

PURPOSE & DESCRIPTION

Green roofs are multi-functional roofing systems that provide significant economic and environmental benefits. Green roofs mitigate the impact of urban development by **managing stormwater, reducing building heat absorption, and creating valued green space.** Filtrex® GrowingMedia™ may be utilized as an important component of the green roof soil media for a successful green roof installation.

The green roof GrowingMedia may be used as: 1) the growing media component of the green roof system; or, 2) the growing media component + mesh containment system using Filtrex GroSoxx®.

APPLICATION

Green roof systems can have a variety of objective applications including: storm water runoff reduction, storm water pollutant reduction, thermal buffering of the building envelope to save energy in cooling and heating, creation of urban wildlife habitat, creation of human recreational green space, air pollution mitigation, and/or mitigation of heat island effects in urban areas.

Green roof systems have been used in Europe for centuries, the first systems appeared as grass or sod roofs that provided thermal insulation in Northern Europe. The engineered green roof systems we use today began to appear over thirty years ago in Germany. Today they are widespread throughout Europe and are becoming common throughout the United States.

All green roof systems utilize the following components (see Figure 8.1):

- High-quality impermeable waterproofing membrane covering the roof structure.
- Drainage layer.
- Lightweight growing medium layer.
- Vegetation.

There are many commercially available green roof systems that vary only slightly. Some systems utilize a drainage layer that unrolls into one continuous cover over the waterproofing while other systems utilize interlocking trays or grids that are combined to create a continuous drainage layer. Additional components, such as root barriers, are also used in some systems.

Green roofs may be divided into two broad categories, intensive and extensive. Intensive green roof systems generally consist of a deep (6 in+, 150mm+) soil layer and vegetation that may include groundcovers, turf grass, shrubs and trees.

Extensive green roof systems have a shallow (1-6 in, 25-150mm) soil layer and only hardy, drought-tolerant groundcover vegetation. Extensive systems are less expensive, lighter weight, lower maintenance and more common than intensive green roof systems.

Green roof systems may be installed during new building construction or retrofitted onto an existing building. Extensive green roof systems are feasible on roofs with up to a 30° slope. The key consideration for extensive systems is whether the roof structure is adequate to hold the weight of the green roof. Extensive green roofs can weigh 12-50 lbs/square ft. (59-244 kg/square m), and intensive roofs often weigh over 50 lbs/square ft (244 kg/square m). Consult a structural engineer to verify the roof and building structure is adequate before installing any green roof system.

Green roof soils are typically engineered to be very lightweight.

They are primarily made of inorganic components such as expanded slate and shale, and extruded clay and perlite, which provide volume and rooting structure with little additional weight. Mixing a small percentage of GrowingMedia into the green roof system soil media will provide the nutrients and water holding capacity necessary for plant growth.

The cost of green roof systems vary with design, and can range from \$12-25/square ft (\$133-278/square m) for extensive roof systems and \$25-\$40+/square ft (\$278-444+/square m) for intensive roof systems (Velasquez, 2005).

Extensive green roof systems are specifically designed to be low-maintenance. Typical maintenance procedures include: irrigation to establish vegetation, semi-annual inspection and removal of invasive weeds.

ADVANTAGES AND DISADVANTAGES

Advantages

- Green roofs reduce stormwater quantity by absorbing rainfall in the GrowingMedia, plant material, and drainage layer. It has been shown that green roof systems may absorb 50-90% of total rainfall.
- Green roofs improve stormwater quality (rooftop pollutants are generated from acid rain, atmospheric deposition, and roofing materials) by filtering runoff through GrowingMedia and vegetation before it leaves the roof surface.
- GrowingMedia has the ability to bind and adsorb soluble nutrients, metals, and hydrocarbons in storm water runoff, thereby reducing loading to receiving waters or storm drains.
- Green roofs remove pollutants from storm water through plant uptake.
- Microorganisms in GrowingMedia have the ability to degrade organic pollutants and cycle captured nutrients into beneficial and/or less toxic forms.
- Green roof systems slow down runoff velocity, thereby reducing pollutant transport.

ADVANTAGES			
	LOW	MED	HIGH
Installation Difficulty		✓	
Durability			✓
Runoff Reduction			✓
Runoff Velocity Reduction		✓	
Storm Water Pollution Reduction		✓	
Aesthetic/Recreation Potential			✓
Thermal Insulation/Energy Saver			✓
Urban Wildlife Habitat		✓	

- GrowingMedia reduces peak runoff flows and runoff volumes by increasing soil porosity, water holding capacity, and infiltration rates.
- GrowingMedia stores and maintains more water on-site helping to reduce storm pressure and maintain base flows to receiving waters.
- Green roof systems reduce the temperature of storm runoff.
- Green roofs can help to mitigate the urban heat island effect. It has been shown that urban areas are often several degrees warmer than adjacent outlying areas due to increased impervious surfaces. The surface temperature of a green roof is often 40-50% cooler than conventional roof systems.
- Green roof systems provide roof insulation and have been shown to reduce heating and cooling loads for buildings.
- Green roofs improve air quality by filtering and binding dust particles prevalent in urban air-sheds.
- Green roofs create wildlife habitat. At least 23 bird species and many more insects have been observed within the Chicago City Hall green roof system.
- GrowingMedia increase biological activity and diversity in the soil complex, allowing for increased ecological diversity in rooftop plant and animal communities.
- Green roofs extend the longevity of the roof by up to 100% compared to conventional roof systems.
- Many municipalities offer incentives such as reduced impact fees and storm water utilities or increased allowable development area for building projects with green roof systems.
- Green roofs are aesthetically attractive and can be included in urban and suburban beautification projects.
- Green roofs may be designed to accommodate human use and recreation creating a valuable useable green space.
- Green roof design is flexible, allowing for unique solutions that accommodate a variety of different project types and goals.
- Humus colloids and organic matter in GrowingMedia provide physical structure for seed, establishing seedlings and mature plants used in green roof systems.
- Humus colloids and organic matter in GrowingMedia provide increased water holding capacity and reduced water evaporation to aid plant sustainability.
- GrowingMedia is a good option for arid and semiarid regions where germination, moisture management, and irrigation can be difficult.
- GrowingMedia provides organic nutrients that slow release for optimum efficiency to establishing vegetation.
- Soxx used with the Green Roof GrowingMedia offer a light weight containment system for green roof growing media and vegetation.
- Green Roof GrowingMedia may assist in qualification for LEED® Green Building Rating and Certification credits under LEED Building Design & Construction (BD+C), New Construction v4. Awarded credits may be possible from the categories of Sustainable Sites, Water Efficiency, Materials & Resources, and Innovation. *Note: LEED is an independent program offered through the U.S. Green Building Council. LEED credits are determined on a per project basis by an independent auditing committee. Filtrexx neither guarantees nor assures LEED credits from the use of its products. LEED is a trademark of the U.S. Green Building Council.*

Disadvantages

- If not installed correctly, maintained or used for a purpose or intention that does not meet specifications, performance may be

diminished.

- If the green roof soil does not contain the appropriate mix of inorganic structural components and GrowingMedia, performance may be diminished.
- If the green roof system does not include all of the roof component layers, performance and longevity may be diminished.
- Green roofs can only be used on buildings that have adequate structural integrity to support the roof.
- Irrigation may be necessary, depending on the type of plants chosen and the climate in which the project is constructed.
- Some green roof systems may not be compatible with human access and use.

MATERIAL CHARACTERISTICS

Green Roofs use only GroSoxx® photodegradable or biodegradable netting materials available from Filtrexx International, and are the only mesh materials accepted in creating green roof systems for any application. For GroSoxx Material Specifications see Table 8.1.

GROWINGMEDIA™ CHARACTERISTICS

Filtrexx Green Roofs use Filtrexx GrowingMedia which is a composted material that is specifically designed for management of storm water runoff, and establishment and sustainability of rooftop plant vegetation. GrowingMedia can be third party tested to meet minimum performance criteria defined by Filtrexx International. Performance parameters include: hydraulic flow-through rate, percent cover of vegetation, water holding capacity, pH, organic matter, soluble salts, moisture content, biological stability, percent inert material, bulk density and particle size distribution. For information on the physical, chemical, and biological properties of GrowingMedia refer to Specification 6.2 Filtrexx® GrowingMedia™.

PERFORMANCE

Performance of a green roof system is contingent on the purpose of objectives of the system, the particular system installed, and the soil media and plants specified. The properties of the soil media will depend on the type and amount of inorganic substrate that is mixed with the GrowingMedia. For potential performance of rainwater absorption and runoff reduction using GrowingMedia refer to the next section.

DESIGN CRITERIA

Sizing

There are many commercially available green roof systems that should fit the needs of almost any project. A consulting architect and landscape architect will be able to help you select the most appropriate product. Green roof systems can have a variety of design functions including: storm water runoff reduction, storm water pollutant reduction, thermal buffering of the building envelope to save energy in cooling and heating, creation of urban wildlife habitat, creation of human recreational green space, air pollution mitigation, and/or mitigation of heat island effects in urban areas. This section concentrates on plant selection, growing media options, and the storm water design benefits of a green roof system.

Plant Selection

The selection of vegetation to use on the green roof is extremely important. The plants must be able to withstand harsh conditions – an extensive green roof is likely to be a hot, dry, sunny, windy, exposed location with a shallow soil layer. Relatively few species

of plants will thrive in these conditions. One type that is well adapted is the sedums. Sedums are low-growing succulent plants that are extremely drought-tolerant and able to do well in shallow, well-drained green roof soils. There are literally hundreds of sedum varieties – check with a local landscape architect or plant nursery to find out which ones will perform best in your region. Table 1 lists several species that are recommended by Emory Knoll Farms, a nursery that specializes in green roof plants (www.greenroofplants.com).

In addition to sedums, there are many native plants that may do well in green roof conditions. Plants that are typically found growing naturally on rock outcroppings, xeric (dry) meadows and other dry, sunny, shallow-soiled ecosystems may perform well in the similar conditions found on a green roof. Again, check with a local landscape architect or plant nursery to find out which plants will do well in your region.

Growing Media Options

Options for green roof growing media mixes may be limitless, depending on design limitations, objectives, plant material selection and climate. Filtrexx International recommends the following options for growing media blends as a component of the Filtrexx Green Roof GrowingMedia if 100% GrowingMedia is not desirable or does not meet design limitations and/or objectives. It should be noted that if stormwater runoff reduction and/or water holding capacity are key design objectives, increasing organic matter content through increased GrowingMedia inclusion rates should be strongly considered.

The German Landscape Research, Development and Construction Society (FLL) guidelines for green roof growing media specify a maximum organic matter content of < 8% (dry weight basis). This equates to a maximum compost content of 20% of the green roof mixture. The remaining 80% of the mixture should be composed of light-weight porous aggregates, including: expanded or calcined clay, expanded shale, or expanded slate. Vermiculite and perlite are not recommended for green roof growing media due to longevity and density concerns. Total bulk density (dry weight) for the green roof growing media mixture should be < 50 lbs/ft³ (0.8 g/cm³) and pH should be between 6.5 and 8.5. For maximum nutrient and salt content; minimum hydraulic conductivity and water holding capacity; and particle size distribution specifications for FLL green roof growing media, contact Filtrexx International.

Pollutant load reduction from stormwater originating from rooftops can be reduced in two ways: reduction of stormwater volume, or treatment of storm water runoff. Volume reduction strategies include: increasing organic matter content in the green roof growing media by using GrowingMedia (see below), or capturing runoff using cisterns or rain barrels. Rooftop runoff nutrients (nitrogen and phosphorus) and metals (Cd, Cr, Cu, Ni, Pb, Zn) can be treated on the rooftop by using Filtrexx Nutrient Removal Agent (Section 4.2) and Heavy Metals Removal Agent (Section 4.4) aggregates in the growing media mixture. Note: green roof systems that are intensive and specify plant materials that cover the growing media surface may consider perlite, vermiculite, and organic matter media – such as GrowingMedia due to reduced exposure to high UV and freeze-thaw conditions.

GrowingMedia Containment Option

Green roof systems may use growing media containment systems to reduce the effects of wind erosion, such as the Filtrexx GroSoxx tubular mesh netting containment system. GroSoxx use only photodegradable netting materials available from Filtrexx

International. For GroSoxx tubular mesh material specifications see Table 8.1. Green Roof GrowingMedia should be pre-blended and can be filled into the GroSoxx mesh on-site, or off-site and delivered via pallets only by a Filtrexx Certified Installer. See Table 8.3 for summary specifications on the manufactured containment system. Irrigation drip-tape can be installed into the containment system at the time of manufacture for temporary or permanent irrigation. For specifications on the irrigation system see Filtrexx Drip Tape Irrigation (Section 6.6). Use of drip tape irrigation will assist in plant material establishment and survival while conserving water use. Green roof plant materials can be planted directly into the GroSoxx containment system after installation. It should be noted that the GroSoxx containment system will reduce UV exposure to growing media, potentially making organic matter, perlite, and vermiculite more viable.

Rainfall Absorption/Runoff Reduction

While green roof systems can absorb between 50 and 90% of total rainfall, increasing the organic matter content of the soil media by increasing the inclusion rate of GrowingMedia will increase the rainwater absorption and initial abstraction (Ia) properties of the green roof soil media.

It is important to understand that many green roof plants, including sedums, do not thrive in organic rich soil media. If rainfall absorption/runoff reduction is one of the key design objectives, plant material selection may need account for organic matter tolerance.

For every ½ in (15mm) of GrowingMedia added to the green roof soil media, it will hold approximately 8 cubic ft (0.2 cubic m) of water per 1000 sq. ft (93 sq m), or 360 cubic ft/ac (26 cubic m/ha). Alternatively, GrowingMedia typically holds approximately 1.6 oz (45 g) of water per 3.6 oz (100 g) of GrowingMedia (dry weight); 1 gal (0.004 cubic m) of water per 20 lbs (9 kg) of GrowingMedia (dry wt) or per 30 lbs (14 kg) of GrowingMedia (wet wt). This equates to approximately 40 gal (0.15 cubic m) of water per cubic yard (0.76 cubic m) of GrowingMedia and 5,400 gal (722 cubic ft, 20 cubic m) of water per acre inch (0.01 ha meter, 103 cubic m) of GrowingMedia, and 10,800 gal (1444 cubic ft, 41 cubic m) of water for a 2 in (50mm) GrowingMedia. An acre inch (0.01 ha meter) of GrowingMedia requires approximately 135 cubic yards (103 cubic meters) of material.

Organic Matter Content Method for Intensive Systems Using Topsoil

As extensive systems typically do not use topsoil for soil media mixes, this option is only appropriate for intensive systems with roof and building structures that can withstand significant weight loads.

Average organic matter content of GrowingMedia is approximately 25% (or 50% by dry weight; average water content of GrowingMedia is 50%) and weighs approximately 1000 lbs per cubic yard (593 kg/cubic m) (wet weight). Soil weighs approximately 2000 lbs per cubic yard (1187 kg/cubic m) (wet weight). For each 1% of organic matter increase 80 lbs (36 kg) of GrowingMedia (20 lbs [9 kg] of organic matter) should be added to 1 cubic yard (0.76 cubic m) of soil.

Alternatively, if you assume the top 6 in (150mm) of soil weighs approximately 1000 tons/acre (2250 Mg/ha) (dry weight) you need to add 10 tons (9 Mg) of organic matter to increase soil organic matter 1%. 10 tons of organic matter (9 Mg) (dry weight) is equivalent to 40 tons (36 Mg) of GrowingMedia (wet weight), or 80 cubic yards (61 cubic m) (wet weight). As a conservative estimate, one should assume a 25% decline in organic matter

after the first year of application. This can vary between 10-50% depending on the climate zone. Once vegetation is mature and healthy, soil organic matter levels may stabilize.

If soil and GrowingMedia test results for organic matter content and bulk density are available, and the targeted soil organic matter content is known, the following equation can be used to determine GrowingMedia application rate (WDOE, 2005):

$$CR = D \times (SBD \times [SOM\% - FOM\%]) / (SBD \times [SOM\% - FOM\%] - CBD \times [COM\% - FOM\%])$$

Where:

CR = compost application rate (to determine final soil organic matter content goal)

D = depth of finished incorporation (in or mm)

SBD* = soil bulk density (lbs/cubic yard or kg/cubic m, dry wt.)

SOM% = initial soil organic matter content (%)

FOM% = final target soil organic matter content (%)

CBD** = compost bulk density (lbs/cubic yd or kg/cubic m, dry wt.)

COM% = compost organic matter (%)

Assumptions: This equation calculates compost rate using an additive approach. For example, a 3 in (75mm) compost rate incorporated to an 8 in (200mm) depth will be a final mix containing 3/8 compost and 5/8 soil by volume. Organic matter measurements are based on the commonly used “loss-on-ignition” method.

* SBD: to convert Soil Bulk Density in g/cm³ units to lb/cubic

yard, multiply by 1697.

** CBD: to convert Compost Bulk Density from lb/cubic yard “as is” to lb/cubic yard dry weight, multiply by solids content.

INSTALLATION

Installation should follow the manufacturer’s specifications for the specific system being installed.

Green Roofs may be manufactured and installed on-site using a blower truck, Filtrexx FX Machine, or delivery of pre-manufactured system on pallets to jobsite. The project designer shall specify placement of system. Green roof soil media and GrowingMedia may be installed using a blower truck in most situations. Green roof vegetation should be installed soon after soil installation.

INSPECTION & MAINTENANCE

Inspection and maintenance should follow the manufacturer’s specifications for the specific system being installed.

In general, it is recommended that inspections be performed at least semi-annually to check to make sure the vegetation is healthy and monitor for invasive weeds. Soxx should be inspected to make sure UV exposure is not weakening the containment system.

DISPOSAL/RECYCLING

Green roofs are a permanent installation and require no disposal.

Engineer shall notify Filtrexx of location, description, and details of project prior to the bidding process so that Filtrexx can provide design aid and technical support.

FIELD APPLICATION PHOTO REFERENCES



GrowingMedia mix and seedum cuttings



Green Roof Installed with GroSoxx (GrowingMedia + Mesh)

ADDITIONAL INFORMATION

For other references on this topic, including additional research reports and trade magazine and press coverage, visit the Filtrexx website at filtrexx.com

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Call for complete list of international installers and distributors.

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Table 8.1. Filtrexx GroSoxx® Mesh Material Specifications.

Material Type	NATURAL ORIGINAL (Cotton Fiber)	NATURAL PLUS (Wood Fiber)	BASIC (5 mil High Density Polyethylene HDPE)	BASIC PLUS (Multi-Filament Polypropylene MFPP)	DURABLE (Multi-Filament Polypropylene MFPP)	ORIGINAL / DURABLE PLUS / DURASOXX HD (Multi-Filament Polypropylene MFPP)	EXTREME (Multi-Filament Polypropylene MFPP)
Material Characteristic	Biodegradable	Biodegradable	Photodegradable	Photodegradable	Photodegradable	Photodegradable	Photodegradable
Design Diameters	5 in (125mm), 8 in (200mm), 12 in (300mm)	5 in (125mm), 8 in (200mm), 12 in (300mm)	8 in (200mm), 12 in (300mm), 18 in (400mm)	8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)	5 in (125mm), 8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm), 32 in (800mm)	5 in (125mm), 8 in (200mm), 12 in (300mm), 18 in (400mm), 24 in (600mm)	8 in (200mm), 12 in (300mm)
Mesh Opening	1/8 in (3mm)	1/8 in (3mm)	3/8 in (10mm)	3/8 in (10mm)	1/8 in (3mm)	1/8 in (3mm)	1/16 in (1.5mm)
Tensile Strength (ATSM D4595) ¹	MD: 193 lbs TD: 158 lbs	MD: 210 lbs TD: 289 lbs	MD: 211 lbs TD: 79 lbs	MD: 236 lbs TD: 223 lbs	MD: 545 lbs TD: 226 lbs	MD: 670 lbs TD: 423 lbs	MD: 1062 lbs TD: 797 lbs
% Original Strength from Ultraviolet Exposure (ASTM G-155)	ND	ND	23% at 1000 hr	100% at 1000 hr	100% at 1000 hr	100% at 1000 hr	100% at 1000 hr
Functional Longevity/ Project Duration ²	up to 12 months ³	up to 18 months ⁴	up to 4 yr	up to 4 yr	up to 5 yr	up to 5 yr	up to 5 yr

¹Tensile Strength is based on 12" diameter using ATSM D4595. See Filtrexx TechLink #3342 for full tensile strength testing.

²Functional longevity ranges are estimates only. Site specific environmental conditions may result in significantly shorter or longer time periods.

³Data based on Caltrans research and specifications

⁴See TechLink #3339 for research & testing

Table 8.2. Preferred Green Roof Plant List.

- Allium schoenoprasum
- Delosperma nubigenum 'Basutoland'
- Sedum acre 'Aureum'
- Sedum album
- Sedum album 'Murale'
- Sedum floriferum 'Weihenstephaner Gold'
- Sedum kamtschaticum
- Sedum reflexum
- Sedum sexangulare
- Sedum spurium 'Fuldaglut'
- Sedum spurium 'John Creech'
- Sedum spurium 'Roseum'
- Sedum spurium 'White Form'
- Talinum calycinum

(Source: Emory Knoll Farms, Inc.)

Figure 8.1. Typical Green Roof Cross-Section.

