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Sustainable Building Rating Systems Summary

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Executive Summary

The market place of the design and construction of high performance buildings is dynamic and evolving. Professionals through out the building industry use assessment rating systems to evaluate and differentiate their product or design. GSA is a significant participant in the building industry and it is critical for GSA to evaluate the performance of projects. Since 2003, all GSA projects are to use and achieve a certified rating from the U.S. Green Building Council's Leadership in Enviromental and Energy Design (LEED®) green building rating system. In order to keep pace with the evolving and developing rating systems available, Section 609 of the Transportation, Treasury, Housing and Urban Development, the Judiciary, the District of Columbia, and Independent Agencies Appropriations Act, 2006 (PL109-115, signed November 30, 2005), states: "… the Administrator shall report to the relevant congressional committees of jurisdiction on the progress and next steps toward recognition of other credible sustainable building rating systems within the U.S. General Services Administration (GSA) sustainable building procurement process." This summary document was prepared to offer information on sustainable building rating systems for GSA's consideration in their response to this request. This document does not provide a recommendation for GSA but rather a summary of the information found for each sustainable building rating system.

GSA buildings are typically built for a 100 year life following stringent guidelines to enhance the asset value. GSA's Design Excellence program compels design teams to create the highest quality buildings. It is commonly recognized that a whole building, integrated design approach upholds a sustainable or green building design, which in turn provides the optimal performance for the desired design goals. Sustainable design tools used for GSA projects must set parameters to improve quality, decrease the life cycle environmental impact, and optimize life cycle costs of the buildings. The tools must support long-term performance for an innovative and flexible future. GSA must evaluate its buildings consistently using one system in order that the projects can be compared equally with other GSA buildings, other Federal buildings, and the U.S. building market. Using one sustainable building rating system allows for comparisons and benchmarking of existing buildings as well as a mechanism to track GSA's progress toward designing and operating the best buildings for their occupants.

The information compiled in this document was collected from January 15 – May 1, 2006 through literature reviews and internet available information. Information was also provided directly from the rating system owners. Sustainable building rating systems evolve, therefore a time frame was used to create absolute boundaries. The rating systems change frequently to adjust to the market which makes capturing the current state behind the scenes a challenge. Although publicly available information and rating system provided information do not tell "the whole story", this is documentable information for the rating system selection process. Additionally, there are green building experts that can offer anecdotal information on their experience with these rating systems. This type of information was not solicited or included due to the challenge of ensuring a balanced and currently accurate review.

This summary is organized in sections which sequentially collect, narrow and filter the building rating system information to those which would be fitting for GSA's business objectives. Section I positions the purpose of the document. Section II lists the numerous systems that were found during the search for whole building analysis tools. This search identified many tools that were not applicable to the review but known in the buildings' industry. Appendix B lists these tools for reference. Additionally, in Section II, the list of building rating systems is shortened by combining rating systems with multiple country applications or systems that were tailored from other applications. Next, Section III outlines the screening criteria used to narrow down the review to rating systems that would be potentially usable to GSA. Section IV further narrows the summary by defining the GSA drivers for sustainable design and rating systems which were used to develop review criteria. Section V specifically defines the review criteria to filter each rating system's features. Section VI provides summary descriptions of each rating system which advanced through the screening analysis. Subsequently, Section VII presents the quantifiable and comparable information for the five selected sustainable building rating systems. Finally, the document summary in Section VIII provides a brief highlight of the information found for each of the selected rating systems but, as noted above, does not offer recommendations.

The review criteria of were defined to address GSA drivers for sustainable design and the use of a rating system. The Federal drivers include:

- Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (January 2006)
- Energy Policy Act of 2005 (July 2005), Public Law 109-58
- Office of Management and Budget Circular No. A-11, Section 55, "Energy and Transportation Efficiency Management" (2002)
- Executive Order 13123, "Greening the Government through Efficient Energy Management" (June 1999)
- Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition" (September 1998)

The criteria include the applicability to GSA project and building types, the system maturity and dependability, and the ability to clearly communicate the rating system results of various building types to multiple audiences. This review does not investigate the details of the technical basis and assumptions behind the rating systems. It does not compare the rating systems score to measured performance, nor does it consider the broader sustainability impact. It does not investigate the supporters or developers of the rating systems. It does not address the fact that the rating systems reflect the values and priorities of their developers and countries. It is understood that these are important considerations when selecting a sustainable building rating system; however the information included in this review was limited to address the current request of Section 609 of the Appropriations Act only.

The five rating systems which progressed through the screening criteria were:

- BREEAM (Building Research Establishment's Environmental Assessment Method)

- CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)
- GBTool
- Green Globes™ U.S.
- LEED® (Leadership in Energy and Environmental Design)

These rating systems require varying levels of specialized sustainable design knowledge to be effectively used. A brief summary of the information provided in the document for each rating system includes:

- BREEAM has a long track record in the United Kingdom, but it is not extensively used in the U.S. and it is difficult to obtain current information about the system. Based on the information available, it would not be applicable to all of the GSA project types, specifically tenant build-out for leases. BREEAM is updated annually; however, the current version is not publicly available for purchase and must be acquired through a licensed assessor. The licensed assessor organization determines the BREEAM rating based on quantifiable sustainable design achievements. Although most in the sustainable design profession are aware of BREEAM and many rating systems have used it as their development basis, the rating system results are neither used nor recognized by U.S. design professionals.

- CASBEE is a relatively new system developed for the Japanese market that is available in English, but has not been tested in the U.S. However, CASBEE is potentially applicable in the U.S. market and offers the unique "BEE approach" to representing the performance evaluation data. Based on the information available, it would not be applicable to all of the GSA project types, specifically tenant build-out. The system requires documentation of quantifiable sustainable design achievements which are assessed by trained, first-class architects, which have passed the CASBEE assessor examination. Major modifications are expected to be made to the system every year; however the process for those revisions is unknown. Fewer than 10 buildings have used the system and all of those are in Japan, thus it is relatively unknown in the U.S. market.

- GBTool is an international system that has been used to evaluate U.S. buildings for the Green Building Challenge, including one GSA building. With respect to applicability to GSA project types, GBTool would be applicable for all but tenant build out and operations and maintenance applications; however, an operations and maintenance version is under development. A third party team establishes the qualitative and quantitative measures that are used to evaluate sustainable design achievements and expected building performance. The system has undergone 4 updates since its inception in 1998, which occur based on the experiences gained through its use. Due to the flexibility inherent in the application of GBTool, it tends to require greater technical expertise to implement than other rating systems, which has limited its exposure in the U.S. market.

- Green Globes™ US was adapted from Green Globes Canada in 2004 and is the newest system considered in this review. Currently, the U.S. version is not available for all of the GSA project types; however, Green Globes™ US is developing tools that address the major renovation, tenant build-out, and operations and maintenance applications. The Green Building Initiative received accreditation as a standards developer by ANSI and is working toward developing Green Globes™ US as an official ANSI standard. Currently, sustainable design and construction information is submitted on-line for third-party verification, which is provided by a Green Building Initiative-approved and Green Globes trained professional. According to feedback provided by the Green Building Initiative, 6 regional assessors were expected to be trained by June 2006. Following the completion of the ANSI process, it is expected the third party verification process will be revised. The Green Globes™ US rating system was not consistently available on-line during the review period and the current version of the on-line rating system tool is still not available and no date is given for its expected completion. Although there has been much publicity around Green Globes™ US in recent years, according to feedback provided by the Green Building Initiative, 4 buildings have received Green Globes ratings and 63 buildings have registered, which means they may potentially pursue verification in the future.

- LEED® is currently the dominant system in the United States market and is being adapted to multiple markets worldwide. The currently available LEED® rating systems address all of the GSA building and project types. A *Product Development and Maintenance Manual* is publicly available which governs how changes are made to the LEED® rating systems. The steps followed for the development of U.S. Green Building Council rating system products include technical development by committee, pilot testing, public comment period, approval by council membership, and then release for public use. For the existing LEED® rating systems, minor updates can occur no more than once a year, while major updates are expected to occur on a 3-5 year cycle, and will follow a defined process including a public comment period. Documentation of the quantifiable sustainable design measures are provided to the U.S. Green Building Council, the developer of the LEED® rating system, for third-party verification. The assessors have been trained and must pass an assessor examination. More than 400 U.S. buildings have received LEED® ratings and more than 3400 buildings are registered and therefore potentially seeking certification. LEED® is not only the U.S. market leader, but is also the most widely use rating system by Federal and state agencies, which makes it easy to communicate a building's sustainable design achievements with others.

GSA will determine which rating system is the most appropriate sustainable building rating system available for evaluation of GSA projects using the following elements:

- A system that is applicable to the large scale and complexity of federal building projects.

- A stable rating system such that the evaluation of building performance is not subject to drastic change.
- A system which tracks quantifiable achievements in sustainable design and is third party verified by a qualified assessor.
- A system used in the current market with practitioner awareness.

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Sustainable Building Rating Systems Summary

I. Introduction

The purpose of this document is to offer information to compare and contrast sustainable building rating systems in response to Section 609 of the Transportation, Treasury, Housing and Urban Development, the Judiciary, the District of Columbia, and Independent Agencies Appropriations Act, 2006 (PL109-115, signed November 30, 2005), which stated: "… the Administrator shall report to the relevant congressional committees of jurisdiction on the progress and next steps toward recognition of other credible sustainable building rating systems within the U.S. General Services Administration (GSA) sustainable building procurement process." This document was prepared to offer information on sustainable building rating systems for GSA's consideration in their response to this request. This review does not:

- provide a recommendation for GSA but rather a summary of the information found for each sustainable building rating system
- investigate the details of the technical basis and assumptions behind the rating systems
- compare rating system scores to measured building performance,
- consider the broader implications of a sustainable society,
- investigate the supporters or developers of the rating systems, or
- address the fact that the rating systems reflect the values and priorities of their developers and countries.

The authors acknowledge that these are important considerations when selecting a sustainable building rating system; however the information included in this review were selected to address the current request.

World-wide there are hundreds of building evaluation tools that focus on different areas of sustainable development and are designed for different types of projects. These tools include life cycle assessment, life cycle costing, energy systems design, performance evaluation, productivity analysis, indoor environmental quality assessments, operations and maintenance optimization, whole building design and operations tools, and more.

For the purposes of this review, 'sustainable building rating systems' are defined as tools that examine the performance or expected performance of a 'whole building' and translate that examination into an overall assessment that allows for comparison against other buildings. For a rating system to add value to the sustainable design and/or operation of a building, it must offer a credible, consistent basis for comparison, evaluate relevant technical aspects of sustainable design, and not be over-burdensome to implement and communicate. In order to identify the most applicable rating systems for GSA projects, the following review approach was used:

1. Identification of sustainable building rating systems
2. Screening analysis of rating systems to limit review to most applicable systems *(screening criteria)*
3. Identification of GSA drivers for a credible rating system *(review criteria)*
4. Data collection on applicable rating systems for comparative review

5. Review of the merits of applicable rating systems as they apply to the GSA procurement processes

Federal requirements and GSA's values and goals guide their decisions on sustainable design. The Federal regulatory drivers include the Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (January 2006), Energy Policy Act of 2005 (July 2005), Office of Management and Budget Circular No. A-11, Section 55, "Energy and Transportation Efficiency Management" (2002), Public Law 109-58, Executive Order 13123, "Greening the Government through Efficient Energy Management" (June 1999), and Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition" (September 1998). GSA's fiscal year 2006 values and goals include the continued focus on results orientation and maintaining world class workforces and workplaces. GSA is committed to designing, building, and operating high performance, sustainably designed buildings. This is clearly stated in the GSA facilities standards for the public building service and is exemplified by the incorporation of sustainable design strategies throughout the document. A sustainable building rating system is one of the tools that facilitates consistent application of sustainable design principles and serves as a measure of accomplishment.

More than 30 potentially useful whole building tools/systems were identified for this review, however most of them did not meet GSA's basic requirements or were variations of the same systems. Screening criteria were developed to narrow down the list of sustainable building rating systems to those where a more detailed review would offer a useful comparison of tools. Five sustainable building rating systems were examined more thoroughly using review criteria to provide a structure for the comparison between systems.

II. Sustainable Building Rating Systems

Literature reviews, internet searches, and a presentation from Greenbuild 2005 co-authored by GSA (Boecker, et al., 2005) were utilized to identify currently marketed sustainable building rating systems (see Appendix A for the list of references used to perform this review). Rating system documentation that was identified and publicly available during the time period of January 15, 2006 through May 1, 2006 was used for this review. As an illustration of the necessity to create time boundaries, during the review time period two of the systems made significant changes to their primary webpages and many features were identified as under development. It is recognized that there are planned updates to various rating systems, however for the purpose of this review only the active attributes were considered. Some systems found in the literature review were immediately determined to be not appropriate and are listed in Appendix B along with the reason they were eliminated from the analysis. Table 1 contains an alphabetical list of whole building assessment tools that were considered at the beginning of this review (column one). Column two offers the known development basis for each of those tools.

Table 1. Rating System Source(s)	
Sustainable Building Rating Systems	**Development Basis**
BREEAM (Building Research Establishment's Environmental Assessment Method)	Original
BREEAM Canada	BREEAM
BREEAM Green Leaf	BREEAM, Green Leaf™
Calabasas LEED	LEED®
CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)	Original
CEPAS (Comprehensive Environmental Performance Assessment Scheme)	LEED®, BREEAM, HK-BEAM, IBI
Earth Advantage Commercial Buildings (Oregon)	Undisclosed
EkoProfile (Norway)	Undisclosed
ESCALE	Undisclosed
GBTool	Original
GEM (Global Environmental Method) For Existing Buildings (Green Globes) – UK	Green Globes Canada
GOBAS (Green Olympic Building Assessment System)	CASBEE, LEED®
Green Building Rating System – Korea	BREEAM, LEED®, BEPAC
Green Globes Canada	BREEAM Green Leaf
Green Globes™ US	Green Globes Canada
Green Leaf Eco-Rating Program	Original
Green Star Australia	BREEAM, LEED®
HK BEAM (Hong Kong Building Environmental Assessment Method)	BREEAM
HQE (High Environmental Quality)	Undisclosed
iDP (Integrated Design Process)	Original
Labs21	Original
LEED® (Leadership in Energy and Environmental Design)	Original
LEED Canada	LEED®
LEED India	LEED®
LEED Mexico	LEED®
MSBG (The State of Minnesota Sustainable Building Guidelines)	LEED®, Green Building Challenge '98, and BREEAM
NABERS (National Australian Built Environment Rating System)	Undisclosed
PromisE	Undisclosed
Protocol ITACA	GBTool
SBAT (Sustainable Buildings Assessment Tool)	Original
Scottsdale's Green Building Program	Undisclosed
SPiRiT (Sustainable Project Rating Tool)	LEED®
TERI Green Rating for Integrated Habitat Assessment	Original
TQ Building Assessment System (Total Quality Building Assessment System)	Original

Many of the systems listed in column one were created by modifying a single system, or integrating multiple systems. Rating systems that were created using other systems and rating systems that had multiple country applications were merged for the screening analysis. For multiple country applications, if there was a rating system developed for a United States use, that system was selected for comparison. If no U.S.

system was available, systems from the United Kingdom or Canada were selected for comparison (when available). When these options were not available, the original system was selected for comparison. Systems where the basis was not apparent or where other groupings were not valid were considered separately. The rating systems highlighted in bold are the rating systems that were screened further. References used to research the rating systems identified in this document can be found in Appendix A.

III. Screening Analysis of Rating Systems

As each of these rating systems was researched it became evident that many of them did not fit the sustainable building rating system needs of GSA. Therefore screening criteria were identified in order to concentrate the review on the systems that had the greatest potential of addressing GSA needs. The screening criteria include:

- Relevance: Does the rating system provide a "whole building evaluation" rather than an evaluation of an individual design feature?
- Measurable: Does the rating system use measurable characteristics to demonstrate the extent of sustainable design incorporated into the building?
- Applicability: Can the rating system be used on all of the types of commercial buildings that GSA builds or leases (e.g., offices, courthouses, and border stations)?
- Availability: Is the rating system easily adaptable to the U.S. market or currently available for use in the U.S. market?

As mentioned previously, there is also a list of sustainable building related tools that were eliminated prior to the screening analysis provided in Appendix B. For each of the unique sustainable building rating systems identified in Table 2, the screening analysis was performed. The results are shown in Table 2.

Key	
✓	Does Meet Criterion
-	Does Not Meet Criterion
(blank)	Information Unknown

Table 2. Rating Systems Screening Criteria Scores

Rating System Name	Relevance	Measurable	Applicability	Availability
BREEAM	✓	✓	✓	✓
CASBEE	✓	✓	✓	✓
CEPAS	✓	✓	✓	-
Earth Advantage Commercial Buildings	✓		-	✓
EkoProfile	✓	✓	-	-
ESCALE	✓	✓		-
GBTool	✓	✓	✓	✓
GOBAS	✓	✓	-	-
Green Building Rating System	✓		-	-

Table 2. Rating Systems Screening Criteria Scores				
Rating System Name	**Relevance**	**Measurable**	**Applicability**	**Availability**
Green Globes™ US	✓	✓	✓	✓
Green Leaf™	✓		-	✓
Green Star	✓	✓	-	✓
HQE	✓		✓	-
iDP	✓	-	✓	✓
Labs21	✓	✓	-	✓
LEED®	✓	✓	✓	✓
MSBG	✓		✓	✓
NABERS	✓	✓	-	✓
PromisE	✓	-	-	-
SBAT	✓	✓	-	-
Scottsdale's Green Building Program	✓	✓	✓	-
TERI	✓	✓	✓	-
TQ Building Assessment System	✓		✓	-

Five sustainable building rating systems scored positively on all of the screening criteria (see Table 3). Each of the systems in Table 3 has been considered more thoroughly using the review criteria defined in Section V.

Table 3. Applicable Rating Systems after Screening Criteria
BREEAM (Building Research Establishment's Environmental Assessment Method)
CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)
GBTool
Green Globes™ US
LEED® (Leadership in Energy and Environmental Design)

Only two of these systems have a U.S. specific version, Green Globes™ US and LEED®. Green Globes™ US was developed based on Green Globes Canada. The Green Globes™ US version is being used in the comparison since it has been developed specifically for this market. As for the other systems, BREEAM does not have a U.S. version but has been applied minimally in the U.S.; GBTool can be and has been applied to the U.S. market; and CASBEE is available in English and offers an additional comparison from an international perspective. For the rating systems that did not score positively on all of the screening criteria, many still held innovative approaches that may be of interest to GSA. Some of the systems, such as the Australian Green Star Environmental Rating System are developing modules that will broaden their applicability to GSA in the future, but were not ready for consideration in this review. A summary description of each of the ratings systems in Table 3 can be found in Section VI. A comparison based on the review criteria can be found in Section VII. For purposes of comparing the development and technical content of the

rating systems, only the "new construction" versions of each rating system were used, unless otherwise noted.

IV. GSA Drivers for Sustainable Design and Use of a Rating System

In order to establish review criteria for the rating systems that are consistent with GSA's drivers for applying a rating system, Federal regulatory drivers as well as agency and program goals related to the design and operation of sustainable buildings are identified and summarized in this section. Those drivers include:

- Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (January 2006)
- Energy Policy Act of 2005 (July 2005), Public Law 109-58
- Office of Management and Budget Circular No. A-11, Section 55, "Energy and Transportation Efficiency Management" (2002)
- Executive Order 13123, "Greening the Government through Efficient Energy Management" (June 1999)
- Executive Order 13101, "Greening the Government through Waste Prevention, Recycling, and Federal Acquisition" (September 1998)
- GSA Mission, Values, Priorities (Fiscal Year 2006 (FY06))
- GSA Sustainable Design Program Goals (FY06)

Other environmental laws applicable to the GSA include the National Environmental Policy Act (NEPA, 1969), the Clean Air Act (CAA, 1990), the Resource Conservation and Recovery Act (RCRA, 1976), Executive Order 13134 "Developing and Promoting Biobased Products and BioEnergy" (EO13134, 1999), and Executive Order 13148 "Greening the Government through Leadership and Environmental Management" (EO13148, 2000). These laws do not specifically mention sustainable design, but support the Agency's environmental ethic.

In January 2006, a Memorandum of Understanding was signed by 19 Federal agencies, including GSA. It states the Federal government commitment to "designing, locating, constructing, maintaining, and operating its facilities in an energy efficient and sustainable manner that strives to achieve a balance that will realize high standards of living, wider sharing of life's amenities, maximum attainable reuse and recycling of depletable resources, in an economically viable manner, consistent with Department and Agency missions." The use of "life cycle concepts, consensus-based standards, and performance measurement…" is encouraged, when appropriate.

The Energy Policy Act states that if life cycle cost effective, "sustainable design principles are applied to the siting, design, and construction of all new and replacement buildings" (Section 109. Federal Building Performance Standards, page 51) and each building project will "comply with third party certification standards for high-performance, sustainable buildings." The Energy Policy Act also sets the current energy efficiency goals for Federal agencies, previously stated in Executive Order 13123.

The Office of Management and Budget Circular A-11 Section 55 was established to document "funding requested for energy efficiency management as required by

Executive Order 13123…". In the guidance for completing the table for energy efficiency data it is recommended that a sustainable building rating system be used and it is stated that although sustainable design can be incorporated at no additional cost, if additional costs are incurred, they need to be reported.

Executive Order 13123 Section 403 (d) Sustainable Building Design, GSA and DOD were directed to "develop sustainable design principles [and apply those] principles to the siting, design, and construction of new facilities." Agencies are guided to "optimize life-cycle costs, pollution, and other environmental and energy costs associated with the construction, life-cycle operation, and decommissioning of the facility." The "sustainable design principles" were developed by GSA, DOD, and other Federal agencies and are included in the Sustainable section of the Whole Building Design Guide (WBDG). (WBDG, 1999 & 2006) The sustainable design principles, processes, management practices, and recommendations found on this webpage offer a centralized, objective resource for the comparative review of the rating systems. The principles are used later in the document when the technical content is compared, and include: optimizing site potential, optimizing energy use, protecting and conserving water, using environmentally preferable products, enhancing indoor environmental quality, and optimizing operational and maintenance practices. Also in Section 403 (e), it states that built-to-lease solicitations shall include sustainable design and development principles.

Executive Order 13101, in its section on Acquisition Planning (Section 401), guides material selection for building design projects to address the elimination of virgin material requirements, use of bio-based products, use of recovered materials, reuse of products, life cycle cost, recyclability, and the use of environmentally preferable products.

GSA is committed to designing, building, and operating high performance, sustainably designed buildings. This is clearly stated in the GSA facilities standards for the Public Buildings Service and is exemplified by the incorporation of sustainable design strategies throughout the document. As it applies to sustainable design and development, the GSA FY06 Mission, Values, Priorities state the Agency will have a "results orientation" providing the best value for customer agencies and taxpayers, while operating efficiently and maintaining a world class workplace. The Sustainable Design Program goals address the Agency's strategic goals by:

- Providing tools and guidance applicable to existing buildings to better incorporate sustainable design principles.
- Strengthening sustainable design and development contracting language within the leasing program and support the implementation of green leases.
- Being identified as a trusted sustainable design advisor for new design and construction projects in order to expand the success of GSA projects.
- Assisting with building performance metrics to demonstrate the value of high performance, sustainable buildings.
- Communicating approaches to create world class workplaces using integrated, sustainable design principles.

- Continuing to be a sustainable design resource to other public entities.

These Federal regulatory and GSA drivers have prompted the need to evaluate building design and operation in a consistent, credible manner which can be documented and communicated clearly to a wide audience. Sustainable building rating systems are the current tool available in the market to meet these needs.

V. Review Criteria for Applicable Rating Systems

The screening criteria used in Section III were used to focus the review on a set of potentially applicable sustainable building rating systems (Table 3). The review criteria defined in this section will be used to offer review information for each of the applicable ratings systems. Using the above Federal and GSA drivers for sustainable design, seven sustainable building rating system review criteria were identified (detailed definitions provided in Table 4):

1. Applicability – for a rating system to address Executive Order 13123 guidance, the Energy Policy Act of 2005 and the GSA goals it needs to be usable on all of its project and building types.
2. Development – for the rating system to be aligned with the Memorandum of Understanding, the use of life cycle concepts, consensus-based standards, and performance measurement is encouraged.
3. Usability – for the rating system to be applied effectively for all of the GSA building types and projects, it needs to be relatively simple and practical to use.
4. System Maturity – for the rating system to address the GSA goal of being a trusted advisor on sustainable design projects, the system needs to be dependable, have a proven track record, and be endorsed by respected organizations.
5. Technical Content – for the rating system to address the Memorandum of Understanding, the Energy Policy Act, and Executive Order 13101, the system needs to address the primary areas of sustainable design – siting, energy use, water use, indoor environmental quality, and materials selection.
6. Measurability & Verification – for the rating system to address the Energy Policy Act guidance to comply with third party certification standards and the GSA goal for assisting with performance metrics, the system needs to have a standardized, verifiable system for documenting sustainable design related performance.
7. Communicability – for the rating system to address the GSA goal of being able to communicate their sustainable design approaches for creating world class workplaces in a corporate reporting style, the results needs to be versatile across building and project types, well-known by outside organizations, and easy to understand.

These criteria also contribute to the credibility of the rating system. It is critical to understand the basis of the rating systems in order to explain it to others and ensure the sustainable design environmental performance goals are being met when desired ratings are achieved. Other credibility considerations for sustainable building rating systems include measurements of environmental impacts, development and ownership by legitimate organizations, and having a proven track record of success. (Cole, 2001)

Table 4. Review Criteria
Applicability Type of Projects: Rating system can be used on all GSA project types, such as New Construction, Major Renovations, Tenant Build-Out (leases), and Operations & Maintenance. Type of Buildings: Rating system can be used on all GSA building types, such as Office Buildings, Courthouses, and Border Stations.
Development System Management: Identify the level of involvement in the development, funding, and management of the rating system by Government, Private Industry, Non-Governmental Organizations, and others. Development Approach: Identify if system was developed using a consensus-based approach, life cycle analysis, expert opinion approach, or other. Openness of Operations: Ability to gather information on the rating system membership and represented organizations. Transparency of Rating System: Ability to access relevant information either from the internet or other sources.
Usability Cost: Identify the cost of using a system, including cost for use or rating system materials, cost of project registration, fees associated with certification, and time typically needed to complete an application. Ease of Use: Complexity of the tools and technical knowledge needed to complete rating system process, especially for the optimization of energy use, environmentally preferable products use, and indoor environmental quality enhancement. Product support: Availability and responsiveness of direct requests for assistance, availability of training, and usability of information available on the website, through case studies, documented inquiries, and frequently asked questions.
System Maturity System Age: Identify when the rating system was developed, first used, first available for public use, and when the most recent revision was completed. Number of Buildings: Identify the number of buildings participating in the rating system and the number of buildings that have completed the process for denotation as a green building. Stability of system: Identify the processes that allow for full implementation of a rating system, including development, testing, and review process, systems for upgrades, process for modifications, and expected frequency of modifications.
Technical Content Relevance to Sustainability: Representative of sustainable design needs of the Federal government as identified in the Whole Building Design Guide. Thoroughness: Detailed review of how rating system addresses key sustainable design characteristics such as optimizing Energy Use, using Environmentally Preferable Products, and enhancing Indoor Environmental Quality (IEQ). Measurement comparison: Identify the mechanism used as the baseline for comparison, such as industry benchmark or checklist.
Measurability & Verification Standardization: Established collection procedures exist. Quantification: Numeric measurements facilitate absolute and relative performance evaluation. Certification/Verification Process: Define system for verifying sustainable design practices for a particular application, including who evaluates the application and at what level of detail do they review the applications. Documentation: Identify what type of documentation is necessary and at what stages of the project the information is collected. Verifiable/Defendable: Provide documentation of the actual state of the building with respect to the rating system evaluation; include costs and benefits of using the rating system.
Communicability Clarity: Well-defined, easily communicated, and clearly understood among multiple parties. Versatility: Number of systems that use it as its basis for development or comparison.

Table 4. Review Criteria
Comparability: Amenable to normalization for comparisons over varying building types, locations, years, or different sustainable design characteristics. Results Usability: Usability of rating system documentation for communicating the accomplishments of the building project.

Where available, information on each of these review criteria was collected for the five rating systems being compared in this document.

VI. Rating System Summaries

Summaries of these five sustainable building rating systems and visual examples of their output are offered in alphabetical order in this section.

BREEAM

BREEAM (Building Research Establishment's Environmental Assessment Method) was developed in the United Kingdom in 1990 and is the building environmental assessment method with the longest track record. BREEAM covers a range of building types including: offices, homes, industrial units, retail units, and schools. Other building types can be assessed using Bespoke BREEAM ("bespoke" is another word for custom-made). When a building is assessed, points are awarded for each criterion and the points are added for a total score. The overall building performance is awarded a "Pass", "Good", "Very Good" or "Excellent" rating based on the score.

BREEAM major categories of criteria for Design and Procurement include the following:

- Management (commissioning, monitoring, waste recycling, pollution minimization, materials minimization)
- Health & Wellbeing (adequate ventilation, humidification, lighting, thermal comfort)
- Energy (sub-metering, efficiency and CO_2 impact of systems)
- Transport (emissions, alternate transport facilities)
- Water (consumption reduction, metering, leak detection)
- Materials (asbestos mitigation, recycling facilities, reuse of structures, facade or materials, use of crushed aggregate and sustainable timber)
- Land Use (previously used land, use of remediated contaminated land)
- Ecology (land with low ecological value or minimal change in value, maintaining major ecological systems on the land, minimization of biodiversity impacts)
- Pollution (leak detection systems, on-site treatment, local or renewable energy sources, light pollution design, avoid use of ozone depleting and global warming substances)

The figures below show sample reporting and certification pages found on-line for a BREEAM example. References consulted for this review of BREEAM included: AggRegain, 2006a-c; BREEAM, 2006; BRE Ltd., 2006; Cole, 2001; FABER MAUNSELL, 2006; Federation of Master Builders, 1999; Peter & Somervell, 2004; and LACC, 2005.

BREEAM Offices 2005 - Design & Procurement Assessment tool

Design Stage Assessment Results

BREEAM Rating: Example 1	Good

Core & Design & Procurement Credit Allocation Table

Overall Credit Allocation	Env Weighting	Available	Achieved	Percentage section credits achieved	Overall Weighted Percentage
Management	15%	10	5	50.00%	7.50%
Health & Wellbeing	15%	15	8	53.33%	8.00%
Energy		17	9	52.94%	
Transport		14	7	50.00%	
Energy & Transport	25%	31	16	51.61%	12.90%
Water	5%	6	4	66.67%	3.33%
Materials	10%	12	4	33.33%	3.33%
Land Use & Ecology	15%	11	6	54.55%	8.18%
Pollution	15%	12	6	50.00%	7.50%
				Totals	50.75%

BRE BREEAM

BREEAM Offices 2005 - Design & Procurement Assessment tool

Design Stage Assessment Results

BREEAM Rating: Example 1	Good

BREEAM Rating	% Benchmark
Unclassified	<25
Pass	≥25 - <40
Good	≥40 - <55
Very Good	≥55 - <70
Excellent	≥70

CASBEE

CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) was developed in Japan, beginning in 2001. The family of assessment tools is based on the building's life cycle: pre-design, new construction, existing buildings, and renovation. CASBEE presents a new concept for assessment that distinguishes environmental load from quality of building performance. By relating these two factors, CASBEE results are presented as a measure of eco-efficiency or BEE (Building Environmental Efficiency). Results are plotted on a graph, with environmental load on one axis and quality on the other – the best buildings will fall in the section representing lowest environmental load and highest quality. Each criterion is scored from level 1 to level 5, with level 1 defined as meeting minimum requirements, level 3

defined as meeting typical technical and social levels at the time of the assessment, and level 5 representing a high level of achievement. The CASBEE Technical Manual presents detailed definitions of each level for each criterion and includes reference material and calculation tools where needed.

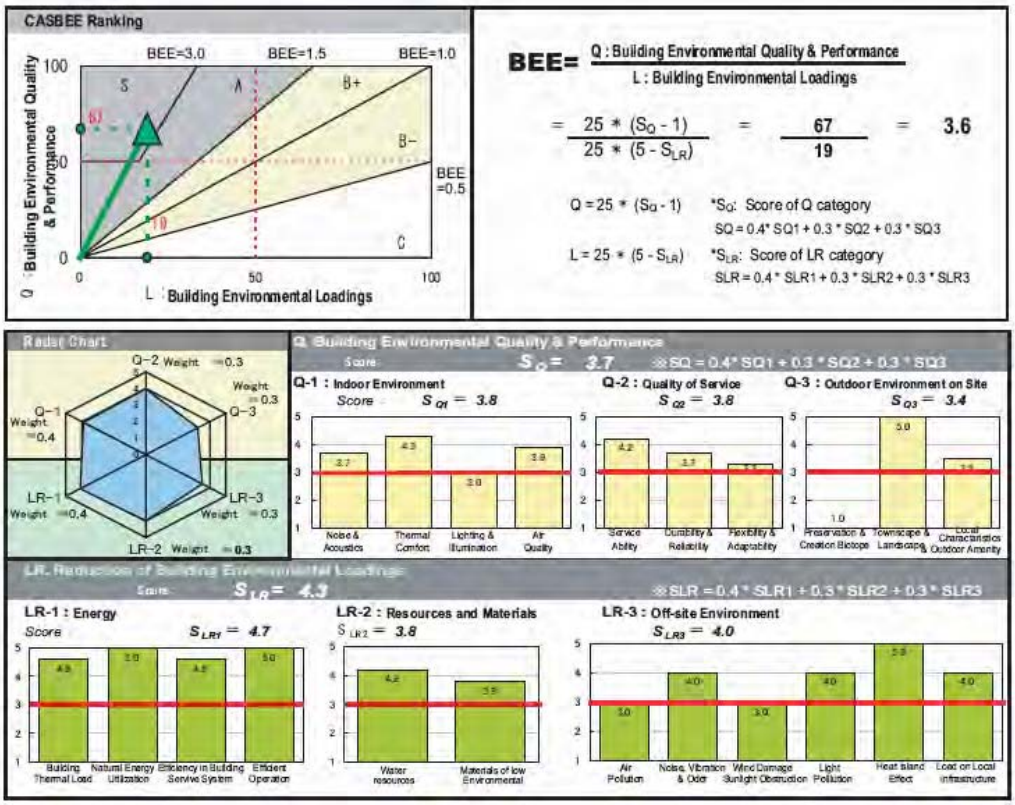
CASBEE major categories of criteria include the following:
Building Environmental Quality and Performance

- Indoor environment (noise and acoustics, thermal comfort, lighting and illumination, and air quality)
- Quality of services (functionality and usability, amenities, durability and reliability, flexibility and adaptability)
- Outdoor environment on site (preservation and creation of biotope, townscape and landscape, and outdoor amenities)

Building Environmental Loadings

- Energy (thermal load, use of natural energy, efficiency of systems, and efficient operations)
- Resources and materials (water conservation, recycled materials, sustainably harvested timber, materials with low health risks,
- Reuse and reusability, and avoidance of CFCs and halons)
- Off-site environment (air pollution, noise and vibration, odor, sunlight obstruction, light pollution, heat island effect, and local on local infrastructure)

Below is an example of CASBEE reporting documentation. References consulted for this review of CASBEE included: PC IBEC, 2006; CASBEE, 2004; CASBEE, 2006; JSBC, 2005; Murakami, 2003; CASBEE brochure; and HK Buildings Department, 2005.



GBTool

GBTool was developed by the International Framework Committee for the Green Building Challenge, an international project that has involved more than 25 countries since 1998. GBTool is designed to be adapted by sponsors to reflect regional conditions and context. It includes criteria in categories such as Site Selection, Project Planning and Development; Environmental Loadings; Energy and Resource Consumption; Indoor Environmental Quality; Functionality; Long-Term Performance; and Social and Economic Aspects. Criteria are assessed using scales that are based on local benchmarks of "typical" practice; buildings can score -1 if below typical practice or from +1 to +5, representing good to very high performance. All criteria must be scored, thus providing a complete assessment of the building. Both benchmarks of typical practice and weightings of criteria are established by the sponsoring organization to represent national, regional, or local codes, practice, context, conditions, and priorities. GBTool has evolved over time as it has been tested by participating countries and results have been presented at a series of international conferences. Originally addressing only an as-designed assessment, GBTool is developing versions to address pre-design, design, as built, and operations. The tool itself comprises two spreadsheets, one for data entry (to be completed by the project team) and one for establishing weights and benchmarks and completing the assessment (to be completed by third party sponsors or assessors).

GBTool major categories of criteria include the following:

- Energy consumption is assessed through total use of non-renewable energy (embodied and operational), electrical peak demand for operations, use of renewable energy, and commissioning.
- Resource consumption is assessed through materials use (salvaged, recycled, bio-based and sustainably harvested, locally produced, designed for disassembly, re-use, or recycling) and water use for irrigation, building systems, and occupant use.
- Environmental loadings include greenhouse gas emissions, other atmospheric emissions, solid wastes, stormwater, wastewater, site impacts, and other local and regional impacts.
- Indoor environmental quality is assessed through indoor air quality, ventilation, temperature and relative humidity, daylight and illumination, and noise and acoustics.
- Other criteria include selection of appropriate site (in terms of land use, brownfields, access to transportation and amenities), project planning, urban design (density, mixed uses, compatibility, native plantings, and wildlife corridors), building controls, flexibility and adaptability, maintenance of operating performance, and a few social and economic measures.

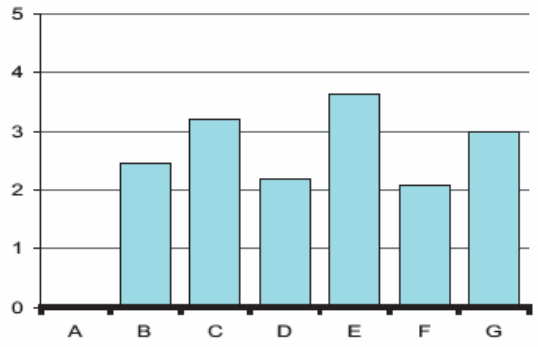
Below is an example of GBTool documentation. References consulted for this review of GBTool included: PC GBTool, 2006; GBTool 1998, 2000, 2002, 2005; Todd, et al, 2001; GBC 1998; and SB, 2000, 2002, 2005.

Results for SHIIODOME TOWER, Tokyo, Japan

Actual performance results based on information available during Operations Phase	*Active Phase (set in Module A)*	**Operations Phase**

Relative Performance Results

0 = Acceptable Practice; 3 = Good Practice; 5 = Best Practice



Performance Issue Areas

Scores for Operations are based on measurement of actual performance and on verification that certain measures planned earlier have actually been undertaken.

Key Facts About This Project

This project occupancy type(s) includes Office Occupancy and Retail Occupancy. The total gross area of the project is 78043 m2, in a building that has 38 floors above grade. The building is new construction only.			
Assumed life span is 100 years. Monetary units are in Yen	Amortization rate for embodied energy of existing materials is set at 0 percent.		
	There is no existing building on the site that can be re-used.		
With current context and building data, the number of active low-level parameters is:	42	Max. potential low-level parameters:	50
The number of low-level mandatory parameters with a score of less than 2 is:	8	Active low-level mandatory parameters:	12
To see a full list of issues go to the Issues worksheet; to alter weights, go to the Weights worksheets.		Active Weights	Weighted scores
A	Site Selection, Project Planning and Development	0%	0.0
B	Energy and Resource Consumption	24%	2.5
C	Environmental Loadings	19%	3.2
D	Indoor Environmental Quality	19%	2.2
E	Functionality and Controllability of Building Systems	14%	3.6
F	Long-Term Performance	14%	2.1
G	Social and Economic aspects	10%	3.0
Total weighted building score			2.7

Green Globes™ US

Green Globes™ US was adapted from the Green Globes Canada rating system in 2004. Green Globes Canada was developed as a web-based version of the combination of BREEAM Canada and Green Leaf. The development of Green Globes™ US is funded by The Green Building Initiative. The Green Globes™ US system is an on-line tool designed for use by architects and builders for any size commercial building. The preliminary assessment occurs after conceptual design and the final assessment occurs after the construction documentation stage. Green Globes allows its users to evaluate their systems based on the amount of applicable available points, having the option of "not applicable" in some categories. Projects that are third-party verified and have achieved over 35% of the points can earn a rating of 1 to 4 Green Globes. Unless otherwise noted, this review used the text form of Green Globes™ US Version 1.0 (April 2006 release). Version 0 was the text form version available when this review began, and as of May 2006, Version 0 is the only version available for on-line interactive use. During the rating system review, there was a period of time (approximately 6 weeks) when no text form of a rating system was available on-line.

Green Globes major categories of criteria include the following:

- Project Management (integrated design, environmental purchasing, commissioning, emergency response plan)
- Site (site development area, reduce ecological impacts, enhancement of watershed features, site ecology improvement)
- Energy (energy consumption, energy demand minimization, "right sized" energy-efficient systems, renewable sources of energy, energy-efficient transportation)
- Water (flow and flush fixtures, water-conserving features, reduce off-site treatment of water)
- Indoor Environment (effective ventilation systems, source control of indoor pollutants, lighting design and integration of lighting systems, thermal comfort, acoustic comfort)
- Resource, Building Materials and Solid Waste (materials with low environmental impact, minimized consumption and depletion of material resources, re-use of existing structures; building durability, adaptability and disassembly; and reduction, re-use and recycling of waste)

Below is an example of Green Globes Version 0 documentation found on-line of a Canadian building. References consulted for this review of Green Globes included: PC GBI, 2006; ECD, 2002; ED+C, 2005; GBI, 2006a-c; Green Globes a-b; and Issaquah Highlands, 2006.

LEED®

LEED® (Leadership in Energy and Environmental Design) was developed and piloted in the U.S. in 1998 as a consensus-based building rating system based on the use of existing building technology. The development of LEED® has been through the U.S. Green Building Council member committees. The rating system addresses specific environmental building related impacts using a whole building environmental performance approach. In addition to LEED-NC (for new construction and major renovations), there are versions for existing buildings, commercial interiors, core and shell, homes, and neighborhood development. There are also application guides that can be used to increase the applicability and flexibility of LEED® (e.g., multiple buildings and campuses, schools, health care, laboratories, lodging, and retail (pilot)). Unless otherwise noted, this review used LEED-NC Version 2.2. The LEED Reference Guide presents detailed information on how to achieve the credits within the following major categories:

- Sustainable Sites (construction related pollution prevention, site development impacts, transportation alternatives, stormwater management, heat island effect, and light pollution)

- Water Efficiency (landscaping water use reduction, indoor water use reduction, and wastewater strategies)
- Energy and Atmosphere (commissioning, whole building energy performance optimization, refrigerant management, renewable energy use, and measurement and verification)
- Materials and Resources (recycling collection locations, building reuse, construction waste management, and the purchase of regionally manufactured materials, materials with recycled content, rapidly renewable materials, salvaged materials, and sustainably forested wood products)
- Indoor Environmental Quality (environmental tobacco smoke control, outdoor air delivery monitoring, increased ventilation, construction indoor air quality, use low emitting materials, source control, and controllability of thermal and lighting systems)
- Innovation and Design Process (LEED® accredited professional, and innovative strategies for sustainable design)

Below is an example of LEED® Version 2.0 documentation found on-line. References consulted for this review of LEED® included: PC USGBC, 2006; USGBC, 2004; USGBC, 2005; Lewis, Miranda, 2002; Scheuer, Keoleian, 2002; and USGBC, 2006.

SSA Child Care Center, LEED Project # 0265
LEED Version 2.0 Certification Level: CERTIFIED
Feb. 27, 2003

28 Points Achieved — Possible Points: 69

Certified 26 to 32 points | Silver 33 to 38 points | Gold 39 to 51 points | Platinum 52 or more points

6	Sustainable Sites — Possible Points: 14	
Y	Prereq 1	Erosion & Sedimentation Control
1	Credit 1	Site Selection 1
	Credit 2	Urban Redevelopment 1
	Credit 3	Brownfield Redevelopment 1
1	Credit 4.1	Alternative Transportation, Public Transportation Access 1
	Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms 1
	Credit 4.3	Alternative Transportation, Alternative Fuel Refueling Stations 1
	Credit 4.4	Alternative Transportation, Parking Capacity 1
1	Credit 5.1	Reduced Site Disturbance, Protect or Restore Open Space 1
1	Credit 5.2	Reduced Site Disturbance, Development Footprint 1
1	Credit 6.1	Stormwater Management, Rate and Quantity 1
	Credit 6.2	Stormwater Management, Treatment 1
	Credit 7.1	Landscape & Exterior Design to Reduce Heat Islands, Non-Roof 1
	Credit 7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof 1
1	Credit 8	Light Pollution Reduction 1

2	Water Efficiency — Possible Points: 5	
1	Credit 1.1	Water Efficient Landscaping, Reduce by 50% 1
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

5	Energy & Atmosphere — Possible Points: 17	
Y	Prereq 1	Fundamental Building Systems Commissioning
Y	Prereq 2	Minimum Energy Performance
Y	Prereq 3	CFC Reduction in HVAC&R Equipment
2	Credit 1.1	Optimize Energy Performance, 20% New / 10% Existing 2
2	Credit 1.2	Optimize Energy Performance, 30% New / 20% Existing 2
1	Credit 1.3	Optimize Energy Performance, 40% New / 30% Existing 2
	Credit 1.4	Optimize Energy Performance, 50% New / 40% Existing 2
	Credit 1.5	Optimize Energy Performance, 60% New / 50% Existing 2
	Credit 2.1	Renewable Energy, 5% 1
	Credit 2.2	Renewable Energy, 10% 1
	Credit 2.3	Renewable Energy, 20% 1
	Credit 3	Additional Commissioning 1
	Credit 4	Ozone Depletion 1
	Credit 5	Measurement & Verification 1
	Credit 6	Green Power 1

6	Materials & Resources — Possible Points: 13	
Y	Prereq 1	Storage & Collection of Recyclables
	Credit 1.1	Building Reuse, Maintain 75% of Existing Shell 1
	Credit 1.2	Building Reuse, Maintain 100% of Existing Shell 1
	Credit 1.3	Building Reuse, Maintain 100% Shell & 50% Non-Shell 1
1	Credit 2.1	Construction Waste Management, Divert 50% 1
1	Credit 2.2	Construction Waste Management, Divert 75% 1
	Credit 3.1	Resource Reuse, Specify 5% 1
	Credit 3.2	Resource Reuse, Specify 10% 1
1	Credit 4.1	Recycled Content, Specify 25% 1
1	Credit 4.2	Recycled Content, Specify 50% 1
1	Credit 5.1	Local/Regional Materials, 20% Manufactured Locally 1
1	Credit 5.2	Local/Regional Materials, of 20% Above, 50% Harvested Locally 1
	Credit 6	Rapidly Renewable Materials 1
	Credit 7	Certified Wood 1

7	Indoor Environmental Quality — Possible Points: 15	
Y	Prereq 1	Minimum IAQ Performance
Y	Prereq 2	Environmental Tobacco Smoke (ETS) Control
	Credit 1	Carbon Dioxide (CO_2) Monitoring 1
	Credit 2	Increase Ventilation Effectiveness 1
	Credit 3.1	Construction IAQ Management Plan, During Construction 1
1	Credit 3.2	Construction IAQ Management Plan, Before Occupancy 1
1	Credit 4.1	Low-Emitting Materials, Adhesives & Sealants 1
	Credit 4.2	Low-Emitting Materials, Paints 1
1	Credit 4.3	Low-Emitting Materials, Carpet 1
	Credit 4.4	Low-Emitting Materials, Composite Wood 1
1	Credit 5	Indoor Chemical & Pollutant Source Control 1
	Credit 6.1	Controllability of Systems, Perimeter 1
	Credit 6.2	Controllability of Systems, Non-Perimeter 1
1	Credit 7.1	Thermal Comfort, Comply with ASHRAE 55-1992 1
1	Credit 7.2	Thermal Comfort, Permanent Monitoring System 1
	Credit 8.1	Daylight & Views, Daylight 75% of Spaces 1
1	Credit 8.2	Daylight & Views, Views for 90% of Spaces 1

2	Innovation & Design Process — Possible Points: 5	
1	Credit 1.1	Innovation in Design: Exemplary Performance 38% Local Materials 1
	Credit 1.2	Innovation in Design: 1
	Credit 1.3	Innovation in Design: 1
	Credit 1.4	Innovation in Design: 1
1	Credit 2	LEED™ Accredited Professional 1

VII. Review of Applicable Rating Systems

The five sustainable building rating systems being reviewed in this document are listed in Table 3. Throughout the remainder of the document these systems will be referred to by its acronym or the shortest version of its title. As stated earlier, unless otherwise noted, the rating system information used for this review was identified and publicly available during January 15, 2006 through May 1, 2006. A brief description of each rating system was provided in Section VI. This section documents how each rating system meets the seven review criteria shown in Table 4.

The information for each rating system was initially gathered through publicly available and relatively easy to locate information using the internet, conference proceedings and journal articles. A review of the rating systems information was offered to both the rating system owners and known technical experts in sustainable building rating systems in order to identify additional information and to clarify information where needed. Rating system owner feedback was received from all of the rating system owners except for BREEAM although there were multiple requests and extended deadlines.

The following tables are organized by the review criteria. Quantifiable and comparable information was collected for each rating system. Where feasible, this information has been captured in data tables to allow for comparison and additional, relevant information is provided following the tables as appropriate. The key for the tables is the following:

Key	
✓	Does Meet Criterion
○	Under development
✓/-	Meets Criterion with Exception(s)
-	Does Not Meet Criterion
(blank)	Information Unknown
n/a	Not applicable

When the answer can be a simple "Does Meet Criterion" or "Does Not Meet Criterion" it is unlikely additional information will be provided below the tables. When the current information available results in an "Under development" or "Meets Criterion with Exceptions" response, there will be additional information provided below the tables.

Table 5 summarizes the data gathered for the Applicability review criterion.

Applicability

Type of Projects: Rating system can be used on all GSA project types, such as New Construction, Major Renovations, Tenant Build-Out (leases), and Operations & Maintenance.

Type of Buildings: Rating system can be used on all GSA building types, such as Offices Buildings, Courthouses, and Border Stations.

Table 5. Applicability

	Applicability						
	Type of Projects				Types of Buildings		
	New Construction	Major Renovations	Tenant Build-Out	Operations & Maintenance	Office Buildings	Courthouses	Border Stations
BREEAM	✓	✓	-	✓	✓	✓	✓
CASBEE	✓	✓	-	✓	✓	✓	✓
GBTool	✓	✓	-	○	✓	✓	✓
Green Globes US	✓	○	○	○	✓	✓	✓
LEED	✓	✓	✓	✓	✓	✓	✓

A Green Globes™ US module for existing buildings is in the pilot development stage, as an adaptation of the Green Globes Canada modules. According to The Green Building Initiative feedback, the Green Globes™ US existing buildings module is used for the major renovation, tenant build-out and operations and maintenance types of projects.

Although none of these sustainable building rating systems have specific modules for courthouses or border stations, all of the rating system documentation implied that the office version could be or has been used for these building types.

Table 6 summarizes the data gathered for the Development review criterion. A "✓" in the System Management column indicates if there was any development, funding, or management of the rating system by a particular entity. For example if a rating system had some private industry involvement but no direct private industry funding it would still receive a "✓".

Development

System Management: Identify the level of involvement in the development, funding, and management of the rating system by Government, Private Industry, Non-Governmental Organizations, and others.

Development Approach: Identify if system was developed using a consensus-based approach, life cycle analysis, expert opinion approach, or other.

Openness of Operations: Ability to gather information on the rating system membership and represented organizations.

Transparency of Rating System: Ability to access relevant information either from the internet or other sources.

Table 6. Development

	Development					
	System Management			Development Approach		
	Government	Private Industry	NGO	Consensus-based	Life Cycle Analysis	Expert Opinion
BREEAM		✓	✓			
CASBEE	✓/-	✓	✓	✓	✓/-	✓
GBTool	✓	-	✓	✓	✓	✓
Green Globes US	✓/-	✓	✓	○	✓/-	✓
LEED	✓	✓	✓	✓	○	✓

BREEAM was co-developed by the Building Research Establishment Ltd. (BRE) and ECD (now part of Faber Maunsell's Sustainable Development Group). CASBEE is managed by the newly-formed Japan Sustainable Building Consortium which is a non-governmental organization comprised of industry, the Japanese government, and academic members GBTool has been developed and revised by the International Framework Committee (IFC) composed of representatives of all participating countries (approximately 25 countries have been involved thus far), including the U.S. government. Green Globes™ US was developed from Green Globes Canada, funded by the Green Building Initiative. The Green Building Initiative is a Section 501(c)3 non-profit organization. Green Globes Canada is maintained by the Canadian Energy Efficiency Alliance. The Green Globes Canada copyright and trademark are owned by ECD Energy and Environment Canada. The adaptation of the Canadian tool to Green Globes™ US was initially completed by one individual. Government involvement has been Canadian, not U.S. LEED® has received U.S. government funding and was

developed by the U.S. Green Building Council member committees. The U.S. Green Building Council is a 501(c)3 non-profit organization.

The rating systems self-identified their development approach which resulted in each of them stating they used expert opinions and various levels of "consensus-based" development. The Green Building Initiative plans to follow ANSI approved procedures to make Green Globes™ US a consensus-based standard. An ANSI technical committee has been formed.

CASBEE has a mechanism for including life cycle analysis in the process as an optional assessment, but the life cycle analysis does not impact the primary Building Environmental Efficiency assessment. For GBTool, life cycle analysis (LCA) was used as the basis for materials criteria and embodied energy criteria in earlier versions; in the 2005 version, materials credits were based on attributes because many users did not have access to LCA data. According to the Green Building Initiative, Green Globes™ U.S. awards points in the Resources section for carrying out a life cycle assessment. Green Globes recommends using Athena at the Schematic Design Stage and BEES at the Construction Documentation Stage. The life cycle impact of design choices was considered in the development of LEED®, however, the inclusion of LCA into the LEED® rating systems is under development for Version 3.0.

Tables 7.1 and 7.2 summarize the data gathered for the Usability review criterion.

Usability

Cost: Identify the cost of using a system, including cost for use or rating system materials, cost of project registration, fees associated with certification, and time typically needed to complete an application.

Ease of Use: Complexity of the tools and technical knowledge needed to complete rating system process, especially for the optimization of energy use, environmentally preferable products use, and indoor environmental quality enhancement.

Product support: Availability and responsiveness of direct requests for assistance, availability of training, and usability of information available on the website, through case studies, documented inquiries, and frequently asked questions.

Table 7.1. Usability (1)

	Usability (1)							
	Cost			Product Support				
	Project Registration	Certification Fees	Time Est.	Case Studies	Record of Inquiries	FAQ	Training available	Available in English
BREEAM		$1,290 each stage		-	-	-	✓	✓
CASBEE	$0	$3,570 - $4,500	3-7 days	✓	✓/-	✓/-	✓	✓/-
GBTool	n/a	n/a		✓	-	-	-	✓
Green Globes US	$500	Avg $4000	5-7 days	✓	-	✓	✓/-	✓
LEED	$450	$1,250 - $17,500	7 weeks	✓	✓	✓	✓	✓

If using BREEAM, a maximum of $17,500 is the expected cost of the needed design and procurement assessments. GBTool requires "upfront" work to establish the

weighting factors, but once that is completed, the level of effort per building decreases. U.S. Green Building Council membership dues range from $300 to $12,500/year based on type of organization. The LEED® cost of applying the system is based on U.S. Green Building Council member prices and for LEED® Version 2.2, which are based on the size of the building. Certification fees for LEED® Versions 2.0 and 2.1 range from $1,200 to $6,000.

These rating systems require varying levels of specialized sustainable design knowledge to be effectively used. The time and cost associated with this specialized knowledge is an important consideration but it is not addressed as part of this analysis. For all of the systems, the time estimated to complete the rating system documentation depends on the knowledge level of the people involved and the complexity of the building. The costs and challenges of using a system are expected to be higher initially and decrease over time once the system is known by the design professionals (assuming no major rating system changes have occurred). GSA standards are high and documentation that buildings meet those standards is required. Therefore, the cost to prepare detailed documentation, specific to the rating system is considered a standard operating cost and is not a criterion for this review.

CASBEE has a record of inquiries and frequently asked questions (FAQs), but it is not currently available in English. Training is available in major Japanese cities. Some of the CASBEE information, such as case studies, is available in both English and Japanese, but other aspects of the system are not currently available in English. GBTool is typically applied by those that have been involved in the development; therefore there is no training available for its use. Green Globes™ US has a webpage dedicated to training, but the page was posted as “under development” during this rating system review (as of 5/1/06). In-person training has been performed and can be scheduled. LEED® Workshops, LEED® Topic Modules, web-based professional accreditation, project certification, and integrated design, and the Greenbuild conference are opportunities for LEED® related training. Greater than 30,000 people have been trained and the U.S. Green Building Council has 23,000 LEED® Accredited Professionals as part of their technical network.

Table 7.2. Usability (2)

	Usability (2)		
	Openness of Operations	Transparency of Rating System	
	Membership Numbers	How much information is available publicly?	Availability of Information that is not on-line (How to obtain?)
BREEAM		Assessment Prediction Checklists	E-mail address
CASBEE	✓	Rating system and manuals	E-mail help desk
GBTool	34+ Countries	All materials	-
Green Globes US	31 sponsor/paying organizations/ 5700 non-paying individuals	Rating System, Webcast, Test Drive, and FAQs	Contact form and E-mail addresses
LEED	>6000 paying organizations	Rating system, Checklist, Credit Interpretations, Application Guides, and FAQs	E-mail help desk and local/regional USGBC Chapters

There are various types of membership in the organizations sponsoring the systems – some have organizations as the member unit while others have individuals; some have free memberships, others have fees for memberships, and others have a combination of the two. BREEAM enrollment information was not found on-line, and as mentioned earlier, there was no response to requests for additional information. The CASBEE members list is available on-line. The Green Building Initiative has both organizational memberships for a fee and individual memberships that are free.

Table 8 summarizes the data gathered for the System Maturity review criterion.

System Maturity

System Age: Identify when the rating system was developed, first used, first available for public use, and when the most recent revision was completed.
Number of Buildings: Identify the number of buildings participating in the rating system and the number of buildings that have completed the process for denotation as a green building.
Stability of system: Identify the processes that allow for full implementation of a rating system, including development, testing, and review process, systems for upgrades, process for modifications, and expected frequency of modifications.

Table 8. System Maturity

	System Maturity						
	System Age			Number of buildings		Stability of system	
	Initiated	Available for public use	Recent revision	Enrolled	Completed	Testing & Development	System for revisions
BREEAM	1990	1990	2005		600+	✓	✓
CASBEE	2001	2002	2005		7	✓	✓/-
GBTool	1996	1998	2005			✓	✓
Green Globes US	2004	2005	2006	63	4	○	○
LEED	1998	1998	2005	>3,400	>400	✓	✓

BREEAM is updated every fall. CASBEE has a major modification once a year. GBTool has been updated 4 times since it was established following the testing of the

tool and presentations at international conferences. All of the Green Globes™ US buildings that have been completed are pilot studies using Version 0. The U.S. Green Building Council has the *LEED Product Development and Maintenance Manual* available on-line that governs how changes are made to the LEED® rating systems. New rating systems have detailed steps they must follow including pilot testing and a public comment period. The existing systems can have minor updates as frequently as one time a year and major updates are expected every 3-5 years.

Table 9 summarizes the data gathered for the Technical Content review criterion. The rating systems were compared using the WBDG sustainable design and development principles. Additional comparable information on the technical content of these five rating systems is summarized in Appendix C.

Technical Content

Relevance to Sustainability: Representative of sustainable design needs of the Federal government as identified in the Whole Building Design Guide.

Thoroughness: Detailed review of how rating system addresses key sustainable design characteristics such as optimizing Energy Use, using Environmentally Preferable Products, and enhancing Indoor Environmental Quality (IEQ).

Measurement comparison: Identify the mechanism used as the baseline for comparison, such as industry benchmark or checklist.

Table 9. Technical Content

	Technical Content						
	Optimize Site Potential	Optimize Energy Use	Protect and Conserve Water	Use Environmentally Preferable Products	Enhance IEQ	Optimize Operational & Maintenance Practices	Other
BREEAM	15%	25%	5%	10%	15%	15%	15%
CASBEE	15%	20%	2%	13%	20%	15%	15%
GBTool	15% 12.5%	25% 20.8%			15% 16.7%	15% 16.6%	30% 33.4%
Green Globes US	11.5%	36%	10%	10%	20%		12.5%
LEED	20%	25%	7%	19%	22%		7%

BREEAM has 15% of its points that don't fit within the WBDG categories. That 15% is in the Management category that includes best practices for construction and construction waste management. CASBEE has 15% of its points in "other", which included pollution mitigation and solar energy gain for the Offsite Environment category. GBTool weightings for categories are established by the user based off of GBTool's default weightings (shown on the bottom part of the row). The top part of the row is an example set of weights established for the GSA Denver Courthouse's participation in Green Building Challenge 2005. Green Globes™ US has 12.5% of its points in "other", which included Project Management (integrated design process, commissioning, and emergency planning) and Emissions (boiler air emissions, ozone depletion and global warming, contamination of sewers and waterways, land and water pollution, integrated pest management, and storage of hazardous material). LEED® allows for 7% of its credits to be "innovation" credits. These credits could be targeted

at unique design strategies, unique pieces of equipment, the expected operational and maintenance practices of the building, or hiring a LEED® Accredited Professional.

U.S. building codes and standards are referenced in both Green Globes™ US and LEED®. LEED® establishes minimum code performance for various technical elements as part of the "pre-requisites" of the system. If a building design does not meet those minimum standards it cannot receive LEED® certification. Note that identifying how successful the rating systems are at driving the building design beyond code was not part of the review.

Tables 10.1 and 10.2 summarize the data gathered for the Measurability & Verification review criteria.

Measurability & Verification

Standardization: Established collection procedures exist.
Quantification: Numeric measurements facilitate absolute and relative performance evaluation.
Certification/Verification Process: Define system for verifying sustainable design practices for a particular application, including who evaluates the application and at what level of detail do they review the applications.
Documentation: Identify what type of documentation is necessary and at what stages of the project the information is collected.
Verifiable/Defendable: Provide documentation of the actual state of the building with respect to the rating system evaluation; include costs and benefits of using the rating system.

Table 10.1. Measurability

	Measurability			
	Measurement comparison		Standardization	Quantification
	Benchmark	Checklist	Established collection procedures	Numeric Measurements
BREEAM	-	✓		✓
CASBEE	✓		✓	✓
GBTool	✓	-	✓	✓/-
Green Globes US	✓	✓	✓/-	✓
LEED	✓	✓	✓	✓

GBTool criteria include both qualitative and quantitative measurements. Green Globes™ US uses the webtool to complete a checklist for a building project. Information was not found on the Green Globes™ US or Green Globes Canada websites as to how much additional documentation would need to be collected to support the completed checklist.

Table 10.2. Verification

	Verification				
	Documentation		Certification/Verification Process		
	Type	At what stages of project	Level of detail of check	Third Party	Assessor Qualification
BREEAM			Detailed Assessment of documentary evidence	✓	Trained and licensed by BRE
CASBEE	On-line Excel spreadsheet	Preliminary design, execution design, and completion.	Depends on the Assessment tools used. Document review is required.	✓	Trained and must pass an assessor examination. Must be a first-class architect to qualify.
GBTool	On-line Excel spreadsheet	After Design is complete	n/a	-	n/a
Green Globes US	On-line tool	Concept Design, Construction Documentation & Site Inspection	Review of documentation & Site inspection.	✓	○
LEED	On-line and/or hard copy	Design Review & Construction Review	Administrative and Credit Audit	✓	Trained and must pass an assessor examination.

In BREEAM, each category has between 7 and 70 points in which the building could be awarded all or none of the points. In CASBEE, some of the indicators are measured according to benchmarks set by current laws, guidelines and expected practice. For GBTool, each country has a third party team that establishes benchmarks for each criterion. The criteria include a mix of quantitative and qualitative measures. Green Globes™ US uses the EPA Target Finder as an energy benchmark and prescriptive paths for smaller office buildings. There was sample on-line questionnaire, but during this review, details on the information that would need to be collected and the collection procedures were not available. Following the completion of the American National Standards Institute (ANSI) process, the Green Building Initiative expects a third party will train and authorize verifiers.

Tables 11.1 and 11.2 summarize the data gathered for the Communicability review criterion.

Communicability

Clarity: Well-defined, easily communicated, and clearly understood among multiple parties.
Versatility: Number of systems that use it as its basis for development or comparison.
Comparability: Amenable to normalization for comparisons over varying building types, locations, years, or different sustainable design characteristics.
Results Usability: Usability of rating system documentation for communicating the accomplishments of the building project.

Table 11.1. Communicability (1)

	Communicability (1)			
	Clarity			Versatility
	Well-defined	Results easily communicated	Process & Rating System Information clearly understood	Basis for development
BREEAM	✓	✓	-	12
CASBEE	✓	✓	✓/-	1
GBTool	✓	-	-	5
Green Globes US	✓/-	✓	○	0
LEED	✓	✓	✓	10

Detailed BREEAM rating system information is available through the assessors, but a current version of the system was not publicly available for purchase. The CASBEE rating system manual offers specific definitions of criteria for all building types, which means it is more difficult to comprehend the system quickly. The availability variability of the Green Globes™ US on-line information (from January through 5/1/06) created a challenge for locating key, consistent rating system information and for verifying the rating system feedback that was provided during the review cycle.

With respect to the versatility criterion, BREEAM, LEED®, and GBTool have been used as the development basis of new rating systems. Green Globes™ US is adapted from Green Globes Canada, which has been used as a development basis for at least two other tools.

Table 11.2. Communicability (2)

	Communicability (2)	
	Comparability	
	Results Representation	Result Product
BREEAM	Pass, Good, Very Good, Excellent	Certificate
CASBEE	"spider web" diagram, histograms and BEE graph	Certificate and website published results
GBTool	Range of detailed and broad Histograms	n/a
Green Globes US	One to four globes (1=35-54%, 2=55-69%, 3=70-84%, 4=+85%)	Plaque, report and case study
LEED	Certified (40%), Silver (50%), Gold (60 %), Platinum (80%)	Award letter, certificate and plaque

Rating systems are only a means to the goal of a high quality, low environmental impact building. To meet the GSA reporting needs, the rating systems must be able to clearly communicate an overall performance rating without compromising detail. (Cole, 2001) The rating system needs to be sufficiently universal to facilitate comparison of performance across the various regions and building types. It is useful for GSA to use a common assessment and communication method for comparability across Federal agencies, GSA building types, and varying project types (new construction, existing buildings, etc.). The rating system results must have a minimal range of possible interpretations and offer a consistent, unambiguous summary of results. All of the rating systems have a clear way of representing the results of the rating system assessment. Examples can be found on their main webpages. LEED® uses the same representation for its different versions for new construction, existing buildings, commercial interiors, core and shell, homes, and neighborhood development, which makes it easy to compare the relative achievement of different project and building types.

VIII. Summary

There are many rating system and sustainable design tools that offer potentially useful techniques for building design depending on the needs of the user. Five sustainable building rating systems were reviewed in detail based on Federal and GSA drivers:

- BREEAM (Building Research Establishment's Environmental Assessment Method)
- CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)
- GBTool
- Green Globes™ US
- LEED® (Leadership in Energy and Environmental Design)

The purpose of this document is to offer information to assist in the comparison of sustainable building rating systems. GSA has identified that the ratings systems need to address the following elements:

- A system that is applicable to the large scale and complexity of federal building projects.
- A stable rating system such that the evaluation of building performance is not subject to drastic change.
- A system which tracks quantifiable achievements in sustainable design and is third party verified by a qualified assessor.
- A system used in the current market with practitioner awareness.

A description of how each of the potentially relevant sustainable building rating systems addressed these elements is summarized below.

- BREEAM has a long track record in the United Kingdom, but it is not extensively used in the U.S. and it is difficult to obtain current information about the system. Based on the information available, it would not be applicable to all of the GSA project types, specifically tenant build-out for leases. BREEAM is updated annually; however, the current version is not publicly available for purchase and must be acquired through a licensed assessor. The licensed assessor organization determines the BREEAM rating based on quantifiable sustainable design achievements. Although most in the sustainable design profession are aware of BREEAM and many rating systems have used it as their development basis, the rating system results are neither used nor recognized by U.S. design professionals.

- CASBEE is a relatively new system developed for the Japanese market that is available in English, but has not been tested in the U.S. However, CASBEE is potentially applicable in the U.S. market and offers the unique "BEE approach" to representing the performance evaluation data. Based on the information available, it would not be applicable to all of the GSA project types, specifically tenant build-out. The system requires documentation of quantifiable sustainable design achievements which are assessed by trained, first-class architects, which have passed the CASBEE assessor examination. Major modifications are

expected to be made to the system every year; however the process for those revisions is unknown. Fewer than 10 buildings have used the system and all of those are in Japan, thus it is relatively unknown in the U.S. market.

- GBTool is an international system that has been used to evaluate U.S. buildings for the Green Building Challenge, including one GSA building. With respect to applicability to GSA project types, GBTool would be applicable for all but tenant build out and operations and maintenance applications; however, an operations and maintenance version is under development. A third party team establishes the qualitative and quantitative measures that are used to evaluate sustainable design achievements and expected building performance. The system has undergone 4 updates since its inception in 1998, which occur based on the experiences gained through its use. Due to the flexibility inherent in the application of GBTool, it tends to require greater technical expertise to implement than other rating systems, which has limited its exposure in the U.S. market.

- Green Globes™ US was adapted from Green Globes Canada in 2004 and is the newest system considered in this review. Currently, the U.S. version is not available for all of the GSA project types; however, Green Globes™ US is developing tools that address the major renovation, tenant build-out, and operations and maintenance applications. The Green Building Initiative received accreditation as a standards developer by ANSI and is working toward developing Green Globes™ US as an official ANSI standard. Currently, sustainable design and construction information is submitted on-line for third-party verification, which is provided by a Green Building Initiative-approved and Green Globes trained professional. According to feedback provided by the Green Building Initiative, 6 regional assessors were expected to be trained by June 2006. Following the completion of the ANSI process, it is expected the third party verification process will be revised. The Green Globes™ US rating system was not consistently available on-line during the review period and the current version of the on-line rating system tool is still not available and no date is given for its expected completion. Although there has been much publicity around Green Globes™ US in recent years, according to feedback provided by the Green Building Initiative, 4 buildings have received Green Globes ratings and 63 buildings have registered, which means they may potentially pursue verification in the future.

- LEED® is currently the dominant system in the United States market and is being adapted to multiple markets worldwide. The currently available LEED® rating systems address all of the GSA building and project types. A *Product Development and Maintenance Manual* is publicly available which governs how changes are made to the LEED® rating systems. The steps followed for the development of U.S. Green Building Council rating system products include technical development by committee, pilot testing, public comment period, approval by council membership, and then release for public use. For the

existing LEED® rating systems, minor updates can occur no more than once a year, while major updates are expected to occur on a 3-5 year cycle, and will follow a defined process including a public comment period. Documentation of the quantifiable sustainable design measures are provided to the U.S. Green Building Council, the developer of the LEED® rating system, for third-party verification. The assessors have been trained and must pass an assessor examination. More than 400 U.S. buildings have received LEED® ratings and more than 3400 buildings are registered and therefore potentially seeking certification. LEED® is not only the U.S. market leader, but is also the most widely use rating system by Federal and state agencies, which makes it easy to communicate a building's sustainable design achievements with others.

There are many resources available for incorporating sustainable design principles into a building life cycle. Sustainable building rating systems are used to examine the performance or expected performance of a 'whole building' and translate performance assessment into a tool that can be used to compare the building performance of other buildings or a performance standard. The information provided in this document offers comparative details on each of the rating systems using the review criteria developed from GSA and other Federal drivers.

Appendix A - References

Note: Webpage addresses included in references were correct as of March 2006, unless otherwise noted.

AggRegain. *BREEAM Offices.* Waste & Resources Action Programme (WRAP). Accessed February 2006a. http://www.aggregain.org.uk/sustainability/examples_of_tools_and_approaches/breeam/index.html

AggRegain. *BREEAM Offices. Step 3: Credit Calculations.* Accessed March 2006b. http://www.aggregain.org.uk/sustainability/examples_of_tools_and_approaches/breeam/breeam_offices_3.html

AggRegain. *BREEAM Offices. Step 4: BREEAM Ratings*. Accessed March 2006c. http://www.aggregain.org.uk/sustainability/examples_of_tools_and_approaches/breeam/breeam_offices_4.html

American Forest & Paper Association (AF&PA). *Wood Products: Green Building.* Accessed January 2006. http://www.afandpa.org/Content/NavigationMenu/Wood_Products/Green_Building/Green_Building.htm

American Forest & Paper Association. *Green Building Fact Sheet: Wood and the Greening of Commercial and Residential Buildings.* Accessed February 2006. http://www.afandpa.org/Content/NavigationMenu/Wood_Products/Green_Building/Green_building_Fact_Sheets/GBfact2.pdf

American Institute of Architects (AIA) Seattle Chapter. January 2006. *Kudos & Thanks: Weber + Thompson.* http://www.aiaseattle.org/notables_and_heroes.htm#Kudos

American Institute of Architects (AIA). 2005. *Green/High-Performance Building Resources.* http://www.aia.org/adv_st_green_highperformance

Annex 31. 2006. *Assessment Framework and Rating: Ekoprofile.* http://annex31.wiwi.uni-karlsruhe.de/MainFrame_tools_norway.htm

Annex 31. October 2001. *Directory of Tools: A Survey of LCA Tools, Assessment Frameworks. Rating Systems, Technical Guidelines, Catalogues, Checklists and Certificates.* http://annex31.wiwi.uni-karlsruhe.de/pdf/Microsoft%20Word%20-%20Annex%2031%20Directory%20of%20Tools%20by%20Country%20and%20.pdf

ARUP. 2006. *SPeAR®: Product overview.* http://www.arup.com/environment/feature.cfm?pageid=1685

ATHENA™ Sustainable Materials Institute, ATHENA™ Institute International. March 2002. *US Federal and Military Applications of LEED: Lessons Learned.* http://www.athenasmi.ca/projects/leed/docs/LLL%20Report.pdf

ATHENA™ Sustainable Materials Institute. September 2002. *LEED Canada Adaptation and BREEAM/Green Leaf Harmonization Studies: Part I Project Summary and Overview Observations.* http://www.athenasmi.ca/projects/leed/docs/PartI_LEED_CanadaHarm.pdf

Australian Building Greenhouse Rating. 2004. http://www.abgr.com.au/new/default.asp

Australian Government: Department of the Environment and Heritage. March 17, 2006. *Sustainable Construction*. http://www.deh.gov.au/settlements/industry/construction/

Boecker, John, Joel Ann Todd, Ann Kosmal, "A Decade of Green Building Rating Systems: Lessons Learned", presented at GreenBuild, Atlanta, GA, November 2005

Bowen, Ted S. November 4, 2005. *Constructive criticism for green standards: LEED building program confronts critics and growing pains.* http://www.msnbc.msn.com/id/9925473/from/RL.2/

Bespoke BREEAM. 2006. http://www.breeam.org/bespoke.html and http://www.breeam.org/pdf/Bespoke%20Guidance%20-%20For%20Clients_v1.1_.pdf

BREEAM: Building Research Establishment's Environmental Assessment Method. 2006. http://www.breeam.org/

Building Green Inc. March 2005. *Green Globes Emerges to Challenge LEED.* Environmental Building News. http://www.buildinggreen.com/auth/article.cfm?filename=140304b.xml

Building Research Establishment Ltd. (BRE Ltd.) *Search for BREEAM Offices.* Accessed February 2006. http://www.brebookshop.com/search.jsp

Canadian Standards Association. 2006. *Building Materials and Structural Products Certification Program.* http://www.csa-international.org/product_areas/building_and_structural/

CASBEE for New Construction Technical Manual, March 2004 Edition and Software CD 2004 Edition

CASBEE Web Site (in English). 2006. http://www.ibec.or.jp/CASBEE/english/

Cementation Foundations Skanska. May 16, 2005. *M4I (Movement for Innovation).* http://www.skanska.co.uk/skanska/templates/page.asp?id=2969

Center for Sustainable Building Research (CSBR). 2005. *The State of Minnesota Sustainable Building Guidelines (MSBG): Buildings, Benchmarks & Beyond.* College of Architecture and landscape Architecture – University of Minnesota. http://www.csbr.umn.edu/B3/index.html

Center for Sustainable Building Research. July 1, 2004. *Print Version for the Minnesota Sustainable Building Guidelines Version 1.1*. College of Architecture and Landscape Architecture – University of Minnesota. http://www.csbr.umn.edu:16080/B3/MSBG_v1_1.pdf

Central Point of Expertise on Timber Procurement (CPET). Accessed March 2006. http://www.proforest.net/cpet

City of Scottsdale, Arizona. 2006. *Environment & Preservation: Green Building Program.* http://www.scottsdaleaz.gov/greenbuilding/default.asp?catID=5&linkID=101&lType=1

Cole, Raymond J. February 1, 2001. *A Building Environmental Assessment Method for British Columbia.* Environmental Research Group, School of Architecture University of British Columbia

Comprehensive Assessment System for Building Environmental Efficiency (CASBEE), Japan Sustainable Building Consortium brochure

CRISP Database available at http://www.crisp.cstb.fr

CSIR Building and Construction Technology Sustainable Buildings Group FPM. August 31, 2003. *The Sustainable Building CD: Users Manual*. http://www.sustainablebuildings.co.za/introduction/SB%20manual.pdf

CSTB - Centre Scientifique et Technique du Bâtiment. 2006. *Sustainable Development.* http://international.cstb.fr/frame.asp?URL=research/default.asp

DeStefano, Jim. August 2005. *Understanding Green Building Rating Systems.* Structure Magazine. http://www.structuremag.org/archives/2005/August%202005/Understanding-Green-Building-Ratings.pdf

ECD Energy and Environment Canada Ltd. February 2002. *LEED Canada Adaptation and BREEAM/Green Leaf Harmonization Studies: Part III BREEAM GREEN LEAF HARMONIZATION STUDY.* http://www.athenasmi.ca/projects/leed/docs/Part_III_Harmoniz_Rpt.pdf

Energy and Resources Institute. November 24, 2005. TERI-GRIHA (TERI–Green Rating for Integrated Habitat Assessment). http://www.sustainable-buildings.org/files/TL54.pdf?PHPSESSID=3f99fa29b907568d3a2438e142a648ba

Energy Star. September 27, 2005. *Tools of Trade: ENERGY STAR Collaborates with the New Jersey Chapter of USGBC on Energy Wokshop.*https://www.energystar.gov/index.cfm?c=new_bldg_design.new_bldg_design_news

Energy Tech. 2006. *Ecobuilding - Building Optimisation with Total Quality (TQ) Assessment.* http://www.energytech.at/static/architektur/publikationen/results/id1772.html

Environment and Development Foundation (EDF). 2006. *Greenmark Program.* http://greenmark.epa.gov.tw/english/index.asp

Environmental Design+Construction (ED+C). November 7, 2005. *GBI becomes ANSI accredited standards developer.* http://www.edcmag.com/CDA/Articles/Industry_News/a0e1142e8e697010VgnVCM100000f932a8c0

Ervin, Christine. May 25, 2005. *Pressure on LEED: Threat or Boon?* Greener Buildings. http://www.greenerbuildings.com/news_detail.cfm?NewsID=28152

European Thematic Network on Construction and City Related Sustainability Indicators. 2006. *CRISP Sustainable Construction Indicators Database.* http://crisp.cstb.fr/db_ListIS.asp

Executive Order 13101. *Greening the Government through Waste Prevention, Recycling, and Federal Acquisition.* http://www.wbdg.org/pdfs/eo13101.pdf

Executive Order 13123. *Greening the Government through Efficient Energy Management.* http://www.wbdg.org/pdfs/eo13123.pdf

FABER MAUNSELL. *BREEAM: FAQ.* Accessed March 2006. http://www.fabermaunsell.com/Resources/40/87/index.jsp

Federation of Master Builders. January 22, 1999. *Minister Unveils BREEAM '98.* http://www.fmb.org.uk/publications/masterbuilder/november98/breeam.asp

Five Winds International. July 2004. *Environmental Concepts and Tools: Green Building Design.* http://www.fivewinds.com/uploadedfiles_shared/GreenBuildingDesign040127.pdf

Forest Stewardship Council. 2006. http://www.fscus.org

Frangos, Alex. October 19, 2005. *Is It Too Easy Being Green? Eco-Friendly Certification Is Big With Builders, Tenant; Critics See a 'Broken' System.* The Wall

Street Journal Online. (members only)
http://online.wsj.com/article/SB112967950603172567.html

GBTool 1998, 2000, 2002, 2005 and applicable Manuals available at www.iisbe.org

Gibberd, Jeremy, et al. 2005. *Assessing Sustainable Buildings in Developing Countries – The Sustainable Building Assessment Tool (SBAT) and the Sustainable Building Life Cycle.* SB05, Tokyo, Japan.

Gibberd, Jeremy. 2003. *Developing a Sustainable Development Approach for Buildings and Construction Processes*. CIB International Conference on Smart and Sustainable Built Environment.

Geissler, Susanne, and M. Bruck. *Total Quality (TQ) Assessment as the Basis for Building Certification in Austria.*
http://www.argetq.at/zertifikat/materialien/tq_oslo.pdf

Green Building Challenge (GBC). 1998. Conference Proceedings. Vancouver, British Columbia, Canada.

Green Building Council Australia. 2006. *Green Star*.
http://www.gbcaus.org/greenstar/page.asp?id=117

Green Building Council Korea. 1999. *Green Building Rating System*. http://www.gbc-korea.co.kr/eng-8.asp

Green Building Initiative (GBI). Accessed May 2006a. *Energy & Environmental Performance Assessment and Benchmarking of Buildings.* Green Globes (GG) webcast.
http://www.thegbi.org/greenglobes/pdf/webcast.pdf

GBI. Accessed March 2006b. *Green Globes webpage*.
http://www.thegbi.com/greenglobes/

GBI. Accessed February 2006c. Not available as of February 24, 2006. Green Globes:*Assessment and Rating System: Program Summary and Users Guide.*
http://www.thegbi.com/commercial/greenglobes/pdf/U.S.Summary-Final.pdf

Green Globes. 2006a. *GEM UK – Environmental Assessment of Buildings*.
http://www.greenglobes.com/existing/homeuk.asp

Green Globes. 2006b. *Green Globes USA, Green Globes Canada, GEM UK*.
http://www.greenglobes.com/

Herz, Johnathan. *Public Architecture and LEED: Making It Green AND Fair*. The American Institute of Architects. Accessed January 2006.
http://www.aia.org/pa_a_20041204_LEED

HKBEAM Society. 2003. HK-BEAM: *The Hong Kong Building Environmental Assessment Method.* http://www.hk-beam.org.hk/general/home.php

Hong Kong (HK) Special Administration Region Government, Buildings Department. 2005. *Comprehensive Environmental Performance Assessment System for Buildings: New Assessment Method for Building Sustainability in High Density Urban Context*, Brochure distributed at SB05.

IEA-BCS Annex 31. February 19, 2002. *Finland Energy certification for residential and office buildings.* http://www.uni-weimar.de/scc/PRO/TOOLS/fin-certification.html

International Initiative for a Sustainable Built Environment. March 2004. *Advanced Building News.* http://greenbuilding.ca/ABNnews/ABN_02.pdf

Issaquah Highlands. 2006. *Blakely Hall Receives Dual Green Certifications.* http://www.issaquahhighlands.com/greenglobeaward2.html

James, Peter, and D. Somervell. April 29, 2004. *Assessing the Environmental Performance of Buildings in Higher Education.* Summary of a HEEPI workshop, University of Leicester. http://www.heepi.org.uk/documents/Assessing%20the%20environmental%20performance%20of%20Buildings%20in%20HE.doc

JSBC: Japan Sustainable Building Consortium. 2005. *CASBEE: Comprehensive Assessment System for Building Environmental Efficiency*. http://www.ibec.or.jp/CASBEE/english/index.htm

Labs 21. March, 7, 2006. *Labs for the 21st century.* http://www.labs21century.gov/

Langer, Kenneth, and R. Watson. November 7, 2005. *Bringing LEED to China*. http://www.edcmag.com/CDA/Articles/Feature_Article/5a10142e8e697010VgnVCM100000f932a8c0

LEGEP®. 2006. *LEGEP®: Tool for integrated lifecycle performance of buildings.* http://www.legoe.de/index.php?AktivId=1125

Lewis, Malcolm, and H. Miranda. 2002. *Impacts of a Green Building Rating System on the Design and Construction Process: A Summary of Ten Projects Using LEED™*. http://www.sbis.info/docs/Conf/SB2002/Cities/001_lewis.pdf

Los Angeles Community Colleges (LACC). December 2, 2005. *LACCD Project is First in U.S. to Receive BREEAM Certification.* http://www.propositiona.org/newsroom/Awards/BREEAM_award_02dec05.htm

Minnesota Sustainable Communities Network (MSCN), NextStep. October 13, 2005. *Minnesota Sustainable Design Guide.* http://www.nextstep.state.mn.us/res_detail.cfm?id=71

Memorandum of Understanding. January 2006. *Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding.* http://www.wbdg.org/pdfs/sustainable_mou.pdf

Murakami, Shuzo. January 20-23rd, 2003. *Today's approach for promoting s approach for promoting sustainable building in Japan.* http://www.asian-forum.net/conference_2003/pdf/CASBEE_Murakami_AsianForum.pdf

National Associate of Home Builders (NAHB). 2006. *NAHB's Model Green Home Building Guidelines.* *http://www.nahb.org/fileUpload_details.aspx?contentTypeID=7&contentID=1994*

National Australian Built Environment Rating System (NABERS). 2006. *NABERS – Frequently Asked Questions.* http://www.nabers.com.au/nabers/faq.htm

Natural Resources Canada. April 12, 2005. *Buildings Group: C-2000 Program*. http://www.buildingsgroup.nrcan.gc.ca/projects/c2000_e.html

O'Brian, Mary, and J. Nile. 2003. *BUILDING BETTER BUILDINGS: The Transition to Environmental Building in Canada.* http://www.fes.uwaterloo.ca/ers/research/90sForWeb/ObrienNiles.pdf

Office of Management and Budget (OMB). 2002. "Section 55 – Energy and Transportation Efficiency Management." OMB Circular No. A-11

PEFC Council (Programme for the Endorsement of Forest Certification schemes). Accessed March 2006. http://www.pefc.org/internet/html/

Personal communication (PC) from representatives of GBTool. March 29th, 2006.

Personal communication (PC) from representatives of the Green Building Initiative (GBI). April 5th, 2006.

Personal communication (PC) from representatives of the Institute for Building Environment and Energy Conservation (IBEC). April 14, 2006.

Personal communication (PC) from representatives of the U.S. Green Building Council (USGBC). April 5th, 2006.

Personal communication with Ilari Aho October 27, 2005.

Provisional Construction Industry Co-ordination Board, Buildings Department. November 2005. *Comprehensive Environmental Performance Assessment Scheme Paper No. PCICB/126.* http://www.pcicb.gov.hk/eng/meeting/download/p-pcicb-126-e.doc

Provisional Construction Industry Co-ordination Board. November, 2004. C*omprehensive Environmental Performance Assessment Scheme.*

Robert Lechner et al., *Total Quality Building (TQB), The Austrian Building Assessment Tool*, SB05, Tokyo

Scheuer, Chris W., and G.A. Keoleian. September 2002. *Evaluation of LEED® Using Life Cycle Assessment Methods.* Center for Sustainable Systems, University of Michigan. http://www.bfrl.nist.gov/oae/publications/gcrs/02836.pdf

Shendler, Auden, and R. Udall. October 27, 2005. *LEED Is Broken; Let's Fix It.* http://www.grist.org/comments/soapbox/2005/10/26/leed/index1.html

Shik Shin, Kee. *Green Building Certification System in Korea*, SB05, Tokyo

Solomon, Nancy B. *How Is LEED Faring After Five Years in Use?* Architectural Record: McGraw Hill Construction. Accessed March 2006. http://archrecord.construction.com/features/green/archives/0506edit-1.asp

Schwartz, Jerry. January 23, 2005. Steven Winter Associates, Inc. LEED® Cost Study: Final Report. Summarization. Prepared by AF&PA.

Steven Winter Associates, Inc. October 2004. LEED® Cost Study: Final Report. http://www.getf.org/file/toolmanager/CustomO16C45F60590.pdf

Sustainable Buildings (SB). 2000. Conference Proceedings. Maastricht, The Netherlands.

Sustainable Building (SB). 2002. Conference Proceedings. Oslo, Norway.

Sustainable Building (SB). 2005. Conference Proceedings. Tokyo, Japan.

Sustainable Forestry Initiative. March 24, 2006. *SFI® Labeling Program.* http://64.29.218.149/sfilabel_use.asp

Sustainable Forestry Initiative® (SFI). *Where Can Interested Stakeholders Go for Accurate and Objective Information Comparing Forest certification programs?* www.aboutsfi.org Provided by Jerry Schwartz, AF&PA.

Sylviane Nibel, et al, *ESCALE, Assessment Method of Buildings Environmental Performance*, Sustainable Buildings 2000, Maastricht, Netherlands, October 2000

Sylviane Nibel, et al., *French Certification for Non-Residential "High Environmental Quality" Building Projects*, SB05, Tokyo;

Tamm, Elanna. September 30, 2005. *Green Building Products.* United States Commercial Service. http://www.buyusainfo.net/docs/x_1251980.pdf

Technical Office for the Use of Steel (France). 2006. *The HQE® (High Environmental Quality) programme.* http://www.otua.org/expertises_sustainable_development6.htm

Timo Rintala and Ilari Aho, *PROMISE: Environmental Classification of Buildings: Current Situation and Objectives*, June 25, 2003

Todd, Joel Ann, et al. 2001. "Comparative Assessment of Environmental Performance Tools and the Role of Green Building Challenge," *Building Research and Information*, (2001) 29(5), 324-335.

Transportation, Treasury, Housing and Urban Development, the Judiciary, the District of Columbia, and Independent Agencies Appropriations Act, 2006, Public Law 109-115.

Trine Pettersen et al, Ecoprofile – a simplistic environmental assessment method: experiences and new challenges," SB2000, Oslo, Norway

U.S. Army Corp of Engineers, Department of the Army. May 1, 2001. *Sustainable Design for Military Facilities.* http://www.usace.army.mil/inet/usace-docs/eng-tech-ltrs/etl1110-3-491/entire.pdf

U.S. Army Engineer Research and Development Center. 2000. Sustainable Project Rating Tool (SPiRiT). http://www.cecer.army.mil/earupdate/nlfiles/2000/sustainable2.cfm

U.S. Green Building Council (USGBC). 2006. *U.S. Green Building Council.* http://www.usgbc.org/

USGBC. October, 2005. *LEED for New Construction and Major Renovation.* http://www.usgbc.org/

USGBC. January, 2006. LEED Product Development and Maintenance Manual. https://www.usgbc.org/ShowFile.aspx?DocumentID=626

U.S. Environmental Protection Agency. Environmental Labeling Issues, Policies, and Practices Worldwide: Taiwan's Green Mark Program. http://www.epa.gov/oppt/epp/pubs/envlab/taiwan.pdf#

University of California Berkeley, Department of Architecture. 2006. Sustainability Resources for Further Information. http://arch.ced.berkeley.edu/courses/arch249x_1_SP03/RatingResources.htm

University of Minnesota - College of Architecture and Landscape Architecture. 2001. *Minnesota Sustainable Design Guide.* http://www.sustainabledesignguide.umn.edu/

Walsh, Bill. August 9, 2005. *Green Building Movement Shows Its True Colors: Highlights From The AIA Sustainability Summit.* Healthy Building Network. http://www.healthybuilding.net/news/aia_true_colors-080905.html

Walsh, Bill. July 19, 2005. *Conflicts of Interest at the American Institute of Architects: Trade Associations Set The Greenwash Agenda.* Healthy Building Network. http://www.healthybuilding.net/news/aia-071905.html

Whole Building Design Guide (WBDG). 1999. "Letter to Beth Shearer regarding response to Executive Order 13123."

Whole Building Design Guide (WBDG), Sustainable Committee. March 2006. *Sustainable*. http://www.wbdg.org/design/sustainable.php

World Green Building Council. 2006. http://www.worldgbc.org/?id=86

Appendix B - List of Sustainable Design and Operations Related Systems Pre-Screened from the Analysis

Sustainable Design Tools	***Why Not Included***	**Sustainable Design Tools**	***Why Not Included***
Green Building Advisor (US)	*Catalogue*	Environmental Profiles of construction materials, components and buildings (UK)	*Database of LCA information*
Energy Star	*Energy analysis*	Quest	*Policy choice tool*
Energy Certification for Buildings (Finland)	*Energy analysis*	BM Bau Building Passport (Germany)	*Product specification guide*
BSEA 1.0 (Finland)	*Energy Analysis*	The Movement for Innovation (M4i)	*Construction & Design Safety*
NEN 2916/5128, NPR 2917/5129 (Netherlands)	*Energy Modeling Software*	EcoProP	*Requirements management system*
SIMBAD (Finland)	*Energy Modeling Software*	Costing Reference Model	*Residential*
EDIP (Denmark)	*Environmental assessment of products*	Super E House Program (Canada)	*Residential*
Environmental Classification of Properties	*Environmental impact assessment*	AccuRate (Australia)	*Residential*
Papoose (Finland)	*Environmental impact assessment*	Alameda County (CA)	*Residential*
Envest	*Environmental impact assessment tool*	BASIX Building Sustainability Index (Australia)	*Residential*
EcoEffect (Sweden)	*Environmental Impact Software model*	BERS (Australia)	*Residential*
ISO 14001	*Environmental Management System*	Build a Better Clark (Clark County Washington HBA)	*Residential*
MRPI Netherlands	*Environmental product declaration*	Build A Better Kitsap Home Builder Program (Kitsap, WA HBA)	*Residential*
Cities for Climate Protection Software	*GHG emissions inventories tool*	National Association of Home Buildings (NAHB) Green Guidelines	*Residential*
City of Santa Monica Green Building & Construction Guidelines	*Guideline*	Built Green Alberta (Canada)	*Residential*
ECDG - Japan	*Guideline*	Built GreenTM (MBA of King and Snohomish Counties, WA)	*Residential*
Green Building Program (Austin, TX)	*Guideline*	Built GreenTM Colorado (HBA of Metro Denver)	*Residential*
National Packages Sustainable Building (Netherlands)	*Guideline*	California Green Builder Program	*Residential*
NYC High Performance Building Guidelines	*Guideline*	Chula Vista (CA) GreenStar Building Incentive Program	*Residential*
Seattle Sustainable Building Action Plan and Built Smart (Seattle, WA)	*Guideline*	City of Boulder Green Points (CO)	*Residential*
Tokyo Metro Green Building Program	*Guideline*	City of Frisco (TX) Green Building Program	*Residential*

Sustainable Design Tools	*Why Not Included*	Sustainable Design Tools	*Why Not Included*
"Green" Hotels Association (US)	*Hotels/Lodging*	County of Santa Barbara Innovative Building Review Program (CA)	*Residential*
Coalition for Environmentally Responsible Economies (CERES) Green Hotel Initiative (US)	*Hotels/Lodging*	Earth Advantage Home (US)	*Residential*
Green Globe 21 (US)	*Hotels/Lodging*	Earth Advantage Program (Portland General Electric)	*Residential*
Green Leaf Eco-Rating Program (Canada)	*Hotels/Lodging*	EarthCraft House (Greater Atlanta, GA HBA)	*Residential*
Green Rating Program (Africa)	*Hotels/Lodging*	EarthCraft House (US)	*Residential*
Green Seal Certification (US)	*Hotels/Lodging*	EcoHomes (UK)	*Residential*
HVS International ECOTEL Certification	*Hotels/Lodging*	EnerGuide Houses Program (Canada)	*Residential*
Sustainable Ecotourism Rating (Costa Rica)	*Hotels/Lodging*	Energy Rated Homes of Colorado	*Residential*
Vermont Green Hotels in the Green Mountain State	*Hotels/Lodging*	Energy Star (US, Canada)	*Residential*
Green Rating Initiative (Ethiopia)	*Industrial*	Evergreen Building Guide (Issaquah, WA)	*Residential*
Green Rating of Indian Industry	*Industrial*	FirstRate (Australia)	*Residential*
Sustainable Project Appraisal Routine (SPEAR)	*Industrial*	G/Rated (Portland, OR)	*Residential*
Global Reporting Initiative	*Industrial Reporting*	Green Building Program, Austin Energy (TX)	*Residential*
BEAT 2000 (Denmark)	*Life Cycle assessment tool*	Green Built Home (Wisconsin Environmental Initiative)	*Residential*
BRI LCA (Japan)	*Life Cycle assessment tool*	Green Built Program (HBA of Greater Grand Rapids, MI)	*Residential*
EcoIndicator (Netherlands)	*Life Cycle assessment tool*	Green Home Designation (Florida Green Building Coalition)	*Residential*
EcoInstall (Netherlands)	*Life Cycle assessment tool*	Green Points Building Program (Boulder, CO)	*Residential*
EcoPro (Germany)	*Life Cycle assessment tool*	Hawaii BuiltGreenTM	*Residential*
EcoQuantum (Netherlands)	*Life Cycle assessment tool*	Health House Advantage Certification (US)	*Residential*
LCA-House (Finland)	*Life Cycle assessment tool*	HERS (US)	*Residential*
LCAiT (Sweden)	*Life Cycle assessment tool*	Home Builders Association of Greater Kansas City (MO)	*Residential*
Legoe (Germany)	*Life Cycle assessment tool*	HomeRun (Canada)	*Residential*
OGIP (Switzerland)	*Life Cycle assessment tool*	Hudson Valley HBA Green Building Program (NY)	*Residential*
REGENERS (Finland)	*Life Cycle assessment tool*	Multifamily Green Building Guidelines (Alameda County, CA)	*Residential*

Sustainable Design Tools	***Why Not Included***	**Sustainable Design Tools**	***Why Not Included***
TAKE-LCA (Finland)	*Life Cycle assessment tool*	NatHERS (Australia)	*Residential*
TEAM (Finland)	*Life Cycle assessment tool*	New Mexico Building America Partner Program (HBA of Central New Mexico)	*Residential*
Athena Model (Canada)	*Life Cycle assessment tool*	Novoclimat (Quebec, Canada)	*Residential*
BEES (US)	*Life Cycle assessment tool*	R-2000 (Canada)	*Residential*
GaBi 4	*Life Cycle assessment tool*	Schenectady HBA Green Building Program (NY)	*Residential*
KCL-ECO	*Life Cycle assessment tool*	SeaGreen (Seattle)	*Residential*
LISA (Austrailia)	*Life Cycle assessment tool*	Southern Arizona Green Building Alliance	*Residential*
Umberto	*Life Cycle assessment tool*	Super E House Program (Canada)	*Residential*
Solution Spaces (Canada)	*Life cycle cost and impact of urban development forecasting tool*	Super Good Cents and Natural Choice Homes	*Residential*
Equer (France)	*Life Cycle simulation tool*	The BREEAM Green Leaf for Multi-Residential Buildings (Canada)	*Residential*
Environmental Choice Program	*Materials assessment method*	The Green Builder Program (NM)	*Residential*
MMG (Netherlands)	*Materials assessment method*	Vermont Built Green	*Residential*
SIA 493 (Switzerland)	*Materials checklist*	Western North Carolina Green Building Council	*Residential*

Appendix C - Additional Rating System Review Data

The WBDG is the portal to "up-to-date information on integrated 'whole building' design techniques and technologies." In response to Executive Order 13123, sustainable design principles were developed by GSA, DOD, and other Federal agencies and were provided on the WBDG Sustainability webpage. In addition to the sustainability principles provided on this webpage, general design recommendations are also included on these pages. These recommendations offer ideas and comprehensive guidance on how to implement the sustainable design principles:

- Optimize Site Potential
- Optimize Energy Use
- Protect and Conserve Water
- Use Environmentally Preferable Products
- Enhance Indoor Environmental Quality (IEQ)
- Optimize Operational and Maintenance Practices

For each of these principles there is a list of actions that could be taken to address the principle. These previously endorsed recommendations were used as a tool to compare some of the rating systems' technical information. In this appendix the WBDG sustainable design principles and subsequent recommendations are being used for a comparison of how each rating system addressed these items. In the interest of brevity, only half of the principles were selected for this comparison: optimize energy use, use environmentally preferable products, and enhance indoor environmental quality. Optimizing energy use is a primary interest for GSA because increased energy efficiency helps GSA meet its energy use reduction goals and reduces operating costs. The use of environmentally preferable products is important to GSA because of its interest in minimizing its life cycle environmental impact. Enhancing indoor environmental quality is important to GSA because of its interest in providing high quality work environments for Federal workers.

The following key is provided to be used in conjunction with the tables in this appendix.

> * These WBDG categories are covered by a credit whose points have been designated to another category.
>
> ** Credit C.3 is an alternate Path B for buildings ≤ 20,000ft2. The amount of points achievable is 110.
>
> *** The heading for section E designates this section at 100 points. The actual addition of all categories was 102 points. The percentage calculations were calculated using the total of 102 points.
>
> **** Weights in GBTool are established by third party assessment authority.

Table C.1. Optimize Energy Use - Comparison of Rating System Emphasis

	BREEAM			CASBEE			GBTool		Green Globes			LEED		
WBDG Criteria for Optimize Energy Use	**Energy**	**80**	**% of total**	**Energy**	**92.5**	**% of total**	**Energy and Resource Consumption**	********	**Energy**	**360**	**% of total**	**Energy and Atmosphere**	**17**	**% of total**
Reduce Heating, Cooling, and Lighting Loads through Climate-Responsive Design and Conservation Practices	Losses minus gains kWh/m^2 (predicted according to the fabric and form of the building)	40	50%	Natural energy utilization and Building thermal load	25	27%	Lot orientation to maximize passive solar potential and Predicted non-renewable energy used for building operations		C.1 - Energy Consumption	110	31%	EA Prerequisite 2 – Minimum Energy Performance * EA Credit 1 - Optimize Energy Performance EQ Credit 7 – Thermal Comfort * EQ Credit 1 – Outdoor Air Delivery Monitoring *	10	59%
Employ Renewable or High-Efficiency Energy Sources	At least 10% of either heat demand or electricy consumption in the building is supplied from local renewable energy sources	12	15%	Natural energy utilization	10	11%	Assessment of Renewables Feasibility and Plans for use of on-site renewable energy sources and Plans for use of off-site energy that is generated from renewable sources		C.4 - Renewable Energy Sources	45	13%	EA Credit 2 - On-site Renewable Energy EA Credit 6 - Green Power	4	24%
Specify Efficient HVAC and Lighting Systems	External light design is in compliance with ILE guidance notes for reduction of light pollution.	12	15%	HVAC system and Lighting system	22.5	24%			C.3 - Integration of Energy Efficient Systems (alternate Path B for buildings ≤ 20,000ft^2)	**	**	EA Credit 1 – Optimize Energy Performance	*	*
Optimize Building Performance and System Control Strategies				Building thermal load and operational management system	25	27%	Predicted non-renewable primary energy used for building operations and Predicted electrical peak demand for building operations and Provision of building management control system and Designed capability for partial operation of building technical systems		C.1 Energy Consumption OR C. 3 "Right-sized" energy-efficient systems	*	*	EA Credit 1 – Optimize Energy Performance * EA Credit 5 - M&V	1	6%
Monitor Project Performance	Electrical sub metering for major consuming items. Electrical sub metering of tenancy areas.	16	20%	Monitoring and operational management system	10	11%	Measures planned for on-going monitoring and verification of performance		C.2 - Energy Demand Minimization	135	38%	EA Credit 5 M&V * EA Credit 3 Enhanced Commissioning	1	6%
									C.5 - Energy Efficient Transportation	70	19%	EA Prerequisite 3 - Fundamental Refrigerant Management EA Credit 4 - Enhanced Refrigerant Management	1	6%

Table C.2 Enhance IEQ - Comparison of Rating System Emphasis

	BREEAM			CASBEE			GBTool		Green Globes v.1			LEED		
WBDG Criteria for Enhance Indoor Environmental Quality (IEQ)	**Health & Wellbeing**	**150**	**% of total**	**Indoor Environment**	**101**	**% of total**	**Indoor environmental quality**	********	**Indoor Environment**	**200**	**% of total**	**Indoor Environmental Quality**	**15**	**% of total**
Facilitate Quality IEQ through Good Design, Construction, and O&M Practices	Ease of cleaning, maintenance and replacement of cooling towers/evaporative condensers	10	7%	Source control	6.3	6%	Indoor air quality - finishes, limit pollutant migration, maintenance, etc.					EQ Prerequisite 1 - Minimum IAQ Performance EQ Credit 1 - Outdoor Air Delivery Monitoring EQ Credit 3 - Construction IAQ Management Plan	3	20%
Value Aesthetic Decisions	Occupant distance to view out of window	10	7%	Perceived spaciousness and access to views	4	4%	Social aspects - views, privacy		G.3 - Lighting design and integration of lighting systems	45	23%	EQ Credit 8 - Daylighting and Views	2	13%
Provide Thermal Comfort	Ventilation criteria met. Local control of office area. Thermal comfort levels used in servicing efforts.	30	20%	Thermal comfort	35	34%	Air temperature and relative humidity		G.4 - Thermal Comfort	25	13%	EQ Credit 6.2 - Controllability of Systems - Thermal EQ Credit 7 - Thermal Comfort	3	20%
Supply Adequate Levels of Ventilation and Outside Air	Adequate cross ventilation is promoted.	10	7%	Ventilation	7.5	7%	Ventilation		G.1 - Effective Ventilation System	60	30%	EQ Credit 2 - Increased Ventilation EQ Credit 5 - Indoor Chemical & Pollutant Source Control	2	13%
Prevent Airborne Bacteria, Mold, and Other Fungi	Steam humidification is installed, or no humidification is present.	10	7%	Control of mites and mold	3.1	3%	Humidity and limit pollutant migration		G.2 - Source Control of Indoor Pollutants	45	23%			
Limit Spread of Pathogens	Minimize risk of Legionellosis in hot and cold water systems	10	7%				Limit pollutant migration					EQ Prerequisite 2 - Environmental Tobacco Smoke Control		
Avoid the Use of Materials High in Pollutants				Chemical pollutants	3.1	3%	Selection of finishes, materials		G.2 - Control of Indoor Pollutants	*	*	EQ Credit 4 - Low-Emitting Materials	4	27%
Assure Acoustic Privacy and Comfort	Ambient internal noise levels specified	10	7%	Noise and acoustics	15	15%	Noise and acoustics		G.5 - Acoustic Comfort	25	13%			
Control Disturbing Odors through Contaminant Isolation and Product Selection	Air intake serving occupied areas avoid major sources of external pollution	10	7%	Ventilation and control of smoking	2.5	2%	Limit pollutant migration		G.2 - Source Control of Indoor Pollutants	*	*			
Create a High—Performance Luminous Environment	High frequency ballasts. Lighting design compliance to guide. Occupant controlled glare control. Daylighting. Lighting Zones <4 workplaces.	50	33%	Lighting and illumination	25	25%	Daylighting and illumination		G.3 - Lighting design and integration of lighting systems	*	*	EQ Credit 6.1 - Controllability of Systems - Lighting	1	7%
Provide Quality Water														
Be Aware of Exposure to Electric and Magnetic Fields (EMF)														
Balance IEQ Strategies with Security Requirements														

Table C.3 Use Environmentally Preferable Products - Comparison of Rating System Emphasis														
	BREEAM			CASBEE			GBTool		Green Globes			LEED		
WBDG Criteria for Use of Environmentally Preferable Products	**Materials**	**98**	**% of total**	**Resources and Materials**	**85.85**	**% of total**	**Materials**	********	**Resources, Building Materials and Solid Waste *****	**102**	**% of total**	**Materials & Resources**	**13**	**% of total**
Renovate Existing Facilities, Products, and Equipment	Reuse of the existing structure.	8	8%	Reuse existing building structure and reuse efficiency of materials in structure	15.3	18%	Planned reuse of existing structures, planned reuse of salvaged materials		E.3 Reuse of existing structures	10	10%	MR Credit 1 - Building Reuse MR Credit 3 - Resource Reuse	5	38%
Evaluate Environmental Preferability Using LCA						0%			E.1 Materials with low impact environmental impact	40	39%			
Maximize the Recycled Content of All New Materials	Use of recycled façade, aggregate or masonry materials.	16	16%	Recycled Materials	29.75	35%	Planned use of recycled materials from off-site sources		E.2 Minimized consumption and depletion of material resources	30	29%	MR Credit 4 - Recycled Content	2	15%
Specify Materials Harvested on a Sustained Yield Basis	Timber and composite timber products are specified from sustainably managed sources or are reused or recycled timber.	18	18%	Timber from sustainable forests	3.4	4%	Planned use of bio-based products obtained from sustainable sources		E.2 Minimized consumption and depletion of material resources	*	*	MR Credit 6 - Rapidly Renewable Materials MR Credit 7 - Certified Wood	2	15%
Encourage the Use of Recyclable Assemblies and Products				Reusability of components and materials	15.3	18%	Design for disassembly, reuse or recycling		E.4 Building durability, adaptability and disassembly	12	12%			
Limit Construction Debris									E.5 Reduction, re-use and recycling of waste.	10	10%	MR Credit 2 - Construction Waste Management	2	15%
Eliminate the Use of Materials that Pollute or are Toxic During Their Manufacture, Use, or Reuse	No asbestos used or remains in the structure.	8	8%	Materials with low health risk. Avoidance of CFCs and Halons	22.1	26%			E.1 Low impact systems and materials	*	*			
Give Preference to Locally Produced Materials with Low Embodied Energy Content							Planned use of materials that are locally produced		E.2 Minimal consumption of resources	*	*	MR Credit 5 - Local/Regional Materials	2	15%
Not Specified	Install carpets/floor finishes that are specified by the new tenants.	8	8%									MR Prerequisite 1 - Storage & Collection of Recyclables		
Not Specified	Major building elements evaluation against Green Guide specifications or Ecopoints benchmarks.	32	33%											
Not Specified	A central dedicated storage space for recyclable materials is located within the building or on site.	8	8%											