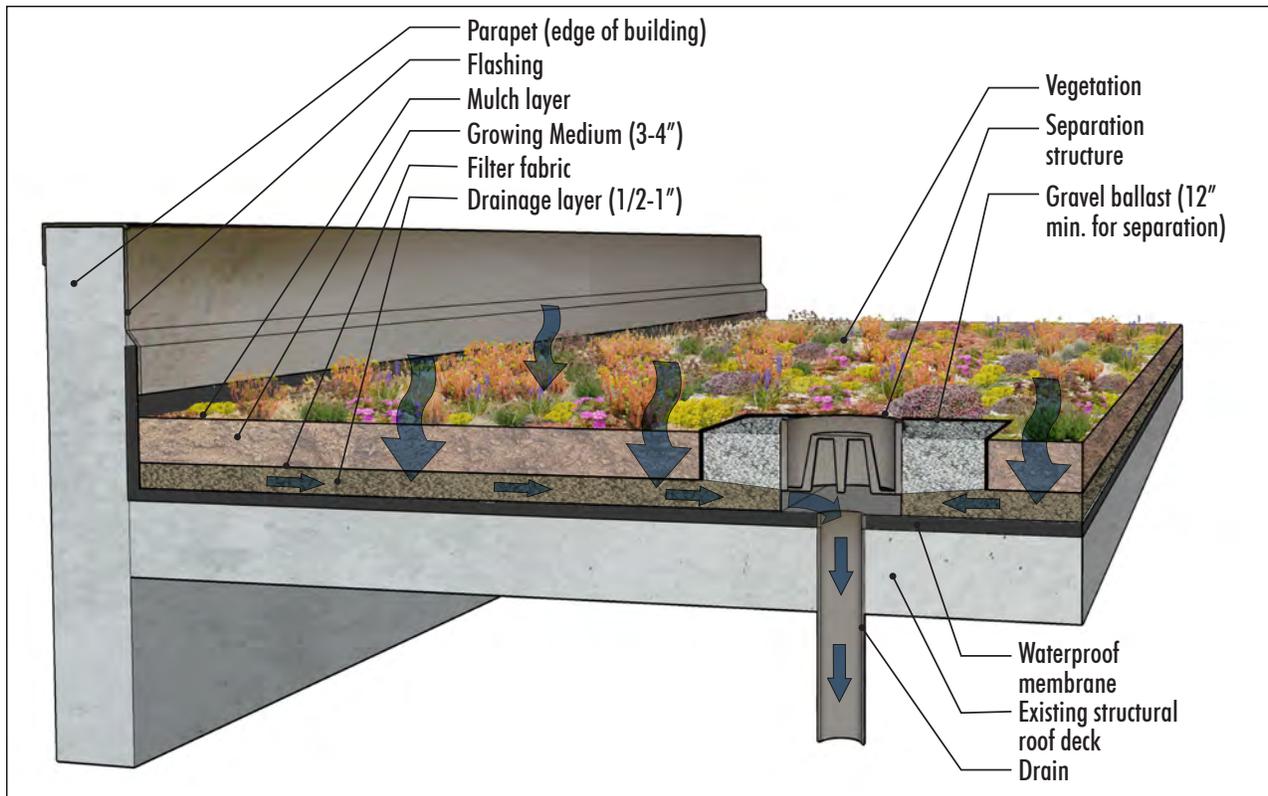
*Clean Water Services Field Operations*

## Description

A green roof (or ecoroof) is a lightweight vegetated roof system with waterproofing material, drainage, growing medium, and specially selected plants. A green roof can reduce site impervious area and manage stormwater runoff. Green roofs reduce peak runoff to near pre-development rates and reduce annual runoff volume by at least 50% (Cost Benefit Evaluation of Ecoroofs, Portland Bureau of Environmental Services, 2008). Green roofs also help mitigate runoff temperatures by keeping roofs cool and retaining most of the runoff in dry seasons. Green roofs typically have thin layers of lightweight growing medium (4 to 8 inches) and low-growing succulent vegetation. Alternatively, roof gardens that are designed to be walked on have deeper soils (8+ inches) and are more heavily planted. Professional design consultation may be necessary to ensure the structural requirements of building codes are met. The design must be low maintenance and use irrigation only to sustain the health of vegetation.

## Application & Limitations

Green roofs may be considered 100% pervious in water quality calculations, thus reducing the size of water quality facilities. Green roofs can be applied to a range of building types, from 'flat' rooftops (minimum of 1/4" slope per foot) to sloped rooftops with up to 4:12 pitch (3H:1V slope) or higher with adequate slope control. Depending on configuration and structure of the roof, the vegetated area may be partial or 100% coverage. The structural roof support must hold the additional weight of the green roof. Greater flexibility and options are available for new buildings, but retrofits are possible. For retrofit projects, an architect, structural engineer, or roof consultant can determine the condition of the existing building structure and what might be needed to support a green roof. Generally, the building structure must hold an additional 15 to 30 pounds per square foot for saturated weight.



## Design Factors

### Sizing

Green roofs replace impervious area at a 1:1 ratio. They may not receive water from other impervious areas such as an adjacent conventional roof.

### Slope

Maximum roof pitch is 4:12 (3H:1V slope) unless the applicant provides documentation of runoff retention and erosion control on steeper slopes.

### Waterproofing

On the roof surface, use a good waterproofing material such as modified asphalt, synthetic rubber, or reinforced thermal plastics. Waterproofing materials also may act as a root barrier. Waterproof membranes should be thoroughly tested to identify and remedy potential defects and leaks prior to installation of any green roof components.

### Protection boards or materials (recommended)

These materials protect the waterproof membrane from damage and are usually made of soft fibrous materials. They may be required to maintain the waterproofing warranty, depending on the membrane used. Consult with roofing manufacturer for requirements.

### Ballast (optional)

Gravel ballast may be placed along the roof perimeter and at air vents or other vertical elements to separate roofing elements and vegetation. The need for ballast depends on the type of roof and rooftop flashing details. Ballast or rooftop pavers may be used to provide access, especially to vertical elements that require maintenance.

### Header/separation board (optional)

If needed, a header or separation board may be placed between gravel ballast and soil or drains.

### Root barrier

A root barrier may be required, depending on the waterproofing material, warranty requirements, and the types of vegetation proposed. Root barriers impregnated with pesticides, metals, or other chemicals that could leach into stormwater should not be applied unless documentation that leaching does not occur is provided. If a root barrier is used it must extend under any gravel ballast and the growing medium, and up the side of any vertical elements.



Hamilton Apartments, Portland



Beranger Condominiums, Gresham

## Design Factors (continued)

### Drainage

A method of drainage should allow excess water to flow into drains when soils are saturated. A manufactured drain mat, filter fabric, aggregate or gravel layers, or the growing medium itself may be used if water drains when soils are saturated. Every green roof should have an approved discharge location and drain or drains. Check with the local jurisdiction.

### Growing medium

The growing medium depth is 3 to 4 inches or more, depending on the project. This material should be lightweight and provide a good base for plant growth. Mixes range from 5% organic/95% inorganic to 30% organic/70% inorganic, depending on specific vegetation needs.

Growing media should be stable over time and not break down into fine particles that might increase compaction and clog drainage layers. Components include pumice, perlite, paper pulp, digested organic fiber, and water retention components such as expanded slate, diatomaceous earth, or polymers. For growing media specification, include all constituent elements and their % composition, and a saturated weight per cubic foot (pcf) that has been tested by a third party lab.

### Vegetation and coverage

Green roof vegetation traits:

- Adapted to seasonal drought, excess heat, cold and high winds and other harsh conditions
- Fire resistant
- Requires little or no irrigation once established
- Predominately self-sustaining, low maintenance, with minimal fertilizer
- Perennial or self-sowing annuals that are dense and mat-forming
- Diverse palette to increase survivability and good coverage

Examples of appropriate species include: Sedum, ice plant, blue fescue, sempervivum and creeping thyme. Other herbs, forbs, grasses, and low groundcovers can provide additional benefits and aesthetics, but may need more watering and maintenance to survive and may be prone to additional fire risk if allowed to dry out. For a list of acceptable plants refer to page 76.

### Establishment Period

Achieve 90% plant coverage within the 2 year establishment period. At least 70% of the green roof should be evergreen species. No more than 10% of the green roof may be non-vegetated components such as gravel ballast or pavers for maintenance access. Mechanical units may protrude through the green roof, but are not considered elements of the green roof and may be removed from square foot totals.

Irrigation during the 2-year establishment period should not exceed ½ inch of water per week (7 days) for the irrigation season (May through October). Post- establishment irrigation should not exceed ¼ inch of water every 10 days during the irrigation season.

Exposed areas during establishment periods should be mulched with an approved, biodegradable mesh blanket, straw, gravel, and pebbles or pumice to protect exposed soil from erosion.



*Bethany Athletic Club, Beaverton*



*Multnomah County Office Building, Portland*



*Clean Water Services Field Operations*

## Long Term Maintenance

The property owner is responsible for ongoing maintenance per a recorded maintenance agreement (see see page 88 for example maintenance agreement).

Green roofs should be low maintenance but will require some scheduled maintenance to avoid or resolve problems. The level of maintenance will vary depending on soil depth, vegetation type, and location.

- During the winter rainy season, check drains monthly and remove any accumulated debris.
- Remove dead plants and replant as needed in spring and fall to maintain the required 80% plant coverage.
- During the first growing season remove weeds and undesirable plant growth monthly, and in late spring and early fall in subsequent years.
- Pesticides and herbicides of any kind are prohibited, unless approved by the District to contain a detrimental outbreak of weeds or other pests.

Due to the low level of organic material, fertilizers may be required for plant growth. These should be non- chemical, organic and slow release as approved by the District.

Minimal irrigation may be necessary to maintain vegetation health and ecological function of green roofs. Harvested rainwater is highly recommended for landscape irrigation. Green roofs larger than 1,000 square feet should have an automatic irrigation system for more efficient coverage and to eliminate the need for hand watering. Those larger than 5,000 square feet also should have an irrigation flow meter to monitor water usage.

## References

- Clean Water Services Design and Construction Standards