



GREEN ROOFS

STORMWATER MANAGEMENT

What is a Green Roof?

A Green Roof is a system of waterproofing material with a soil/vegetation protective cover. A Green Roof can be used in place of a traditional roof as a way to reduce impervious surfaces and increase water permeability. Green roofs vary in size, and can be implemented from small residential areas to large-scale commercial sites.

Green Roofs attempt to mimic ground cover with the purpose of reducing stormwater runoff rates. Green Roofs also help mitigate runoff temperatures by keeping roofs cool and retaining most of the runoff in warm seasons.



Extensive Green Roof in Washington D.C.
Source: US EPA

Extensive Green Roof

More simple, hardy plants used (such as succulents), low maintenance, require less water, more lightweight and therefore require less structural support. *Extensive Green Roofs are recommended.*

Intensive Green Roof

More complex, larger, deep-rooted, less hardy plants used, more maintenance and water required, heavier and therefore more structural supports required

Disclaimer

Check with a licensed architect, structural engineer, or roof consultant to ensure the structure can support the weight of a green roof.

Green Roof Installation should be done by a licensed contractor and all manufacture guidance must be followed.

Materials List

Structural Roof Support:

- Additional supports may include decking, roof trusses, joists, columns, and/or foundations.
- Generally, the building structure must be adequate to hold an additional 10 to 25 pounds per square-foot (psf) saturated weight, depending on the vegetation and growth medium that will be used. (This is in addition to snow load requirements.) For example, an existing rock ballast roof may be structurally sufficient to hold a 10-12 psf green roof. (Ballast typically weighs 10-12 psf.)

Waterproof Membrane (Impermeable

Liner): made of various materials, such as modified asphalts (bitumens), synthetic rubber (EPDM), hypolan (CPSE), and reinforced PVC. Some of the materials come in sheets or rolls and some are in liquid form. They have different strengths and functional characteristics. Many of these products require root barriers and other materials to protect the membrane.

- #### Root Barrier (If needed):
- made of dense materials that inhibits root penetration. The need for a root barrier depends on the waterproof membrane selected. Modified asphalts usually require a root barrier, while synthetic rubber (EPDM) and reinforced PVC generally do not.

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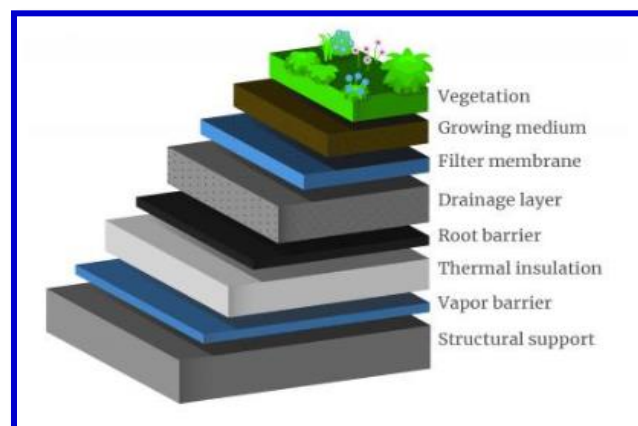
Check with the manufacturer to determine if a root barrier is required for a particular product.

- **Drainage Layer** (If needed): products range from manufactured perforated plastic sheets to a thin layer of gravel. Some eco-roof designs do not require any drainage layer other than the growth medium itself, depending on roof slope and size (for example, pitched roofs and small flat roofs).
- **Soil:** generally 2 to 6 inches thick and well drained. It weighs from 10 to 25 pounds per square-foot when saturated. A simple mix of 1/3 topsoil, 1/3 compost, and 1/3 perlite may be sufficient.
- **Vegetation:** a mix of sedum/ succulent plant communities is recommended due to low maintenance and watering needs. Forbs, grasses, and other low groundcovers can also be used, but require more maintenance and watering.
- **Gravel Ballast** (rarely needed): gravel ballast is sometimes placed along the perimeter of the roof and at air vents or other vertical elements. The need for ballast depends on operational and structural design issues. It is sometimes used to provide maintenance access, especially to vertical elements requiring periodic maintenance. In some situations a header or separation board may be placed between the gravel ballast and adjacent elements (such as soil or drains). If a root barrier (C) is used, it must extend under the gravel ballast and growth medium, and up the side of the vertical elements.
- **Drain:** a green roof must safely drain runoff from the roof to an approved stormwater disposal point.

Installation Instructions

1. **Verify Structural Support** with licensed contractor
 - Maximum roof slope shall be 25%, unless the applicant can provide documentation for runoff control on steeper slopes.
2. Install the **Waterproof Membrane** over the existing roof

3. Install a **Root Barrier** (sometimes required)
4. Install a **Layer of insulation** (optional)
5. Install a **Drainage Layer** over the entire roof area; must be present to carry away excess water. On very shallow extensive Green Roofs the drainage layer may be combined with the filter layer.
6. A **filter fabric** for fine soils, the engineered growing medium or soil substrate (minimum of 2.5 to 3-inches to support a diverse and healthy plant community, Soil of adequate fertility and drainage capacity needs to be applied at depths of 2-6 inches.)
7. Install **Plants and Irrigation:** 90% of plant coverage shall be achieved within 2 years. Temporary irrigation to establish plants is recommended. A permanent irrigation system using potable water may be used, but an alternative means of irrigation, such as cooling tower condensate or other non-potable sources is recommended. Alternative sources should be analyzed to determine if the source has chemicals that might harm or kill the vegetation.



Common Green Roof Layers
Source: US EPA

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8. **Erosion Control:** Additional items can include a "wind blanket," such as a jute or coco liner-type mesh, to help stabilize and establish the roots of the new plants, as well as measures to prevent shearing and erosion on roofs of 20° or more. Soil coverage to prevent erosion shall be established immediately upon installation, either by using mulch or protective blanket or vegetation mats (sod).
9. **Drain:** the Green Roof must safely drain to an approved discharge location.
10. **Additional support with cross battens:** needed on steep roofs. A raised grid structure is installed to secure the growing substrate. A shallow layer of gravel or pebbles are placed from 18" to three feet within the outside perimeter of the roof to provide for additional drainage, fire control and roof access.

Plants

Green roof plants can be installed using vegetation mats (similar to sod), plugs, potted plants, or broadcast seed. Vegetation mats provide immediate erosion control and require less maintenance than the other methods.

Green Roof plants cover can range from a thin moss layer to an assortment of native grasses and shrubs.

When selecting plants, the following are favorable traits:

- Shallow root systems
- Sun-tolerant, resistant to direct solar radiation
- Drought-tolerant, requiring little or no irrigation after establishment
- A growth pattern that allows the plants to thoroughly cover the soil
- Planted to cover 90% of the Green Roof within two years
- Self-sustaining, without the need for fertilizers, pesticides, or herbicides
- Able to withstand heat, cold (frost), and high winds

- Very low maintenance, needing little or no mowing or trimming
- Perennial or self-sowing
- Fire-resistant

Irrigation

Most commonly, a drip tubing system is needed for Extensive Green Roof establishment. Such systems directly target the root zone. Once established (typically in three years), Green Roofs no longer need irrigation except in cases of extreme drought.

Hand watering or other automatic sprinkler systems may be used.

Fertilization

In cases where soil tests or plant health indicates a lack of nutrients, minimal fertilizer may be used.

Otherwise fertilizer should be limited to avoid leaching into stormwater runoff.

Maintenance

All facility components (*see materials list*) shall be inspected throughout the life of the Green Roof.

Maintenance shall include the following:

- Replace eroded growing materials. Identify source of erosion and initiate measures to reduce or eliminate erosion.
- Maintain structural components per manufacturer's recommendations.
- Inspect the drainage flow paths (look for leaks and blockages)
- Clear away debris and sediment to allow stormwater flow from the drainage layer to the roof drain
- Remove weeds and non-native vegetation regularly
- Dead vegetation shall be removed and replaced.

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- Replant vegetation to provide 90% plant cover.
- Mow grasses as needed (if applicable)
- During the Establishment Period (one to three years), water sufficiently to assure plant establishment.
- Irrigate plants sufficiently during establishment period. Supplemental watering may be necessary during summer and extreme drought.

Cost

Green roof installation starts at \$10 per square foot for simpler extensive roofing, and \$25 per square foot for intensive roofs. Annual maintenance cost for either roof range from \$0.75 to \$1.50 per square foot (EPA).

When the savings associated with deferred maintenance and reduced energy consumption are taken into account, vegetated rooftops are comparable in cost to conventional roofs.

Resources

Environmental Protection Agency (EPA)

JSWCD Green roof Plant List