

SS Sustainable Sites
Credits Overview

P1 Construction Activity Pollution Prevention
(prerequisite)

1. Site Selection
2. Development Density & Community Connectivity
3. Brownfield Redevelopment
4. Alternative Transportation
5. Site Development
6. Stormwater Design
7. Heat Island Effect
8. Light Pollution Reduction

- *Develop appropriate sites*
- *Reuse existing buildings*
- *Protect natural areas*
- *Reduce need for automobiles*
- *Protect and restore the site*

A building's location has a multitude of impacts to its surrounding area. For example, the size of a building's footprint and the land-use type where a development takes place seriously effect the preservation of natural ecosystem functions and health of the community. Project teams should be aware of a development's impact on land consumption, ecosystems, natural resources, and energy use. Buildings in the LEED 2.2 Rating System that develop within an existing dense infrastructure, enhance the preservation of a natural outdoor environment, and provide alternative transportation for its inhabitants will earn points toward certification.

Slide 2

SS Sustainable Sites: Prerequisite 1
Construction Activity Pollution Prevention

INTENT - Reduce pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation.

REQUIREMENTS
Create and implement an Erosion and Sedimentation Control (ESC) Plan for all construction activities associated with the project.

The ESC Plan shall conform to either:

- the erosion and sedimentation requirements of the **2003 EPA Construction General Permit**

OR

- local erosion and sedimentation control standards and codes

*** Whichever is more stringent.**

Soil erosion on building sites can be a major source of sediment pollution in waterways. The runoff of sediment carries pollutants and excessive nutrients that enter the water systems at concentrated levels. This phenomenon is called *sedimentation*. Sedimentation causes the water to become silty and cloudy, limiting sunlight and preventing photosynthesis from happening. Although the impacts of one building site may seem miniscule, the cumulative effect of polluted runoff from thousands of building sites can have a dramatic impact on water quality.

The major on-site effect of erosion is the loss of topsoil. Topsoil is the media where plants, microbes, and nutrients grow best, and the loss of topsoil greatly reduces the ability for the land to support biodiversity.

SS Sustainable Sites: Prerequisite 1
Construction Activity Pollution Prevention

Erosion and Sediment control plan MUST:

- Protect topsoil from storm water runoff and wind erosion
- Prevent sedimentation of storm sewer or receiving stream
- Prevent air pollution from dust and particulate matter

Referenced Standard:
U.S. EPA Document No. EPA 832/R-92-005
(Sept. 1992), Storm Water

Management for Construction Activities
OR
Local erosion and sedimentation control codes, whichever is more stringent.



Stockpiling topsoil for later use on site

To achieve this credit the project team must develop and implement an erosion control plan that prevents the loss of topsoil, runoff of soil by stormwater, and particulate matter in the air. It is best to create an erosion control plan early in the project that includes the three components above.

SS Sustainable Sites: Prerequisite 1
Construction Activity Pollution Prevention

Design Strategies:

- Sediment traps
- Sediment basins
- Mulching
- Earth dikes
- Temporary and permanent seeding
- Silt fencing



Silt Fencing



Permanent Seeding




Compost Blanket

Silt fencing is the most common method of erosion prevention for commercial construction, but it needs to be maintained to work properly. There are numerous other strategies that may be better suited to a particular site. A compost blanket is a new and untapped strategy that is flexible for any project. A compost blanket is a layer of compost that is applied on top of the layer of soil to prevent it from being exposed. Using compost for erosion control has many benefits; such as absorbing water, filtering pollutants, facilitating plant and microbial growth, and improving the soil. Of course, the outcome of these applications depends on the conditions at a specific site and the necessary maintenance provided throughout the project.

SS Sustainable Sites: **Credit 1**
Site Selection

INTENT - Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.



Avoid building on:

- Prime agricultural land
- Previously undeveloped land < 5' above the 100-yr. flood plain
- Land within 100' of wetlands
- Previously undeveloped land within 50' of a water body
- Threatened species habitat
- Prior public parkland

Referenced Standards:


- U.S. Dep't. of Agriculture Definition of Prime Agricultural Land
- Federal Emergency Management Agency (FEMA) 100-Year Flood Definition

Development in non-urban areas has increased. Because this development trend has the potential to encroach on precious endangered species habitats, wetlands, and prime farmland, this credit is targeted at encouraging developers to look at areas previously developed in order to preserve and protect our Earth's natural ecosystems. The most sustainable approach in site selection is to develop in previously developed areas when available and appropriate. This strategy has many benefits by improving upon a previously developed area, preserving undeveloped land and also helps by preventing urban sprawl. Efforts should be made to try and minimize the impact to the site by having a smaller building footprint.

* Like a lot of the Sustainable Sites credits, there may be little the design team can do to impact the outcome of the site selection because the site has already been chosen by the time the design team is designated. However, there are other credits in Sustainable Sites that can be achieved through proper site development, site restoration, community connectivity, etc.

SS Sustainable Sites: **Credit 2**
Development Density & Community Connectivity

INTENT: Channel development to urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources.



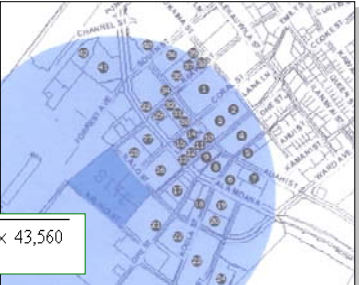
Requirements – OPTION 1

- Construct or renovate on a previously developed site
- In a community with minimum density of 60,000 sq. ft / acre

(Property Density Calculation)

$$\text{Density [ft]} = 3 \times \sqrt{\text{Property Area [acres]} \times 43,560}$$

Radius



This credit hopes to prevent the negative effects of urban sprawl such as increased oil use for vehicles, increased air pollution and a decreased quality of life as more time is spent driving. Developments with access to basic services and amenities provide a walkable community for the inhabitants of the building and reduce the dependency of cars for transportation. There are two means in which to achieve this credit.


Option 1, is calculation based to determine the development density. Development density refers to the project's density on site with reference to the surrounding area. To determine the development density of a project, a density boundary must be calculated and the density for all of the properties within the density boundary must be determined. The average property density must not exceed 60,000 sq.ft. per acre. This is the more academic option that does not work in many situations, but is easily attainable in large cities.

* Note: the submittal templates can be helpful in performing the density calculations.

SS Sustainable Sites: **Credit 2**
Development Density & Community Connectivity

Requirements – OPTION 2

- Construct or renovate on a previously developed site
- Within ½ mile of a residential zone with average density of 10 units / acre
- Within ½ mile of at least 10 basic services
- With pedestrian access from building to **services**



Services for Option 2 include:

- Bank
- School
- Supermarket
- Park
- Post Office
- Community Center
- Place of Worship
- Museum
- Cleaners
- Fire Station
- Beauty Shop
- More...

Option 2 involves determining the community services within a half mile radius of the project. There must be at least 10 community services within the project radius, and they all must be accessed by pedestrians without being blocked by walls, highways, or other permanent barriers. Keep in mind that restaurants can only be counted twice and all other amenities can be counted once. This option is more flexible for different project types, but requires a residential zone near the project site. The project team can document this credit with tools such as Google Maps.

* There are several Site credits that allow flexibility if you can achieve credit 2. Building in a dense area allows for more flexibility on green space, green roofs, and hard-scape credits. For example, green roofs can count as green space for SS 5.2: Site Development – Maximize Open Space, as it is understood that the building density most likely does not permit much opportunity to restore open space.

SS	Sustainable Sites: Credit 3
	Brownfield Redevelopment
INTENT: Rehabilitate damaged sites where development is complicated by environmental contamination, reducing pressure on undeveloped land.	
REQUIREMENTS:	SUBMIT:
Develop on a site documented as contaminated with an ASTM E1903-97 Phase II Environmental Site Assessment or a local Voluntary Cleanup Program	Pertinent section of ASTM E1903-97 Phase II Environmental Site Assessment
OR	OR
On a site defined as a brownfield by a local, state or federal government agency	Letter from local, state, or federal regulatory agency confirming they classify the site as a brownfield

Previous industrial sites, called brownfields, have the potential to be renewed with proper remediation efforts that remove hazardous materials from the site's soil and groundwater. Redevelopment on brownfields prevents development on undeveloped greenfields that may serve as a habitat for wildlife. Brownfield sites usually have existing infrastructure necessary for the new development. Reclamation of contaminated sites can provide economic support to the surrounding area and catalyze further development.

* The submittal to achieve this credit must prove that the site is a brownfield and the site was remediated. Asbestos and underground storage tanks must be remediated.



SS Sustainable Sites: *Credit 3*
Brownfield Redevelopment

What is a Brownfield?
"Brownfields are abandoned, idled, or under-used industrial and commercial facilities where expansion or redevelopment is complicated by real or perceived environmental contamination."

SEE: **EPA Brownfields Definition**

Residential (below) and community park (right) at Glenwood Park

Early stages of Brownfield redevelopment in Glenwood Park



Glenwood Park in downtown Atlanta, Georgia is a developed brownfield site which also represents a sustainable community. The recovered materials from the abandoned site were recycled. The community has a density that is four times greater than normal subdivision developments, saving 100 acres of land. It also is a mixed use development that provides walkable access to retail spaces and community amenities. More information about Glenwood Park can be found at: www.glenwoodpark.com.

* Atlantic Station in downtown Atlanta is another successful brownfield development case study that has transformed into a live-work-play community.

SS Sustainable Sites: [Credit 4.1](#)
Alternative Transportation: Public Access

INTENT - Reduce pollution and land development impacts from automobile use.

Locate Project Within:



- ½ mile of a [commuter rail, light rail, or subway station](#) (existing or planned and funded)

OR

- ¼ mile of [two or more public or campus bus lines](#) usable by building occupants

Submit:

Area drawing or transit map highlighting building location and fixed rail stations & bus lines, with distances between them clearly indicated



Increased use of public transportation can decrease air pollution and traffic congestion in urban areas. People are willing to use public transit if it is convenient, so choosing a site close to public transportation gives building occupants the option to use public transport to and from work. The increased use of public transport by building occupants reduces the building footprint by requiring only a minimum of parking space. A reduced parking space decreases stormwater runoff and the urban heat island effect, which in turn also helps the project earn points in Sustainable Sites Credits 6.1 and 6.2, Stormwater Design and credit 7.1, Heat Island Effect (Non-Roof).

Campus buses can be included as a bus line if the busline stops within a quarter mile of the project. However, the campus bus must be available for the building's occupants use, not just to students. If a bus line does not run within a quarter mile of the building, try negotiating with the city and prove that a bus line is effective in the project's area.

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Sustainable Sites: [Credit 4.2](#)

Alternative Transportation: Bicycle Storage & Changing Rooms


INTENT - Reduce pollution and land development impacts from automobile use.

REQUIREMENTS:

- Provide secure bicycle racks and/or storage (within 200 yards of the building entrance) for 5% or more of all building users

AND

- Provide shower and changing facilities (within 200 yards of the building entrance) for 0.5% of Full-Time Equivalent Occupants (FTE)



Sample Calculations (non-residential)

Full-time occupants = 80
 Part-time occupants (4 hr/day) = 60
 Peak visitors = 10
FTE = 80 + (60/2) = 110
Peak Occupants = 80 + 30 + 10 = 120
 Secure bicycle spaces = 120 x 5% = 6
 Shower and facilities required = 1

NOTE: For residential buildings, bike racks for at least 15% of the occupants is required.

FTE = Occupant Hours / 8
 Peak Occupants = FTE + visitors

Select a site that provides convenient biking paths, safe bike storage, and close shower facilities to building occupants. The showering facilities must be within 200 yards of the entrance to the building pursuing LEED certification. To determine the number of bike racks necessary for the project, calculate the Full Time Equivalent (FTE) building occupants and Peak Occupants and provide for racks at least 5 percent. For showers, only the FTE will be needed to calculated to determine the amount needed, as showers are only required for 0.5 percent of the Full-Time Equivalent occupants (see the sample calculation).

The Full Time Equivalent Occupant is defined as an occupant that is in the building 8 hours per day. An 8 hour occupant has a FTE value of 1, while a part time occupant has a FTE value based on their hours per day divided by 8 (see the equation provided). In addition to the full time and part time occupants, college buildings or buildings with high visitors or short time students must consider their transient occupant calculation (see table).

For Residential Buildings:

The bike racks are used by all people going to the building on a given day (peak occupants). However, the showers are only used by the occupants of the building (FTE). If the FTE is 200 or less, you only need one shower. A residential building such as a dormitory assumes that all occupants have a shower, so calculating them is not necessary, but there must be three times the bike racks and they must be covered.

* Please note that the FTE must remain the same across all credits that require the FTE value as a determining factor to achieve the credit (SS 4.2, SS 4.3, SS 4.4, WE 2, WE 3.1-3.2).

SS Sustainable Sites: [Credit 4.3](#)
Alternative Transportation: Low Emitting & Fuel Efficient Vehicles

INTENT - Reduce pollution and land development impacts from automobile use.

OPTION 1


- Provide low-emitting & fuel-efficient vehicles for 3% of FTE building occupants AND provide preferred parking for these vehicles

OPTION 2

- Provide preferred parking for low-emitting & fuel-efficient vehicles for 5% of the total vehicle parking capacity of the site

OPTION 3

- Install alternative-fuel refueling stations for 3% of total vehicle parking capacity of site



Personal vehicles are responsible for the decline in air quality and contribute pollutants, smog and ozone into the atmosphere. The poor air quality of many American cities contributes to the increased asthma and respiratory diseases affecting the developing lungs of children. Fuel efficient vehicles reduces hazardous green house gasses such as carbon dioxide (CO₂) from contributing to global climate change. Providing low emitting vehicles to employees to use for work related purposes or providing preferred parking to drivers of low emitting vehicles reinforces the incentive of owning this vehicle type to the public.

All three options for this credit promote the use of alternative fueled vehicles. Option 1 asks that any company fleet vehicles are alternatively fueled. Option 2 requires that the parking area on site provides preferred parking to alternatively fueled vehicles (AFVs). In Option 3, the owner can provide re-fueling stations for AFVs on site.

The submittals required to achieve this credit include the FTE number for the building (consistent throughout the project documentation) and the calculations for one of the options stated.


SS Sustainable Sites: [Credit 4.3](#)
Alternative Transportation: Low Emitting & Fuel Efficient Vehicles

Low Emitting & Fuel Efficient Vehicles:

- Use low-polluting fuels such as electricity, hydrogen, propane, compressed or liquid natural gas, methanol, and ethanol
- Gasoline vehicles can be used, provided they score ≥ 40 on [ACEEE's annual vehicle rating guide](#)

Examples:

- Flexcar
- Zipcars
- Hybrid Gas
- Electric Vehicles
- Propane / CNG Vehicles
- Biodiesel



To view the ACEEE's (American Council for an Energy Efficient Economy) list of vehicle ratings, visit www.greencars.com.

* Note: The rating guide considers high efficiency hybrids, not including SUV hybrids.

SS Sustainable Sites: [Credit 4.4](#)
Alternative Transportation: Parking Capacity


INTENT - Reduce pollution and land development impacts from single occupancy vehicle use.

OPTION 1 – Non Residential

- Size parking capacity to meet, but not exceed, minimum local zoning requirements
- Provide preferred parking for carpools or vanpools for 5% of total parking spaces

OPTION 2 – Non Residential projects that provide parking for less than 5% of FTE building occupants

- Provide preferred parking for carpools or vanpools for 5% of total parking spaces



Limiting parking capacities on site for single-occupancy vehicles encourages building occupants to carpool or use alternative transportation. Carpooling can help decrease negative impacts from vehicle use, such as air pollution and traffic congestion, while decreasing the need for impervious surfaces that increase the urban heat island effect and stormwater runoff.

This slide describes the various compliance paths for achieving this credit. The options vary depending on the type of building, but all require the FTE occupancy of the project, the total parking capacity of the site, and documentation supporting the project compliance path.

Options 1 and 2 are the requirements for commercial buildings, but differ in the amount of parking provided for the building occupants.

Option 2 provides little parking to the building occupants and also carpooling spaces for 5% of all parking spaces.

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Sustainable Sites: [Credit 4.4](#)

Alternative Transportation: Parking Capacity

OPTION 3 – Residential

- Size parking capacity to not exceed minimum local zoning requirements
- Provide infrastructure and support programs to facilitate shared vehicle usage (e.g. carpool drop-off, designated parking for vanpools, car-share services, shuttle services to mass transit)

OPTION 4 – All pre-existing buildings

- Provide no new parking

One-Way Mileage	Monthly cost of vanpooling	Monthly cost of driving alone
20 miles	\$77	\$525
30 miles	\$85	\$785
40 miles	\$95	\$1047
50 miles	\$98	\$1309

Option 3 is for residential projects where a large amount of parking is needed for building occupants. For credit compliance meet local zoning codes and support a ride-share program for occupants.

Option 4, is another economically attractive option because a project gains a point for not doing anything. Sharing parking lots with adjacent buildings will decrease overall construction costs and prevent the need for development of additional parking space. For example, a church in retail area can share parking, and saves costs and land use.

SS Sustainable Sites: **Credit 5.1**
Site Development: Protect or Restore Habitat

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


OPTION 1 – Greenfield Sites

Limit disturbance including earthwork and clearing to:

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

OPTION 2 – Previously Developed Sites

- Restore or protect a minimum of 50% of the site area
- (excluding building footprint) with native or adapted vegetation
- Projects earning SS credit 2 and using a green roof may apply the vegetated area to this calculation if the plants meet the definition of native and/or adapted vegetation



It is important to enhance the natural elements of the project site such as native plants and trees, soils, and watersheds. There are many approaches to achieve the requirements of this credit:

Replace paved areas with open space.

Lay out tree protection areas on the project site to prevent damage by construction equipment.

Replace turf grass with native plants.

Create a green roof with native species if no space on site can be restored. This area will count toward restoring space. The vegetated roof synergizes with SS 2, SS 6.1-6.2, SS 7.2.

On greenfield sites, the key to achieving this credit is to minimize the building footprint as much as possible in the design. Utilize strategies such as sharing facilities, and stacking the parking with the building. During construction, create strict boundaries for equipment that minimize land disturbance.

* For both options, select only native or adapted plant materials.

SS Sustainable Sites: [Credit 5.2](#)
Reduced Site Disturbance: Maximize Open Space

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



OPTION 1

- Reduce the development footprint and/or provide vegetated open space within the project boundary to exceed the local zoning's open space requirement for the site by 25%

OPTION 2

- For areas with no local zoning requirements, provide vegetated open space area adjacent to the building that is equal to the building footprint

OPTION 3

- When a zoning ordinance exists, but there is no requirements for open space, provide vegetated open space equal to 20% of the project's site area

Open space is beneficial in urban environments to wildlife whose habitats are increasingly disappearing and for people who have public access to the outdoors. Smaller building footprints and more greenspace helps with the urban heat island effect and provides for better stormwater retention.

Zoning is the key word in knowing the difference between the three options. Option 1 fits best with projects that have a local zoning open space requirement. Option 2 is ideal for university or military space where green space can be equal to the footprint of the building on campus. If no zoning policy exists use the building footprint to measure the amount of greenspace necessary in the project.

Options for urban open space include green roofs, pedestrian hardscapes or small parks. Strategies include compact underground parking and stacking floor plans.

Credit synergy and wetland options:

Projects that are in urban areas earning SS credit 2 for vegetative roofs are eligible for SS credit 5.2.

Projects that are in urban areas earning SS credit 2 for pedestrian oriented hardscapes are eligible for SS credit 5.2 as long as a minimum of 25% of the open space is vegetated.

* Wetlands or naturally designed ponds may count as open space if the side slope gradients average 1:4 (vertical:horizontal) or less and are vegetated.

SS Sustainable Sites: **Credit 6.1**
Stormwater Design: Quantity Control

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

If Existing Imperviousness is \leq 50%:


- Post-development 1-year and 2-year 24 hour peak discharge rate does not exceed the pre-development rate and quantity

OR

- Implement strategies that protect receiving stream channels from excessive erosion

If Existing Imperviousness is $>$ 50%:

- Use stormwater management strategies to decrease rate and quantity of stormwater runoff by at least 25% (from the 2-year 24 hour storm)



The goal of this credit is to decrease the amount of stormwater runoff that leaves the site. The options depend on the pre-development conditions on the site. If it is a greenfield, prevent an increase in stormwater runoff on site after development. If the site has existing impervious surfaces, decrease the amount of stormwater that exits the site by 25% after development. Various approaches exist to meet the requirements of this credit:

Rain gardens

Green roofs

Bioswales

Retention ponds

Reduce paved surfaces

Smaller building footprint

Stormwater harvesting for reuse in irrigation or buildings

Pervious paving materials (see photo)

Increasing open greenspace

SS Sustainable Sites: **Credit 6.2**
Stormwater Design: Quality Control

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

REQUIREMENTS
Implement a stormwater management plan to:

- reduce impervious cover
- promote infiltration
- capture and treat the stormwater runoff from 90% of the average annual rainfall
- use acceptable best management practices (BMPs)

90% guidelines:

Humid Zone - (≥ 40 " annual)
design for 1" of rainfall

Semi-arid Zone - (20-40" annual)
design for 0.75" of rainfall

Arid Zone - (<20 " annual)
design for 0.5" of rainfall

Implement **EPA Best Management Practices** to remove 80% Total Suspended Solids (TSS) – capturing and treating stormwater runoff from 90% of the average local annual rainfall.

Where SS Credit 6.1 is about the quantity of stormwater that leaves the site, SS Credit 6.2 is about the quality, or cleanliness, of the water that leaves the site. To meet the requirements of LEED, create and implement a stormwater management plan that is designed to capture and treat runoff from 90% of the average annual rainfall. Also, the best management practices used to treat runoff must remove 80% of the average annual post development total suspended solids (TSS) load.

Design in accordance with a state or local program that has adopted these performance standards.

Use in-field performance monitoring data to demonstrate compliance with the criteria.

SS Sustainable Sites: Credit 6.2
Stormwater Design: Quality Control



Methods of Treatment:

- Infiltration Basins & Trenches
- Porous Pavement
- Permeable Surfaces
- Vegetated Filter Strips
- Grassed Swales
- Filtration Basins
- Constructed Wetlands
- Detention Ponds
- Vegetated roofs
- Rain Gardens
- Rainwater Recycling

Rain gardens (top) and vegetated filter strips (left) are aesthetically pleasing and require limited maintenance.

The strategies used to clean stormwater can be non-structural or structural measures:

Non-structural measures promote infiltration with minimizing the impervious areas, using pervious pavement, and creating vegetated areas to absorb the runoff. The water can naturally filter into the soil and groundwater aquifer, and will be treated naturally with microorganisms and plants.

Structural management approaches are better in urban areas because they require less surface area on site to treat water effectively. Options include ponds, wetlands, rainwater capture with a cistern, and manhole treatment. These strategies are great in urban environments because they do not require as much land use to treat the water.

* Both of these management strategies reduce runoff of stormwater into the sewage, and reduce the pollutants in the water before it is turned back to the ground or watershed.

SS Sustainable Sites: [Credit 7.1](#)
Heat Island Effect: Non-Roof

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

At parking lots, roads, walkways, plazas, courtyards, etc.:

OPTION 1


- 50% of non-roof impervious surfaces have a **Solar Reflectance Index (SRI) of at least 29**,

OR

- Open grid pavement,

OR

- Will be shaded within 5 years of occupancy.



OPTION 2

- Place 50% of **parking underground** or under structured parking (any roof used to shade or cover parking must have an SRI of at least 29).

Heat island effect is the phenomenon when warmer temperatures are experienced in urban areas as a result of solar energy absorption by constructed surfaces such as roofs and pavement.


Use high-albedo materials (those that will more easily reject solar heat) that will attain the required SRI such as light concrete or cementitious coatings. The SRI value means the ability to reject solar heat. Do not use asphalt, as its dark color absorbs heat. Provide shading near the building with native trees or shrubs to cool the air via shade and evapotranspiration. Limit impervious surfaces by using open grid pavement and reducing the parking footprint with stacked parking decks.

SS Sustainable Sites: **Credit 7.2**
Heat Island Effect: Roof

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


OPTION 1

- 75% of roof is **high-albedo** material (reflective)
75% of roof must have a Solar Reflectance Index (SRI) of at least
 - **78 for Low-Sloped Roofs** ($\leq 2:12$)
 - **29 for Steep-Sloped Roofs** ($>2:12$)



OPTION 2

- 50% of roof area is vegetated



OPTION 3


- Majority of roof is combination of vegetated & reflective. High-albedo and vegetated roof surfaces that (in combination) meets the following calculation:
 $(\text{Area of SRI Roof} / 0.75) + (\text{Area of Vegetated Roof} / 0.5) \geq \text{Total Roof Area}$

Green roofs are roofs with planted vegetation that reduce heat island effect by replacing heat-absorbing surfaces with vegetation. There are many benefits of green roofs. They provide insulation that can help reduce energy loads, aesthetic appeal, and a usable outdoor surface to building occupants. Green roofs also last longer than conventional roofs with added material and vegetation layers. Green roofs also limit stormwater runoff and act as a great filter and collection area for stormwater harvesting.

Similarly to the non-roof high albedo material applications, the least absorbent roofs use high albedo materials and vegetation. A building can achieve this credit with either of these strategies or a combination of both.

* Product information is available from the Cool Roof Rating Council website, at www.coolroofs.org.

SS Sustainable Sites: **Credit 8**
Light Pollution Reduction



INTENT: Minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction, and reduce development impact on nocturnal environments.

REQUIREMENTS:

<u>Interior Lighting</u>	<u>Exterior Lighting</u>
<ul style="list-style-type: none">• No light trespass outside building,	<ul style="list-style-type: none">• Must meet “Dark”, “Low”, “Medium”, “High” classifications per IESNA RP – 33.
OR	
<ul style="list-style-type: none">• Lighting controls for cut-off during non-business hours for non-emergency lights.	<ul style="list-style-type: none">• Do not exceed 80% of the lighting power densities for exterior areas and 50% for building facades and landscape features as defined in ASHRAE/IESNA Standard 90.1-2004, Exterior Lighting Section, without amendments.

** Meet IESNA foot-candle levels & design to minimize light trespass from the site.*

Reference Standard: **ASHRAE/IESNA Standard 90.1 – 2004 – Section 9**

The credit includes three compliance paths that minimize light pollution through:

- 1) Interior building lighting
- 2) Exterior lighting power density
- 3) Exterior light distribution

If following ASHRAE 90.1:

All interior lighting are required to have automatic lighting controls unless the project is less than 5000 square feet.


The exterior lighting requirements depend on the site zones as specified in IESNA RP-33: Dark (parks and rural settings), Low (residential areas), Medium (commercial/industrial, high-density residential) or High (major city centers).

SS Sustainable Sites: Credit 8
Light Pollution Reduction


Terms to be familiar with:

- Curfew Hours*
- Cutoff Angle
- Illuminance
- Full Cutoff
- Lighting Power Density
- Glare
- Light Trespass
- Luminance
- Angle of Maximum Candela*
- Light Pollution*
- Outdoor Lighting Zone Definitions*
- Shielding
- Foot Candle* (fc)

Exterior Light Glow



No Exterior Light Glow



* Definitions provided P.110 of LEED 2.2 Reference Guide

Most project teams find it worth while to hire a lighting designer to do the calculations. This saves time and makes it easier to document credit compliance. Also, many lighting brands will do the documentation for you if you specify that you are pursuing a LEED project.

Potential lighting strategies to meet the LEED requirements include:

- 1) All non-emergency interior lighting be automated to turn off with a programmable control. Controls include sweet timers, occupancy sensors or master lighting control panels. Also interior lighting should be located such that the direct light beam hits solid surfaces, preventing light spill from transparent surfaces to exterior areas.
- 2) Set lower outdoor lighting densities than the referenced standard by 20%. Reduce landscape lighting by 50% and select energy efficient fixtures to meet the lighting density reductions.
- 3) The lighting distribution must meet the requirements under pre-curfew conditions (before 10 pm or business closing). Consider curfew timers and controls for outdoor lighting. Shielded fixtures and low intensity fixtures also help reduce light pollution. Down lighting techniques are excellent light pollution prevention measures that still help illuminate areas for security and signage.

SS Sustainable Sites	
Points Summary	
P1 Construction Activity Pollution Prevention (Prerequisite)	
1. Site Selection	1
2. Development Density / Community Connectivity	1
3. Brownfield Redevelopment	1
4. Alternative Transportation	1 - 4
5. Site Development	1 - 2
6. Stormwater Design	1 - 2
7. Heat Island Effect	1 - 2
8. Light Pollution Reduction	1
TOTAL	8 - 14