Campus Sustainable Design Guidelines

November 2004

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University of Connecticut

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Section I - Goals of the Sustainable Design Guidelines

Introduction

The University of Connecticut (University) has long been committed to academic excellence, social responsibility, and the economic vitality of the state of Connecticut and beyond. The University's main campus at Storrs, as well as the five regional campuses across the state, recognizes the value of careful land use planning and the protection of natural resources. The University's Environmental Policy Advisory Committee (EPAC), under the direction of the Office of the Director of Environmental Policy, serves to seek and implement strategies that will establish the University as a leader in environmental stewardship. The EPAC has adopted a policy statement that defines the principles for environmental leadership, setting the course for future campus initiatives. The EPAC's Land Use and Sustainable Development Subcommittee seeks to incorporate guidelines for low-impact, sustainable design for the University's construction program. The Sustainable Design Guidelines represent this goal and the University's commitment to protect our natural resources.

This document is divided into three sections and appendices:

- Section I – Goals of the Sustainable Design Guidelines describes the vision of the University, the principles that are significant to that vision, and the role future development can play towards implementing these principles.
- Section II – Technical Guidelines should be considered for future development projects. Not every recommendation will be applicable to every University project; however, each recommendation's intent should be considered to determine whether alternate strategies might achieve the same environmental benefit.
- Section III – Process Guidelines recognizes that the Technical Guidelines alone are insufficient to impact change within a university. Therefore, this section includes recommendations for providing an overlay for implementing sustainable strategies within the University's process and procedures for the design and construction as defined in the Planning and Design Standards document.
- Appendices include Resources (Appendix A) and a Sample Sustainability Matrix (Appendix B), and are provided for both designers and University staff to aid in the implementation of the guidelines established in this document.

Sustainable Design Guidelines recognize the environmental cost of buildings and development. The ultimate goal is to protect our finite natural resources such as water, forests, land, and the protection of human health.

These guidelines recommend strategies for future development that can minimize the environmental impact within the following five broad categories:

- Planning Sustainable Sites
- Safeguarding Water
- Conserving Materials and Resources
- Improving Energy Efficiency
- Enhancing Indoor Environmental Quality

University of Connecticut
Environmental Policy Statement
April 22, 2004

In fulfilling its mission as Connecticut's land grant, public research university and its corresponding obligation to protect and preserve natural resources for an environmentally sustainable future, the University of Connecticut commits to the following principles of environmental leadership:

Performance: The University will institutionalize best practices and continually monitor, report on and improve its environmental performance.

Responsible management and growth: The University will endeavor to design, construct and maintain its buildings, infrastructure and grounds in a manner that ensures environmental sustainability and protects public health and safety.

Outreach: The University will promote environmental stewardship in Connecticut and embrace environmental initiatives in partnership with its surrounding communities.

Academics: The University will advance understanding of the environment through its curriculum, research and other academic programs, and will employ an ethic of environmental stewardship in all intellectual pursuits.

Conservation: The University will conserve natural resources, increase its use of environmentally sustainable products, materials and services, including renewable resources, and prevent pollution and minimize wastes through reduction, reuse and recycling.

Teamwork: The University will encourage teamwork and provide groups and individuals with support, guidance and recognition for achieving shared environmental goals.

We, the community of students, faculty, staff and administration at the University of Connecticut, both individually and collectively, affirm our commitment to act in accordance with these principles.

"The building of Shelter consumes one-sixth of the world's fresh water supply, one quarter of its wood harvest, and two-fifths of its fossil fuels and manufactured materials."
James Wines, *Green Architecture*

The LEED Rating System as a Sustainability Benchmark

The Leadership in Energy and Environmental Design Rating System (LEED™) is a tool created by the U.S. Green Building Council (USGBC), a private, non-profit, consensus-based organization, to help promote and measure sustainable design. LEED™ is a widely accepted system for certifying a building's sustainability, and since it was first introduced to the public in 2000, it has been widely used throughout the country. LEED™ is a list of non-prescriptive environmental goals organized into five categories:

- Sustainable Sites
- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality

These categories were created in response to the broad environmental issues affecting global health and are a reflection of how green building might minimize adverse global impact. There are several goals within each category. Based on the number of goals that a project is able to successfully implement, the building is awarded a rating. Out of a possible 69 points, if 26-32 of those points are implemented, the project is awarded a "LEED™ certified" rating. A "LEED™ certified silver" rating is awarded for 33-38 points, 39-51 points would merit a "LEED™ certified gold" rating, and 52 points or more would earn a "LEED™ certified platinum" rating.

Rather than mandating that all future development at the University meet a predetermined LEED™ level, such as "silver," LEED™ will be used, together with the Technical Guidelines outlined in this document, as a goal-setting tool – a benchmark. Projects should seek to incorporate as many sustainable strategies as feasible, given site, program, or budget restrictions. During the initial planning of a project, the University should work with the design consultants to review the 34 goals included in LEED™, determining which of those goals are well suited to the specific project.

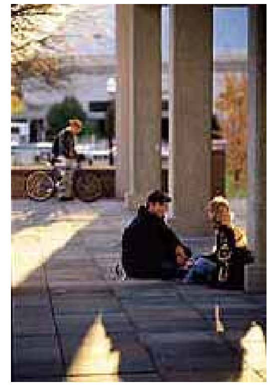
There are several advantages to using the LEED™ as a benchmark:

- It has gained widespread acceptance and is considered to be the national standard for measuring sustainable buildings.
- It is an evolving guideline and is structured to allow for updates as new ideas are found, new environmental considerations are discovered, and new standards of practice increase in mainstream environmental performance. LEED™ is updated every five years. LEED™ version 3.0 will be released in 2005.
- It attempts to quantify the environmental performance of a building. In so doing, the initial cost premium associated with designing and constructing green buildings can be determined.

Section II - Technical Guidelines

Introduction

The following section establishes recommended goals and strategies, and lists technical resources to be considered during the design of capital improvement projects, including new construction, renovation, and retrofits at all University campuses and facilities. These Technical Guidelines are arranged in five categories:



- Planning Sustainable Sites
- Safeguarding Water
- Conserving Materials and Resources
- Improving Energy Efficiency
- Enhancing Indoor Environmental Quality

The guidelines incorporate content from a variety of other published sustainable design guidelines and standards, including LEED™ for both new construction and existing buildings. The strategies have been tailored to address issues relevant and specific to the University's campuses, the regional climate in Connecticut, and standards and practices already in place at the University.

Selected strategies from these guidelines will be incorporated into the design of individual projects if the University determines that those strategies are prudent and feasible given the unique site and building characteristics. This determination will be based on an evaluation of several factors, including:

- Environmental benefits.
- Capital cost differential.
- Operational cost savings.
- Maintenance implications.
- Aesthetic and design consistency.
- Compatibility with intended use.

Strategies selected for final incorporation should carefully balance these and other considerations. No single factor should determine whether or not a strategy is considered prudent and feasible.

Planning Sustainable Sites

Goal 1 Plan campus growth on the most suitable sites possible, avoiding unnecessary environmental impacts to the existing campus open space and natural resources.

Strategies

- Ensure consistency with the current campus master plan and state and local plans for conservation and development in accordance with the current State of Connecticut Office of Policy and Management Plan Locational Guide.
- Protect lands that meet the definition of direct recharge areas (as contained in the regulations of the Connecticut Department of Environmental Protection for existing and potential reservoir and diversion sites) and aquifer protection areas.
- Adopt practices consistent with the respective plans of conservation and management produced by the University's Department of Natural Resources Management and Engineering for designated University forest tracts.
- Preserve and protect wetland areas. Preserve vegetated buffers, to the extent possible, when disturbance is anticipated in proximity to wetlands.
- Prevent development on lands within flood plains as defined by the Federal Emergency Management Agency (FEMA).
- Protect habitats of species of special concern (threatened and endangered species).

Goal 2 Minimize the physical impact of new development on the surrounding natural landscape.

Strategies

- Conserve high quality natural areas and restore damaged landscapes.
- Encourage development over the footprint of previously developed or disturbed areas.
- Establish limits of disturbances on all previously undisturbed sites. Plan for construction staging areas that avoid sensitive site areas.
- Work with the University's Arboretum Committee to limit the disruption of trees and vegetation according to the University's tree protection guidelines.
- Exceed applicable requirements for mitigation of any wetlands impacted by development.
- Exceed applicable requirements for mitigation of any floodplains impacted by development.
- Consider using native or adapted planting for their lower maintenance, water efficiency, ornamental and pest tolerance characteristics, and educational value.
- Anticipate and plan for maintenance access throughout the campus to minimize impacts to landscaped areas.

Goal 3 Reduce the impact of automobiles and roadways by providing and encouraging alternative transportation methods and alternative energy vehicles.

Strategies

- Create an effective program for evaluating potential transportation needs when designing and siting all future campus facilities. Encourage clustering of residential, academic, research, and recreational uses, and other student services to reduce the potential need for vehicular travel.
- Develop guidelines for the design of new campus roadways that provide an appropriate and attractive context for campus buildings and easily accessible housing. Encourage pedestrian and bicycle use.
- Implement a program with measurable goals to encourage pedestrian and bicycle travel on campus and to the surrounding community.
- Use parking management as a tool to encourage walking and bicycling. Align parking requirements with the current campus master plan. Provide the majority of long-term parking on the campus periphery.
- Maintain pedestrian-friendly campus cores served by a campus-wide bus system. Extend future campus transit and pedestrian routes as required to service all campus buildings. Extend routes to serve common off-campus destinations. Provide adequate transit service frequency to minimize wait times.
- Consider purchasing new buses and/or maintenance vehicles that use alternative fuels such as natural gas, electricity, or bio-diesel when new campus vehicles are added to the University's fleet.

Goal 4 Develop site features to minimize adverse impacts to the site's microclimate.

Strategies

- Consider using light colored (minimum reflectance 0.3) materials for paved areas such as pedestrian walks, bicycle paths, and roads.
- Comply with the Environmental Protection Agency's (EPA) ENERGY STAR® Roofing Guidelines[1] for flat roofs. Use of flat roofs is discouraged in the current campus guidelines and, therefore, should be limited.
- Develop strategies to alleviate severe conditions in the summer. Consider shading large paved areas by providing landscape islands (preferably curbless, vegetated bio-retention landscape islands) with shade trees, trellises, or canopies.
- Consider locating large paved areas on the north side of the building, allowing the building to shade a portion of the paving.
- Plan for the strategic placement and layout of buildings and landscape to alleviate severe conditions in winter. Explore opportunities for mutual sheltering of buildings, establishing windbreaks where necessary and protecting open space, parking, and building entryways.

[1] The EPA's ENERGY STAR® program allows for voluntary partnerships between the U.S. Department of Energy, the U.S. Environmental Protection Agency, product manufacturers, local utilities, and retailers. The ENERGY STAR® program identifies roofing products that reduce the amount of air-conditioning needed in buildings and can reduce energy bills by up to 50 percent (source: EPA). Roofing products with the ENERGY STAR® logo meet the EPA criteria for reflectivity and reliability. http://www.energystar.gov

Goal 5 Provide site lighting that is sensitive to light pollution of the night sky and minimizes impacts on nocturnal environments.

Strategies

- Meet the light levels and uniformity ratios recommended by the *Illuminating Engineering Society of North America (IESNA) Recommended Practice Manual: Lighting for Exterior Environments.*[2]
- Design exterior light fixtures with shielding to prevent light spillage to the night sky per the following standards:
  - Exterior fixtures with output greater than 3500 lumens shall be Full Cutoff.
  - Exterior fixtures with output less than 3500 lumens shall be Cutoff or Full Cutoff.
  - Locate, aim, and shield all exterior light fixtures to minimize light trespass across campus boundaries.

[2] This standard provides general exterior lighting design guidance and acts as a link to other IESNA outdoor lighting Recommended Practices (RPs). IESNA RP documents address the lighting of different types of environments. Also covered are exterior lighting design issues including community-responsive design, lighting ordinances, luminaire classification, structure lighting, and hardscape and softscape lighting.

LEEDTM 2.1 requires that light levels meet or are lower than those prescribed by IESNA. Given concerns for nighttime campus safety, the University of Connecticut Planning and Design Standards advise to meet and not to exceed IESNA levels.

Safeguarding Water

Goal 1 Reduce development stormwater runoff[3] impacts on the quantity and quality of the area's water resources.

Strategies

- Prevent any increase in the rate of stormwater flow leaving the site. Provide for infiltration of stormwater runoff on both greenfield and previously disturbed sites. Strategies for implementing both of these goals include:
  - Promoting permeable paving technologies in lieu of the conventional impervious surfaces for drives and parking lots. Perform a life-cycle cost analysis that recognizes the long-term maintenance costs with the resulting benefits when choosing the appropriate system.
  - Collecting rainwater from project roofs, where feasible, and store it for reuse or slow release.
  - Implement landscaping that has a higher rate of absorption than conventional turf grass.
  - Reducing the need for stormwater utilities and detention basins. Introduce stormwater bio-retention basins, swales, or rain gardens within the project site or within the adjacent campus or clusters of buildings.
  - Using a vegetated roof for flat or low sloping roofs.
- Incorporate on-site stormwater treatment and infiltration to meet the guidelines of the *Connecticut Department of Environmental Protection, Connecticut Stormwater Quality Manual, 2003*. Strategies for consideration, in order of preference, for implementing this goal include:
  - Incorporating bio-retention areas, rain gardens, vegetated basins, vegetated swales, constructed wetlands, etc. on site to treat stormwater.
  - Including on-site mechanical filtration systems to treat stormwater to meet the standards as defined in the manual.

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[3] General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities: Fact Sheet PDF General Permit and Forms; Word Forms 500 KB, *zipped*
DEP-PERD-GP-015, 22 Pages, Reissued 10/01/02; DEP-PERD-REG-015, 5 Pages, Rev. 01/23/01; DEP-PERD-CONST-NOT-001, 1 Page, Rev. 01/23/01; excludes required Common Forms

Flood Management Certification – http://dep.state.ct.us/pao/iwrdfact/flood.htm

Water Diversion – http://dep.state.ct.us/pao/iwrdfact/waterdiv.htm

Note: Stormwater management should combine efforts to minimize impervious surfaces with efforts to maximize infiltration of precipitation into the ground. However, there are some areas where infiltration should be avoided, for example: areas with steep unstable slopes; impermeable soils; areas close to water supply wells; areas close to septic systems; areas close to sensitive structural foundations; and contaminated sites that would leach with added flow. Untreated stormwater should not be allowed to discharge directly into surface or subsurface waters. http://www.scseagrant.org/scnemo/pdf/bcd_fs.pdf/bcdnemofs7.pdf

Goal 2 Reduce potable water consumption associated with landscape irrigation.

Strategies

Consider the following strategies for prominent campus areas that require irrigation:
- Utilize drought tolerant planting in lieu of providing irrigation; include drought tolerant turf mixes where turf grass is a landscape requirement.
- Encourage the use of native vegetation beds and meadows that require no irrigation, pesticide use, or fossil fuel expenditure for mowing.
- When required, use high-efficiency irrigation systems in lieu of conventional irrigation systems as appropriate and as justified by a life-cycle cost analysis.
- Draw on non-potable sources for irrigation systems, such as adjacent ponds or collected rainwater.

Goal 3 Consider reducing the consumption of potable water and potentially reducing stormwater impacts by incorporating grey water systems for waste conveyance.[4]

Strategies

- Collect wastewater from sinks, mechanical condensate, and drinking water fountains for reuse in toilet/urinal flushing.
    - Work with local public health department[5] early in the design process to determine the parameters for the system to gain approval. Determine the required filtration of the collected grey water.
    - Investigate the environmental and long-term economic advantages by performing a life-cycle cost analysis of the system.

Goal 4 Reduce overall water consumption inside buildings.

Strategies

- Replace plumbing fixtures to meet (at a minimum) the Energy Policy Act of 1992[6] for fixture performance requirements for renovations and retrofits of existing buildings.
- Use waterless urinals in lieu of conventional urinals.[7] Work with University maintenance staff to determine if the maintenance requirements can be met.

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[4] Grey water systems are only recently being considered by Connecticut authorities. Committee Bill 6414- 2001 - AN ACT CONCERNING A MUNICIPAL PILOT PROGRAM FOR GREY WATER - establishes a pilot program for the use of grey water from publicly owned treatment works. As part of the pilot program, the department may approve the use of such treated grey water in public schools and municipal facilities in manners determined by the department, provided such uses do not negatively impact public health.

[5] See Public Health Code
http://www.dph.state.ct.us/phc/phc.asp

[6] This Act was promulgated by the U.S. government and addresses energy and water use in commercial, institutional and residential facilities.

[7] Waterless urinals have been used in Eastern Connecticut State University in Willimantic, Western Connecticut State College in Danbury, and other schools. The University of Connecticut has a trial installation of waterless urinals at the Storrs Campus. Bruce Bockstael, Chief Architect for the State of Connecticut's Department of Public Works, has approved their use, and Daniel Tiemey, Deputy State Building Inspector, has approved their standards for testing compliance.

- Utilize dual-flushing toilets in women's facilities.[8]
- Install low-flow, power-assisted toilets.[8]
- Use infrared sensors on faucets. Include sensors as part of the building commissioning.
- Utilize showers and faucets with flow restrictors to meet or exceed the Energy Policy Act of 1992 for fixture performance requirements.
- Specify clothes washing machines in dormitories to comply with the EPA's ENERGY STAR® program.[9]

Goal 5 Explore the use of alternative wastewater treatment methods to reduce demand on campus waste treatment facilities.

Strategies

- Consider incorporating alternative waste treatment systems to treat black water generated from buildings such as composting toilets, living machines, and constructed wetlands.

[8] While considering emerging technologies to meet environmental goals, evaluate that these products meet testing standards, comply with local requirements, and will perform adequately in their anticipated use.

[9] ENERGY STAR® products not only conserve energy, but also conserve water.

Conserving Materials and Resources

Goal 1 Maintain and expand campus-wide areas for recycling paper, corrugated cardboard, glass, plastics, and metals from building waste streams.

Strategies

- Provide easily accessible recycling stations throughout the campus that allow for the collection and separation of paper, corrugated cardboard, glass, plastics, and metals. Size recycling stations to accommodate the University's standard recycling containers.
- Provide recycling stations at convenient locations both inside and outside of buildings, including event gathering areas, parking lots, and site plazas.

Goal 2 Reduce the quantities of construction and demolition waste generated from University projects.

Strategies

- Consider the viability of adaptive reuse of existing structures in lieu of new construction.
- Pattern future development to be flexible and long lasting. Use durable materials that extend the life of the project. Consider future alternative uses for the building when determining floor-to-floor heights and planning modules. Plan development to accommodate future growth.
- Minimize the waste impacts associated with future reconfiguration of interior offices by using open office environments, flexible systems furniture, and modular partitions for office areas.
- Design projects to be recyclable. Use products that can easily be disassembled and/or recycled at the end of a project's useful life.
- Specify carpet and ceiling tiles (and other products) from companies that participate in reclamation programs (companies who will take back their products for recycling after their useful life).
- Strive to recycle and salvage as much demolition waste as possible if existing development on site cannot be reused. Explore the economic advantages to recycling construction waste rather than conventional demolition.
- Expand campus waste streams analysis to find destinations that can reuse/recycle common construction waste streams such as steel, concrete, and asphalt.
- Require contractors to incorporate a construction waste management plan, such that a minimum of 50 percent of construction waste is diverted from landfills.

Goal 3 Consider the associated environmental impacts when selecting materials.

Strategies

Expand the evaluation criteria used when selecting building and site materials to include the following criteria:

Durable

- Reduce the consumption of resources by using materials that have a long service life and, therefore, require less replacement.
- Evaluate the life-cycle cost implications of material options, since the initial cost of more durable materials are often more than their counterparts. This evaluation should compare the initial cost investment, the service life, and the annual maintenance costs over a 50-year life cycle.

Locally Manufactured

- Require that a minimum of 20 percent of the materials used in the project have been manufactured within a 500-mile radius of the site to minimize the fossil fuel depletion and impacts associated with transporting materials.

Locally Extracted

- Require that 10 percent of the materials used in the project are not only locally manufactured, but are comprised of raw materials that have been extracted from within a 500-mile radius to minimize fossil fuel depletion and impacts associated with transporting materials.
- Consider specifying products that come from sources within a 500-mile radius of the campus and ideally are manufactured within a 300-mile radius when specifying steel, brick, concrete, and slate[10] used within a project. This strategy not only minimizes fossil fuel depletion, but also supports local industry.

Recycled

- Divert materials from waste streams and minimize consumption of virgin resources by specifying materials with a recycled content wherever feasible. As a minimum, for a material to be deemed "recycled," it should have a 20 percent post-consumer content or a 40 percent post-industrial content.[11] Opportunities for recycled materials include:
  - Concrete mixes that contain fly-ash or ground blast furnace slag (post-industrial waste).
  - Acoustical ceiling tiles with a high recycled (newspaper) content.
  - HDPE toilet partitions from recycled sources.
  - Ceramic tiles that use recycled glass.
  - MDF (recycled wood fibers) for millwork substrates.
  - 100 percent recycled drywall.
  - Carpet products with a high recycled content.

[10] Each of these products is manufactured locally without restricting procurement flexibility.

[11] These values correspond with the criteria of LEED™ (version 2.0).

Recyclable

- Facilitate the future recyclability of materials at the end of a project's useful life by incorporating materials that can be readily recycled in the future.
- Avoid composite systems (products that permanently combine different materials), given that these are difficult to separate and recycle.
- Favor materials that can be recycled indefinitely, as opposed to materials that can only be recycled once.

Salvaged

- Favor materials that come from salvaged sources, where feasible.
- Look to salvage reusable items from campus demolition projects for reuse in future projects.

Renewable

- Use materials that can be replenished within a ten-year cycle, such as natural linoleum, bamboo, wood, and wheatboard from millwork substrates.

Biodegradable

- Favor the use of materials that can biodegrade to those that cannot, where appropriate.
- Consider natural and biodegradable soil and erosion control strategies, such as earth dikes and straw bales.

Non-Toxic

- Avoid materials that contain toxic constituents.
- Use chromated copper arsenate (CCA) free pressure treatment for exterior woodwork. Opportunities include the use of naturally decay resistant woods, such as cedar, or ammonium copper quat (ACQ) pressure treatment.
- Avoid products that contain mercury (thermostats) or chrome (plumbing fittings).[12]

Favorable Life-Cycle Assessment

- Consider the overall environmental performance (which examines how the manufacture, installation, and demolition of a material contributes to environmental problems such as acidification, critical air pollution, ecological toxicity, eutrophication, fossil fuel depletion, global warming, habitat alteration, human health concerns, indoor air quality, ozone depletion, smog, and water consumption) associated with a given material.
- Study life-cycle environmental performance of materials using Building for Environmental and Economic Sustainability (BEES) 3.0, developed by the National Institute of Standards and Technology with support from the U.S. EPA.

[12] The EPA has found chromium to potentially cause long-term effects including damage to the liver, kidneys, circulatory system and nerve tissue, as well as skin damage and cancer.

Goal 4 Require that wood products be obtained from sources certified by the Forest Stewardship Council (FSC).[13]

Strategies

- Strive to specify at least 50 percent of all wood-based products from FSC certified sources. This requirement addresses all wood (including, but not limited to, architectural woodwork, all rough carpentry, all prefabricated millwork, wood windows, wood doors, wood concrete formwork, etc.).

[13] FSC was created in 1993 to establish international forest management standards (known as the FSC Principles and Criteria) to assure that forestry practices are environmentally responsible, socially beneficial and economically viable. These Principles and Criteria have been established to ensure the long-term health and productivity of forests for timber production, wildlife habitat, clean air and water supplies, climate stabilization, spiritual renewal, and social benefit, such as lasting community employment derived from stable forestry operations.

Improving Energy Efficiency

Goal 1 Reduce the total energy consumption of buildings.

Strategies

Effectively reduce a building's energy consumption by first identifying strategies to reduce the building's dependence on mechanical heating and cooling, followed by the identification of systems that increase the operational efficiencies, and, lastly, harnessing site energy.

Reduce Conditioning Loads

- Request energy modeling to optimize energy performance by way of assessing the interactions of simultaneous strategies.
- Perform energy modeling to determine the optimal R-values for the building envelope. Alternatively, require that exterior wall assemblies are a minimum of R-19 and that roof assemblies are a minimum of R-30.
- Require all glazing to incorporate double-glazed insulated glass units with a low-E coating, argon-filled with a U-factor of $\leq$0.27.
- Examine passive solar design strategies when determining site concepts for new buildings such as orienting the building to the south, providing windows to collect winter sun, and providing thermally massive materials inside the building to store collected heat. Minimize glazing on the east, west, and north elevations, while maximizing glazing on the south elevation.
- Consider providing seasonal shading to south facing glazing.
  - Shade the south facade with deciduous trees.
  - Incorporate porches to south facades to shade the glazing.
  - Use horizontal sun shades and roof overhangs to shade the glazing from summer sun.
- Consider west-facing glazing with a high shading coefficient if ideal orientations are not feasible and it is difficult to minimize west-facing glazing. This can be achieved by using ceramic frit-coated glass or tinted glass.
- Incorporate thermal mass within a building. High mass buildings can stabilize temperature swings by storing heat during the day and releasing it during the evening, thus reducing the building's peak cooling loads.

Increase Operational Efficiency

- Use the campus' Central Utility Plant for steam and chilled water needs within buildings whenever possible.
- Require that all projects comply with the minimum level of energy efficiency as prescribed by ASHRAE Standard 90.1-2001.
- Require ENERGY STAR® products where applicable, including all new equipment, transformers, and kitchen appliances.
- Use energy efficient equipment with premium efficiency motors acceptable with the local utility. Use variable speed drives.

- Utilize high-efficiency lighting. Use only electronic ballasts.
- Avoid over-sizing equipment. This will ensure that equipment is running at peak efficiency.
- Utilize a demand-controlled ventilation strategy for classroom spaces and other spaces with large occupancy swings. By providing monitors that measure the CO_2 levels within a space, ventilation rates can reduce to minimums when the room is not occupied.[14]
- Use heat recovery systems that capture waste heat to reduce heating energy consumption. Consider total energy recovery systems that capture both latent and sensible heat to reduce both heating energy and cooling energy.[14]
- Provide occupancy sensors that control lighting in all spaces not regularly occupied, including common areas.
- Explore fuel cells and other alternative energy supply systems. Capture the heat created from fuel cells through waste heat utilization strategies.

Harness Site Energy

- Examine the feasibility of mixed-mode natural ventilation to cool and ventilate buildings when the outside temperature is suitable.
- Consider installing operable windows, especially in classrooms and offices, and providing micro-switches that control the room ventilation/cooling when the window is open.
- Require that air economizers be used in new buildings.
- Explore the use of solar domestic hot water heaters.[14]
- Provide adequate natural daylight to regularly occupied rooms; utilize daylight sensors that modulate interior lighting levels based on natural light levels. Lighting modulation can be achieved through multiple switching or dimmable ballasts.[14]

Goal 2 Generate a portion of the project's electricity demand through renewable energy sources.

Strategies

- Evaluate the economic feasibility of providing photovoltaics or wind turbines as part of new projects.[14]
- Examine the implications of incorporating photovoltaics when planning and siting a new project, such as proper solar orientation, solar angle, and the size of the photovoltaic array.
- Consider purchasing power from a green power company.[15] [16]

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[14] Perform a life-cycle cost analysis to determine if this strategy is economically justified.

[15] Green-E certified providers are available in Connecticut. Connecticut College has established a goal of purchasing 20 percent of their energy from renewable energy sources. Wesleyan has powered one building using Green-E certified renewable energy. Other universities, such as Carnegie Mellon, Penn State, University of Vermont, Oberlin, et. al. generate a portion or all of their energy demand from green power sources.

[16] Since the Storrs Campus will meet its electricity needs through the campus cogeneration facility, green power is applicable for spot purchases at Storrs or to provide power at the regional campuses.

Goal 3 Eliminate the use of ozone-depleting substances in campus buildings.

Strategies

- Require that all refrigerants within new buildings not contain CFCs or HCFCs.
- Phase out CFC and HCFC refrigerants in existing buildings.
- Do not include halons in fire suppression systems in new buildings.

Goal 4 Verify and monitor the performance of building systems to ensure they have been designed, installed, and are operating to meet the maximum efficiencies intended.

Strategies

- Require that all new buildings be fully commissioned by an independent third party commissioning agent. The systems to be commissioned include HVAC systems, building control systems, duct work and piping insulation, renewable energy and alternative energy technologies, lighting controls, heat recovery, and automatic sensors.[17]
- Involve the commissioning agent early in the design process as part of the design team so that they can review and comment on the systems' designs.
- Require the commissioning agent to produce a manual that describes the procedures for re-commissioning the building in the future.
- Perform and record building operations training that covers the procedures for start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, controls set-up and programming, troubleshooting, alarms, interactions with other systems, adjustments, and optimizing methods for energy conservation, special maintenance and replacement sources, use of the O&M Manuals, and review of control drawings and schematics.[18]

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[17] This requirement is consistent with commissioning activities currently in place at the University of Connecticut.

[18] From the LEED™ 2.1 Reference Guide, Prerequisite 1 for Energy and Atmosphere, Table 4; Training Issues to be Addressed by the Commissioning Authority.

Enhancing Indoor Environmental Quality

Goal 1 Ensure that indoor air quality is acceptable and free from known contaminants.

Strategies

Plan to Minimize Pollutant Infiltration

- Relocate designated smoking areas away from major building entrances and air intakes.
- Separate air intakes from loading areas and building exhausts.
- Provide permanent entrance mats at all entranceways.
- Comply with ASHRAE 62-1999[19] (Ventilation for Acceptable Indoor Air Quality) for all new construction.
- Design exterior wall and roof systems to prevent mold from developing within the building. Develop exterior wall enclosure systems to prevent water infiltration, favoring enclosure systems with vented cavities with drainage provided at the cavity bottom.

Remediate Existing Air Quality Problems

- Test for and identify potentially hazardous materials within existing buildings and develop a plan for remediation. Hazardous materials may include asbestos, silica dust, radon, and mold.

Prevent Long-Term Air Quality Contamination from Construction Practices

- Require the contractor to submit a plan that coordinates the scheduling of absorptive products with the application of off-gassing products.
- Require the contractor to replace filtration media after completion of construction.
- Consider requiring a two week building flush-out period.
- Protect exterior wall assemblies and absorptive building materials during construction to prevent future mold contamination within the completed building.

Specify Low-Emitting Materials for Interior Finishes

- Use only no- or low-volatile organic compounds (VOC) paints for all interior applications. VOC limits should meet LEED™ standards as described in Credit EQ 4.
- Use only no- or low-VOC sealants for all interior applications. VOC limits should meet LEED™ standards as described in Credit EQ 4.

[19] This standard specifies minimum ventilation rates and indoor air quality (IAQ) levels to reduce the potential for adverse health effects. The standard specifies that mechanical or natural ventilation systems be designed to prevent uptake of contaminants, minimize the opportunity for growth and dissemination of microorganisms, and filter particulates, if necessary.

- Maintain campus requirement that all carpets comply with the Carpet and Rug Institute Green Label Testing Program.[20]
- Use only no- or low-VOC adhesives for all interior applications. VOC limits should meet LEED™ standards as described in Credit EQ 4.
- Require all composite wood products used inside of buildings to be free from urea-formaldehyde resins.

Monitor Indoor Air Quality to Alert Users of Contamination Problems

- Consider providing CO_2 monitoring to ensure adequate ventilation is being provided, especially in high occupancy spaces.
- Examine providing carbon monoxide and VOC monitoring to alert occupants of any unhealthy air conditions inside the building.

Goal 2 Create healthy interior spaces that support learning and are comfortable to users.

Strategies

- Consider designing interiors to comply with ASHRAE 55-1992: Thermal Environmental Conditions for Human Occupancy.[21] If compliance with this standard requires a building humidification system, determine the cost premium associated with the system in order to decide if this approach is justified. Confirm whether humidification would compromise the building program, such as in spaces for conservation of artifacts.
- Provide ample natural light into interior spaces wherever possible. As a target, the Daylight Factor of each regularly occupied room should meet or exceed 2 percent.[22]
- Plan for internal shading strategies to reduce glare.
- Offer views to the outside from most interior spaces wherever possible. Designs should strive to provide a connection to the outdoors.

[20]The Carpet and Rug Institute is a trade organization representing the carpet and rug industry. The organization established the Green Label Testing Program Limits to identify low-emitting carpet products for consumers.

[21] This standard identifies the range of design values for temperature, humidity and air movement that provide satisfactory thermal comfort for a minimum of 80 percent of building occupants.

[22] Refer to the LEED™ – NC v. 2.1 Reference Guide, Credit EQ 8 for calculations required to determine a room's daylight factor.

Section III - Process Guidelines

Introduction

Technical Guidelines alone are not sufficient to ensure that future development is environmentally and economically sustainable. The design and construction process should be interactive and collaborative, meeting the project program while integrating sustainable strategies to form a holistic design by actively engaging the University and the consultant design team.

The University's current design and construction process is collaborative and encourages integrated thinking. Therefore, it easily lends itself to the sustainable design process – recognizing that numerous systems and components of the project are interrelated and seeking to find synergies throughout the design process.

It is imperative that sustainability goals are established at the project's initiation. Involving the University and the consultant design team in the goal-setting and design process enables the resulting design to efficiently in1corporate these goals without significant initial cost premiums. This will also ensure that the resulting project is compatible with the expectations and culture of the University, and supportive of the project's program. It is assumed that the consultant design team will coordinate the sustainable design process in achieving the project goals. Consistent with current University practices, the Office of the Director of Environmental Policy will be responsible for the review and approval of the sustainable aspects for the project. The Director of Environmental Policy may delegate a member of the Building Committee to fulfill these functions.

The following process guidelines build on the University's existing design and construction processes. Incorporating these recommendations (as applicable to the project) will ensure successful integration of the Technical Guidelines.

Pre-Design

Design Initiation and Professional Selection Phases

The University should:

- Ensure that all new developments (especially those not addressed in the current campus master plan) are placed on the most suitable site possible, avoiding unnecessary impacts to campus open areas and important natural resources, working within the framework of the current campus master plan.
- Establish an obtainable sustainable target (use LEED™ as a benchmark) for the new project, recognizing the opportunities and constraints within a given project such as site, program, budget, and broader University goals.
- Develop the project "Request for Qualifications," indicating the project's sustainable goal. Require submitted qualifications to include the consultant's experience with regard to sustainable design and LEED™ documentation, including their documentation fees from recently completed projects (see Appendix A – Resources; *Writing the Green RFP*).

Pre-Design Planning

The consultant design team should:

- Discuss broad sustainable approaches during the programming phase with the Project Team (Architectural & Engineering Services (AES) Project Manager, Building Committee, and Office of Director of Environmental Policy representative). Overview the benefits of sustainable design with the Project Team to identify worthwhile strategies for consideration. Perform a benchmarking analysis of other projects of similar program that have incorporated sustainable strategies. This will help identify strategies and relevant approaches.
- Ensure that a climate/site analysis is performed. Sustainable designs must respond to site and climate conditions. This analysis should identify the direction of prevalent summer and winter winds, anticipated wind speeds, annual rainfall, site slopes, solar sun paths, existing site habitats, stormwater patterns, and other relevant site features.
- Identify, for building projects, the utility loads for a typical building of similar program and site to determine the primary resource consumption areas of the building. This knowledge will allow the consultant design team to prioritize strategies to address the significant loads of the proposed building.
- Hold a Green Workshop with the Project Team. A Green Workshop is an interactive meeting involving representatives from the University and all of the disciplines of the consultant design team. The purpose of the workshop is to evaluate, establish, and prioritize sustainable goals for the new project. These goals are recorded using a Sustainability Matrix, and the champions responsible for implementing each goal are assigned. Submit the completed Sustainability Matrix for review by the Office of the Director of Environmental Policy.

The University should:

- Submit the Sustainability Matrix to the Building and Grounds Committee for consensus and final approval upon completion of review.

Design

Schematic Design

The consultant design team should:

- Consider sustainable concepts for the new project; include discussions with the Project Team on how each concept will contribute to the project's sustainable goals as identified in the Green Workshop and documented on the Sustainability Matrix.
- Investigate, for building projects, alternative HVAC designs and analyze based on considerations of energy conservation and life-cycle cost to determine the most efficient and economical system. Examples of HVAC systems to be considered include building ventilation systems, heat recovery systems, renewable technologies, and chiller/boiler systems (if not part of a central utility).

Design Development

The consultant design team should:

- Develop life-cycle cost analyses as needed when considering green strategies to understand the economic implications of that strategy.
- Hold a final sustainability workshop as part of the design review process to finalize the sustainable strategies incorporated into the design. Update the project's Sustainability Matrix to record outcomes and submit for review by the Office of the Director of Environmental Policy.

The University should:

- Submit the Sustainability Matrix to the Building and Grounds Committee for final approval upon completion of review.
- Continue to allow for a third party commissioning agent to review the completed Design Development drawings. This step will ensure that the systems proposed as part of the final commissioning effort meet the University's requirements for performance, functionality, cost, and environmental protection.

Construction Documentation

The consultant design team should:

- Work within the existing process for design review to periodically update the University on the team's progress towards implementing the sustainable strategies into the final design.
- Submit an updated Sustainability Matrix at the pre-established review milestones for review by the Office of the Director of Environmental Policy.
- Develop specifications for environmentally sensitive procedures, project commissioning, and other aspects related to the project's sustainable goals.

The University should:

- Submit the report from the commissioning agent's review of the Design Development drawings to the consultant design team to incorporate these review comments into the Construction Documents.

Construction

Bidding and Contract Negotiations

The University should:

- Request that contractors submit documentation of experience with sustainable construction practices and projects in developing the contractor's qualification requirements.
- Consider the contractor's sustainable construction practices for pre-qualification.
- Provide the selected contractor with a copy of the Campus Sustainable Design Guidelines.

Construction

The consultant design team should:

- Work with the contractor to discuss the project's sustainable strategies identified in the project Construction Documents so that the construction team understands the project goals.
- Verify that the necessary considerations for implementing specific sustainable strategies are being discussed at the appropriate pre-construction meetings and that all material substitution requests are in alignment with the project goals.

- Require the contractor to submit a Construction Waste Management Plan and a Construction Indoor Air Quality Management Plan during the first months of construction, when applicable.
- Include discussions pertaining to the project's Construction Indoor Air Quality Management Plan at construction progress meetings as needed.
- Prepare the required documentation submittal (e.g., LEED™) and submit this documentation to the University and the appropriate reviewing agency (e.g., U.S. Green Building Council) where agreed upon.

The University should:

- Provide the third party commissioning agent with a selective review of the contractor submittals pertaining to the commissioned equipment to ensure that the systems being provided meet the project specifications and University requirements.

Occupancy

The University should:

- Ensure that commissioning of the sustainable systems is underway.
- Monitor the project performance to gather and document the lessons learned so that future projects may benefit from the experiences of the completed project.
- Work with the commissioning agent to develop and implement a training procedure. As part of the training effort, videotape operational training and maintenance procedures so that current and future maintenance staff will be familiar with the special maintenance requirements necessary to keep the project operating at full efficiency.

Appendix A - Resources

The US Green Building Council
www.USGBC.org

The U.S. Green Building Council (USGBC) is the nation's foremost coalition of leaders from across the building industry working to promote buildings that are environmentally responsible, profitable, and healthy places to live and work. The USGBC created and administers LEED™ . Their web site includes useful resources for learning more about LEED™ and sustainable design, including case studies, LEED™ credit interpretations, publications, newsletters, educational programs, and metrics on LEED™.

LEED™ version 2.1 for New Construction and Major Renovations
http://www.usgbc.org/LEED/publications.asp

LEED™ is a tool created by the U.S. Green Building Council to help promote and measure sustainable design. LEED™ is the most widely accepted system for certifying a building's sustainability, and since its introduction to the public in 2000, it has been widely used throughout the country. LEED™ version 2.1 provides technical clarifications and streamlines certification submittal requirements. LEED™ version 2.1 can be downloaded at the web link provided above.

LEED™ for Existing Buildings
http://www.usgbc.org/LEED/existing/leed_existing.asp

The earliest versions of LEED™ were only applicable to new construction or major renovation projects. LEED™ for Existing Buildings (LEED™-EB) was created to address the issues specific to operations and maintenance of existing buildings. LEED™-EB is a set of *performance standards* for the sustainable operation of existing buildings. It includes building operations and upgrades of systems and/or processes in existing buildings where these upgrades do not significantly change the interior or exterior surfaces of the building. The LEED™-EB rating system can be downloaded at the web link provided above.

***The Cost and Financial Benefits of Green Buildings. A Report to California's Sustainable Building Task Force*, October 2003**
http://www.usgbc.org/Docs/News/News477.pdf

This report was developed to examine the financial implications of California's Executive Order D-16-00, which established the requirement that all public state buildings be designed to meet LEED™ standards. By identifying the first cost premiums and operational cost savings associated with incorporating LEED™ strategies within a design, the report has been called "the most definitive cost benefit analysis of green building ever conducted."

Stanford University's *The Guidelines for Sustainable Buildings*, March 2002
http://cpm.stanford.edu/process_new/Sustainable_Guidelines.pdf

The Stanford Guidelines for Sustainable Buildings includes a description of the importance of sustainability and outlines a process for incorporating sustainable design strategies into the project delivery process at the University. The guidelines also include technical strategies that are compatible with the aesthetics, culture, and climate of the Stanford campus.

***The Minnesota Sustainable Design Guide,* March 2002**
http://www.sustainabledesignguide.umn.edu/default.htm

Building on LEED™, as well as other international environmental assessment tools, the Minnesota Sustainable Design Guide is a tool that illustrates how sustainable design is integrated into the building design and operation processes for facilities within the state of Minnesota. It exceeds LEED™'s scope in that it not only addresses technical strategies, but also sustainable activities during the life-cycle phases of a building.

***WRITING THE GREEN RFP: Sustainable Design Language for Consultant Requests*, the American Institute of Architects**
http://www.aia.org/pia/cote/rfp/

This tool, created by the American Institute of Architect's Committee on the Environment, assists clients in writing requests for proposals or qualifications from consultants, as well as development, construction, and construction management services. This document touches on the basic elements of an RFP for design services for a sustainable project, as well as some of the issues to be considered.

***Charrette Guide for High Performance Projects*, the Department of Energy's Office of Energy Efficiency and Renewable Energy, September 2003**
http://www.eere.energy.gov/buildings/highperformance/charrette_handbook.html.

The U.S. Department of Energy created this handbook to provide guidance for planning and conducting a "high-performance building" charrette, which is similar to what these guidelines call a "Green Workshop." The handbook defines the purpose, recommended attendees, and content of this workshop. It also contains samples of agendas, invitation letters, and other commonly used workshop materials.

***Building for Environmental and Economic Sustainability (BEES) 3.0*, the National Institute of Standards and Technology**
http://www.bfrl.nist.gov/oae/software/bees.html

The National Institute of Standards and Technology developed this software, which can be downloaded at the web link listed above, to help designers select cost-effective, environmentally preferable building products. BEES measures the environmental performance of building products by using the life-cycle assessment approach. All stages in the life of a product are analyzed including raw material acquisition, manufacture, transportation, installation, use, recycling, and waste management.

Appendix B - Sample Sustainability Matrix

LEED Credit	Action	Goals	Intent	Criteria and Metrics - Standards	Implementation Strategies	Challenge to Implementation	Response to Challenge	Action Required	Documentation Required	Prime Team Member(s)	LEED Points Proposed	LEED Points Possible	LEED Points Available
ACTION: 1=Highly recommended, 2=Recommended, 3=Study Required, 4=Not Recommended/Not Applicable						INITIAL COST FACTOR: 0=no change, $=up to $10,000 $$=$10,001-50,000 $$$=over $50,000 ($)=Cost Savings							
Sustainable Sites													
SS Pre 1	1	Erosion and Sediment Control	Reduce and control erosion and stormwater runoff, and the negative effect that has on water and air quality	Design an erosion control plan that conforms to best management practices in the EPA's Storm Water Management for Construction Activities, EPA Document No. EPA-833-R-92-001									Required
SS 1	1	Site Selection	Avoid development of inappropriate sites and reduce the environmental impact from the location of the building on a site	Not agricultural land as defined by the Farmland Trust. Land not a habitat for endangered species. Land was not previously a public park.									1
SS 4.1	3	Alternate Transportation - Proximity to Public Transportation	Reduce pollution and land development impacts from automobile use.	Locate building within 1/2 miles of a commuter rail, light rail or subway station or 1/4 mile of 2 or more bus lines.									1
SS 4.2	1	Alternate Transportation - Encourage Commuting by Bicycle	Reduce pollution and land development impacts from automobile use.	Provide a suitable means for securing bicycles, with convenient changing/shower facilities for use by cyclists, for 5% or more of building occupants.									1
SS 4.3	4	Alternate Transportation - Encourage non-petrol vehicles	Reduce pollution and land development impacts from automobile use.	Provide alternative-fuel refueling station(s) for 3% of the total vehicle parking capacity of the site. Liquid or gaseous fueling facilities must be separately ventilated or located outdoors.									1
SS 4.4	1/3	Alternate Transportation - Reduce Parking	Reduce pollution and land development impacts from automobile use.	Limit number of parking spaces not to exceed local zoning AND provide preferred parking for carpools or vanpools capable of serving 5% of the building occupants, OR, add no new parking for rehabilitation projects AND provide preferred parking for carpools or van pools capable of serving 5% of the building occupants.									1
SS 5.1	1	Reduced Site Disturbance	Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.	Set limits of disturbance to 40' beyond building perimeter, 5' beyond roadways/walkways, and 25' beyond parking areas.									1
SS 5.2	1/3	Reduced Site Disturbance	Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.	Reduce the footprint of the building, roadways, and parking to exceed the local zoning's open space requirement for the site by 25%.									1

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