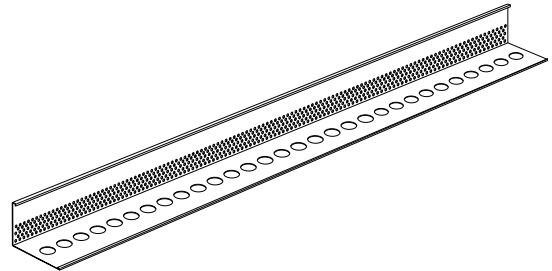
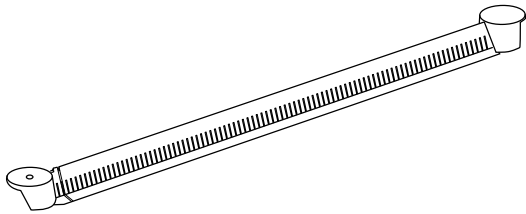
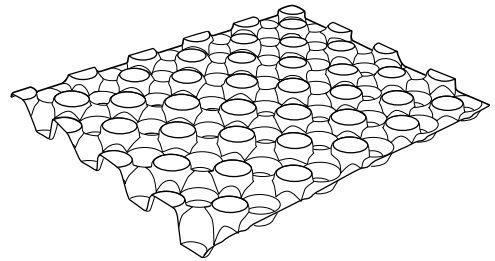
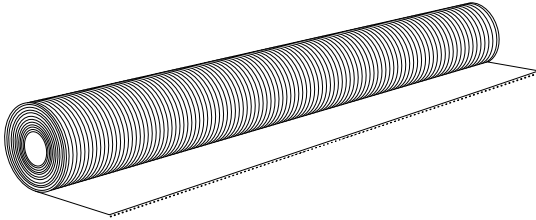
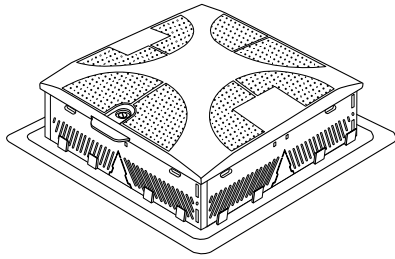


Green Roof Handbook



GENERAL INFORMATION

ABOUT CONSERVATION TECHNOLOGY: Conservation Technology has been a supplier of state-of-the-art technology for roofing, waterproofing, and water containment since 1984. Our RoofTechnology division supplies advanced sheet rubber membranes and liquid rubber coatings, and now supplies Optigreen green roof components in North America. Our PondTechnology division is a major supplier to the aquatic gardening industry and offers an extensive selection of pumps, filters, and plumbing for water quality management. Our RainwaterTechnology division is pioneering rainwater catchment in North America and offers a full range of filters, tanks, pumps, and controls specifically engineered for this application.

ABOUT OPTIGREEN: Optigreen (Optigrün International AG) is a world leader in the green roof industry. Optigreen green roof fabrics, drainage systems, soils, and accessories represent the culmination of thirty years of field experience. Optigreen has supplied the components for building more than 350,000,000 square feet of green roofs, perhaps one-third of all green roofs built in recorded history!

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PRICING AND DISCOUNTS: End-user pricing can be found in the component listing at the end of this handbook. Discounted pricing is offered to green roof contractors and re-sellers, based on annual purchases. Please note that all prices and product specifications are subject to change without notice.

TECHNICAL ASSISTANCE: In the few pages that follow, we have tried to convey only the basics of green roof construction. For additional technical support, please fax a simple sketch of your project.

PAYMENT: Our minimum order is \$25. We accept Mastercard, VISA, Discover, American Express, checks, bank drafts, money orders, or wire transfers. Credit terms are available for dealers and active contractors.

HOURS OF OPERATION: We're open Monday through Friday from 8:30 AM until 5:30 PM Eastern time, and often later. If you call during our busier months you may need to leave a message, but we try to return all calls the same day.

PICKUPS: You are welcome to visit our Baltimore warehouse at 2233 Huntingdon Avenue in Baltimore to pick up merchandise, but please place your order by telephone before you visit since we do not currently have a showroom or retail store.

STOCKING: We try to stock everything we sell and try to ship quickly. However, the green roof market is growing too rapidly to predict demand, so please contact us well in advance of construction to assure material availability. In particular, allow several months for projects larger than 10,000 square feet.

SHIPPING: With the exception of soils, we can ship all of the components for small green roofs economically by UPS. Components for larger roofs must ship by motor freight, but our substantial discounts permit us to offer very reasonable rates to almost any point in North America. Please note that someone must be available to unload and inspect truck merchandise.

INSPECTING SHIPMENTS: Although we rarely have shipping damage, it is essential that you inspect all motor freight shipments thoroughly before signing the freight bill, note any damage on the freight bill, and call us within one business day to report the damage. If you follow this procedure, we will guarantee free repair materials in the event of minor damage, and free replacement in the event of major damage. If you fail to note damage before accepting a truck shipment, you may be denied this protection, so insist on taking the time for a thorough inspection.

CONSERVATION TECHNOLOGY

tel: (800) 477-7724 fax: (410) 366-1202 www.conservationtechnology.com

INTRODUCTION TO GREEN ROOFS

Green roofs are roofs that are substantially covered with living plants. Although historical and archaeological evidence suggests that green roofs have been built for more than three thousand years, widespread acceptance has always been limited by the structural cost of supporting heavy soils and by the technical challenges of low-slope waterproofing. Recent advances in membrane waterproofing technology combined with the development of lightweight thin-profile green roofs have finally made green roofs practical for most new construction: there are now more than one billion square feet of lightweight green roofs!

WHY BUILD GREEN ROOFS? Although the structural, waterproofing, and drainage requirements of green roofs will always make them more expensive than bare roofs, green roofs offer significant long-term economical and environmental advantages that more than justify the higher initial cost:

- Green roofs are visually attractive. The variegated coloring of flowers, grasses, and wild herbs is more appealing than stark black or white monolithic surfaces. Green roofs can transform urban wastelands into urban gardens.
- Green roofs are energy-efficient. They are cool in the summer and can be as effective as white roofs in reducing the urban heat island effect. The thermal mass of the soil reduces heat gain and loss by averaging temperature extremes.
- Green roofs significantly reduce stormwater runoff, typically retaining half to three-quarters of the annual rainfall and retarding the runoff of most of the remainder.
- Green roofs are permanent. By shielding the waterproofing from the sun and reducing temperature swings, synthetic membranes can last fifty years and more.

ANATOMY OF A GREEN ROOF: A modern green roof requires eight functional layers:

sturdy roof structure: Green roofs must typically support 25 to 100 pounds more load per square foot than conventional flat roofs. New roofs, whether made of wood, steel, or concrete, can be designed to support green roofs at minimal additional expense. Existing roofs almost always require costly structural reinforcing.

reliable waterproofing membrane: Leaks in green roofs can be very difficult to identify, and repairs or replacement can be expensive. For a long, maintenance-free life, green roof waterproofing must be sufficiently elastic to withstand building movement, must withstand ponded water, must be non-biodegradable, and must be resistant to root penetration. Some rubber and plastic sheet-applied and liquid-applied membranes meet these criteria but most asphalt products do not.

root-barrier/ponding membrane: If the primary waterproofing system is not resistant to root penetration, it can be covered with a secondary root-barrier membrane. Secondary membranes are also used with some green roof systems where water is intentionally ponded so that the primary waterproofing membrane still drains.

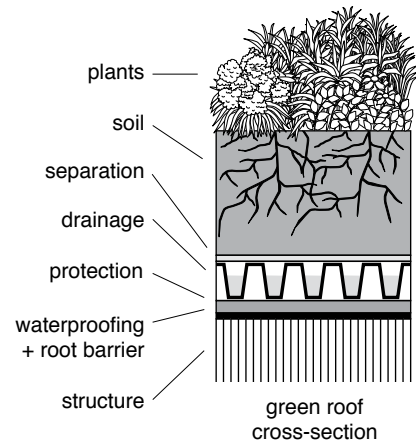
tough protection mat: A synthetic mat protects the waterproofing or root barrier/ponding membrane from mechanical damage during construction and roof maintenance. Protection mats typically weigh 500 to 900 grams per square meter (15 - 27 ounces per square yard). Mats with enhanced water storage and capillarity are preferred for some green roof systems.

water-storing drainage layer: It is desirable to store water in green roofs to help plants survive through periods of dry weather. However, the dry-climate plants that thrive on green roofs will not survive unless excess water is rapidly drained from the plant root zone. The optimal combination of water storage and rapid drainage can be provided by several water-storing drainage products including well-graded granular inorganic media, dimpled plastic sheets, and ribbed fabric laminates.

non-clogging separation fabric: For the water storage and drainage layer to function properly, it must be kept free of soil. A synthetic soil separation fabric serves this function, but the fabric must have a structure that resists clogging from fine soil particles such as silts and clays.

engineered soil: Green roof soil is not ordinary soil. It must be lightweight, have good water storage characteristics, have a low organic content, have suitable chemical parameters, and have a good distribution of particle sizes.

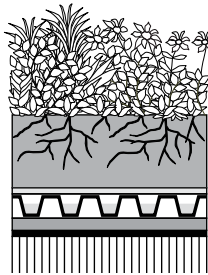
appropriate plants: Green roof plants must survive in the green roof environment which is often hot and dry. Thin green roofs usually require sedums and herbs, whereas thicker green roofs can often accommodate a wide range of native plants.



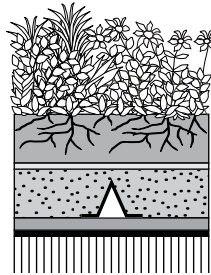
GREEN ROOF SYSTEMS

It is useful to categorize green roofs by drainage type and nominal thickness. The combination of these factors determines the structural load, the allowable slope, the type of vegetation supported, and the rainwater retention characteristics.

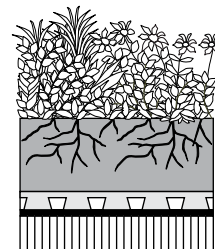
DRAINAGE TYPE: Drainage Type P utilizes *drainage plates*, waffled plastic sheets that store water above and drain water below. Drainage plates are lightweight, are easy to install, and are available in two sizes to meet the drainage and water storage requirements of almost any green roof. Drainage Type G utilizes a lightweight, porous inorganic *granular media* embedded with slotted plastic triangular drainage conduit. Granular media is heavier and is more labor-intensive to install than drainage plates, but provides a superior environment for plant root growth. Drainage Type M utilizes a *drainage mat*, a multi-layer fabric mat that combines soil separation, drainage, and protection functions into one product. This system is the fastest to install and creates the thinnest and lightest green roof assembly. However, its water storage and drainage capacity is limited, so it is primarily used for sloped roofs not suitable for Drainage Type P or Type G.



Drainage Type P
Drainage Plate

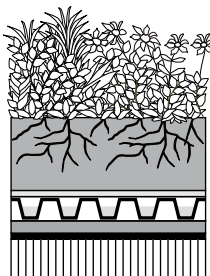


Drainage Type G
Granular Media

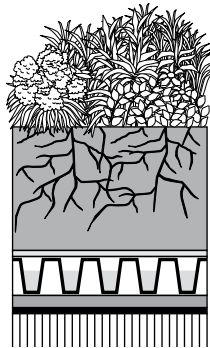


Drainage Type M
Drainage Mat

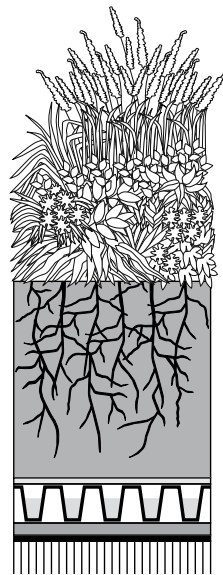
NOMINAL THICKNESS: The *nominal thickness* of a green roof is the approximate total height of the soil and drainage components that constitute the green roof system, excluding the roof structure, insulation, waterproofing, and plants. It is common practice to use the term *extensive* to describe green roofs that are very thin and will only support hardy, drought-resistant vegetation such as sedums, herbs, and perennials; *intensive* to describe green roofs that are thick enough to support a wider range of vegetation including grasses, shrubs, and small trees; and *semi-intensive* for roofs that are somewhere in between. These distinctions can be more precisely quantified by the four thickness ranges shown below:



Thickness Type 1
3" to 4"
sedums, herbs



Thickness Type 2
5" to 7"
sedums, herbs, perennials



Thickness Type 3
8" to 11"
perennials, grasses, shrubs



Thickness Type 4
12" +
grasses, shrubs, trees

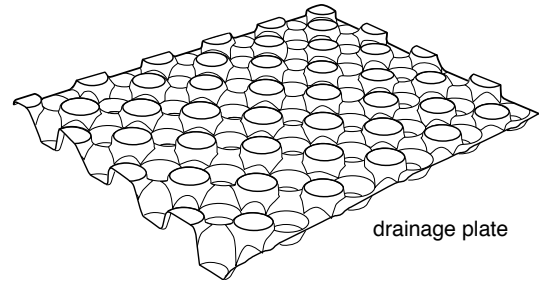
SYSTEMS: In this manual, three types of drainage four system thicknesses are combined to yield ten green roof systems designated P1, P2, P3, P4, G1, G2, G3, G4, M1, M2.

SYSTEMS WITH DRAINAGE PLATES

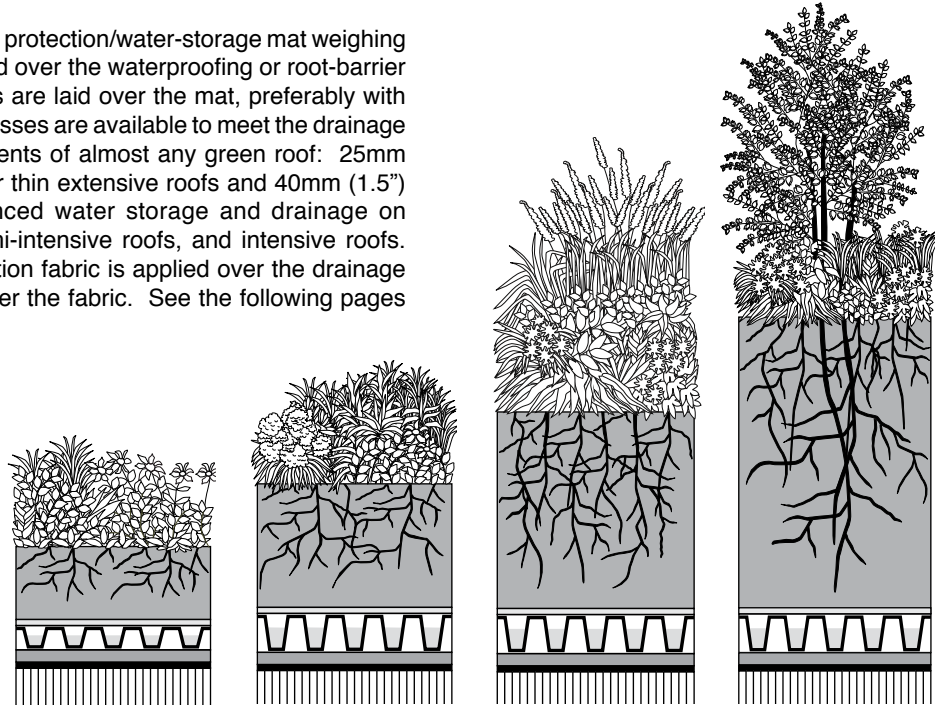
DESCRIPTION: Green roof systems of this type are drained by waffled plastic sheets called *drainage plates*. Water is retained within pockets on the upper sides; excess water flows through small holes and spills over the edges to be carried off the roof. An air gap between the high-water level of the plates and the top of the plates assures proper soil drainage at all times.

APPLICATION: Since drainage plates are lightweight and easy to install, they have become the most popular drainage system for green roofs. Drainage plates are recommended for roofs with slopes less than 1:12.

COMPONENTS: A synthetic protection/water-storage mat weighing 500g/m² (15 oz/yd²) is applied over the waterproofing or root-barrier membrane. Drainage plates are laid over the mat, preferably with staggered joints. Two thicknesses are available to meet the drainage and water storage requirements of almost any green roof: 25mm (1" thickness) is standard for thin extensive roofs and 40mm (1.5") is recommended for enhanced water storage and drainage on thicker extensive roofs, semi-intensive roofs, and intensive roofs. A 200g/m² (6 oz/yd²) separation fabric is applied over the drainage plates, and soil is spread over the fabric. See the following pages for installation details.



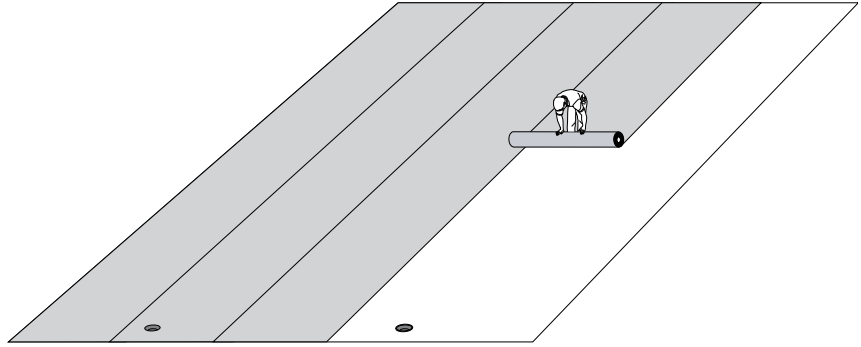
drainage plate



system designation	P1	P2	P3	P4
typical plants	sedum herbs	sedum herbs perennials	perennials grasses shrubs	grasses shrubs trees
extensive soil mix	3"	5"	-	-
intensive soil mix	-	-	8"	12"
separation fabric	1/8"	1/8"	1/8"	1/8"
drainage plate	1"	1-1/2"	1-1/2"	1-1/2"
protection mat	1/4"	1/4"	1/4"	1/4"
nominal thickness	4"	7"	10"	14"
dry weight	13 lbs/ft ²	21 lbs/ft ²	34 lbs/ft ²	51 lbs/ft ²
saturated weight	21 lbs/ft ²	34 lbs/ft ²	53 lbs/ft ²	78 lbs/ft ²
minimum slope	1/4:12	1/4:12	1/4:12	1/4:12
maximum slope	1:12	1:12	1:12	1:12
water retention	50%	60%	70%	80%

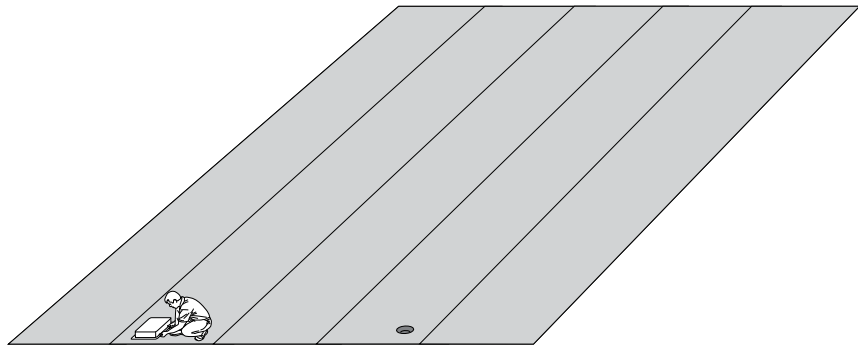
1. LAY PROTECTION MAT

If the primary roof waterproofing is not root resistant, first apply a root barrier membrane. Then unroll Optigreen Standard Protection Mat, overlapping adjacent sheets at least six inches, and cut openings for roof drains. For greater mechanical protection or enhanced water storage capacity, substitute Optigreen Heavy-Duty Protection Mat.



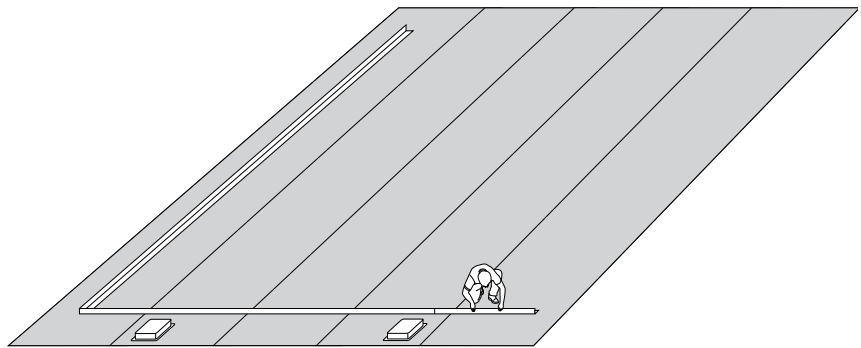
2. INSTALL DRAIN ACCESS BOXES

Position Optigreen Drain Access Boxes over roof drains, adding sidewall elements as needed to match the system thickness.



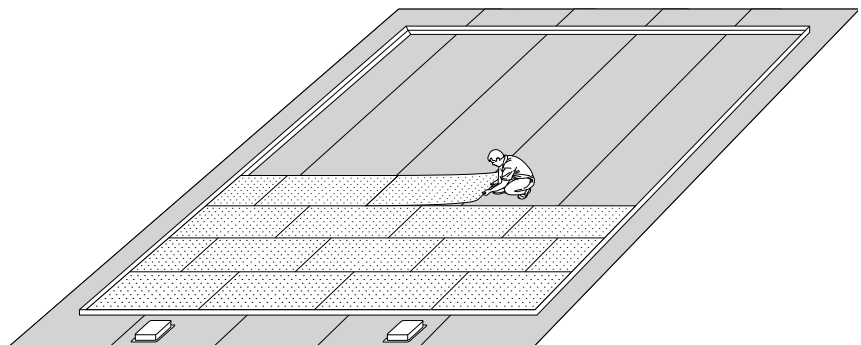
3. INSTALL RETAINING EDGE

Optigreen Retaining Edge should be installed on extensive green roofs approximately 30" from roof edges with roof drains and 18" from other edges. If there will be a gravel perimeter, the retaining edge will separate the soil and gravel and does not need to be attached. If there will be no gravel perimeter, the retaining edge should be attached to the waterproofing membrane or the protection mat so it will stay in place.



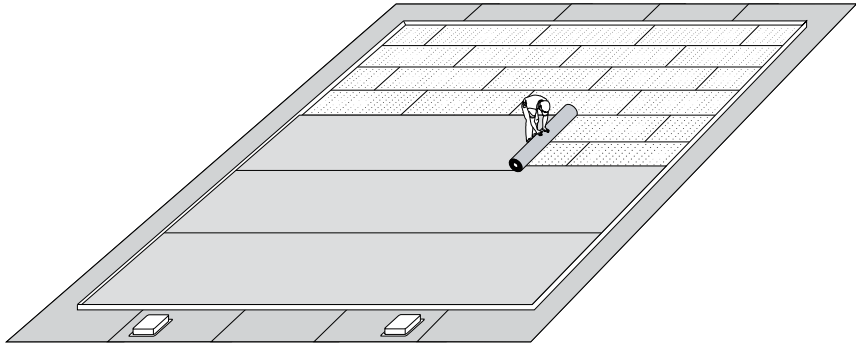
4. LAY DRAIN PLATES

Lay Optigreen Drain Plates in a staggered pattern. Multiple layers of plastic plates can be easily cut with a circular saw, or half-sheets can be purchased to speed installation. The plates should fit tightly but are not overlapped. Two thicknesses are available to match drainage and water storage requirements: 25mm (1") and 40mm (1.5").



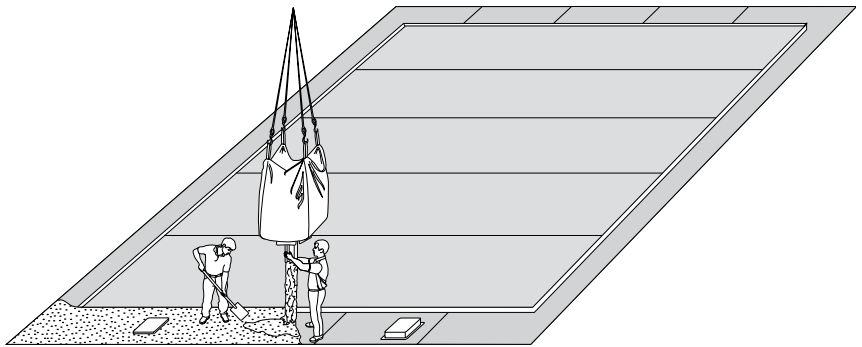
5. LAY SEPARATION FABRIC

Optigreen Separation Fabric is engineered to retain soil without clogging while allowing plant roots to easily penetrate to reach water in the drain plates. Unroll Optigreen Separation Fabric over the drain plates, overlapping adjacent sheets at least six inches. Trim the fabric carefully at the edges.



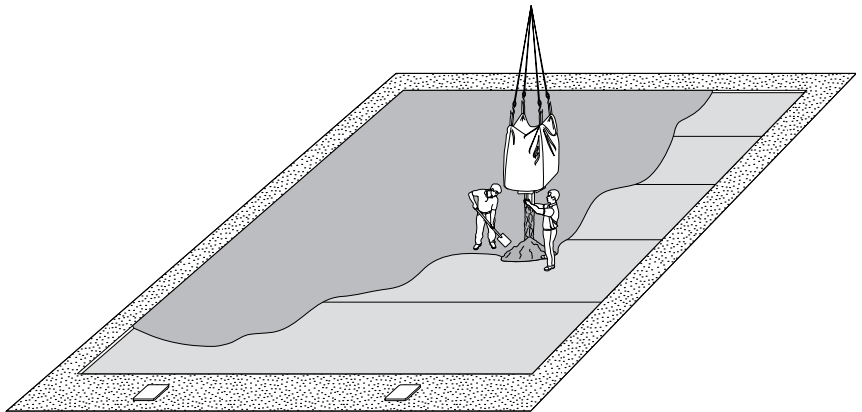
6. SPREAD GRAVEL PERIMETER

Spread well-washed gravel screened to 3/8" minimum particle size. Whenever possible, the gravel should be dispersed from supersacks suspended from cranes to minimize the potential for damage.



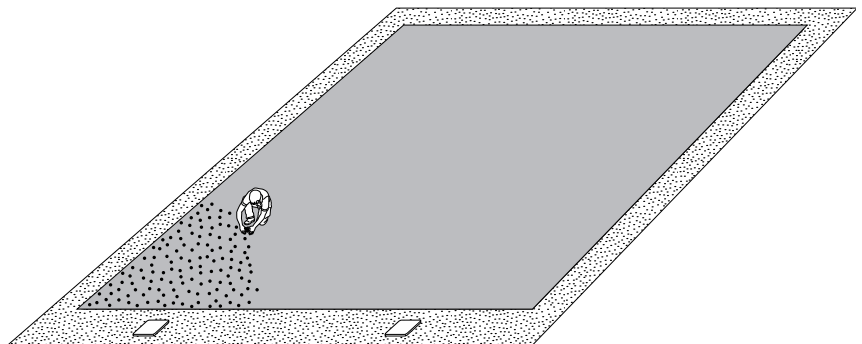
7. SPREAD SOIL

For extensive roofs, spread Optigreen Extensive Green Roof Soil at a minimum rate of one cubic yard per 100 square feet (3"). For intensive roofs, spread Optigreen Intensive Green Roof Soil as needed to obtain the required system thickness. Where possible, the media should be dispensed from supersacks suspended from cranes to minimize the potential for damage.



8. PLANT

Insert green roof plants in a random pattern, two per square foot. Water thoroughly after installation, and during extended dry periods for the first two years. Broadcast Optigreen Slow Release Fertilizer twice yearly on extensive roofs.

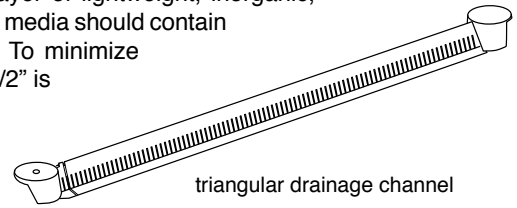


SYSTEMS WITH GRANULAR DRAINAGE

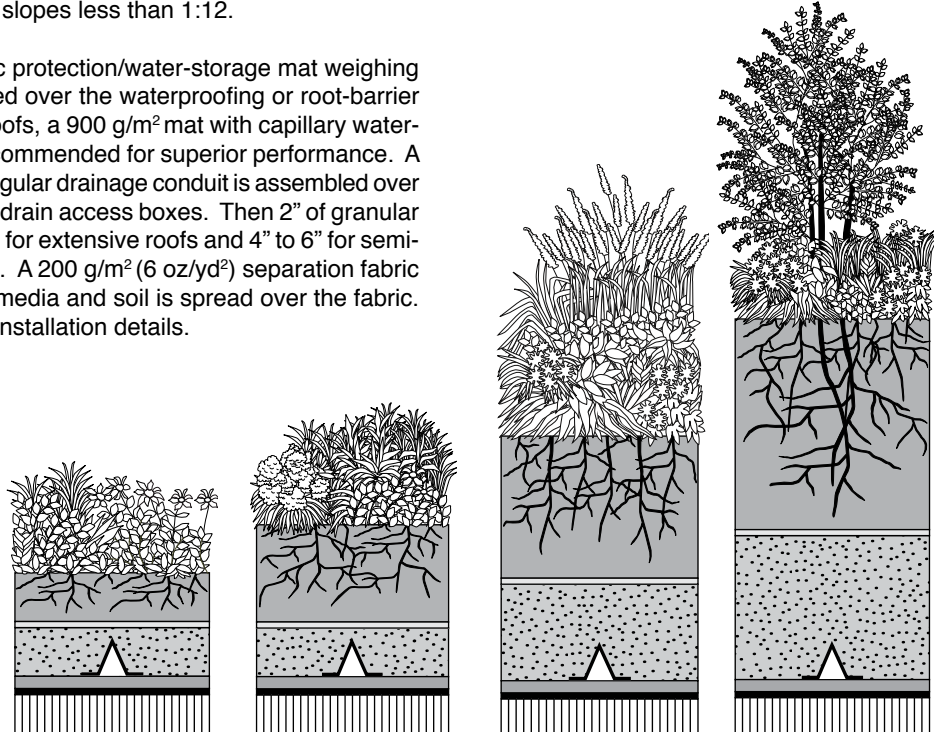
DESCRIPTION: Green roof systems of this type are drained by a base layer of lightweight, inorganic, granular media. To maximize water storage and minimize weight, the granular media should contain a significant percentage of porous material such as heat-expanded rock. To minimize separation, a well-graded blend of particles with sizes ranging from 1/8" to 1/2" is preferred. A slotted plastic drainage conduit with a triangular cross-section is embedded within the media to transport excess water.

APPLICATION: Although granular media is heavy and labor-intensive to install when compared with other drainage systems, it provides an optimal environment for plant root growth. Granular drainage is recommended for roofs with slopes less than 1:12.

COMPONENTS: A synthetic protection/water-storage mat weighing 900 g/m² (27 oz/yd²) is applied over the waterproofing or root-barrier membrane. For extensive roofs, a 900 g/m² mat with capillary water-equalization properties is recommended for superior performance. A network of slotted plastic triangular drainage conduit is assembled over the mat and connects to roof drain access boxes. Then 2" of granular media is spread over the mat for extensive roofs and 4" to 6" for semi-intensive and intensive roofs. A 200 g/m² (6 oz/yd²) separation fabric is applied over the granular media and soil is spread over the fabric. See the following pages for installation details.



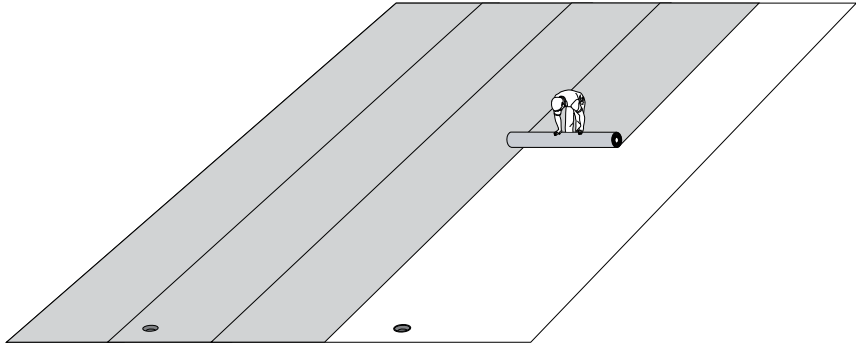
triangular drainage channel



system designation	G1	G2	G3	G4
typical plants	sedum herbs	sedum herbs perennials	perennials grasses shrubs	grasses shrubs trees
extensive soil mix	2"	4"	-	-
intensive soil mix	-	-	6"	9"
separation fabric	1/8"	1/8"	1/8"	1/8"
granular drainage	2"	2"	4"	5"
protection mat	1/4"	1/4"	1/4"	1/4"
nominal thickness	4"	6"	10"	14"
dry weight	16 lbs/ft ²	24 lbs/ft ²	40 lbs/ft ²	56 lbs/ft ²
saturated weight	23 lbs/ft ²	36 lbs/ft ²	58 lbs/ft ²	82 lbs/ft ²
minimum slope	0:12	0:12	0:12	0:12
maximum slope	1:12	1:12	1:12	1:12
water retention	50%	60%	70%	80%

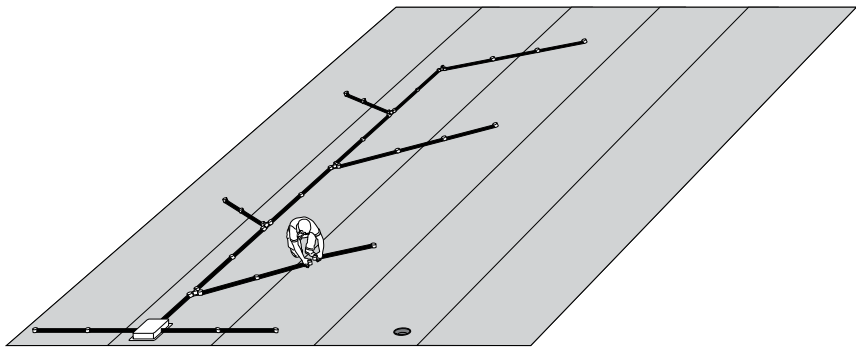
1. LAY PROTECTION MAT

If the primary roof waterproofing is not root resistant, first apply a root barrier membrane. Then unroll a protection mat with water-storage capacity, overlapping adjacent sheets at least six inches, and cut openings for roof drains. Use Optigreen Standard Protection Mat, or for optimal performance use Optigreen Capillary Protection Mat for extensive roofs and Optigreen Heavy-Duty Protection Mat for intensive roofs.



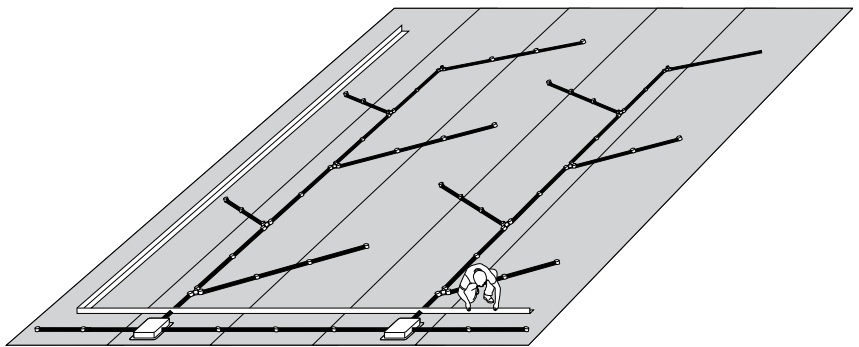
2. INSTALL DRAINAGE SYSTEM

Position Optigreen Drain Access Boxes over roof drains, adding sidewall elements as needed to match the system thickness. Construct drainage “trees” using Optigreen triangular drainage channels and tees. For optimum performance, any point on the roof should be within two channel lengths of the closest point of the drainage tree: this will be achieved if the “branches” of each drainage tree are laid four channel lengths (4 meters or 13 feet) apart.



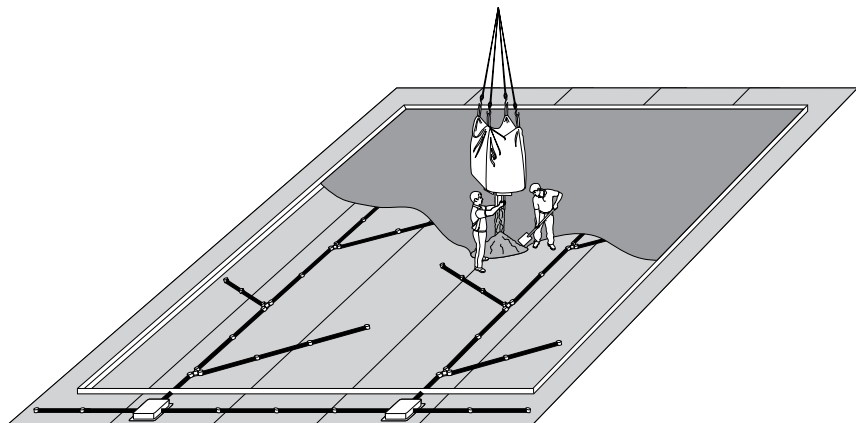
3. INSTALL RETAINING EDGE

Optigreen Retaining Edge should be installed on extensive green roofs approximately 30” from roof edges with roof drains and 18” from other edges. If there will be a gravel perimeter, the retaining edge will separate the soil and gravel and does not need to be attached. If there will be no gravel perimeter, the retaining edge should be attached to the waterproofing membrane or the protection mat so it will stay in place.



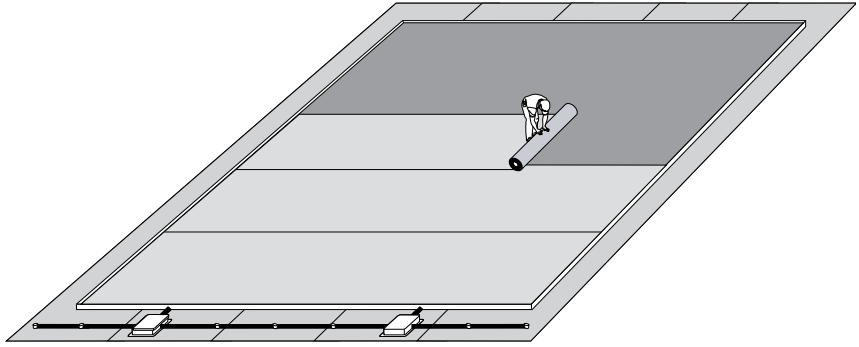
4. SPREAD GRANULAR MEDIA

Spread Optigreen Granular Drainage Media or other free-draining inorganic media with well-graded particle size and neutral pH. Apply a minimum of one cubic yard per 150 square feet (2”) for extensive or semi-intensive roofs and one cubic yard per 75 square feet (4”) for intensive roofs. If feasible, the media should be dispensed from supersacks suspended from cranes to minimize the potential for damage.



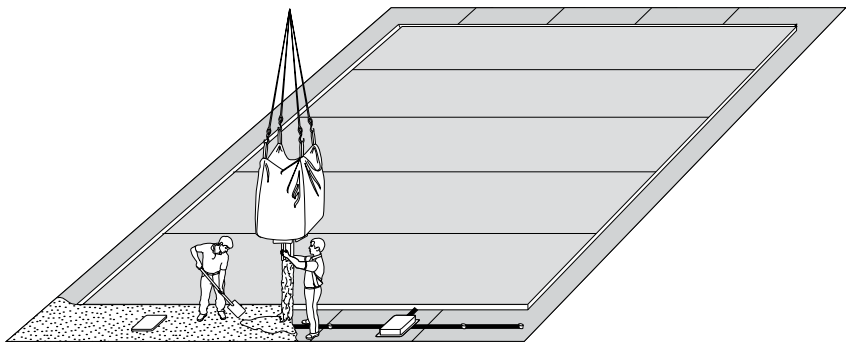
5. LAY SEPARATION FABRIC

Optigreen Separation Fabric is engineered to retain soil without clogging while allowing plant roots to easily penetrate to reach water in the granular media and protection mat. Unroll Optigreen Separation Fabric over the granular media, overlapping adjacent sheets at least six inches. Trim the fabric carefully at the edges.



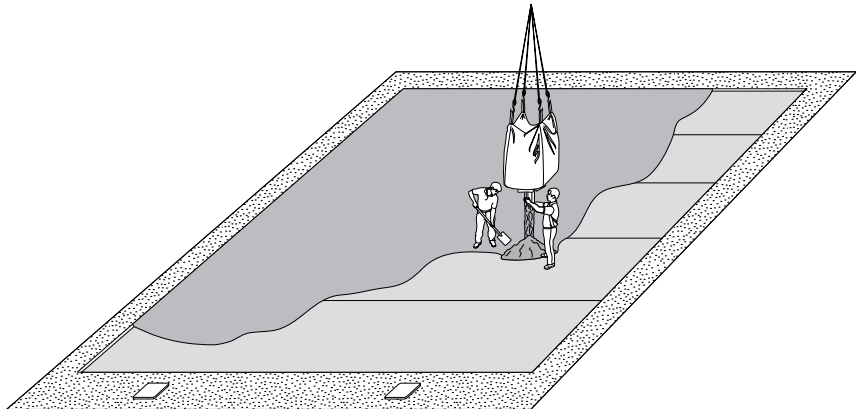
6. SPREAD GRAVEL PERIMETER

Spread well-washed gravel screened to 3/8" minimum particle size. If feasible, the gravel should be dispensed from supersacks suspended from cranes to minimize the potential for damage.



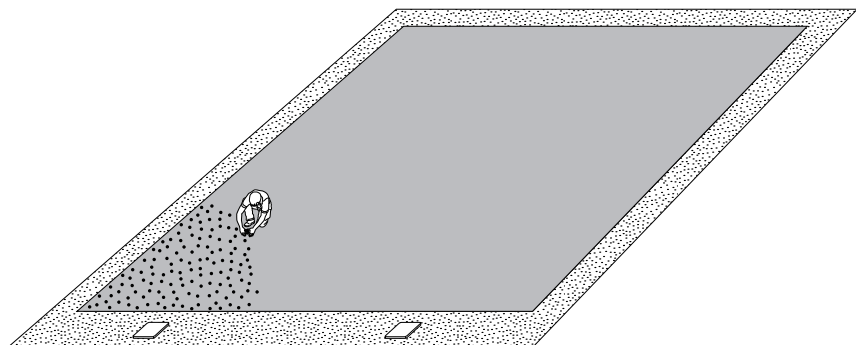
7. SPREAD SOIL

For extensive roofs, spread Optigreen Extensive Green Roof Soil at a minimum rate of one cubic yard per 150 square feet (2"). For intensive roofs, spread Optigreen Intensive Green Roof Soil as needed to obtain the required system thickness. Where possible, the media should be dispensed from supersacks suspended from cranes to minimize the potential for damage.



8. PLANT

Insert green roof plants in a random pattern, two per square foot. Water thoroughly after installation, and during extended dry periods for the first two years. Broadcast Optigreen Slow Release Fertilizer twice yearly on extensive roofs.



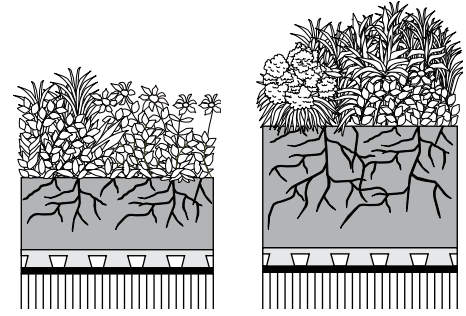
SYSTEMS WITH DRAINAGE MATS

DESCRIPTION: Green roof systems of this type are drained by a multi-layer fabric mat called *drainage mat* that combines soil separation, drainage, and protection functions. Compared with green roofs systems using drainage plates or granular drainage, this system is the fastest to install and creates the thinnest and lightest green roof assembly. However, its water storage and drainage capacity is limited, so it is primarily used for sloped roofs not suitable for Drainage Type P or Type G.

APPLICATION: Drainage mats are only recommended for roofs with slopes greater than 1:12. For this reason, they are frequently used for residential green roofs.

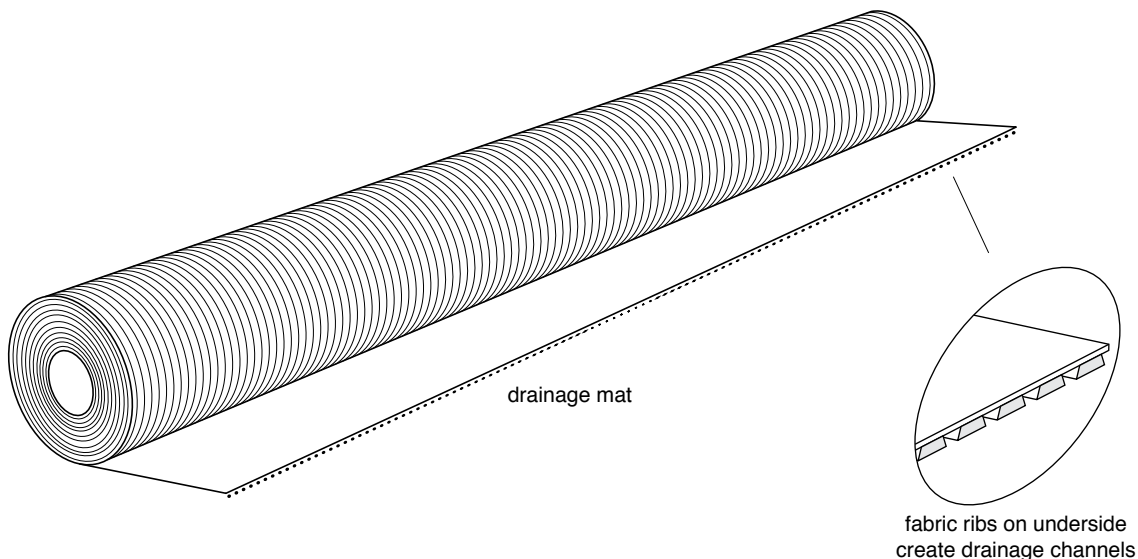
COMPONENTS: A synthetic protection/water-storage mat weighing 500 g/m² (15 oz/yd²) is applied around the perimeter of the roof over the waterproofing or root-barrier membrane. Drainage mat is laid over the protection mat and the remainder of the roof with the ribbed drainage channels following the roof slope. Finally, soil is spread over the drainage mat. See the following pages for installation details.

If the roof slope exceeds 2:12, a mechanical slope stabilization product is installed over the drainage mat. If the roof slope exceeds 3:12, the drainage mat should be mechanically fastened at the high end of the roof.



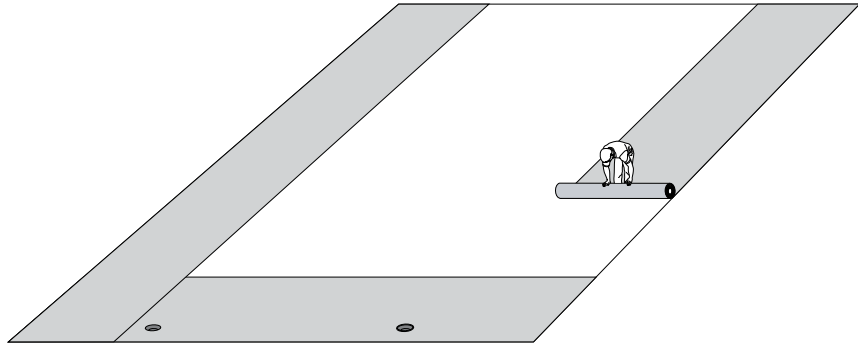
system designation	M1	M2
typical plants	sedum herbs	sedum herbs perennials
extensive soil mix	3"	5"
drainage mat	3/8"	3/8"
protection mat	*	*
nominal thickness	3"	5"
dry weight	13 lbs/ft ²	21 lbs/ft ²
saturated weight	20 lbs/ft ²	32 lbs/ft ²
minimum slope	1:12	1:12
maximum slope	3:12	3:12
water retention	50%	60%

* protection mat only used at edges



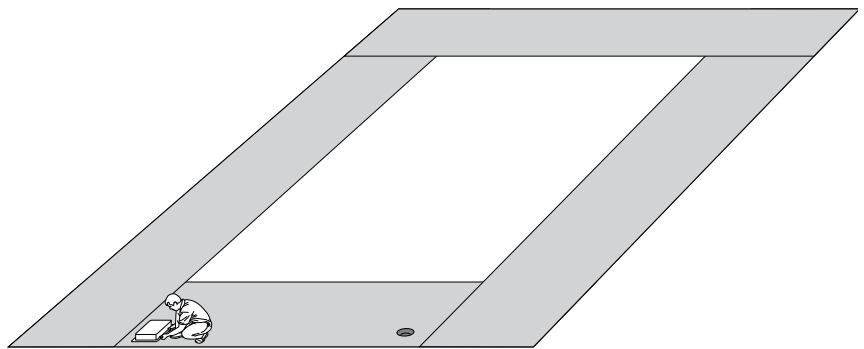
1. LAY PROTECTION MAT

If the primary roof waterproofing is not root resistant, first apply a root barrier membrane. Then unroll a protection mat around the roof perimeter and cut openings for roof drains. Although Optigreen Standard Protection Mat is suitable for the sides and top of the roof, Optigreen Capillary Protection Mat is preferred for the base of the roof to prevent water accumulation.



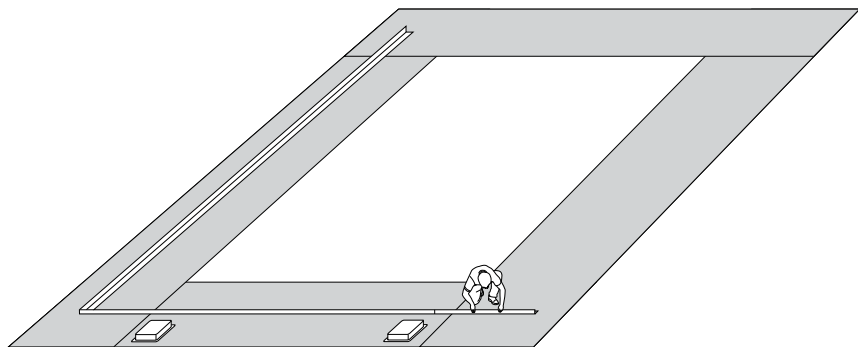
2. INSTALL DRAIN ACCESS BOXES

Position Optigreen Drain Access Boxes over roof drains. On sloped roofs that use scuppers instead of roof drains, Drain Access Boxes are not required.



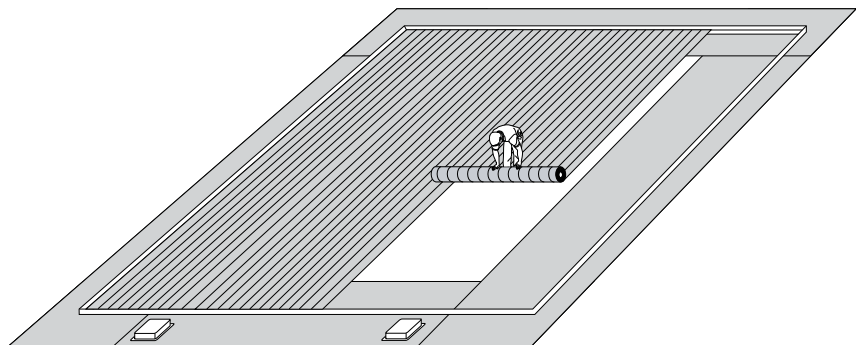
3. INSTALL RETAINING EDGE

Optigreen Retaining Edge should be installed approximately 30" from roof edges with roof drains and 18" from other edges. If there will be a gravel perimeter, the retaining edge will separate the soil and gravel and does not need to be attached. If there will be no gravel perimeter, the retaining edge must be attached to the waterproofing membrane or the protection mat. If there will be no gravel perimeter, the Retaining Edge should be attached to the waterproofing membrane or the protection mat so it will stay in place.



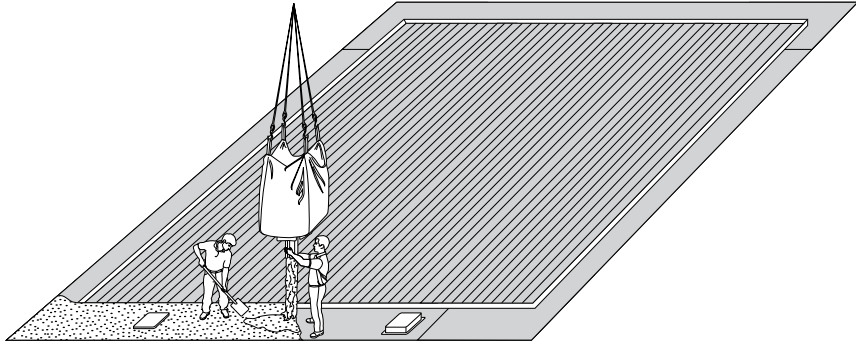
4. LAY DRAINAGE MAT

Unroll Optigreen Drainage Mat, overlapping adjacent sheets at least six inches. This mat combines the functions of protection, water storage, and drainage in one product.



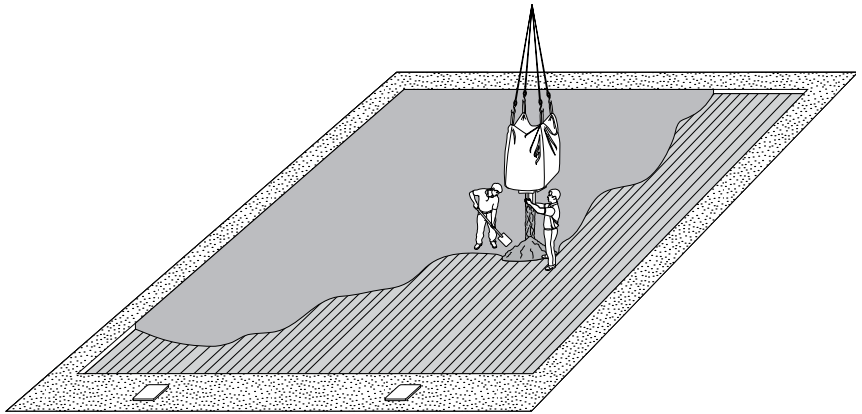
5. SPREAD GRAVEL PERIMETER

Spread well-washed gravel screened to 3/8" minimum particle size. If feasible, the gravel should be dispensed from supersacks suspended from cranes to minimize the potential for damage.



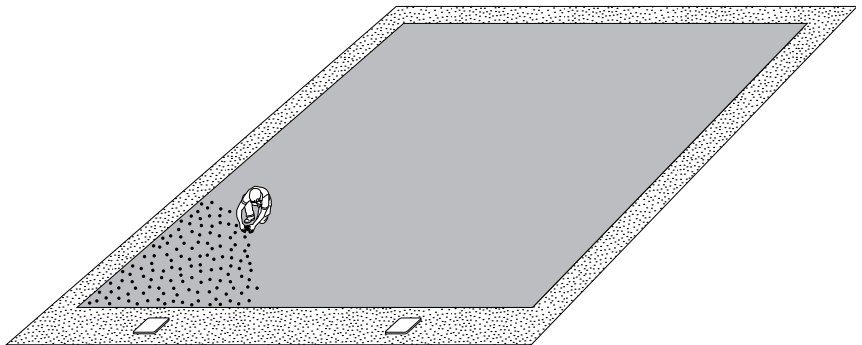
6. SPREAD SOIL

Spread Optigreen Extensive Green Roof Soil at a minimum rate of one cubic yard per 100 square feet (3"). Where possible, the media should be dispensed from supersacks suspended from cranes to minimize the potential for damage.



7. PLANT

Insert green roof plants in a random pattern, two per square foot. Water thoroughly after installation, and during extended dry periods for the first two years. Broadcast Optigreen Slow Release Fertilizer twice yearly on extensive roofs.

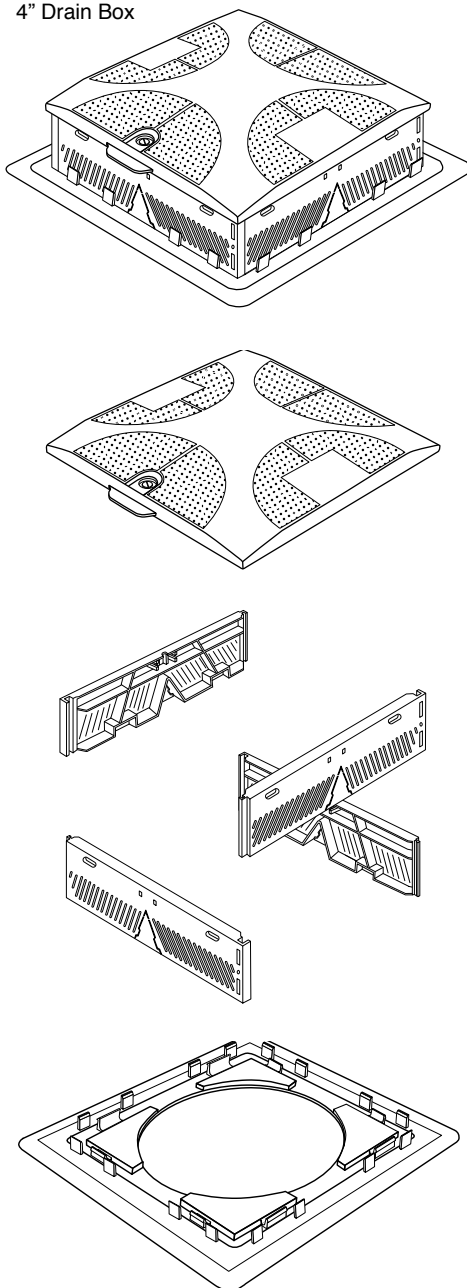


DRAIN BOXES

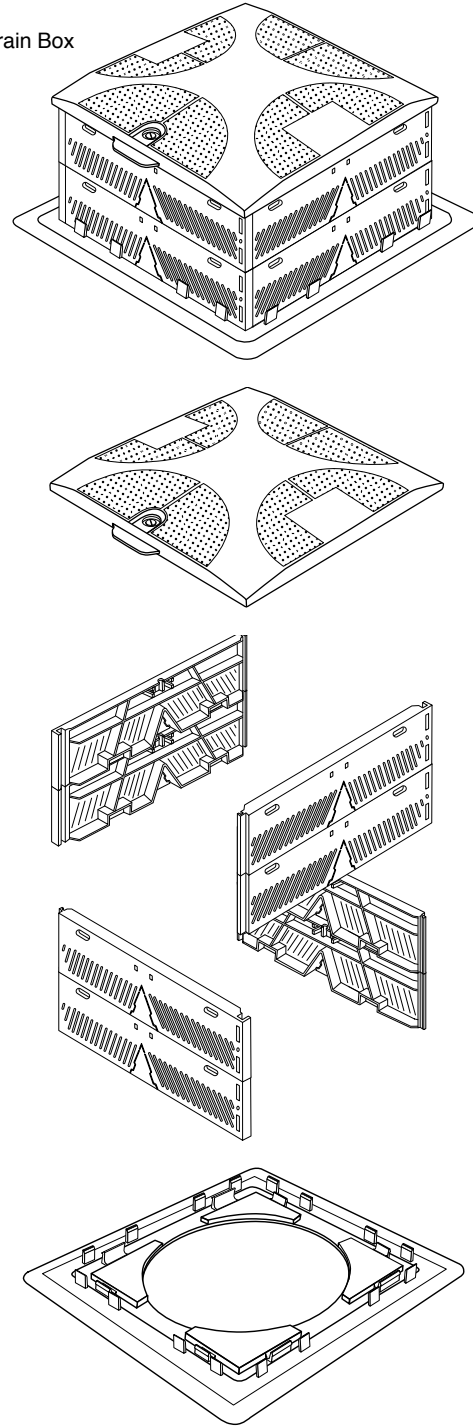
Optigreen Drain Boxes prevent soil and granular drainage media from entering roof drains but allow water to flow freely through slots covering the sides and top. Their modular design accommodates extensive, semi-intensive, and intensive green roof systems from 4" to 32" thick. A 12" hole in the base of the box fits over most membrane roof drains. Triangular knockouts in each sidewall panel allow easy connection to Optigreen Triangular Drainage Channels used for green roof systems with granular media drainage. The Drain Boxes are made of black ABS plastic that is unaffected by extremes in temperature.

ASSEMBLY: A Drain Box consists of a top cover, a bottom plate, and as many sidewall panels as needed to obtain the required height. Each sidewall panel consists of four 4" elements molded together and can be snapped apart to yield one, two, or three elements. Sidewall elements can be stacked provided joints on adjacent sides are staggered. Assemblies taller than 16" should be screwed together through the holes provided at each corner.

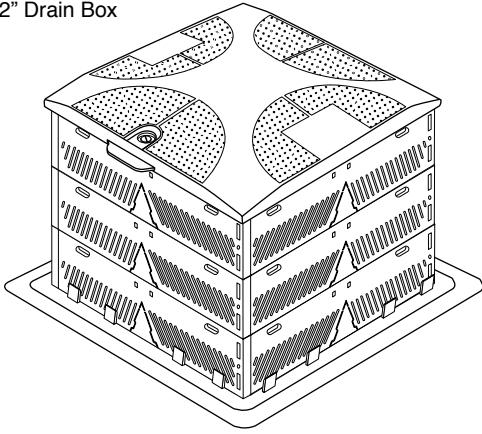
4" Drain Box



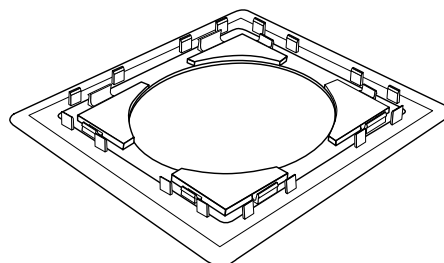
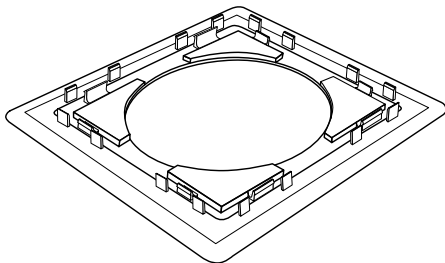
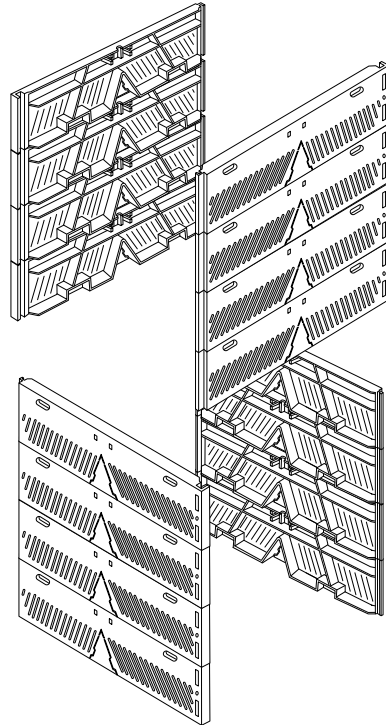
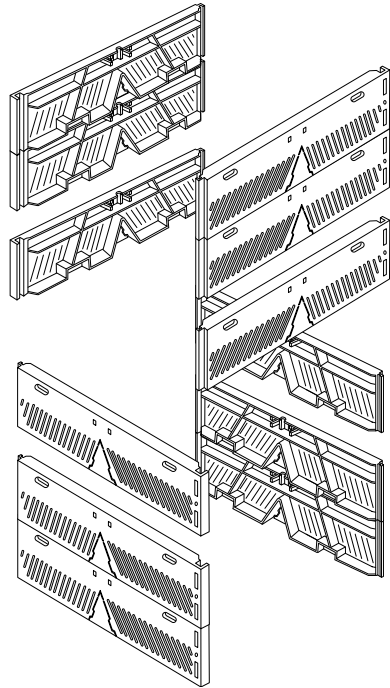
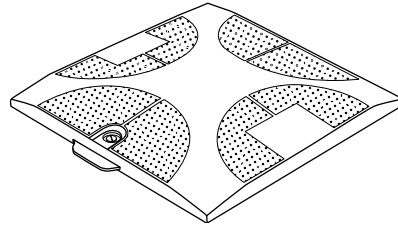
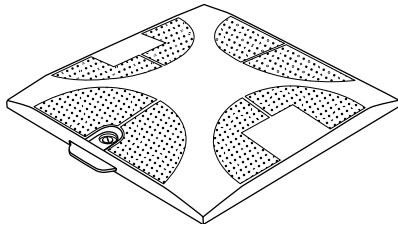
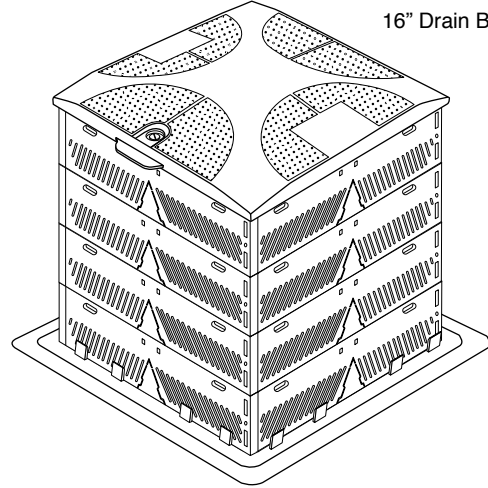
8" Drain Box



12" Drain Box



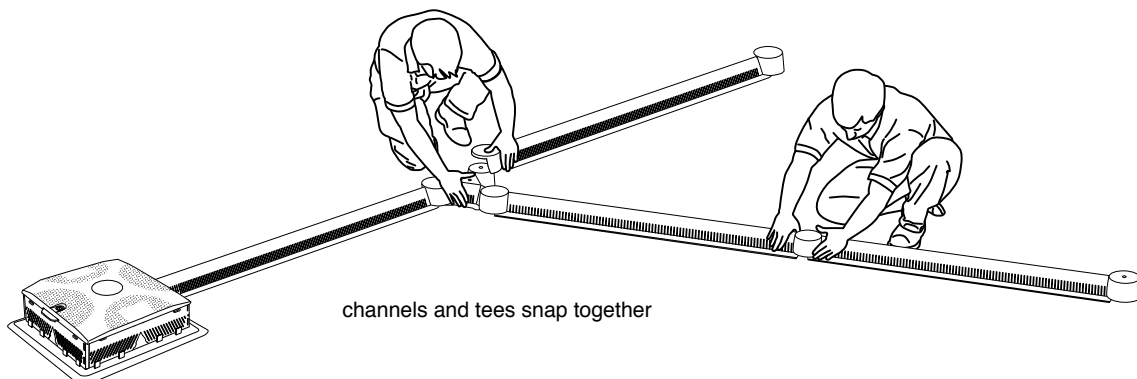
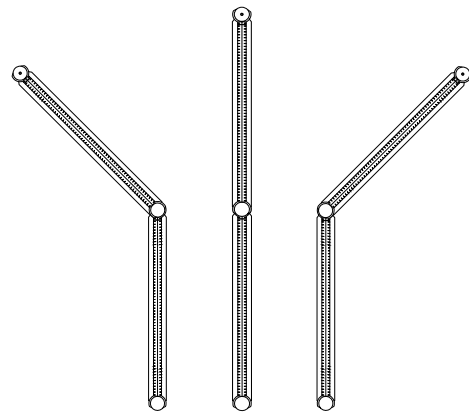
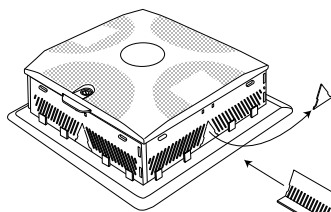
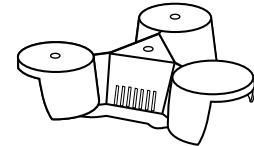
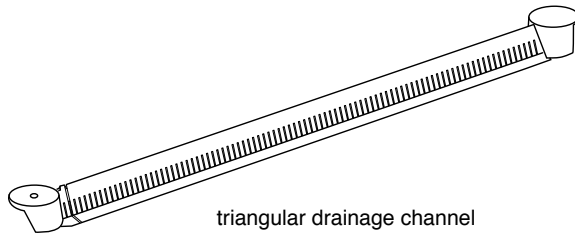
16" Drain Box

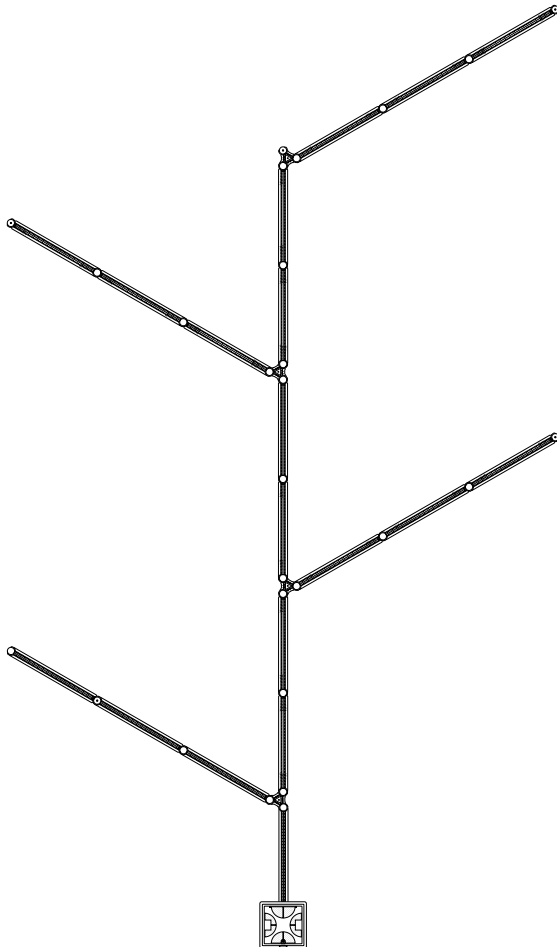


TRIANGULAR DRAINAGE CHANNELS

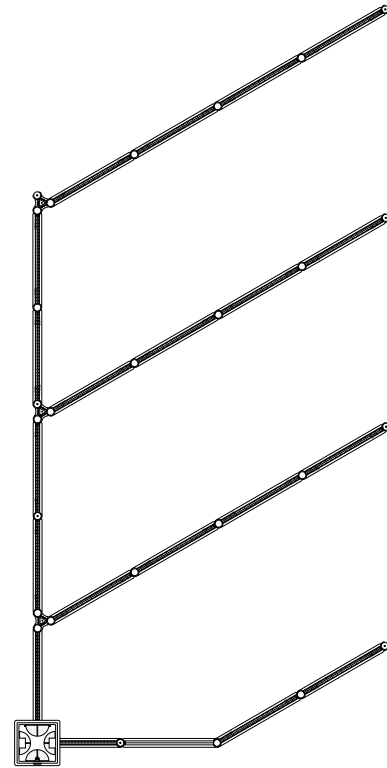
Optigreen Triangular Drainage Channel is embedded in granular drainage media in order to carry excess water to roof drains or scuppers. Each element is 1m (40") long and 50mm (2") tall. The unique triangular cross-section provides optimal surface area and prevents the channel from floating upward. Interlocking ends allow 90° rotation.

SYSTEM DESIGN: The illustrations that follow show typical drainage channel manifolds. For optimum performance, every point on the roof should be within two channel lengths of a drain channel: this will require at least one channel for every 50 square feet of roof area.

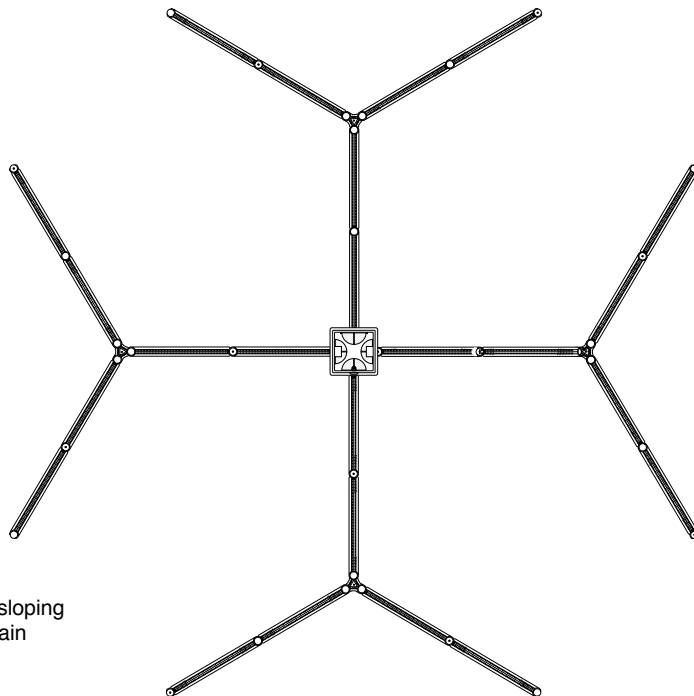




single-plane roof sloping to drain at edge of roof



single-plane roof sloping to drain at corner of roof

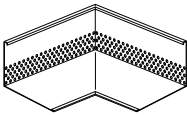
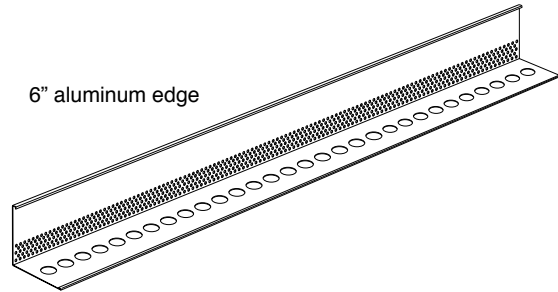
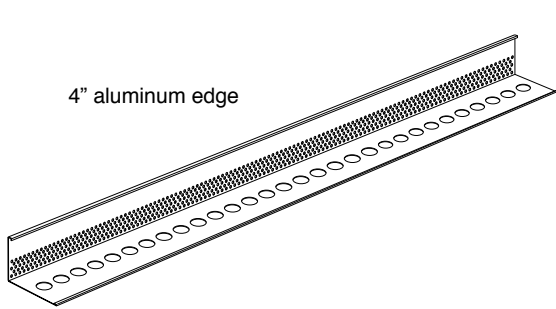


four-plane roof sloping to center drain

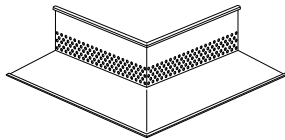
ALUMINUM EDGE

Optigreen Aluminum Edge is used to retain soil at roof edges, to separate soil from gravel borders, and to separate soil from paved areas. Hundreds of small holes are punched on the vertical leg to provide ample drainage while retaining soil. Two standard heights are available: 4" (100mm) and 6" (150mm). Both are made from a 60 mil (1.5mm) high-strength aluminum alloy, and both have a 6" (150mm) extra-wide base flange for stability. The flange can also be taped or welded to underlying membranes or fabrics through the large holes provided.

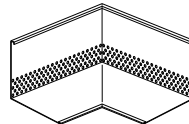
Aluminum Edge is supplied in 79" (2m) lengths. Multiple edges are joined by connectors that slide into folds in their edges, and welded corners with both inside and outside flanges join with the same connectors to provide strong, attractive corners.



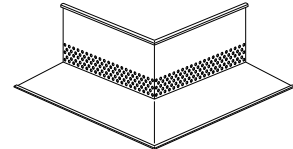
4" corner with inside flange



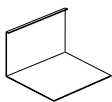
4" corner with outside flange



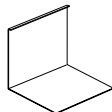
6" corner with inside flange



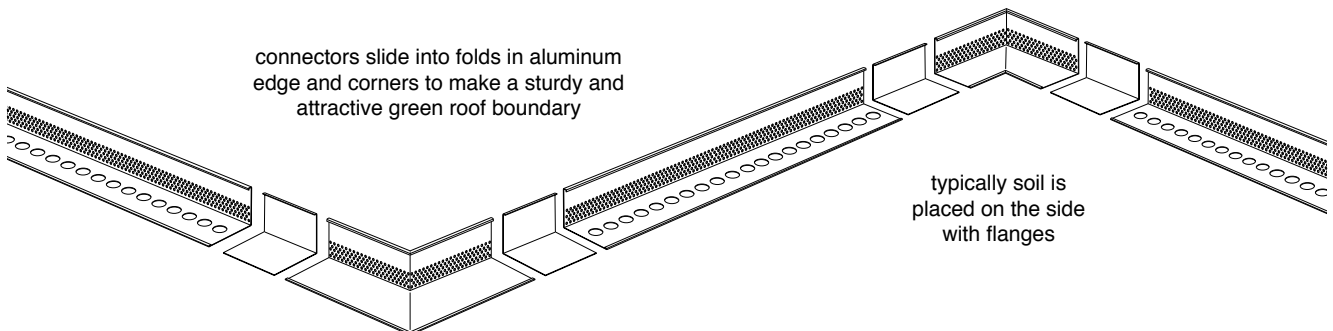
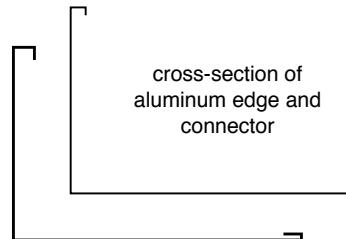
6" corner with outside flange



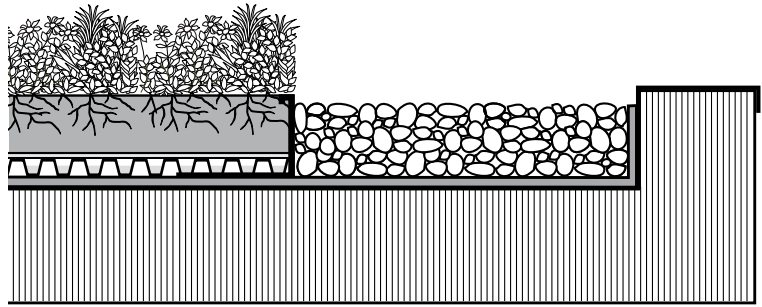
4" connector



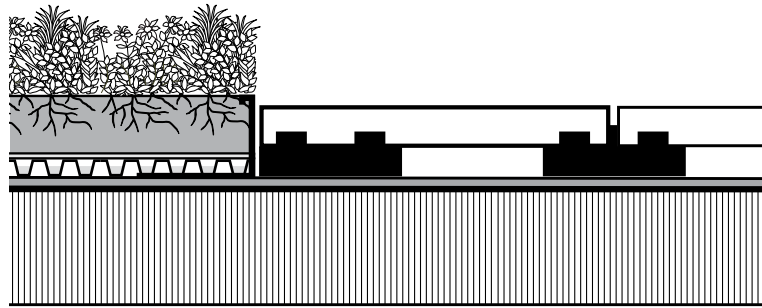
6" connector



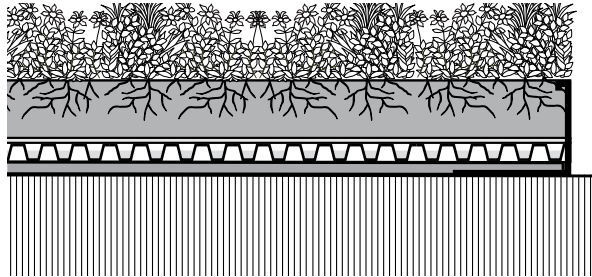
Optigreen Aluminum Edge can be used to separate green roof soil from a gravel edge band.



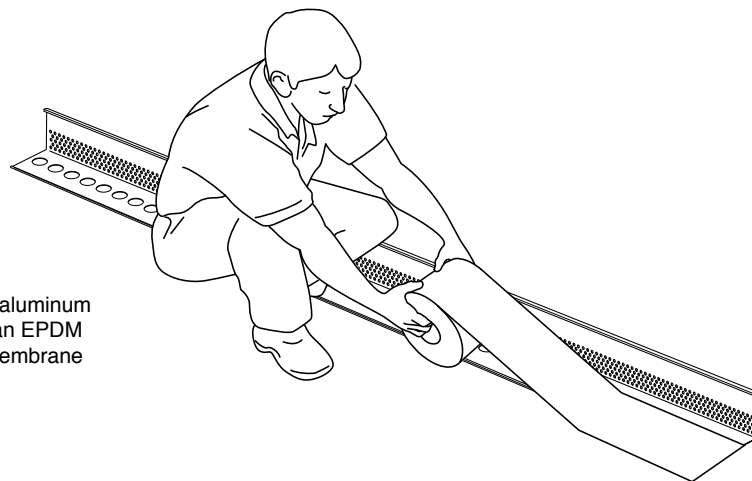
Optigreen Aluminum Edge can be used to separate green roof soil from a paver deck (shown here supported on paver pedestals).



Optigreen Aluminum Edge can be used to retain green roof soil at the edge of a roof. The aluminum edge can be secured to waterproofing membranes or root barrier membranes with cold-applied tapes, heat-applied strips or liquids sealers.



taping an aluminum edge to an EPDM rubber membrane

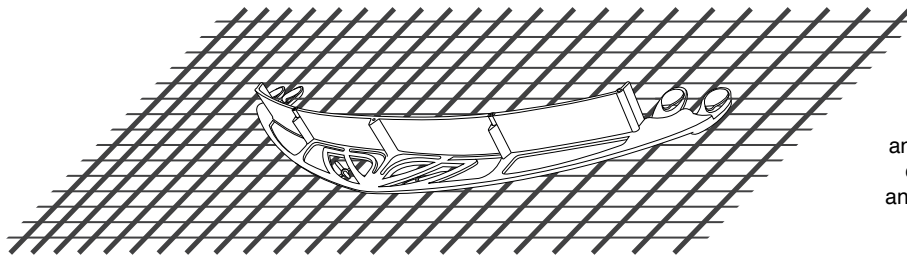
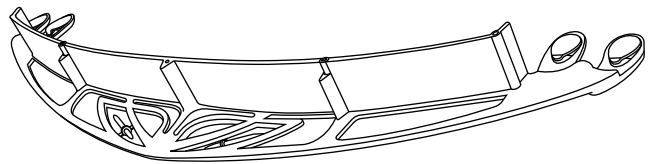


SLOPE STABILIZATION

When roof slopes reach 2:12, or approximately 10°, special precautions must be taken to prevent soil from sliding down the roof. Root-resistant waterproofing membranes must be fully adhered to the underlying roof structure: independent root barriers or floating membranes are not recommended. Optigreen Drainage Mat is used in place of Drainage Plates or other plastic drainage substrates that cannot withstand the shear stresses on slopes. When slopes reach 3:12, or approximately 15°, it is essential to use a mechanical slope stabilization system. We offer two basic types to accommodate different roof architecture: one system transfers soil loads up the roof and one transfers soil loads down the roof.

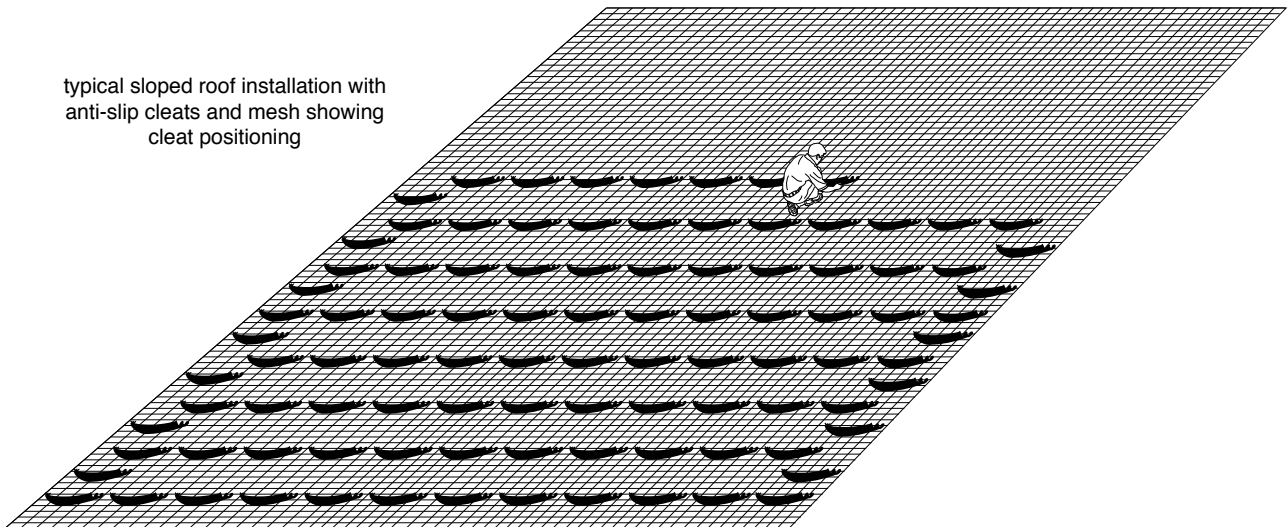
ANTI-SLIP CLEATS AND MESH: This system offers a simple and inexpensive means to prevent soil sliding by transferring soil loads up the roof. Optigreen Anti-Slip Mesh is simply laid over Optigreen Drainage Mat and Optigreen Anti-Slip Cleats are clipped onto the mesh. The high-strength structural plastic mesh is mechanically fastened at the top of the roof, or if the roof is gabled or barrel-shaped one side of the roof can be used to balance the opposite side. The row spacing of the banana-shaped plastic cleats varies from 10" to 50" depending on the roof slope. To distribute load on the mesh each row is shifted one-quarter cleat from the row above and below and extra cleats are inserted between rows at edges to fill the voids.

anti-slip cleat

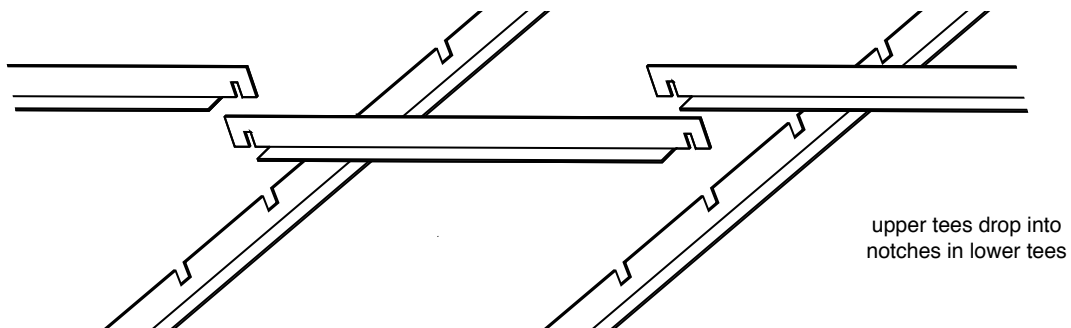
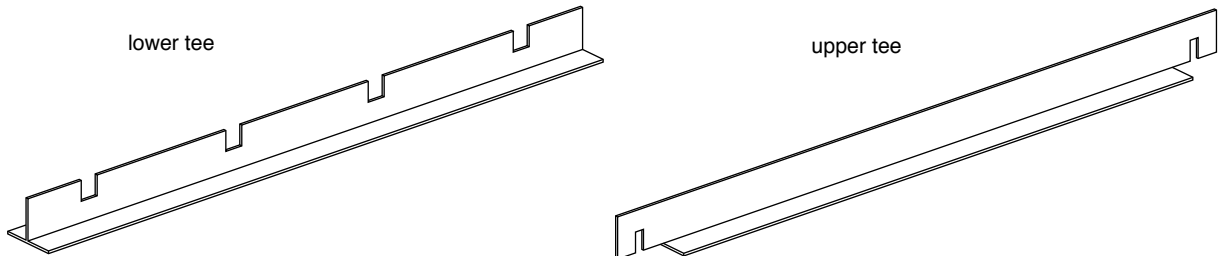


anti-slip cleat
clipped to
anti-slip mesh

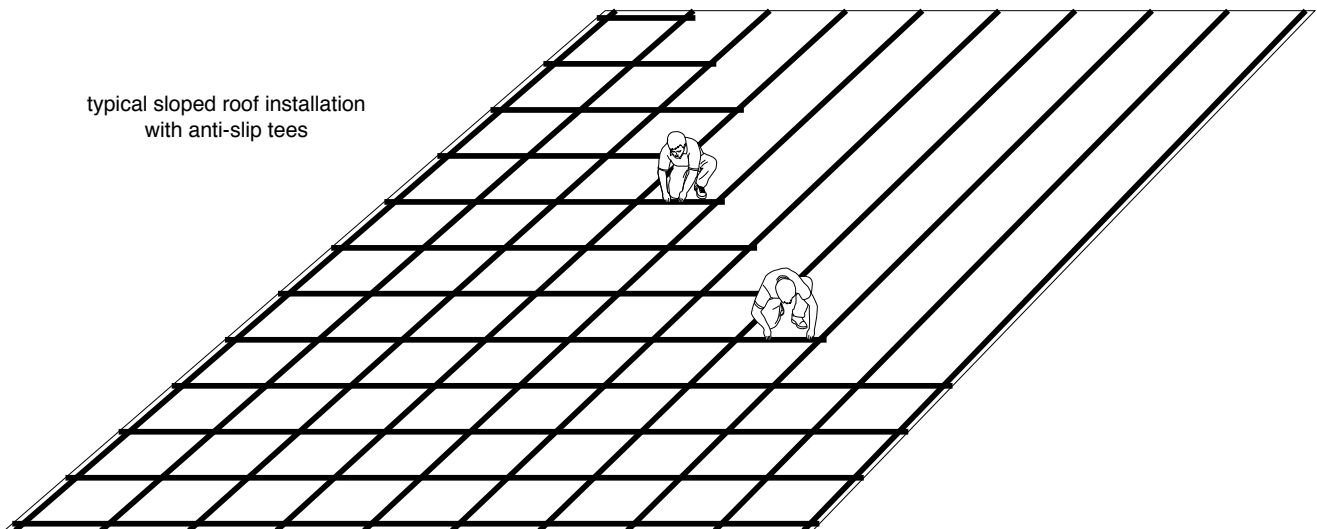
typical sloped roof installation with
anti-slip cleats and mesh showing
cleat positioning



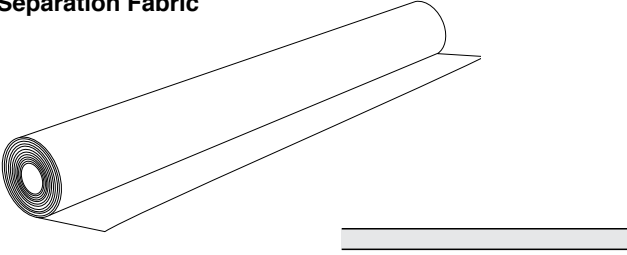
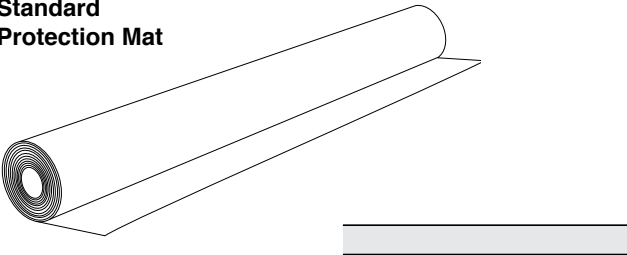
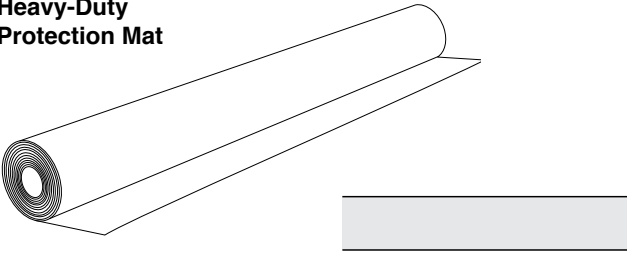
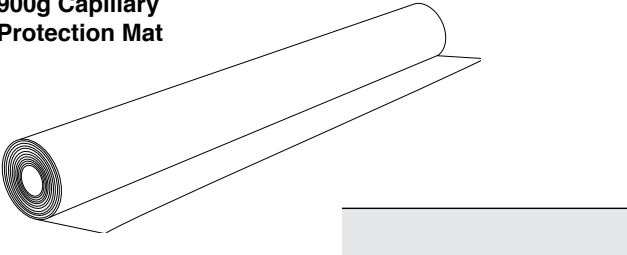
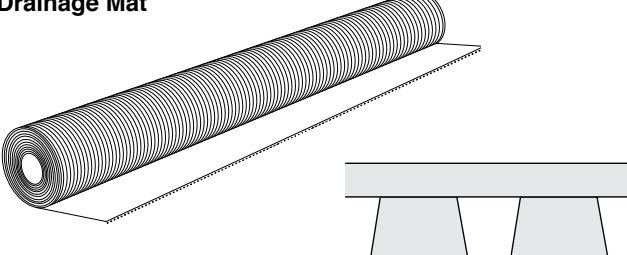
ANTI-SLIP TEES: In contrast with the cleat/mesh system, The Optigreen Anti-Slip Tee system transfers soil load down the roof to a structural parapet or fascia at the bottom of the roof slope. The system consists of two interlocking T-shaped plastic extrusions: the lower one follows the slope of the roof and the upper one crosses the slope of the roof. The lower tees are spaced approximately one meter (40") apart and the spacing of the upper tees varies from 10" to 50" depending on the roof slope.



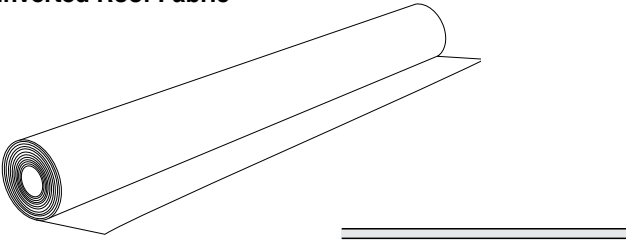
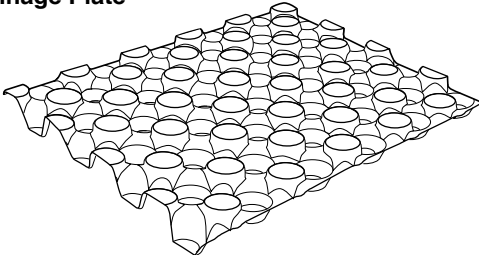
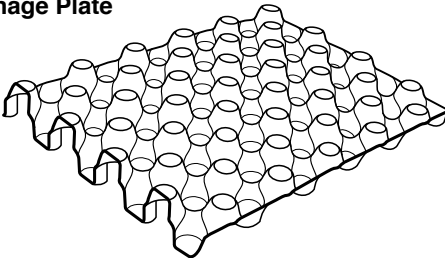
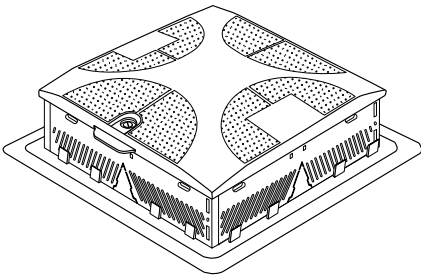
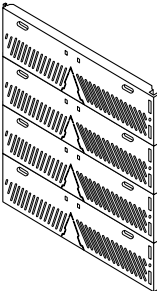
typical sloped roof installation
with anti-slip tees



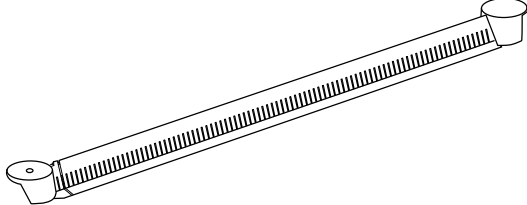
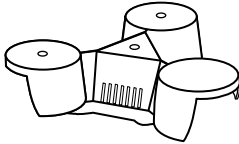
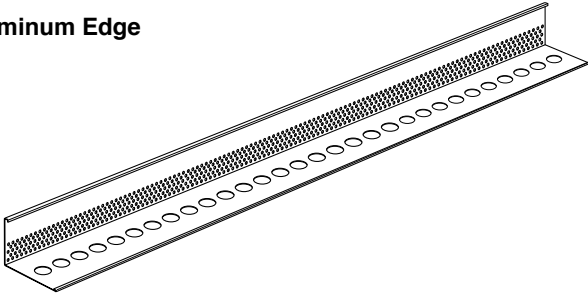
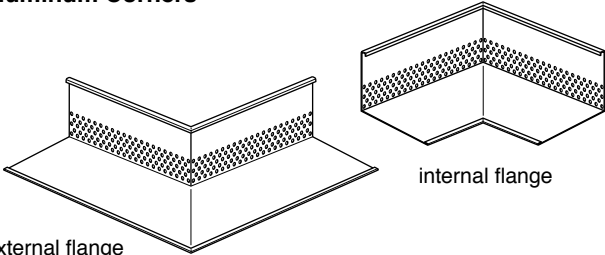
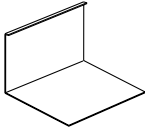
GREEN ROOF COMPONENTS

ILLUSTRATION	DESCRIPTION
<p>Separation Fabric</p> 	<p>Optigreen Separation Fabric is a non-woven geotextile made from recycled polypropylene. Since it is significantly less likely to clog than common filter fabrics, it is ideal for separating green roof soils from underlying drainage media or drainage plates. Optigreen Separation Fabric weighs approximately 200 g/m² (6 oz/yd²). Rolls measure 2m x 25m (6'8" x 82') and cover approximately 500 square feet of roof with a 15 cm (6") overlap.</p>
<p>Standard Protection Mat</p> 	<p>Optigreen Standard Protection Mat is a non-woven geotextile made from recycled polypropylene. It is puncture resistant and has a water storage capacity of 4 l/m² (0.10 gal/ft²), making it ideal for protection and supplemental water storage under plastic drainage plates. Optigreen Standard Protection Mat weighs 500 g/m² (15 oz/yd²). Rolls measure 2m x 25m (6'8" x 82') and cover approximately 500 square feet of roof with a 15cm (6") overlap.</p>
<p>Heavy-Duty Protection Mat</p> 	<p>Optigreen Heavy-Duty Protection Mat is a non-woven geotextile made from recycled polypropylene. It is extremely puncture resistant and has a water storage capacity of 6 l/m² (0.15 gal/ft²), making it ideal for protection and supplemental water storage under granular drainage media. Optigreen Heavy-Duty Protection Mat weighs 900 g/m² (27 oz/yd²). Rolls measure 2m x 15m (6'8" x 49') and cover approximately 300 square feet of roof with a 15cm (6") overlap.</p>
<p>900g Capillary Protection Mat</p> 	<p>Optigreen Capillary Protection Mat is a non-woven geotextile made from a blend of rayon and recycled polypropylene. It has an exceptional water storage capacity of 9 l/m² (0.22 gal/ft²) and can wick water and distribute it evenly, making it ideal for use under granular drainage media on extensive roofs. Optigreen Capillary Protection Mat weighs 900 g/m² (27 oz/yd²); rolls measure 2m x 15m (6'8" x 49') and cover 300 square feet of roof a 15cm (6") overlap.</p>
<p>Drainage Mat</p> 	<p>Optigreen Drainage Mat is a multi-layer fabric mat made from a blend of polypropylene and acrylic. It combines the functions of a separation fabric, protection mat, and drainage system into one product with a water storage capacity of 6 l/m² (0.15 gal/ft²). It is ideal for use on extensive roofs with slopes from 1:12 to 3:12. Optigreen Drainage Mat weighs 800 g/m² (24 oz/yd²); rolls measure 2m x 10m (6'8" x 33') and cover 200 square feet of roof with a 15cm (6") overlap.</p>

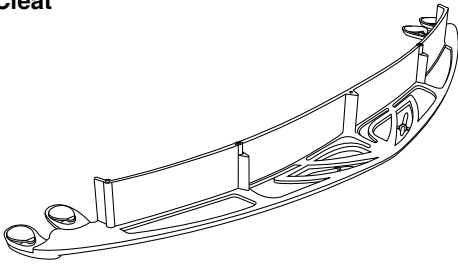
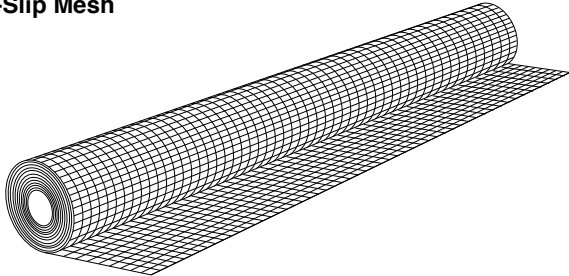
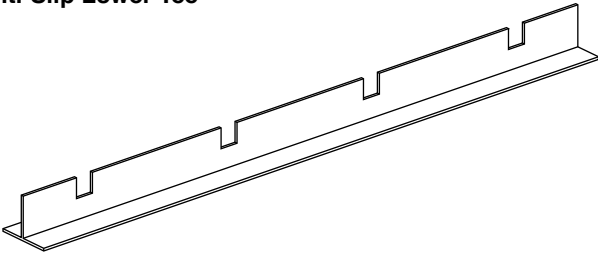
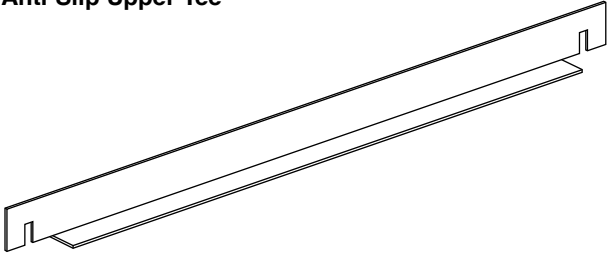

GREEN ROOF COMPONENTS

ILLUSTRATION	DESCRIPTION
<p>Inverted Roof Fabric</p> 	<p>Optigreen Inverted Roof Fabric is a non-woven geotextile specially designed for use over high-density extruded polystyrene insulation that is applied over a waterproofing membrane. It prevents soil from penetrating the insulation, but it is breathable and does not hold water that could lead to loss of thermal value in the insulation. Rolls measure 2.25m x 100m (7'6" x 328') and cover 2300 square feet of roof with a 15 cm (6") overlap.</p>
<p>25mm Drainage Plate</p> 	<p>Optigreen 25mm (1") Drainage Plate is a waffled plastic sheet made of recycled polypropylene. The upper side of the sheet stores 5 l/m² water (0.12 gal/ft²) and the lower space serves as a high-volume drainage passageway. Water only fills to the midpoint of the sheet, leaving an air gap under the separation fabric. Sheets measure 1m x 2m (40" x 80") and cover approximately 21.5 square feet of roof, or 20 square feet of roof with a minimal overlap.</p>
<p>40mm Drainage Plate</p> 	<p>Optigreen 40mm (1-1/2") Drainage Plate is a waffled plastic sheet made of recycled polypropylene. The upper side of the sheet stores 7 l/m² water (0.17 gal/ft²) and the lower space serves as a high-volume drainage passageway. Water only fills to the midpoint of the sheet, leaving an air gap under the separation fabric. Sheets measure 1m x 2m (40" x 80") and cover approximately 21.5 square feet of roof, or 20 square feet of roof with a minimal overlap.</p>
<p>Drain Box</p> 	<p>Optigreen Drain Box is a sturdy plastic roof drain cover made of black recycled ABS. Slots on the sides and top allow water to flow freely but retain soil and drainage media. A 12" (30cm) diameter hole in the base plate provides unobstructed drain access. Each Drain Box includes a top, base, and set of 4" (10cm) sidewall elements. Additional sidewall extensions allow heights up to 32" (80cm) in 4" increments to accommodate any extensive or intensive roof.</p>
<p>Drain Box Sidewall Extension</p> 	<p>Optigreen Sidewall Extensions, made of black recycled ABS plastic, can be separated or stacked to extend the height of Optigreen Drain Boxes up to 32" (80cm). Each extension consists of four 4" (10 cm) sections that are molded together but can be separated as needed. When extensions are stacked, joints on adjacent sides must be staggered. Assemblies taller than 16" (40cm) should be screwed together through the holes provided at each corner.</p>

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<p>Triangular Drainage Channel</p> 	<p>Optigreen Triangular Drainage Channels are black recycled ABS plastic drainage elements with rows of slots on each side. They can be embedded in granular drainage media in order to carry excess water to roof drains or scuppers, and can also be used in reverse for flood irrigation of intensive roof systems with granular media. Each element is 1m (40") long and 50mm (2") tall. The unique triangular cross-section provides optimal surface area and prevents the channel from floating upward. Interlocking ends permit 45° rotation to the left or right.</p>
<p>Triangle Tee</p> 	<p>Optigreen Triangle Tees are black recycled ABS plastic drainage elements with slotted sides and round end connectors. They are used to join Optigreen Triangular Drainage Channels in order to make drainage manifolds. The unique end design permits 45° rotation to the left or right and requires no tools for assembly. Optigreen Triangle Tees share the unique triangular cross-section of the channels to prevent upward flotation in granular media when used on extensive roofs.</p>
<p>Aluminum Edge</p> 	<p>Optigreen Aluminum Edge is made from a 1.5mm (0.060") tempered aluminum alloy. It is used to retain soil and at roof edges or to separate soil from gravel and pavers. Holes on the vertical leg provide ample drainage while retaining soil. It is available in 2m (6'8") lengths in heights of 100mm (4"), and 150mm (6"), both with extra-wide 150mm (6") bases punched with large holes to permit taping or welding to underlying membranes.</p>
<p>Aluminum Corners</p> 	<p>Optigreen Aluminum Corners are made from a 1.5mm (0.060") tempered aluminum alloy. They are used to make strong, attractive 90° connections with Optigreen Aluminum Edge. They are available in heights of 100mm (4"), and 150mm (6"), both with extra-wide 150mm (6") bases. External-Flange Corners are typically used around skylights and roof drains, Internal-Flange Corners are typically used at roof perimeters.</p>
<p>Aluminum Connectors</p> 	<p>Optigreen Aluminum Connectors are made from a 1.0mm (0.040") tempered aluminum alloy. They slide into the top and bottom folds found in Optigreen Aluminum Edge and Optigreen Aluminum Corners to make secure, invisible connections. They are available in heights of 100mm (4"), and 150mm (6").</p>

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ILLUSTRATION	DESCRIPTION
<p>Anti-Slip Cleat</p> 	<p>Optigreen Anti-Slip Cleats are black recycled ABS plastic soil retaining elements used with Optigreen Anti-Slip Mesh to prevent soil from sliding down sloped green roofs by transferring soil loads to the top of the roof. If the roof is gabled or barrel-shaped, one side of the roof can be used to balance the other; otherwise the mesh must be mechanically fastened at the top of the roof. Rows of cleats are spaced 10" to 50", depending on the roof slope.</p>
<p>Anti-Slip Mesh</p> 	<p>Optigreen Anti-Slip Mesh is an extraordinarily strong structural plastic mesh used with Optigreen Anti-Slip Cleats to prevent soil from sliding down sloped green roofs by transferring soil loads to the top of the roof. If the roof is gabled or barrel-shaped one side of the roof can be used to balance the opposite side; otherwise It must be mechanically fastened at the top of the roof.</p>
<p>Anti-Slip Lower Tee</p> 	<p>Optigreen Anti-Slip Lower Tees are used with Optigreen Anti-Slip Upper Tees to prevent soil from sliding down sloped green roofs by transferring soil loads to a structural parapet or fascia at the bottom of the roof. They are made of thick recycled polyethylene and are pre-notched to accept the upper tees. Lower tees are installed to follow the slope of the roof and are spaced approximately 1m (40") apart. Standard lengths are 2.15m (7'1") and 3.25m (10'8").</p>
<p>Anti-Slip Upper Tee</p> 	<p>Optigreen Anti-Slip Upper Tees are used with Optigreen Anti-Slip Lower Tees to prevent soil from sliding down sloped green roofs by transferring soil loads to a structural parapet or fascia at the bottom of the roof. They are made of thick recycled polyethylene and are pre-notched to drop into the lower tees. Upper tees are installed to cross the slope of the roof and are spaced 25cm to 125cm (10" to 50") apart, depending on the roof slope. Standard lengths are 1m (40").</p>
<p>Fertilizer</p> 	<p>Optigreen Extensive Roof Fertilizer is a slow-release fertilizer specifically formulated to meet the nutritional requirement of sedums on extensive green roofs. Apply it twice yearly beginning the second year, typically in April and July, at the rate of 4lbs per 1000 square feet. Standard bags contain 55lbs and cover approximately 14,000 square feet.</p>