CHAPTER 1
Introduction

1.1 An Introduction to Sustainable Development

There are many definitions of *sustainability* and *sustainable development*. What is sustainable for one group may not be as sustainable for another. The most accepted worldwide definition of *sustainable development* is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). However, in an effort to address some of the sustainability ideals and goals in the United States, a subset of sustainability referred to as *sustainable construction* and its subcomponent called *green building* are emerging. They offer a look at sustainability in terms of a smaller scope, such as typical building or construction in an area of the developed world, and in the shorter term, perhaps the life of a building.

Sustainable construction is any construction, while green building focuses on vertical construction. There is also a movement developing to address horizontal construction (transportation and utility corridors). The horizontal construction program related to roads in the United States is usually referred to as *green highways*, although there are also publications that refer to some of the designs as *sustainable streets.* The Green Highway Partnership is an organization which has the U.S. Environmental Protection Agency (EPA) and the Federal Highway Administration (FHWA) among its partners. This partnership began in the Washington, D.C., area and is expanding nationally. Another initiative relating mainly to the outdoors and horizontal construction is the Sustainable Sites Initiative (SSI), which is a collaboration between the American Society of Landscape Architects (ASLA), the Lady Bird Johnson Wildflower Center (The Wildflower Center), and the United States Botanic Garden (USBG) among others. More information can be found at their website: http://www.sustainablesites.org/.

Sustainable construction is an international concern. Although this book focuses on the process in the United States, great efforts have been made to develop sustainable policies and practices throughout the world. The sustainable practices range from procurement or supply chain practices through wastewater reuse practices in the operational phases. Good solutions and practices for sustainable construction may not be the same in all areas of the world and for all societies. Therefore, the rating systems developed and the techniques used will differ. Energy efficiency is a high priority in many countries, particularly in countries with cold winters. There has been much publication and research into improving energy efficiencies internationally both for new construction and as retrofits in existing buildings.

By looking at the green building movement in the United States, it is obvious that the green rating system as developed by the U.S. Green Building Council (USGBC)

has had wide acceptance to date and is becoming more widespread. This system is referred to as LEED®, which stands for Leadership in Energy and Environmental Design.* Since LEED grew out of energy program initiatives, it is already developed in focus areas of both architects and mechanical engineers. Sometimes the construction that focuses on energy efficiency and also water efficiency is referred to as *high-performance* building.

Sustainable construction research and applications are still in their infancy. There is a great need for research, education, and case studies from applications to further develop a more sustainable future in development and construction. Even the definitions of what is or what is not sustainable need to be researched and further evaluated. For instance, certain people may believe that keeping as much as possible of the natural environment pristine is one of the most important goals of sustainability, whereas others may believe that an improved food supply for humans is more important. Thus, not only do the principles behind sustainability differ from group to group, or may be in contrast or seeming incompatibility with one another, but also the ranking or value judgments of the importance of various factors to sustainability are very difficult to develop and find consensus on.

To facilitate the further development and implementation of the green building system in the United States, engineers and other professionals must be educated in the rating systems used, and in the parameters and principles that have been established in the use of these rating systems. The intention of the author is to develop a text that educators can use to teach engineers and professionals about sustainable development, particularly the LEED system. The emphasis is on the development of skills to facilitate the use of this system, as well as guidance on potential additional research avenues to further improve the green building movement, with stress on environmental aspects, as future developments and needs arise.

The author likes to explain that a sustainable environmental goal will focus on both how construction impacts the environment and how environmental decisions impact development. It is a two-way road, and things must be looked at from both directions. In addition, other impacts in the entire life cycle of the facilities or practices need to be looked at. What may seem like an environmentally sound practice may in fact not turn out quite that way when input into an anthropogenic world. Two examples which follow are the sustainability of stormwater ponds and the use of certain additives in gasoline.

A common form of stormwater management is the use of a retention or a detention pond for storage and possibly infiltration of additional runoff caused by an increase in paved or roofed areas. Therefore in an approved site plan set, a pond may be called for. However, it has been shown that in many cases the specified ponds are not installed, much less maintained to sustain a more manageable stormwater system. Why? The reasons are not known, but perhaps the contractor or owner does not understand the environmental impact that the lack of a pond may cause; installation of one may not seem important.

Then there is the use of MTBE (methyl-tertiary-butyl ether) as an additive in gasoline to improve air quality, which was a common practice in the 1990s. It was considered to be a sound environmental practice with respect to air issues. However, there were some unexpected consequences. Traditionally in the United States, gasoline

*LEED is a registered trademark of the U.S. Green Building Council.

is made at a refinery, is transported and distributed through a network of petroleum facilities, and ends up at the retail outlet, the gasoline station. Gasoline is usually stored in underground tanks, for many reasons including safety, at this end resale site. Underground tanks are currently fairly well regulated and monitored in the United States, but that was not always the case. In many sites, gasoline has leaked into the ground, and the product sits on or in the groundwater. Most constituents in gasoline are nonpolar organics which do not dissolve readily in polar water, but might prefer to adsorb to organic material in the soil. So even though the groundwater may slowly flow off-site, most of the gasoline contaminants remain closer to the site. However, MTBE is an ether, and ethers are more polar than many gasoline constituents such as benzene. Polar organics tend to be more soluble in water and may have a greater tendency to travel with the groundwater gradient. Therefore, there are many places where some gasoline leakage in the soils at a site did not initially cause an off-site concern until the MTBE was added and moved more rapidly off-site. In this way a practice that is an environmental benefit for one system may not be as sustainable in another.

There are several other green rating systems for vertical construction in the United States, but the LEED system and the alternative Green Globes system are by far the most prominent. Green Globes is distributed by the Green Building Initiative (GBI) and is based on a system developed in Europe and later also used in Canada. The European version is referred to as the Building Research Establishment's Environmental Assessment Method (BREEAM). This text is based on the LEED system, but this in no way implies that the other systems are not useful and viable. The LEED rating system was chosen as the focus of this text as it is currently more widespread in the United States. It also does not allow for a self-certification method, which makes it more restrictive and possibly more difficult to complete, but at the same time also gives greater control and consistency to green building.

The text has a heavy focus on some of the civil and environmental aspects of the rating system, since the author is first targeting this engineering community. However, it also addresses in some fashion other issues in the rating system. One of the reasons for its being more all encompassing in the topics reviewed is to educate the civil and environmental engineers about the other credits and criteria so that they can effectively work with other disciplines in a cooperative fashion to better implement sustainable construction practices.

There is a need for further involvement from the civil and environmental engineering community in the development of the LEED rating system. The evaluation of best practices and goals for many of these aspects is still in its infancy. It is here that much research and teaching may be needed to further develop the rating system effectively in a timely manner. There has been a substantial amount of green building at the University of South Carolina since 2003, and a few of the categories of sustainable construction in which additional research, the development of best practices, and optimization are needed include the following:

1. Construction and demolition (C&D) debris recycling and reuse. There is a need to optimize construction practices to facilitate C&D debris recycling in an economic fashion and to develop the recycling and reuse infrastructure in many areas of the United States to support these practices. Figure 1.1.1 shows a construction debris waste container yard at a LEED registered project in Columbia, S.C.

Figure 1.1.1 Construction debris container yard at a LEED registered project in 2005 at the University of South Carolina in Columbia, S.C. (*Photograph taken by Steve Bruner.*)

2. Design-procurement-construction process integration and optimization.
3. Construction management processes.
4. Stormwater management and low-impact development (LID).

There is a need for research and development of best management practices and integrated management practices with respect to the nonpoint source type of pollutants. One area includes new infrastructure and materials with respect to stormwater management such as pervious pavements. An example of a multipurpose landscape amphitheater and stormwater management feature at a LEED certified project in Columbia, S.C., is shown in Fig. 1.1.2. Additional information on LID can be found in Chap. 10.

The text is also intended to be used by other engineers and professionals such as mechanical engineers, architects, planners, community leaders, and construction managers, as it does present the overall holistic approach of the LEED rating system and can facilitate the understanding of many of the credits and criteria outside the traditional purview of these disciplines. Again, the intention is to let all the professionals and affected parties learn to "talk the talk" of the other team members and understand the viewpoints and engineering decisions in an interdisciplinary fashion. It is very important that all interested parties, including the community, be involved in the sustainable construction process. Criteria that are important to many participants can be incorporated into the design and implementation of green construction. One example concerns the maintenance of the "historical" feel in a community. Green does not mean the buildings and facilities have to look different. Figure 1.1.3 depicts a structure built

Figure 1.1.2 Landscaped amphitheater also functions as a stormwater management feature at the LEED Certified West Quad Housing Complex at the University of South Carolina. (*Photograph taken in September 2006*.)

in 1939 at the University of South Carolina, and it shows how the new "green" building in Fig. 1.1.2 can still fit in well with the other historic buildings at this university.

There are many other excellent references to consult in the understanding and educating of others about sustainable construction and green building. Several of these are also focused on the USGBC LEED. However, this book is different from many of the other references that cover the LEED rating system in that it presents the information and criteria in a fashion that is useful for then doing mathematical and design exercises for further understanding and familiarity with the criteria and parameters in use. Several excellent references on sustainable development, industrial ecology (terminology referring to sustainable development from a more industrial viewpoint), sustainable construction, and green building are listed in the References section of this chapter. There are also many website resources from which sustainable education materials can be accessed. One of note is the ImpEE (Improving Engineering Education) Project website developed by the University of Cambridge in the United Kingdom, and another is the Green Design Institute at Carnegie Mellon.

There are a plethora of current publications in journals based on how universities and other institutions are implementing sustainability into the curricula. For instance, *The International Journal of Engineering Education* focused Part I of its vol. 23, no. 2, 2007 issue on "Educating Students in Sustainable Engineering."

One very important reference which should be highlighted here is the LEED NC-2.2 Reference Guide, as developed by the USGBC. This text in sustainable construction is intended to supplement the subject Reference Guide. The Reference Guide, just like building codes and legislation, presents the parameters and suggested practices for

Figure 1.1.3 Preston College Building at the University of South Carolina, built in 1939. Similar architecture to the new green West Quad Facility opened in 2004 (as shown in Fig. 1.1.2).

implementation of the rating system that other entities can adopt to facilitate building in a more sustainable fashion. The Reference Guide also expands upon the environmental, societal, and economic principles used in the determination of the various prerequisites and credits, and presents many excellent examples, case studies, and references which can be used to aid in the implementation of the LEED system. This text takes the basic parameters and principles of the subject Reference Guide, particularly with respect to many of the civil and environmental design issues, and further expands them into equations and teaching formats which may be helpful in a classroom situation. It is with gratitude that the author acknowledges the USGBC in allowing her to use most of the USGBC rating system verbiage for each prerequisite and credit in this text and many of the tables, definitions, and other information from the Reference Guide.

LEED-NC 2.2 is the current (2007) version of the USGBC rating system for New Construction and Major Renovations. The first edition of LEED-NC version 2.2 was released in October 2005. It replaced LEED-NC version 2.1 as the current rating system for newly registered projects. Since that time, there have been several corrections and addenda to version 2.2, and a listing of these can be found as errata available for download to the general public from the USGBC website. This text is based on the LEED-NC version 2.2 released in October 2005 and as amended through the second edition dated September 2006 and errata as posted in the spring of 2007. Projects that were started under the LEED-NC version 2.1 may remain under that version, although all new projects will be expected to adhere to version 2.2 or future versions as they are officially adopted. There are substantial differences between versions 2.2 and 2.1 for many of the subcategories, and it is expected that the next version also will contain substantial changes to many of the credits. Practitioners and educators should ensure that these changes are incorporated in future projects and class curricula.

This text focuses on the LEED-NC rating system, which is the premier and most heavily used green rating system in the United States at this time. LEED-NC is for new construction and major renovations for mainly commercial, institutional, industrial, and large residential (four stories or more) projects. The USGBC and several other organizations have also developed, or are in the process of developing, rating systems for other types of projects. One other organization of note is the National Association of Home Builders (NAHB), which through the GBI is offering its voluntary Model Green Home Building Guidelines.

Some of the other LEED rating systems are listed in Table 1.1.1.

		Status as of May 2007	Comments
LEED-EB	Existing Building operations and maintenance	Approved 10/22/04 Current Version 2.0	Both for later recertification of buildings previously certified and for existing building renovations
LEED-CI	Commercial Interiors	Approved 11/17/04 Updated November 2004 Current Version 2.0	For commercial tenant space in a building which may or may not have the core and shell certified
LEED-CS	Core and Shell	Approved July 2006 Current Version 2.0	For the core and shell of a building which may or may not have the commercial interior tenant space certified
LEED-H	Homes	Pilot started in 2005 Pilot Version 1.11a released 2/1/07 Launch expected 2007	
LEED-ND	Neighborhood Development	Pilot expected start in 2007	Integration of smart growth, urbanism, and green building for neighborhood design
LEED for Schools	Schools (K–12)	Launched in April 2007	Based on LEED-NC, but required for K–12 academic buildings. May be used for K–12 nonacademic buildings
LEED for Retail	Retail construction*	Draft Version 2.0 April 2007	Two rating systems. One is based on NC 2.2. Second is based on CI 2.0
LEED for Healthcare	Healthcare facilities*	Under development	
LEED for Labs	Facilities with laboratories*	Under development	

*Can also be viewed as a part of LEED-NC (or CI for retail) with suggested guidances as listed in Table 1.2.1.

Table 1.1.1 Other LEED Rating Systems

The USGBC is currently working on revamping its premier rating system (LEED-NC) to version 3.0. It is unclear whether the various other rating systems will be incorporated directly into version 3.0 or whether they will remain stand-alone systems. Either way, one of the goals in the revamping is to make the various rating systems for the numerous types of applications more consistent and interchangeable.

Finally, note that sustainability is not just an environmental concept. Many are quick to point out that sustainability focuses on a triple bottom line: economic, environmental, and societal. Many of the concepts relating to future economic and societal concerns are dependent on current resource and environmental management and best practices. Hawken, Lovins, and Lovins further expand on this in their book *Natural Capitalism, Creating the Next Industrial Revolution.*

1.2 Introduction the USGBC LEED-NC Rating System

LEED-NC is applicable to a large portion of the most expensive vertical construction projects in the United States. It basically covers most commercial, institutional, and industrial projects and includes residential construction of facilities of four or more stories.

Guidances

There are many projects which have unique criteria that may not fit well into the credit intents and requirements as listed in LEED-NC 2.2. To facilitate LEED certification and sustainable practices for certain categories of projects, the USGBC has or is developing guidances specific to many special subsets of project application types. They are referred to as application guides. Table 1.2.1 is a listing of several of the guidances being developed.

These guidances serve many purposes. They serve to aid in modifying or embellishing criteria for specific credits when it may be difficult to apply the credit directly as written for a particular type of project, and they also identify some items that may be used for a particular project type for one of the first four Innovation & Design credits. Table 1.2.1 can also be found as Table 7.0.1 in Chap. 7. Chapter 9 is a special section on the U.S. military and sustainable construction and explores in greater detail how one of the guidances, LEED for Lodging, may relate to LEED-NC, with particular emphasis on indoor air quality. For any project that deals with any of these special applications, the guidances should be used in conjunction with the LEED-NC 2.2 rating system.

Application	Status as of September 2006
LEED for Multiple Buildings/Campuses	Guide available
LEED for Lodging (<4 stories)	Developed by USAF but not yet voted on for adoption by USGBC membership
LEED for Healthcare	Under development
LEED for Labs	Under development

TABLE 1.2.1 Application Guidances

How LEED-NC Is Set Up

LEED-NC contains both credits and prerequisites. All eight prerequisites are mandatory for each project. None of the credits (currently up to 69 points from these credits) are mandatory at this time. (The carbon commitment and other future goals may make some credits mandatory for certain projects in the future.) The credits are worth a certain number of points, and a combination of credit points adds up to a certain level of certification. The current levels of certification and the number of points associated with each level are as listed:

- Certified: 26 to 32 points
- Silver: 33 to 38 points
- Gold: 39 to 51 points
- Platinum: 52 to 69 points

LEED-NC is subdivided into six categories for which there are prerequisites, subcategories, and credits representing possible points. Usually each credit has one associated point, but two of the Energy and Atmosphere credits are multipoint. The six categories and their associated numbers of prerequisites, subcategories, and possible points (excluding exemplary performance points associated with that category) are as noted:

- **Sustainable Sites** (SS)
  - Prerequisites: 1
  - Subcategories: 8
  - Possible points: 14
- **Water Efficiency** (WE)
  - Prerequisites: none
  - Subcategories: 3
  - Possible points: 5
- **Energy and Atmosphere** (EA)
  - Prerequisites: 3
  - Subcategories: 6
  - Possible points: 17
- **Materials and Resources** (MR)
  - Prerequisites: 1
  - Subcategories: 7
  - Possible points: 13
- **Indoor Environmental Quality** (EQ)
  - Prerequisites: 2
  - Subcategories: 8
  - Possible points: 15
- **Innovation and Design Processes** (ID)
  - Prerequisites: None
  - Subcategories: 2
  - Possible points: 5

LEED-NC Documents

Information is provided from the USGBC on several different levels. The main level of information provided for LEED-NC 2.2 is the governing document as approved by the USGBC for the rating system. It is entitled *LEED-NC Green Building Rating System for New Construction & Major Renovations Version 2.2 for Public Use and Display*. It is available free of charge to the general public for download and public display and can be found on the USGBC website (www.usgbc.org). The verbiage from various sections of this document is included verbatim throughout this text. The exact wording is important to read to adequately interpret the intent and expanse of the requirements listed. Some other items provided to the general public for free from the USGBC website are the errata sheets (which include corrections to both the governing document and the Reference Guide as described in the following paragraph) and various fact sheets and sample items, including sample templates. Templates are the online format used by the USGBC for credit submittals and calculations. The USGBC also provides a project checklist for overall summary credit and prerequisite tracking.

As mentioned earlier, the USGBC provides a reference guide for the LEED-NC 2.2 rating system. This reference guide is supplemental to the governing document and is available for purchase. It gives example calculations, case studies, and additional references, and it expands upon the intent and definitions necessary to better understand the prerequisite and credits for certification. Members of the USGBC and people associated with registered projects can also log on to the system and view the Credit Interpretation Rulings (CIRs), which are replies to Credit Interpretation requests. The Credit Interpretation Rulings are further explained in the following sections and allow the members or projects to keep up with future interpretations and enhancements to the rating system. Project personnel can also use the template system directly online to continually track credit and prerequisite performance.

Credit Formats

The information given in the credit write-ups for the various credits is set in a standard format. The format in version 2.2 is slightly different from that of version 2.1. The formats used in the governing document (Public Display Portion) and the Reference Guide in version 2.2 are also slightly different and are summarized as follows:

- In Public Display Portion:
  Intent
  Requirements
  (No longer lists submittals to allow for greater flexibility)
  Potential Technologies and Strategies
- In Reference Guide:
  Intent
  Requirements
  Summary of Referenced Standards
  Approach and Implementation
  Calculations (Yes or No)
  Exemplary Performance Point (Yes or No)
  Submittal Documentation

Considerations
- Environmental
- Economic
- Community (Sometimes)

Resources
Definitions

Registration, Certification, Membership, and Accreditation

There are two main definitions of various status categories with respect to building projects and the USGBC LEED process: registration and certification. There are currently fees associated with both registration and certification.

Registration with the USGBC is completed at the inception of a project to begin the certification process. The project team then receives access to many of the management features and templates available on the USGBC website to aid in keeping track of the project. The project is usually registered at the current version of the rating system, and the project is tracked at this level.

Certification at one of the certification levels listed previously is intended for that project after it is complete. Certification is requested through an application process. Certification is received at the version of the rating system for which the project is registered. Figures 1.2.1 and 1.2.2 are photographs of the first private building in South Carolina that received certification under the USGBC LEED-NC rating system.

Figure 1.2.1 Cox and Dinkins Engineers and Surveyors in Columbia, S.C: First private building to receive certification under the USGBC LEED-NC rating system in South Carolina. (*Photograph taken in June 2007.*)

Figure 1.2.2 Cox and Dinkins Engineers and Surveyors in Columbia, S.C. USGBC LEED-NC rating system certification plaque. (*Photograph taken in June 2007.*)

Formerly, the application for certification was one step near the end of a project. In LEED-NC 2.2 this application process has been optionally divided into two phases. Several of the design phase credits can be applied for prior to completion of the project, with the remaining applied for at the end of the construction phase. Each project is allowed one design phase review. This aids in expediting paperwork and understanding final interpretations of the applicable credits.

There are some additional definitions of various status categories with respect to people and the USGBC LEED process:

> **Membership** to the USGBC is by organization, and then individuals within that organization can become members under the umbrella of their organization (organizations pay dues, individuals do not). A person can also be a **member of a chapter** such as the USGBC-SC (South Carolina) chapter (individuals usually pay dues to a chapter). Students and recent graduates may also become members of the Emerging Green Builders (EGB), a special membership category usually associated with local chapters for students and young professionals.
>
> **Accreditation** is the mechanism by which individuals can become LEED-Accredited Professionals (LEED-AP). This is a process developed by the USGBC to determine whether a person can be recognized as a professional with respect to its rating system. It is an exam-based accreditation process.

Project Checklist and Templates

Development of effective project management and green concept integration into construction projects will be a continual challenge as the green movement expands in

the United States. Some simplified suggestions for improvement and implementation will be discussed in later chapters. In addition, substantial efforts are under way to research optimization methods for implementation of the green process. There are many tools and suggestions developed by the USGBC to facilitate becoming green, which can be found in example format on the USGBC website (www.usgbc.org). Two of the main tools are the project checklist and the templates. The project checklist is used to keep track of overall project success with respect to green construction, and the templates are used to keep track of individual prerequisites and credits during the project and to submit information to the USGBC during the certification application process.

At the onset of a project after registration, the USGBC supplies the LEED-NC Registered Project Checklist to the project team. Table 1.2.2 shows a blank LEED-NC 2.2 checklist as downloaded from the USGBC website in May 2007.

Templates, or letter templates as they were frequently referred to in LEED-NC 2.1, are provided for use by the project team after project registration. They are online and provide an interactive format for many of the calculations needed for credit verification. They are used for summary calculations and as a tool to track the necessary documentation for submittals for each prerequisite and credit applied for. Figure 1.2.3 is a summary figure of the format for part of a submittal for a prerequisite that requires drawing submittals and narratives explaining the project adherence to the requirements. It is based on the example template available for download from the USGBC website for the Sustainable Sites prerequisite one (SSp1) for Construction Activity Pollution Prevention. Note that it refers to "credit" requirements, even though it is a prerequisite and does not earn points, but this is purely a matter of keeping the template formats consistent. Figure 1.2.4 is a summary figure of the format for the first portion of Option 1 for the Energy and Atmosphere credit number 1 (EAc1), Optimize Energy Performance. It is depicted to show a template where actual numbers and data are input to the USGBC. The actual online template process is interactive and will provide appropriate calculations from some of the data input.

What to Do If Things Are Not Clear for Your Project

Credit Interpretation Rulings (CIRs) represent the format that the USGBC has chosen to continually aid projects with interpretations of the rating system for their specific circumstances. Requests for interpretation of credits are submitted to the USGBC, and the USGBC replies with Credit Interpretation Rulings. It is a formal process that lists the rulings of the interpretations online for use by other projects to allow for both consistency from project to project and expediency in having the explanation and interpretations readily available without constant revisions to the governing documents. The CIR process is very important to the rating system's success and certification. It is expected that project team members are very familiar with this process. In the LEED-NC 2.1 Reference Guide, the CIR process was summarized in the following four steps:

1. Consult the Reference Guide.
2. Review the Reference Guide and self-evaluate.
3. Review the CIR web page for previously logged CIRs.
4. If still unanswered, submit a CIR with an online form.

LEED for New Construction v2.2 Registered Project Checklist (p.1)						
Project Name and Address:						
Yes	?	No				
			Sustainable Sites			**14** Points
Y			Prereq 1		**Construction Activity Pollution Prevention**	Required
			Credit 1		**Site Selection**	1
			Credit 2		**Development Density & Community Connectivity**	1
			Credit 3		**Brownfield Redevelopment**	1
			Credit 4.1		**Alternative Transportation**, Public Transportation Access	1
			Credit 4.2		**AlternativeTransportation**, Bicycle Storage & Changing Rooms	1
			Credit 4.3		**Alternative Transportation**, Low-Emitting & Fuel-Efficient Vehicles	1
			Credit 4.4		**Alternative Transportation**, Parking Capacity	1
			Credit 5.1		**Site Development,** Protect of Restore Habitat	1
			Credit 5.2		**Site Development,** Maximize Open Space	1
			Credit 6.1		**Stormwater Design,** Quantity Control	1
			Credit 6.2		**Stormwater Design,** Quality Control	1
			Credit 7.1		**Heat Island Effect,** Non-Roof	1
			Credit 7.2		**Heat Island Effect,** Roof	1
			Credit 8		**Light Pollution Reduction**	1
			Water Efficiency			**5** Points
			Credit 1.1		**Water Efficient Landscaping**, Reduce by 50%	1
			Credit 1.2		**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
			Credit 2		**Innovative Wastewater Technologies**	1
			Credit 3.1		**Water Use Reduction**, 20% Reduction	1
			Credit 3.2		**Water Use Reduction**, 30% Reduction	1
			Energy & Atmosphere			**17** Points
Y			Prereq 1		**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2		**Minimum Energy Performance**	Required
Y			Prereq 3		**Fundamental Refrigerant Management**	Required
			Credit 1		**Optimize Energy Performance**	1 to 10
					10.5% New Buildings or 3.5% Existing Building Renovations	1
					14% New Buildings or 7% Existing Building Renovations	2
					17.5% New Buildings or 10.5% Existing Building Renovations	3
					21% New Buildings or 14% Existing Building Renovations	4
					24.5% New Buildings or 17.5% Existing Building Renovations	5
					28% New Buildings or 21% Existing Building Renovations	6
					31.5% New Buildings or 24.5% Existing Building Renovations	7
					35% New Buildings or 28% Existing Building Renovations	8
					38.5% New Buildings or 31.5% Existing Building Renovations	9
					42% New Buildings or 35% Existing Building Renovations	10
			Credit 2		**On-Site Renewable Energy**	1 to 3
					2.5% Renewable Energy	1
					7.5% Renewable Energy	2
					12.5% Renewable Energy	3
			Credit 3		**Enhanced Commissioning**	1
			Credit 4		**Enhanced Refrigerant Management**	1
			Credit 5		**Measurement & Verification**	1
			Credit 6		**Green Power**	1

TABLE 1.2.2 Blank LEED-NC 2.2 Project Checklist (Sheet 1)

The LEED-NC 2.2 Reference Guide summarizes the CIR process in three steps following the project team's being unable to adequately answer a question based on its interpretation of the Reference Guide. The three steps are as follows:

1. Review the CIR web page for previously logged CIRs. Note that some of the CIRs for other rating systems or versions may not be applicable.
2. If no applicable CIR exists, then submit a CIR via the CIR web page. This web page has guidelines for how a CIR should be submitted, with particular

LEED for New Construction v2.2 Registered Project Checklist (p.2)					
			Materials & Resources		**13** Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
			Credit 1.1	**Building Reuse**, Maintain 75% of Existing Walls, Floors & Roof	1
			Credit 1.2	**Building Reuse**, Maintain 100% of Existing Walls, Floors & Roof	1
			Credit 1.3	**Building Reuse**, Maintain 50% of Interior Non-Structural Elements	1
			Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
			Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
			Credit 3.1	**Materials Reuse**, 5%	1
			Credit 3.2	**Materials Reuse**, 10%	1
			Credit 4.1	**Recycled Content**, 10% (post-consumer + ½ Pre-consumer)	1
			Credit 4.2	**Recycled Content**, 20% (post-consumer + ½ Pre-consumer)	1
			Credit 5.1	**Regional Materials**, 10% Extracted, Processed & Manufactured Regionally	1
			Credit 5.2	**Regional Materials**, 20% Extracted, Processed & Manufactured Regionally	1
			Credit 6	**Rapidly Renewable Materials**	1
			Credit 7	**Certified Wood**	1
			Indoor Environmental Quality		15 Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
			Credit 1	**Outdoor Air Delivery Monitoring**	1
			Credit 2	**Increased Ventilation**	1
			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
			Credit 4.2	**Low-Emitting Materials**, Paints & Coatings	1
			Credit 4.3	**Low-Emitting Materials**, Carpet Systems	1
			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber Products	1
			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
			Credit 6.1	**Controllability of Systems**, Lighting	1
			Credit 6.2	**Controllability of Systems**,Thermal Comfort	1
			Credit 7.1	**Thermal Comfort**, Design	1
			Credit 7.2	**Thermal Comfort**, Verification	1
			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1
			Innovation & Design Process		**5** Points
			Credit 1.1	**Innovation in Design**: Provide Specific Title	1
			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
			Credit 1.3	**Innovation in Design**: Provide Specific Title	1
			Credit 1.4	**Innovation in Design**: Provide Specific Title	1
			Credit 2	**LEED® Accredited Professional**	1
			Project Totals(pre-certification estimates)		**69** Points
Certified: 26-32 points, **Silver:** 33-38 points, **Gold:** 39-51 points, **Platinum:** 52-69 points					

TABLE 1.2.2 Blank LEED-NC 2.2 Project Checklist (Sheet 2)

information on what should be in the request. The main focus is on the intent of the credit. The CIR will eventually be posted on the CIR web page and is not intended to include a long description of a particular project, but rather a more overall question to be interpreted for application for the project and other similar project circumstances.

3. The USGBC will rule on the CIR either via e-mail or by posting on the CIR web page.

As mentioned earlier under LEED-NC documents, the USGBC has a process to periodically post errata to both the governing document (Public Display Portion) and the Reference Guide, which are also periodically included in new editions of the versions.

LEED-NC 2.2 Submittal Template
SS Prerequisite 1: Construction Activity Pollution Prevention

(Responsible Individual) (Company Name)
I, _____, from_____
Verify that the information provided below is accurate to the best of my knowledge.
_____

CREDIT COMPLIANCE
Please select the appropriate compliance path

Option 1: The Erosion and Sedimentation Control Plan (ESC) conforms to the 2003 EPA Construction General Permit, which out lines the provisions necessary to comply with Phase I and Phase II of the National Pollutant Discharge Elimination System (NPDES) program. _____

OR

Option 2: The ESC Plan follows local erosion and sedimentation control standards and codes, which are more stringent than the NPDES program requirements. _____

SUPPORTING DOCUMENTATION
The noted project drawing(s) have been uploaded. The drawing(s) shows the erosion and sedimentation control measures implemented on the site.

Sheet Description Log
Please include sheet name, sheet number and file name for each uploaded, refereneced drawing (e.g. A-101, Site Plan, siteplan.pdf)
_____
_____
_____
_____

_____ I have provided the appropriate supporting documentation in the document upload section of LEED Online.
Please refer to the above sheets.

NARRATIVE (Required)
Provide a narrative to describe the Erosion and Sedimentation control measures implemented on the project. If local standard has been followed, please provide specific information to demonstrate that the local standard is equal to or more stringent than the referenced NPDES program.
_____
_____
_____

NARRATIVE (Optional)
Please provide any additional comments or notes regarding special circumstances or considerations regarding the project's credit approach.
_____
_____
_____ The project is seeking point(s) for this credit using an alternate compliance approach.The compliance approach including references to any applicable Credit Interpretation Rulings is fully documented in the narrative above.

Project Name:

Figure 1.2.3 Portion of example template from the USGBC website for a prerequisite which requires drawings and narrative for submittal (SSp1).

LEED-NC 2.2 Submittal Template
EA Credit 1: Optimize Energy Performance

(Responsible Individual) (Company Name)
I, _____ , from_____
Verify that the information provided below is accurate to the best of my knowledge.
_____

CREDIT COMPLIANCE
(Please complete the color coded criteria(s) based on the option path selected)

Please select the appropriate compliance path option
___ Option 1 (Pg2): Performance Rating Method, ASHRAE 90.1-2004 Appendix G or equivalent (upto 10 points possible)
___ Option 2 (Pg14): ASHRAE Advanced Energy Design Guide for Small Office Buildings 2004 (4 points)
___ Option 3 (Pg14): Advanced Buildings Benchmark™ Version 1.1, Basic Criteria & Prescriptive Measures (1 point)

OPTION 1: PERFORMANCE RATING METHOD
___ I Confirm that the energy simulation software used for this project has all capabilities described in EITHER section'G2 Simulation General Requirements' in Appendix G of A SHRAE 90.1-2004 OR the analogous section of the alternative qualifying code used.

___ I Confirm that the baseline building and proposed building in this project's energy simulation runs use the assumptions and modeling methodology described in EITHER Appendix G of ASHRAE 90.1-2004 OR the analogous section of the alternative qualifying energy code used.

Complete the following sections to document compliance using Option1:
Section 1.1 – General Information
Section 1.2 – Space Summary……
_
…….Section 1.8 – Performance Rating Method Compliance Report

Section 1.1 – General Information
……

Section 1.2 – Space Summary
Provide the space summary for your project
(click "CLEAR" to clear the contents of any row. All numeric entries must be entered as whole numbers without commas):

Table 1.2 – Space Summary

Building Use (Occupancy Type)	Conditioned Area (sf)	Unconditioned Area (sf)	Total Area (sf)	
				CLEAR
				CLEAR
				CLEAR
				CLEAR
				CLEAR
				CLEAR
				CLEAR
Total				

FIGURE 1.2.4 Portion of example template from the USGBC website for a credit which requires data and narrative for submittal (EAc1: Option 1). Shaded areas in the table are for user input of data. Blank areas in the table will be filled in automatically.

1.3 New and Future Developments

Organizations

An important part of specifications and design for construction is the use of established standards. Many organizations are recognized as established sources for many standards and have procedures for accrediting, developing, reviewing, and revising standards. The organization that accredits organizations as a standards developer in the United States is the American National Standards Institute (ANSI). On November 27, 2006, ANSI accredited the U.S. Green Building Council as an official Standards Developing Organization. Some of these organizations which help develop or accredit standards as mentioned in this text include the following:

AIA	American Institute of Architects.
ANSI	The American National Standards Institute accredits standards for products, services, processes, and systems in the United States; accredits organizations that perform certifications; and coordinates U.S. standards with international standards.
ASHRAE	The American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., publishes standards in the areas of HVAC and refrigeration.
ASTM	ASTM International was originally formed in 1898 as the American Society for Testing and Materials. It develops technical standards for materials, products, systems, and services.
IESNA	The Illuminating Engineering Society of North America is recognized as an authority on lighting and illumination standards in the United States.
ISO	The International Organization for Standardization (Organisation Internationale de Normalisation) is the largest international developer of standards. ANSI is the U.S. voting member body for ISO.

Standard 189

In 2006, the USGBC, ASHRAE, IESNA, and AIA joined together to develop Standard 189, a new minimum standard for high-performance green building. The standard is being led by the newly developed ASHRAE Standard Project Committee 189 (SPC 189). The standard was initially proposed in January 2006 and as a standard under development is referred to as SPC 189P. The preliminary title, purpose, and scope as revised through November 8, 2006 read as follows:

Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings

1 Purpose:

The purpose of this standard is to provide minimum requirements for the design of high-performance, green buildings to:

(a) Balance environmental responsibility, resource efficiency, occupant comfort and well being, and community sensitivity, and

(b) Support the goal of the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

2 Scope:

2.1 This standard provides minimum criteria that:
(a) Apply to new buildings and major renovation projects (new portions of buildings and their systems): a building or group of buildings, including on-site energy conversion or electric-generating facilities, which utilize a single submittal for a construction permit or which are within the boundary of a contiguous area under single ownership
(b) Address sustainable sites, water use efficiency, energy efficiency, the building's impact on the atmosphere, materials and resources, and indoor environmental quality (IEQ).

2.2 The provisions of this standard do not apply to:
(a) single-family house, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes) and manufactured houses (modular).
(b) buildings that do not use either electricity or fossil fuel.

2.3 This standard shall not be used to circumvent any safety, health or environmental requirements.

Computer-Aided Design

There has been much interest in incorporating environmental assessments as well as material selection options and evaluations based on life-cycle information and built performance into the computerized early design stages of projects. One result is the development of an *LCADesign* program in Australia. In November 2006, the USGBC and Autodesk announced that they had formed a relationship to further the use of technology and the development of sustainable design. Autodesk is one of the largest companies in the world developing computer-aided design software. Its premier product is Autocad and is used on many projects in the United States.

The Carbon Commitment

Global climate change is a major issue of concern in the world. Some details of mechanisms and suspected causes of this phenomenon are treated in subsequent chapters. The USGBC has made a commitment to focus on emphasizing strategies and green building goals which would help lower the emission of carbon dioxide into the atmosphere. Carbon dioxide is recognized as a gas with a global warming potential (GWP) and is thought to be a major contributor to current changes in the atmosphere. Carbon dioxide levels in the atmosphere have increased in recent decades, as has the use of fossil fuels for energy. Fossil fuels are carbon-based, and their use is thought to impact the global carbon cycle, with more carbon being released to the atmosphere (in the form of carbon dioxide) than sequestered in the crust, ocean, or flora (usually in dissolved, fossil fuel, mineral rock, or vegetation form). Fuels that cannot be readily reproduced in our human-generation time frames, such as fossil fuels, are referred to as *nonrenewable* while energy sources such as wind or wood which can be regrown are referred to as *renewable*. Even though the burning of wood releases carbon into the air in the form of carbon dioxide, it is considered renewable with respect to the carbon cycle, since new trees recycle carbon from the atmosphere during their growth. Renewable energy sources that are still a part of the carbon cycle such as corn-based ethanol or wood-burning are typically referred to as *carbon-neutral.* Other energy sources such as wind harvesting which do not use carbon-based chemicals as part of the energy transfer mechanism are referred to by the author as *carbon-free*.

In late 2006, the USGBC announced some very progressive goals for reducing carbon emissions. These include a proposed 2007 goal of all newly registered projects to

strive to attain a minimum of 2 credits for LEED credit EAc1 (Energy and Atmosphere credit 1, *Optimize Energy Performance*), and to reduce carbon emissions by at least 50 percent (the reduction percentage is higher for the higher levels of certification). Optimizing energy performance as a part of the carbon commitment will reduce energy use, and as most energy use in the United States is based on fossil fuels, this should result in decreased dependence on fossil fuels and decreased carbon emissions from these nonrenewable fuels. The goals also include a commitment that the USGBC itself, in its operations, be carbon-neutral by 2008.

Miscellaneous USGBC Initiatives

There are several other official initiatives at the USGBC to improve the development of the LEED rating system. Four of the major initiatives as listed in July 2007 are Harmonizing and Aligning LEED Rating System, Integrated Committee Structure, Technical Development, and Regular Update Cycle for LEED. The intention of Harmonizing and Aligning LEED Rating System is to try to align the various USGBC rating systems so that they are easier to use and have consistency between similar credits. The proposed Integrated Committee Structure will recategorize the committees from being LEED rating system specific and will instead focus on Technical, Market, and Certification issues. The Technical Development initiative will help focus on some of the environmental issues of concern, add in greater regional variability, and incorporate more technical analyses such as life-cycle assessment. Finally, the proposed regular update cycle for LEED is intended to help incorporate market and technological developments into the rating system on a consistent basis that allows for improved input from the community and stakeholders.

Other environmental concerns that are currently not a part of LEED-NC 2.2 are also being incorporated into future rating systems; one example is sound pollution and acoustics. In the USGBC LEED for Schools rating system released in 2007, there is both a prerequisite and a credit in the Indoor Environmental Quality category relating to acoustics. The green building rating system is constantly being improved and built upon, and as noted previously, the movement is responding to this perpetual need for changes and enhancements by reestablishing the mechanisms by which changes are incorporated and distributed.

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Exercises

1. What is the current version of LEED-NC and when was it adopted?

2. Download the errata for LEED-NC 2.2. Separate errata into two categories, errata to the rating system and errata to the Reference Guide only. Incorporate these errata into appropriate sections of this text.

3. Update Table 1.1.1 with the current status of the rating systems listed, and add other or modified rating systems from the USGBC website www.usgbc.org.

4. Update Table 1.2.1 as to the current status of the guidances. Are there additional guidances mentioned on the USGBC website?

5. What are the categories in the BREEAM rating system?

6. What is the current status of the Green Globes rating system? What are the categories in this system?