



# STYROFOAM™ BRAND INSULATION, LEED AND GREEN ROOF ASSEMBLIES

## GREEN BUILDING

Dow Building Solutions is an active supporter of “green building” efforts. Among its many affiliations and alignments with organizations dedicated to sustainable design and construction, Dow is a member of the U.S. Green Building Council (USGBC), a nonprofit coalition that promotes high-performance green building design.

The USGBC has developed a system to rate new building designs, called Leadership in Energy and Environmental Design (LEED) for New Construction and Major Renovations (LEED-NC). This is a voluntary, consensus-based standard that recognizes the life-cycle costing of construction. The Canada Green Building Council has developed a similar LEED system based on the USGBC model.

The rating system lets design professionals accumulate credits based on meeting criteria for the use of environmentally friendly, sustainable and energy-efficient products and systems.

By reaching certain point levels, buildings can be LEED certified at these levels: certified, silver, gold and platinum. In some states/provinces and localities, LEED certification can result in financial incentives.

## GREEN ROOF ASSEMBLIES

STYROFOAM™ Brand Extruded Polystyrene Insulation from Dow can be used in green roof assemblies to contribute to LEED points for new construction and major renovations. Table 1 details the credit name and number, the number of possible points and the requirements to meet the criterion. These credits are based on LEED for New Construction Version 2.2.

### Green Roof

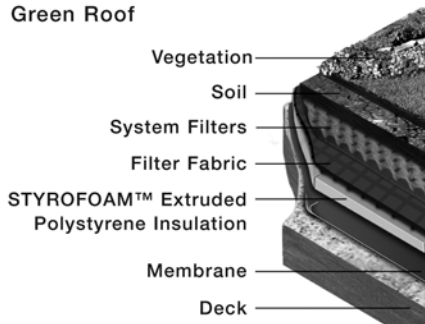


TABLE 1: CONTRIBUTION TO LEED POINTS FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS – GREEN ROOF ASSEMBLIES

| CREDIT NUMBER  | CREDIT NAME  | NUMBER OF POINTS | REQUIREMENTS  |
|--|--|------------------|---|
| Sustainable Sites (SS) Credit 5.1                    | Site Development, protect or restore habitat                 | 1                | Projects earning SS Credit 2 and using vegetated roof surface may apply the vegetated roof surface to this calculation (if the plants meet the definitions of native/adapted), in which case the requirement is 20 percent of the site area (including building footprint). This option is intended for urban sites with little or no building setback. |
| SS Credit 5.2  | Site Development, maximize open space                        | 1                | For all compliance options, when projects are located in urban area earning SS Credit 2, vegetated roof areas can contribute to credit compliance.  |
| SS Credit 6.1  | Stormwater Design, quantity control                          | 1                | Green roof can promote infiltration, reduce imperviousness and reduce stormwater runoff, which contribute to achieving the credit requirements.   |
| SS Credit 6.2  | Stormwater Design, quality control                           | 1                | Green roof can promote infiltration, reduce imperviousness and solids loading, and reduce stormwater runoff, which contribute to achieving the credit requirements.   |
| SS Credit 7.2  | Heat Island Effect, roof                                     | 1                | Install 50 percent of the roof area with green roof to reduce urban heat island effect.   |
| Water Efficiency (WE) Credit 1.1                     | Water-Efficient Landscaping, reduce by 50 percent            | 1                | Green roof with native or adaptive vegetation has high level of rainwater retention to satisfy irrigation needs. This credit is more applicable to urban areas where green space around the building perimeter is limited.  |
| WE Credit 1.2  | Water-Efficient Landscaping, no potable use or no irrigation | 1                | Green roof with native or adaptive vegetation has high level of rainwater retention to satisfy irrigation needs. With proper design, landscaping irrigation needs may be eliminated. This credit is more applicable to urban areas where green space around the building perimeter is limited.  |
| Energy and Atmosphere (EA) Prerequisite 2 (Required) | Minimum Energy Performance                                   | N/A              | Green roof helps increase energy efficiency to meet the Minimum Energy Performance prerequisite.  |
| EA Credit 1  | Optimize Energy Performance                                  | 2-10             | Green roof can help achieve higher energy-efficiency levels for a building by providing better insulation and little heat island effect. Along with other energy-efficiency measures for a building, the credits that can be achieved range from 2-10 points.   |

TABLE 1 CONTINUED ON NEXT PAGE

**SUPPLEMENTAL INFORMATION**

**SUSTAINABLE SITES (SS)**

**CREDIT 5.1 – SITE DEVELOPMENT: PROTECT OR RESTORE HABITAT**

**Intent:**

Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.

**Requirements:**

For greenfield sites (not previously developed or graded and in a natural state), limit all site disturbance to:

- 40 feet beyond the building perimeter
- 10 feet beyond surface walkways, patios, surface parking and utilities less than 12 inches in diameter
- 15 feet beyond primary roadway curbs and main utility branch trenches
- 25 feet beyond constructed areas with permeable surfaces

Or, on previously developed or graded sites, restore or protect a minimum of 50 percent of the site area (excluding the building footprint) with native/adapted vegetation.

An Innovation credit can be earned with 75 percent of the site area covered with native/adapted vegetation.

Projects earning SS Credit 2 and using a vegetated roof surface may apply this to the calculation (if the plants meet the definitions of native/adapted). In this case, the requirement is 20 percent of the site area, including the building footprint. This option is intended for urban sites with little or no building setback.

**CREDIT 5.2 – SITE DEVELOPMENT: MAXIMIZE OPEN SPACE**

**Intent:**

Provide a high ratio of open space to development footprint to promote biodiversity.

**Requirements:**

*Option 1:* Reduce the development footprint (defined as the total area of building footprint, hardscape, access roads and parking) and/or provide vegetated open space within the project boundary to exceed the local zoning open space requirements by 25 percent.

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| CREDIT NUMBER                                 | CREDIT NAME  | NUMBER OF POINTS | REQUIREMENTS   |
|---|--|------------------|--|
| Materials and Resources (MR) Credit 4.1       | Recycled Content, 10 percent <sup>(1)</sup> (post-consumer plus half pre-consumer)                           | 1                | Many components of the green roof assembly – such as waterproof membrane and filter fabric – provide recycled post-consumer and pre-consumer recycle content.  |
| MR Credit 4.2                                 | Recycled Content, 20 percent <sup>(2)</sup> (post-consumer plus half pre-consumer)                           | 1                | Many components of the green roof assembly – such as waterproof membrane and filter fabric – provide recycled post-consumer and pre-consumer recycled content. |
| MR Credit 5.1                                 | Regional Materials, 10 percent extracted, processed and manufactured regionally                              | 1                | Many components of the green roof assembly – such as waterproof membrane, filter fabric and insulation – are harvested, processed and manufactured regionally. |
| MR Credit 5.2                                 | Regional Materials, 20 percent extracted, processed and manufactured regionally                              | 1                | Many components of the green roof assembly – such as waterproof membrane, filter fabric and insulation – are harvested, processed and manufactured regionally. |
| Indoor Environmental Quality (EQ) Credit 7.1  | Thermal Comfort, design  | 1                | Green roof can help achieve better energy efficiency to meet the ASHRAE 55.2 Thermal Environmental Design standards to provide comfort for building occupants. |
| Innovation and Design (ID) Process Credit 1.1 | 100 Percent Green Roof for Exemplary Performance of SS Credit 7.2  | 1                | Double the existing credit requirements to provide exemplary performance.  |
| ID Credit 1.2                                 | Green Roof Accounts for 40 Percent of the Project Site Area for SS Credit 5.1                                | 1                | Double the existing credit requirements to provide exemplary performance.  |
| ID Credit 1.3                                 | Green Roof Area Doubles the Requirements of SS Credit 5.2, depending on local zoning open space requirements | 1                | Double the existing credit requirements to provide exemplary performance.  |

(1) LEED-NC in U.S.; 7.5 percent for LEED in Canada  
 (2) LEED-NC in U.S.; 15 percent for LEED in Canada

*Option 2:* For areas without local zoning requirements – such as some university campuses and military bases – provide vegetated open space adjacent to the building that is equal to the building footprint.

*Option 3:* Where zoning exists without a requirement for open space, provide vegetated open space equal to 20 percent of the project's site area.

*For all of the options:*

- For projects located in urban areas that earn SS Credit 2, vegetated roof areas can contribute to credit compliance.

- For projects located in urban areas, pedestrian-oriented hardscape areas can contribute to credit compliance. For such projects, a minimum of 25 percent of the open space counted should be vegetated.
- Wetlands and naturally designed ponds may count as open space if the side slope gradients that average 1:4 (vertical:horizontal) or less are vegetated.

The building may be awarded an Innovation credit if the project has doubled the open space requirement.

**CREDIT 6.1 – STORMWATER DESIGN: QUANTITY CONTROL**

**Intent:**

Limit disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration and managing stormwater runoff.

**Requirements:**

Impervious surfaces promote runoff of precipitation volumes instead of infiltration into the subsurface.

*Option 1:* Where existing imperviousness is less than or equal to 50 percent, implement a stormwater management plan to prevent:

- Post-development peak discharge rate (typically calculated by a civil engineer based on surface characteristics and data on stormwater frequency, intensity and duration)
- Quantity from exceeding the pre-development peak discharge rate
- Quantity for the one- and two-year, 24-hour design storms

Or, implement a stormwater management plan that protects receiving stream channels from excessive erosion by implementing a stream channel strategy and quantifying control strategies.

*Option 2:* Where existing imperviousness is greater than 50 percent, implement a stormwater management plan that results in a 25 percent decrease in the volume of stormwater runoff from the two-year, 24-hour design storm.

**Strategies:**

Design the project site to maintain natural stormwater flows by promoting infiltration. Specify vegetated roofs, pervious paving and other measures to minimize impervious surfaces. Reuse stormwater generated for non-potable use, such as landscape irrigation, toilet and urinal flushing and custodial uses.

**CREDIT 6.2 – STORMWATER DESIGN: QUALITY CONTROL**

**Intent:**

Reduce or eliminate water pollution by reducing impervious cover, increasing on-site infiltration, eliminating sources of contaminants, and removing pollutants from stormwater runoff.

**Requirements:**

Implement a stormwater management plan that reduces impervious cover, promotes infiltration, and captures and treats the stormwater runoff from 90 percent of the average annual rainfall, using acceptable best management practices (BMP).

BMPs used to treat runoff must be capable of removing 80 percent of the average annual post-development total suspended solids (TSS) load, based on existing monitoring reports.

**Strategies:**

Use alternative surfaces – such as vegetated roofs, pervious pavement or grid pavers – and nonstructural techniques to reduce imperviousness and promote infiltration, thereby reducing pollutant loadings.

Use sustainable design strategies to design integrated natural and mechanical treatment systems – such as constructed wetlands, vegetated filters and open channels – to treat stormwater runoff.

Nonstructural techniques include vegetated swales and the disconnection of impervious pavement. Structural techniques include rainwater cisterns, manholes and ponds, and are preferred in urban and constrained areas.

**CREDIT 7.2 – HEAT ISLAND EFFECT: ROOF**

**Intent:**

Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.

**Requirements:**

*Option 1:* Use roofing materials with an SRI (solar reflectance index) equal to or greater than the values below for a minimum of 75 percent of the roof surface.

Low-sloped roof: ( $\leq 2:12$ )  
SRI 78

Steep-sloped roof: ( $> 2:12$ )  
SRI 29

*Option 2:* Install a vegetated roof for at least 50 percent of the roof area.

*Option 3:* Install high albedo (reflective) and vegetated roof surfaces that, in combination, meet the following criteria:

$$(\text{Area of SRI Roof}/0.75) + (\text{Area of Vegetated Roof}/0.5) \geq \text{Total Roof Area}$$

**Strategies:**

Consider installing high albedo and vegetated roofs to reduce heat absorption.

An Innovation credit can be earned if the total roof area is 100 percent high albedo or vegetated roof, excluding mechanical equipment, photovoltaic panels and skylights.

**WATER EFFICIENCY (WE)**

**CREDIT 1.1 – WATER-EFFICIENT LANDSCAPING, REDUCE BY 50 PERCENT**

**Intent:**

Limit or eliminate the use of potable water – or other natural surfaces or subsurface water resources available on/near the project site – for landscaping irrigation.

**Requirements:**

Reduce potable water use for irrigation by 50 percent from a calculated mid-summer baseline case.

Reduction should be attributed to any combination of the following:

- Plant species factor
- Irrigation efficiency (such as drip irrigation or micro-irrigation)
- Use of captured rainwater
- Use of recycled wastewater
- Use of water treated and conveyed by a public agency specifically for non-potable use

**Strategies:**

To reduce or eliminate irrigation requirements, perform a soil/climate analysis to determine the appropriate plant material and design the landscape with native/adapted vegetation.

Where needed, use high-efficiency equipment and/or climate-based controllers. Drip irrigation is high-efficiency irrigation where water is delivered at low pressure through buried mains and sub-mains. Micro-irrigation uses small sprinklers and micro jets or drippers designed to apply a small volume of water.

**CREDIT 1.2 – WATER-EFFICIENT LANDSCAPING, NO POTABLE USE OR NO IRRIGATION**

**Intent:**

Eliminate the use of potable water – or other natural surfaces or subsurface water resources available on/near the project site – for landscaping irrigation.

**Requirements:**

Achieve Credit 1.1 and use only captured rainwater, recycled wastewater, recycled gray water, or water treated and conveyed by a public agency specifically for non-potable use.

Or, install landscaping that does not require permanent irrigation systems. Temporary irrigation used for plant establishment is allowed.

**Strategies:**

To reduce or eliminate irrigation requirements, perform a soil/climate analysis to determine appropriate plant material and design the landscape with native/adapted vegetation.

Consider using stormwater, gray water and/or condensate water. Gray water is defined by the Uniform Plumbing Code as untreated household wastewater that has not come into contact with toilet waste, excluding water from kitchen and dishwashers.

**ENERGY AND ATMOSPHERE (EA)  
PREREQUISITE 2 – MINIMUM ENERGY PERFORMANCE**

**Intent:**

Establish the minimum level of energy efficiency for the proposed building and systems.

**Requirements:**

Design the building project to comply with both the:

- Mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4 and 10.4) of ASHRAE/IESNA Standard 90.1-2004
- Prescriptive provisions (Sections 5.5, 6.5, 7.5 and 9.5) of ASHRAE/IESNA Standard 90.1-2004

**Strategies:**

Design the building envelope, HVAC, lighting and other systems to maximize energy performance. For projects pursuing Credit 1, a computer simulation model may be used to confirm the satisfaction of this prerequisite.

If a local code has demonstrated the quantitative and textual equivalence, it may be used in lieu of ASHRAE.

**CREDIT 1 – OPTIMIZE ENERGY PERFORMANCE (2-10 POINTS)**

**Intent:**

Achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

**Requirements:**

Use one of the following options (all are assumed to be in compliance with Prerequisite 2).

*Option 1: Whole Building Energy Simulation (1-10 points); minimum requirements: 2 points*

Based on Performance Rating Method in Appendix G, the minimum energy cost savings (percentage) for each point is shown below. The first percentage listed is for new buildings; the second percentage is for existing building renovations:

- 1 point – 10.5/3.5 percent
- 2 points – 14/7 percent
- 3 points – 17.5/10.5 percent
- 4 points – 21/14 percent
- 5 points – 24.5/17.5 percent
- 6 points – 28/21 percent
- 7 points – 31.5/24.5 percent
- 8 points – 35/28 percent
- 9 points – 38.5/31.5 percent
- 10 points – 42/35 percent

**Additional requirements:**

- Must comply with mandatory provisions in ASHRAE 90.1-2004
- Must include all the energy costs within – and associated with – the building
- Must be compared against a baseline building – the default process energy costs are 25 percent of the total energy usage (if it is lower than this, the LEED submittal must include supporting documentation to make sure process energy inputs are appropriate)

*Option 2: Prescriptive Compliance Path (4 points)*

Comply with ASHRAE Advanced Energy Design Guide for Small Office Building 2004.

The following restrictions apply:

- Buildings must be less than 20,000 square feet
- Buildings must be office occupancy
- Project teams must fully comply with all the applicable criteria set in the guide for the particular climate zone

*Option 3: Prescriptive Compliance Path (2-5 points)*

Comply with the prescriptive measures in the Advanced Buildings Core Performance Guide by New Buildings Institute.

The following restrictions apply:

- Buildings must be less than 100,000 square feet
- Buildings may not be health care, warehouse or laboratory projects
- Project teams must fully comply with Sections One (“Design Process Strategies”) and Two (“Core Performance Requirements”)

Minimum points achieved under Option 2 (2-3 points)

- Three points are available for office, school, public assembly and retail projects less than 100,000 square feet that comply with Sections One and Two
- Two points are available for all other project types less than 100,000 square feet (except health care, warehouse or laboratory projects) that implement the basic requirements of the Core Performance Guide

Additional points available under Option 3 (2 additional points)

- Up to two additional points are available to projects that implement performance strategies listed in Section Three (“Enhanced Performance”)
- For every three strategies implemented from Section Three, one point is available
- Any strategies applicable to the project may be implemented except:
  - 3.1 Cool Roofs
  - 3.8 Night Venting
  - 3.13 Additional Commissioning

These strategies are addressed by different aspects of the LEED program and are not eligible for additional points under EA Credit 1.

**Strategies:**

Use a computer model to demonstrate the energy performance and the cost-effective energy efficiency measures. The replacement of the ASHRAE standard is possible upon proven equivalency.

**MATERIALS AND RESOURCES (MR)****CREDIT 4.1 – RECYCLED CONTENT, 10 PERCENT (POST-CONSUMER PLUS HALF PRE-CONSUMER) AND CREDIT 4.2 – RECYCLED CONTENT, 20 PERCENT (POST-CONSUMER PLUS HALF PRE-CONSUMER)****Intent:**

Increase demand for building products that incorporate recycled-content materials, thereby reducing impacts resulting from extraction and processing of virgin materials.

**Requirements:**

Use materials with recycled content such that the sum of post-consumer recycled content plus one half of the pre-consumer content constitutes at least 10 or 20 percent (based on costs) of the total value of the materials in the project. For projects certified by the Canada Green Building Council, the required recycled content is 7.5 percent and 15 percent, respectively.

Post-consumer material is waste material generated by households or by commercial, industrial and institutional facilities in their roles as end users of the product, which can no longer be used for its intended use. Pre-consumer material is diverted from the waste stream during the manufacturing process. Excluded is the reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it.

The recycled-content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of the assembly to determine the recycled-content value.

Mechanical, electrical and plumbing components and specialty items such as elevators shall not be included in the calculation. Only include materials permanently installed in the project. Furniture may be included providing it is included consistently in MR Credit 3-7.

**Strategies:**

Establish a project goal for recycled-content material and identify material suppliers that can achieve this goal. During construction, ensure that specified recycled-content materials are installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

While no recycle information is available for steel products, assume a default recycle content of 25 percent post-consumer. No other material is recognized as having similar recycle content. Some steel products will contain 90 percent or higher. It is recommended to check with the manufacturer.

An Innovation credit can be earned if 30 percent or greater recycle content can be achieved.

**CREDIT 5.1 – REGIONAL MATERIALS, 10 PERCENT EXTRACTED, PROCESSED AND MANUFACTURED REGIONALLY AND CREDIT 5.2 – REGIONAL MATERIALS, 20 PERCENT EXTRACTED, PROCESSED AND MANUFACTURED REGIONALLY****Intent:**

Increase demand for building materials and products that are extracted and manufactured within the region – thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation.

**Requirements:**

Use building materials or products that have been extracted, harvested, recovered or manufactured within 500 miles of the project site – for a minimum of 10 percent or 20 percent (based on costs) of the total materials value. If only a fraction of a product or material is extracted/harvested, recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

Mechanical, electrical and plumbing components and specialty items such as elevators shall not be included in the calculation. Only include materials permanently installed in the project. Furniture may be included providing it is included consistently in MR Credit 3-7.

**Strategies:**

Establish a project goal for locally sourced materials, and identify materials and suppliers that can achieve this goal. During the construction, ensure that the specified local materials are installed and quantify the total percentage of local materials installed. Consider a range of environmental, economic and performance attributes when selecting products and materials.

An Innovation credit can be earned if 40 percent or greater regionally harvested, extracted and manufactured products can be achieved.

**INDOOR ENVIRONMENTAL QUALITY (EQ)****CREDIT 7.1 – THERMAL COMFORT, DESIGN****Intent:**

Provide a comfortable thermal environment that supports the productivity and well-being of building occupants.

**Requirements:**

Design the HVAC systems and the building envelope to meet the requirements of ASHRAE 55-2004 Thermal Comfort Conditions for Human Occupancy. Demonstrate design compliance in Section 6.1.1 documentation.

**Strategies:**

Establish comfort criteria per ASHRAE 55-2004 that support the desired quality and occupant satisfaction. Evaluate air temperature, radiant temperature, air speed and humidity in an integral fashion and coordinate these criteria with EQ Prerequisite 1, EQ Credit 1 and EQ Credit 2:

- Active conditioning
- Passive conditioning
- Mixed mode conditioning

ASHRAE 55-2004 is based on the Predicted Mean Vote (PMV) comfort model with seven levels ranging from +3 (hot) to -3 (cold).

**INNOVATION AND DESIGN (ID) PROCESS**  
**INNOVATION IN DESIGN**

**Intent:**

Provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by LEED for New Construction Green Building Rating Systems and/or innovative performance in green building categories not specifically addressed by this rating system.

**Requirements:**

In writing, identify the intent of the proposed innovation credit, the proposed requirements for compliance, the proposed submittals to demonstrate compliance, and the design approach (strategies) that might be used to meet the requirements.

**Strategies:**

Substantially exceed a LEED for New Construction performance credit such as Energy Performance or Water Efficiency. Apply strategies or measures that demonstrate a comprehensive approach and quantifiable environmental and/or health benefits.



Photo courtesy of American Hydrotech, Inc.

**GREEN ROOF BEGINS WITH PMR**

*When planning an earth-friendly green roof, a roof that leaves the membrane protected is an essential component. The protected membrane roof (PMR), with STYROFOAM™ Brand Extruded Polystyrene Insulation above the waterproofing membrane, has represented the best in flat roof technology since it was developed and patented by Dow in 1968. Back then, few could have foreseen the dramatic results that PMR assemblies would deliver to building owners: Some of these original roof membranes remain in exceptional condition – 40 years after they were installed.*

*PMR (also known in some regions as an inverted roof membrane assembly, or IRMA) has become a worldwide success and provides an ideal foundation for a garden or green roof, where landscaping or plantings are used on the top surface. Energy-efficient, reusable STYROFOAM™ Brand Insulation is a key to PMR and an essential component of a long-lasting green roof.*

For information about STYROFOAM™ Brand Insulation and other Dow products that support sustainable design objectives, call Dow at 1-866-583-BLUE (2583) or visit [www.dowbuildingsolutions.com](http://www.dowbuildingsolutions.com).

To learn more about LEED, visit [www.usgbc.org](http://www.usgbc.org) or [www.cagbc.org](http://www.cagbc.org).

**www.dowbuildingsolutions.com**

**Technical Information**  
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CAUTION: This product is combustible. Protect from high heat sources. A protective barrier or thermal barrier may be required as specified in the appropriate building code. For more information, consult MSDS, call Dow at 1-866-583-BLUE (2583) or contact your local building inspector. In an emergency, call 1-989-636-4400 in the U.S. or 1-519-339-3711 in Canada.

Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mold formation. No material supplier including Dow can give assurance that mold will not develop in any specific system.

