Greening Dalhousie's Built Environment

Researching Sustainable Sites at Dalhousie to Achieve LEED Certification for Existing Buildings: Life Sciences Centre

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C O N T E N T

ABSTRACT

The 'Greening the Campus' movement aims to address sustainability and environmental awareness and action on campus. This project is directed at assessing the Life Sciences Centre building at Dalhousie University for three credits that would count toward gaining LEED (Leadership in Energy and Environmental Design) for Existing Buildings certification. We used GIS (Geographical Information System) software to map and analyze vegetation and impervious surface information to determine if the LSC meets Credit 5: Site Development: Protect or Restore Open Habitat, Credit 6: Storm water Quantity Control, and Credit 7.1: Heat Island Reduction: Non-Roof, in the Sustainable Sites category. We found that the LSC site qualifies for 1 point from Credit 5 and 1 point from Credit 7.1, with opportunities to gain additional credits for exemplary performance. Additional research is required to determine the status of the LSC regarding Credit 6, but thorough recommendations have been made.

2.1 BACKGROUND

Universities have a social responsibility to become leaders in sustainability, and considering the impact campus buildings have on the environment, there is no better place to start than with our built environment. One potential measure that can be taken to increase sustainability on campus is to employ "green design" features to new and existing buildings, since they can have a profound effect on a university's environmental footprint.

2.1.1 LEED CERTIFICATION

The Leadership in Energy and Environmental Design (LEED) rating system has become the most popular benchmark for the design, construction, and operation of green buildings. The main goal of the LEED rating system is to "encourage and accelerate global adoption of sustainable green building and development practices through the creation and implementation of universally understood and accepted tools and performance criteria" (Canada Green Building Council, 2010). The LEED rating system focuses on a buildings sustainable site development, water efficiency, energy efficiency, materials and resource selection, and indoor environmental air quality. The main intent of the sustainable sites development (our area of interest) is to promote soil and erosion control measures, protect ecological features, encourage alternative transportation and limit light pollution.

Transforming our built environment will lead to a sustainable future for Dalhousie University, as well as the regional municipality of Halifax. For LEED certification, the most important environmental issues are considered during the design process. The system has Certified, Silver, Gold, and Platinum award levels, depending on how many credit points are acquired. A true "green building" is Platinum certified or even too "green" for LEED, surpassing the requirements necessary for certification. Producing an entirely sustainable building can be expensive, and many universities are unable to work LEED certification for some or all of their buildings into their budget. Moreover, the certification process can be very costly from the purchase of necessary documentation to hiring additional professionals. This money could otherwise be spent directly on improving building performance and design. Dalhousie runs on a five-year budget, and if the money invested is not coming back into the University within five years (as many benefits of sustainable building would not), the proposal may be rejected. Some Universities are opting out of actual certification and using the extra money to add to the sustainability of their buildings, but the power of actually being LEED certified comes through the optics of third-party verification (Carlson, 2008). It is an important check to ensure that builders and the building are doing what they are supposed to, and also to moderate cost-cutting administrators who might compromise the environmental standards of a building.

The reasons that Dalhousie and the regional municipality of Halifax would desire LEED certification are as follows. Primarily, having a LEED-certified building is more sustainable for the environment, in its structure, the way it operates, its resource use, and the environment that surrounds it. The person or institution that gains LEED certification for a building will achieve and demonstrate sustainability, gain recognition for green building efforts, validate the achievement through third party review, qualify for government incentives, and contribute to a growing green building knowledge base (Canada Green Building Council, 2010). All of these things are important for Dalhousie, especially being able to demonstrate sustainability by becoming a leader in changing the way we operate for the good of the environment. LEED provides a clear strategy and a framework for Dalhousie to become a sustainability leader in terms of our built environment. If the requirements for LEED are met, natural resources are saved and materials are recycled in the building process, the building uses less water and energy, contributes less GHG emissions, has highly efficient heating and air-conditioning systems, and has lots of natural lighting, saving the user money in the long run.

2.1.2 NATIVE SPECIES

LEED certification in the sustainable sites category requires more native and adaptive species on site, because they are better for the surrounding environment. Part of our current ecological crisis could actually be caused by the invasion of alien species. With the increasing interest of studying the impact of alien species in local environments, research shows that there are multiple ways that exotic species fit themselves into the new environment. They can invade in a new life form, take in resources differently, use the natural resources that cannot be taken in by native species, or directly replace indigenous species that have a relatively low growth rate, like Pinus invade Helicia shrubs. Also, the alien species' productivity increases if their type of photosynthesizing fits well (or better than the native species') in the new habitat.

Once the exotic species becomes a dominant species, it is able to change soil nutrients, moisture, salinity, pH, and landscape formation. All of these patterns give alien species comparative advantages to push or even eliminate indigenous species, and also to change the outer environment and decrease biodiversity, upsetting the balance of the ecosystem.

There are at least two major ecological benefits of preserving indigenous species. First, because native species evolved over millions of years with surrounding flora and fauna groups, they support each other by providing habitat, food, and fertilization. For example, the pines at Dalhousie University are not only homes for squirrels, but also act as their food source–pine cones. Compared to mammals, birds are even more sensitive to habitat change partly because many of them are quite cautious about where they build their nests. The valuable symbiotic relations also happen in the soil, where micro-organisms break down nutrients and minerals to the level that can absorbed by the plant's root, where a alien species or a new tree might not be able to process them as efficiently as a native species.

Secondly, protecting indigenous species contributes to biodiversity. At present, over 500 plant and animal species are considered endangered in Canada. Considering the geological conditions of Nova Scotia, where most soils are developed from glacial sediment, this means that in most areas of the province, there is only a thin layer of acidic soil covering the bedrock. With so many endangered species, it can be said that the ecosystems of Nova Scotia are quite vulnerable. Under such circumstances, the introduction of exotic species should be monitored carefully in case they eliminate native species, disrupting natural ecosystem functions.

Preserving native species can reduce our human footprint. Nova Scotia has a relatively harsh environment for trees. The temperature in winter is quite low and the summer is short and cool, combined with the thin soil that has neither a very strong ability to hold water, nor very much organic matter. That is why well-drained and strong species like sugar maple, yellow birch, red spruce, pine, and eastern hemlock are successful here. Taking care of alien species requires water consumption, human resources, electricity (as they might need weed control or a greenhouse in certain seasons) and pesticides (as they might not have the immunity to local insects). All of these consumptions demand energy, which increase the emissions of CO_2.

Also, because some plants naturally grow together, like trees, firs and grass, it is easier to plant several local species more densely together, creating habitat and reducing storm water runoff, while planting an adapted tree in a native environment may not work as well. The idea of combining several levels of native plants can clearly increase campus sustainability because they produce oxygen more efficiently, reduce the heat island effect, and provide a natural habitat for other wildlife.

2.1.3 STORM WATER RUNOFF AND THE HEAT ISLAND EFFECT

In an urban environment, large areas of impervious surfaces allow runoff from precipitation to disrupt natural water systems by draining pollution, sediment, pesticides, fertilizers, vehicle fluid, and salt into Halifax Harbour and surrounding waterways, and also by overloading pipes and sewers. Some of this runoff water needs to be detained or left to infiltrate into vegetated ground, where it can restore aquifers or depleted streams. Collecting and re-using water can save vast amounts of money once the collection systems are put into place. Pervious pavement can also be used to mitigate the effects of storm water runoff, but it can cost up to 3x as much as normal asphalt or concrete (Canada Green Building Council, 2009).

Another feature of urban environments that disturbs the natural ecosystem is the heat island effect, also known as thermal gradient differences between developed and undeveloped areas. When it is warmer in some areas compared to others, and much warmer in the daytime than night, there are negative impacts on micro-climates and habitats, both for wildlife and humans. Dark, non-reflective surfaces absorb radiation from the sun and radiate it into the surroundings, causing the temperature in urban areas to be 1-3°C higher compared to surrounding suburban and country areas (Canada Green Building Council, 2009). Plants and animals are sensitive to fluctuations in temperature. Reducing the heat island effect through the use of shade on dark surfaces and lighter coloured pavements with high reflectivity will mitigate negative effects on the environment and also save money on cooling systems in the warmer months.

2.2 PROJECT DEFINITION

Our project addresses the need to make Dalhousie University greener and more sustainable by incorporating LEED principles for our existing buildings, primarily increasing the area covered by native species, reducing storm water runoff, and reducing the heat island effect on campus. The primary objective of our research was to develop GIS (Geographical Information System) site maps of the natural environment on the land surrounding the LSC (Life Sciences Centre) on the Dalhousie campus. The location and number of existing trees and shrubs around this building have been recently collected in a database by the Dalhousie Office of Sustainability, and the information was analysed and used to evaluate what needs to be completed in the sustainable sites category to contribute to Credit 5: Site Development: Protect or Restore Open Habitat, Credit 6: Storm water Quantity Control, and Credit 7.1: Heat Island Reduction: Non-Roof for LEED for Existing Buildings (see Appendix for specific requirements) such as maintenance, replacing impervious and unreflective surfaces, and planting native species.

The GIS maps were used to determine how much of the LSC is covered by vegetation in general, the current cover of native species, the estimated amount of storm water needed to be detained, and what is necessary to reduce the heat island effect. This information helped us determine where native species could be most appropriately planted, and what best species to plant in the area are based on the original flora.

2.3 SCOPE

Our project concentrates on a defined study boundary focused on the Life Sciences Centre at Dalhousie University's Studley Campus. Only one source of data for trees and shrubs on campus is available and comes from research done by the Office of Sustainability in 2009. The concept of our project is limited to research and making suggestions for the University based on this research. Because of the time scale of the project, we most likely will not be involved in the actual implementation process.

3.1 RESEARCH TOOLS

A central piece of this project was to develop existing site maps for the area around the Life Sciences Centre. To do this, we used GIS software. GIS is a spatial mapping tool that connects spatial information, points, polygons and lines, with tables of data to allow for multiple types of manipulation, graphical representation, modeling and other spatial analysis. This is a quantitative exercise. An alternative hand-drawn method could have been used to create these existing site maps; however, once the data is created in GIS as a shape layer (.shp file), then GIS is a faster, easier and potentially more accurate option for someone familiar with the software. In addition, once the data is in shape layer format, the campus-wide vegetation information can be used for a number of analysis purposes for any Office of Sustainability project.

We also used online and published books as resources for information on native vegetation characteristics to recommend replacement species. Online resources and site visits were used to investigate other LEED projects, such as the new academic building at Dalhousie and the NSCC Waterfront Campus.

3.2 SAMPLE

Our data sample consists of trees and shrubs around the LSC as they relate to the requirements of 'LEED Canada for Existing Buildings' credit 5, 6 and 7.1. In this case, our data sample is the complete population as virtually all trees and shrubs on campus have been documented. This work was completed by staff at the Office of Sustainability over the summer of 2009. Some of the information documented includes leaf condition, wood condition, canopy cover width, light exposure, and crown loss. There were, however, some data missing from the survey. In this case our group surveyed the missing areas and identified species using online and published resources. We then transferred this data into a GIS shape layer for analysis.

Throughout the study we have had data problems. Most of these stem from the fact that much of the campus vegetation data was not ready for use in this project. As such, we had to revise the project to focus only on the LSC building and not the Medjuck and Tupper buildings as originally proposed. The data for these buildings remains unavailable as this report is submitted.

3.3 PROCEDURES

Direct measurement and site survey methods, based on the requirements set out in LEED Canada for Existing Buildings: Operations and Maintenance (see Appendix), were used to analyze vegetation around the LSC. *Posteriori* analysis results will inform the Office of Sustainability as to which of the LEED credits the study building may qualify for. Triangulation through observation was conducted in the form of ground-truthing. The group surveyed the site multiple times and an identification and measuring survey was completed for the data that was missing. Time of year prevented us from completing a thorough survey of missing plants and the data collected by our group was only for the use of this study. Including our survey data improved the quality of our results compared to the option of ignoring the missing data. A qualified arborist will need to survey missing data for it to be officially added to the campus vegetation GIS data.

Credit 5: GIS data and the vegetation inventory data were used to map the land area of the LSC covered by native species. This same data was also used to develop wood and leaf condition for vegetation on site.

Credit 6: We also used an online precipitation calculator from UK-based Lenntech Water Treatment Solutions and Environment Canada data to determine the amount of annual rainfall on site. This allowed us to determine the total volume of rainfall that must be captured on site to achieve LEED Credit 6. This informed our recommendations for landscaping changes.

Credit 7.1: Site surveys and GIS data were used to determine the areas of impervious surface by surface type. Further surveys determined the areas of impervious surface which are shaded by architectural devices or trees. This information was then used to calculate on-site heat absorption through Solar Reflectance Index (SRI) ratings and equations provided by LEED Canada.

3.4 PARTICIPANTS

Current participants include our group, Rochelle Owen at the Office of Sustainability, as well as Dalhousie Facilities Management and the University Landscaping Dept. Sue Sirrs, (Landscape Architect, Outside Planning and Design Studio) was also consulted. Our results consist of building specific data that can be compared to the LEED standards outlined below to determine the next steps to achieving LEED for the LSC. Based on these findings we consider and outline recommendations to the University Facilities Management Planning Department and the Office of Sustainability regarding landscaping changes and improvements that will increase natural habitats on campus and also result in potentially achieving additional LEED certification credits.

3.5 RELIABILITY AND VALIDITY

Reliability is the ability of a study to be repeated with consistent results (Palys & Atchison, p.61). Validity is the ability of a research method to yield results pertinent to the study (Palys & Atchison, p.62). Reliability and validity of our research depends partly on the instrumentation and procedures used by the data collection team. Rochelle Owen has overseen both of these projects and can ensure the validity of the data collection. Base GIS data for the University originates with the Halifax Regional Municipality. This data is deemed to be reliable as the municipality is a trusted source. Upon completion our data will be 'member-checked' by Rochelle Owen and Matt Follett (the Arborist conducting the campus survey). As our site is on campus, we have all spent time in the field and are quite familiar with our study area. An external auditor will be part of the process when the University applies for LEED certification for the LSC. (Creswell, p.196). Measures of vegetation were operationalized by the arborist and were quite varied, including two perpendicular crown width measurements, wood condition, leaf condition, diameter at breast height, species place of origin, and die back. Due to the requirements of LEED and limits on time, we were only able to utilize places of origin and mean crown width measurements (we did also map leaf and wood condition, though not directly related to a LEED credit). This procedure may bring concern of mono-operation bias and mono-method bias (ibid), however, our method was appropriate for the specific purpose of our research. The primary objectives of our research are very definite and inflexible as they are the specifically laid out requirements for each LEED credit of interest. Therefore, few options exist for method choice. Our method was appropriate for our research goals as it allowed us to develop both spatial results and mathematical results and the use of GIS technology saved time and improved data accuracy.

3.6 LIMITATIONS AND DELIMITATIONS

Time restraint was the biggest limitation on our project. As this is a class project we were limited in the amount of time we had to complete our project objectives. Our time frame for completion was February 15, 2010 to April 13, 2010. The short period of time we had to complete the proposed project required that our research focused on only a small number of variables, potentially taking away from the comprehensiveness of the study. The short time frame only allowed our group to make suggestions for future implementation based on research and analysis of GIS maps, preventing our group from being directly involved in the greening the campus process. This project is really about setting the stage for further time investment in pursuing LEED certification for the LSC. A similar limitation was time for group meetings due to the various schedules of all group members. In order to overcome this we had to develop a strong vision together and then work in sub-groups and take initiative as individuals. A further limitation came unexpectedly in the form of unavailable data for the Tupper and Medjuck buildings.

Rochelle Owen, Director of the University's Office of Sustainability, requested that the primary objective of our study be focused only on select campus buildings that she is interested in obtaining LEED Canada certification for existing buildings. Delimitations of our project include the requirements listed under LEED, specifically involving credits 5, 6, and 7.1 (see Appendix), and the spatial boundary determined by the group, Rochelle, and the Facilities Management Dept. Limited by our temporal, geographical, and conceptual boundaries we will not be making recommendations for the entire campus. This limitation potentially weakens our project design because we will not be looking at areas on campus in terms of greatest need for green space or greatest potential for things such as storm water management.

4.1 LEED CREDIT 5: PROTECT OR RESTORE OPEN HABITAT

For the purposes of this credit, native plants must be indigenous to the Halifax region or plants that have adapted to the local climate and are not considered invasive species (Canada Green Building Council, 2009). Based on the species inventory made by arborist Matt Follett in summer 2009 and the boundaries set out in the scope of this project, it was calculated that 85.5% of all the plant species within the boundaries of the LSC are native (Figure 1). There are 8826.38 square meters of native plant coverage, which is 38% of the total site area (excluding the building footprint). This calculation only considers plants that are indigenous to the region and does not include adapted plants. Most of the native species coverage, 78% consists of two different species: Red Oak and Red Maple (Figure 2). Sugar Maples also have a relatively high coverage than the other species. There are 243 different plant species recorded within the boundaries of the LSC. Of these species 178 are native to the region, 6 are native to North America, 4 are naturalized, 46 are introduced, and 9 are considered invasive.

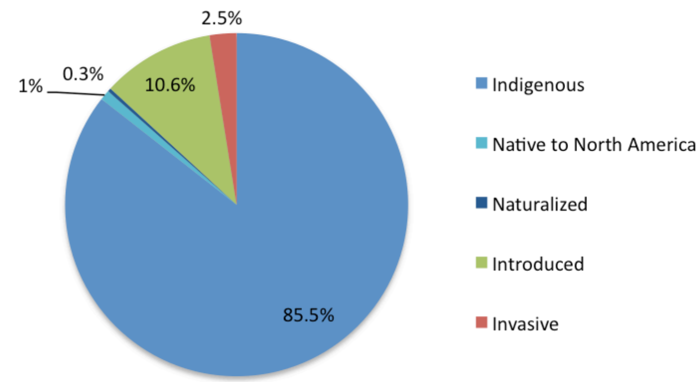

Figure 1. Origins of plant species within the boundaries of the Life Sciences Centre on Dallhousie Campus in Halifax, Nova Scotia in Spring of 2010.

Within the boundaries of the LSC there is approximately 0.3 meters of erosion adjacent to many major impermeable walking routes as well as compacted eroded pathways on major vegetated walking routes. There are also points of erosion of vegetated sites adjacent to major automobile routes and erosion caused by maintenance vehicles. There are vegetated areas (on the East side of the building), which are currently being used as storage areas for objects associated with LSC maintenance and operation. There are other vegetated areas that are unplanted and low traffic in the courtyard and on the South and Southeast sides of the building.

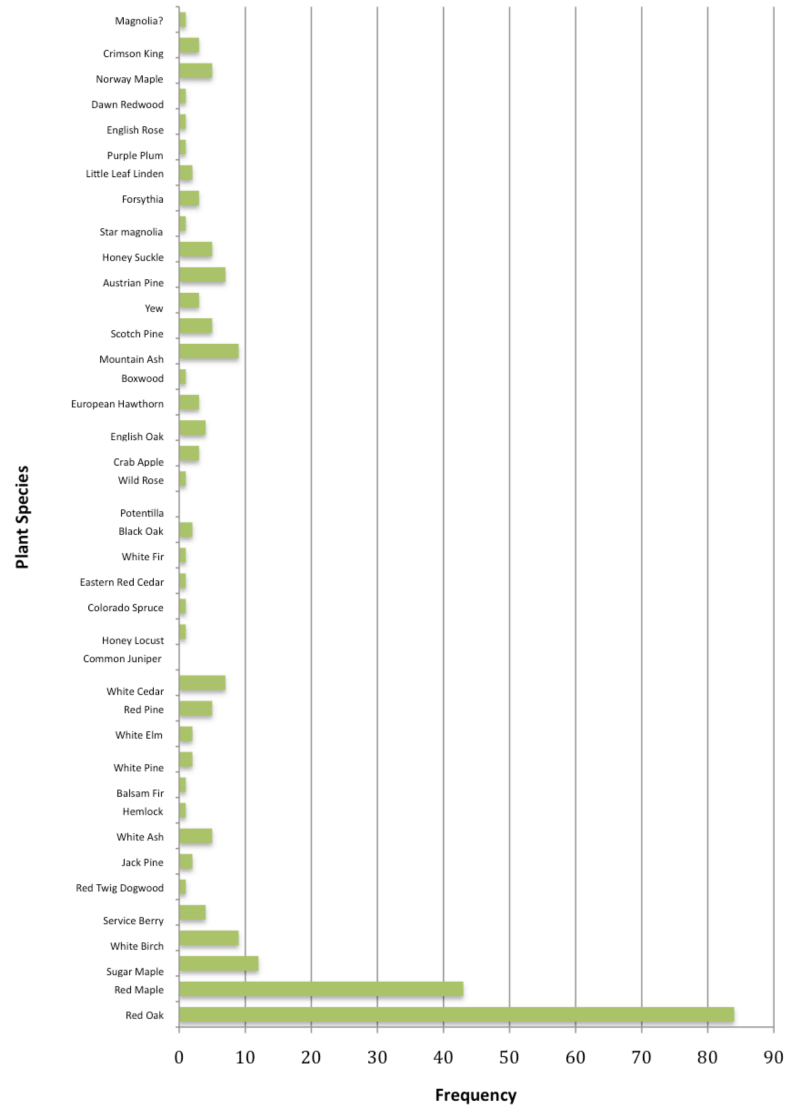

Figure 2. Plant species distribution within the boundaries of the Life Science Centre on Dallhousie Campus in Halifax, Nova Scotia in Spring of 2010.

4.2 LEED CREDIT 6: STORM WATER QUANTITY CONTROL

In order to attain Credit 6, 15% of the precipitation that falls on the building site on average every year must infiltrate the soil and vegetation, be collected and reused, or evapo-transpirated by vegetation. This can be achieved by decreasing impervious surface cover or increasing infiltration. Total precipitation falling on the LSC site averages 1452 mm/year (World Meteorological Association, 2010). Using an online precipitation calculator from UK-based Lenntech Water Treatment Solutions (2009) we found that about 3444 m^3/year of precipitation must be collected and reused on site at the LSC or infiltrated into the soil and vegetation.

In order to calculate what volume fifteen percent of the precipitation falling on the LSC would be, we needed to find out what size the roof and surface hardscape were and what the annual precipitation for Halifax is. The size of the roof and surface hardscape was found using our GIS maps, which was a total of 15,808 m^2, and the annual precipitation was found through Environment Canada on the World Meteorological Association website, which was 1452 mm per year. These two amounts were then entered into the precipitation calculator on the Lenntech website, which calculates the total volume of precipitation that can be collected, which was 22, 960 m^3 per year. This volume was then multiplied by 0.15 in order to obtain the fifteen percent value needed to meet the LEED requirements; this amount was 3444 m^3 per year.

4.3 LEED CREDIT 7.1: HEAT ISLAND REDUCTION: NON-ROOF

The current situation at the LSC is best suited for Option A under Credit 7.1 (see Appendix, maps A+B). Essentially, the site has to have 50% of the hardscape shaded by vegetation or buildings, having a solar reflectance index (SRI) of at least 29, or part of an open-grid paving system.

What the LSC has:

- Total hardscape area (T)
    - New White Concrete: 754 m²; New Gray Concrete: 447 m²; Gravel; 574 m²; Brick/ Granite: 294 m²; Weathered Asphalt: 5256 m²
        - 7325 m²
- Hardscape areas shaded by trees (S)
    - Asphalt: 1309 m²; White Concrete: 608 m²; Gray Concrete: 108 m²
        - 2005 m²²
- Hardscape areas shaded by solar panels (E)
    - 0 m²
- Hardscape surfaces shaded by architectural devices with SRI at least 29 (A)
    - Brick: 294 m²; White Concrete: 108 m²; Gray Concrete: 60 m²
        - 462 m²
- Hardscape surfaces above SRI 29 (white and grey cement) (R)
    - 1201 m²
- Hardscape surfaces with open-grid paving system (O)
    - 0 m²
- Total Qualifying Area (Q) = (S+E+A+R+O)
    - Q = 3668 m²
- Total Qualifying Area must be more than or equal to 50% of total hardscape area (7325 m²/2) to achieve credit
    - 3668 m² > 3662.5 m²
    - Credit achieved

5.1 LEED CREDIT 5: PROTECT OR RESTORE OPEN HABITAT

We learned from Mike Wilkinson, Grounds and Horticultural Services Supervisor, that Dalhousie buys their trees and other plants from wholesale nurseries such as Blomidon and Springvale, both of which have a large selection of local and locally grown species.

This credit requires that 25% of the total site area (excluding the building footprint) be covered with native or adapted vegetation (Canadian Green Building Council, 2009), which is 5740.75 square meters. According to our study the LSC site has exceeded this requirement by 13%, and therefore is eligible to use Sustainable Sites Credit 5 towards LEED certification. The LSC could earn an Innovation in Operations credit for exemplary performance by having onsite native or adapted vegetation covering a minimum of 50% of the site area (Canadian Green Building Council, 2009), so it could be beneficial to cover 12% more of the site area with native plant species. To attain this extra credit it may be beneficial to add adaptive plants to the native species coverage calculation.

This extra credit could also be achieved by installing a vegetated roof surface. The LSC is an ideal candidate for a vegetated roof surface as it has flat roofs and is the centre for earth science and biological studies. A feasibility study would have to be completed to determine whether the building structure can support the added weight of planting beds, including retained water. This should involve hiring a professional to determine which species would likely utilize the space, mostly birds and insects, and select plants that will help support these species. The same professional should also assess the impacts of LSC on resident and migratory wildlife to determine the best way to reduce the threat that windows pose to birds (Canadian Green Building Council, 2009). This should not be a significant factor as there are relatively few windows around the building surrounded by trees.

One species that could be focused on for a roof garden is the Monarch (*Danaus plexippus*). There are many native plant species that could be planted to make a butterfly garden. There are four native milkweed plants (*Asclepias incarnata, A. incarnata incarnata, A. syriaca,* and *A. tuberosa*), which the Monarch uses as larval hosts. Butterflies also rely on the nectar of wildflowers, including many native asters and goldenrod (Evergreen, 2010). Butterflies usually prefer yellow, pink, orange, and purple flowers (Nature Canada, 2010). The Monarch is considered a Schedule 1 *Special Concern* species under the Species At Risk Act (Government of Canada, 2010). If a vegetated roof garden is deemed unfeasible, it would be a worthwhile consideration to plant a butterfly garden elsewhere, within the boundaries of the LSC.

There are a few more ways to increase native vegetation to 50% by reducing the amount of unused space. The courtyard is a good example of a space that is not heavily planted or used by many people. There are a few areas in the courtyard where there are excessive concrete slabs on the ground. These should be removed and replaced with native landscape, not only increasing the amount of native coverage but also decreasing the number of impermeable areas. As turf grass does not count towards LEED credit it would also be beneficial to replace excessive turf grass, found not only in the courtyard but all across campus, with natural landscape features: native grasses, native ferns, native wildflowers, and other native plants that can provide different habitat than the trees and shrubs. Having a range of different types of plant species, other than trees and shrubs, contributes to increased biodiversity, which is the variety of life in the area and the ecological processes of which they are a part (Environment Canada, 2006).

As seen in Figure 2 of the results section, only two different trees make up most of the native species coverage, which takes away from the sites diversity. Maintaining biodiversity is essential to the functioning of an ecosystem, ensuring that species are able to adapt to changing environments, thereby increasing resiliency (Evergreen, 2006). There are 63 native tree species alone (Evergreen, 2010), many of which would be suitable for the LSC site. This should be a consideration when planning to plant more trees. Planting shade tolerant ferns and other plant species within a dense area of trees can increase the biodiversity of the site as well. The Southeast corner of the LSC site area is an example of an area with high canopy cover.

There was one invasive plant species recorded within the boundaries of the LSC, Norway Maple (*Acer platanoides*). The Norway Maple has dense foliage and shallow roots, which prevent native species from growing (Evergreen, 2010). Facilities management could use control methods such as digging or pulling out any saplings of invasive plants to ensure native species have space to grow.

Due to the volume of pedestrian traffic along the walkways, there is visible erosion along the edges of most of the walkways. The compacted soil not only decreases the vegetative site coverage but it also decreases infiltration rates for that area. Without a protective vegetative cover, soil erosion is also likely to occur (Pimentel & Kounang, 1998) further decreasing the sustainability of these walking spaces. It is recommended that these areas be rehabilitated to decrease further erosion. A native, salt tolerant shrub that could be planted at the interface of an eroded vegetated site and a walkway would be an appropriate solution to the problem, ensuring that no further erosion will take place. It is suggested that driving on any vegetated surface should kept to a minimum in order to conserve the natural site area.

5.2 LEED CREDIT 6: STORM WATER QUANTITY CONTROL

According to 'LEED Canada for Existing Buildings' the purpose of storm water management is to lessen the disruption of the hydrological cycle caused by the buildings on the property and the grounds that surround that building. It will be necessary to hire a professional to calculate how much water is currently reused or infiltrated on site. If this amount meets the credit requirement, then the credit will be achieved but additional water retention is still seen as a benefit.

If more water needs to be reused or infiltrated, storm water retentive features should be installed. Our first recommendation would be to install rain barrels. Rain barrels are an inexpensive way to collect and reuse rain water, and according to the Clean Annapolis River Project they cost anywhere from seventy to five hundred dollars or can be easily made by reusing common materials. The collected rainwater can be used for irrigation purposes, and if the rain barrels are placed in well-situated areas for custodial workers to access them the water could be used for cleaning. However, irrigation at Dalhousie is minimal, and limited to post-planting so that the plants adapt to rely on rainfall. When irrigation is needed, a drag-line and sprinkler are used, or a tank and pump where a water source is not close by. Perhaps rain barrels could be placed in these areas.

Three particular areas of the LSC would benefit the most from storm water management and occur where implementation is most necessary. The first area consists of four sites in the back of the LSC that are on slopes. One site is a small forested area across from Shirreff Hall that lacks an herbaceous layer. One is where the oldest tree on campus (an oak) can be found, another is across from the old oak tree and the last is on the far side of the building. The last three mentioned are surrounded by turf grass, which is neither native nor retains water well. All four sites are bordered by a driveway, a parking lot, or both. One way to stop runoff in these areas is to have it infiltrate the soil and vegetation. We would recommend that the two sites be planted with native ferns such as braken, christmas, and cinnamon (Evergreen, 2000-2010). Runoff would be collected and retained in the roots of the ferns and then released into the atmosphere through evapo-transpiration, as the ferns are a dynamic part of the hydrological cycle. Since the ferns we are suggesting to be planted are native they would also count toward Credit 5.

There are three sites in this area that would be ideal for a vegetated swale. A vegetated swale is a wide and shallow depression similar to a trench or ditch (RiverSides, 2005-2009). Vegetated swales are effective at removing and filtering car and road pollution before they enter the sewer system and are planted with species that can retain and infiltrate storm water (RiverSides, 2005-2009). The site with the old oak tree, the site across from it, and the site on the far side of the building are the areas we would suggest installing vegetated swales. The vegetated swales should be planted with not only water retaining plants but with salt tolerant ones as well. Since the sites are bordered by driveways and parking lots that are heavily salted in the winter months, the storm water runoff contains among other things high levels of salt and the swale should have plants that can withstand this. Some suggested plants are grasses such as Bluejoint because it requires moist to wet soil and is a native species (Evergreen, 2000-2010). According to Carol Goodwin in an article written by Anne Marie Van Nest in Canadian Gardening, common yarrow is a good salt tolerant species and it is also a native species (Evergreen, 2000-2010). Common juniper would also be appropriate because it is a native species that can be found growing next to salty shores (Summer Hill Nursery). It is important to have a variety of species that can tolerate different environmental conditions in a vegetated swale.

The next area of focus is the courtyard of the LSC. This area would also benefit from a vegetated swale. Some plants that are native species and would be appropriate for this area are northern bent grass and fringed brome because their habitats are swamps and marshes, and red osier dogwood, a shrub known for its storm water retention capabilities (Evergreen, 2000-2010). The red osier dogwood would also contribute to providing habitat for butterflies and birds, which pertains to Credit 5. There is a hilly area that runs down to a large concrete walkway that is infrequently used. Removing the concrete pavers and installing a vegetated swale at the bottom of the hill to catch storm water runoff would be advised. The runoff would be infiltrated by the vegetated swale instead of running off the pavers and into the sewer. There is an air conditioner in this area but it would not be affected by the installation of the swale and access to the air conditioner for maintenance would not be blocked.

There is a large concrete flower box in this area that is being under-used and a corner plot by the entrance of the courtyard that is on a slope and contains turf grass. These two spots could be made into rain gardens. Rain gardens are gardens that are planted with plants that are adapted to and filter rain water (Clean Annapolis River Project, 1991). They are large enough and deep enough to accommodate for the depth and levels of gradation required for an effective rain garden. Cattails, Turtleheads, and marsh marigolds are efficient native species for rain gardens and they are ecstatically pleasing (Clean Annapolis River Project, 1991). Since the concrete flower box is already in place and the corner plot would not require much work, the two rain gardens would inexpensive to implement. Most of the planted areas on campus have been built up with imported soil and are to some extent already functioning as rain gardens, but infiltration is limited and directed by the underlying bedrock. If the overall area covered by rain gardens and planted areas is increased on site, overall infiltration will be enhanced.

The last area of concern is the area between the LSC and the Henry Hicks Academic Administration building. This site has walkways above and between two areas with vegetation and is slightly sloped. There is a lot of soil compaction in this area from pedestrian traffic. We suggest that black chokecherry, which is a salt tolerant native shrub (Evergreen, 2000-2010) be planted along the perimeter of each area. The planting of black chokecherry would stop further soil compaction, which would lessen runoff. The chokecherry would also be able to withstand winter salting of the walkways. This shrub is very pretty in the summer with white and pink flowers, it has fall colours, and it provides habitat for birds and squirrels.

5.3 LEED CREDIT 7.1: HEAT ISLAND REDUCTION: NON-ROOF

The LSC just qualifies for one credit under Credit 7.1 using our calculations. The hardscape surfaces receive adequate shade from surrounding trees and architectural structures. However, further credits could be achieved if the hardscape surfaces on the LSC were changed. For example, asphalt currently covers the majority of hardscape area surrounding the LSC. Asphalt has the lowest SRI value of 6 since most of it is weathered and not new. If the asphalt were removed and replaced by a material that has a higher SRI value, such as concrete, then Dalhousie could potentially receive additional credits. Additionally, Dalhousie should consider the possibility of using more granite bricks on site. The asphalt in particular, as well as the cement are weathered in many areas, indicating they do not have a particularly long lifespan. The granite bricks are substantially more durable, and more resistant to developing cracks from weathering. This indicates they have a much longer life span.

Dalhousie could also ponder the idea of including solar panels on site because currently there are none. Solar panels are a potential source of renewable energy and shade for darker hardscape surfaces. Additionally, Facilities Management should pressure wash cementious materials (walkways, roofs) every two years to restore reflectance close to their original value.

RECOMMENDATIONS FOR FURTHER RESEARCH

We recommend that further study be done in areas that lack progress now but that are most likely to be developed in the future. Based on our current research done on the Life Sciences Centre, we recommend that further research be done toward LEED Water Efficiency Credit 3: Water Efficient Landscaping. The intent of Credit 3 is to "eliminate or limit the use of potable water, or other natural surface or subsurface resources available on or near the project site, for landscape irrigation" (Canada Green Building Council, 2009, p. 20) A current barrier for calculating Credit 3 is lack of data. The irrigation of the Life Science Centre is now done minimally and at random, and as we are likely to be adding more trees in the area for the achievement of other credits, the data related to irrigation water around the LSC is currently unpredictable.

The advantage of researching the site for water efficiency Credit 3 is that some of the changes being made to earn other credits can provide a baseline for improving water efficiency. For example, LEED certification requires planting more native and water retentive plants for Credit 3, but the action has already been recommended for LEED Credit 5. The storm water management Credit 6 can also contribute to water efficiency Credit 3, as the credit requires the participation of professionals and possible equipment for measuring and monitoring water use. We could collect a great deal of data for water efficiency Credit 3 during the process of fulfilling the requirements for Credit 6.

The recommended goals for researching the potential of the LSC for Credit 3 would be: collecting storm water as part of a usable water resource for irrigation, consideration of vegetation health, microclimate status and student health, and limiting or eliminating fresh water use for irrigation around the Life Science Centre.

RECOMMENDATIONS FOR ACTION

There are over one hundred LEED credits related to achieving certification for existing buildings, and many of them can be achieved or improved by sustainable landscape design. Based on our observations and analysis of the surrounding site of Dalhousie's Life Science Centre and our study of relevant credits, we think there are several aspects that can be improved that can either contribute to additional points in the credits we already have, or to achieving new credits.

- Planting more native plant species

As shown in our results, the requirements for LEED Credit 5 for the LSC site have already been satisfied by exceeding the target by 13% of the total cover area. As extra Innovation in Operations points can be earned for having native plants cover 50% or more of the area, we recommend increasing the native plant covered area by 12%.

- Hire professionals and install water measuring and monitoring tools

To achieve LEED credit 6, we decided it is necessary to hire professionals to determine how much water is currently reused and infiltrated, and how much storm water can be currently collected and whether it is qualified to use as irrigation and cleaning. For additional points in Water Efficient Landscaping, it is also important to measure current irrigation amounts to calculate if future reduction can satisfy the credit requirement.

- Reducing surface reflectance and increasing shade

Reducing surface reflectance of a building is a very efficient way to reduce the heat island effect and minimize impacts on microclimates and human and wildlife habitats. To achieve LEED Credit 7.1, we suggest Dalhousie considers covering exposed surfaces of the Life Science Centre by installing solar panels or an open-grid paving system. Solar panels can not only shade exposed areas and reduce the heat radiated from sunlight, but also provide sustainable energy and decrease the carbon dioxide emissions of the LSC. An open-grid paving system can accommodate plants and increase vegetation cover which would block sunlight while not affecting open space.

- Landscape re-design

To assist in the improvement of LEED Credit 6 and water efficiency Credit 3: Water Efficient Landscaping, we recommend that research be done to consider re-designing several areas around the Life Science Centre. The school could also re-design the courtyard of the Life Science Centre to add rain gardens, which detain rainwater and adjust microclimate. It is also worth considering growing plants of different heights together which form multiple layers of vegetation, increasing the efficiency of water use.

In the global environmental movement, Universities have a social responsibility to become leaders in sustainability, and considering the impact campus buildings have on the environment, there is no better place to start than with our built environment. This project was directed at assessing the Life Sciences Centre at Dalhousie for three credits that would count toward gaining LEED for Existing Buildings certification. Using GIS software to map and analyze vegetation and impervious surface information to determine if the LSC meets Credit 5: Site Development: Protect or Restore Open Habitat, Credit 6: Storm water Quantity Control, and Credit 7.1: Heat Island Reduction: Non-Roof, we found that the LSC site qualifies for 1 point from Credit 5 and 1 point from Credit 7.1, with opportunities to gain additional credits for exemplary performance. Additional research is required to determine the status of the LSC regarding Credit 6, but thorough recommendations have been made if further action is necessary.

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APPENDIX

Map A, Credit 7.1 - Areas shaded by architectural devices

Map B, Credit 7.1 - Areas shaded by trees

Map C, Vegetation canopy cover

Map D, Native vegetation canopy cover

Map E, Vegetation by habitat of origin

Map F, Leaf condition of existing vegetation

Map G, Wood condition of existing vegetation

Followed by LEED Canada requirements for Sustainable Sites credits 5, 6, and 7.1.


New White - 754 m2
New Grey - 447 m2
Gravel - 574 m2
Brick/Granite - 294 m2
Weathered Ashphalt - 5256 m2
Surfaces Shaded by Architectural Devices
0 5 10 20 30 40
Meters


New White - 754 m2
New Grey - 447 m2
Gravel - 574 m2
Brick/Granite - 294 m2
Weathered Ashphalt - 5256 m2
Surfaces Shaded by Trees
0 5 10 20 30 40
Meters

Vegetation Cover
0 4.5 9 18 27 36
Meters
N


Native Species Cover
0 4.5 9 18 27 36
Meters
N


Habitat of Origin
1 - Indigenous
2 - Native to N.A.
3 - Natualized
4 - Introduced
5 - Invasive
0 4.5 9 18 27 36
Meters
N

Vegetation
unknown
Leaf Condition
0 - Poor
1
2
3
4
5 - Good
0 5 10 20 30 40
Meters
N


Vegetation
unknown
Wood Condition
1 - Poor
2
3
4
5 - Good
0 5 10 20 30 40
Meters
N

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

SUSTAINABLE SITES

SITE DEVELOPMENT: PROTECT OR RESTORE OPEN HABITAT

INTENT

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

REQUIREMENTS

During the performance period, have in place native or adapted vegetation* covering a minimum of 25% of the total site area (excluding the building footprint) or 5% of the total site area (including the building footprint), whichever is greater.

Improving and/or maintaining off-site areas with native or adapted plants can contribute toward earning SS Credit 5. Every 2 square meters off-site can be counted as 1 square meter on-site. If off-site areas are used to contribute to the credit, at least half of the on-site soft landscaping shall comply with the credit requirements. Off-site areas must be documented in a minimum 5-year contract with the owner of the offsite area that specifies the required improvement and maintenance of the off-site area. The off-site area must be located within an 800km radius of the project site.

The off-site area must meet the Canadian Land Trust Alliance (CLTA) member land trust requirements by either being donated to a CLTA member land trust, or the property owner must enter into a conservation agreement with a CLTA member land trust. If the *LEED® Canada for Existing Buildings: Operations and Maintenance* applicant is not the off-site property owner prior to the arrangement with a land trust, the *LEED® Canada for Existing Buildings: Operations and Maintenance* applicant must be contractually responsible for any endowment funds that the land trust requires and for any required improvement and/or maintenance activities.

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

Other ecologically appropriate features that contribute to this credit are natural site elements beyond vegetation that maintain or restore the ecological integrity of the site, including water bodies, exposed rock, unvegetated ground or other features that are part of the historic natural landscape within the region and provide habitat value.

Projects using vegetated roof surfaces may apply the vegetated roof surface to this calculation if the plants meet the definition of native/ adapted and provide the habitat and biodiversity intent of the credit.

POTENTIAL TECHNOLOGIES & STRATEGIES

Perform a site survey to identify site elements and adopt a master plan for management of the building site. Activities may include removing excessive paved areas and replacing them with landscaped areas or replacing excessive turf grass area with natural landscape features. Work with local horticultural extension services or native plant societies to select and maintain indigenous plant species for site restoration and landscaping. Coordinate with activities, technologies and strategies under SS Credit 3.

*For purposes of this credit, native/adapted vegetation or plants are indigenous to a locality or cultivars of native plants that are adapted to the local climate and are not considered invasive species or noxious weeds.

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

BENEFITS & ISSUES TO CONSIDER

ENVIRONMENTAL ISSUES

Development on building sites often damages site ecology, indigenous plants, and regional animal populations. Natural areas provide important ecological services, including effective and natural management of stormwater volumes. Restoring native and adapted vegetation and using other ecologically appropriate features (i.e., natural site elements beyond vegetation that maintain or restore ecological integrity) will enhance the site and provide wildlife habitat. Ecologically appropriate features may include water bodies, exposed rock, bare ground, or other features that are part of the natural, regional landscape and provide habitat value. As wildlife is pushed out of existing habitats, it increasingly crowds into small areas; leading to wildlife overpopulation and invasion of surrounding site developments. Establishing strict site boundaries and staging areas during construction reduces damage to the site and helps preserve wildlife habitats and migration corridors.

ECONOMIC ISSUES

Indigenous plants require less maintenance than nonnative plants and reduce maintenance costs over the building life-cycle by minimizing use of fertilizers, pesticides, and water. It may be advantageous to implement site restoration in phases to spread costs over time. Strategic plantings can shade the site's impervious areas, decreasing cooling loads during warm months and reducing energy expenditures.

RELATED CREDITS

Installing on-site vegetation, including vegetated roofs, can assist project teams with stormwater management practices by providing areas for infiltration and evapotranspiration; see the following credit:

- SS Credit 6: Stormwater Management

On-site native or adapted vegetation can help contribute to reductions in heat island effect, as described in these 2 credits:

- SS Credit 7.1: Heat Island Reduction—Nonroof
- SS Credit 7.2: Heat Island Reduction—Roof

Native and adapted plants are likely to produce less landscape waste, minimize the need for pest management, require little to no fertilization, and substantially reduce or eliminate the need for irrigation. This kind of landscaping also contributes to achieving the following credits:

- SS Credit 3: Integrated Pest Management, Erosion Control, and Landscape Management Plan
- WE Credit 3: Water-Efficient Landscaping

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

SUMMARY OF REFERENCED STANDARDS

Canadian Land Trust Alliance (CLTA)
http://www.clta.ca/

The CLTA's mission is "to strengthen the land trust movement in Canada through education and training, and to promote the voluntary conservation of private lands". All CLTA members are obligated to adhere to the CLTA's "Canadian Land Trust Standards and Practices", which "helps land trusts uphold public trust and build strong and effective land conservation programs".

IMPLEMENTATION

Preserve and enhance natural site elements, including water bodies, healthy soil, ecosystems, trees, and other vegetation. Identify opportunities for site improvements that would increase the area of native or adapted vegetation and other ecologically appropriate features. Monoculture plantings (e.g., turf) cannot contribute to the credit requirements even if they meet the definition of native or adapted. Restoration and maintenance activities might include establishing new plants, eliminating or controlling invasive and nonnative species, monitoring biodiversity of flora and fauna, harvesting and propagating seeds or spores, constructing habitats, preventing and mitigating pollutants, and other practices that encourage appropriate populations of native or adapted species. Horticultural extension agencies and native plant societies can help identify appropriate species for the local conditions.

For urban projects with few landscaping opportunities, consider installing a vegetated roof to help meet the credit requirements (see also SS Credits 6 and 7.2). Select native or adapted noninvasive species and confirm that the roof structure is designed to support the added weight of planting beds (including retained water). Lightweight soil media and modular planting beds can make vegetated roofing feasible on existing structures with limited load-bearing capacity; investigate strategies increase the roof's capacity to bear additional weight. Research the species that are likely to utilize this space (primarily birds and insects) and select plants that will help support them by providing food, forage, or nesting areas. Vegetated roofs that lack a diversity of habitat-providing species types and plant sizes do not meet the intent of the credit.

In addition to vegetation, other ecologically appropriate features that maintain or restore the ecological integrity of the site can contribute to earning SS Credit 5. Examples include water bodies, exposed rock, and bare ground if they are part of the region's historical natural landscape and provide habitat value. At least 5% of the total site area (including building footprint) must be restored or protected with native or adapted vegetation.

Supporting the restoration and maintenance of an off-site natural area can contribute in part to satisfying the credit requirements. The off-site area must meet CLTA member land trust requirements by either being donated to a CLTA member land trust, or the property owner must enter into a conservation agreement with a CLTA member land trust (a link to the list of CLTA members is provided under Resources). The agreement can stipulate support through financial or service commitments; it must detail the location and size of the off-site area and the level and type of support to be provided. Enough detail should be used in contractual documents to clearly define the responsibilities and expected outcomes of the agreement.

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

Assess the impact of building and site development on resident and migratory wildlife and determine the best way to reduce the threat that windows pose to birds. Site strategies to maximize vegetated open space may increase the number of bird collisions. Assess the problem and use birdsafe landscaping and façade treatments as appropriate. Specifically, plant habitat that attracts birds may be placed either very close to windows (3 feet or less) or far enough away that it is not reflected in the glazing. Bird-safe treatments to the building design and glazing include using exterior shading devices, introducing etched or frit patterns in the glass, and creating "visual markers" in sufficient locations. Visual markers are differentiated planes, materials, textures, colors, opacity, or other visually contrasting features that help fragment window reflections and reduce overall transparency and reflectivity.

TIMELINE AND TEAM

Assess the possibility of earning this credit through on-site or off-site natural areas during the initial stages of project planning, including ensuring that any off-site locations being considered meet the Canadian Land Trust Alliance (CLTA) member land trust requirements. Landscape architects, ecologists, and other professionals who can provide site-specific expertise should perform a site survey to inventory existing native and adapted vegetation and make recommendations for meeting the requirements of this credit. For urban sites, evaluate the feasibility of installing a green roof by consulting with a structural engineer and landscape designer. New installations or contracts for supporting off-site natural areas should be in place before the performance period ends. During the performance period, document which natural areas are being maintained.

CALCULATIONS

Compliance with the credit requirements is based on the project building's site area, the building footprint and the size of on-site and/or off-site areas covered with native or adapted vegetation, or other ecologically appropriate features. Determine the total area within the LEED project boundary and subtract the area of the building footprint. Using scaled site drawings, determine the size of qualifying on-site and off-site natural areas (as defined in Documentation Guidance section). These areas must contain polycultures of native or adapted plant species or otherwise meet the definition of an ecologically appropriate site feature. Every 2 square meters of off-site area is considered equivalent to 1 square meter on-site area. The natural area (or equivalent amounts of off-site natural area associated with the project) must be at least 25% of the total site area, less the building footprint. The credit can be achieved through any combination of on-site and off-site natural areas.

EQUATION 1. MINIMUM NATURAL SITE AREA
On-Site Natural Area + 0.5 (Off-Site Natural Area) ≥ 0.25 (Total Site Area – Building Footprint)

A minimum of 5% of the total site area, including building footprint, must be restored or protected with native or adaptive vegetation on-site. Vegetated roof surfaces may apply to this requirement if the plants meet the definition of native or adapted. Using scale drawings, determine the size of qualifying vegetated roof area.

EQUATION 2. MINIMUM ON-SITE NATURAL SITE AREA
On-Site Natural Area + Compliant Vegetated Roof Area ≥ 0.05 (Total Site Area)

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

DOCUMENTATION GUIDANCE

The following list spells out the major requirements for this credit. Refer to the corresponding LEED Letter Template for the complete descriptions of all required declarations and documentation.

- ❑ Provide the performance period dates for this credit.
- ❑ Provide the LEED building footprint (in square meters) and the total LEED project site area (in square meters or hectares).
- ❑ Provide the area (in square meters or hectares) within the LEED project boundary covered in native or adapted vegetation.
- ❑ Provide the project roof area (in square meters) covered in native or adapted vegetation.
- ❑ Provide a completed Licensed Professional Exemption Form from a registered landscape architect who meets the requirements of the licensed professional exemption path, documenting that the design meets the credit requirements,, OR proper documentation including scaled site drawings highlighting areas of native or adapted vegetation, AND photographs taken during the performance period that document the landscape layout for at least 50% of the area highlighted in the site drawings. If both on-site and off-site natural areas contribute to the credit, provide photographs covering 50% of each area.

OPTION A. STREAMLINED PATH:
LEED Design and Construction, for project buildings that have previously earned a LEED Site Development: Protect or Restore Habitat credit.

- ❑ Provide a copy of the CaGBC-generated scorecard or final LEED review documenting that the project has earned at least one point under Site Development: Protect or Restore Habitat under LEED for New Construction, or LEED for Core & Shell.
- ❑ Describe the site changes and explain how the project meets the requirements despite these changes OR verification that the protection or restoration of site habitat has not been altered, replaced, or removed since the final LEED review.

OPTION B.
On-site protection or restoration of open space

- ❑ Provide verification from a registered landscape architect that the credit criteria are satisfied OR a narrative listing the native or adapted plants or other ecologically appropriate features on site.

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

OPTION C.
Off-site protection or restoration of open space

- ❑ Provide the off-site area (in square meters or hectares) covered in native or adapted vegetation.
- ❑ Provide a copy of the 5-year contract with the owner of the off-site natural area that details the nature and level of support provided by the LEED project in improving or maintaining the off-site natural area.
- ❑ Provide the distance of the off-site area from the project site (must be within 800 km).
- ❑ Provide documentation that the off-site area meets Canadian Land Trust Alliance (CLTA) member land trust requirements.
- ❑ Provide verification from a registered landscape architect that the credit criteria are satisfied OR a list of the native or adapted plants or other ecologically appropriate features present in the off-site area and the improvement or maintenance activities that occurred during the performance period as part of the maintenance contract.

EXAMPLES

The Fast Distributor project building is on a 1 hectare site. The building's footprint is 6,000 square meters; so the remaining site area is 4,000 square meters. The on-site natural area necessary to meet the credit requirements is 1,000 square meters (i.e., twenty-five percent of 4,000 square meters).

Because of the existing conditions, non compliant soft landscaping exists on 1,000 square meters of the site. During the performance period, the project team members were able to replace 500 square meters of the soft landscaping with native vegetation; meeting the credit requirement for a minimum 50% of on-site soft landscaping comprised of native or adapted vegetation.

Project team members also explored options with CLTA for supporting the restoration of an off-site area and have contracted with a CLTA member organization to provide funding to purchase the plants and supplies needed for a riverbank restoration project within 800 km of the *LEED Canada EB:O&M* project site. Although an additional 500 square meters of on-site natural areas is still required, because off-site natural areas must be twice the size of on-site natural areas, the area that Fast Distributor must help the riverbank project restore is 1,000 square meters.

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

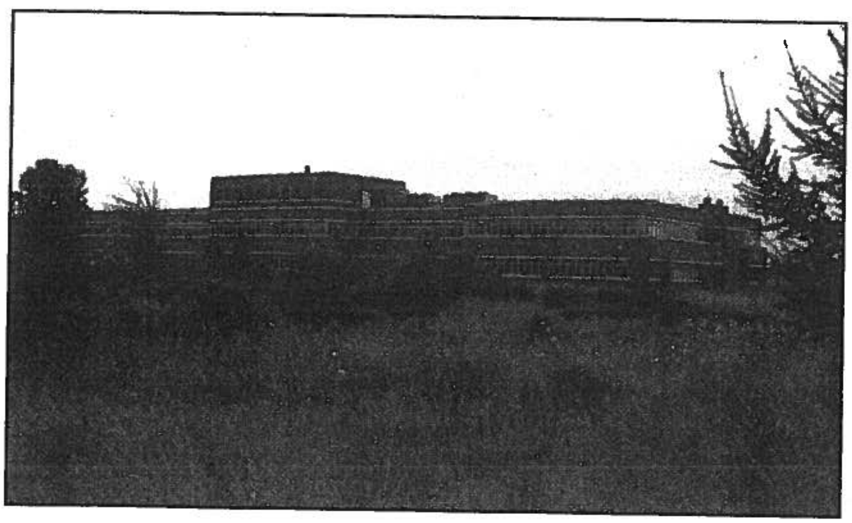
CASE STUDY

Ecology and Environment Corporate Headquarters
Lancaster, New York
Rating: Platinum
Owner: Ecology and Environment

Ecology and Environment (E & E) designated 85 acres surrounding its corporate headquarters in Lancaster, New York, as a wildlife protection area. More than 96% of E & E's 121-acre property is open or natural space, and nature trails throughout the property are available for employee use. The entire property is monitored on a regular basis by E & E wildlife biologists and evaluated so that best management practices can be implemented for the preservation and restoration of native plant and animal species.

E & E's entire landscape is made up of native and adapted plant species, selected for their habitat value and function within a natural, sustainable plant community. Over the past 20 years, previously disturbed areas on the property have been restored with native trees, shrubs, grasses, and wildflowers that provide food and habitat for birds, insects, and wildlife. The demonstration gardens located near the building are dedicated to the cultivation of New York State's listed species of concern. These gardens serve as a seed bank for the propagation and reintroduction of species of concern into the landscape.

E & E has implemented a nesting box plan, field cutting plan, and seasonal feeding plan on its property to support native bird populations. The grasslands surrounding the facility are actively managed to slow the succession into woodlands through seasonal mowing rotation. Grassland areas are managed for species that require a specific ground-nesting habitat, including such now-uncommon bird species as the bobolink, bluebird, American woodcock, meadowlark, and savannah sparrow. To date, more than 160 species of birds have been identified on the property.



EXEMPLARY PERFORMANCE

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

Project teams can earn an Innovation in Operations credit for exemplary performance by having onsite native or adapted vegetation covering a minimum of 50% of the site area (excluding the building footprint) or 10% of the total site area (including the building footprint), whichever is greater. For off-site habitat protection or restoration, double the required areas.

Project buildings that have previously earned SS Credit 5.1, Site Development -Protect or Restore Habitat, under LEED for New Construction are also eligible to earn exemplary performance.

REGIONAL VARIATIONS

Strategies for restoring native and adapted vegetation vary greatly by region and climate. Ecologically appropriate features may include natural site elements beyond vegetation that maintain or restore the ecological integrity of the site, such as waterbodies, exposed rock, unvegetated ground, or other features that are part of the region's historical natural landscape.

RESOURCES

WEBSITES

American Society of Landscape Architects
www.asla.org

ASLA is the national professional association representing landscape architects. Its website provides information about products, services, publications, and events.

CLTA Members
http://www.clta.ca/clta/founding.htm

Any land trust on the list of CLTA member organizations can be used to achieve compliance with SSc5, Option C.

Ecological Restoration
http://ecologicalrestoration.info

This quarterly print and online publication from the University of Wisconsin–Madison Arboretum provides a forum for people interested in all aspects of ecological restoration.

Evergreen Foundation
http://www.evergreen.ca/en/

This foundation is a registered national charity founded in 1991, and works to create healthy cities through innovative community naturalization projects across Canada – on school grounds, on public lands, and on the home landscape.

SS	WE	EA	MR	EQ	IO	RP

Credit 5

1 Point

Lady Bird Johnson Wildflower Center
www.wildflower.org

The Wildflower Center, in Austin, Texas, has the mission of educating people about the environmental necessity, economic value, and natural beauty of native plants. The site offers a nationwide native plant information network and a national suppliers directory.

North American Native Plant Society
www.nanps.org

A nonprofit association dedicated to the study, conservation, cultivation, and restoration of native plants. The site contains links to state and provincial associations.

Plant Native
www.plantnative.org

This organization is dedicated to moving native plants and "naturescaping" into mainstream landscaping practices. The site helps users locate native plant nurseries and regional plants.

Society for Ecological Restoration International
www.ser.org

A nonprofit consortium of scientist, planners, administrators, ecological consultants, landscape architects, and engineers, this organization promotes ecological restoration as a means of sustaining the diversity of life and reestablishing an ecologically healthy relationship between nature and culture.

Soil and Water Conservation Society
www.swcs.org

This organization focuses on fostering the science and art of sustainable soil, water, and related natural resources management.

PRINT MEDIA

Design for Human Ecosystems: Landscape, Land Use, and Natural Resources, by John Tillman Lyle (Island Press, 1999).

The book explores methods of landscape design that function like natural ecosystems.

Landscape Restoration Handbook, by Donald Harker, Marc Evans, Gary Libby, Kay Harker, and Sherrie Evans (Lewis Publishers, 1999).

This comprehensive guide to natural landscaping and ecological restoration provides information on 21 ecological systems.

Design with Nature, by Ian McHarg (John Wiley & Sons, 1969 ISBN 0-471-11460-X)

This book laid out the fundamental principles of planning of the built environment to protect and enhance natural ecological systems.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

SUSTAINABLE SITES

STORMWATER QUANTITY CONTROL

INTENT

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

REQUIREMENTS

Implement a stormwater management plan that, during the performance period, infiltrates, collects and reuses runoff or evapotranspirates runoff from at least 15% of the precipitation falling on the whole project site (including the roof area) both for an average weather year and for the two-year, 24-hour design storm.

Implement an annual inspection program of all stormwater management facilities to confirm continued performance. Maintain documentation of inspection, including identification of areas of erosion, maintenance needs and repairs. Perform all routine required maintenance, necessary repairs or stabilization within 60 days of inspection.

POTENTIAL TECHNOLOGIES & STRATEGIES

Collect and reuse stormwater for non-potable uses such as landscape irrigation, toilet and urinal flushing and custodial uses. During facility or site alterations or additions, specify the 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 improve perviousness, thereby restoring or maintaining natural stormwater flows. Incorporate stormwater management facilities into routine preventive and corrective maintenance programs.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

BENEFITS & ISSUES TO CONSIDER

ENVIRONMENTAL ISSUES

Stormwater is a major source of pollution for all types of waterbodies in the United States[11]. Impervious surfaces, such as roads and parking lots, produce stormwater runoff that contains sediment and other contaminants, including atmospheric deposition, pesticides, fertilizers, vehicle fluid leaks, and mechanical equipment waste. Increased stormwater runoff can overload pipes and sewers and damage water quality, affecting navigation and recreation. Furthermore, municipal systems that convey and treat runoff require significant infrastructure and maintenance. As well, in many municipalities, combined stormwater and sewage collection and treatment systems are often subject to surcharges that result in water body pollution in extreme rainfall events.

The health of streams is closely linked to stormwater runoff velocities and volumes. Increases in the frequency and magnitude of stormwater runoff due to development can increase overflow events and erosion, widen channels, and cause downcutting for streams. Effective on-site stormwater management practices detain stormwater flow, or let stormwater infiltrate the ground, thereby reducing the volume and intensity of peak flows[12]. Additionally, reducing stormwater helps maintain the natural aquifer recharge cycle and assists in restoring depleted stream base flows.

ECONOMIC ISSUES

Water detention and retention features, such as rain gardens and retention ponds, entail costs for design, installation, and maintenance but can also add significant value as site amenities. The use of infiltration strategies like pervious pavements may reduce the need for infrastructure to support conveyance as well as expensive and space-consuming retention options. However, the initial cost for properly installing pervious paving may be up to three times higher than conventional asphalt or concrete and may also require ongoing maintenance.

Even small stormwater collection and treatment systems lessen the burden on municipalities for maintenance and repair, resulting in a more affordable and stable tax base. Using stormwater for non-potable purposes, such as flushing urinals and toilets, custodial applications, and building equipment uses, would lower costs associated with potable water use. A water analysis can help determine the estimated volumes of water available for reuse.

RELATED CREDITS

Efforts to decrease impervious surfaces on the project site through pervious pavements, vegetated roofing, and vegetated open space can help meet the requirements of the following credits:

- SS Credit 5: Site Development—Protect or Restore Open Habitat
- SS Credit 7.1: Heat Island Reduction—Nonroof
- SS Credit 7.2: Heat Island Reduction—Roof

Harvested rainwater can be reused inside the building in non-potable applications or as landscape irrigation, assisting projects with earning these credits:

- WE Credit 2: Additional Indoor Plumbing Fixture and Fitting Efficiency
- WE Credit 3: Water-Efficient Landscaping

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

SUMMARY OF REFERENCED STANDARDS

There is no standard reference for this credit.

IMPLEMENTATION

The exact approach to this credit depends on project site conditions, as well as the region and climate zone. Prepare a stormwater management plan to preserve or restore natural functions of the site in managing stormwater, based on the natural soil conditions, habitat, and rainfall. The stormwater management plan should also include procedures for the ongoing monitoring and maintenance of any installed features that assist in stormwater mitigation.

CONTROLLING STORMWATER RUNOFF

Minimize stormwater runoff volume by limiting the amount of impervious area, thereby reducing the need for stormwater infrastructure, where it is known that soil conditions indicate that infiltration is an appropriate approach. Strategies to minimize or mitigate impervious surfaces may include using pervious paving materials, harvesting stormwater for reuse in irrigation and/or indoor water consumption, installing vegetated roofs, designing infiltration swales and retention ponds, and planting vegetated filter strips.

Regularly evaluate stormwater management facilities to ensure they are performing properly. At a minimum, annually inspect facilities and verify continued performance. Stormwater management factors that should be inspected include changes in landscape contour, areas of erosion, maintenance needs and repairs, and precipitation levels. Promptly repair any components of the stormwater management equipment and structures found to be underperforming during the inspection, and maintain records of inspection activities and equipment repairs.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

HARVESTING STORMWATER RUNOFF

Stormwater harvested in water features, cisterns or other kinds of tanks can be substituted for potable water in landscape irrigation; and in many jurisdications for fire suppression, toilet and urinal flushing and custodial uses. These approaches become more valuable where soil conditions indicate that infiltration is inappropriate.

Storage options range from small rain barrels to underground cisterns that hold large volumes of water. Designers of stormwater harvesting systems, whether large or small, should consider the following:

- Water budget. How will the harvested water be used and when will it be needed? For example, if stormwater will be used to irrigate landscaping for four summer months, estimate the amount of water needed and the amount and timing of precipitation expected.
- Drawdown. The storage system design must provide for the use or release of water between storm events for the design storage volume to be available.
- Drainage area. The size and imperviousness of the area draining to the storage system determines how much runoff will be available for harvesting.
- Conveyance system. Reused stormwater and graywater systems must not be connected to domestic or commercial potable water systems. Pipes and storage units should be clearly marked (e.g., "Caution: Reclaimed water—do not drink").
- Pretreatment. Screens or filters may be needed to remove debris and sediment from runoff and to minimize pollutants.
- Pressurization. Uses for harvested rainwater may require pressurization. For example, most irrigation systems require a water pressure of at least 15 pounds per square inch (psi) to function properly. Stored water has a pressure of 0.43 psi per foot of water elevation, and the water pressure at the bottom of a 3 meter (10 foot) vault would be 4.3 psi (3 m (10 ft). x 0.43 psi). Pressurization (pump, pressure tank, and filter) costs more but creates a more usable system.

Provincial and local governments have different design requirements for capturing and reusing stormwater runoff. Regulations may specify locations where stormwater may be captured and reused, length of time stormwater can be held in a cistern, and type of water treatment required before reuse. Project teams and designers should check with local authorities to determine best management practices that will affect collection and use of harvested stormwater.

TIMELINE AND TEAM

Decide on additional stormwater control measures during the earliest planning phases of the project. For example, incorporating stormwater best management practices such as bioswales into the project may require coordination with local municipalities, as well as adjustments to current site pathways and public spaces. Because the achievement of this credit requires performance tracking, it is important that teams include these systems in early project decisions. This allows time for adequate tracking over the credit performance period and embeds stormwater management controls into the project's infrastructure and subsequent operations.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

CALCULATIONS

Total annual rainfall data as well as region-specific values for the 2-year, 24-hour frequency storm are widely available, and various methods and computer programs exist to estimate stormwater runoff rates and volumes. The method used will depend on the available data and the preference of the project team.

VOLUME CAPTURED VIA COLLECTION AND RETENTION FACILITIES

The amount of runoff reduced by a stormwater harvesting system is based on its storage volume, the rate at which the system is emptied, and the interval between storm events. Use Equation 1 to determine the amount of capture runoff, and Equation 2 to assess the minimum drawdown rate necessary to empty the tank prior to the next rainfall event. If the actual drawdown rate is less than the minimum drawdown rate, the volume of runoff presumed to be captured by system must be reduced accordingly.

EQUATION 1. Volume of Captured Runoff

Vr (cubic metres) = (P)(Rv)(A) / 100 cm/m
Where; Vr = volume of captured runoff

P = average rainfall event (cm)
Rv = 0.05 + (0.009)(I) where I = percent impervious of collection surface
A = area of collection surface (m^2)

EQUATION 2. Minimum Drawdown Rate

Qr (m^3/second) = Tank Capacity (m^3)/ Rainfall event interval (seconds)
Where, Qr = Minimum Drawdown Rate

VOLUME OF RUNOFF

The Stormwater Management Calculator in the LEED Letter Template uses default runoff coefficients and the Rational Method (see Equation 3) to calculate stormwater runoff volumes. The Rational Method is an empirical equation that relates runoff to rainfall intensity and is based on surface types, areas and rainfall intensity. To complete the calculations, determine the two-year, 24-hour design storm rainfall intensity (millimetres per hour), and the areas and surface types of each unique surface, covering the project building and associated grounds. The total area within the LEED project boundary must be accounted for in the calculations, with the exception of surface waters (though rainfall delivery direct to detention facilities should be reflected in the claimed capacity of the system). Table 1 shows the default runoff coefficients for each surface type. Calculations must be based on these default values unless project teams substantiate the use of different values. Substitute coefficients must demonstrate their appropriateness to the project locale based on soil characteristics.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

EQUATION 3. Determining Rainwater Runoff

Q = (CiA)/360
Where Q = peak runoff rate (m^3/s)

C = runoff coefficient
i = rainfall intensity (millimetres per hour)
A = drainage area (hectares).

TABLE 1. DEFAULT RUNOFF COEFFICIENTS

SURFACE TYPE	RUNOFF COEFFICIENT	SURFACE TYPE	RUNOFF COEFFICIENT
Pavement, Asphalt	0.95	Turf, Flat (0-1% Slope)	0.25
Pavement, Concrete	0.95	Turf, Average (1-3% Slope)	0.35
Pavement, Brick	0.85	Turf, Hilly (3-10% Slope)	0.40
Pavement, Gravel	0.75	Turf, Steep (>10% Slope)	0.45
Roofs, Conventional	0.95	Vegetation, Flat (0-1% Slope)	0.10
Roof, Garden Roof (<100 mm)	0.50	Vegetation, Average (1-3% Slope)	0.20
Roof, Garden Roof (100-200 mm)	0.30	Vegetation, Hilly (3-10% Slope)	0.25
Roof, Garden Roof (200-500 mm)	0.20	Vegetation, Steep (>10% Slope)	0.30
Roof, Garden Roof (> 500 mm)	0.10		

DOCUMENTATION GUIDANCE

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

The following list spells out the major requirements for this credit. Refer to the corresponding LEED Letter Template for the complete descriptions of all required declarations and documentation.

- ❑ Provide the performance period dates for this credit.

OPTION A. STREAMLINED PATH:

LEED Design and Construction, for a project building that has previously earned a LEED Stormwater Design: Quantity Control credit

- ❑ Provide a copy of the CaGBC-generated scorecard or final LEED review documenting that the project has earned at least one point in Stormwater Design: Quantity Control under LEED for New Construction or LEED for Core & Shell.
- ❑ Provide a brief (one to two paragraph) narrative that describes changes made to the stormwater management system since the original LEED certification, and explain how the project continues to meet Stormwater Design: Quantity Control requirements despite these changes OR provide a letter signed by a representative of the building owner or manager that the Stormwater Design: Quantity Control efforts have not been altered, replaced, or removed since the original LEED certification.
- ❑ Provide a brief (one to two paragraph) narrative that summarizes the annual stormwater inspection program that confirms continued performance and explains how inspection documentation is generated and tracked.
- ❑ Provide a copy of the most recent stormwater inspection and a log showing that any needed maintenance or repairs were performed within 60 days of the inspection.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

OPTION B. LEED CANADA FOR EXISTING BUILDINGS O&M PATH

- ❑ Provide the completed Licensed Professional Exemption Form from a registered professional engineer or a registered landscape architect who meets the requirements of the licensed professional exemption path, documenting that the design meets the credit requirements.

  OR

- ❑ Provide a stormwater assessment report generated during the design phase, according to presiding regulations, that accurately accounts for current site conditions OR a stormwater assessment report produced by a qualified industry professional (e.g., civil engineer) OR an equivalent assessment report.

  OR

- ❑ Calculate the percentage of stormwater mitigated using the *LEED Canada for EB: O&M* Stormwater Management Calculator, included in the LEED Letter Template.
- ❑ Provide a brief (one to two paragraph) narrative that describes the stormwater management strategies.
- ❑ Summarize the annual inspection program that confirms continued performance and how inspection documentation is generated and tracked.
- ❑ Provide a copy of the most recent stormwater inspection and a log showing that any needed maintenance or repairs were performed within 60 days of the inspection.

EXAMPLES

Rainwater is harvested from a 1,000-square-metre roof (100% impervious). The system is designed to capture the runoff from the average rainfall event (2 centimetres of rainfall for humid watersheds). The volume of the proposed storage system is the amount of runoff captured (Vr):

$$Vr = \frac{(P)\,(R_v)\,(A)}{100cm} = \frac{(2cm)\,(0.95)\,(1{,}000m^2)}{100cm/m} = 19.0m^3\ (19{,}000L)$$

Where, $R_v = 0.05 + (0.009)\,(I) = 0.05 + (0.009)\,(100) = 0.95$
R_v = Volumetric Runoff Coefficient
I = Percentage Imperviousness

The tank must be emptied after each storm. Using a tank that is 3.2-by-3-by-2-metres gives a total storage volume (Vs) of 19 cubic metres. Using a design storm interval of three days (72 hours), the drawdown rate (Qr) is

$$Qr = 19\ m^3 / 259{,}200\ sec. = 7.4 \times 10^{-5}\ m^3/s \text{ or } 4.4\ lpm$$

In this example, the captured rain must be drained within three days, or at a minimum rate of 4.4 lpm, for the tank to be emptied before the next storm. If the drainage rate is slower, full capacity cannot be assumed to be available during the two-year, 24-hour design storm.

Source: 2000 Maryland Stormwater Design Manual, Vols. I, II (MDE, 2000)

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

CASE STUDY

Johnson Diversey Global Headquarters
Sturtevant, Wisconsin
Rating: Gold
Owner: JohnsonDiversey, Inc.

Detention ponds and restored wetlands at Johnson Diversey's Global Headquarters site in Sturtevant, Wisconsin, collect 100% of the site's stormwater runoff. Additional runoff from neighboring sites and roadways is also collected by the 12 acres of restored wetlands and ponds. The collected stormwater supplies the headquarters' irrigation water, effectively replacing 100% of the potable water use for landscape irrigation. This saves the local water utility an estimated 2 million gallons of water annually; the payback on the initial investment was less than years. An estimated 34% of the 57-acre site consists of impervious surface, making retention ponds for controlling sediment, pollution, and flooding essential. JohnsonDiversey actively monitors and maintains the site to ensure the effective management of stormwater and reduced impacts on the site environment. Native prairie plants covering 30 acres of the site also aid in stormwater management while providing habitat and creating open space.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

EXEMPLARY PERFORMANCE

Projects may earn an Innovation in Operations credit for exemplary performance by demonstrating that they have implemented a stormwater management plan that infiltrates, collects and reuses, or evapotranspirates runoff from at least 30% of the precipitation falling onsite.

REGIONAL VARIATIONS

The approach for achieving this credit varies dramatically across regions and climate zones. The strategies employed in an urban environment, where water is discharged to a municipal master system will be different from the approach for a rural project that discharges to small streams or lakes with high water quality standards. Regions that are generally dry and need to retain and reuse rain water but also have seasonally heavy rainfall can benefit greatly from collection and storage strategies.

RESOURCES

WEBSITES

Center for Watershed Protection
www.cwp.org

A nonprofit dedicated to disseminating watershed protection information to community leaders and watershed managers, the center offers online resources, training seminars, and *Watershed Protection Techniques.*

Environment Canada's Reducing Flood Damage – Stormwater Management
http://www.ec.gc.ca/water/en/manage/floodgen/e_mngt.htm

A discussion on Stormwater management.

EPA Office of Wetlands, Oceans, and Watersheds
www.epa.gov/owow

This website has information about watersheds, water resources, water conservation, landscaping practices, and water pollution.

EPA Low Impact Development Website
www.epa.gov/owow/nps/lid

EPA provides valuable information on low-impact development through fact sheets, design guides, and cost estimates for low-impact development strategies that reduce stormwater runoff.

Model Low Impact Development Strategies for Big Box Retail Stores
http://dnr.metrokc.gov/wlr/stormwater/low-impact-development.htm

Prepared by King County, Washington with EPA funding, this report focuses on stormwater best practices for retail development; the information is also relevant to other large developments that traditionally have large parking lots, such as schools and industrial parks.

SS	WE	EA	MR	EQ	IO	RP

Credit 6

1 Point

U.S. National Pollutant Discharge Elimination System (NPDES)
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

EPA offers help on managing stormwater, including fact sheets on the six minimum control measures for best management practices.

Stormwater Manager's Resource Center
www.stormwatercenter.net

This site for practitioners and local government officials provides technical assistance on stormwater management issues.

PRINT MEDIA

Low Impact Development Technical Reference Manual for Puget Sound (Puget Sound Action Team and Washington State University Pierce County Extension, 2005).

This manual provides technical data, specifications, and performance data for low-impact development design strategies. The manual is available for download at www.psp.wa.gov/downloads/LID/LID_manual2005.pdf.

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

SUSTAINABLE SITES

HEAT ISLAND REDUCTION: NON-ROOF

INTENT

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

REQUIREMENTS

Choose one of the following options:

OPTION A

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

- Provide shade from existing tree canopy or within five years of landscape installation; landscaping (trees) must be in place at the time of certification application.
- Provide shade from structures covered by solar panels that produce usable energy used to offset some non-renewable resource use.
- Provide shade from architectural devices or structures that have a solar reflectance index (SRI) of at least 29. Implement a maintenance program that ensures these surfaces are cleaned at least every two years to maintain good reflectance.
- Have paving materials with an SRI of at least 29 and implement a maintenance program that ensures these surfaces are cleaned at least every two years to maintain good reflectance.
- Have an open-grid pavement system (at least 50% pervious).

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

OR

OPTION B
Place a minimum of 50% of parking spaces under cover (defined as underground, under deck, under roof or under a building). Any roof used to shade or cover parking must have an SRI of at least 29, be a vegetated green roof, or be covered by solar panels. Implement a maintenance program that ensures all SRI surfaces are cleaned at least every two years to maintain good reflectance. The top parking level of a multilevel parking structure is included in the total parking spaces calculation but is not considered a roof and is not required to be an SRI surface.

OR

OPTION C
Projects in urban sites with little or no building setbacks (i.e. zero lot line), no site hardscape or on-site parking, and that comply with SS Credit 7.2 will be deemed to meet the requirements of SS Credit 7.1.

To meet SS Credit 7.1 Options A or B requirements, the total area of parking used in the credit calculation must include on-site and off-site parking.

POTENTIAL TECHNOLOGIES & STRATEGIES

Employ strategies, materials and landscaping techniques that reduce heat absorption of exterior materials. Use shade (calculated on June 21, noon solar time) from native or adapted trees and large shrubs, vegetated trellises or other exterior structures supporting vegetation. Consider the use of new coatings and integral colorants for asphalt to achieve light-colored surfaces instead of blacktop. Position photovoltaic cells to shade impervious surfaces.

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, such as concrete, to reduce the heat absorption.

BENEFITS & ISSUES TO CONSIDER

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

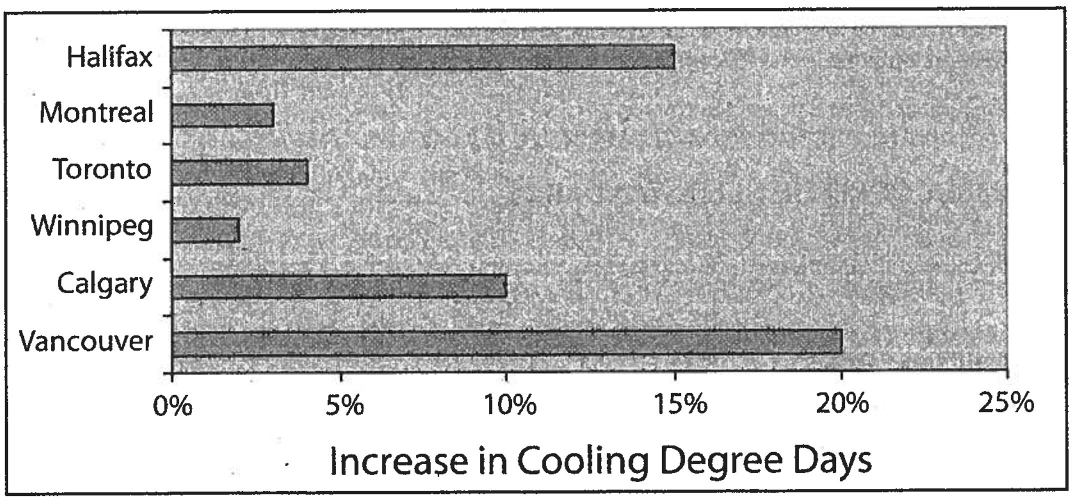
ENVIRONMENTAL ISSUES

The use of dark, non-reflective surfaces for parking, roofs, walkways, and other hardscapes contributes to heat island effects by absorbing the sun's radiation, which then radiates into the surroundings. Because of the heat island effect, ambient temperatures in urban areas are artificially elevated by 1° to 3°C compared with surrounding suburban and undeveloped areas.[13] The result is increased cooling loads in the summer, requiring larger HVAC equipment and greater electricity consumption, both of which generate greenhouse gases and pollution. Plants and animals are also sensitive to large fluctuations in daytime and nighttime temperatures and may not thrive in areas affected by heat islands.

ECONOMIC ISSUES

The energy used to cool a building represents a substantial cost in the operating budget over the building's lifetime. Reducing heat islands can significantly lower the cost of cooling and HVAC equipment needs. The figure below illustrates heat island effects in various cities throughout Canada. The greater amount of cooling degree-days in urban locations means that air-conditioning systems must work harder and use more energy to maintain thermal comfort in buildings.

FIGURE 1: HEAT ISLAND EFFECTS IN VARIOUS CITIES THROUGHOUT CANADA



SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

Although a project team may higher initial costs from the installation of additional landscaping or architectural shading devices, these items have an acceptable payback when integrated into a systems approach to maximizing energy savings.

Some high-reflectance pavements, such as concrete made with white cement, may cost up to twice as much as those made with gray cement, but some blended cements (e.g., slag) are very light in colour and cost the same as or slightly less than Portland-only gray cement[14]. High-reflectance pavements also increase overall light levels and may allow a building to use fewer site lighting fixtures. Building owners should assess the cost of installing highly reflective pavements or coatings to reduce heat island effect against possible energy savings from possible reduced site lighting.

RELATED CREDITS

Installing native or adapted plants to shade hardscapes can assist with earning the following credit:

- SS Credit 5: Reduced Site Disturbance—Protect or Restore Open Habitat

Properly designed and installed open-grid pavements capture and treat stormwater runoff, helping project teams earn this credit:

- SS Credit 6: Stormwater Quantity Control

If vegetation is used to shade hardscapes, refer to the landscape irrigation requirements outlined in the following credit to reduce potable water use:

- WE Credit 3: Water-Efficient Landscaping

SUMMARY OF REFERENCED STANDARDS

There is no standard referenced for this credit.

IMPLEMENTATION

Strategies for mitigating heat island effect include using materials with higher solar reflectance properties on the project site, adding high-reflectance coatings to existing hardscapes, providing shaded areas, and reducing hardscape surfaces.

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

HIGHER SOLAR REFLECTANCE

Hardscape materials vary in their ability to reflect sunlight. Dark paving materials, such as asphalt, generally have low reflectance and consequently low SRI values; gray or white concrete has a higher reflectance and a higher SRI value. Applying microsurfaces and light-coloured coatings over existing pavement can help meet the requirements of this credit. Coatings and integral colourants can be used in cement pavers or cast-in-place parking surfaces to improve solar reflectance.

Light-coloured surface coatings, slurry seals, emulsion sealcoats, or chip seals can increase the SRI value of black asphalt. White-topping is concrete, usually 10 to 20 centemeters (4 to 8 inches) thick, laid over existing asphalt pavement. Fiber-reinforced white-topping can applied in a layer as thin as 5 to 10 centemeters (2 to 4 inches) and still withstand normal loads on low-traffic areas[15]. White-topping helps increase reflective qualities, thereby reducing heat island effects while also increasing the service life of the existing asphalt pavement.

Dirt and oil buildup on pavement reduces its reflectivity. Incorporate a maintenance program for cleaning pavement surfaces to achieve and maintain optimal performance and effectiveness in reflecting sunlight. Schedule a cleaning using low-impact cleaning products at least once every two years.

Because higher reflectance pavements increase overall light levels, lighting evaluations should include an assessment of interreflected components and high-reflectance materials. High reflectance materials (such as white concrete) can result in glare, which impairs vision and increases light pollution. Minimize the amount of light that is directed from site lighting fixtures directly onto reflective paving surfaces.

SHADING

Vegetation can reduce heat islands by shading buildings and pavements from solar radiation and cooling the air through evapotranspiration. Provide shade using landscape features such as native or adapted trees, large shrubs, and noninvasive vines. Newly installed landscape features should be designed to provide the desired level of shading within five years of the planting date and must be in place at the time of certification application. Trellises and other exterior structures can support vegetation to shade parking lots, walkways, and plazas. Deciduous trees allow solar heat gain during the winter months. Where tree planting is not possible, use architectural shading devices and structures to block direct sunlight. Solar energy system installations, including photovoltaics, can contribute to shading nonroof hardscapes.

Avoid planting trees and vegetation in locations likely to be reflected in building glazing unless specific measures are taken to reduce bird collisions. Such measures include using exterior shading devices, introducing etched or frit patterns in the glass, and creating "visual markers" in sufficient locations. Visual markers are differentiated planes, materials, textures, colors, opacity, or other visually contrasting features that help fragment window reflections and reduce overall transparency and reflectivity.

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

LESS HARDSCAPE

Limit the amount of impervious hardscape areas on the site to reduce heat island effects. Where subsurface conditions make it appropriate, replace impervious areas, such as parking lots, roads, and walkways, with open-grid pavement systems that are at least 50% pervious and accommodate vegetation within the open cells. Another way to reduce hardscape surfaces is to place a minimum of 50% of parking spaces under shading structures or under cover. This strategy can include using multistory or underground parking structures. Any roof used to shade or cover parking must have an SRI of at least 29, be a vegetated roof, or be covered in solar panels. There is no SRI requirement for parking that is underground, under a deck, or under a building as long as any exposed parking surface area is 50% or less of the total parking surface area.

TIMELINE AND TEAM

Early in the project, project teams should assess existing site features and consider opportunities for mitigating the heat island effect. Coordinate with the building owner and an architect and landscape architect to determine the feasibility of installing shading devices, planting vegetation, and replacing hardscapes with reflective surfaces. Teams may wish to consult a civil engineer to determine whether open-grid pavements can also contribute to increased stormwater management on the project site. Any alterations to the site's features should be complete before the performance period ends.

CALCULATIONS

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

OPTION A

1. Identify all non-roof hardscape surfaces on the project site as well as off-site parking and sum the total area (T).

   Hardscapes must, at a minimum, include all roads, sidewalks, courtyards, and parking lots within the LEED project boundary as well as off-site parking lots.

2. Identify all hardscape surfaces shaded by trees or other landscape features (either at the end of the performance period or within five years from the date of installation). Shade coverage shall be calculated at 10 A.M., 12 noon, and 3 P.M. on the summer solstice. The arithmetic mean of these three values will be used as the effective shaded area. Calculate the effective shaded area (S).

3. Identify all hardscape surfaces shaded by solar panels that produce usable energy and sum the total area (E).

   The shaded area can be considered equivalent to the area covered by the panels on the site plan (from a direct overhead aerial perspective).

4. Identify all hardscape surfaces shaded by architectural devices or structures that have an SRI of at least 29 and sum the total area (A).

   The shaded area can be considered equivalent to the area covered by the architectural devices/structures on the site plan (from a direct overhead aerial perspective).

5. Identify all the hardscape surfaces that have an SRI of at least 29 and sum the total area (R).

   SRI can be calculated from emissivity and reflectance values through the use of the LEED SRI Calculator in the SS Credit 7.1 Letter Template. Emissivity is calculated by manufacturers according to ASTM E 408 or ASTM C 1371 and solar reflectance is calculated according to ASTM E 903, ASTM E 1918, or ASTM C 1549. Alternatively, Table 1 lists SRI values for typical paving materials; these SRI values may be used in lieu of obtaining specific emissivity and reflectance measurements for the listed materials.

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

TABLE 1. SOLAR REFLECTANCE INDEX (SRI) FOR STANDARD PAVING MATERIALS

MATERIAL	EMISSIVITY	REFLECTANCE	SRI
Typical new gray concrete	0.9	0.35	35
Typical weathered[1] gray concrete	0.9	0.20	19
Typical new white concrete	0.9	0.70	86
Typical weathered[1] white concrete	0.9	0.40	45
New asphalt	0.9	0.05	0
Weathered asphalt	0.9	0.10	6

[1]Reflectance of surfaces can be maintained with cleaning. Typical pressure washing of cementitious materials can restore reflectance close to original value. Weathered values are based on no cleaning.Identify all hardscape surfaces that have an open grid paving system that is at least 50% pervious and sum the total area (O).

6. Sum the area of all qualifying surfaces to determine the total qualifying area (Q), using Equation 1.

   Each surface should be counted only once. For example, a 10 square meter area that is 55% pervious, has an SRI of 30 and is shaded by a tree contributes only 10 square meters to the total.

   EQUATION 1

   $Q = (S + E + A + R + O + Q)$

7. The total qualifying area must be greater than or equal to 50% of the total hardscape area (T), as calculated in Equation 2.

   EQUATION 2

   $Q \geq T / 2$

OPTION B

1. Determine the total number of parking spaces within the project boundary as well as in off-site parking used by the project.
2. Determine the number of parking spaces that are under covered (include underground, under deck, under roof, or under building). This number must greater than or equal to 50% of the total number of parking spaces. For the purposes of this credit, any roof used to shade or cover parking must have an SRI of at least 29, be a vegetated green roof, or be covered by solar panels for the parking to count as covered.

OPTION C

All calculations required for this option are submitted as part of SS Credit 7.2: Heat Island Reduction: Roof.

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

DOCUMENTATION GUIDANCE

The following list spells out the major requirements for this credit. Refer to the corresponding LEED Letter Template for the complete descriptions of all required declarations and documentation.

- ❑ Provide the performance period dates for this credit.

STREAMLINED PATH: LEED DESIGN AND CONSTRUCTION.

Project building previously earned a LEED credit for Heat Island Reduction: Non-Roof

- ❑ Provide a copy of the CaGBC-generated scorecard or final LEED review documenting that the project building earned at least one point relating to Non-Roof Heat Island Reduction under LEED for New Construction or LEED for Core & Shell. Verify that the project is using the same site boundaries specified in the LEED design and construction application.
- ❑ Describe any alterations, replacement, or removal and explain how the project meets the requirements despite these changes OR provide verification that the features that contributed to earning at least one point in a credit related to Non-Roof Heat Island Reduction were not altered, replaced, or removed since the project building's previous final LEED review.
- ❑ Describe the maintenance program; if shade from architectural structures or devices were used to demonstrate credit compliance as part of the LEED design and construction application, include information about cleaning procedures and schedules for maintaining the reflectance of SRI surfaces over time.
- ❑ Confirm whether the project was eligible to earn an exemplary performance point for Heat Island Reduction: Non-Roof under LEED for New Construction or LEED for Core and Shell.

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

OPTION A.

Heat island reduction using shading, reflective paving, and/or open-grid pavement

- ❑ Provide a site drawing, accurate at the close of the performance period, highlighting all non-roof hardscape areas. Clearly label each portion of hardscape that counts toward compliance.
- ❑ Indicate the area of the total non-roof hardscape, in square meters. This area is to include roads, sidewalks, courtyards, parking lots (both on-site and off-site) and any other non-roof hardscape within the project boundary.
- ❑ Indicate the area of each portion of hardscape that counts toward compliance, in square meters.
- ❑ Provide a completed Licensed Professional Exemption Form, from a registered landscape architect, architect, or professional engineer who meets the licensed professional exemption path requirements, stating the area of vegetative shading, shading from solar energy panels, shading from architectural devices or structures, reflective paving materials (with a SRI greater than 29), and open-grid pavement systems OR, for each compliant surface type, provide the associated supporting documentation:
  - Vegetative shading. If the area is based on future shading, provide a site plan that shows the shading conditions expected within five years of the date of installation, and describe the landscape features, including information about the species planted, size at installation, and typical annual growth rates.
  - Shading from solar energy panels. Provide representative photos of the solar energy panels demonstrating that they shade the non-roof hardscapes.
  - Shading from architectural devices or structures. Provide documentation for each architectural device or structure providing shade on the non-roof hardscape that establishes its SRI value. Provide representative photos of the architectural devices or structures showing that they shade the non-roof hardscape and describe the maintenance program, including information about cleaning procedures and schedules.
  - Reflective paving materials. Provide documentation for each reflective paving material that establishes its SRI value and describe the maintenance program, including information about cleaning procedures and schedules.
  - Open-grid pavement system. Provide representative photos of the open-grid pavement system.

OPTION B.

Heat island reduction strategies using covered parking

- ❑ Indicate the total number of parking spaces attributed to this project, both on-site and off-site.
- ❑ Indicate the number of on-site and off-site parking spaces under cover.
- ❑ Provide a site plan(s) that shows all parking spaces attributed to the project. Mark and label parking located under cover and indicate the type of cover (underground, under deck, under roof, or under building).
- ❑ Provide documentation establishing the SRI value for each roof or cover that directly shades parking, and describe the maintenance program, including information about cleaning procedures and schedules.

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

OPTION C.

Heat island reduction using zero hardscape

- ❑ Confirm the project site has little or no building setback, no site hardscape and no on-site parking.
- ❑ Provide a site plan that shows the building and LEED project boundary, confirming that there is little or no building setback, no site hardscape and no on-site parking.
- ❑ Confirm the project meets the requirements of SS Credit 7.2.

EXAMPLES

A building is located on a 2,300-square-meter site, of which 1,380 square meters is occupied by the building footprint and vegetated areas. The project team employs strategies to reduce heat island effect for nonroof surfaces, installing deciduous trees to shade parking and driveway areas and using light-colored surface coatings with an SRI of 35 for driving aisles and walkways (Figure 2). Areas that contain both light-colored hardscapes and are shaded by trees are counted only once. Table 2 lists the areas of qualifying surfaces.

TABLE 2. SAMPLE QUALIFYING SURFACE AREA

DESCRIPTION	AREA (SQUARE METERS)
Total nonroof hardscapes	920
Shaded areas	270
Areas of hardscapes with minimum SRI-29	370
Total qualifying surfaces	640

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

FIGURE 2. SHADING AND SRI FOR CREDIT COMPLIANCE

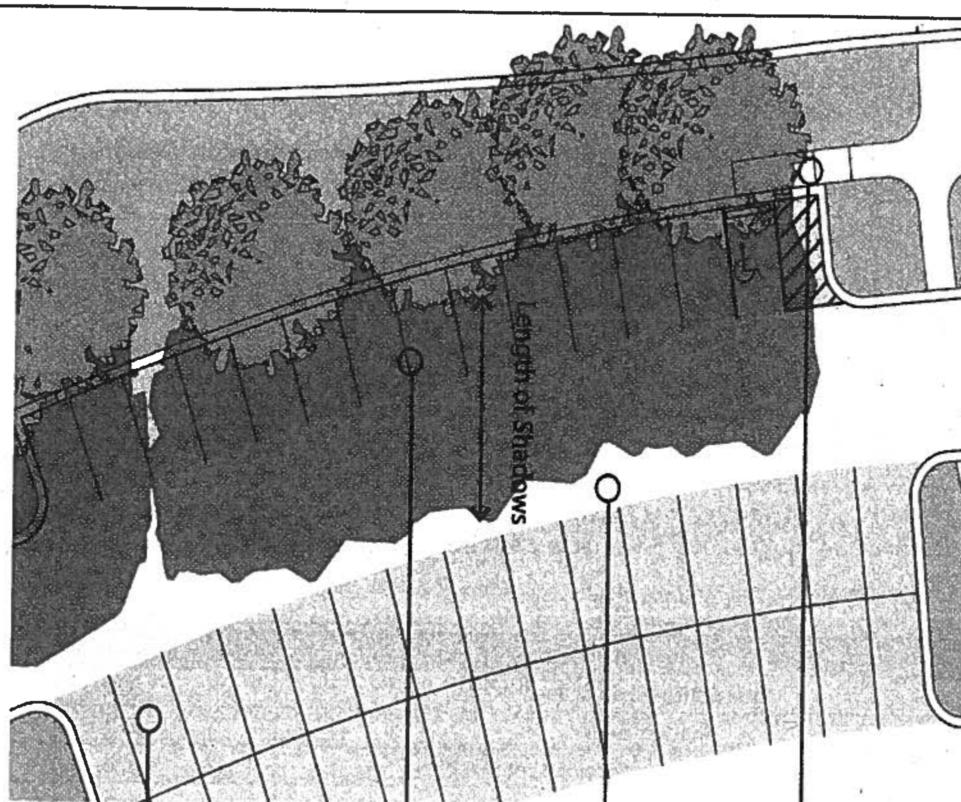


Diagram courtesy of OWP/P

EXEMPLARY PERFORMANCE

Projects may earn an Innovation in Operations credit for exemplary performance by demonstrating that either (1) at least 95% of nonroof impervious surfaces have been constructed with SRI-compliant materials and/or open-grid paving or will be shaded within 5 years; or (2) at least 95% of the on-site parking spaces have been located under cover. A project deemed eligible to earn an exemplary performance point for Heat Island Reduction: Non-Roof in a LEED Design and Construction Rating System is eligible for an exemplary performance point in *LEED Canada EB:O&M*.

REGIONAL VARIATIONS

SS	WE	EA	MR	EQ	IO	RP

Credit 7.1

1 Point

Heat island intensities depend on weather and climate, proximity to water bodies, and topography[16]. Buildings in very cold climates or at high latitudes may not experience the same rise of surface and ambient temperatures. Buildings located in urban areas are most affected by heat islands and are likely to benefit from measures that decrease cooling loads. In sunny climates, project teams should mitigate glare from reflective pavements into the building by providing shading devices. Consider hardscape surfaces and parking cover that are appropriate for the region's weather.

RESOURCES

WEBSITES

American Concrete Pavement Association
www.pavement.com

This national association represents concrete pavement contractors, cement companies, equipment and material manufacturers, and suppliers. See "Albedo: A Measure of Pavement Surface Reflectance," R&T Update 3.05, June 2002 (www.pavement.com/Downloads/RT/RT3.05.pdf).

Cool Alternative Paving Materials and Techniques
www.cleanaircounts.org/Resource%20Package/A%20Book/Paving/other%20pavings/coolpave.htm

This website maintains a list of new and resurfaced pavement options and provides cost data on each application.

EPA Heat Island Effect
www.epa.gov/heatisland

EPA offers basic information about heat island effect, its social and environmental costs, and strategies to minimize its prevalence.

Lawrence Berkeley National Laboratory Heat Island Group
http://eetd.lbl.gov/HeatIsland/

The lab conducts research on ways to minimize heat island effects; current efforts focus on developing more reflective surfaces for roadways and buildings.