ICPI INTERLOCKING CONCRETE PAVEMENT INSTITUTE®
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Achieving LEED® Credits with Segmental Concrete Pavement

Background

Rapidly rising energy and material costs have accelerated energy and natural resource conservation in design and construction. Sustainable development has evolved as a response and ethos to encourage conservation. It is also a framework for creating environments that enhance human existence and natural processes.

Broadly defined, sustainable development meets the needs of the present without compromising the ability of future generations to meet their needs. Within the North American design and construction community, a means for addressing sustainability or 'green building' is through LEED® or Leadership in Energy and Environmental Design. Developed by the U.S. Green Building Council (USGBC) in 1998, LEED® provides voluntary guidelines for reducing energy and wasted resources from building and site design. The Canadian Green Building Council (CaGBC) formed in 2003 published similar LEED® guidelines tailored to Canadian climates. U.S. and Canadian guidelines were developed by a range of representatives from the building industry and environmental science.

LEED® establishes a consensus-based means for measuring building and site performance. It promotes designs that integrate energy and resource conservation. LEED® is being applied to many publicly funded projects and a growing number of private ones. A primary objective of LEED® is to help facility owners reduce maintenance and life-cycle costs. This is accomplished by including all players in an integrated development process during the design stages of a project.

Purpose

LEED® rating systems have been developed or are under development for:

- New Commercial Construction and Major Renovation projects
- Existing Building Operations and Maintenance
- Commercial Interior projects
- Core and Shell Development projects
- Homes
- Neighborhood Development
- Guidelines for Multiple Buildings and On-Campus Building Projects
- LEED® for Schools

This publication provides guidance on applying the rating system for New Commercial Construction and Major Renovation projects or LEED-NC to the family of segmental concrete pavement products. This family includes interlocking concrete pavements, permeable interlocking concrete pavements, concrete grid pavements and precast concrete paving slabs. The products can also be used to satisfy the requirements in the other rating systems listed above.

LEED-NC version 2.2 is promulgated by the USGBC and version 1.0 by the CaGBC. Excerpts from each version that relate to segmental concrete pavement are presented in this technical bulletin with application guidance. Each version has similar evaluation criteria for sustainable design and some minor differences. USGBC LEED-NC version 2.2 likely will be adopted by CaGBC in 2007, thereby making each organization's version identical or very similar. Readers should check with www.usgbc.org and www.cagbc.org for the most current versions.

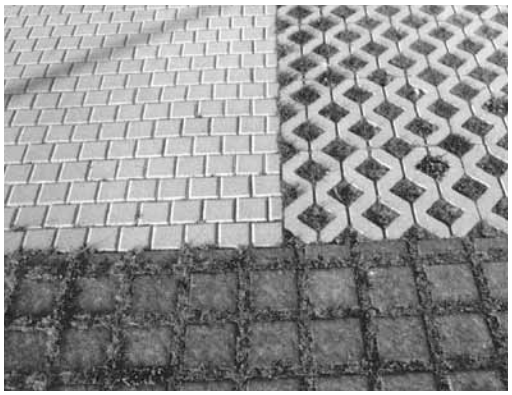

Figure 1. Sustainability for buildings extends to the site with sustainable paving that promotes infiltration and reflects sunlight.

The LEED® Process

The decision to apply for LEED® certification must occur early in the design process. The project owner and designers evaluate categories and associated criteria explained in the rating categories below for compatibility with the project, architectural program, budget

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and resulting environmental impact. This enables energy and cost-saving synergies for site and building design decisions.

To start the LEED® certification process, the project is registered on the USGBC or CaGBC web site with payment of a fee based on the total area of the project plus a registration fee. The web site specifies materials to be submitted such as project plans and documentation. The person seeking LEED® certification is sent a project checklist to evaluate aspects of the project might be eligible for LEED® credits. A letter template is also provided to help standardize documentation of credits. The registration fee enables access to the member-only parts of the web site and to access to the history of credit interpretations.

LEED® documentation can come from all involved on the project team including product manufacturers, contractors, cost estimators, specification writers and designers. Responsibility for managing this process will vary with each project. However, this effort is often coordinated by a LEED® Accredited Professional, one who has taken a course sponsored by USGBC or CaGBC and an exam on the credits and their requirements.

Once documentation is submitted with the LEED® application, they are reviewed for acceptance for LEED® credits. Additional documentation can be requested from the USGBC (or CaGBC) as needed and the project team has a specified amount of time to provide this. Final certification is granted within 30 days of receipt of all necessary documentation. LEED® certificates and a plaque are issued to the project design team.

LEED® Credits

For new commercial construction or LEED®-NC, the US and Canadian Green Building Councils grant certification based on the same number of points earned from each rating system. The minimum number of required points is 26. Higher ratings are shown in Table 1.

New projects and major renovations earn points from six broad rating categories with specific subcategories. The major categories include:

- Sustainable Sites
- Water Use Efficiency (for building)
- Energy and Atmospheric Pollutants
- Materials and Resources
- Indoor Air Quality
- Innovative Ideas and Designs

The two primary categories that pertain to segmental concrete paving are Sustainable Sites and Materials and Resources. Within these categories, there are several subcategories for rating various aspects of the building and site for LEED® points.

Table 1. LEED®-NC Points

Level	Points
Certification	26-32
Silver	33-38
Gold	39-51
Platinum	52 or more

LEED® in Specifications and Project Management

Upon registering a project for LEED® certification, a project checklist is provided by the USGBC or CaGBC that lists all of the LEED® credits in a table. The project is compared to the applicable LEED® credits thereby identifying which credits will require the appropriate documentation or tests. This evaluation helps scope the level of certification to be attained by the project. Generally, the higher the certification, the more effort is placed into documentation and into building and site systems that comply with LEED® requirements. The LEED® project checklist can also be used to identify responsibility among the architect, contractor or owner for complying with applicable credits.

Besides identifying which parts of the building or site could comply with LEED® requirements, the project checklist identifies which sections of the specification will need to be written to include LEED® requirements, and into Part 1, 2 or 3 of each Section in the project specifications. Division 01, General Conditions should include the owner's goals for achieving LEED® credits, substitution procedures for green building products that contribute to LEED® points, submittal procedures (which may be covered in greater detail for each product in the relevant specifications sections), and a waste management plan. Submittals should occur before construction begins and substitutions should be conducted at the bid stage rather than during construction. The latest specification formats include sections for specifying sustainable building products.

Specific requirements and procedures for compliance to LEED® credits for segmental concrete paving products for sustainable sites and materials and resources should be included in the specifications. Examples include a letter from the manufacturer stating the recycled content of the paving units could be a required submittal, waste management goals, or drainage calculations showing the required reduction of stormwater runoff contributed by permeable interlocking concrete pavement or grid pavements. If segmental paving is indoors and sealed, or the joint sand stabilized with a liquid, such materials should comply with indoor air quality construction requirements in LEED®.

Many projects have a pre-bid conference where the scope of the project is presented with details on the bid documents. The person running the conference should be familiar with LEED® goals for the project and also review submittal requirements and substitution request procedures with prospective bidders. During construction, the owner's representative or contractor should appoint someone responsible for enforcing the contract provisions pertaining to achieving LEED® requirements and documentation. The importance and role of this person should be presented at the pre-bid conference. This person could be responsible fulfilling contractor related items on the project checklist.

The additional project cost for compliance to LEED® certification is small and segmental concrete paving products used in the normal course of project design (roads, plazas, sidewalks, roof decks, etc.) can earn LEED® credits. Higher levels of certification (Silver, Gold, etc.) will likely increase project costs. However, the initial investment in sustainable design and construction should be returned to the owner in lower maintenance costs during the life of the building and site. When properly designed and installed, segmental concrete pavement has very low maintenance.

Life Cycle Assessment

Groundwork is being prepared for incorporation of life cycle analysis or LCA into LEED®. Integration of LCA in LEED® will likely occur within the next three to five years. According to Trusty and Horst (Trusty), "LCA is a methodology for assessing the environmental performance of a service, process, or product, including a building, over its entire life cycle. Although the technique is still maturing, especially the aspects dealing with ultimate impacts on human and ecosystem health, it has become the recognized international approach to assessing the comparative environmental merits of products or processes." LCA includes goal and scope definition, inventory analysis, impact assessment, and interpretation of social, environment and economic impacts of a project. The method is described in detail in the ISO 14000 series of standards (see ISO references). LCA has been used by major corporations to reduce costs for products through creating efficiencies that generate less impact on human and natural systems.

LCA consists of analyzing environmental impacts of a product or system. Impacts are weighted and their weightings are justified as part of the analysis. The impacts include:

- Global warming (from greenhouse gases)
- Acidification (typically from acid rain)
- Eutrophication (aging of water bodies through excess nutrient intake)
- Fossil fuel depletion
- Indoor air quality
- Habitat alternation
- Water intake
- Criteria air pollutants
- Smog
- Ecological toxicity
- Ozone depletion
- Human health

LCA is incorporated into British and European green building guides. The British *Green Guide to Specification* (BREAM 2002) is an LCA based methodology for assessing the human and environmental impacts of many building systems. Consideration is given to impacts from "cradle to grave" or from the energy used to extract natural resources to make the products, as well as manufacturing and recycling impacts. The Green Guide uses an A, B, C rating system where an A rating notes a low environmental impact, B is moderate and C is high. Table 2 illustrates the evaluation criteria and ratings of various pavement types with segmental concrete products receiving favorable ratings.

Other Evaluation Systems

Besides LEED®, there are other environmental assessment programs such as Green Globes (www.greenglobes.com). According to their web site Green Globes has an on-line auditing tool that enables designers, property owners and managers to assess and rate existing buildings against best practices and standards for sustainable design. Evaluations are done by those using their web site and third party assessments are at the user's option.

Table 2. British Green Guide *Life Cycle Assessment Rating of Various Pavement Materials*

Paving Type	Summary Rating	Climate Change	Fossil Fuel Depletion	Ozone Depletion	Human Toxicity to air & water	Waste Disposal	Water Extraction	Acid Deposition	Ecotoxicity	Eutrophication	Summer Smog	Minerals Extraction	Typical Replacement Interval, yrs	Recycled Content	Recyclability	Recycled Currently	Energy Saved by Recycling	Initial Cost
Asphalt	C	C	C	A	C	C	A	C	C	C	C	A	20	C	B	B	A	Low
Clay pavers	B	B	B	A	A	B	A	A	A	A	C	A	40	C	A	A	A	Medium
Concrete pavers/ PICP	A	A	A	A	A	B	A	A	A	A	B	A	40	A	A	A	A	Medium
Concrete Paving slabs	A	A	A	A	A	B	A	A	A	A	A	A	40	C	A	A	A	Medium
Concrete grid pavers	A	A	A	A	A	B	C	A	A	B	C	A	30	C	A	A	A	Medium
Cast-in-place concrete	C	C	A	A	B	C	B	B	A	C	B	C	60	C	A	A	A	Low
Granite pavers	B	A	A	A	A	B	A	A	A	A	A	B	60	C	A	A	A	High
Stone slabs	A	A	A	C	A	A	A	A	A	A	A	A	60	C	A	A	A	High
Gravel	B	A	A	A	A	C	B	A	A	A	A	C	10	C	B	B	C	Low

USGBC LEED®-NC Version 2.2 Credits

Sustainable Sites

Credits applicable to segmental concrete paving products for sustainable sites include the following:

SS Credit 6.1 Stormwater Design: Quantity Control
SS Credit 6.2 Stormwater Design: Quality Control
SS Credit 7.1 Heat Island Effect: Non-roof
SS Credit 7.2 Heat Island Effect: Roof

USGBC LEED® SS Credit 6.1 Stormwater Design: Quantity Control

1 Point

Intent

Limit disruption of natural water hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from stormwater runoff, and eliminating contaminants.

Requirements

CASE 1 — EXISTING IMPERVIOUSNESS IS LESS THAN OR EQUAL TO 50%

Implement a stormwater management plan that prevents the post-development peak discharge rate and quantity from exceeding the pre-development peak discharge rate and 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 protection strategy and quantity control strategies.

OR

CASE 2 — EXISTING IMPERVIOUSNESS IS GREATER THAN 50%

Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the two-year 24-hour design storm.

Potential Technologies & Strategies

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

Application of Credit SS 6.1

Permeable interlocking concrete pavement (PICP) is a type of pervious paving that can help earn this LEED® credit. Figure 2 illustrates examples of PICP for runoff reduction. A typical design consists of paving units with openings filled with small, open-graded crushed stone. The units are bedded on a 2 in. (50 mm) thick layer of the same filling material. The bedding layer is compacted into the base consisting of open-graded aggregate base and sub-base. They have sufficient space between stones to store water and allow it to infiltrate into the soil. The water storage capacity is typically 30% to 40% of the total volume of the base and sub-base. This water is allowed to infiltrate into the soil usually within 24 to 36 hours. Water that does not infiltrate can be filtered through the base and drained through perforated pipes at the bottom of the sub-base.

PICP benefits:

- Meet national/provincial/state stormwater regulations: part of best management practice (BMP) mix
- Conserves space: pavement built on detention facility
- Reduce retention requirements
- Filter and reduce nutrients, metals
- Groundwater recharge
- Lower peak flows/volume that helps preserve drainage system capacity while reducing downstream erosion
- Reduce runoff temperatures
- Potentially fewer drainage appurtenances
- Reinstatement of surface after repairs
- Filters oil drippings
- Resists frost heave and can be snowplowed
- Visually more attractive than alternatives

An in-depth presentation of design, specification, construction and maintenance is found in the ICPI publication, *Permeable Interlocking Concrete Pavements* (ICPI 2000). Most PICP will infiltrate runoff falling directly on it from 80% to 90% of all storms. The infiltration rate of the soil, base thickness (reservoir capacity) and any runoff from contributing areas will determine if PICP qualifies for reducing the peak discharge to the pre-development one and two year, 24 hour peak discharge rate. In most cases PICP will meet this requirement.

Pavement infiltration rates are a function of several factors including permeability of the fill material for the surface openings and for the base materials. No. 8 stone typically used in the openings has an infiltration rate exceeding 500 in./hr (12.7 m/hr). Infiltration rates of Nos. 57 and 2 stone used for the base and sub-base exceed 1,000 in./hr (25 m/hr). Over time, the voids in these materials can become clogged, especially around the stone in the surface openings. Nearby sources of sediment can typically run onto the pavement. Periodic maintenance with vacuum sweeping will help maintain high surface infiltration rates. Research has shown that high infiltration rates can be maintained by removing the sediment in the first inch (25 mm) of the openings (Gerrits 2002).

Figure 2. Examples of permeable interlocking concrete pavements for earning LEED® points. The photo on the left shows a hotel entrance in southern California. The photo on the right shows the driveway and parking lot for a fire station in Toronto.

Peak discharge rate, Q, can be calculated using the Rational Method where Q = CIA where C = the coefficient of runoff from the catchment, I = intensity of rainfall in in./hour, and A = area of the catchment. The Rational Method is a simple, first order method to estimate peak flows from a site with varying degrees of perviousness.

According to Ferguson (2005), the runoff coefficient, C, will vary with each storm. For small storms permeable pavements will infiltrate all of the rainfall rendering a low runoff coefficient. In intense storms, and when the soil is saturated from antecedent storms, the runoff coefficient will be higher. Since most sites are exposed to a range of storm intensities and durations, the overall runoff coefficient of 0.25 to 0.35 can be assumed for PICP.

Concrete grid pavements (see Figure 3) are another type of permeable pavement. They are typically used for less intense vehicular applications than PICP such as overflow parking and emergency fire lanes. Unlike PICP, the base is typically dense-graded, compacted aggregate. The grids are bedded in sand and the openings are filled with aggregate or topsoil and grass. If they have grass in the openings, the surface will require lawn maintenance such as mowing, seeding and fertilizing. *ICPI Tech Spec 8 Concrete Grid Pavements*

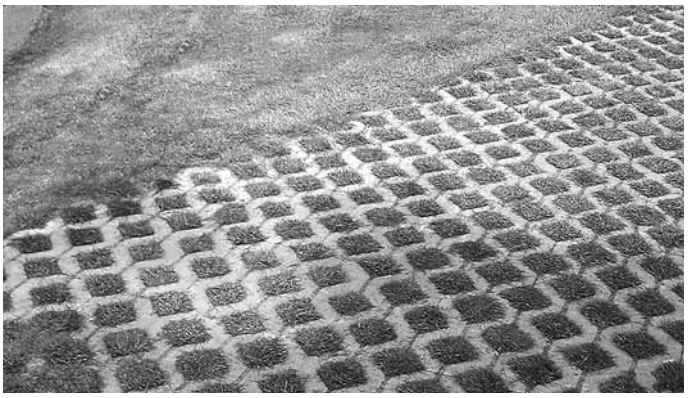

Figure 3. Concrete grid pavement substantially reduces runoff to levels approximating grass cover.

provides detailed information on applications, design, specifications, construction and maintenance. Concrete grid pavements can be used to earn this LEED® credit for runoff reduction. For Rational Method calculations a C value of 0.4 can be assumed if the grids are over a dense-graded aggregate base (Day 1980).

A more sophisticated runoff calculation method for calculating peak flow is the U.S. National Resource Conservation Service (NRCS) TR-55 method. TR-55 relies on development of a Curve Number or CN that characterizes the amount of runoff depth from various land uses within a catchment. The CN for PICP will vary with the infiltration rate of the underlying soil. For example, a typical CN for permeable pavements in sandy soils is in the 40s and for clay soils it might be in the 60s. Bean (2005) has characterized CNs for PICP and grid pavements.

Some municipalities use computer models to characterize urban runoff and project impacts on drainage systems. Models are sometimes calibrated with field measurements of rainfall, runoff, flows and pollutant loads. The hydrological characteristics of PICP and grid pavements can be input into these models to simulate their benefits on urban hydrology. The U.S. EPA Stormwater Management Model (SWMM) has been incorporated into software for computing the infiltration capacity of PICP (James 2003).

For the purposes of calculating site perviousness, PICP should be counted as almost 100% pervious. The rationale is that with an open-graded material in the openings and base, the long-term conservative pavement surface infiltration rate is approximately 3 in./hour (75 mm/hour). This well exceeds the the rainfall intensity of common rainfall events.

If runoff from an impervious area is directed to PICP, then PICP will be handling additional water other than rain falling directly on it. In such cases, calculate the average coefficient of runoff, C from the contributing area and the PICP and use the average for both areas. The averages would be weighted by the area of each surface. In these cases, the coefficient of runoff, C for PICP will likely be 0.25 to 0.4. Low C values should be used in high-infiltration sandy soils and higher values for lower-infiltration silt and clay soils.

Concrete grid pavements with topsoil and grass have lower, long-

term surface infiltration rates, typically 1 to 2 in./hour (25 to 50 mm/hour) (Smith, 1984). Like all pervious surfaces, grid pavement will infiltrate runoff from commonly occurring storms and eventually yield 100% runoff when saturated from concentrated high-intensity storms. The advantage of grid and PICP systems is they will store runoff for a period of time and release it at saturation well after adjacent saturated soil and vegetated areas. This storage and delay in generating runoff should be considered in drainage calculations.

A design example (Table 3) follows for calculating imperviousness with PICP and grid pavers for a 40,000 sf (3,716 m^2) site consisting of roofs and paving. This exemplifies the information required for LEED® documentation (USGBC 2003). The site has sandy soils with high infiltration rates. The following equations apply:

Impervious Area = Surface area x Runoff coefficient

$$\text{Site Imperviousness [\%]} = \frac{\text{Total impervious area}}{\text{Total site area}}$$

This example shows 52% site imperviousness reduced to 32% by using PICP and grid pavement. This represents a 38% reduction in impervious cover and a corresponding runoff quantity reduction. If the total site imperviousness for conventional design was less than 50% or less, the engineer must demonstrate that a design with sustainable pavements will have a peak discharge rate not exceeding that from a 2 year, 24 hour storm. In this case, the conventional site design imperviousness exceeded 50%. With a 38% reduction in site imperviousness, the designer demonstrated site design with PICP and grid pavement resulted in a minimum 25% reduction in the rate and quantity of runoff.

Table 3. Design Case for Calculating Impervious Area

Surface	Area (sf)	Runoff coefficient, C (imperviousness)	Conventional design Impervious area (sf)	LEED® design with PICP & grid pavement	Impervious area, PICP & grid pavement
Asphalt pavement	14,000	0.95	13,300	2,000 (entrance)	1,900
Conventional roof	8,000	0.95	7,600	7,600	7,600
PICP		0.25		12,000 (parking)	3,000
Grid pavement		0.40		400 (fire lane)	160
Total Paved Surface Area	22,000		20,900	22,000	12,660
Total Site Area	40,000		40,000		40,000
Site Imperviousness			52%		32%

USGBC LEED® SS Credit 6.2 Stormwater Design: Quality Control

1 Point

Intent

Limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements

Implement a stormwater management plan that reduces impervious cover, promotes infiltration, and captures and treats the stormwater runoff from 90% of the average annual rainfall[1] using acceptable best management practices (BMPs).

BMPs used to treat runoff must be capable of removing 80% of the average annual post development total suspended solids (TSS) load based on existing monitoring reports. BMPs are considered to meet these criteria if (1) they are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards, or (2) there exists in-field performance monitoring data demonstrating compliance with the criteria. Data must conform to accepted protocol (e.g., Technology Acceptance Reciprocity Partnership [TARP], Washington State Department of Ecology) for BMP monitoring.

Potential Technologies & Strategies

Use alternative surfaces (e.g., vegetated roofs, pervious pavement or grid pavers) and nonstructural techniques (e.g., rain gardens, vegetated swales, disconnection of imperviousness, rainwater recycling) to reduce imperviousness and promote infiltration thereby reducing pollutant loadings. Use sustainable design strategies (e.g., Low Impact Development, Environmentally Sensitive Design) to design integrated natural and mechanical treatment systems such as constructed wetlands, vegetated filters, and open channels to treat stormwater runoff.

[1] In the United States, there are three distinct climates that influence the nature and amount of rainfall occurring on an annual basis. Humid watersheds are defined as those that receive at least 40 inches of rainfall each year, Semi-arid watersheds receive between 20 and 40 inches of rainfall per year, and Arid watersheds receive less than 20 inches of rainfall per year. For this credit, 90% of the average annual rainfall is equivalent to treating the runoff from:
(a) Humid Watersheds – 1 inch of rainfall;
(b) Semi-arid Watersheds – 0.75 inches of rainfall; and
(c) Arid Watersheds – 0.5 inches of rainfall.

Application of SS Credit 6.2

Roofs, sidewalks, driveways and streets (impervious cover) contribute additional runoff and pollution by denying infiltration of stormwater. These surfaces generate excessive amounts of runoff with sediment (total suspended solids or TSS) and water carrying nutrients (total phosphorous or TP and nitrogen forms) and metals. Other pollutants such as pesticides, detergent, fertilizer, oils, other chemicals and salts remain in suspension or solution in the flowing water which can damage wildlife and fish. Increased runoff flows and pollution are directed into waterways decreasing property values, fishing income and recreation opportunities. Some municipalities have older, combined sanitary and storm sewer systems. These discharge raw sewage into rivers when storm flows exceed the processing rate of the local waste treatment plant.

Since PICP reduces runoff through infiltration, it has the ability to reduce TSS and TP. Several studies have demonstrated at least 80% reduction of TSS, a good indicator pollutant treatment. Studies include James (1997) and Rushton (2001). Studies that demonstrate at least 40% TP reduction include James (1997), Rushton (2001) and Bean (2005). All studies compared reductions of pollutants from PICP to that from impervious pavements. These studies provide evidence of the ability of PICP to reduce TSS and TP. In addition, the *LEED® Reference Guide (2005)* suggests a 60%-80% removal efficiency for pervious pavement.

Pre-treatment and filtering of runoff prior to entering PICP will assist in reducing TSS and TP emissions. Practices such as bioswales and sand filters can receive and filter runoff prior to entering adjacent PICP as well as receive outflows from PICP. The entire flow path design for runoff should be considered, especially when PICP is designed to receive runoff from impervious surfaces.

Integration with Other LEED® Credits

In addition to earning LEED® credits for reducing stormwater runoff and pollution, PICPs may earn points from Credit 7.1, Heat Island Effect, non-roof when the paving units have a minimum Solar Reflectance Index of 29. Another point can be earned from Credit 1.1, Water Efficiency under Water Efficient Landscaping when water captured in the PICP base is used for toilet grey water or for exterior irrigation.

USGBC LEED® SS Credit 7.1 Heat Island Effect: Non-Roof

1 Point

Requirements

OPTION 1

Provide any combination of the following strategies for 50% of the site hardscape (including roads, sidewalks, courtyards and parking lots):

- Shade (within 5 years of occupancy) • Paving materials with a Solar Reflectance Index (SRI)[2] of at least 29
- Open grid pavement system

OR

OPTION 2

Place a minimum of 50% of parking spaces under cover (defined as under ground, under deck, under roof, or under a building). Any roof used to shade or cover parking must have an SRI of at least 29.

Potential Technologies & Strategies

Shade constructed surfaces on the site with landscape features and utilize high-reflectance materials for hardscape. Consider replacing constructed surfaces (i.e. roof, roads, sidewalks, etc.) with vegetated surfaces such as vegetated roofs and open grid paving or specify high-albedo materials to reduce the heat absorption.

[2]The Solar Reflectance Index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980-01. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Default values for some materials will be available in the LEED®-NC v2.2 Reference Guide.

Applications of SS Credit 7.1

All segmental concrete paving can meet three of the four above Submittals. While PICP doesn't provide shade, it can be used as paving around shade trees to allow air and water to reach roots. This indirect benefit ensures a longer tree life compared to impervious pavement that deprives air and water from reaching tree roots. An example of this application in a parking lot protecting an historic tree is found in the ICPI brochure, *Project Profiles – Permeable Interlocking Concrete Pavement* (ICPI 2005).

Solar Reflectance Index (SRI) of Segmental Concrete Paving Products—SRI consists of combined albedo and emittance measurements. Albedo is the ratio of outbound or reflected solar radiation divided by the inbound radiation. Lighter colored surfaces indicate a higher albedo than dark surfaces. The highest albedo of 1.0 means all solar energy reflects back from a surface with no absorbed energy. The test method for determining albedo is ASTM E 903, *Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres* (ASTM 2005). Reflectance is measured over a range of wavelengths and averaged to provide a single albedo value.

According to the *LEED® Reference Guide* (2003) new concrete made with grey cement has an albedo of 0.35 to 0.40 and weathered concrete 0.20 to 0.30. New concrete made with white cement generally has an albedo of 0.7 to 0.8 and 0.4 to 0.6 when weathered. White cement is about twice as expensive as grey cement. However, some normal cement can be light in color and be cost competitive. Cement and aggregate colors influence concrete color. For segmental concrete paving products, light colored aggregates and surface treatments with white cement can contribute to a higher albedo. Figure 4 shows an application with light colored paving slabs. By

comparison, asphalt reflectance is 0.05 to 0.10 when new and 0.10 to 0.15 when weathered.

Periodic surface cleaning may be required to maintain a minimum required SRI values. *ICPI Tech Spec 5 – Cleaning, Sealing and Joint Sand Stabilization of Interlocking Concrete Pavement* provides additional guidance. When measured and documented in the LEED application process, existing interlocking concrete pavement surfaces can qualify for this credit. Samples taken from areas can be measured for their SRI and averaged to achieve this credit.

A study by Lawrence Berkeley National Laboratories (Pomerantz, 2000) notes that new asphalt exhibited an albedo of 0.04 and five year-old pavements 0.12, substantially lower the 0.3 recommended in the LEED® rating system. In their experiments, they found that an increase in albedo of about 0.1 produces a decrease in pavement temperature of about 4° ±1° C (-7° ± 2° F) when there is little wind. Increasing wind speed lowers the surface temperature and diminishes the influence of the change in albedo.

Emittance measures a material's ability to release radiant heat (in watts/m^2) from a given wavelength spectrum. It is measured using *ASTM E 408 – Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques*. Emittance and albedo measurements are combined to calculate SRI per *ASTM E 1980 – Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces*. As noted earlier, surface color affects albedo and indirectly affects emittance. Since most manufacturers provide a range of colors, SRI measurements should be requested from manufacturers for specific product color or ranges, especially lighter colored products. Testing laboratories can provide requirements for specimen sizes cut from segmental concrete paving products. Specimen sizes are generally 2 x 2 in. (50 x 50 mm) by ½ in. (13 mm) thick. The overall all objective of the SRI is to encourage light colored surfaces that reduce surface temperatures. High SRI surfaces can help reduce the urban heat island, the dome of warm air over a city that increases summer air conditioning costs and traps air pollutants.

Grid pavement— LEED® defines open-grid pavement as one having less than 50% imperviousness. This includes concrete grid pavements with grass. Compared to asphalt, grassed grid pavements will reduce surface air temperatures by 2° to 4° F (1° to 2° C) and radiometric temperatures by 4° to 6° F (2° to 4° C) (Smith, 1981). Evapo-transpiration from the grass provides this cooling. Concrete grid pavers are recommended for overflow or intermittent parking areas and aren't intended where cars park regularly. Grids and grass will provide heat reducing benefits for these areas. Areas with regular parking should be paved with PICP.

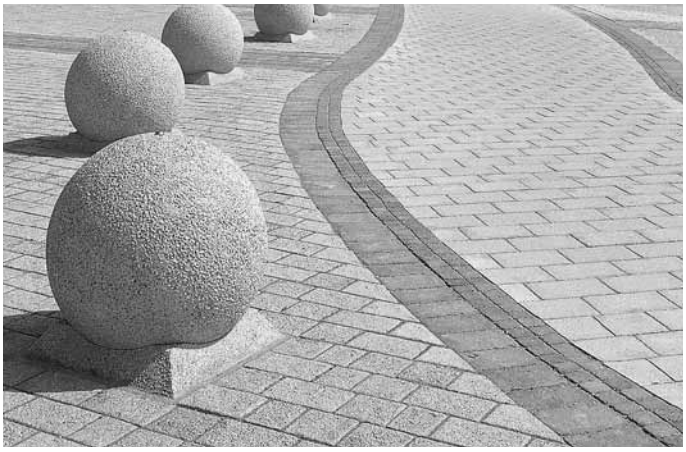

Figure 4. Light colored paving units reflect light and help reduce mico-climatic temperatures.

USGBC SS Credit 7.2 Heat Island Effect: Roof

1 Point

Requirements

OPTION 1

Use roofing materials having a Solar Reflectance Index (SRI)[3] equal to or greater than the values in the table below for a minimum of 75% of the roof surface.

OR

OPTION 2

Install a vegetated roof for at least 50% of the roof area.

OR

OPTION 3

Install high albedo and vegetated roof surfaces that, in combination, meet the following criteria: (Area of SRI Roof / 0.75) + (Area of vegetated roof / 0.5) ≥Total Roof Area

Roof Type	Slope	SRI
Low-Sloped Roof	≤2:12	78
Steep-Sloped Roof	>2:12	29

Potential Technologies & Strategies

Consider installing high-albedo and vegetated roofs to reduce heat absorption. SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371. Default values will be available in the LEED®-NC v2.2 Reference Guide. Product information is available from the Cool Roof Rating Council website, at www.coolroofs.org.

[3]The Solar Reflectance Index (SRI) is a measure of the constructed surface's ability to reflect solar heat, as shown by a small temperature rise. It is defined so that a standard black (reflectance 0.05, emittance 0.90) is 0 and a standard white (reflectance 0.80, emittance 0.90) is 100. To calculate the SRI for a given material, obtain the reflectance value and emittance value for the material. SRI is calculated according to ASTM E 1980. Reflectance is measured according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Emittance is measured according to ASTM E 408 or ASTM C 1371.

Calculations

Simple formulas for calculating shade, pervious portion of the site and vegetated roof percentages are provided below (USGBC 2003):

$$\text{Shade [\%]} = \frac{\text{Shaded Impervious Area}}{\text{Total Impervious Area}}$$

$$\text{Pervious Portion [\%]} = \frac{\text{Pervious Parking Area}}{\text{Total Parking Area}}$$

$$\text{Vegetated Roof [\%]} = \frac{\text{Vegetated Roof Area}}{\text{Total Roof Area}}$$

Some projects may combine a green roof with high reflectance roofing materials such concrete pavers or paving slabs. A sample calculation to meet the CaGBC credit calculates the minimum areas of green roof and reflective roof using the following formula:

(1.5 x Area green roof) + Area of reflective roof = 0.75 x Total roof area

For example, if the total roof area is 10,000 sf (1,000 m^2) and 4,000 sf (400 m^2) were designed as a green roof, the area of the reflective roof required to meet this credit is 1,500 sf or 150 m^2, or:

$$(1.5 \times 4{,}000 \text{ sf}) + X = 0.75 \times 10{,}000 \text{ sf}$$
$$6000 + X = 7500$$
$$X = 1500$$

Figure 5. Light colored paving on low-slope roofs reflects light saving on air-conditioning costs while protecting the waterproofing.

Materials and Resources

USGBC LEED® Credits applicable to segmental concrete paving products include the following:

Credit MR 2.1 Construction Waste Management: Divert 50% from Disposal
Credit MR 2.2 Construction Waste Management: Divert 75% From Disposal
Credit MR 3.1 Materials Reuse: 5%
Credit MR 3.2 Materials Reuse: 10%
Credit MR 4.1 Recycled Content: 10% (post-consumer + ½ post-industrial)
Credit MR 4.2 Recycled Content: 20% (post-consumer + ½ post-industrial)
Credit MR 5.1 Regional Materials: 10% Extracted, Processed and Manufactured Regionally
Credit MR 5.2 Regional Materials: 20% Extracted, Processed and Manufactured Regionally

USGBC LEED® MR Credit 2.1 Construction Waste Management: Divert 50% from Disposal

1 Point

Intent

Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements

Recycle and/or salvage at least 50% of non-hazardous construction and demolition debris. Develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or comingled. Excavated soil and land-clearing debris do not contribute to this credit. Calculations can be done by weight or volume, but must be consistent throughout.

Potential Technologies & Strategies

Establish goals for diversion from disposal in landfills and incinerators and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, acoustical tile, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area(s) on the construction site for segregated or comingled collection of recyclable materials, and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials on-site.

USGBC LEED® MR Credit 2.2 Construction Waste Management: Divert 75% from Disposal

1 Point in addition to MR Credit 2.1

Intent

Divert construction and demolition debris from disposal in landfills and incinerators. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements

Recycle and/or salvage an additional 25% beyond MR Credit 2.1 (75% total) of non-hazardous construction and demolition debris. Excavated soil and land-clearing debris do not contribute to this credit. Calculations can be done by weight or volume, but must be consistent throughout.

Potential Technologies & Strategies

Establish goals for diversion from disposal in landfills and incinerators and adopt a construction waste management plan to achieve these goals. Consider recycling cardboard, metal, brick, acoustical tile, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area(s) on the construction site for segregated or commingled collection of recyclable materials, and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designated materials. Note that diversion may include donation of materials to charitable organizations and salvage of materials on-site.

Application of Credits MR 2.1 and 2.2

High tipping fees at landfills and threat of soil pollution have forced recycling of construction and demolition waste. The US EPA estimates this type of waste accounts for 23% of municipal solid waste (USGBC 2003). Like most concrete, pavers can be crushed and recycled, or removed and reinstated elsewhere on the site.

A key consideration is that waste material reused on-site or processed and shipped off-site cannot be used for other LEED® credits such as those from Resource Reuse, Recycled Content or Regional Materials content credits. These three credits are based on costs. The intent of Credits MR 2.1 and 2.2 is to recycle construction waste on the site, or process and place it into the market for recycled materials. These actions do not involve a purchase transaction. The types of demolition waste from a site should be estimated (by weight or volume) and listed in a waste management plan. Their ultimate destination should also be identified as well as the percentage of waste that remains on the site.

The crowded nature of construction in dense urban areas will almost always require collection of concrete in waste bins for shipment to off-site processing. Other projects may have sufficient space on the site to separate and process waste construction materials. In such cases, local regulations for processing should be followed.

In contrast, concrete removed from the site, processed and sold back to the same job site, or recycled material purchased from elsewhere and brought to the site can qualify for Recycled Content and Regional Materials credits. Examples are shipping used concrete pavers to a recycler, crushing them and purchasing them back for re-use on the site as base material. Another example is purchasing recycled, crushed concrete for a base under interlocking concrete pavements. These two examples could earn Recycled Content and Regional Materials content credits.

Documentation

If the project involves renovating an existing site, concrete pavers at the site can be re-used or directed to other appropriate sites. Concrete pavers can also be crushed and re-used for road base materials. A list of the total construction waste is required, measured by weight or volume, specifying those that will be diverted from the landfill. This list is typically prepared by the company responsible for waste management on the site. Calculations can be in weight or volume, but they must be consistent. They do not include hazardous waste and excavated soil. Typically, waste containers are sized by volume and are weighed at the material recovery facility or landfill site. Typical factors for converting concrete paver volume to weight are 140 to 145 lbs/ft^3 (2240 to 2350 kg/m^3) for stacked pavers and approximately 100 lb/ft^3 (1600 kg/m^3) for loose pavers in a bin.

The following equation is used to calculate the percent recycled:

$$\% \text{ Recycled} = \frac{\text{Recycled Waste}}{\text{Recycled Waste} + \text{Garbage}}$$

Where Garbage is the land-filled material and the Recycled Waste is the recycled construction, demolition and land clearing wastes.

USGBC LEED® MR Credit 3.1 Materials Reuse: 5%

1 Point

Requirements

Use salvaged, refurbished or reused materials such that the sum of these materials constitutes at least 5%, based on cost, of the total value of materials on the project.

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

Potential Technologies & Strategies

Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items.

USGBC LEED® MR Credit 3.2 Materials Reuse: 10%

1 Point in addition to MR Credit 3.1

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 10% of building materials.

Requirements

Use salvaged, refurbished or reused materials for an additional 5% beyond MR Credit 3.1 (10% total, based on cost). Mechanical, electrical and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3–7.

Potential Technologies & Strategies

Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items.

Application of Credits MR 3.1 and 3.2

A material salvaged during a building renovation can be applied to this credit only if it can no longer serve its original function and has been reprocessed and installed for a different use. An example would be crushing salvaged concrete pavers for reuse as pavement base material. However, on a project where an existing building is being demolished or deconstructed the material salvaged and installed on the new site can be used to comply to this credit.

Documentation

To calculate the percentage of salvaged material, list all of the salvaged materials and their costs. If the cost of the salvaged material is below market value, use the replacement cost. For example, salvaged concrete pavers may be purchased for \$.50/ft² (\$5.38/m²) and new pavers would cost \$2.50/ft² (\$26.90/m²). For this credit, use the new cost in the following salvage calculation:

$$\%\ \text{Salvage Rate} = \frac{\text{Market value of salvage materials if purchased new}}{\text{Total project material costs}}$$

For example, total material costs on a project are \$1,600,000 (excluding labor and equipment costs). Existing concrete pavers on the site are salvaged and reused for a 35,000 ft² (3,500 m²) parking lot at a potential new cost of \$2.50/ft² (\$26.90/m²). The market value of new replacement material is \$87,500. Therefore, 5.4% of the materials costs are spared through salvaging and reuse. This qualifies for one point. An additional point is earned if other salvaged materials from the project are added to this to bring this calculation to over 10%.

USGBC LEED® MR Credit 4.1 Recycled Content: 10% (post-consumer + 1/2 pre-consumer)

1 Point

Intent

Increase demand for building products that incorporate recycled content materials, therefore 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% (based on cost) of the total value of the materials in the project.

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 assembly to determine the recycled content value.

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

Recycled content shall be defined in accordance with the International Organization of Standards document, *ISO 14021—Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling).*

Post-consumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose. Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process. Excluded is 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.

Potential Technologies & Strategies

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

USGBC LEED® MR Credit 4.2 Recycled Content: 20% (post-consumer + 1/2 pre-consumer)

1 Point in addition to MR Credit 4.1

Requirements

Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes an additional 10% beyond MR Credit 4.1 (total of 20%, based on cost) of the total value of the materials in the project.

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 assembly to determine the recycled content value.

Mechanical, electrical and plumbing components and specialty items such as elevators shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3–7. Recycled content shall be defined in accordance with the International Organization of Standards document, *ISO 14021—Environmental labels and declarations—Self-declared environmental claims (Type II environmental labeling).*

Post-consumer material is defined as waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

Pre-consumer material is defined as material diverted from the waste stream during the manufacturing process. Excluded is 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.

Potential Technologies & Strategies

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

Application of Credits MR 4.1 and 4.2

Segmental concrete paving products can be made with recycled materials and contribute to this credit. A portion of the cement can be replaced with flyash (coal combustion by-product), silica fume (by-product of silicon production), ground granulated blast furnace slag (from steel production), and recycled aggregate. They are called supplementary cementitious materials or SCMs.

There is a growing amount of evidence that release of CO_2 from combustion and methane gasses contribute to global warming. For every ton of cement produced about a ton of CO_2 is released into the atmosphere. (Compare this to one gallon (3.8 l) of gasoline generates about 20 lbs (9 kgs) of CO_2.) Cement production comprises approximately 6% of CO_2 generated throughout the world. Replacing a portion of cement with SCMs reduces CO_2 output.

The potential for replacing cement will vary among paver manufacturers based on their location, which affects price and availability of recycled materials. Consult with an ICPI producer member to determine use of cement substitutes in paving products. Some cement suppliers to paver producers may provide cement with SCMs. Recycled content within cement does not count toward this credit unless the cement supplier provides a statement of recycled content for the cement.

Documentation

The percentage requirements in this LEED® credit are based on cost. Post-consumer recycled content refers to recycled materials or products recovered and recycled after use by the consumer, e.g. a plastic bottle. For manufactured concrete pavers, this is typically not used in the calculation. Post industrial waste for concrete pavers means recycled materials or products recovered and traded such as flyash, slag or silica fume. These materials should meet the ASTM and CSA definitions for SCMs.

Using a concrete mix without supplementary cementing materials is compared to the mix ingredients used with SCMs to calculate the Portland cement reduction. This is converted to a percent with a factor of 2 applied to account for the environmental merits of reducing Portland cement by substituting it with SCM's. An example follows:

Basic mix: Concrete paver cement content: 16% Portland cement (by weight of total dry mix)

SCM mix: Concrete paver with SCMs: 14% Portland cement + 2% flyash (by weight of total dry mix)

Percentage of Portland cement reduction = [(Portland cement content of pavers without SCMs – Portland cement content used with SCMs)/Portland cement content of pavers without SCMs] x 100 x 2

$$\text{Reduction in Portland Cement} = \left(\frac{16 - 14}{16}\right) \times 100 \times 2 = 25\%$$

This is the post industrial recycled content contributed by the concrete pavers. It is used to calculate the recycled content value in the concrete pavers. For example, if the concrete pavers for a 30,000 ft² (3,000 m²) project were purchased for $75,000, the post industrial recycled value is $75,000 x 25% x ½ = $9,375. This result is added to post-consumer and other post industrial contributions from other materials used for the project. The total post-consumer and post industrial contribution are divided by the total material costs for the project to determine the percent of recycled content. All materials with recycled content are listed on a spreadsheet with their cost, percentage of post-consumer and one-half of the percentage of post-industrial recycled content and resulting dollar values of recycled content. Installation costs are excluded. If the percentage of the value recycled content is 10% or more one point is earned. Two points are earned if the percentage is 20% or more.

USGBC LEED® MR Credit 5.1
Regional Materials: 10% Extracted, Processed & Manufactured Regionally
1 Point

Intent
Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation.

Requirements
Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% (based on cost) 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 and equipment shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3–7.

Potential Technologies & Strategies
Establish a project goal for locally sourced materials, and identify materials and material suppliers that can achieve this goal. During 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.

USGBC LEED® MR Credit 5.2
Regional Materials: 20% Extracted, Processed & Manufactured Regionally
1 Point in addition to MR Credit 5.1

Intent
Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation.

Requirements
Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for an additional 10% beyond MR Credit 5.1 (total of 20%, based on cost) of the total materials value. If only a fraction of the material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

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

Application of Credit MR 5.1 and MR 5.2
Segmental concrete paving products can earn these credits since most extraction of aggregate and sand from quarries and the manufacturing plant are often within 500 miles (800 km) of the project site.

Documentation
Credits 5.1 and 5.2 are met by the contractor providing costs to the designer for all materials that meet these requirements. The invoice cost is typically used but must exclude transportation costs. In addition, a letter from the manufacturer should indicate the location of the manufacturing facility and location of the source(s) of extracted materials. Material product sheets can be provided instead of a letter if the sheets clearly state the manufacturing location and resource extraction locations.

A single letter from a manufacturer can certify compliance with more than one credit. For example, a single letter can be supplied for concrete pavers with a recycled content and production within 500 miles (800 km) of the project.

Other Sources of LEED® Credits

Innovation and Design Processes—USGBC LEED® Credits applicable to segmental concrete paving products include one to four points for Innovation in Design and an additional point for using a LEED® Accredited Professional. Innovation in Design encourages new ideas in sustainability to gain recognition. The LEED® Accredited Professional encourages designers to have a person with this credential on the design team.

The USGBC and CaGBC LEED® Credit 1 for Innovation in Design are almost identical. See below and page 23. Likewise, USGBC LEED® Credit 2.1 and CaGBC LEED® Credit 2 for Accredited Professional are almost identical. See below and page 23.

USGBC LEED® ID Credit 1-1.4 Innovation in Design

1 to 4 Points

Intent

To provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED® Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED® Green Building Rating System.

Requirements

Credit 1.1 (1 point) In writing, identify the **intent** of the proposed innovation credit, the proposed **requirement** for compliance, the proposed **submittals** to demonstrate compliance, and the **design approach** (strategies) that might be used to meet the requirements.

Credit 1.2 (1 point) Same as Credit 1.1

Credit 1.3 (1 point) Same as Credit 1.1

Credit 1.4 (1 point) Same as Credit 1.1

Potential Technologies & Strategies

Substantially exceed a LEED® performance credit such as energy performance or water efficiency. Apply strategies or measures that demonstrate a comprehensive approach and quantifiable environment and/or health benefits.

Application of Credit 1

This credit category enables designers to incorporate innovative improvements in building materials and design into the LEED® rating system. Besides original innovative design, credits may be awarded if a project achieves exceptional performance under an existing LEED® credit for that project. Examples include exceeding or using water exfiltrated from PICP for landscape irrigation or grey water reuse in the building. As a general rule of thumb, ID credits for exceptional performance are awarded for doubling the credit requirements and/or achieving the next incremental percentage threshold.

USGBC LEED® ID Credit 2.1 LEED® Accredited Professional

1 Point

Intent

To support and encourage the design integration required by a LEED® Green Building project and to streamline the application and certification process.

Requirements

At least one principal participant of the project team shall be a LEED® Accredited Professional (AP).

Potential Technologies & Strategies

Educate the project team members about green building design & construction and application of the LEED® Rating System early in the life of the project. Consider assigning the LEED® AP as a facilitator of an integrated design & construction process.

CaGBC LEED®-NC Version 1.0 Credits

Sustainable Sites

Credits applicable to segmental concrete paving products for sustainable sites include the following:

SS Credit 6.1 Stormwater Management, Rate and Quality
SS Credit 6.2 Stormwater Management, Treatment
SS Credit 7.1 Heat Island Effect, Non-roof
SS Credit 7.2 Heat Island Effect, Roof

CaGBC LEED® SS Credit 6.1 Stormwater Management, Rate and Quantity

1 point

Intent

Limit disruption and pollution of natural water flows by managing stormwater runoff.

Requirements

If existing imperviousness is less than or equal to 50%, implement a stormwater management plan that prevents the post-development 1.5 year, 24 hour peak discharge rate and quantity from exceeding the pre-development 1.5 year, 24 hour peak discharge rate and quantity.

OR,

If existing imperviousness is greater than 50%, implement a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff.

Submittals

Provide the LEED® Letter Template, signed by the civil engineer or responsible party, declaring that the post-development 1.5 year, 24 hour peak discharge rate and quantity does not exceed the pre-development 1.5 year 24 hour peak discharge rate and quantity. Include calculations demonstrating that existing site imperviousness is less then or equal to 50%.

OR,

Provide the LEED® Letter Template, signed by the civil engineer or responsible party, declaring and demonstrating that the stormwater management strategies result in at least a 25% decrease in the rate and quantity of stormwater runoff. Include calculations demonstrating that existing site imperviousness exceeds 50%.

If an audit of this Credit is requested during the certification process:

For sites with less than 50% net imperviousness, provide pre-construction and post-construction site drawing. Include area calculations demonstrating no increase in net imperviousness of the site.

OR,

For sites with greater than 50% net imperviousness, provide a copy of the stormwater management plan. Include calculations describing how the measures of the plan decrease net imperviousness of the site by 25% over existing conditions.

Potential Technologies & Strategies

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

CaGBC LEED® SS Credit 6.2 Stormwater Management, Treatment

1 point

Intent

Limit disruption of natural water flows by elimination stormwater runoff, increasing on-site infiltration and eliminating contaminants.

Requirements

Construct site stormwater treatment systems designed to remove 80% of the average annual post-development total suspended solids (TSS) and 40% of the average annual post-development total phosphorous (TP) based on the average annual loadings from all storms less than or equal to the 2-year/24 hour storm.

Do so by implementing the Best Management Practices (BMPs) outlined in Chapter 4, Part 2 (Urban Runoff), of the United States Environmental Protection Agency's (EPA's) Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, January 1993 (Document No. EPA-840-B-92-002) or the local government's BMP document (which ever is more stringent).

Submittals

Provide the LEED® Letter Template, signed by the civil engineer or responsible party, declaring that the design complies with or exceeds EPA or local government Best Management Practices (whichever set is more stringent) for removal of the total suspended solids and total phosphorous.

If an audit of this Credit is requested during the certification process:

Provide drawings and specifications describing EPA Best Management Practices implemented for removal of TSS and TP.

Provide calculations to demonstrate that the BMP's meet or exceed the minimum treatment requirements of the credit.

Potential Technologies & Strategies
Design mechanical or natural treatment systems such as constructed wetlands, vegetated filter strips and bioswales to treat the site's stormwater.

CaGBC LEED® SS Credit 7.1 Heat Island Effect: Non-Roof

1 Point

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

Requirements
Provide shade (within 5 years) and/or use light-coloured / high-albedo materials (reflectance of at least 0.3) and/or open grid pavement for at least 30% of the site's non-roof impervious surfaces, including parking lots, walkways, plazas, etc.;

OR,

Place a minimum of 50% of parking spaces underground or covered by structured parking;

OR,

Use an open-grid pavement system (less than 50% impervious) for a minimum of 50% of the parking lot area.

Submittals
Provide the LEED® Letter Template, signed by the civil engineer or responsible party, referencing the site plan to demonstrate areas of paving, landscaping (list species) and building footprint, and declaring that:

A minimum of 30% of non-roof impervious surfaces areas are constructed with high-albedo materials and/or open grid pavement and/or will be shaded within five years

OR,

A minimum of 50% of parking spaces have been placed underground or are covered by structural parking

OR,

An open-grid pavement system (less than 50% impervious) has been used for a minimum of 50% of the parking lot area.

If an audit of this Credit is requested during the certification process:

Provide drawings highlighting all non-roof impervious surfaces and potions of these surfaces that will be shaded within five years. Including calculations demonstrating that a minimum of 30% of non-roof impervious surfaces areas will be shaded within five years.

OR,

Provide specifications and cut sheets for high-albedo materials applied to non-roof impervious surfaces highlighting reflectance of the installed materials.

OR,

Provide drawings and cut sheets for a pervious paving system with a minimum perviousness of 50%. Including calculations demonstrating that the paving system covers a minimum of 50% of the total parking area.

Potential Technologies & Strategies
Shade constructed surfaces on the site with landscape features and minimize the overall building footprint. Consider replacing constructed surfaces (i.e. roof, roads, sidewalks, etc.) with vegetated surfaces such as garden roofs and open grid paving or specify high-albedo materials to reduce the heat absorption.

CaGBC LEED® SS Credit 7.2 Heat Island Effect: Roof

1 Point

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

Requirements
Use ENERGY STAR® compliant (highly reflective) AND high emissivity roofing (emissivity of at least 0.9 when tested in accordance with ASTM 408) for a minimum of 75% of the roof surfaces;

OR,

Install a "green" (vegetated) roof for at least 50% of the roof area.

Combinations of high albedo and vegetated roof can be used but they must collectively provide an effective area equal or greater than the 75% coverage that would be provided by a reflective roof alone but accounting for the relative weighted contributions.

Submittals
Provide the LEED® Letter Template, signed by the civil engineer or responsible party, referencing the building plan and declaring that the roofing material comply with the ENERGY STAR® Label requirements and have a minimum emissivity of 0.9. Demonstrate that high-albedo and vegetated roof areas combined constitute at least 50% of the total roof area.

OR,

Provide the LEED® Letter Template, signed by the architect or responsible party, referencing the building plan and demonstrating that combined vegetated roof areas and high albedo surfaces are equivalent to at least 75% of the total roof area using a high albedo surface.

If an audit of this Credit is requested during the certification process:

Provide specifications and cut sheets highlighting roofing materials that are Energy Star labeled, with a minimum initial reflectance of 0.65, and a minimum three-year-aged reflectance of 0.5, and a minimum emissivity of 0.9. Include area calculations demonstrating that the roofing material covers a minimum of 75% of the total roof area.

OR

Provide specifications and cut sheets highlighting a green vegetated roof system. Include area calculations demonstrating that the roof system covers a minimum of 50% of the total roof area.

OR

Provide specifications and cut sheets highlighting reflective, low emittance roofing materials and green vegetated roof systems that collectively meet the credit requirement. Include area calculations demonstrating that the combined roof system provides an equivalent minimum area to the 75% coverage using a high albedo surface.

Potential Technologies & Strategies

Visit the ENERGY STAR® Web site, www.energystar.gov, to look for compliant products. Consider installing high-albedo and vegetated roofs to reduce heat absorption.

Application of SS Credit 7.2

Emittance – Emissivity or infrared emittance is a parameter between 0 and 1 which measures the ability of a warm or hot material to shed some of its heat in the form of infrared radiation (Cool Roofing). The wavelength range for this radiant energy is approximately 5 to 40 micrometers. Most building materials are opaque in this part of the spectrum and have an emittance of roughly 0.9. Concrete paving products have a minimum emissivity of 0.9 so they would conform to this requirement. ASTM E 408, *Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques* is used to determine emittance of materials (ASTM 2005).

ENERGY STAR® Rating –ENERGY STAR® is a U.S. government rating system to assess the ability of roof material to reflect solar radiation which reduces air conditioning loads. Lighter colored roof surfaces yield lower air conditioning costs. To qualify for ENERGY STAR®, roof products such as concrete pavers and paving slabs must have warranties comparable to non-reflective roof products. They also must meet the criteria in Table 3 for albedo or solar reflectance.

Practically all paving products used in roofs would be in low-slope applications. ASTM E 903 is used to determine solar reflectance or albedo. Specifiers should request reflectance data from suppliers. Albedo of paving products for non-roof applications applies to those used on roofs.

The ENERGY STAR® website <www.energystar.gov> lists compliant roofing products and also cross references with the reflectance and emissivity data listed in the Lawrence Berkeley National Laboratory's Cool Roofing Materials Database. This data does not include concrete unit paving. Specifiers may request reflectance and emissivity data from suppliers.

Table 3 . ENERGY STAR ® *reflectance requirements*

Roof Slope	Initial Solar Reflectance	3rd Year Solar Reflectance
Low-slope (≤ 2:12 inches)	> 0.65	> 0.50
Steep-slope (> 2:12 inches)	> 0.25	> 0.15

Materials and Resources

USGBC and CaGBC LEED® Credits applicable to segmental concrete paving products include the following:

Credit MR 2.1 Construction Waste Management: Divert 50% from Landfill
Credit MR 2.2 Construction Waste Management: Divert 75% From Landfill
Credit MR 3.1 Resource Reuse: 5%
Credit MR 3.2 Resource Reuse: 10%
Credit MR 4.1 Recycled Content: 7.5% (post-consumer + ½ post-industrial)
Credit MR 4.2 Recycled Content: 15% (post-consumer + ½ post-industrial)
Credit MR 5.1 Regional Materials: 10% Extracted and Manufactured Regionally
Credit MR 5.2 Regional Materials: 20% Extracted and Manufactured Regionally

CaGBC LEED® MR Credit 2.1 Construction Waste Management: Divert 50% from Landfill

1 Point

Intent

Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements

Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage at least 50% of construction demolition and land clearing waste. Calculations can be done by weight or volume,

but must be consistent throughout.

Submittals
Provide the LEED® Letter Template, signed by the architect, owner or responsible party, tabulating the total waste material, quantities diverted and the means by which diverted, and declaring that the Credit requirements have been met.

If an audit is requested during the certification process:

Provide a copy of the Waste Management Plan for the project highlighting recycling and salvage requirements. Include calculations demonstrating that 50% of the non-shell components were reused.

Provide calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.

Potential Technologies & Strategies
Establish goals for landfill diversion and adopt a construction waste management plan to achieve these goals. Consider recycling land clearing debris, cardboard, metal, brick, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area on the construction site for recycling and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designation of materials. Note that salvage may include donation of materials to charitable organizations such as Habitat for Humanity.

CaGBC LEED® MR Credit 2.2 Construction Waste Management: Divert 75% from Landfill

1 Point

Intent
Divert construction, demolition and land clearing debris from landfill disposal. Redirect recyclable recovered resources back to the manufacturing process. Redirect reusable materials to appropriate sites.

Requirements
Develop and implement a waste management plan, quantifying material diversion goals. Recycle and/or salvage and additional 25% (75% of total) of construction, demolition and land clearing waste. Calculations can be done by weight or volume, but must be consistent throughout.

Submittals
Provide the LEED® Letter Template, signed by the architect, owner or responsible party, tabulating the total waste material, quantities diverted and the means by which diverted, and declaring that the Credit requirements have been met.

If an audit is requested during the certification process:

Provide a copy of the Waste Management Plan for the project highlighting recycling and salvage requirements.

Provide calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 75% of construction wastes were recycled or salvaged.

Potential Technologies & Strategies
Establish goals for landfill diversion and adopt a construction waste management plan to achieve these goals. Consider recycling land clearing debris, cardboard, metal, brick, concrete, plastic, clean wood, glass, gypsum wallboard, carpet and insulation. Designate a specific area on the construction site for recycling and track recycling efforts throughout the construction process. Identify construction haulers and recyclers to handle the designation of materials. Note that salvage may include donation of materials to charitable organizations such as Habitat for Humanity.

CaGBC LEED® MR Credit 3.1 Resources Reuse: 5%

1 Point

Intent
Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements
Use salvaged, refurbished or reused materials, products and furnishings for at least 5% of the total cost of building materials.

Submittals
Provide the LEED® Letter Template, signed by the architect, owner or responsible party, declaring that the credit requirements have been met and listing each material or products used to meet the credit. Include details demonstrating that the project incorporates the required percentage of reused materials and products and showing their costs and the total cost of materials for the project.

The salvaged or refurbished status of each material must be validated by a statement from the provider of that material, in case this Credit is audited.

If an audit is requested during the certification process:

Provide specifications and contractor submittals highlighting salvaged and refurbished materials used on the project

Potential Technologies & Strategies
Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items.

CaGBC LEED® MR Credit 3.2 Resource Reuse: 10%

1 Point

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 10% of the total cost of building materials.

Submittals

Provide the LEED® Letter Template, signed by the architect, owner or responsible party, declaring that the credit requirements have been met and listing each material or products used to meet the credit. Include details demonstrating that the project incorporates the required percentage of reused materials and products and showing their costs and the total cost of materials for the project.

The salvaged or refurbished status of each material must be validated by a statement from the provider of that material, in case this Credit is audited.

If an audit is requested during the certification process:

Provide specifications and contractor submittals highlighting salvaged and refurbished materials used on the project

Potential Technologies & Strategies

Identify opportunities to incorporate salvaged materials into building design and research potential material suppliers. Consider salvaged materials such as beams and posts, flooring, paneling, doors and frames, cabinetry and furniture, brick and decorative items.

CaGBC LEED® MR Credit 4.1 Recycled Content: 7.5% (Post-Consumer + ½ Post-Industrial)

1 Point

Intent

Increase demand for building products that incorporate recycled content materials, therefore reducing impacts resulting from extraction and processing of new virgin materials and by-passing energy and green house gas – intensive industrial and manufacturing processes.

Requirements

Use materials with recycled content such that the sum of the post-consumer recycled content plus one-half of the post-industrial content constitutes at least 7.5% of the total value of the materials in the project.

The value of the recycled content portion of the materials or furnishing shall be determined by dividing the weight of the recycled content in the item by the total weight of all material in the item, then multiplying the resulting percentage by the total cost of the item.

Mechanical and electrical components shall not be included in this calculation. Recycled content materials shall be defined in accordance with the Federal Trade Commission document, Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e), available at www.ftc.gov/bcp/grnrule/guides980427.htm.

Submittals

Provide the LEED® Letter Template, signed by the architect, owner or responsible party, declaring that the credit requirements have been met and listing the recycled content products used. Include details demonstrating that the project incorporates the required percentage of recycled content materials and products and showing their cost and percentage(s) of post-consumer and/or post-industrial content, and the total cost of all materials for the project.

If Supplementary Cementing Materials (SCMs) are used as part of the percentage recycled content, a letter signed by the concrete supplier/manufacturer or professional engineer must be submitted that certifies the reduction in Portland cement from Base Mix to Actual SCM Mix (as a percentage), where Base Mix is defined in LEED® reference guide calculations. This can be provided as a total reduction in Portland cement for all the concrete used on the project.

If an audit is requested during the certification process:

Provide specifications and contractor submittals highlighting recycled content materials installed.

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.

CaGBC LEED® MR Credit 4.2 Recycled Content: 15% (Post-Consumer + ½ Post-Industrial)

1 Point

Intent

Increase demand for building products that incorporate recycled content materials, therefore reducing impacts resulting from extraction and processing of new virgin materials and by-passing energy and green house gas – intensive industrial and manufacturing processes.

Requirements

Use materials with recycled content such that the sum of the post-consumer recycled content plus one-half of the post-industrial content constitutes at least 15% of the total value of the materials in the project.

The value of the recycled content portion of the materials or furnishing shall be determined by dividing the weight of the recycled content in the item by the total weight of all material in the item, then multiplying the resulting percentage by the total cost of the item.

Mechanical and electrical components shall not be included in this calculation. Recycled content materials shall be defined in accordance with the Federal Trade Commission document, Guides for the Use of Environmental Marketing Claims, 16 CFR 260.7 (e), available at www.ftc.gov/bcp/grnrule/guides980427.htm.

Submittals

Provide the LEED® Letter Template, signed by the architect, owner or responsible party, declaring that the credit requirements have been met and listing the recycled content products used. Include details demonstrating that the project incorporates the required percentage of recycled content materials and products and showing their cost and percentage(s) of post-consumer and/or post-industrial content, and the total cost of all materials for the project.

If Supplementary Cementing Materials (SCMs) are used as part of the percentage recycled content, a letter signed by the concrete supplier/manufacturer or professional engineer must be submitted that certifies the reduction in Portland cement from Base Mix to Actual SCM Mix (as a percentage), where Base Mix is defined in LEED® reference guide calculations. This can be provided as a total reduction in Portland cement for all the concrete used on the project.

If an audit is requested during the certification process:

Provide specifications and contractor submittals highlighting recycled content materials installed.

Potential Technologies & Strategies

Establish a project goal for recycled content materials and identify material suppliers that can achieve this goal. During construction, ensure that the specified recycled content materials are installed and quantify the total percentage of recycled content materials installed.

CaGBC LEED® MR Credit 5.1 Regional Materials: 10% Extracted and Manufactured Regionally

1 Point

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 transportations.

Requirements

Use a minimum of 10% of building materials or products for which at least 80% of the mass is extracted, processed and manufactured within 800 km (500 miles) of the project site.

OR,

Use a minimum of 10% of building materials or products for which at least 80% of the mass is extracted, processed and manufactured within 2,400 km (1,500 miles) of the project site and shipped by rail or water.

OR,

Use a minimum of 10% of building materials or products that reflect a combination of the above extraction, processing, manufacturing and shipping criteria (e.g. 5% within 800 km (500 miles) and 5% shipped by rail within 2400 km (1,500 miles).

Submittals

Provide the LEED® Letter Template, signed by the architect, or responsible party, declaring that the credit requirements have been met. Include evidence of transportation service by rail or water if applicable; and calculations demonstrating that the project incorporates required percentages of regional materials/products and showing their cost, distance from project to furthest site of extraction or manufacture, and the total cost of all materials for the project.

If an audit is requested during the certification process:

Provide product cut sheets, product literature, and letters from the manufacturers or other evidence showing the distance from the final point of manufacture to the site and mode of transportation, and the distance from the materials extraction to the site.

Potential Technologies & Strategies

Establish a project goal for regionally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified regional materials are installed and quantify the total percentage of local materials installed.

CaGBC LEED® MR Credit 5.2 Regional Materials: 20% Extracted and Manufactured Regionally

1 Point

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 transportations.

Requirements

Use a minimum of 20% of building materials or products for which at least 80% of the mass is extracted, processed and manufactured within 800 km (500 miles) of the project site.

OR,

Use a minimum of 20% of building materials or products for which at least 80% of the mass is extracted, processed and manufactured within 2400 km (1,500 miles) of the project site and shipped by rail or water.

OR,

Use a minimum of 20% of building materials or products that reflect a combination of the above extraction, processing, manufacturing and shipping criteria (e.g. 5% within 800 km (500 miles) and 5% shipped by rail within 2400 km (1,500 miles).

Submittals

Provide the LEED® Letter Template, signed by the architect, or responsible party, declaring that the credit requirements have been met. Include evidence of transportation service by rail or water if applicable; and calculations demonstrating that the project incorporates required percentages of regional materials/products and showing their cost, distance from project to furthest site of extraction or manufacture, and the total cost of all materials for the project.

If an audit is requested during the certification process:

Provide product cut sheets, product literature, and letters from the manufacturers or other evidence showing the distance from the final point of manufacture to the site and mode of transportation, and the distance from the materials extraction to the site.

Potential Technologies & Strategies

Establish a project goal for regionally sourced materials and identify materials and material suppliers that can achieve this goal. During construction, ensure that the specified regional materials are installed and quantify the total percentage of local materials installed.

CaGBC LEED® MR Credit 8 Durable Building

1 Point

Intent

Minimize materials use and construction waste over a building's life resulting from premature failure of the building and its constituent components and assemblies.

Requirements

Develop and implement a Building Durability Plan, in accordance with the principles in *CSA S478-95 (R2001) – Guideline on Durability in Buildings*, for the components within the scope of the Guideline, for the construction and pre-occupancy phase of the building as follows:

Design and construct the building to ensure that the predicted service life exceeds the design service life established in *Table 2* in *CSA S478-95 (R2001) – Guideline on Durability in Building.*

Where components and assembly design service lives are shorter than the design service life of the building, design and construct those components and assemblies so that they can be readily replaced, and use a design service life in accordance with *Table 3* in *CSA S478-95 (R2001) – Guideline on Durability in Building*, as follows:

For components and assemblies whose categories of Failure are 6, 7 or 8 in *Table 3*, use a design service life equal to the design service life of the building. For components and assemblies whose categories of Failure are 4 or 5 in *Table 3*, use a design service life equal to at least half of the design service life of the building.

Demonstrate the predicted service life of chosen components or assemblies by documenting demonstrated effectiveness, modeling of the deterioration process or by testing in accordance with *Clause 7.3. 7.4 or 7.5* and by completing *Tables A1, A2 & A3* from *CSA S478-95 (R2001) – Guidelines on Durability in Buildings.*

Document the elements of quality assurance activities to be carried out to ensure the predicted service life is achieved, in the format contained in *Table 1*, *Quality Assurance and the Building Process, of CSA S478-95 (R2001) – Guidelines on Durability in Buildings*.

Develop and document the quality management program for the project that ensures the quality assurance activities are carried out, in accordance with the elements identified in Clause 5.3, Elements of Quality Management, *CSA S478-95 (R2001) – Guidelines on Durability in Buildings*.

Submittals

Provide the LEED® Letter Template signed by the professional responsible and the general contractor, declaring that a Building Durability Plan has been developed and implemented. Document the building science qualification certification or training qualifications of the processional(s) responsible for the building envelope design of the building.

Potential Technologies & Strategies

Design strategies specifically included to minimize premature deterioration of the walls and roof and which are appropriate to the region, e.g., shading screens, eaves, overhangs, scuppers, etc., surface materials appropriate to exterior conditions, use of drained walls and continuous air-barrier systems of appropriate strength.

Other Sources of LEED® Credits

Application of Credit MR 8—This credit requires development of a building durability plan according to *CSA S478 Guideline on Durability for Buildings* (CSA 2001). This guideline encourages use of readily replaced construction components and assemblies and design strategies that allow for ease of access for repairs, replacements and alterations of components and assemblies throughout the construction phase and service life of the building. The modular nature of all segmental paving products enables easy access to underground utility repairs and reinstatement of the same paving units with no waste or damage to the surface. *ICPI Tech Spec 6 – Reinstatement of Interlocking Concrete Pavements* provides technical guidance on this topic (ICPI 2005). In addition, roof applications with segmental concrete products and sand bedding or pedestals enable easy access to waterproofing and drains. These unique characteristics of segmental paving enable it to contribute to the building durability plan.

CaGBC LEED® ID Credit 1-1.4: Innovation & Design Process

1 Point

Intent

To provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED® Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED® Green Building Rating System.

Requirements

Cred it 1.1 (1 point) In writing, identify the intent of the proposed innovation credit, the proposed requirement for compliance, the proposed submittals to demonstrate compliance, and the design approach (strategies) that must be used to meet the requirements.

Credit 1.2 (1 point) Same as Credit 1.1
Credit 1.3 (1 point) Same as Credit 1.1
Credit 1.4 (1 point) Same as Credit 1.1

Submittals

Provide the proposal(s) within LEED® Letter Template (including intent, requirement, submittals and possible strategies) and relevant evidence of performance achieved.

Potential Technologies & Strategies

Substantially exceed a LEED® performance credit such as energy performance or water efficiency. Apply strategies or measures that are not covered by LEED® such as acoustic performance, education of occupants, community development or lifecycle analysis of material choices.

CaGBC LEED® ID Credit 2: LEED® Accredited Professional

1 Point

Intent

To support and encourage the design integration required by a LEED® Green Building Project and to streamline the application and certification process.

Requirements

At least one principal participant of the project team that has successfully completed the LEED® Accredited Professional exam.

Submittals

Provide the LEED® Letter Template stating the LEED® Accredited Professional's name, title, company, and contact information. Include a copy of this person's LEED® Accredited Professional Certification.

Potential Technologies & Strategies

Attending a LEED® Accredited Professional Training Workshop is recommended but not required. Study the LEED® Reference Guide. Successfully pass the LEED® accreditation exam.

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