

Green Roof Maintenance Manual

Welcome

Thank you for purchasing a green roof from Columbia Green Technologies. Enclosed are recommendations for the successful establishment and ongoing maintenance of your green roof. Careful attention to these general guidelines will maintain the health, vigor and beauty of your green roof. If you require any further assistance please contact us at info@columbia-green.com or (503) 327.8723.



Green Roofs have been shown to:

- Reduce building heating and cooling costs
- At least double the life of the roof membrane
- Provide on-site stormwater management
- Increase rents/decrease turnover in commercial and residential buildings
- Support habitat for birds, bees and invertebrates
- Reduce the urban heat island effect

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Introduction: Low-Maintenance, but Not No-Maintenance

A regular maintenance regime is key to the success of your green roof. It is important to create a custom, site-specific maintenance plan to keep your green roof looking great and functioning for years to come. While shallow media, or ‘extensive’ green roofs are low maintenance, they do require regular, specialized care. This manual is more focused on extensive systems planted with sedum and/or perennial groundcovers, but is applicable to all systems. More garden-like ‘intensive’ green roofs will require a level of maintenance comparable to at-grade gardens. Use this manual to create a maintenance plan and document related activities. A green roof is a living system that will grow and change. Your maintenance plan will require modification as plants mature.

Document All Maintenance Activities

Consistent, detailed documentation of maintenance activities is vital to successful green roof care. TAKE PHOTOGRAPHS DURING EVERY VISIT. These photos along with written documentation provide the building owner, maintenance contractor and manufacturer with a valuable log should issues or questions arise. This record will help demonstrate regular maintenance was performed in accordance with warranty specifications to ensure that repairs or replacements are covered. SEE APPENDIX FOR DOCUMENTATION LOGS.

MINIMUM MILESTONES FOR DOCUMENTATION:

- Final Project Completion
- During Establishment Period as outlined in Specifications
- Monthly Maintenance Reports
- Annual Inspections

About this Green Roof System *record the basic information on your system*

Building Name/Location: _____

Manufacturer: COLUMBIA GREEN TECHNOLOGIES

Warranty Period: _____

Green Roof Installer: _____

General Contractor: _____

Date of Installation: _____

Initial Maintenance Period thru: _____

Long Term Maintenance Provider: _____

System Type (Tray or Layered)/ Media Depth: _____

Irrigation System, if provided: _____

Maintenance Providers and Budgeting

The green roof installer typically will cover maintenance of the roof for an initial period of time as outlined in the project contract documents. This period typically lasts between 30 days and 2 years. After this period it is the Owner's responsibility to secure ongoing maintenance for the green roof. We recommend contracting with an experienced landscape maintenance contractor that specializes in green roofs.

In determining the labor hours involved in green roof care, consider the design complexity, roof visibility, and the owner's expectations. The Owner may like a more naturalistic landscape, or a highly manicured space. This expectation will have an effect on total labor hours.

Factors that influence maintenance cost include travel time, green roof size, and roof accessibility. Plan for a minimum eight (8) maintenance visits per year. Cost is typically \$0.45- \$0.55 per Square Foot per Year, although costs will depend on project location.

Green Roof Warranty

It is essential to understand the terms, conditions and exclusions that apply to your specific warranty.

Standard Full System Warranty

This warranty comes standard with Columbia Green's Systems and is a limited warranty on materials. This warranty covers the manufactured green roof components- that they will be free from defects in materials and workmanship for the warranty period.

Extended Overburdened Warranty

Manufacturer will cover the cost of removal and replacement of vegetated roof in the event a leak should occur in the roof membrane system below. This warranty is recommended, and may be purchased from Columbia Green separately.

Single-Source Warranty

Covers the roof membrane system and the green roof components together for a specified period and an extended overburden warranty. This Warranty is typically offered through the roofing manufacturer. Contact Columbia Green for a list of roofing manufacturer partners.

Extended Plant Warranty

A separate extended plant warranty which covers a certain plant health and plant coverage on the green roof during a specified period of time (often within 2 years of installation). Documentation of maintenance activities is required- please see the terms and conditions for specifics.

Safety Notes

The green roof maintenance team must understand all relevant safety precautions prior to starting work. Rules will differ according to state or local regulations. There are more safety challenges inherent in rooftop plant care and maintenance than at-grade landscape maintenance. It is extremely important that all relevant access and safety standards are adhered. Refer to all OSHA and US Federal and State Standards including OSHA 29 CFR 1910 Subpart D (General Industry Standards) and 29 CFR 1926 Subpart M, N, X, V and CC (Construction Standards) are the U.S. Federal standard and provide guidelines to accessibility and safety requirements. In Canada, labor safety is under provincial jurisdiction.

Components of Your Green Roof

Vegetation

Consult project Landscape documents for plant list and keep a copy on-hand. An intensive garden-like roof is usually planted with small container plants. An extensive sedum-based green roof will typically be planted using the following methods:

Columbia Green Pregrown Sedum Mats or Tiles, Sedum Cuttings, Plant Plugs, Pre-Grown Trays

Growing Media

Columbia Green's engineered, lightweight media blends include extensive, semi-intensive and intensive mixes.

Green Roof System 'Hard Parts'

Columbia Green has both tray and layered based green roof systems that allow for drainage, air flow and maximize plant health. Both system types require similar plant care.

Tray System- Pregrown or Planted-in-Place

2'x2' Black Polypropylene Trays
Tray Pins (Planted-in-Place Only)
Drip Irrigation (Optional)



Layered (Built-up) System

Drainage Layer: Black Polyprop. geomatrix
Filtration Layer: Gray Spun-bond polyester
Water Retention Layer: White Non-woven polyester



Post-Installation Inspection

Final Inspection and Acceptance

Once green roof installation is complete, make arrangements for Final Inspection within 14 days following Substantial Completion with owner, architect, contractor, installer, and others as requested. The inspection should include the following:

- Verify conformance to Columbia Green's instructions and warranty provisions and identify any issues that may impact the establishment of healthy vegetation.
- Discuss the owner assuming maintenance and care of vegetated roof system following acceptance, except as modified by any maintenance service agreement.
- Document all pertinent information regarding this inspection and submit to the warranty provider.

Plant Establishment Period

The ‘Establishment Period’ runs through the first full growing season following planting. Careful watering and plant care, especially during the first year is key to maintaining healthy plants, establishing a strong root system, and preventing future maintenance difficulties down the road.

Installation Season:	Establishment Period Includes:
Fall	Spring and Summer of the following Year
Winter	Spring and Summer of the following Year
Spring	Until onset of cool fall weather
Summer	Through summer of the following year

Watering during Establishment

Your green roof will most likely require supplemental water during establishment. Supplemental watering requirements will vary depending on planting technique, location and weather conditions. An automatic irrigation system is recommended. Hand-watering is also an option.

Watering Recommendations during mild weather:

Sedum Cuttings

- First two weeks after planting: Overhead watering twice daily
- Third Week: Overhead watering once a day
- Weeks Four - Eight: Overhead watering once a week
- For Duration of the Establishment Period: As-needed, check at least weekly

Sedum Plugs, Pregrown Sedum Mats or Tiles, Pre-Grown Trays

- First four (4) weeks: Once a week
- For duration of the Establishment Period: As-needed, check at least weekly

If at any time the plants begin to wilt, it is time to irrigate them!

Water More Often During Prolonged Hot Dry Weather

‘PROLONGED HOT DRY WEATHER’ is defined as periods of 75 degree or hotter weather, with less than 1 inch of rainfall over a month. Beyond this time period, an extensive green roof will need supplemental irrigation to survive. This window of time will be shorter in hotter temperatures, or on roofs that are sloped, exposed to persistent winds or reflected sunlight. These conditions can dry out the soil, causing the plants to go dormant, or cause die-off.

Inspections

During establishment, check the green roof frequently to ensure that the automatic irrigation system is supplying an adequate and consistent amount of water or hand-water, and to keep tabs on weed germination. Remember the importance of documenting your activities!

Ongoing Maintenance Activities

After the initial Establishment Period, the green roof will have developed a strong root system helping it to become more resilient. Maintenance activities can shift to upkeep and observation. Visits might occur monthly, and also following major weather events such as heavy rainfall or high winds. On these visits it is very important to double check that drains have not become obstructed. Keeping these areas free of debris is one of the most important ongoing maintenance tasks. The following activities should be part of an ongoing maintenance regimen:

Inspect Vegetation-Free Zones

Vegetation-free zones are areas located at green roof perimeters and around roof penetrations and drains where plants are held back to prevent vegetation encroachment. These zones are often delineated with metal edging and can be filled with ballast rock or aggregate. Inspect Vegetation-free zones at least every two to four weeks. Remove errant green roof plantings and any debris (pebbles, sticks, leaves, trash, etc.) from the drainage system and drainage pathways to allow roof drains to function properly. Any water backup from blocked drains can kill plants, waterlog media, and cause serious damage to the roofing system and even structural failure.

Remove Debris

Remove debris including trash, pebbles, sticks, and leaves from the green roof regularly.

Control Weeds

Address any sign of weeds immediately- this is more often necessary during the first year of growth until the plants have reached full coverage. Once the green roof grows into a dense cover over the media, weed germination should become less significant. During monthly inspections, check and remove any weeds immediately, before they set seed. REMOVE TREE SEEDLINGS IMMEDIATELY TO PREVENT THEIR STRONG ROOT SYSTEMS FROM COMPROMISING THE WATERPROOFING SYSTEM. Occasionally perennial weeds, like clover, can become a problem. In those circumstances, a careful, spot-spray of a glyphosate herbicide may be used. Limit herbicide use whenever possible.

Deadhead Sedum

Most sedum species flower in the spring or summer. Spent flower stalks may remain throughout the fall and winter. You may choose to trim off spent flowers.

Check Irrigation/Moisture Levels

GENERALLY SPEAKING, AVOID OVER-WATERING SEDUM PLANTED GREEN ROOFS. DRY SOIL ENCOURAGES TOUGHER SEDUM PLANTS.

Inspect your automatic irrigation system at each visit to ensure proper functionality. Check all valve locations and joints for signs of leaks or breaks in the piping. Inspect spray heads and drip emitters as they run to ensure there are no clogs. Check soil moisture levels around the roof and adjust run times to ensure the media is fully saturated. Growing media drains quickly, so short, more frequent watering will help avoid irrigation runoff and maximize plant water uptake.

When hand-watering, apply a consistent amount of water over the entire roof. Focus watering efforts during the summer, and periods of ‘prolonged hot dry weather’ as previously defined. Supplemental water will not be needed during periods of rain or milder temperatures.

If the plants are wilting, it is time to irrigate.

During ‘prolonged hot dry weather’ or when plants become drought stressed, supplemental water should be applied, to re-wet the soil to the point of saturation. Thoroughly irrigating will pay off significantly. The plants will be plump and healthy so they can cover the soil effectively.

Irrigation System Winterization

Drip Irrigation Winterization- CGT Planted-in-Place Drip system

Step 1: When freezing weather is anticipated, simply turn off your main water supply to the irrigation system and make sure that the backflow device, valves, filter, pressure regulator, pipe, sprinklers, drip hose, and drippers are free of water.

Step 2: After the main water supply is shut down, run the timer/ controller through its normal watering cycle. This will allow each of the valves to open and relieve water pressure on the main line and valves. Allow the lines to drain slightly. After the timer/controller runs through its cycles, turn the controller off, or to Rain Off position.

Step 3: Ensure that all exposed pipe is wrapped with insulating tape. The insulation should cover everything exposed up to the risers; however, it is unnecessary to wrap sprinkler heads or hose bibs.

Step 4: Through the height of winter leave the system off and drained. If needed, water the green roof with a hose only. In most cases, there is enough moisture from rain to sustain the plants during the winter.

CGT Planted-in-Place Drip Irrigation Spring Startup

Step 1: After the last frost danger has passed and you are ready to turn on the system in the spring, the first step is to flush it out. During the winter small insects may take up residence in the emitters, tubes and pipes. Open the ends of drip tubes and flush them out by turning on the water. Make sure that standing water doesn't drain back into the pipes, taking media back in with it.

Step 2: After flushing, check the system out by running it. Look for clogged emitters or nozzles, check for leaking valves and make any necessary repairs.

Step 3: Check the controller to ensure that it is properly programmed for each station. If it has a back-up battery replace it with a fresh one.

Overhead Spray or Custom Drip System Winterization and Spring Startup

Please consult the irrigation component manufacturer or a landscape contractor for their recommendations.

Fertilizing

A green roof is an integral part of the site stormwater management system. It is essential to avoid over-fertilizing which can introduce water pollutants downstream. An established green roof should need little, if any, fertilizer. We recommend a media soil fertility lab test be performed prior to any fertilizing to determine if it is needed. Excessive fertilizing encourages soft growth, which is more vulnerable to damage from drought or temperature extremes. Use slow release and balanced organic fertilizers, applying once in the spring. Do not fertilize during fall, it will stimulate tender growth and compromise the hardiness of the plant material as it heads into winter. Sedums do not require high levels of fertility to thrive. Maintaining a sedum green roof in a state of low fertility after establishment can also help discourage weed growth.

Troubleshooting

Plant Coverage Expectations

This growth chart details the extent of growth you should expect within the first three years.

Coverage	Planted Per square foot	After one full year	After two full years	After three years
72 Cell Plugs	2	60%	80%	90%
	2.4	70%	85%	95%
	3	75%	90%	95%
	4	80%	95%	95%
Bulk Cuttings	4 lbs. per 100 sf	25%	50%	70%
	10 lbs. per 100 sf	50%	70%	90%
	15 lbs. per 100 sf	70%	80%	95%
	20 lbs. per 100sf	80%	90%	95%
Pregrown Sedum Tiles or Mats	Full Coverage	90%	95%	95%

Reference Materials

Example Average First and Last Frost Dates

Most green roof maintenance activities will fall between first and last frost. Keep these dates in mind when planning for irrigation winterization/spring start-up. See www.plantmaps.com

Location	Average First Frost	Average Last Frost
Baltimore, MD	Nov 11 – Nov 20	Mar 21 – Mar 31
Boston, MA	Nov 1 – Nov 10	April 11 – April 20
Chicago, IL	Oct 21- Oct 31	April 11 – April 20
Cincinnati, OH	Oct 21- Oct 31	April 11 – April 20
Nashville, TN	Oct 21- Oct 31	April 11 – April 20

Location	Average First Frost	Average Last Frost
New York, NY	Nov 1 – Nov 10	April 1 – April 10
Philadelphia, PA	Nov 1 – Nov 10	April 1 – April 10
Portland, OR	Nov 21 – Nov 30	Feb 21 – Feb 29
San Francisco, CA	Rare	Rare
Toronto, Ontario	Nov 1- Nov 10	April 11 – April 20
Vancouver, B.C.	Nov 5th	March 21- March 31
Washington, D.C.	Nov 1- Nov 10	April 1 – April 10

Glossary of Terms

Intensive- A green roof system with a growing medium depth of 6” or more

Extensive- A green roof system with a growing medium depth of 6” or less

Growing Media- A lightweight engineered combination of organic and inorganic material that anchors vegetation on a green roof, retains stormwater, freely drains once saturated, and sustains healthy plant growth.

Establishment Period- The period of time during which the green roof grows in and acclimates to the particulars of a given rooftop environment. Particular care should be given through the first complete growing season.

Ongoing Maintenance- Maintenance activities beyond the green roof ‘Establishment Period.’

Green Roof- Plants, an engineered media, and drainage located on a structure. An assembly consisting of a deck, waterproofing system (membrane, associated components), root barrier, drainage layer, filter layer, growing media and vegetation.

Overburden- A term used to refer to anything placed on top of the roof membrane. i.e. growing media, vegetation, ballast, etc.

Sedum/Succulent- A water-retaining plant with shallow root system that has evolved in arid climates and soils and frequently used on green roofs.

Vegetation Free Zone- An area of the green roof that is designed to be kept free of green roof media and planting. Examples include around drain, vents, HVAC units, etc.

Weed- Any unwanted plant. Weeds and their roots should be removed from the green roof as soon as possible to prevent spreading.

Green Roof Post-Installation Checklist

Date and Location:

Participants:

Weather Conditions:

Yes	No	N/A	Plants
			Plants are green and appear to be healthy
			Plants show no signs of wilting or stress
			Pregrown trays or tiles meet specified coverage (usually 80%+)
			Plugs are showing evidence of root growth and are spaced appropriately
			Sedum cuttings show evidence of root and leaf growth
			Minimal weed presence
Growing Media			
			Media depth matches project documents and/or jurisdictional requirements
			Growing media has been spread even and level
			Growing media has been lightly compacted
			Loose growing media has been cleaned from walkways and other roof surfaces
Automatic Irrigation			
			Water source is 'on'
			Backflow Prevention device is in place and has been tested
			Each irrigation zone has been tested and is performing as designed with full coverage
			Automatic controller has been programmed
			Drip emitters are clear, and drip tubes are watering consistently
			Overhead spray nozzles are 'popping'
			If hand watering, a hose-bib and hose are available
Metal Edgers			
			Pieces are fitted together correctly
			No gaps are present
			Tray edging (if used) conceals tray edges
			Corners are properly formed
Trays – For Tray-Based Green Roof Systems			
			Sides are fitted together cleanly, overlapped at interlocked and level with roof surface
			Tray Pins, where used, are properly secured. (Planted-in Place Trays System only)
Layered Components – For Layered Based Green Roof Systems			
			Filter Fabric turned up at all sides, inside and below height of edge flashing
			Drainage layer and water retention layers are tightly butted together, but not overlapped
Drainage			
			Water freely flows under the system to drains/scuppers/gutters without obstruction
			Vegetation-Free-Zones around drains and at perimeters are free of any obstructions
Maintenance			
			Debris (leaves, trash and other non-garden materials) have been removed
			A project-specific maintenance plan has been created and implemented
Digital Photography			
			Document any areas of concern and average conditions.
Other Notes:			

Green Roof Establishment Period Log

Refer to the **ESTABLISHMENT PERIOD** and **ONGOING MAINTENANCE** sections of the Green Roof Maintenance Guide for recommendations on plant establishment and general care. Record your activities and observations below. You may wish to make additional blank copies, as needed.

Initial Date of Green Roof Installation and Location:

This log pertains to the following Dates:

Work Overseen by:

Weekly Visit #: <i>(Or daily visits if establishing cuttings)</i> Indicate Date of visit	Example: 07/01	1	2	3	4	5	6	7
Conditions During past week: (Indicate all that Apply) M = Mild C = Cold R = Rain D = Dry W = Windy	<i>M, D</i>							
Moisture Levels Checked?	✓							
Irrigation Water Applied? (if needed)	✓							
Vegetation Free Zones Inspected and Cleared?	✓							
Debris Removed?	✓							
Weeds Removed?	✓							
Digital Photos Taken?	✓							
Any Concerns Noted? (If so, document separately)	<i>No</i>							
Work By:	<i>EK</i>							

Report Authored By: _____
Issue Date: _____

Ongoing Green Roof Maintenance Log

Refer to the **ONGOING MAINTENANCE** section of the Green Roof Maintenance Manual for recommendations on general care. Record your activities and observations below. You may wish to make additional blank copies, as needed.

This log pertains to the following Dates:

Work Overseen by:

Visit Date:							
Conditions During past week: (Indicate all that Apply) M = Mild C = Cold R = Rain D = Dry W = Windy							
Moisture/ Irrigation System Checked?							
Water Applied? (if needed)							
Vegetation Free Zones and Drains Inspected?							
Debris Removed?							
Weeds Removed?							
Spent Flowerheads Deadheaded?							
Digital Photos Taken?							
Any Concerns Noted? (If so, document separately)							
Work By:							

Report Authored By: _____
 Issue Date: _____

Green Roof Annual Inspection

Complete this form on the yearly anniversary of the green roof installation and every year following. Record your observations and any corrective actions below. Make additional blank copies, as needed.

Inspection Date:

Work Overseen by:

Note the condition of the following items and take corrective action as needed:

Yes	No	N/A	Plants
			Plants are green and appear to be healthy; Neat and Tidy Appearance
			Plants show no signs of wilting or stress
			Plants appear to have adequate available nutrients
			Plants meet coverage expectations. Please note the Estimate % Coverage:
			Minimal weed presence
			Growing Media
			Growing media is even and level
			Growing media is not migrating into Vegetation Free Zones
			Loose growing media has been cleaned from walkways and other roof surfaces
			Irrigation
			Water source is 'on'
			Backflow Prevention device is in place and testing is up-to-date.
			Each zone has been tested and is performing as designed
			Automatic controller is properly programmed
			Drip emitters are unclogged
			Overhead spray nozzles are 'popping' and coverage is complete
			If hand watering, a hose-bib and hose are available
			Metal Edgers
			Pieces are fitted together correctly
			No gaps are present
			Tray edging (if used) conceals tray edges
			Corners are properly formed
			Trays (if installed)
			Fitted together in interlocking fashion for monolithic installation
			Pins, where used, are properly secured. (Post-planted Trays Only)
			Layered Components (if installed)
			Filter Fabric turned up at all sides, inside and below height of edge flashing
			Drains
			Water freely flows under the system to drains/scuppers/gutters
			Free from potential obstructions

(See next page)

Report Authored By: _____
 Issue Date: _____

Yes	No	N/A	Vegetation-Free-Zones: Clear of Roots and Debris
			Perimeter Zones
			Penetrations (Vent Pipes, etc.)
			HVAC Equipment
			Abutting Vertical Surfaces
			Exposed Roof Membrane
			Maintenance
			Debris (leaves, trash and other non-garden materials) have been removed
			A maintenance plan is in place. Make adjustments as needed.
			Digital Photography
			Document any areas of concern; average conditions.

Note additional Supplies/Actions Needed.

Yes	No	N/A	Additional Supplies Needed
			Replacement Growing Media
			Additional Trays, Layered components or edgers
			Supplemental Drain Rock or Aggregate
			Pavers
			Replacement Plants: Plugs, Cuttings, Tiles

Actions	Done in the past year? Note Date	To Be Completed in the Upcoming Year?
Soil Testing/ Monitoring		
Slow-Release Fertilizer Application		
Pesticide Application- Only when necessary!		
Herbicide Application- Only when necessary!		
Replanting		

Notes and Next Steps:

Report Authored By: _____
Issue Date: _____