Sustainable Sites

# Prerequisite 1: Construction Activity Pollution Prevention

### **For what is this LEED point intended?**

The intent is to reduce pollution from construction work by controlling soil erosion, waterway sedimentation and airborne duct during the construction project.

### What are the issues?

Uncontrolled soil erosion can lead to additional site management and environmental concerns, such as increased use of fertilizers, irrigation, and pesticides, as well as increased storm water runoff that adds to the pollution of nearby lakes and streams. Airborne dust from construction activity can have both environmental and human health impacts, creating problems like asthma, decreased lung function, and breathing difficulties.

### What are the economic implications?

Erosion and sedimentation control measures required by local building cones in most areas are meant to minimize difficult and expensive mitigation measures in receiving waters. The cost will include some minimal expense associated with installing and inspecting the control measures, particularly before and after storm events, and will vary depending on the location, topography and silt conditions of the project.

### What did we do here, and why did we do it?

The site for the McKeown Center is a small dense site with limited room for access and maneuvering during construction. Extreme care was taken to insure the adjacent sites were not contaminated from and of the construction processes on our site.

# Credit 1: Site Selection

### For what is this LEED point intended?

The intent is to avoid the development of inappropriate sites and reduce the environmental impact from the locating of a building on a site.

### What are the issues?

The use of prime farm land should be avoided. Previously undeveloped land whose elevation is lower than 5 feet above the 100-year flood plain should not be developed. Land that is specifically identified as habitat for any species on federal or state threatened or endangered lists should not be developed. Land within 100 feet of any wetlands should not be developed. Previously undeveloped land within 50 feet of a water body such as streams, rivers and lakes should not be developed. Land that is public parkland should not be developed. Prevention of habitat encroachment is an essential element of sustainable site selection. The best strategy for selecting a building site is to choose a previously developed site. Because these sites have already been disturbed, further damage to the environment is limited.

### What are the economic implications?

Channeling development away from sensitive ecological areas in favor of previously disturbed sites can encourage public support for a project present a positive image to the public. Economically, there can be a savings compared to the mitigation costs that would be incurred if the project were developed within a sensitive area.

### What did we do here, and why did we do it?

In the pre-design and programming phases of this project, the design team studied a variety of sites in the Flynntown area of campus. Upon discussion with the owner and review of the current campus master plan, we set criteria that the undeveloped wooded land and fields around the Flynntown area should not be developed. The present site was selected since it serves the long term plan for the eventual replacement of Seton Apartments with a higher density of housing on this previously developed site. Maintaining the goal of not developing more natural landscape was an important goal in the site design. As such, the Seaton parking lot was chosen as the site as the Flynntown parking lot is sufficient to accommodate the current parking needs of Seton.

# Credit 4.1: Alternative Transportation—Public Transportation

### For what is this LEED point intended?

The intent is to encourage development of sites where public transportation is available, allowing for fewer greenhouse gas emissions to be emitted from single occupancy vehicles and to allow for people without vehicles to be able to have access to the same functions.

### What are the issues?

The extensive use of single-occupancy vehicles and their heavy reliance on petroleum contribute to environmental problems. Many people are willing to use other options if they are available to them for transit. The use of mass transit helps reduce energy demand for transportation and associated greenhouse gas emissions, as well as the space needed for parking lots that encroach on the green space of a building site. Minimizing parking lots reduces a building’s footprint and sets aside more space for natural areas or greater development densities.

### What are the economic implications?

Many occupants, staff and students view proximity to mass transit as a benefit, and this can increase the value and marketability of a building. For building occupants costs associated with traveling to and from the building can be significantly reduced by access to public transportation. Not only is this an economic benefit for the users but helps attract new students.

### What did we do here, and why did we do it?

The McKeown Center is located within 300 feet of the intercampus bus line that is used by the students of St. John’s and St. Benedicts. This can significantly reduce the need for parking of individual automobiles in the Flynntown area.

# Credit 4.3: Alternative Transportation—Low Emitting and Fuel Efficient Vehicles

### For what is this LEED point intended?

The intent of this credit is to reduce pollution and land development impacts from automobile use.

### Options

The options for achieving this point include: parking for low-emitting and fuel-efficient vehicles for 5 % of the total vehicle parking capacity of the site, provide alternative-fuel fueling stations for 3% of the total vehicle parking capacity of the site, provide low-emitting and fuel-efficient vehicles for 3% of full-time equivalent occupants or provide building occupants access to a fuel-efficient vehicle-sharing program.

### What are the issues?

Personal vehicles also generate large portions of the air pollutants responsible for smog and ground-level ozone, both of which have negative effects on human health. Alternative-fuel and fuel-efficient vehicles offer the possibility of reducing air pollutants from vehicular travel as well as the negative environmental effects of producing gasoline.

### What are the economic implications?

Hybrid vehicles are gaining traction in the marketplace, which should help drive down their cost. Providing preferred parking generally involves minimal extra cost. For fuel-efficient vehicles, reduced operating costs on a per-mile basis can offset high initial purchase prices or higher fuel costs.

### What did we do here, and why did we do it?

The site for the McKeown Center is relatively small and we can achieve the required number of parking stalls with little difficulty.

# Credit 4.4: Alternative Transportation—Parking Capacity

### For what is this LEED point intended?

The intent of this credit is to reduce pollution and land development impacts from automobile use.

### Options

We can provide parking for carpools or vanpools for 5% of the total parking spaces. Another option is to provide not new parking. We should be able to meet the 5% designation with signage on appropriate stalls on the site.

### What are the issues?

There are a number of environmental issues that relate to this credit. Vehicle operation significantly contributes to global climate change and air quality problems through the emission of greenhouse gases, and pollutants generated from combustion engines and fuel evaporation. In the united State, the transportation sector has generated more carbon dioxide emissions than any other end-use sector since 1999, and in 2007 was responsible for nearly 30% of total GHG emissions.

### What are the economic implications?

Providing preferred parking generally involves minimal extra cost.

### What did we do here, and why did we do it?

We easily were able to include a carpool and a low fuel emitting parking spot in the site.

# Credit 5.2: Site Development—Maximize Open Space

### For what is this LEED point intended?

The intent of this credit is to promote biodiversity by providing a high ratio of open space to development footprint.

### What are the issues?

There are a number of environmental issues related to this credit. Open space provides habitat for vegetation and wildlife. Plants that support insects and other pollinators can help sustain populations higher up the food chain. Open space also reduces the urban heat island effect, increases storm water infiltration, and provides human populations with a connection to the outdoors.

### What are the economic implications?

By preserving topsoil, plants, and trees on a site can, landscaping costs can be reduced. Well-designed open space can increase property values. Building a vertical structure with the same square footage as a horizontal structure with a smaller footprint is generally more resource efficient, resulting in reduced material and energy costs. A more compact building with coordinated infrastructure can reduce initial project costs as well as operations and maintenance costs.

### What did we do here, and why did we do it?

20% of the area is vegetation. We created a 3 story building on the best site and the best amount of open space, however this means that the lower floor is below grade. In order to achieve day lighting in the basement a light well was placed in, but credits for views were forfeited in this decision.

# Credit 6.1: Storm Water Management—Quantity Control

### For what is this LEED point intended?

The intent of this credit is to limit disruption of natural hydrology by reducing impervious cover, increasing onsite infiltration, reducing or eliminating pollution from storm water runoff and eliminating contaminants.

### What are the issues?

Soil compaction caused by site development and the expanse of impervious surfaces, such as roads and parking lots, produce storm water runoff that contains sediment and other contaminants, including atmospheric deposition, pesticides, fertilizers, vehicle fluid leaks, and mechanical equipment waste. The health of streams is closely linked to storm water runoff velocities and volumes.

Increased storm water runoff can overload pipes and sewers and damage water quality, affecting navigation and recreation. Municipal systems require significant infrastructure and maintenance.

Good design reduces the volume and intensity of storm water flows and replenishes natural aquifers.

### What are the economic implications?

Planning for proper drainage early in site planning can be done economically and is much less expensive if done early on. They can add value to a building. The use of pervious pavement as part of an infiltration strategy may reduce the need for expensive and space-consuming retention options as well as the infrastructure needed to support conveyance. Storm water can also be used for non-potable uses like toilets which lessens the burden on municipalities for maintenance and repair, resulting in less water usage, less costs, and a more affordable and stable tax base.

### What did we do here, and why did we do it?

The existing site was almost entirely a paved surface parking lot. We had to implement a storm water management plan that prevents the post development peak discharge rate and quantity from exceeding the predevelopment peak discharge rate and quantity for the once and twice a year 24 hour design storms.

# Credit 6.2: Storm Water Management—Quality Control

### For what is this LEED point intended?

The intent of this credit is to limit disruption and pollution of natural water flows by managing storm water runoff.

### What are the issues?

Storm water management reduces impervious cover, promotes infiltration and captures and treats stormwater runoff from 90% of the average annual rainfall. The intent of this credit is to limit disruption and pollution of natural water flows by managing stormwater runoff.

Buildings don’t allow water to permeate the ground. Gutters, pipes, and sewers send stormwater containing sediment and other contaminants that have negative effects on water quality, navigation, and recreation and degrade aquatic habitats. Conveyance and treatment of stormwater require significant municipal infrastructure and maintenance.

### What are the economic implications?

Planning for proper drainage early in site planning can be done economically and is much less expensive if done early on. They can add value to a building. The use of pervious pavement as part of an infiltration strategy may reduce the need for expensive and space-consuming retention options as well as the infrastructure needed to support conveyance. Storm water can also be used for non-potable uses like toilets which lessens the burden on municipalities for maintenance and repair, resulting in less water usage, less costs, and a more affordable and stable tax base.

### What did we do here, and why did we do it?

We have a detention area on the north side of the building that functions like a rain garden. This is a good way to deter stormwater and use it onsite. It also decreases the need for irrigation.

# Credit 7.1: Heat Island Effect—Non-Roof

### For what is this LEED point intended?

The intent of this credit is to reduce heat islands to minimize impacts on micro climates and human and wildlife habitats.

Options
Place a minimum of 50% of parking spaces under cover. The roof must have a SRI of at least 9, be a vegetated roof or be covered by solar panels that produce energy used to offset some nonrenewable resource use.

OR

Use a combination of strategies for 50% of the site roads, sidewalks, courtyards and parking lots
• Provide shade from existing tree canopy or within 5 years of landscape installation.
• Provide shade from structures covered by solar panels that produce energy used to offset some nonrenewable resource use.
• Provide shade from architectural devised or structures that have a solar reflectance index of at least 29.
• Use hardscape materials with an SRI of at least 29
• Use open-grid pavement system (at least 50% pervious)

### What are the issues?

Because of heat island effect, ambient temperatures in urban areas are elevated by 2 degrees to 10 degrees F, which increases cooling loads in the summer, requiring larger heating, ventilating, and air-conditioning equipment and greater electricity consumption, both of which generate greenhouse gases and pollution.

### What are the economic implications?

Reducing heat islands can lower cooling costs. The up-front cost has an acceptable payback due to reduced cooling costs as some blended cements are light gray and similar to the cost of regular concrete.

### What did we do here, and why did we do it?

We used light gray pavers as some white reflective cements cost twice as much and the gray pavers. Even though the pavers are different from the rest of campus, we decided to use them.

# Credit 8: Light Pollution Reduction

### For what is this LEED point intended?

The intent of this credit is to minimize the light trespass from the building and site, reduce sky glow to increase night sky access, improve nighttime visibility and security through glare reduction and reduce development impact from lighting on nocturnal environments.

### What are the issues?

Outdoor lighting is important for human safety. Illuminating connections between buildings and support facilities such as sidewalks, parking lots, roadways, and community gathering places is necessary for twilight and nighttime use. However, light trespass from poorly designed outdoor lighting systems can affect a site’s nocturnal ecosystem, and light pollution limits the observation of the starry night sky. Through thoughtful design and careful maintenance, outdoor lighting can address night sky visibility issues and site illumination requirements, while minimizing negative impacts on the environment.

Sensitively and creatively designed lighting systems promote a unique appreciation for a place at night. Yet even with the best of luminaries—those designed to reduce light pollution and requiring the lowest wattage—the added light will be reflected off surfaces and into the atmosphere. Using the minimum amount of lighting equipment, limiting or eliminating all landscape lighting, and avoiding light pollution through the careful selection of lighting equipment and controls enables nocturnal life to thrive while still providing for human nighttime activity.

### What are the economic implications?

The initial cost and ongoing operational costs for exterior lighting can be greatly reduced by eliminating luminaries that do not enhance safety. Additionally, using the most efficient light sources, luminaries, and controls further reduces the energy costs of these systems. Long-life lamps can also increase operational savings by requiring a less frequent re-lamping cycle. However, the initial cost per luminaire may be somewhat higher because of increased costs associated with internal reflectors and shielding, more efficient lamp and ballast combinations, and controls.

### What did we do here, and why did we do it?

All indoor lighting is controlled by occupancy sensors, each of which turns off the lights on its circuit 20 minutes after the last motion is detected. This was done to save energy by preventing the use of energy for lighting areas when people are not present, and to prevent light pollution by minimizing the light leaving the interior of the building at night. The twenty-minute time period for which the timers operate was chosen because it is the standard wait period for occupancy sensors at Saint John’s.

Outdoor lighting is provided such that lighting power densities (LPD) for exterior area fixtures do not exceed 80% of the ASHRAE recommendations and that the LPD of exterior facade/landscape lighting does not exceed 50% of the referenced ASHRAE Standard recommendations. Also, full-cutoff fixtures were used such that 0% of the lumens emitted from the lamps are emitted above 90 degrees from nadir. This was done to minimize light pollution and to save energy.

# Credit 1.1 Water Use Reduction

### For what is this LEED point intended?

The intent of this credit is to increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

### What are the issues?

Reducing potable water use in buildings for urinals, toilets, shower heads, and faucets decreases the total amount withdrawn from rivers, streams, underground aquifers, and other water bodies. These strategies protect the natural water cycle and save water resources for future generations. In addition, water use reductions, in aggregate, allow municipalities to reduce or defer the capital investment needed for water supply and wastewater treatment infrastructure.

### What are the economic implications?

Because water heating in commercial buildings account for nearly 15% of building energy use, conservation measures will also reduce end-use energy and energy related pollution. Reductions in water consumption decrease building operating costs and bring about wider economic benefits.

# Credi # 3.1 & 3.2: Water Use Reduction and Process Water Use Reduction

### For what is this LEED point intended?

The intent of this credit is to further increase water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems by 30%.

### What are the issues?

The reduction of potable water use in buildings for process water reduces the total amount withdrawn from rivers, streams, underground aquifers, and other water bodies. Another benefit of municipally supplied potable water conservation is reduced energy use and chemical inputs at municipal water treatment works, as well as reduced energy use and the associated greenhouse gas emission for treatment and distribution.

**What are the economic implications?**
Reasonably priced, water-efficient appliances are becoming increasingly available as consumers and manufacturers recognize the economic and environmental benefits of water conservation. Substantial savings can be realized over the life of these products in both water and energy consumption. We installed high-efficiency washers and 1/8 gallon per flush urinals in the bathrooms.

Energy and Atmosphere

# Prerequisite 1: Fundamental Commissioning of the Building Energy Systems

### For what is this LEED point intended?

The intent of this credit is to verify that the project’s energy-related systems have been installed, calibrated and perform according to our project requirements, the basis of the design and construction documents.

### What are the issues?

Facilities that do not perform as intended may consume significantly more resources over their lifetimes than they should, which causes undue harm to environments and ecosystems both near and far from the project site. Commissioning can minimize the negative impacts buildings have on the environment by helping verify that buildings are designed and constructed to operate as intended and in accordance with our project requirements.

### What are the economic implications?

If commissioning has not been previously included as part of the project delivery process, the costs associated with commissioning may be met with initial resistance. When the long-term benefits are taken into consideration, however, commissioning can be seen as a cost-effective way to ensure that the building is functioning as designed and that planned energy savings are realized in the operation of the building.

Benefits of commissioning include reduced energy use, lower operating costs, reduced contractor callbacks, better building documentation, improved occupant productivity, reduced occupant illness, prevention of premature equipment replacement, and verification that the systems perform in accordance with the project requirements.

### What did we do here, and why did we do it?

The Owner’s Project Requirements (OPR) and Basis of Design (BOD) documentation was compiled to set benchmarks for the building’s performance at its completion. Commissioning requirements were incorporated into the construction documents, for which a plan was developed and utilized. According to this plan, the performance of the building’s mechanical systems was verified and reported. Any problems that surfaced during the commissioning study were prepared. This was all done to ensure that energy would not be wasted by malfunctioning mechanical systems.

# Prerequisite 2: Minimum Energy Performance

### For what is this LEED point intended?

The intent of this credit is to establish the minimum level of energy efficiency for the proposed building and systems to reduce environmental and economic impacts associated with excessive energy use.

### What are the issues?

There are a number of environmental issues related to this credit. Energy efficiency reduces the environmental burdens associated with producing and using energy. Fossil fuels, such as coal and oil, are the most common source of energy used in buildings. However, these fuels are also finite resources. The process of extracting and consuming energy from fossil fuels causes many environmental impacts, including air and water pollution, land degradation, solid waste creation, and greenhouse gas emissions. Mounting evidence connects fossil fuel-based energy use with climate change as well as serious risks to environmental and human health and safety. Data from the U.S. Energy Information Administration show that buildings are responsible for almost half (48%) of all energy consumed and greenhouse gases emitted annually. The U.S. Environmental Protection Agency estimates that if the energy efficiency of commercial and industrial buildings improved by 10%, the resulting reductions in greenhouse gases emissions would be equivalent to taking about 30 million vehicles off the road.

### What are the economic implications?

Optimizing energy performance can reduce overall operating costs. Changing operational strategies to avoid energy use—for example, turning off lights and HVAC systems when the building is unoccupied can often be done at zero or very low initial cost and rapid payback. Even seemingly small conservation measures can be significant; for instance, replacing a single incandescent lamp with a fluorescent lamp, which uses up to 75% less energy, can save more than $30 in energy costs over the life time of the lamp.

### What did we do here, and why did we do it?

The project meets all the mandatory provisions (Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4) of ASHRAE/IESNA Standard 90.1-2004 (without amendments) and the project has used a computer simulation model to document the improved building energy performance resulting from compliance with these provisions.

# Prerequisite 3: Fundamental Refrigerant Management

### For what is this LEED point intended?

The intent of this credit is to reduce stratospheric ozone depletion.

### What are the issues?

There are a number of environmental issues affecting this credit. Chlorofluorocarbons (CFCs), used in refrigeration equipment, cause significant damage to the Earth’s protective ozone layer when the are released into the atmosphere. The reaction between CFC and ozone molecules in the stratosphere destroys the ozone and reduces the stratosphere’s ability to absorb a portion of the sun’s ultraviolet radiation.

As part of the U.S. commitment to implement the Montreal Protocol, the EPA has established regulations for responsible management of ozone-depleting substances. In compliance with the Montreal protocol, CFC production in the United States ended in 1995. Not using CFC-based refrigerants in new equipment and implementing a phase-out of CFC based refrigerants in existing equipment have helped slow the depletion of the ozone layer.

### What are the economic implications?

The standard practice in new buildings is to install equipment that does not use CFC’s.

### What did we do here, and why did we do it?

The air conditioner uses R410A refrigerant, and the chiller uses R407c refrigerant. The refrigerator also uses CFC-free refrigerant. This was done because CFCs are no longer manufactured in the United States as of January 1, 2000, and as such, appliances using CFC refrigerants are no longer manufactured in the United States.

# Credit 1: Optimize Energy Performance

### For what is this LEED point intended?

The intent of this credit is to achieve increasing levels of energy performance beyond the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

### What are the issues?

Energy efficiency reduces the environmental burdens associated with producing and using energy. Fossil fuels, such as coal and oil, are the most common source of energy used in buildings. However, these fuels are also finite resources. The process of extracting and consuming energy from fossil fuels causes many environmental impacts, including air and water pollution, land degradation, solid waste generation, and greenhouse gas emissions. Mounting evidence connects fossil-fuel based energy use with climate change as well as serious risks to environmental and human health and safety. Data from the U.S. Energy Information Administration show that buildings are responsible for almost half (48%) of all energy consumed and greenhouse gases emitted annually. EPA estimates that if the energy efficiency of commercial and industrial buildings improved by 10%, the resulting greenhouse gas reductions would be equivalent to taking about 30 million vehicles off the road.

In addition to fossil fuels, other sources of energy also carry environmental costs. Hydropower activities, for example, can alter aquatic ecosystems and harm endangered species. Nuclear power plants pose an environmental threat when they are decommissioned without appropriate storage sites for spent fuel. Given both the environmental impacts inherent in most energy-production processes and our limited energy supplies, efficiency measures are an important strategy for managing the impacts of energy consumption.

### What are the economic implications?

Some energy-efficiency measures may not require additional first costs. Many measures that do result in higher capital costs may generate savings from lower energy use, smaller equipment, reduced space needs for mechanical and electrical equipment, and utility rebates. These savings may vastly exceed the incremental capital costs associated with the energy-efficiency measures over the life of the project.

Even seemingly small conservation measures can be significant; for instance, replacing one incandescent lamp with a fluorescent lamp will save over $30 in energy costs over the operating lifetime of the lamp.

### What did we do here, and why did we do it?

We ran a whole-building energy simulation for the McKeown Center to ensure that the design for the building was energy-efficient. This modeling has shown that the project has achieved an energy cost savings of 41.8% using the ASHRAE 90.1-2004 Appendix G methodology. Energy efficiency measures incorporated into the building design include an improved thermal envelope, upgraded fenestration, reduced lighting power density, occupancy sensors, daylighting sensors, an air cooled high efficiency chiller, condensing boiler, premium efficiency fans and pumps, and sensible heat recovery.

# Credit 4: Enhanced Refrigerant Management

### For what is this LEED point intended?

The intent of this credit is to reduce ozone depletion and support early compliance with the Montreal Protocol while minimizing direct contributions to climate change.

### What are the issues?

Some refrigerants used in heating, ventilating, air conditioning, and refrigeration systems cause significant damage to the Earth’s protective ozone layer if they are released into the atmosphere. Others contribute to greenhouse gas emissions, causing global climate change. According to a report issued by the LEED Technical and Scientific Advisory Committee, an objective, scientific analysis of trade-offs between global climate change and ozone depletion is extremely complex and will come only from a full understanding of all interacting pathways and effects on economic activities, human health, and terrestrial and oceanic ecosystems. Refrigerant management to minimize the negative impacts on ozone depletion and climate change requires all of the following strategies to reduce dangerous refrigerant leakage to the environment:

- Designing buildings that do not rely on chemical refrigerants.

- Design HVAC&R equipment that uses energy efficiently.

- Selecting refrigerants with zero or low ozone depleting potential (ODP) and minimal direct global warming potential (GWP).

- Maintaining HVAC&R equipment to reduce refrigerant leakage to the environment

Under the Montreal Protocol, an international treaty ratified in 1989, refrigerants with nonzero ODP will be phased out by 2030 in developed countries. This includes the chlorinated refrigerants chlorofluorocarbons (CFCs) and hydrochloroflourocarbons (HCFCs).

### What are the economic implications?

Passive cooling strategies can greatly decrease costs associated with mechanical equipment by reducing or eliminating the need for active cooling systems. Although environmentally preferable refrigerants are becoming standard or available as an option on new air-conditioning equipment, approximately 50% of the water chillers in existing buildings still use CFC-11 as a refrigerant. As environmental impacts are factored into the costs of replacement refrigerant, operation cost savings will be realized through installation of HVAC&R equipment with environmentally preferable refrigerants.

### What did we do here, and why did we do it?

Equipment selection was directed specifically towards equipment with no life-cycle ozone depletion potential and minimal refrigerant charge. The campus facilities staff maintains regular maintenance on all campus equipment, which includes refrigerant monitoring. The building fire protection system has no HCFC's or halons; instead, it uses only water and compressed air. Future building plans are to connect the building to the campus chilled water system, which would further reduce the amount of refrigerants on the site.

# Credit 5: Measurement and Verification

### For what is this LEED point intended?

The intent of this credit is to provide for the ongoing accountability of building energy consumption over time.

### What are the issues?

Measurement and verification of a building's ongoing energy use can assist in efforts to optimize performance and to minimize the economic and environmental impacts associated with its energy-using systems.

### What are the economic implications?

The benefits of optimal building operation, especially in terms of energy performance, are substantial. The lifetime of many buildings is longer than 50 years, and so even minor energy savings are significant when considered in aggregate. Potential long-term benefits often go unrealized because of maintenance personnel changes, aging of building equipment, and changing utility rate structures. Therefore, it is important to institute measurement and verification (M&V) procedures and continuous monitoring to achieve and maintain optimal performance over the lifetime of the building. The goal of M&V activities is to provide building owners with the tools and data necessary to identify systems that are not functioning as expected and thus optimize building system performance.

The cost to institute an M&V program in a new construction project varies with the complexity of the building’s systems and instrumentation and controls in the baseline design. The additional instrumentation and metering equipment, programming of controls, and labor associated with monitoring and processing data can all add to costs. Projects with sophisticated digital controls can often support an effective M&V program without incurring significant additional costs. On the other hand, projects with a series of chillers, air handlers, and simple controls may need to install a significant amount of equipment to generate the necessary data for an effective M&V program. Smaller buildings with packaged HVAC equipment and fewer pieces of equipment overall may have lower cost for instrumentation and metering because there are fewer systems to measure and verify.

The cost of an M&V program must be balanced against the potential performance risk. A sample method of estimating performance risk can be based on the project value and technical uncertainty. A capital and operational budget for M&V can be a significant percentage of the project’s performance risk over a suitable time period. A smaller project with predictable technologies has less performance risk than a larger project that includes less predictable technologies.

### What did we do here, and why did we do it?

A whole-building simulation was performed that conducts thermal and luminous calculations on an hour-by-hour basis, using typical yearly climatic data, to determine the building’s energy loads and system requirements. DOCUMENTATION FOR THIS IS INCOMPLETE.

Materials and Resources

# Prerequisite 1: Storage and Collection of Recyclables

### For what is this LEED point intended?

The intent for this prerequisite is to facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

### What are the issues?

By creating convenient recycling opportunities for all building occupants, a significant portion of the solid waste stream can be diverted from landfills. Recycling of paper, metal, glass, cardboard and plastics reduces the need to extract virgin natural resources. For example, recycling one ton of paper prevents the processing of 17 trees and saves 3 cubic feet of land fill area. Recycled aluminum requires only 5% of the energy required to produce virgin aluminum from bauxite, its raw material form. Diverting waste from landfills can help minimize land, water and air pollution. An occupant education program that addresses the environmental and financial benefits of recycling can encourage occupants to participate in preserving the environment.

### What are the economic implications?

Many communities sponsor and promote recycling programs to reduce the amount of waste sent to landfills. Community recycling efforts return valuable resources to local production processes and many spur increases in employment in the recycling industry. Community-wide participation results in higher recycling rates and, in turn, more stable markets for recycled materials. Recycling infrastructure, such as storage area and bins, may add to project costs and take up floor area that could be used for other purposes. However, recycling offers significant savings through reduced landfill disposal costs or tipping fees. In larger projects, processing equipment can minimize the space required for recycling activities. Some recyclables can generate revenue that offsets collection and processing costs.

### What did we do here, and why did we do it?

The project has provided collection and storage areas for recyclable materials to serve the entire building. The collection area has been sized to meet the projected building needs. Plastics, metals, paper, cardboard, and glass are accommodated by the building’s recycling collection and storage area.

# Credit 2: Construction Waste Management

### For what is this LEED point intended?

The intent for this credit is to divert construction and demolition debris from disposal in landfills and incineration facilities, and to redirect recyclable recovered resources back to the manufacturing process and to redirect reusable material to appropriate sites.

### What are the issues?

Construction and demolition generates enormous quantities of solid waste. The EPA estimates that 136 million tons of such debris was generated in 1996, 57% of it from nonresidential sources. Commercial construction generates between 2 and 2.6 pounds of solid waste per square foot, and the majority of this waste could be recycled.

The greatest environmental benefit is achieved through source control—reducing the total waste generated. This can be done by using design strategies that minimize waste, such as shop fabrication of component parts, modular construction, and the ordering of material cut to size. Working with manufacturers to minimize unnecessary packaging and making arrangements for pallets to be reclaimed after use can also reduce waste volumes and water management costs. Extending the lifetime of existing landfills through effective construction waste management can avoid the need for expansion or new landfill sites.

Recycling of construction and demolition debris reduces demand for virgin resources and reduces the environmental impacts associated with resource extraction, processing and, in many cases, transportation.

### What are the economic implications?

In the past, when landfill capacity was readily available and disposal fees were low, recycling or reuse of construction waste was not economically feasible. Construction materials were less expensive than labor and construction site managers focused on worker productivity rather than on materials conservation. In addition, recycling infrastructure and recycled materials marketplaces that process and resell construction debris did not exist. The economics of recycling has improved in recent years, particularly with the advent of international competition for both raw and recycled materials, and disposal costs have increased. More stringent waste disposal regulation coupled with ever-decreasing landfill capacity has changed the waste management equation.

Waste management plans require time and money to draft and implement; in the long term, however, they provide guidance to achieve substantial savings throughout the construction process.

Recyclable materials have differing market values, depending on the presence of local recycling facilities, reprocessing costs, and the availability of virgin materials on the market. In general, it is economically beneficial to recycle metals, concrete, asphalt, and cardboard. Market values normally fluctuate from month to month, so it is advised to track the values and project different cost recapturing scenarios. When no revenue is received for materials, as is often the case for scrap wood and gypsum wallboard, it is still possible to benefit from recycling by avoiding landfill tipping fees.

### What did we do here, and why did we do it?

From the pre-existing parking lot on the site, 88 tons of concrete and 278 tons of asphalt were recycled. Containers were set up for cardboard, clean wood, concrete, metals, gypsum, paper, aluminum, plastic, and non-recyclable debris, which collected 12.3 tons of clean wood scraps and form lumber from construction and 400 lbs. of cardboard that were later were recycled. Other construction and demolition debris—19.2 tons’ worth—was landfilled. Overall, 95.172% of construction waste from the project was diverted from the landfill.

# Credit 5: Regional Materials

### For what is this LEED point intended?

The intent of this credit is to increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation.

### What are the issues?

There are a number of environmental issues related to this credit. The use of regional materials reduces transportation activities and associated pollution. Trucks, trains, ships, and other vehicles deplete finite reserves of fossil fuels and generate air pollution. It also is important to address the source of raw materials used to manufacture building products; some are harvested or extracted far from the point of manufacture, also contributing to air and water pollution associated with transportation.

### What are the economic implications?

The availability of regionally manufactured building materials depends on the project location. In some areas, the majority of products needed for the project can be obtained within a 500 mile radius. In other areas, only a small portion or not building materials can be sourced locally. However, the purchase of regional building materials is generally more cost-effective because of reduced transportation costs. Also, the support of regional manufacturers and labor forces retains capital in the community, contributing to a more stable tax base and a healthier local economy, as well as showcases the resources and skills of the region.

### What did we do here, and why did we do it?

24.4% of the total value of materials for the project came from materials that were manufactured and/or extracted within a 500 mile radius of the project site.

Indoor Environmental Quality

# Credit 3.2

# Credit 6.1: Controllability of Systems Lighting

### For what is this LEED point intended?

The intent of this credit is to provide a high level of lighting system control by individual occupants or groups in multi-occupant spaces (e.g., classrooms and conference areas) and promote their productivity, comfort, and well-being.

### What are the issues?

There are a number of environmental issues related to this credit. Providing individual controls for lighting increases occupants’ comfort by enabling them to adjust the workspace to their individual needs. Individual controls also allow for multiple lighting possibilities—lighting for specific tasks, general overhead lighting, lighting with consideration of A/V needs, and lecture style lighting with emphasis on learning walls or presentation screens, for example. By balancing ambient light levels and providing user controlled, flexible, task-appropriate lighting, project teams can reduce the overall lighting energy consumption and the heat loads associated with unnecessarily high or uneven levels of indoor lighting.

Effective lighting is important to human comfort, productivity, and communication. In classroom and presentation settings, building occupants must be able to see material on which they are working, as well as material that is presented on white boards and projected onto screens.

### What are the economic implications?

Additional task lights and lighting controls might increase initial costs for the project. These costs are generally offset by a reduced heat load and may enable designers to minimize ambient light levels as well as the number of installed fixtures and lamps. It is important to educate occupants on the design and function of system controls, because abuse of personal controls, such as leaving task lights on when not in classrooms or offices, has the potential to increase energy costs. Integrating individual controls with occupancy sensors provides project teams with an opportunity to reduce the overall energy costs. Integrating light-reflecting surface material with the lighting design may create opportunities to reduce the number of installed luminaries, resulting in potential energy savings.

### What did we do here, and why did we do it?

This building utilizes bi-level fixture control and multi-zone fixture switching to allow users to control lighting levels to what they desire. Occupancy sensors provide auto "off" control with manual switches providing "on" and "off" control.

# Credit 7.1: Thermal Comfort Design

### For what is this LEED point intended?

The intent of this credit is to provide a comfortable thermal environment that promotes occupant productivity and well-being.

### What are the issues?

There are a number of environmental issues related to this credit. Maintaining an acceptable level of thermal comfort for building occupants should be considered a necessity for any building or space with regular occupancy. Studies have shown that people who are comfortable are more productive and generally happier. In a work environment, increases in productivity can reduce the amount of time and energy required for an individual task. Over the course of a year, that can translate to fewer hours running equipment such as computers or task lighting, resulting in energy savings that reduce the strain on the environment.

### What are the economic implications?

Generally, HVAC and building envelope systems that do not adequately address the thermal comfort of occupants are less energy efficient than their more robust counterparts—with the exception of passive or naturally ventilated spaces. Mechanical systems relying on natural ventilation typically have lower capital and construction costs and use less energy than mechanically ventilated systems. In climates with extreme seasonal temperature swings, occupants’ comfort can suffer in a naturally ventilated building, but a well-designed building envelope and HVAC system can help compensate. Buildings with poor envelopes might struggle to maintain a comfortable environment for occupants near the building perimeter. The building HVAC system will expend more energy trying to maintain a comfortable environment for those occupants on the perimeter, increasing the annual energy cost of the building.

HVAC systems with poorly located or inadequate numbers of thermostats or control zones can significantly affect occupants’ comfort. Occupants using areas that could otherwise have been provided individual temperature controls may have to share a thermostat or may use space heaters, which can increase energy use. When spaces have not been properly thermally zoned, occupants may try to heat and cool the same area at the same time, potentially resulting in greater energy use and additional costs to operate the building.

### What did we do here, and why did we do it?

### The building is heated by a combination of an air-side system and hydronic heating along the perimeter for isolated rooms and stairwells. The air-side system has variable volume air supply with reheat coils for each zone which will modulate to maintain programmed setpoints. During the cooling season the spaces are cooled by the variable volume air system. Cool air is supplied from the main air handling unit at humidity conditions of 55 degrees dry bulb and 54 degrees wet bulb, values which are adjustable through the building automation system. Each zone has a sensor directly monitored by the building automation system to ensure maximum occupant comfort. The adjustable parameters of the building automation system temperatures are limited by the acceptable range provided in ASHRAE 55-2004 for occupied conditions. The buildings occupant schedule will cycle the system through the required setpoints during operation.

# Credit 7.2: Thermal Comfort Verification

### For what is this LEED point intended?

The intent of this credit is to provide for the assessment of building occupants' comfort over time.

### What are the issues?

There are a number of environmental issues related to this credit. For many facilities, the HVAC systems that maintain indoor thermal comfort are the largest energy users. A successful green building should minimize the energy use associated with building conditioning—along with the associated energy costs, fuel consumption and air emissions—while maintaining thermal comfort conditions that enhance occupant well-being.

### What are the economic implications?

Monitoring, managing, and maintaining thermal comfort conditions in a building may add capital, operations, and maintenance costs to a facility. Thermal comfort complaints are among the most prevalent from occupants. Maintaining thermal comfort could help operations and maintenance staff to focus on other facility issues by reducing the need to respond to such complaints.

### What did we do here, and why did we do it?

The Environmental Studies Department has developed a survey to question users of the McKeown Center about their level of thermal comfort. The survey includes questions regarding the factors that affect thermal comfort: temperature, thermal radiation, humidity and air speed. Questions are to indicate possible corrective action at the community center: temperature adjustment, air flow adjustment, solar shielding. The date, time of day and location within the building are included as part of the survey.

The survey is to be made available to building’s users during the period 6–18 months after the start of occupation. The Office of Residential Life, in conjunction with the IT Department and Physical Plant will be responsible for administering the survey and responding to issues uncovered as a result of the survey and will take remedial action as needed.

# Credit 8.1: Daylighting and Views/Daylight 75% of Space

### For what is this LEED point intended?

The intent of this credit is to provide the building occupants with a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

### What are the issues?

There are a number of environmental issues related to this credit. Buildings emphasizing daylighting may need larger daylighting apertures. Daylighting reduces the need for electric lighting of building interiors, which, if integrated into the overall approach to lighting, can result in decreased energy use. A well-designed daylit building is estimated to reduce the lighting energy use by 50% to 80%. This conserves natural resources and reduces air pollution impacts due to energy production and consumption.

Daylighting design involves a careful balance of heat gain and loss, glare control, visual quality, and variations in daylight availability. Shading devices, light shelves, courtyards, atriums, and window glazing are all strategies employed in daylighting design. Important considerations include the selected building’s orientation, window size and spacing, glass selection, reflectance of interior finishes, and locations of interior walls. Large expanses of unfragmented or untreated glazing can give the illusion of transparency or can reflect the sky and nearby habitat, causing birds in flight to collide into windows.

### What are the economic implications?

Specialized glazing can increase initial costs for a project and can lead to excessive heat gain if not designed properly. Glazing provides less insulating effects compared to standard walls, resulting in higher energy use and requiring additional maintenance. However, offices with sufficient natural daylight and a visual connection to outdoor environments have been proven to increase occupant productivity and comfort, leading to better employee retention. In most cases, employee compensation significantly outweighs the initial costs of incorporating daylighting measures into a building design.

### What did we do here, and why did we do it?

Enough windows in all areas were provided in the design to allow for 76.7% of regularly occupied spaces to be illuminated by daylight to an luminance of at least 2% of that experienced outside on an overcast day, or around 25 footcandles.